The People's Republic of Bangladesh
Ministry of Planning

DATA COLLECTION SURVEY FOR DISASTER RISK REDUCTION AND PREVENTION IN BANGLADESH

FINAL REPORT

VOLUME 1

October 2022

JAPAN INTERNATIONAL COOPERATION AGENCY

CTI ENGINEERING INTERNATIONAL CO., LTD.
ORIENTAL CONSULTANTS GLOBAL CO., LTD.
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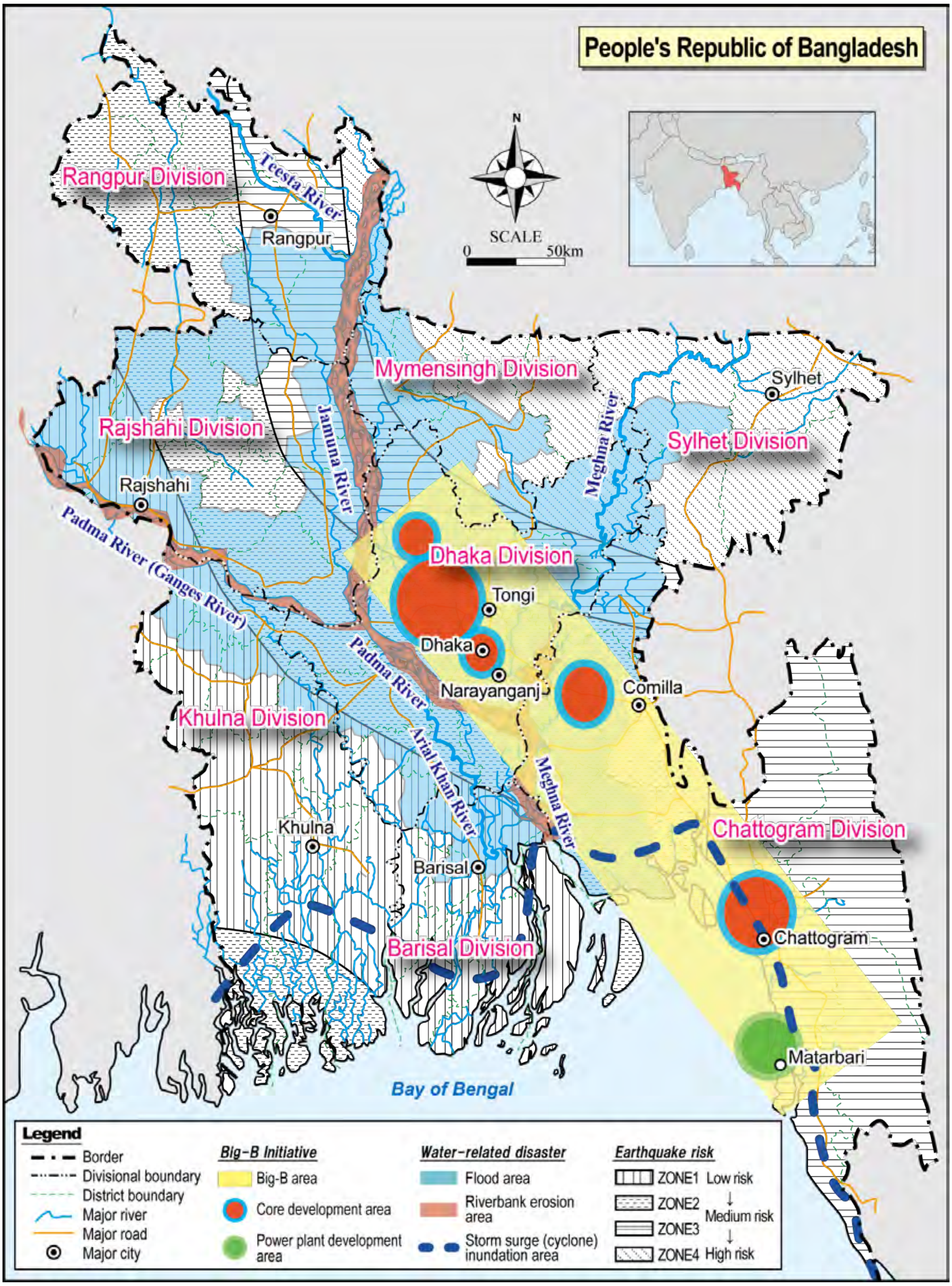

Source

Big-B Initiative	: JICA Website
Water-related Disaster	: National Water Resources Database, WARPO
Earthquake Risk	: Bangladesh National Building Code 2015, HBRI

PROJECT LOCATION MAP

DATA COLLECTION SURVEY FOR DISASTER RISK REDUCTION AND PREVENTION IN BANGLADESH

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ABBREVIATIONS AND ACRONYMS

a2i	Access to Information
ADB	Asian Development Bank
ADPC	Asia Disaster Preparedness Center
ADRC	Asia Disaster Reduction Center
AFD	Armed Forces Division
AI	Artificial Intelligence
APMCDRR	Asia-Pacific Ministerial Conference on Disaster Risk Reduction
ANR	Agriculture and National Resources Sector
APRSAF	Asia-Pacific Regional Space Agency Forum
AR	Assessment Report
ARPDRR	Asian Regional Plan for Disaster Risk Reduction
AusAID	Australian Agency for International Development
AWS	Automatic Weather Station
BAMIS	Bangladesh Agro-Meteorological Information System
BBRA	Bangladesh Building Regulatory Authority
BBS	Bangladesh Bureau of Statistics
BCA	Building Construction Act
BCC	Bangladesh Computer Council
BCCRF	Bangladesh Climate Change Resilience Fund
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BCCT	Bangladesh Climate Change Trust
BCCTF	Bangladesh Climate Change Trust Fund
BCCU	Bangladesh Climate Change Unit
BCG	Bangladesh Coastal Guard
BCP	Business Continuity Plan
BCR	Building Construction Rule
BDP2100	Bangladesh Delta Plan 2100
BDRCS	Bangladesh Red Crescent Society
BDT	Bangladesh Taka
BEZA	Bangladesh Economic Zones Authority
BIG-B	The Bay of Bengal Industrial Growth Belt
BIWTA	Bangladesh Inland Water Transport Authority
BMD	Bangladesh Meteorological Department
BNBC	Bangladesh National Building Code
BNHD	Bangladesh Navy Hydrographic Department
BPATC	Bangladesh Public Administration Training Centre
BR	Bangladesh Railway
BSPP	Building Safety Promotion Project for Disaster Risk Reduction
BTCL	Bangladesh Telecommunication Company Limited
BUERP	Bangladesh Urban Earthquake Resilience Project
BUET	Bangladesh University of Engineering and Technology
BWCSRP	Bangladesh Weather and Climate Services Regional Project
BWDB	Bangladesh Water Development Board
C2RP	Community Recovery and Resilience Project
CA	Conservation Agriculture
CAT-DDO	Catastrophe Deferred Drawdown Option
CC	Climate Change
CCA	Climate Change Adaptation
CCC	Climate Change Cell

CCC	Chattogram City Corporation
CCDMC	City Corporation Disaster Management Committee
CCDMP	City Corporation Disaster Management Plan
CCDRCG	City Corporation Disaster Response Coordination Group
CCGAP	Climate Change and Gender Action Plan
CCKN	Climate Change Knowledge Network
CCTF	Climate Change Trust Fund
CDA	Chattogram Development Authority
CDM	Clean Development Mechanism
CDMP	Comprehensive Disaster Management Programme
CDS	Coastal Development Strategy
CDSP	Char Development and Settlement Project
CEBR	Centre for Economics and Business Research
CEGIS	Centre for Environmental and Geographic Information Services
CEIP	Coastal Embankment Improvement Project
CEPZ	Chittagong Export Processing Zone
CERC	Contingency Emergency Response Component
CFAB	Climate Forecast Applications in Bangladesh
CFF	Climate Fiscal Framework
CHT	Chattogram Hill Tracts
CHTDB	Chattogram Hill Tracts Development Board
CIF	Climate Investment Funds
CIP-EFCC	Country Investment Plan for Environment Forestry and Climate Change
CMCS	Construction of Multipurpose Cyclone Shelters
CMFS	Construction of Multipurpose Flood Shelters
CMIP5	Coupled Model Intercomparing Project, Phase 5
CNCRP	Project for Capacity Development on Natural Disaster-Resistant Techniques of Construction and Retrofitting for Public Buildings
COP	Conference of the Parties
CORDEX	Coordinated Regional Climate Downscaling Experiment
CORS	Continuously Operating Reference Stations
C/P	Counter Part
CPEIR	Climate Public Expenditure and Institutional Review
CPF	Community Policing Forum
CPP	Cyclone Preparedness Programme
CPPPC	Cyclone Preparedness Programme Policy Committee
CPPIB	Cyclone Preparedness Programme Implementation Board
CPTU	Central Procurement Technical Unit
CRA	Community Risk Assessment
CRED	Centre for Research on the Epidemiology of Disasters
CRI	Climate Risk Index
CSO	Civil Society Organization
CSR	Corporate Social Responsibility
CVF	Climate Vulnerable Forum
CWASA	Chattogram Water Supply and Sewerage Authority
CZPO	Coastal Zone Policy
d4PDF	database for Policy Decision making for Future climate change
DAC	Development Assistance Committee
DAE	Department of Agricultural Extension
DANIDA	Danish International Development Agency

DDM	Department of Disaster Management
DDMC	District Disaster Management Committee
DDMP	District Disaster Management Plan
DDRCG	District Disaster Response Coordination Group
DEM	Digital Elevation Model
DEPC	Department of Environmental Pollution Control
DFID	Department for International Development
DGHS	Directorate General of Health Services
DIA	Disaster Impact Assessment
DIDB	Disaster Incident Database
DiDRM	Disability inclusive Disaster Risk Management:
DiMAPS	Integrated Disaster Information Mapping System
DLS	Department of Livestock Services
DMA	Disaster Management Act
DMB	Disaster Management Bureau
DMC	Disaster Management Committee
DMIC	Disaster Management Information Center
DMIN	Disaster Management Information Network
DMRD	Disaster Management & Relief Division
DMTCL	Dhaka Mass Transportation Company Limited
DNCC	Dhaka North City Corporation
DND	Dhaka-Narayangonj-Demra
DoA	Department of Architecture
DoE	Department of Environment
DoF	Department of Fisheries
DoF	Department of Forest
DPHE	Department of Public Health Engineering
DPL	Development Policy Loan
DPP	Development Project Proposal
DRIP	Digital Risk Information Platform
DRM	Disaster Risk Management
DRMEP	Disaster Risk Management Enhancement Project
DRMIS	Disaster Risk Management Information System
DRR	Disaster Risk Reduction
DRR	Directorate of Relief and Rehabilitation
DRRF	Disaster Response and Recovery Facility
DRRO	District Relief and Rehabilitation Officer
DSA	Digital Security Agency
DSCC	Dhaka South City Corporation
DV	Domestic Violence
DWA	Department of Women Affairs
DWASA	Dhaka Water Supply and Sewerage Authority
DX	Digital Transformation
E/N	Exchange of Notes
EBBIP	Eastern Bangladesh Bridge Improvement Project
ECA	Ecologically Critical Area
ECPS	Electronic Construction Permitting System
ECR	Environmental Conservation Rules
ECRRP	Emergency 2007 Cyclone Recovery and Restoration Project
EED	Education Engineering Department

EFCC	Environment, Forestry and Climate Change
EGPP	Employment Generation Programme for the Poorest
EIA	Environmental Impact Assessment
e-Learning	Electronic Learning
EM-DAT	Emergency Events Database (International Disaster Database)
ENSO	El Niño-Southern Oscillation
EOC	Emergency Operation Center
EPABD	Earthquake Preparedness and Awareness Building Committee
ERD	Economic Relations Division
ERF	Early Recovery Facility
EU	European Union
EZ	Economic Zone
F/S	Feasibility Study
FAO	Food and Agriculture Organization
FAP	Flood Action Plan
FCDO	Foreign, Commonwealth and Development Office
FD	Finance Division
FD	Forest Department
FEMA	Federal Emergency Management Agency
FFS	Farmer Field Schools
FFWC	Flood Forecasting and Warning Centre
FPCO	Flood Plan Coordination Organization
FPN	Feature Pyramid Network
FPP	Flood Preparedness Programme
FRERMIP	Flood and Riverbank Erosion Risk Management Investment Program
FSCD	Fire Service & Civil Defense
FY	Fiscal Year
FYP	Five Year Plan
GBV	Gender Based Violence
GC	Governing Council
GCF	Green Climate Fund
GDP	Gross Domestic Product
GED	General Economic Division
GEF	Global Environment Facility
GeoDASH	Geospatial data collection and sharing platform
GFDRR	Global Facility for Disaster Reduction and Recovery
GHGs	Green House Gases
GIDM	Gujarat Institute of Disaster Management
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft fur Internationale Zusammenarbeit
GNSS	Global Navigation Satellite System
GoB	Government of Bangladesh
GPS	Global Positioning System
GRDP	Gross Regional Domestic Product
GSB	Geological Survey of Bangladesh
GSMaP	Global Satellite Mapping of Precipitation
HAZUS	Hazards U.S.
HBB	Herring Bone Bond
HED	Health Engineering Department
HFA	Hyogo Framework for Action

HIC	High-Income Country
HILIP	Haor Infrastructure and Livelihood Improvement Project
IBFCR	Inclusive Budgeting and Financing for Climate Resilience
ICDDR,B	International Centre for Diarrhoeal Disease Research, Bangladesh
ICT	Information and Communication Technology
ICZM	Integrated Coastal Zone Management
IDA	International Development Association
IDNDR	International Decade for Natural Disaster Reduction
IFAD	International Fund for Agricultural Development
IFRC	International Federation of Red Cross and Red Crescent Societies
IMDMCC	Inter-Ministerial Disaster Management Coordination Committee
IOD	Indian Ocean Dipole
IPM	Integrated Pest Management
IPNS	Integrated Plant Nutrition System
IPCC	Intergovernmental Panel on Climate Change
IPSWAM	Integrated Planning for Sustainable Water Management
IRM	Immediate Response Mechanism
IT	Information Technology
IWFM	Institute of Water and Flood Management
IWM	Institute of Water Modeling
IWRM	Integrated Water Resources Management
JBP	Japan Bosai Platform
JCIAD	Japanese Commerce and Industry Association in Dhaka
JETRO	Japan External Trade Organization
JICA	Japan International Cooperation Agency
JIPAD	Japan International Public-private Association for Disaster risk reduction
JST	Japan Science and Technology Agency
KWASA	Khulna Water Supply and Sewerage Authority
LDC	Least Developed Country
LDRRMF	Local Disaster Risk Reduction and Management Framework
LGD	Local Government Division
LGED	Local Government Engineering Department
M&E	Monitoring and Evaluation
MCE	Maximum Considered Earthquake
MDGs	Millennium Development Goals
MDTF	Multi Donor Trust Fund
MDSP	Multipurpose Disaster Shelter Project
MEA	Multilateral Environmental Agreement
MIDI	Maheskhali-Matarbari Integrated Infrastructure Development Initiative
MIROC	Model for Interdisciplinary Research on Climate
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MoA	Ministry of Agriculture
MoDMR	Ministry of Disaster Management and Relief
MoEFCC	Ministry of Environment, Forest and Climate Change
MoF	Ministry of Finance
MoFL	Ministry of Fisheries and Livestock
MoFOOD	Ministry of Food
MoH&FW	Ministry of Health and Family Welfare
MoHPW	Ministry of Housing and Public Works
MoI	Ministry of Industries

MoL	Ministry of Land
MoLGRDC	Ministry of Local Government, Rural Development and Cooperatives
MoPTIT	Ministry of Posts, Telecommunications and Information Technology
MoP	Ministry of Planning
MoPEMR	Ministry of Power, Energy and Mineral Resources
MoSW	Ministry of Social Welfare
MoWCA	Ministry of Women and Children Affairs
MoWR	Ministry of Water Resources
M/P	Master Plan
MRVAM	Multi-Hazard Risk and Vulnerability Assessment, Modeling and Mapping
MTBF	Medium-Term Budget Framework
NADC	Norwegian Agency for Development Cooperation
NAP	National Adaptation Plan
NAPA	National Adaptation Programme of Action
NBS	Nature-Based Solutions
NCLBP	National Council for Licensing of Building Professionals
NDC	National Data Center
NDMAC	National Disaster Management Advisory Committee
NDMC	National Disaster Management Council
NDMP	National Disaster Management Policy
NDRCC	National Disaster Response Coordination Centre
NDRCG	National Disaster Response Coordination Group
NDRRMF	National Disaster Risk Reduction and Management Framework
NDWI	Normalized Difference Water Index
NEMAP	National Environment Management Action Plan
NETIS	New Technology Information System
NGO	Non-governmental Organizations
NHA	National Housing Authority
NIED	National Research Institute for Earth Science and Disaster Resilience
NORAD	Norwegian Agency for Development Cooperation
NPDM	National Plan for Disaster Management
NPDRR	National Platform for Disaster Risk Reduction
NRP	National Resilience Programme
NSDI	National Spatial Data Infrastructure
NWMP	National Water Management Plan
NWP	National Water Policy
NWRC	National Water Resources Council
O&M	Operation and Maintenance
OCAG	Office of the Comptroller and Auditor General
ODA	Official Development Assistance
OECD	Organization for Economic Cooperation and Development
OFDA	Office of US Foreign Disaster Assistance
PCU	Project Coordination Unit
PCMU	Project Coordination and Monitoring Unit
PDB	Power Development Board
PDMC	Pourashava Disaster Management Committee
PDMP	Pourashava Disaster Management Plan
PDNA	Post Disaster Damage and Needs Assessment
PEC	Project Evaluation Committee

PESAROEAOD	Procurement of Equipment for Search & Rescue Operation for Earthquake & Other Disaster
PFM	Public Financial Management
PGA	Peak Ground Acceleration
PIO	Project Implementation Officer
PKSF	Palli Karma-Sahayak Foundation
PMO	Prime Minister's Office
PMU	Project Management Unit
PNT	Positioning, Navigation and Timing
PP2041	Perspective Plan of Bangladesh 2021-2041
PPR	Public Procurement Rules
PRS	Poverty Reduction Strategies
PRSP	Poverty Reduction Strategy Paper
PSC	Project Steering Committee
PSMP	Power Sector Master Plan
PWD	Public Works Department
PWD	Public Works Datum
QPE	Quantitative Precipitation Estimation
R&D	Research and Development
RAC	Regional Accounting Center
RAJUK	Rajdhani Unnayan Kartripakkha (Capital Development Authority)
RAMS	Road Asset Management System
RCP	Representative Concentration Pathways
RDEC	Rural Development Engineering Center
RERMP	Rural Employment & Road Maintenance Programme
RHD	Roads and Highways Department
RIMES	Regional Integrated Multi-Hazard Early Warning System
RRI	Rainfall Runoff Inundation
SAARC	South Asian Association for Regional Cooperation
SADDD	Sex, Age and Disability Disaggregated Data
SAIWRPMP	South-West Area Integrated Water Resources Planning and Management Project
SATREPS	Science and Technology Research Partnership for Sustainable Development
SDC	Swiss Agency for Development and Cooperation
SDGs	Sustainable Development Goals
SDMC	SAARC Disaster Management Center
SFA	SAARC Framework for Action
SFDRR	Sendai Framework for Disaster Risk Reduction 2015-2030
SID	Statistics & Informatics Division
SIDA	Swedish International Development Cooperation Agency
SOB	Survey of Bangladesh
SOD	Standing Orders on Disaster
SOP	Standard Operating Procedure
SPARRSO	Space Research and Remote Sensing Organization
SRTM	Shuttle Radar Topography Mission
SWC	Storm Warning Center
TK	Taka
TR	Test Relief
TRM	Tidal River Management

TSUIB	Project for Technical development to upgrade structural integrity of buildings in densely populated urban areas and its strategic implementation towards resilient cities
UBSP	Urban Building Safety Project
UCV	Urban Community Volunteers
UDCC	Union Disaster Coordination Committee
UDMC	Union Disaster Management Committee
UDMP	Union Disaster Management Plan
UDRCG	Union Disaster Response Coordination Group
UMIC	Upper Middle - Income Country
UN Women	United Nations Entity for Gender Equality and the Empowerment of Women
UNCDF	United Nations Capital Development Fund
UNDAC	United Nations Disaster Assessment and Coordination
UNDP	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations International Children's Emergency Fund
UNISDR	United Nations International Strategy for Disaster Reduction
UNO	Upazila Nirbahi Officer
UNOCHA	United Nations Office for Coordination of Humanitarian Affairs
UNOPS	United Nations Office for Project Services
UNOSAT	United Nations Satellite Center
URP	Urban Resilience Project
USAID	U.S. Agency for International Development
USD	US Dollar
USGS	US Geological Survey
UzDMC	Upazila Disaster Management Committee
V20	Vulnerable Twenty Group
VGF	Vulnerable Group Feeding
WARPO	Water Resources Planning Organization
WASA	Water Supply and Sewerage Authority
WB	World Bank
WCRP	World Climate Research Programme
WDMC	Ward Disaster Management Committee
WHO	World Health Organization
WMA	Water Management Association
WMCA	Water Management Cooperative Association
WMG	Water Management Group
WMIP	Water Management Improvement Project
WMO	World Meteorological Organization
WMOs	Water Management Organizations

CHAPTER 1 OUTLINE OF THE SURVEY

1.1 Background of the Survey

The People's Republic of Bangladesh (hereinafter referred to as "Bangladesh") is located in the world's largest delta formed by three international rivers, the Padma (Ganges), the Jamuna (Brahmaputra) and the Meghna. Lowland areas make up more than two-thirds of the country with an elevation of less than seven meters above sea level. During the rainy season, widespread flooding and inundation are caused on a regular basis by rainfall in the Himalayas, upper reaches of the rivers and in Bangladesh. On the other hand, at the beginning and end of the dry season, inundation caused by cyclones occurs mainly in coastal areas.

In addition, Bangladesh is one of the most vulnerable countries in the world to natural disasters because of the country's soft geological structure and seismic risk due to its location at the periphery of the seismically active Himalayan orogenic belt. Furthermore, the recent surge of cyclones as well as climate change-related damage of land and property due to sea level rise and flooding have resulted in economic losses for various sectors. According to data from the Bangladesh Delta Plan 2100, at the macro level, GDP has been depressed by 1.3 to 2.0% per year and the number of poor people has increased due to the increase in natural disasters.

On the other hand, Bangladesh has achieved stable economic growth of about 6.0% per year on average since 2000, with an accelerating population inflow, especially to major cities such as Dhaka, the capital, and Chattogram, the second largest city, as well as to other regional core cities.

As of 2016, according to World Bank report in 2018, about 35% of the total population (about 57 million people) resided in urban areas, with an annual urban population growth rate of 3.1%, much higher than the national average (1.1%). With the expansion of urban areas in line with economic growth, there is a growing need to strengthen disaster management systems, especially for social infrastructure in urban areas.

According to the Country Development Cooperation Policy for the People's Republic of Bangladesh released in February 2018, Japan has set "accelerating sustainable and equitable economic growth and lifting the country out of poverty toward becoming a middle-income country" as a major goal of its basic policy for ODA to Bangladesh. In order to "overcome social vulnerability," which is one of the priority areas as a medium-term goal, Japan will provide assistance related to disaster risk reduction and climate change adaptation, focusing on disaster forecasting and warning, earthquake countermeasures and river management. In addition, JICA has been shifting the focus of its DRR cooperation in recent years to the realization of pre-disaster investment that effectively and steadily reduces disaster risks to promote the Sendai Framework for Disaster Reduction adopted at the Third United Nations World Conference on Disaster Reduction in 2015.

The Government of Bangladesh has been advocating for the improvement of disaster risk management systems for many years. Through the implementation of early warning systems and other measures, the government has been able to significantly lower the number of fatalities and injuries brought on by natural disasters. The number of deaths due to cyclones in the country has been reduced from about 300,000 in 1970 to 7 in 2017, which is a remarkable achievement[1]. On the other hand, the damage to settlements and crops caused by natural disasters, especially by flooding and riverbank erosion, remain significant challenges. Furthermore, there is growing concern about increasing disaster risk due to climate change, land use change, and the concentration and expansion of population and assets in cities.

To cope with the increase of disaster risk, the Government of Bangladesh has begun new initiatives for disaster risk management. In October 2018, the "Bangladesh Delta Plan 2100 (BDP2100)" has been formulated as a long-term action plan for water management in order to respond to climate change risks and improve environmental management. Its strategy is to promote the strengthening and upgrading of disaster risk management efforts such as measures against storm surges, river floods and urban floods.

[1] EM-DAT (https://www.emdat.be/)

In this context, it has become necessary to re-examine JICA's cooperation policy in the field of DRR considering the continuous increase of disaster risks associated with the expansion of economic activities and the impact of climate change, as well as the movement of the Bangladesh government to formulate a new DRR policy. In particular, it is important to effectively reduce disaster risks and to focus on disaster prevention measures in major urban areas, economic hubs and critical infrastructure in each region from the perspective of minimizing economic damage and supporting national development, while taking into account the synergistic effects of past cooperation.

1.2 Objectives of the Survey

1.2.1 Objectives and Activities of the Survey

The objectives of this survey are as follows:

i. Identification of the status of the DRR sector and selection of priority cooperation fields and areas;
ii. Preparation of short-term project concepts for the next three years; and
iii. Proposition of long-term cooperation policies for DRR sector for the next ten years.

Based on the approach and methodology detailed in Chapter 2, the following activities are considered and carried out.

<u>Organizing and Analyzing Current Situation of the DRR Sector:</u>

The impact of climate change, changes in land use due to economic growth, infrastructure development trends, cooperation by JICA and other donors, disaster risk reduction policies in Bangladesh including BDP2100, and current efforts were reviewed.

<u>Conducting Scientific and Economic Disaster Risk Analysis:</u>

In addition to the results of the current situation analysis, disaster risk analysis was conducted for each target disaster type, taking into account the spatial distribution of population, GDP, critical infrastructure and economic zones. Based on the results of disaster risk analysis, JICA's priority fields and areas for cooperation in DRR sector were identified. In selecting the priority cooperation area, consideration was given to the key areas of the Bay of Bengal Industrial Growth Belt (BIG-B) initiative presented by the leaders of Japan and Bangladesh in 2014, the relevance of existing projects, and the possibility of cooperation and role sharing with other donors.

<u>Support for JICA’s Cooperation Policy Review:</u>

Based on the results of the above-mentioned assessment of the current situation and disaster risk analysis, as well as the results of interviews and hearings with relevant agencies, the information necessary for the formulation of a long-term cooperation policy for the disaster risk reduction sector was collected and the issues were summarized. In addition, based on the consistency with the future investment plans of the Government of Bangladesh for disaster risk reduction, centering on BDP 2100 and the Eighth Five-Year Plan, as well as the status of efforts by other donors, the concept of new projects for yen loans, technical cooperation, and grant aid was studied as short-term cooperation projects to be implemented over the next three to four years.

1.2.2 Target Disaster Types

As detailed in Chapter 3, among various natural disasters, the number of victims, damages, deaths, and outbreaks due to floods, storm surges / storms are extremely large in Bangladesh. In addition, although no major earthquake disasters have occurred in recent years, once it occurs, it is expected to cause extensive damage. Furthermore, although it has been difficult to survey and confirm the damage caused by riverbank erosion with clear figures to date, it is considered to be an area that requires continuous measures in the future, since river channel stabilization has been identified as one of the priority issues in national-level plans such as BDP 2100 and the Eighth Five-Year Plan.

The disaster types targeted in this survey are as follows, based on the disaster occurrence situation in Bangladesh.

Disaster Types: Floods (Major River Flood and Flash Flood), Riverbank Erosion, Urban Flood, Storm Surge, Earthquake (excluding Tsunami)

Regarding floods, the mechanism of occurrence differs between river floods and inland floods in urban areas, so the study will be divided into two. Flood caused by storm surge are categorized as storm surge.

Major river flood is a phenomenon caused by overflows from embankments in major rivers in Bangladesh. River floods from major rivers generally rise and fall slowly over a period of 10 to 20 days or more. Of the total flow, around 80% occurs in the 5 months of monsoon from June to October. On the other hand, flash flood is caused by overflowing of hilly rivers in eastern and northern Bangladesh in April-May and September-November. Compared to major river flood, flash flood is characterized by a sharp rise followed by a relatively rapid recession, and can occur within a few hours.

In Bangladesh, in addition to the above five types of disasters, landslides, saltwater intrusion, droughts, tsunamis, lightning strikes, arsenic contamination, and epidemics are also recognized as disasters. However, the above five disaster types stand out in terms of the number of fatalities, amount of damage in the past, or potential threats. Japan's cooperation in disaster risk reduction to date has also centered on these five disaster types. In addition, the increase or decrease in the risk of damage from these five types of disasters is easily influenced by the social changes that are expected to occur in the future, such as climate change and economic growth. Therefore, in this survey, focus was placed on the above five disaster types[2].

In addition to the above five disaster types, "DRR governance", which is the comprehensive and cross-sectoral management of each disaster type, and "weather forecasting and warning", which is generally involved in reducing water-related disaster risks, were also included in this survey because they are areas of high impact in the disaster risk reduction sector in Bangladesh.

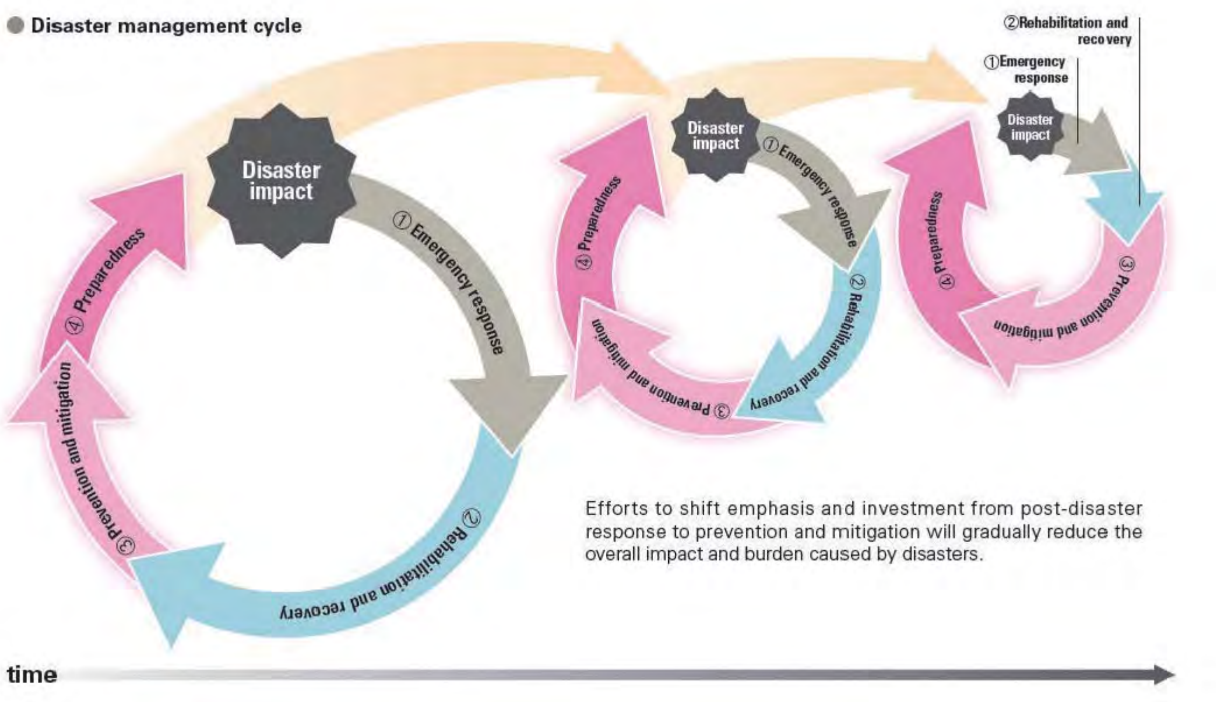
1.2.3 Target Disaster Management Phases

Disaster management measures are divided into (1) emergency response after a disaster, (2) rehabilitation and recovery, (3) prevention and mitigation, and (4) preparedness. By treating these stages as one cycle and repeating the cycle, it is possible to continuously reduce disaster risk.

Disaster Management Phases: Emergency response, Rehabilitation and recovery, Prevention and mitigation (pre-disaster investment), Preparedness

Since all four phases are important to achieve comprehensive disaster risk reduction and management, this survey focuses on these four phases. However, for sustainable economic development in developing countries, it is essential to reduce people and assets exposed to disaster risk (Exposure) in the pre-disaster stage. Therefore, the survey was conducted with a view to promoting pre-disaster investments that contribute to disaster risk reduction.

[2] However, if other disaster types have indirect or compounding impacts on these five disaster types, the project concepts should take these indirect impacts into account. For example, in estuarine areas, there is concern that the impact of saltwater intrusion may reduce channel capacity and impede drainage functions, resulting in more severe flood damage (source: Climate change-induced challenges to sustainable development in Bangladesh, M A Mojid, 2019). In that case, these factors need to be taken into account when planning flood risk management measures.



Source: JICA (https://www.jica.go.jp/activities/issues/special_edition/special02.html), partially changed by JICA Survey Team

Figure 1.2.1 Disaster Management Cycle

CHAPTER 2 SURVEY APPROACH AND METHODOLOGY

2.1 Survey Approach

2.1.1 Areas Covered by the Survey

The survey covers the entire country of Bangladesh.

2.1.2 Relevant Government Organizations and Stakeholders

The relevant ministries, organizations, and stakeholders with whom information was collected and opinions were exchanged in this survey are listed in Table 2.1.1. A seminar was held for the purpose of the final report for some of the following related ministries and the stakeholders.

Table 2.1.1 Relevant Government Organizations and Stakeholders Involved in the Survey

Category	Organization
Organizations for Project Plan Approval	General Economic Division (GED)
Organizations mainly related to water-related disaster risk reduction	Ministry of Water Resources (MoWR), Bangladesh Water Development Board (BWDB), Water Resources Planning Organization (WARPO), Local Government Engineering Department (LGED), Water Supply and Sewerage Authority (WASA), Bangladesh Meteorological Department (BMD)
Organizations mainly related to earthquake disaster risk reduction	Public Works Department (PWD), Roads and Highways Department (RHD), Geological Survey of Bangladesh (GSB), Local Government Engineering Department (LGED)
Organizations mainly related to DRR administration	Ministry of Disaster Management and Relief (MoDMR), Department of Disaster Management (DDM), District Relief and Rehabilitation Officer (DRRO)
Other governmental organizations	Ministry of Finance (MoF), Survey of Bangladesh (SOB), Bangladesh Space Research and Remote Sensing Organization (SPARRSO), Bangladesh Bureau of Statistics (BBS), Rajdhani Unnayan Kartripakkha (RAJUK), Bangladesh Economic Zones Authority (BEZA), Education Engineering Department (EED), Bangladesh Computer Council (BCC), Forest Department (FD)
Other non-governmental organizations	Bangladesh University of Engineering and Technology (BUET), NGOs
International development partners	World Bank (WB), Asian Development Bank (ADB), Embassy of the Netherlands, United Nations Development Programme (UNDP), Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ)
Japanese Stakeholders	Japan External Trade Organization (JETRO) Dhaka Office, Japanese Commerce and Industry Association in Dhaka （JCIAD), Japanese companies operating in Bangladesh

Source: JICA Survey Team

2.1.3 Basic Policies for Conducting the Survey

In conducting the survey, the following basic policies were applied.

2.1.3.1 Utilization of Existing Survey Results

The results of the hazard studies already conducted by the Government of Bangladesh and other development partners were utilized to efficiently proceed with the analysis in this survey. Specifically, hazard assessment results for flood, storm surge, and earthquake produced by the World Bank-supported Multi-Hazard Risk and Vulnerability Assessment, Modeling and Mapping (MRVAM) were used in this survey. In addition, the Institute of Water Modelling (IWM) has produced national-level inundation maps by occurrence probability. These two and other existing studies and assessments were utilized in this survey.

In addition, JICA is currently implementing the "Project for Strengthening Planning Capacity and Technology Adaptation Cycle for Comprehensive River Management" in Bangladesh. The analysis method based on satellite imagery used in the said project was also applied to this survey in order to efficiently analyze the disaster risk of riverbank erosion.

2.1.3.2 Identification of Issues in the Disaster Risk Reduction Sector through Multi-faceted Analysis

In addition to the analysis of each target disaster type presented in Chapter 1, in this survey, issues in the DRR sector were identified and their directions were examined based on the following perspectives.

- Consideration for gender and vulnerable groups;
- Promotion of Digital Transformation (DX);
- Utilization of Japanese technology and knowledge;
- Identification of lessons learned and good practices in Japan and other countries in Southeast Asia

The followings are the survey policies for each item.

(1) Consideration for Gender and Vulnerable Groups

Residents who are vulnerable to disasters vary in their situation and in their coping capacities according to gender, age, physical and mental conditions, economic capacity, behavioral patterns, and social roles. A negative cycle can also be observed in which the poor, left behind from the benefits of economic growth, are directly affected by disasters, making their lives more impoverished. In this study, the gaps in vulnerability and coping capacity by these attributes were analyzed based on actual data. In addition, the approaches needed to improve local vulnerability and coping capacity were analyzed and proposed, especially from the perspective of disaster communication and awareness-raising.

(2) Promotion of Digital Transformation (DX)

Bangladesh is promoting "Digital Bangladesh" as one of the country's core policies. This policy promotes the adoption of digital technology in management, operations, and administration in order to improve efficiency, transparency, and accountability in all sectors of society, including business. In addition to organizing the future direction for promoting DX in DRR in accordance with the said national policy, the knowledge and technologies that are expected to be particularly applicable are reflected in the proposed project concepts.

(3) Utilization of Japanese Technology and Knowledge

Through its long history of fighting against a wide variety of disasters, Japan has developed a variety of excellent technologies for DRR. This survey examines Japanese technologies that can be utilized in Bangladesh.

In recent years, Japan has been promoting public-private partnerships to contribute to the world through DRR technologies. The Japan Bosai Platform is an industry-government-academia collaborative platform, and it has a database which contains solutions by disaster type and by sector. In this survey, the database was used to search for solutions that could be applied in Bangladesh. In addition, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) has compiled a collection of advanced technologies in the water sector from Japanese companies. This information was also used as a reference.

(4) Identification of Lessons Learned and Good Practices in Japan and Other Countries in Southeast Asia

In this survey, after reviewing the history of disaster management and economic development in Japan to date, the direction of DRR policy that Bangladesh should focus on in order to continue its growth and become a middle- and high-income country was examined. In addition, national and local DRR policies and lessons learned in the Philippines, a country advanced in terms of prior DRR investment in Southeast Asia, were summarized.

2.1.3.3 Alignment with the Proposed Projects in BDP2100

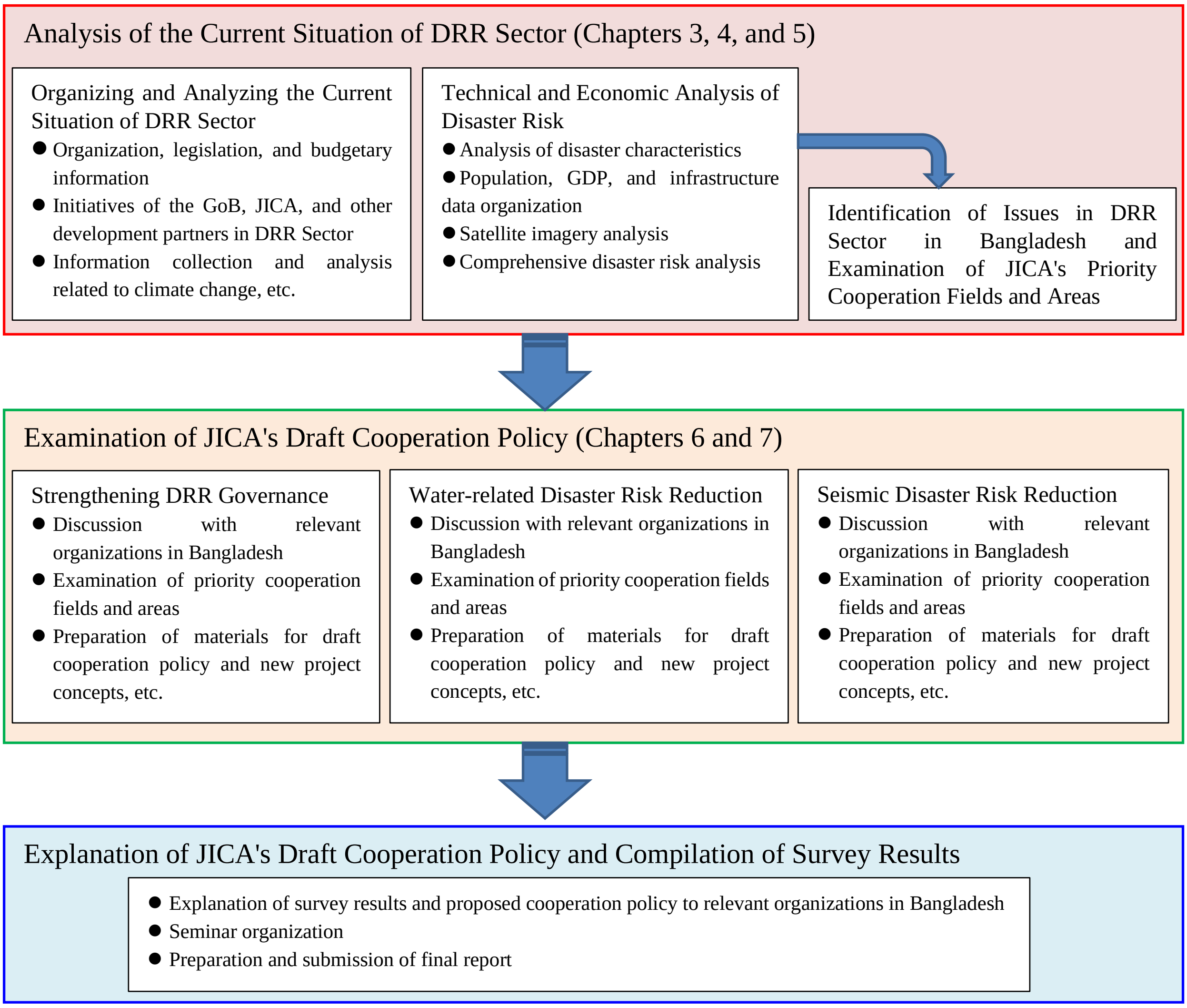
Future water-related disaster management in Bangladesh is expected to be implemented based on BDP 2100. As described in detail in Chapter 4, in BDP2100, the country's land is classified as hotspots in terms of similarity of issues related to water management. In this context, 80 projects were organized and proposed by hotspot as the first investment plan. In proposing project concepts in this survey, the adequacy is evaluated in terms of alignment with the direction of the projects proposed in BDP 2100.

2.1.3.4 Identification of Priority Areas for Economic Activities

In formulating the project concepts, it is important to promote disaster risk reduction measures in major urban areas, economic centers, and critical infrastructure in each region from the perspective of minimizing economic damage and supporting sustainable development in Bangladesh. Based on this recognition, disaster risk analysis was conducted after confirming the population, GDP distribution, and spatial layout of critical infrastructure. In addition, areas that could become economic hubs in the future were also identified through existing data and discussions with relevant organizations. The information was reflected in the proposal of priority projects.

2.1.4 Overall Survey Procedure

The overall survey was conducted in accordance with the flow shown in Figure 2.1.1 below.

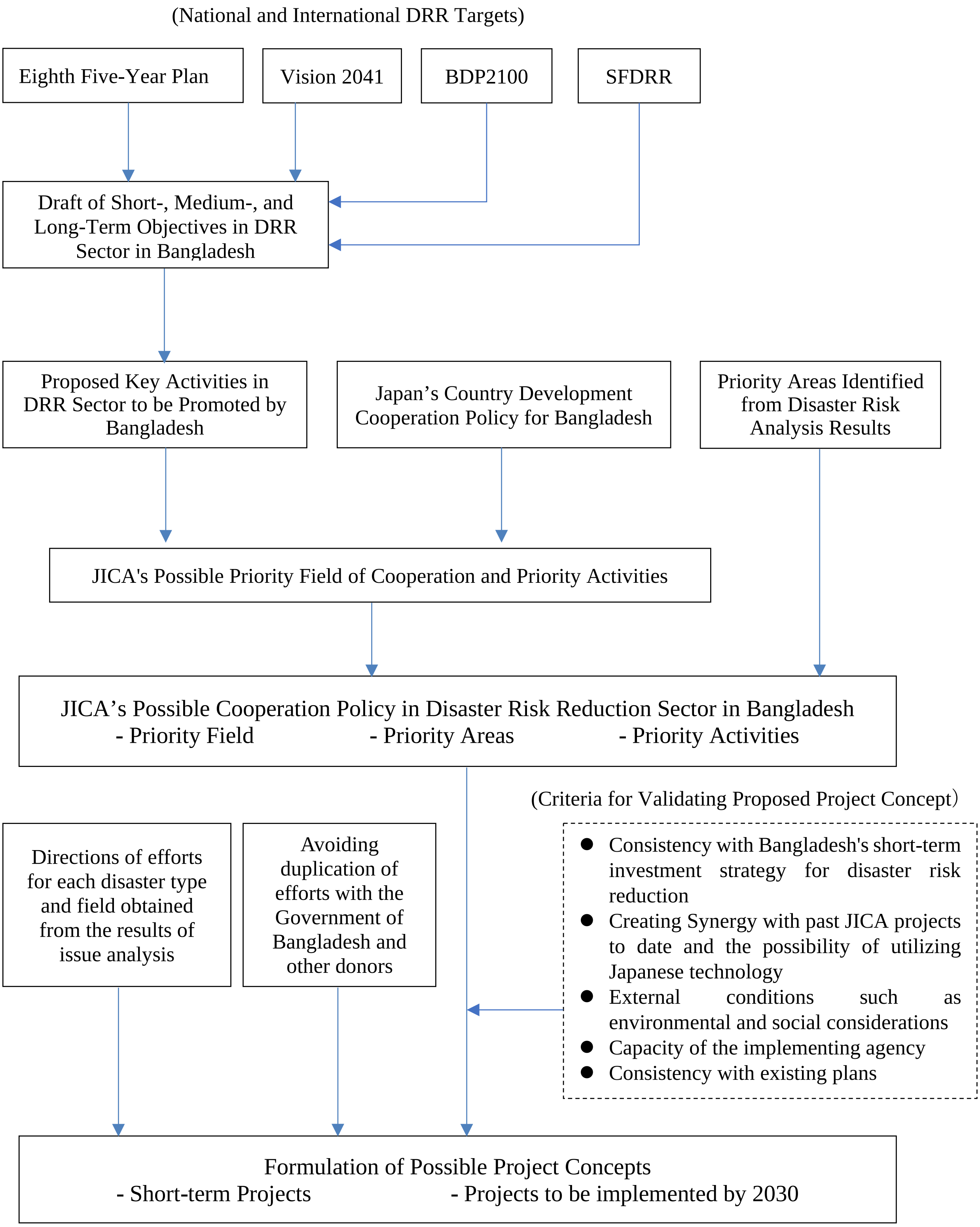


Source: JICA Survey Team

Figure 2.1.1 Overall Survey Procedure

2.1.5 Procedure for Preparing Draft DRR Cooperation Policy

In developing the draft cooperation policy, the flow shown in Figure 2.1.2 below was followed. The methods of each survey and review are described in Section 2.2 in detail.



Source: JICA Survey Team

Figure 2.1.2 Procedure for Preparing Draft DRR Cooperation Policy

2.2 Survey Methodology

Using the information obtained from interviews with relevant organizations, as well as the information accumulated by JICA through past cooperation and materials available on the website, the current status of DRR sector was summarized and disaster risks were analyzed. Based on the results of analysis, issues in DRR sector were identified and JICA's priority cooperation fields and areas were selected. Each item was studied using the methodology described below.

2.2.1 Organizing and Analyzing the Current Situation of DRR Sector

Information was collected, compiled, and analyzed for the items listed in Table 2.2.1 below. In conducting the compilation and analysis, the points to be noted in the same table were taken into consideration. In organizing and analyzing the current situation, information was collected mainly from existing documents and websites during the period when local activities were restricted due to pandemic situation by Covid-19. and then updated through field surveys and interviews with relevant organizations. Thereafter, field surveys were conducted and information analysis was updated through interviews with relevant organizations.

Table 2.2.1 Methodology for Organizing and Analyzing the Current Situation of DRR Sector

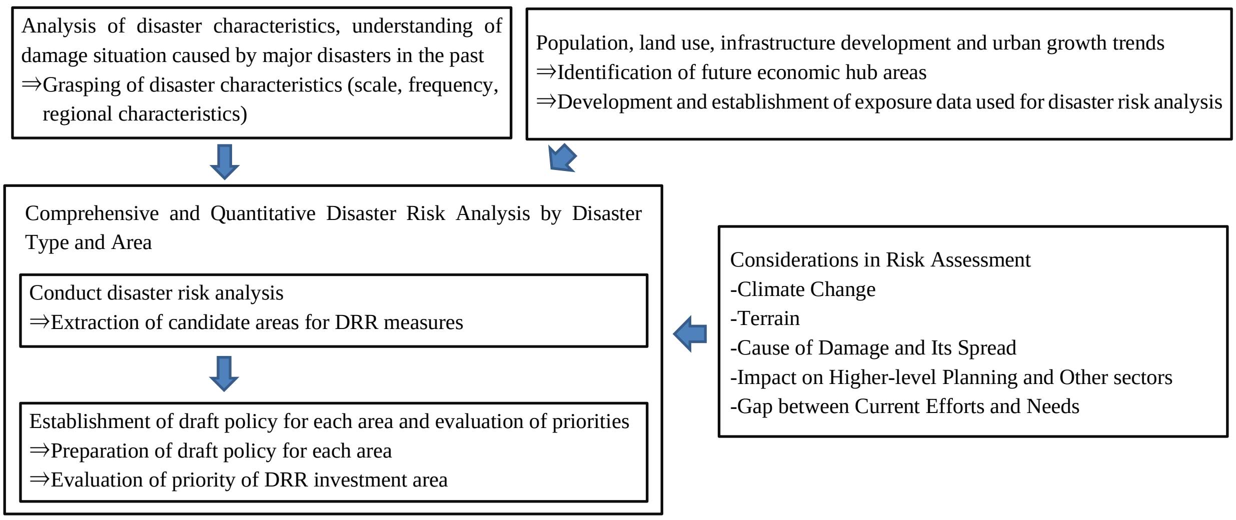
No.	Items	Survey Contents and Considerations in Organizing and Analyzing the Information
1	● Organization of DRR related laws, system, budget allocation and execution status ● Analysis on the economic impact of disaster ● Review of the contents of the Eighth five-years plan	● Information collection on legal systems related to water management, building management, and land development regulations ● Review of the Eighth five-year plan, the National Disaster Management Plan 2021-2025, and status of their implementation
2	● Confirmation of legal basis, duties under jurisdiction, personnel structure, budget, practical capacity, and other relevant information of ministries and organizations related to DRR	● Confirmation of the status of operations under the jurisdiction ● Analysis of problems and their causes
3	● Confirmation of the implementation status, results and future plans of DRR related projects by the Government of Bangladesh	● Analysis of the content, duration, cost, results and challenges of DRR-related projects to date by disaster type and phase ● Confirmation of project plans to be implemented in the future ● Confirmation of the status of achievement of the targets of the Sendai Framework for Disaster Risk Reduction
4	● Review of BDP2100, including analysis of Investment Project list	● Information collection on the overall trend and implementation of BDP2100 ● Confirmation of project outlines, implementation status, and feasibility of investment projects that are expected to be related to JICA's future cooperation projects (status of budget acquisition and coordination with other international development partners, etc.)
5	● Confirmation of the development status of disaster hazard maps	● Confirmation of map type (simulation by probability scale, actual inundation map, etc.) ● Review of analysis methods and accuracy
6	● Identification of gender gaps in DRR sector and analysis of the causes of these gaps ● Analysis of risks to vulnerable groups at the time of disaster and their access to services after disaster	● Identification of characteristics of vulnerable groups including women, the poor, and people with disabilities ● Identification of gaps in the participation of vulnerable groups in DRR-related projects and activities ● Review the results of academic research in related fields
7	● Information collection and proposal on the status and future prospects of DX promotion in DRR sector	● Analysis on the prospects and challenges of DX promotion in Bangladesh ● Information collection and analysis on Japanese technologies for DX promotion that can be utilized in the field of DRR ● Confirmation of the status of “Project for Establishment of National Spatial Data Infrastructure (NSDI)” and the future prospects for its utilization in the field of DRR
8	● Analysis of results and challenges of JICA's cooperation	● Organization of JICA's cooperation achievements by disaster type, scheme, and sector, based on information extracted from existing survey reports and interviews with consultants in charge of projects ● Identification of achievements, challenges, and lessons learned based on the above results

No.	Items	Survey Contents and Considerations in Organizing and Analyzing the Information
9	● Information collection and analysis related to the implementation status and strategies by international development partners	● Confirmation of past projects, outcomes, challenges and lessons learned specific to Bangladesh in implementing the projects, and future cooperation policies ● Confirmation of the possibility of collaboration with JICA projects
10	● Data collection, organization, and analysis of disaster occurrence	● Number of fatalities, people affected, damage amounts, and their variation over time by disaster type and region ● Information organization not only on the five target disaster types but also on other disaster types
11	● Information collection and analysis on climate change-related research and studies	● Organization of mid- to long-term climate change impact projections and assessment results ● Review the status of reflecting climate change impacts in actual measures (reflection in facility design, etc.)
12	● Information collection and analyzing on disaster risk management considerations in critical infrastructure and land use plans, existing urban and regional master plans, BIG-B concepts, and other development plans	● Organization and issue analysis of disaster risk management considerations in regulations, planning, and implementation, including design manuals and other legal precedents, from the perspective of mainstreaming DRR
13	● Conduct interviews with Japanese and local companies regarding their preferences for selecting industrial locations, geographic priority areas, and expectations for DRR	● Interview survey of local Japanese companies, including member companies of the Japan External Trade Organization (JETRO) Dhaka Office and the Japanese Chamber of Commerce and Industry in Dhaka, regarding their conditions for selecting business and factory locations and their expectations for support in DRR
14	● Case study of DRR measures in Japan and other countries advanced in terms of DRR investment in Southeast Asia	● Case study analysis of good practices and lessons learned on disaster risk reduction that have contributed to national and regional economic growth in Japan and the Philippines, an advanced country in terms of DRR investment in Southeast Asia ● Identification of future directions that Bangladesh should take into account for sustainable growth in the future
15	● Japanese technology and knowledge	● Examination of Japanese technologies that can be utilized in the field of DRR in Bangladesh.

Source: JICA Survey Team

2.2.2 Technical and Economic Analysis of Disaster Risk

The process of selecting candidate areas for DRR measures through disaster risk analysis is as follows.



Source: JICA Survey Team

Figure 2.2.1 Process for Conducting Disaster Risk Analysis

2.2.2.1 Analysis of Disaster Characteristics

The past disaster records held by relevant organizations in Bangladesh, the international disaster database (EM-DAT), and hazard maps (inundation maps, simulation results conducted by government agencies and other donors, etc.), as well as the results of technical cooperation projects being conducted by JICA, were used to summarize characteristics of disaster occurrence by disaster type. The following points were taken into account in the analysis.

- ✓ Differences in the extent of damage and number of victims between high frequency (small scale) and low frequency (large scale) disasters
- ✓ Damage characteristics by region
- ✓ Changes in the scale and frequency of damage in the past and in recent years

2.2.2.2 Population, Land Use, Infrastructure Development and Urban Growth Trends

Population and land use transition, as well as future trends in infrastructure development, are important factors in identifying areas at risk from an economic perspective. For population and economic activity, statistical information published by the Bureaus of statistics, such as population, number of workers by industry, GDP per capita, etc., was compiled. Based on the compiled information, future population changes were projected using existing statistical data and research results. Spatial layout of industrial areas and infrastructure layout were also confirmed based on the existing locations and future development plans. These data, organized in GIS, were used as input conditions for the disaster risk analysis described below.

In addition to above studies, the future expansion trend of urban areas was projected based on time-series analysis of satellite imagery for five urban areas. Based on the results of this projection, the scope of prior investment to be made in the future and points to be considered in future development are examined. This urban growth projection was conducted as a sub-contract to a Japanese research company that has been studying advanced data analysis using satellite imagery.

2.2.2.3 Comprehensive and Quantitative Disaster Risk Analysis by Disaster Type and Area

Risk analysis for each disaster type was conducted using the methods shown in Table 2.2.2 below. Areas assessed as having high disaster risk were selected as candidate areas for DRR measures. It should be noted, however, that the analysis is intended to provide a broad overview of areas that should be given particular attention in future DRR investments, rather than focusing on the strict prioritization of individual Upazilas.

For each of the candidate areas identified above, factors that may cause or increase damage, such as climate change and topographical effects, were analyzed, and general policies to be implemented in each area were establish. In addition, the benefits of implementing the proposed policies were quantitatively evaluated by summing the population and GDP of the Upazilas that are expected to directly benefit from the proposed policies. Furthermore, a comprehensive priority assessment was made based on the impact of the disaster on higher-level plans and other sectors, as well as an analysis of areas where no efforts are being made despite the existence of needs.

Table 2.2.2 Methods for Conducting Risk Analysis for Each Type of Disaster

Disaster Type	Methods for Conducting Risk Analysis	Main Items Subject to Damage Assessment (Exposure)
Major River Flood/ Storm Surge	Since information on the extent and intensity of hazard impacts can be obtained and estimated from previous studies, disaster risk was quantitatively assessed by superimposing natural external forces, exposure (population, GDP, etc.), and vulnerability (damage function) according to the intensity of natural external forces. The damage function was established based on previous studies in Bangladesh.	Population, GDP, number of industrial parks, number or length of critical infrastructures (roads, ports, power plants, etc.)
Flash Flood	Because of the difficulty in obtaining comprehensive information on the extent and intensity of the hazard and assessing regional priorities, the damage potential was quantitatively estimated based on the spatial distribution of population, GDP, infrastructure, and industrial parks within each Upazila.	Population, GDP, number of industrial parks, number or length of critical infrastructures (roads, ports, power plants, etc.)
Urban Flood	In the analysis of urban flood in major cities, since sufficient basic data and damage history for hazard assessment were not available, inundation simulation based on ground elevation and rainfall information was conducted to estimate the inundation situation by probability scale.	Population and GDP
Riverbank Erosion	The image analysis of river channel evolution being conducted for the Jamuna River under JICA's "Project for Strengthening Planning Capacity and Technology Adaptation Cycle for Comprehensive River Management" was applied to other major river sections to analyze long-term trends in riverbank erosion. Based on the above, impacts on social and economic conditions along major rivers were evaluated.	Affected land area, population, and critical infrastructures along the river
Earthquake	Since information on the extent and intensity of hazard impacts can be obtained and estimated from previous studies, disaster risk was quantitatively assessed by superimposing natural external forces, exposure (population, GDP, etc.), and vulnerability (damage function) according to the intensity of natural external forces. The damage function was established based on previous studies in Bangladesh.	Population, GDP, number of industrial parks, number or length of critical infrastructures (roads, ports, power plants, etc.)

Source: JICA Survey Team

2.2.2.4 Identification of Issues in DRR Sector in Bangladesh and Examination of JICA's Priority Cooperation Fields and Areas

Based on the results of 2.2.1 and 2.2.2.3, discussions were held with JICA and relevant organizations in Bangladesh to identify issues in DRR sector in Bangladesh and to examine JICA's priority cooperation fields and areas.

2.2.3 Consideration of Draft Cooperation Policy

Based on the analysis results of current status of DRR sector and disaster risk analysis, a draft cooperation policy in DRR sector for the next 10 years was studied, and key indicators of effectiveness to be achieved in Bangladesh by 2030 were proposed for each disaster type (see Chapter 6).

In the study of short-term projects that are expected to be implemented over the next 3 to 4 years, the concept of loan aid, grant aid and technical cooperation projects were considered as higher priority projects. The output of the examination includes the purpose, necessity, outline, scale, implementation framework, approximate project cost, schedule, and environmental and social considerations. All of this information was compiled to provide the basis for the preparation of project planning documents and request forms.

CHAPTER 3 OVERVIEW OF DISASTER RISK REDUCTION SECTOR IN BANGLADESH

3.1 Socio-economic and Natural Conditions

3.1.1 Socio-economic Conditions

3.1.1.1 Social Situation

(1) Overview

The overview of social situation in Bangladesh is as follows.

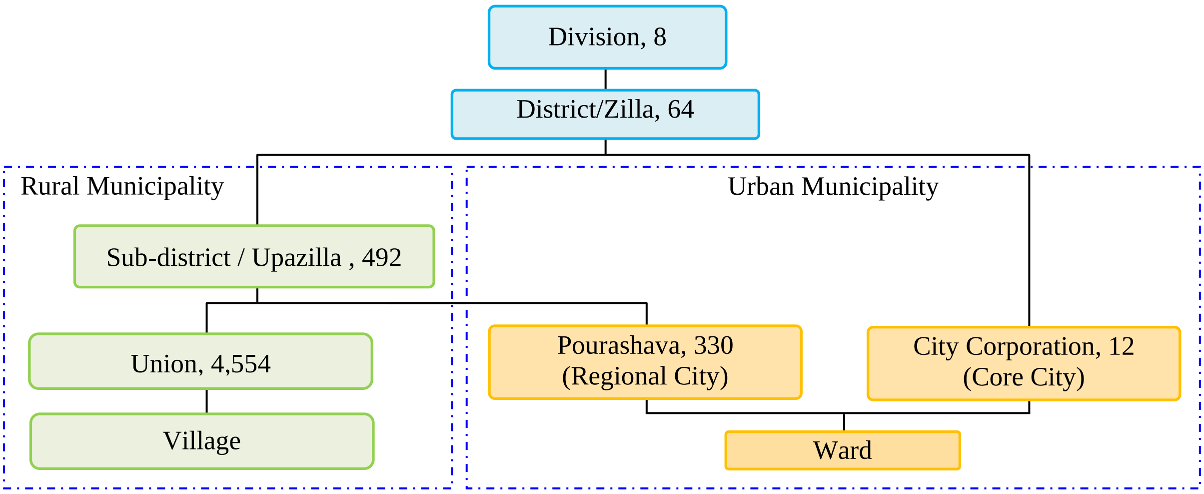
Table 3.1.1 Summary of Social Situation in Bangladesh

Item	Situation	Source
Area	147,000km^2（About 40% of Japan）	Bangladesh Government
Population	164,680,000	2020, World Bank
Capital	Dhaka	
Nation	Buddhist ethnic minorities, mainly the Chakma, live in the Chattogram hills along the Myanmar border. Christian minorities such as Garo and Santal live in the northern part of the country.	
Language	Bengali (Mother language), Adult (over 15 years old) Literacy rate: 75.6%	2020, Bangladesh Bureau of Statistics
Religion	Muslims 88.4%, Others (Hindus, Buddhists, Christians) 11.6%	2020, Bangladesh Bureau of Statistics
Independence Year	August 14, 1947: Independence as part of Pakistan (East Pakistan) December 16, 1971: Independence of Bangladesh	
Government	Head of State: President Md. Abdul Hamid Prime Minister: Sheikh Hasina Foreign Minister: A.K. Abdul Momen	As of August 2022,
Basic Diplomatic Policy	Father of the Nation, Mujibur Rahman, advocates omnidirectional diplomacy with the slogan "Friendship with all nations without hostility." He has built friendly relations centered with major donor countries including Japan, India, other South Asian countries, and Islamic countries. In October 2016, Xi Jinping (China's President) visited Bangladesh, and in July 2019 Prime Minister Hasina visited China. It is growing rapidly in its relationship with China.	

Source：Ministry of Foreign Affairs Website

(2) Administrative Divisions

Administrative divisions in Bangladesh are divided into Divisions, District (Zilla/Zila), and Sub-district (Upazilla/Thana). Under sub-district divisions, there are Unions in rural areas, while there are City Corporation, Pourashava, and Municipality in urban areas.



Source: Revised by JICA Survey Team Based on the Website "An Overview of Spatial Policy in Asian and European Countries", MLIT, Japan (https://www.mlit.go.jp/kokudokeikaku/international/spw/general/bangladesh/index.html)

Figure 3.1.1 Local Administrative System in Bangladesh[1]

3.1.1.2 Economic Situation

(1) Overview

The economic situation in Bangladesh is as follows.

Table 3.1.2 Economic Situation

Item	Situation	Source
Main Industries	Clothing and Garment Industry, Agriculture	
Real GDP	$ 270.7 billion	2020, World Bank
GDP per capita	$ 1,961	2020, World Bank
Economic Growth Rate（GDP）	6.94%	2021, Bangladesh Statistics Bureau
GDP Breakdown	Service sector (51.92%), industrial / manufacturing sector (36.01%), agriculture, forestry, and fisheries industry (12.07%)	2021, Bangladesh Statistics Bureau
Labor Market	Working population: 63.5 million Employed population: 60.82 million Breakdown: Agriculture (40.6%), Service industry (39.0%), Industry / manufacturing industry (20.4%)	2017, Bangladesh Statistics Bureau

Source: Website of Ministry of Foreign Affairs, Japan

3.1.1.3 Aid Record of Japan

According to the Ministry of Foreign Affairs website, Japan's aid record (JFY2019) is as follows.

(1) Bilateral Government Loans

JFY 2020: 373.247 billion yen

Cumulative total: 2,395.829 billion yen (E/N basis)

[1] Number of District, District, Sub-district and Union was taken from Bangladesh Government website (https://bangladesh.gov.bd/index.php) on July 1, 2022.
Number of city corporation and Pourashava was taken from Bangladesh Statistics 2020.

(2) Grant Aid

JFY 2020: 4.134 billion yen

Cumulative total: 50,160.0 billion yen (E/N basis)

(3) Technical Cooperation

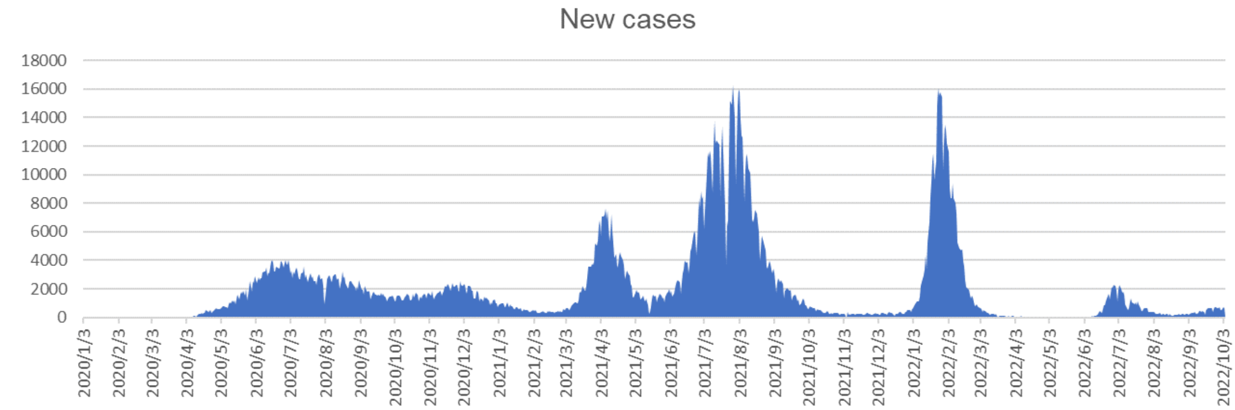
JFY 2020: 2.624 billion yen

Cumulative total: 95.901 billion yen (JICA cost basis[2])

3.1.1.4 Impact of COVID-19

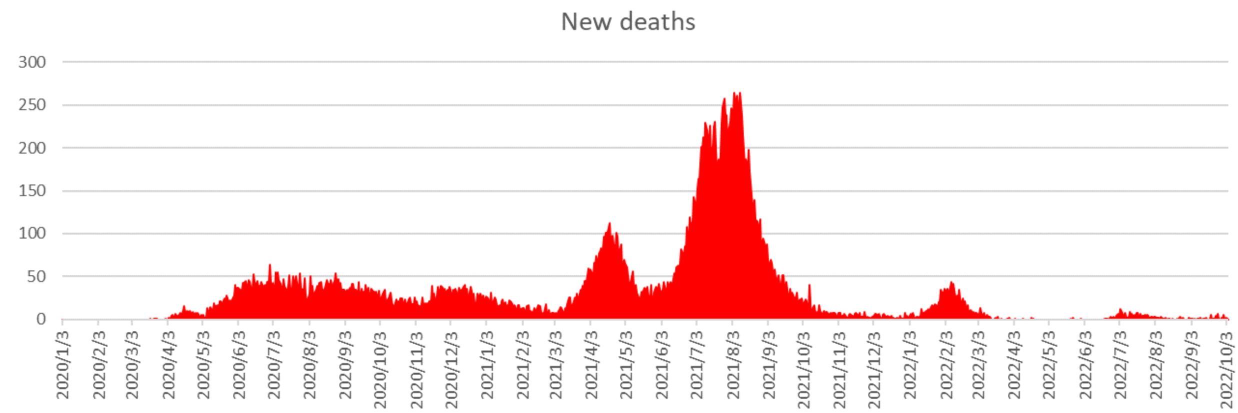
Bangladesh has reported 2,027,565 cases of infection and 29,372 deaths since the first case of COVID-19 was confirmed on March 8, 2020[3](As of October 5, 2022). As a countermeasure, the government has repeatedly strengthened or eased the lockdown (urban blockade) depending on the number of infected people. The total number of vaccinations has reached 299,18 million doses[4](As of October 5, 2022).

The changes in the number of infections and deaths from January 2020 to October 5, 2022, are shown in Figure 3.1.2 and Figure 3.1.3 below.



Source: WHO Website

Figure 3.1.2 Changes in the Number of Infected People due to Covid-19 (As of October 5, 2022)



Source: WHO Website

Figure 3.1.3 Changes in the Number of Deaths due to Covid-19 (As of October 5, 2022)

2 Expenses for technical cooperation expenses, including expenses related to technical assistance by budget, international science and technology cooperation for global issues, grassroots technical cooperation, emergency assistance team, etc.

3 Source: World Health Organization (WHO) Website

4 Source: WHO Website

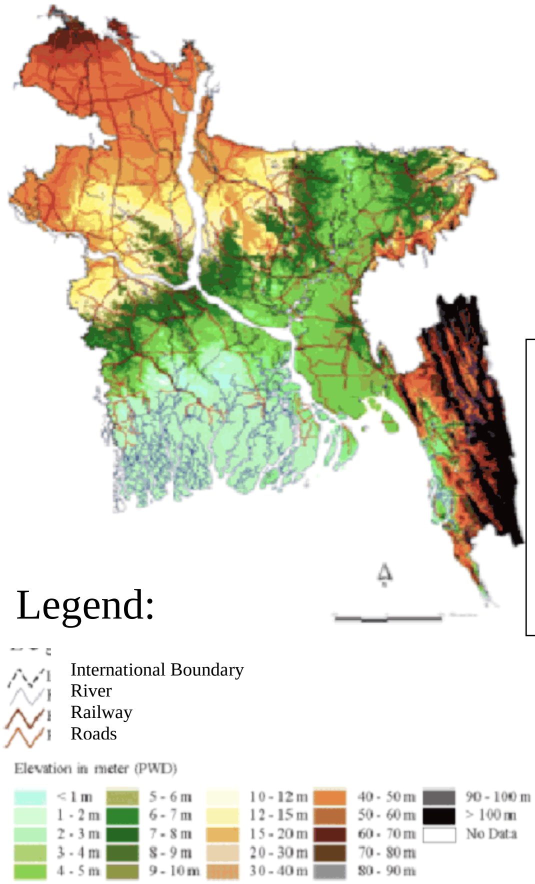
According to the World Bank, the country achieved a GDP growth rate of 8.2% from July 2018 to June 2019 but was affected by the spread of Covid-19, resulting in a GDP growth rate of 3.5% from July 2019 to June 2020[5]. However, the World Bank's "Global Economic Prospects"[6], June 2022, forecasts that Bangladesh's GDP growth rate will be 6.4% from July 2021 to June 2022 and 6.7% from July 2022 to June 2023, indicating that the economy is expected to recover rapidly.

3.1.2 Natural Condition

3.1.2.1 Topography

Bangladesh is located between India and Myanmar, facing the Bay of Bengal. The land is about 147,000 square kilometers. The country is a delta country located in South Asia, in the lowlands formed by the Padma, Jamuna, and Meghna rivers. Most of the land is a flat alluvial plain, but there are hills in the southeastern part of the country. There is the world's longest natural beach in Cox's Bazar, whose length is 120km[7]. The elevation is about 6-13 meters above sea level in the built-up areas on the Pleistocene plateau in the capital city of Dhaka, and more than 50% of the country's land area is less than 7 meters above sea level.

Thus, about 68% of the country is vulnerable to flooding, and 25~30% of the land is inundated by annual floods (Normal Floods). Under these conditions, it is estimated that 25% of the total population lives in flood-prone coastal areas[8].



- About 50% of the country is less than 7 meters above sea level.
- 68% of the country is vulnerable to floods.
- 25-30% of the country is inundated by annual floods. (Normal Flood)

Source: Ministry of Land, Infrastructure, Transport and Tourism, Japan, "Overview of national land policies of each country" Website "Bangladesh"

Figure 3.1.4 Bangladesh Elevation Distribution

[5] World Bank (https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG)
[6] World Bank (https://www.worldbank.org/en/publication/global-economic-prospects)
[7] Source: Banglapedia https://en.banglapedia.org/index.php/Cox%27s_Bazar
[8] Source: Asian Disaster Reduction Center Website (https://www.adrc.asia/nationinformation_j.php?NationCode=50&Lang=jp&NationNum=13)

3.1.2.2 Geology

The topography of Bangladesh, as shown in 3.1.2.1 above, is divided into the following four categories based on the geological age classification and characteristics of its formation:

1) hills of pre-tertiary strata (e.g., Shillong and Chattogram hills);

2) Pleistocene plateaus (typical examples are the Madhupur plateau on the left bank of the Jamuna River and the Barind plateau on the right bank);

3) terrace surfaces lower than the above plateaus. (Cumilla (Tripura) surface on the left bank near the mouth of the Padma River);

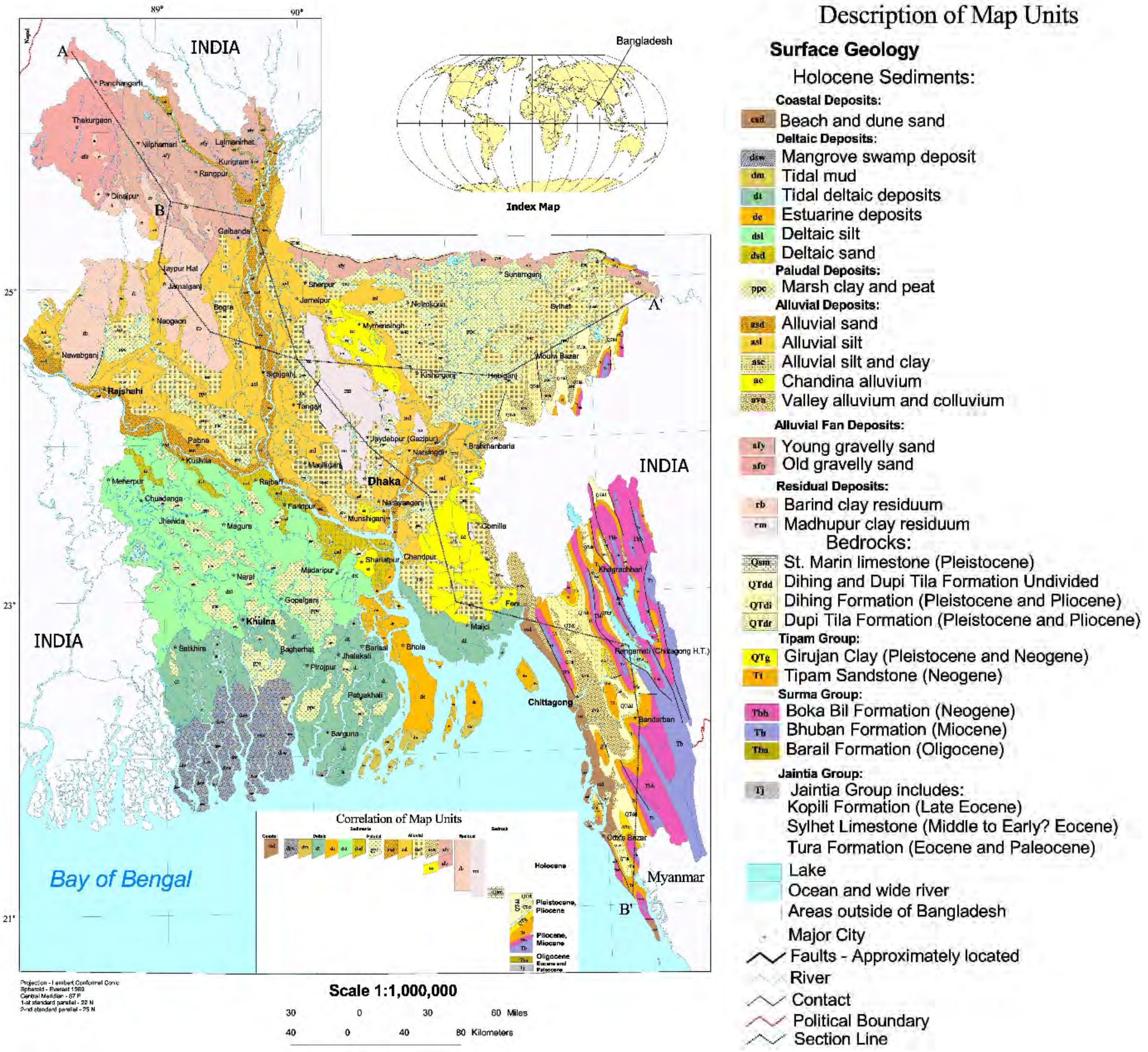
4) Alluvial lowlands are formed by rivers such as the Padma, Jamuna and Meghna Rivers[9].

The northern Shillong Hills and the southeastern Chattogram hills comprise Pliocene and Miocene. The Lower Miocene Surma Formation is widely distributed from the eastern end near Chattogram to the Myanmar border and consists mainly of sandstone, shale and conglomerate. The Middle-Upper Pliocene Tipam Formation unconformably overlies the Surma Formation in the hills between Chattogram and Sylhet. The formation is composed of alternating coarse-grained sandstone and miscellaneous mudstones, interbedded with lignite beds. The Pliocene Duptila Formation occurs near the Assam border and forms the rolling hills between Sylhet and Cox's Bazar. It consists of light red to white medium-grained sandstone and grey to bluish-grey mudstone.

The Pleistocene deposits, known as the Madhupur Clay Formation, are found in the central hilly areas and are composed of red or yellow non-calcareous clay. Floodplain alluvium is widely distributed in the basins of the Padma, Meghna and Jamuna rivers and consists of sand and mud, interspersed in places with peat layers. The deltaic alluvium is widely distributed in the southern plains, near the mouth of the Padma River, and consists of clay layers with peat[10]. The geological map is shown below.

[9] Source: "Geomorphological and Geological Studies for Bangladesh" 2005、Transactions, Japanese Geomorphological Union Vol.26 No.4 https://dl.ndl.go.jp/view/download/digidepo_10807380_po_ART0002464347.pdf?contentNo=1&alternativeNo=

[10] Source: "Materials World Carbon Resources Information (3)" Geological Survey Monthly Report Vol.23 No.11 https://www.gsj.jp/data/bull-gsj/23-11_05.pdf

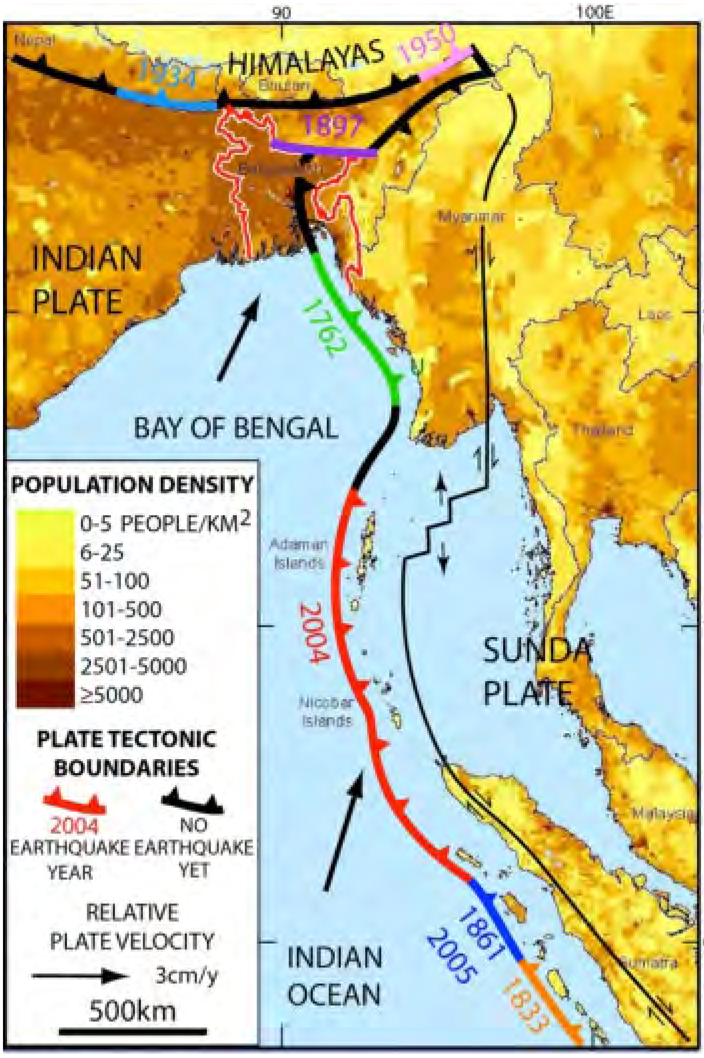


Source: Prepared by JICA Survey Team Based on U.S. Geological Survey Website (https://pubs.er.usgs.gov/publication/ofr97470H)

Figure 3.1.5 Geological Map of Bangladesh

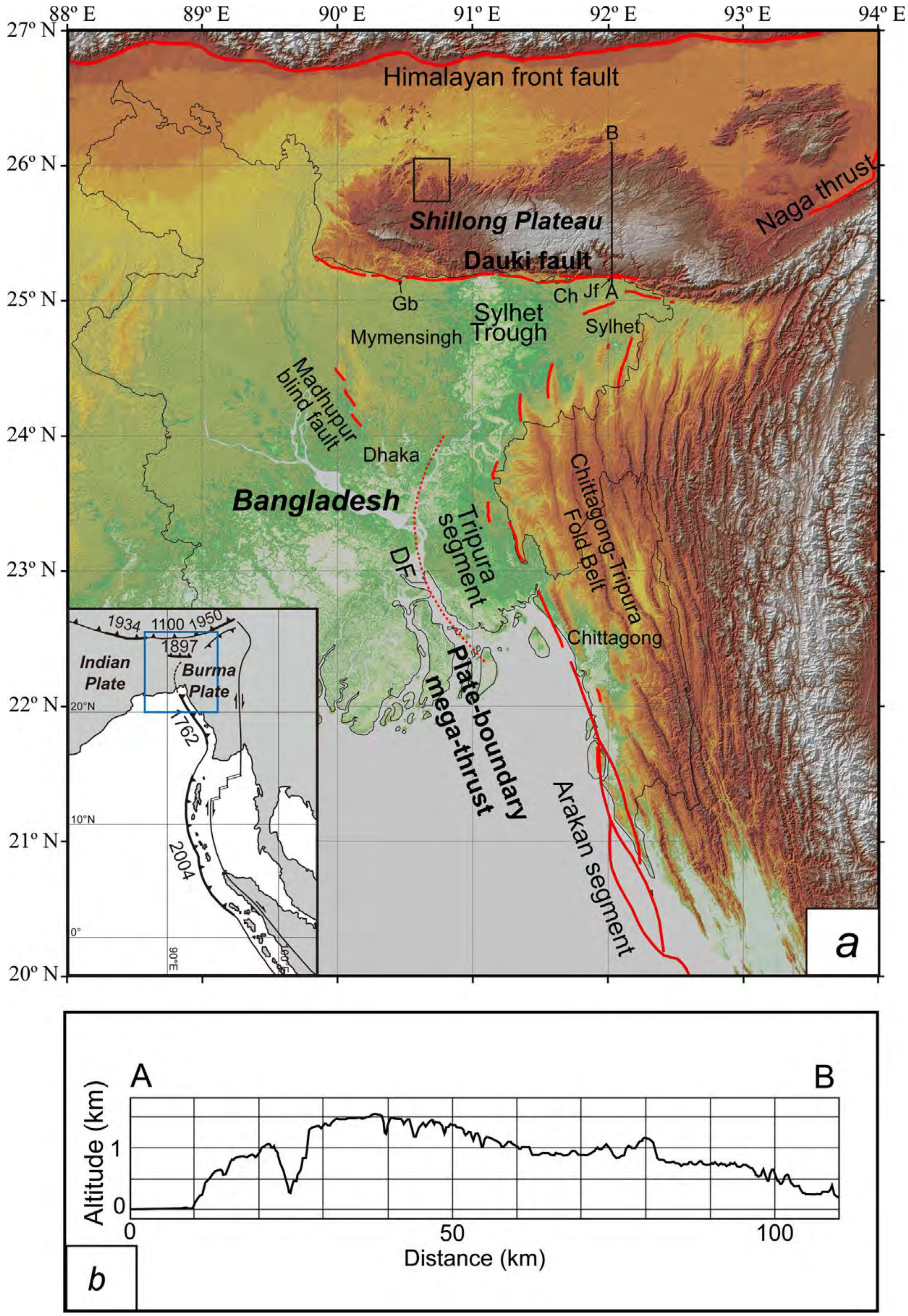
In terms of the seismic aspect, since Bangladesh is located near the boundary between the Indian plate and the Eurasian plate (Sunda plate), seismic activity is relatively active, especially in the northern and eastern regions. There are also some active faults such as the Madhupur Fault. In particular, the Dauki Fault (See Figure 3.1.7) located near the border with India, is said to have caused a major earthquake in 1897. According to the survey on Dauki Fault[11], it is considered the fault may have caused three earthquakes in the past, estimated to be 880-1020, 1548, and 1897. Therefore, the return period of the Dauki fault could be 350-650 years. Under the assumption of 350 years return period, the occurrence probability within 50 years from 2013 is calculated to be 7.7%.

[11] Report of active fault mapping in Bangladesh: Paleo-seismological study of the Dauki fault and the Indian-Burman plate boundary fault, 2013



Source: Michael S. Steckler (Lamont - Doherty Earth Observatory Columbia University), The Wicked Problem of Earthquake Hazard in Developing Countries, American Geophysical Union Earth & Space Science New, March 2018, p20-25 (https://www.researchgate.net/publication/323631970)

Figure 3.1.6 Plate Boundary around Bangladesh

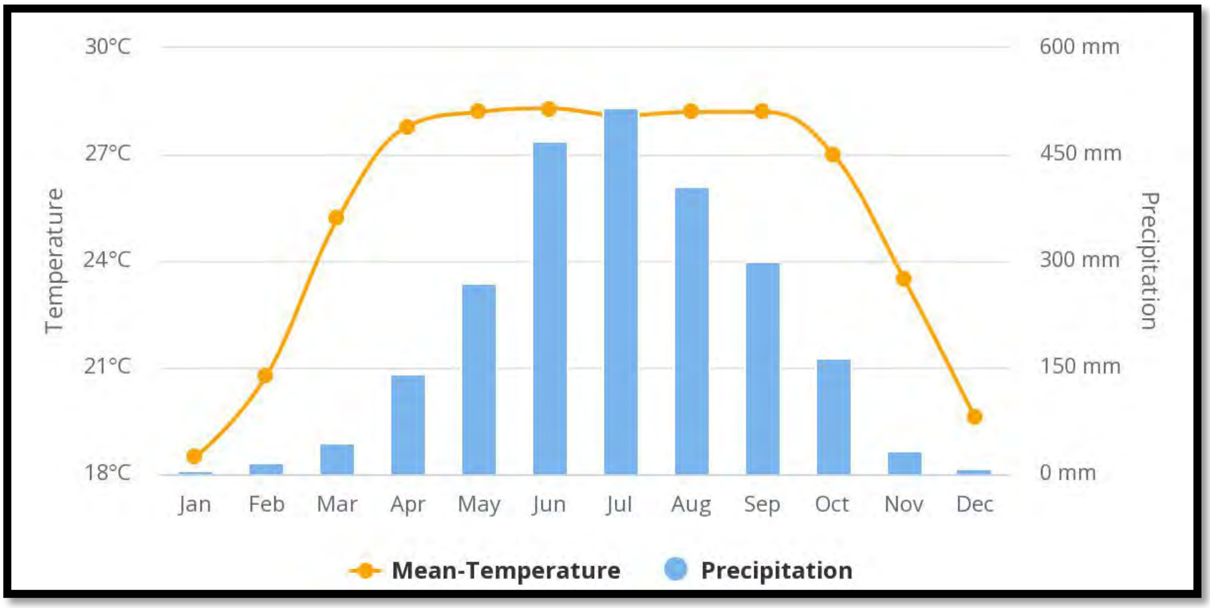


Source：Michio Morino, A paleo-seismological study of the Dauki fault at Jaflong, Sylhet, Bangladesh: Historical seismic events and an attempted rupture segmentation model, Journal of Asian Earth Sciences, September 2014

Figure 3.1.7 Major Active Faults in and around Bangladesh

3.1.2.3 Climate

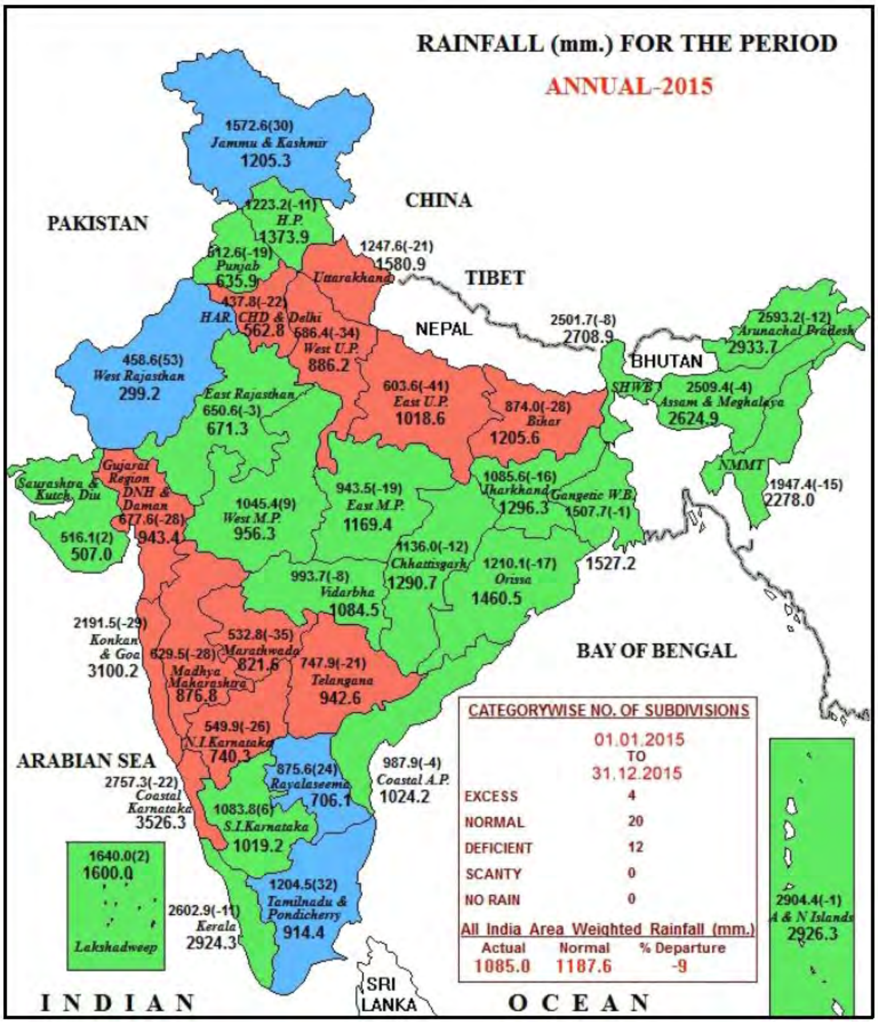
Bangladesh is under tropical monsoon climate influence and is said to have six seasons. The six seasons are spring (February-April), summer (April-June), rainy season (June-August), autumn ((August-October), late autumn (October-December), and winter (December-February), with most rainfall occurring from summer to late autumn (May-October). The following figure shows the monthly average precipitation and temperature data of Bangladesh from 1991 to 2020. The average annual temperature is 25.5 ° C (1991-2020), and the average annual precipitation is 2,214 mm (1991-2020).



The figure and data are taken from the World Bank Climate Change Knowledge Portal and the dataset was created by the Climatic Research Unit (CRU).
Source: https://climateknowledgeportal.worldbank.org/country/bangladesh/climate-data-historical

Figure 3.1.8 Average Temperature and Precipitation in Bangladesh from 1991 to 2020

For reference, precipitation in India is shown in Figure 3.1.9, with a national average of 1,187.6 mm/year based on 2015 data. Inland areas near New Delhi receive 500 to 900 mm/year, while the state of West Bengal adjacent to Bangladesh and its surrounding areas receive 1,000 to 2,000 mm/year. In and around Assam and Meghalaya states located in the northeast of Bangladesh, annual rainfall of 2,000 to 3,000 mm/year is observed. Based on these data, Bangladesh's rainfall is approximately halfway between West Bengal and Assam.



Source: Rainfall Statistics of India – 2015
https://hydro.imd.gov.in/hydrometweb/(S(xbmc4i553d5d2255t5nmai55))/PRODUCTS/Publications/Rainfall%20Statistics%20of%20India%20-%202015/Rainfall%20Statistics%20of%20India%20-%202015.pdf

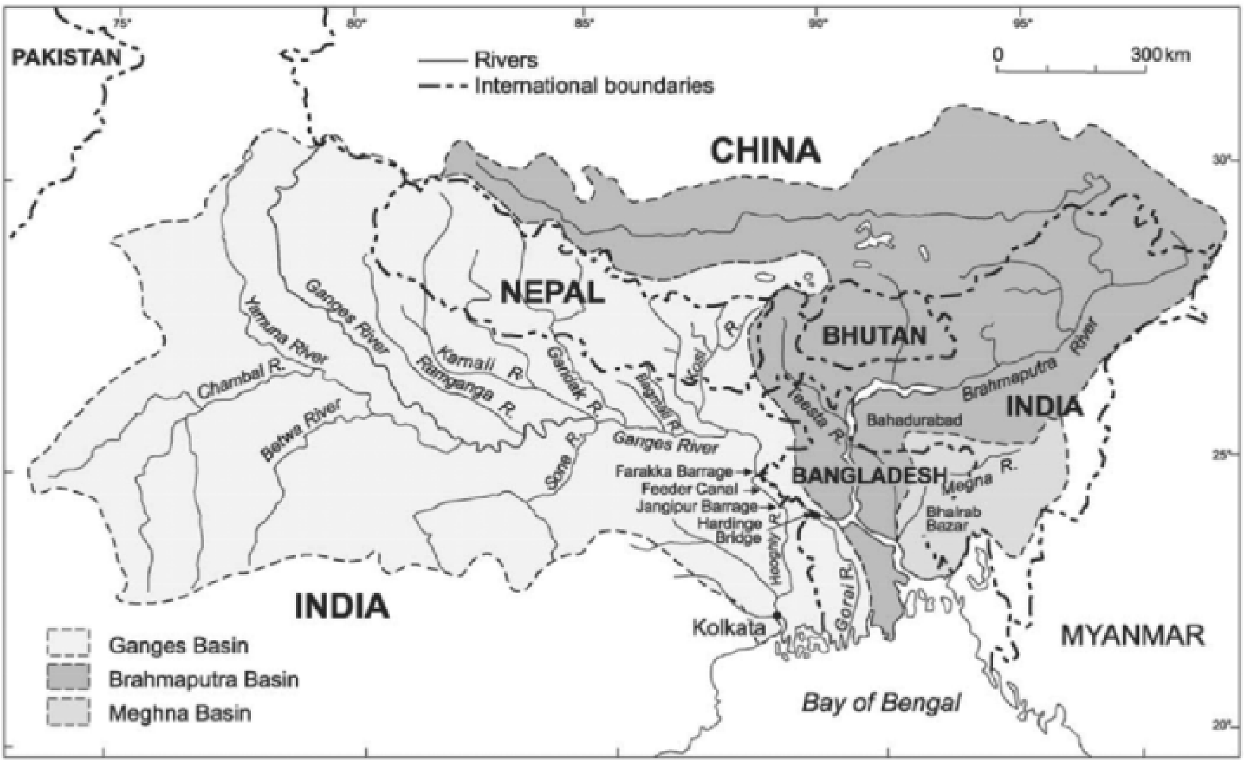
Figure 3.1.9 Rainfall in India in 2015

3.1.2.4 River System

It is said that there are more than 405 rivers in Bangladesh, which is located in the east of the Indian subcontinent. Of these, the three major rivers are the Padma River from the northwest of the Himalayas and the Jamuna River from the northeast, and they merge in the center of the country and are called the Padma River. After that, it joins the Meghna River, which flows down the south side of the Shillong Plateau, at the most downstream part, and flows into the Bay of Bengal.

The total basin area of these three major rivers is about 1.70 million km^2, which extends to Bhutan, China, India, and Nepal, and occupies only 8% of Bangladesh. Since Bangladesh is located in the lower reaches of the basin, water intake in the dry season and floods in the rainy season in the upper reaches have a great impact on the people and the economy. During floods, it carries sediment from upstream and damages cultivated land, while it also has the effect of accumulating in the Bay of Bengal and inland areas, promoting land conversion. The river channel is constantly changing due to repeated erosion and sedimentation.

	Ganges R.	Brahmaputra R.	Meghna R.
Area of Drainage Basin (sq. km)	1,090,000	537,500	77,000
Length of Main Channel (km)	2,200	2,900	900
Average River Flow (m^3/s)	11,300	20,200	4,600



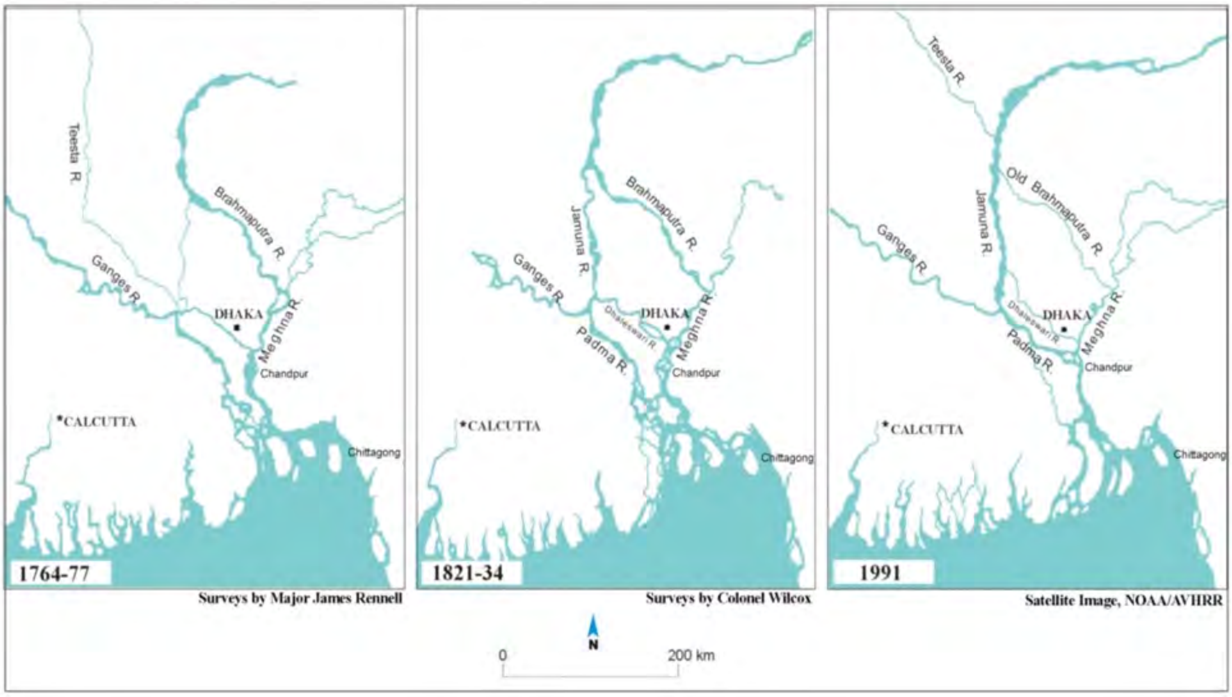
Source: Taro Oka, Flood Disaster in Bangladesh, Kyoto University Disaster Prevention Research Institute Annual Report No. 47, 2004

Figure 3.1.10 Three Major River Basins and Channels in Bangladesh

It is said that the amount of sediment supply is greatly affected by the rivers (Jamuna and Meghna River) that flow down from northeastern India.

Of these, the Jamuna River is a large-scale braided river that flows through lowlands, which is rare in the world, and there are large changes in channel and topography in the long and short term. In the formulation of a large sandbank called Char, riverbank erosion and sedimentation have occurred on a large scale. Although they are being dealt with by revetment maintenance and dredging by the Government of Bangladesh, the power of river flow is uncontrollable.

The Meghna River is considered to receive sediment inflows from erosion in the mountainous areas of the Indian Territory watershed. The sediment inflow into the river channel raises the river bed in the middle reaches of the river, reducing the channel's capacity to carry water, causing poor drainage and prolonging the period of waterlogging in the flooded areas. The evolution of riverbank erosion and sedimentation is shown below in Figure 3.1.11. The recent river channel evolution is further detailed in Chapter 5.



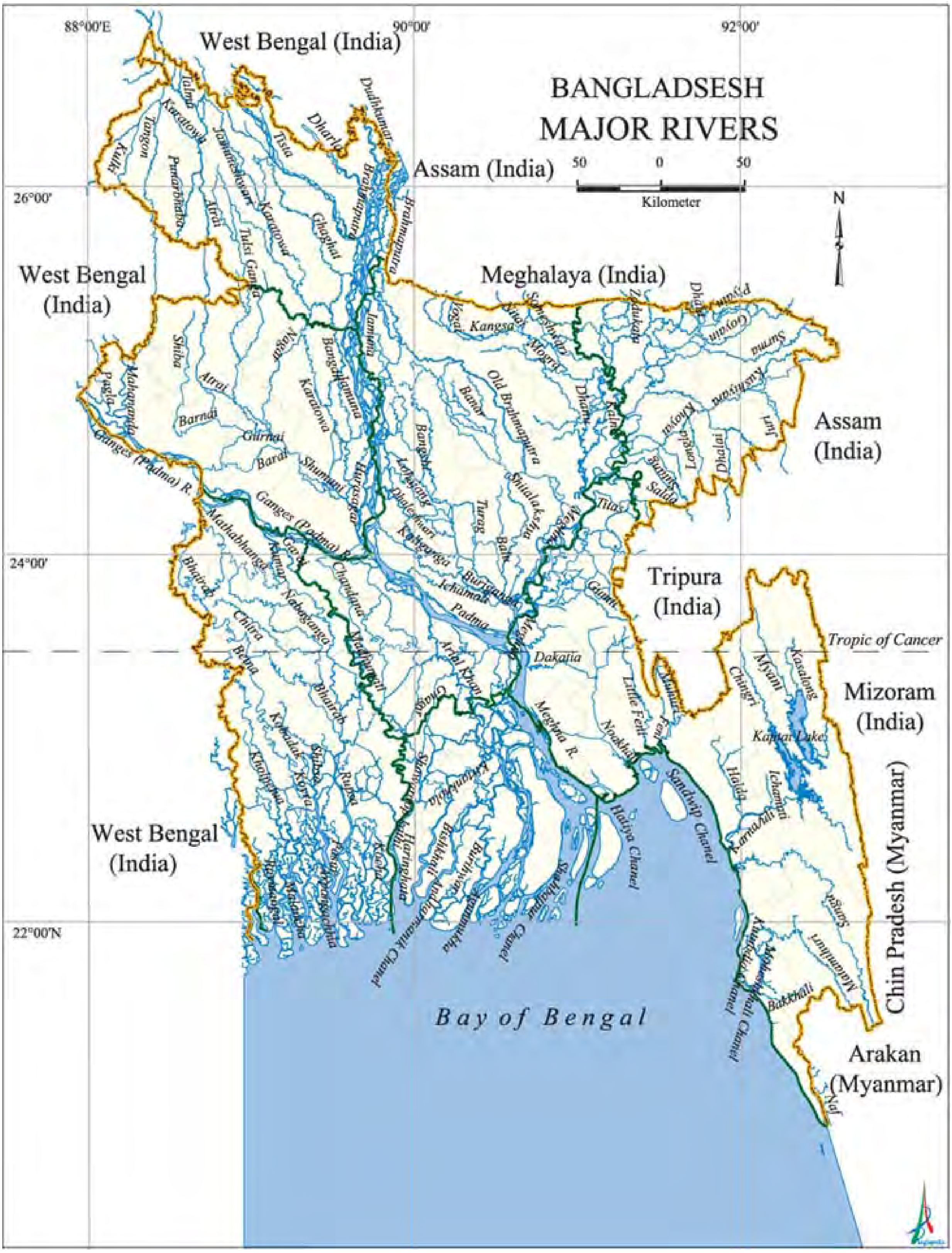
Source: Delta Plan 2100

Figure 3.1.11 Bangladesh's Major Rivers and Their Transitions

In the northeastern lowland area known as Haor, flash floods occur from April to May (around the beginning of the rainy season) and from September to November. Flash floods often occur when there is localized, short-lived heavy rainfall on relatively steep terrain. Especially in April-May, flash floods can cause damage to fields during harvest season. In addition, the entire Haor region is inundated from July to November, but the sedimentation in drainage channels and other areas prevent the removal of inland floodwater, making it impossible to cultivate crops during the dry season. In addition, the foothill areas on the northern border are also vulnerable to flash flooding from the Indian side due to the steep gradients of the river beds.

Near the mouths of these rivers, the delta topography is constantly changing due to the interaction of erosion and sedimentation from the rivers and the sea. It should be noted that the supply of sediment from upstream is also said to be declining, which may reduce riverbed rise in midstream river sections, but may contribute to erosion in downstream areas.

On the other hand, the coastal area from Chattogram to Cox's Bazar facing the Bay of Bengal includes the Feni, Karnaphuli, Sangu, and Matamuhari rivers, which flow from the Chattogram hills to the Bay of Bengal from east to west. The following Figure 3.1.12 shows a map of major rivers in Bangladesh.



Source: National Encyclopedia of Bangladesh (https://en.banglapedia.org/index.php/River)

Figure 3.1.12 Rivers in Bangladesh

3.1.3 Disaster Occurrence and Economic Impact

3.1.3.1 Overview of Disaster Situation

The general situation of natural disasters occurrence in Bangladesh is shown in Table 3.1.3, and the months in which these disasters mainly occur, are shown in Figure 3.1.13. Floods in Bangladesh can be broadly divided into 1) flooding of major rivers, 2) heavy rainfall and poor drainage (inland waters), 3) flash floods in mountainous areas, and 4) storm surges. Of these, the wider impact is due to flooding of rivers, which inundates one-third to two-thirds of the country.

Table 3.1.3 Outline of Natural Disaster in Bangladesh

Disaster Type	Feature
Flood (Including Inland Flood)	More than 80% of the annual rainfall (average 2,214 mm) is concentrated in the rainy season from May to October. At the same time, floodwater, whose volume is more than four times that of rainwater received within Bangladesh, flows through the three major rivers. For these reasons, floods occur almost every year due to the overlap of peak discharge and rainfall in each river. During large scale floodings, one-third to two-thirds of the country is inundated. Since 1980, floods have occurred in 1987, 1988, 1998, 2004, 2007, 2017, and 2019. In particular, the 1998 flood inundated about 68% of the country, killing 1,100 people, and totaling 3.1 million people affected. Flood countermeasures such as embankment construction have been successful over the years, and in recent years direct damage has dropped. On the other hand, in urban areas, drainage has deteriorated due to the progress of embankment development, and inland waters have become more frequent and prolonged.
Storm Surge (Cyclone)	Cyclones occur almost every year and frequently cause storm surge damage to coastal areas. Its characteristic is that it kills many people, 300,000 in 1970, 140,000 in 1991, 3,363 in 2007, and 190 in 2009. Due to many years of efforts, such as strengthening the disaster prevention system, warning system, and expansion of more than 3,739 cyclone shelters[12], no extensive damage has occurred in recent years, causing more than 10,000 deaths.
Riverbank Erosion	In Bangladesh, where three major rivers (Padma, Jamuna, and Meghna) and alluvial soils are predominant, riverbank erosion is a periodic and recurring phenomenon. The banks and channel peripheries of major rivers, such as the Jamuna, Padma, lower Meghna, and Teesta, are particularly prone to erosion. Bank erosion mainly occurs during the rainy season, when there are substantial river flows and higher velocities in each river. Although the erosion process is usually slow, the extent and impact of damage is no less significant than in other disasters. Every year, one million people are displaced and some are forced to move into urban slums[13].
Earthquake	Bangladesh belongs to the Himalayan region where earthquakes occur frequently, and large seismic activity has occurred regularly, including seven large earthquakes with a magnitude of 7 or more in the last 150 years (Three of them had epicenters in India)[14,15]. In particular, some major cities such as Dhaka, Chattogram, and Sylhet are at risk of major rupture due to earthquakes from nearby seismic faults[16]. On the other hand, many buildings do not meet building standards, and it is predicted that a large-scale earthquake will cause serious damage to both the economy and humans.

Sources: Organized by JICA Survey Team based on sources indicated in footnotes.

[12] Source: Emergency Preparedness Plan for Cyclone-2014, CDMP, MoDMR
[13] Source: Preparatory Survey on Cooperation Program for the Disaster Management in Bangladesh, July 2012, JICA
[14] Source: Banglapedia Website (https://en.banglapedia.org/index.php/Earthquake)
[15] Source: A paleo-seismological study of the Dauki fault at Jaflong, Sylhet, Bangladesh:
Historical seismic events and an attempted rupture segmentation model, Jurnal of Journal of Asian Earth Sciences · Sep. 2014
https://www.researchgate.net/publication/263391442_A_paleo-seismological_study_of_the_Dauki_fault_at_Jaflong_Sylhet_Bangladesh_Historical_seismic_events_and_an_attempted_rupture_segmentation_model
[16] Source: Preparatory Survey on Cooperation Program for the Disaster Management in Bangladesh, July 2012, JICA,
Md. Abdullah Al zaman and Nusrath Jahan Monira（Chittagong University), A Study of Earthquakes in Bangladesh and the Data Analysis of the Earthquakes that were generated In Bangladesh and Its Very Close Regions for the Last Forty Years (1976-2016), Journal of Geology & Geophysics, 2017

Disaster Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
River Flood												
Flash Flood												
Inland Flood												
Drought												
Bank Erosion												
Cyclone												
Cold Weather												
Earthquake	Frequency is not affected by season.											

Note: Darker coloring indicates periods of particularly high frequency of occurrence.
Regarding inland flood, since there is not adequate information on past damage and it is difficult to specify the timing based on the history of occurrence, the expected timing of occurrence based on rainfall characteristics is described.
Source: Prepared by JICA Survey Team Based on World Food Programme Document (2011).

Figure 3.1.13 Disaster Calendar of Bangladesh

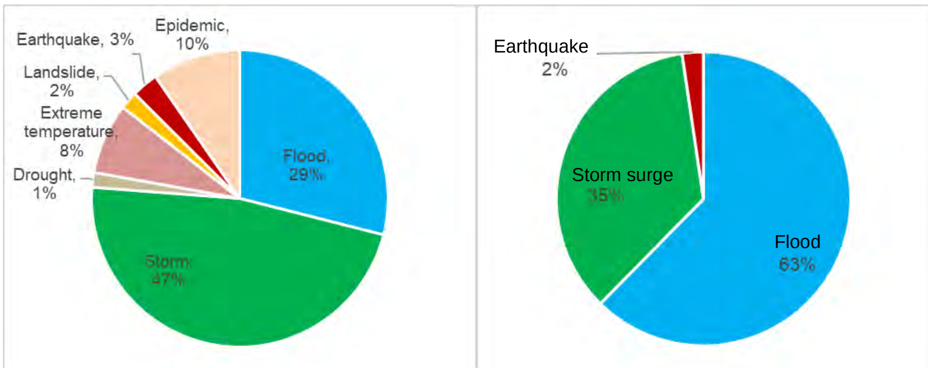
The trend of damage occurrence over time is studied based on EM-DAT[17], the globally used international disaster database. EM-DAT is managed by the Centre for Research on the Epidemiology of Disasters (CRED) in Belgium. As of August 2022, EM-DAT maintains damage data on about 22,000 major disasters that have occurred since 1900. Based on the long-term history of past disasters recorded in EM-DAT, an overview of the occurrence of disasters since 1970 is reviewed. Figure 3.1.14 shows the results. In addition, the number of disasters, the number of victims, the number of fatalities, and the amount of damage by year are shown in Figure 3.1.15 through Figure 3.1.18.

The statistical situation of disaster occurrence is summarized as follows:

- ✓ Regarding the number of occurrences, floods and storm surges account for a large proportion, accounting for 29% and 47% for all disaster types, respectively.
- ✓ Regarding the amount of damage, floods and storm surges were the most common, accounting for 63% and 35%, respectively, of all disaster types.
- ✓ Regarding the number of affected people[18], floods are of considerable size compared to other disasters, accounting for 77% of all disaster types, respectively, indicating that it is the most influential disaster type in the country. In addition, although large-scale drought damage occurred in the 1980s, no significant drought damage have been recorded in recent years.
- ✓ The number of victims due to storm surges is towering. In particular, the 1991 Cyclone Goky reportedly caused about 140,000 casualties.The number of deaths since then has been on the decline.

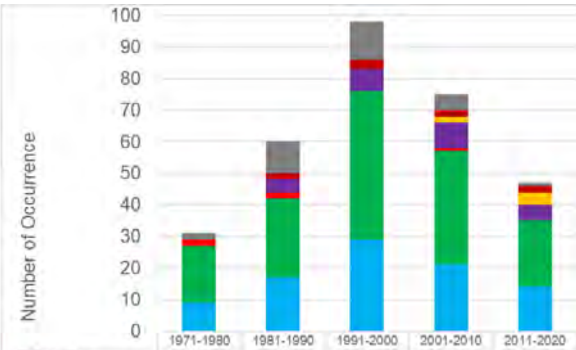
According to these analyzes, it can be confirmed that water disasters centered on floods and storm surges are the recent main disasters in Bangladesh. On the other hand, the occurrence of damage caused by earthquakes is relatively small compared to water-related disasters from the viewpoint of the occurrence history of the past 50 years.

[17] EM-DAT is a useful database that stores a large amount of disaster data, but it should be noted that the information becomes less and less available as the age of the data increases.
[18] The number of victims is the total number of injured people, those who have lost their homes, and those who need assistance such as water supply.

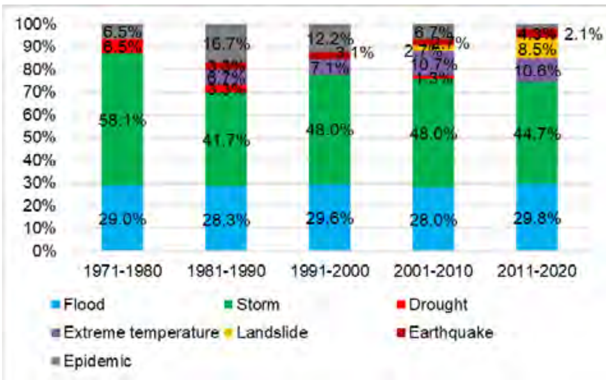


Source: EM-DAT

Figure 3.1.14 Percentage of Number of Disaster Events (Left) and Percentage of Damage Amount (Right)

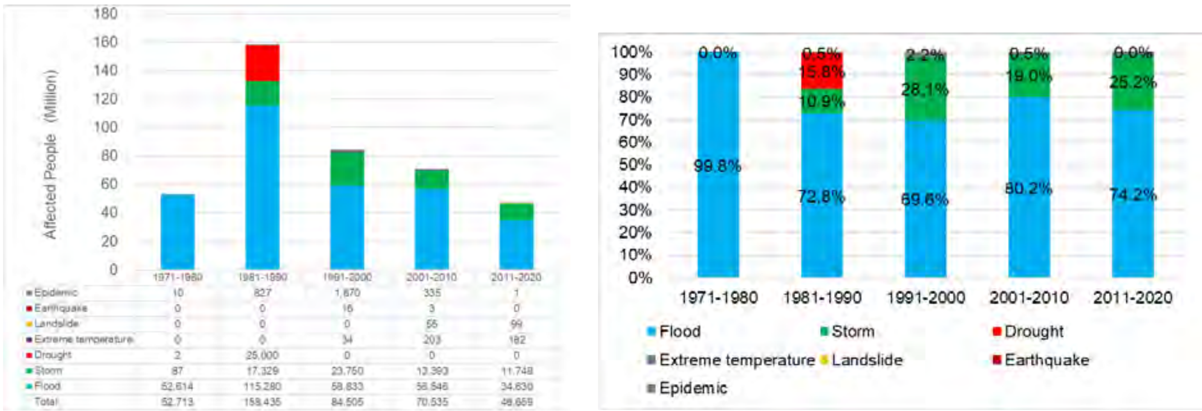


	1971-1980	1981-1990	1991-2000	2001-2010	2011-2020
Epidemic	2	10	12	5	1
Earthquake	0	2	3	2	2
Landslide	0	0	0	2	4
Extreme temperature	0	4	7	8	5
Drought	2	2	0	1	0
Storm	18	25	47	36	21
Flood	9	17	29	21	14
Total	31	60	98	75	47



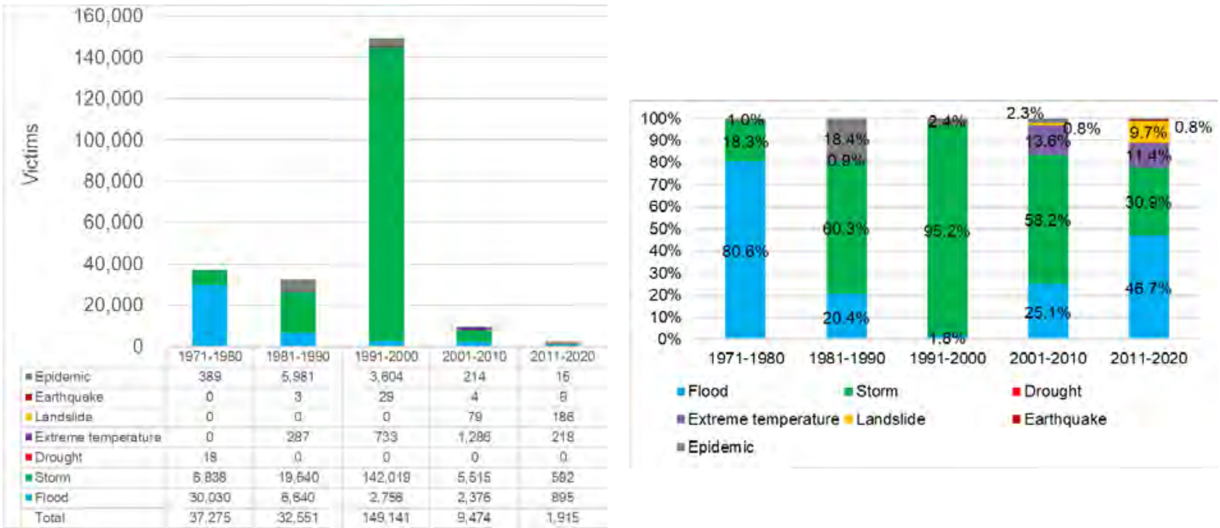
Source: EM-DAT

Figure 3.1.15 Number of Disaster Occurrence and the Ratio by Decade



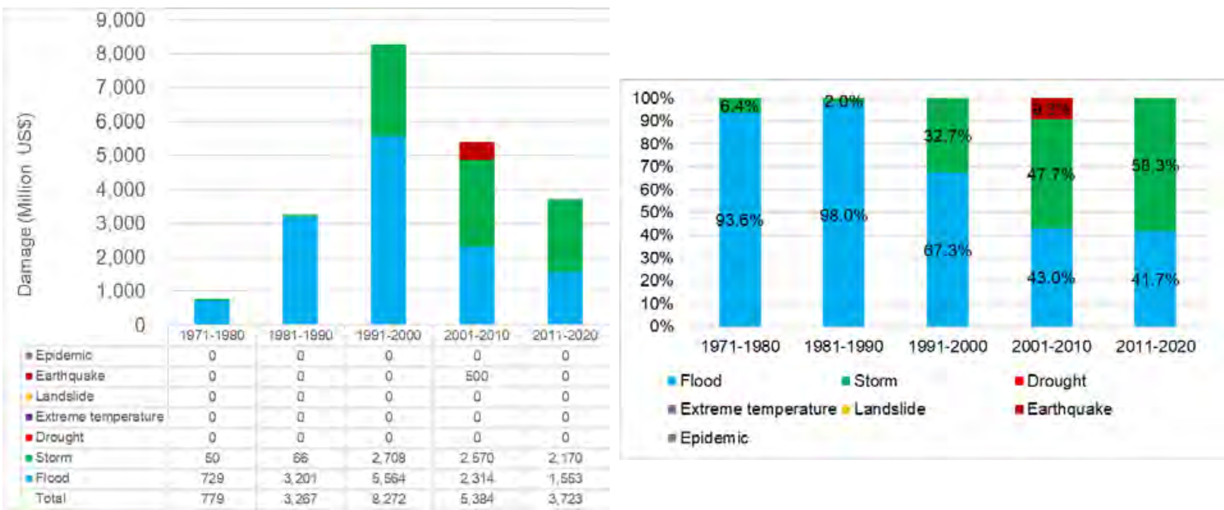
Source: EM-DAT

Figure 3.1.16 Number of Affected People and the Ratio by Decade



Source: EM-DAT

Figure 3.1.17 Number of Victims and the Ratio by Decade



Source: EM-DAT

Figure 3.1.18 Damage Amount (Million USD) and the Ratio by Decade

The 1990s had the highest number of disasters, fatalities, and damage by decade, but only the number of people affected was the highest in the 1980s. This is due to the severe drought in 1982 and the floods in 1987 and 1988. The decrease in flood and drought damage since 1990 is due to the progress of riverine projects supported by countries around the world based on the Flood Action Plan, which was developed in response to lessons learned from flood damage in the 1980s. It is assumed that these projects have contributed to the decrease in the number of people affected by drought and floods. The amount of damage has also been on a downward trend since the 1990s, suggesting that the progress of river projects has had a mitigating effect on damage. (See Chapter 4 for more details on the progress of the river projects.)

EM-DAT was developed in 1988 and began accumulating data. Although disaster data prior to 1988 have been surveyed retrospectively and registered in the database, it may not be sufficiently accurate from the viewpoint of data collection. In particular, it should be mindful that the results of surveys conducted by insurance companies, etc., are used for the amount of damage; still, there is a high possibility that past data is not adequately covered. Furthermore, it is estimated that the amount of damage caused by a disaster of the same magnitude will increase as economic development brings about a rise in GDP per capita and an increase in assets.

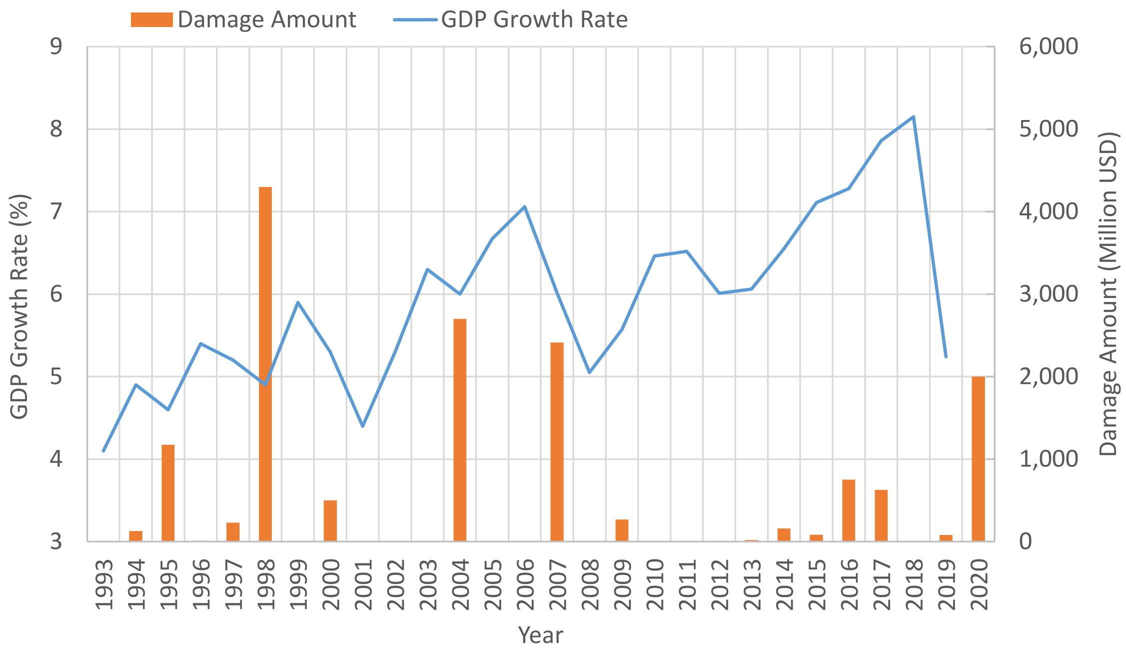
3.1.3.2 Impact of Disasters on Economic Growth

Figure 3.1.19 shows annual changes in the GDP growth rate and the amount of damage caused by disasters. The GDP growth rate was 4-5% throughout the 1990s, and since 2003 has been strong at 6% or more in most years. Behind the stable economic growth rate there are a relatively well-balanced industrial structure (detailed in Chapter 5), strong growth in the export industry centered on sewn products, and stable growth in the agricultural sector. Although it has been in a stable growth trend since the 1990s, the amount of damage caused by disasters exceeded 1,000 million USD annually in 1995, 1998, 2004 and 2007, and a decrease in the GDP growth rate of about 0.3% to 1.0% can be confirmed. On the other hand, in 2016 and 2017, GDP growth rates have been growing steadily, despite the fact that damage amounts of more than USD 5 million have been recorded in these years.

Table 3.1.4 provides an overview of the major disaster events that caused significant damage. From this table, the following can be observed.

- ✓ Disasters with damage amounts exceeding approximately USD 1,000 million tend to have an impact on the slowdown of GDP growth. For damage amounts below that, no clear correlation with GDP growth can be confirmed.
- ✓ Although the same amount of damage occurred in 2004 and 2007, the drop in GDP was greater in the latter. The former was caused by flooding during the monsoon season, with the affected areas spread across the country and the number of affected people reaching approximately 36 million. The latter was caused by a cyclone, and the affected areas are relatively concentrated in the southern part of the country, such as Barisal and Bhola, with approximately 9 million people affected. The amount of damage per capita for the former was USD 0.061 million, while that for the latter was USD 0.256 million, approximately four times higher. Therefore, it is implied that when the total amount of damage is the similar, the impact on GDP is larger when the per capita damage is larger.
- ✓ Similar amounts of damage occurred in 2016 and 2017, approximately USD 500 million and USD 600 million, respectively. There was no decline in GDP in these two years. However, in terms of the slowdown in growth, the former is more significant. The former is due to cyclone damage, which was relatively concentrated in the southern part of the country, including Barisal, Noakhali, and Cox's Bazar. The latter is a result of monsoon floods, and the affected areas are spread across the country. The amount of damage per capita for the former is USD 0.499 million, while that for the latter is USD 0.063 million. Therefore, as mentioned above, if the total amount of damage is the same, the impact on GDP is larger when the per capita damage is larger.

It should be noted, however, that it is difficult to explain GDP growth solely in terms of the occurrence of disasters, since a variety of factors other than disaster occurrence are involved.



Source: Bangladesh Statistical Yearbook (GDP Growth Rate), EM-DAT (Damage Amount)

Figure 3.1.19 Relationship between GDP Growth Rate and Disaster Damage

Table 3.1.4 Recent Major Disasters with Significant Amounts of Damage Recorded

Year	Disaster Type	Major Affected Areas	Damage Amount (Million USD)	Number of Affected People	Damage per capita (Million USD)	GDP Change from Previous Year (%)
1995	Storm Surge	Cox's Bazar, Teknaf, Barguna, Bagerhat, Hatiya, Sadwip, Bhola, Noakhali, Chattogram	800	2,070,000	0.386	-0.30
1998	Flood	Mymensingh, Jamalpur, Sherpur, Rangpur, Sirajangj, Manikganj, Rajshahi, Kurigram, Faridpur, Lalmonirhat, Chattogram, Feni, Comilla, Cox's Bazar, Tangail, Natore	4300	15,000,000	0.287	-0.30
2000	Flood	Gangni, Meherpur Sadar Khulna, Daulatpur, Kushtia Sadar, Chuadanga, Maheshpur, Jhenaidah Rajshahi	500	2,470,000	0.203	-0.60
2004	Flood	Brahamanbaria, Comilla, Chandpur, Kurigram, Rangpur, Rangpur, Bogra, Naogaon, Rajshahi, Sylhet, Dhaka	2200	36,000,000	0.061	-0.30

Year	Disaster Type	Major Affected Areas	Damage Amount (Million USD)	Number of Affected People	Damage per capita (Million USD)	GDP Change from Previous Year (%)
2007	Storm Surge	Bagerhat, Khulna, Satkhira, Patuakhali, Barguna, Pirojpur, Barisal, Jhalokati, Bhola, Madaripur, Gopalganj, Shariatpur	2300	8,980,000	0.256	-1.05
2016	Storm Surge	Barisal, Noakhali, Lakshmipur, Chandpur,Cox’s Bazar, Bhola, Barguna	600	1,200,000	0.499	0.17
2017	Flood	Dinajpur, Kurigram, Lalmonirhat, Moulvibazar, Jessore, Sylhet, Sunamganj, Mymensingh, Jamalpur, Naogaon, Bogra, Tangail, Comilla, Dhaka, Faridpur, Brahamanbaria, Natore, Sirajganj, Rangpur, Sherpur, Netrakona, Chandpur, Rajshahi	500	8,000,000	0.063	0.58

Source: EM-DAT

3.2 Organization of National Development Plans and Global Targets

3.2.1 Vision2041 and PP2041

3.2.1.1 Overview

Vision 2041 seeks to eliminate extreme poverty and reach Upper Middle-Income Country (UMIC) status by 2031, and High-Income Country (HIC) status by 2041 with poverty approaching extinction. To convert Vision 2041 into a development strategy, with policies and programmes, this document launches ‘Making Vision 2041 a Reality: Perspective Plan of Bangladesh 2021-2041’ (PP2041). The PP2041 builds on the successes of PP2021, while also drawing on the good practice experiences of current UMICs and HICs that have already travelled the development path that Bangladesh is endeavoring to travel.

3.2.1.2 Strategic Goals and Milestones of the PP2041

The following strategic goals will be pursued as the essential components of economic policy over the long-term:

- ✓ Eradication of Extreme Poverty by 2031; reducing Poverty to less than 3 percent by 2041
- ✓ Towards Upper middle-income country by FY 2031; High-income country by 2041
- ✓ Industrialization with export-oriented manufacturing will drive structural transformation into the future
- ✓ Paradigm shifts in Agriculture will enhance productivity and ensure nutrition and food security for the future
- ✓ A Service sector of the future will provide the bridge for the transformation of the rural agrarian economy to a primarily industrial and digital economy
- ✓ The Urban transition will be an essential part of the strategy to move to a high-income economy

- ✓ Efficient Energy and Infrastructure will be essential components of the enabling environment that facilitates rapid, efficient and sustainable growth
- ✓ Building a Bangladesh resilient to climate change and other environmental challenges
- ✓ Establishing Bangladesh as a knowledge hub country for promoting a skill-based society

3.2.1.3 Key Elements of PP2041

Two principal visions underpin the PP2041: (i) Bangladesh will be a developed country by 2041, with per capita income of over USD 12,500 in today's prices, and fully in tune with the digital world; (ii) Poverty will become a thing of the past in Sonar Bangla.

Table 3.2.1 Growth and Poverty Targets for PP2041

Indicator	Benchmark FY20	Target FY31	Target FY41
Real GDP Growth (%)	**8.2**	**9.0**	**9.9**
Extreme Poverty (%)	**9.4**	**2.3**	**<1.0**
Poverty (%)	**18.8**	**7.0**	**<3.0**

Source: PP2041, GED

3.2.1.4 Institutions Matter

PP2041 recognizes the criticality of institutions in Bangladesh's development process. Vision 2041 and the associated PP2041 rely on four institutional pillars that will be harnessed by the people, who are the principal drivers of growth and transformation. These are (i) governance; (ii) democratization; (iii) decentralization and (iv) capacity building Bangladesh's path to prosperity as a developed nation must be founded on the strength of these four pillars.

3.2.1.5 Macroeconomic Management for Accelerated Inclusive Growth

PP2041 comes at a time when Bangladesh is experiencing a growth surge spurred by strong national policies of inclusive growth. This growth path is underpinned by prudent macroeconomic management reflected in low inflation, low fiscal deficits, a comfortable balance of payments and low internal and external public debt. This sound macroeconomic management will be maintained under PP2041.

3.2.1.6 Zero Poverty Country

Consistent with the dream of Bangabandhu, the Vision for poverty outcome is that by 2031 extreme poverty will be eliminated and by 2041 the incidence of poverty will be minimal (3% or less). By 2041, all citizens will be guaranteed a minimum quality of life, based on employment income for all who seek work and social protection benefits for the vulnerable population who cannot participate in the labor market owing to age and physical disabilities. Under-employment would be a thing of the past. As in current high-income economies, poverty will become a relative concept.

3.2.1.7 Human Development: Harnessing the Demographic Dividend:

The PP2041 puts a strong emphasis on improving human development both as means to supporting GDP growth through a healthy and skilled labor force as well as to reduce poverty through productive employment. The PP2041 programme for human development is driven by the core growth and poverty targets to achieve high-income status and mostly eliminate absolute poverty by 2041. Specifically, the programme comprises the following Table 3.2.2.

Table 3.2.2 Human Resource Development Program in PP2041

No.	Program Contents
(i)	Institution of a knowledge-based economy
(ii)	Population with 100% literacy rate
(iii)	Universal free education for up to 12 years
(iv)	Flexible supply of training institutions for all who seek to acquire job-based skills
(v)	Universal access to health insurance schemes at affordable prices
(vi)	100% coverage of employment-based accidental and health insurance schemes for all workers in the organized sector
(vii)	Ensuring medical facilities for all at affordable cost

Source: PP2041, GED

3.2.1.8 Sustainable Agriculture to Ensure Food Security and Nutrition

The key priorities for the future of sustainable agriculture include strengthening local adaptive capacity by providing public goods and services, such as better climate information, innovative research for the development of heat-tolerant, salinity- tolerant crop varieties and climate smart production technologies, efficient water-saving irrigation practices and early forecasting/ warning systems. In order to cope with the changing climate, integrated farming system should be followed adopting good agriculture practices like Conservation Agriculture (CA), Integrated Plant Nutrition System (IPNS), and Integrated Pest Management (IPM) options. In water resources, the priority is to scale up existing good practices of water conservation and management and apply more widely integrated water management, including flood control and prevention schemes, flood early warning systems, irrigation improvement, and demand-side management. In the forestry sector, the priority is to implement effective public-private partnerships for reforestation and afforestation.

3.2.1.9 Accelerated Growth with Industrialization and Trade

Bangladesh's future growth and prosperity lie in outward-looking industrialization to create good jobs and income by exploiting our competitive advantage. Bangladesh is already growing at 8% plus annual rate and aspires to reach 9-10% rate.

3.2.1.10 Sustainable Power and Energy

The objectives and targets set for PP2041 will put Bangladesh power and energy sector on a sustained path for a high-income economy. The main elements of the underlying strategies and policies are as following Table 3.2.3.

Table 3.2.3 Strategies and Policies for Electricity and Energy Sector in PP 2041

No.	Strategies and Policies
(i)	Adopting a least-cost power generation expansion path
(ii)	Promoting supply of low-cost primary energy
(iii)	Developing the required infrastructure for primary fuel
(iv)	Ensuring investment balance between generation, transmission and distribution
(v)	Promoting efficient use of installed capacity
(vi)	Promoting private investment in energy
(vii)	Further expanding power trade
(viii)	Ensuring proper energy pricing policy
(ix)	Strengthening power and energy institutions

Source: PP2041, GED

A core objective of the PP2041 power and energy strategy would be to eliminate the existing demand gap while meeting the new demand. Bangladesh already has considerable experience with developing a Power Sector Master Plan (PSMP). The PP2041 will develop a power expansion strategy in line with the 2016 PSMP and update this strategy every 5 years based on the lessons of experience.

3.2.1.11 Creating an Innovation Economy

Digital Bangladesh is an integral part of the government's Vision 2021 and Vision 2041. The Digital Bangladesh initiative includes the items shown in Table 3.2.4. Technologies like artificial intelligence, robotics, quantum computing and 3D printing are upending everything from agriculture to manufacturing to healthcare. Among different technologies, Robotics, and Automation are going to have a significant impact on jobs and the future of work.

Table 3.2.4 Digital Bangladesh Initiatives Indicated in PP2041

No.	Strategies and Policies
(i)	Developing human resources ready for the 21st century
(ii)	Connecting citizens in ways most meaningful to them
(iii)	Taking services to citizens' doorsteps
(iv)	Making the private sector and market more productive and competitive through the use of digital technology

Source: PP2041, GED

3.2.1.12 Building Transport and Communications Infrastructure for sustained growth

The Transport Sector Strategy for PP2041: will focus on the items shown in Table 3.2.5.

Table 3.2.5 Strategies and Policies for Transportation Sector in PP 2041

No.	Strategies and Policies
(i)	Strengthening long-term planning and priority setting
(ii)	Improving inter-modal transport balance
(iii)	Strengthening implementation capacity
(iv)	Introducing a time saving electrical Urban Mass Transit / Metro Rail Network to reduce urban traffic congestion and improve the natural environment
(v)	Ensuring sustainable financing of transport infrastructure
(vi)	Developing and implementing key policies for ensuring quality and reliability of transport services
(vii)	Strengthening management capabilities and efficiency of public transport authorities
(viii)	Implementing and operating modern transport facilities in line with the traffic needs of 2041

Source: PP2041, GED

As communications development strategy, PP2041 will build on the success of PP2021 and continue to modernize communications in Bangladesh. The PP2041 strategy will continue to provide policy and institutional support to private investment in expanding telecommunications network and services, boost the expansion of private print, audio and video media, and provide an enabling environment for competitive and healthy expansion of communication services and knowledge and information sharing. The PP2041 will implement the provisions of the Right to Information Act that supports the growth of an informed and democratic society.

3.2.1.13 Managing the Urban Transition

The PP2041 stipulations for the urban sector is shown in Table 3.2.6.

Table 3.2.6 Strategies and Policies for Urban Sector in PP 2041

No.	Strategies and Policies
(i)	Have an economy where some 80 percent of the population lives in urban areas
(ii)	An urban physical environment where there is a proper balance between ecology, the natural environment and needs of the urban population
(iii)	An urban social structure where there is no incidence of absolute poverty, and there are no slums
(iv)	An urban service industry that provides quality urban infrastructure and urban services on demand and in good quality
(v)	An urban governance structure that is elected by the residents, is responsive to the needs of the residents, and is largely self-financing with a healthy and sustainable combination of urban betterment taxes, predictable national government transfers, cost recovery from services provided and responsible borrowings

Source: PP2041, GED

3.2.1.14 Managing Environment and Climate Change for Sustainable Growth

Many laws and regulations have been enacted over the years to protect the environment and programmes and policies are in place to adapt and mitigate the adverse effects of climate change. This progress continued under the 6th FYP and 7th FYP, with special emphasis on air and water pollution control.

Fundamentally, the main focus of the PP2041 environmental management strategy would be to integrate environment and climate change considerations in the growth strategy. So, essentially, under PP2041 Bangladesh will adopt a green growth strategy. The specific strategies, policies and institutional reforms include the items shown in Table 3.2.7.

Table 3.2.7 Key Strategies, Policies, and Institutional Reform Items for Environmental Considerations and Climate Change Response in PP 2041

No.	Strategies and Policies
(i)	Integrating environmental costs into the macroeconomic framework
(ii)	Implementing the BDP2100 to build resilience and reduce vulnerability to climate change
(iii)	Reduce air and water pollution
(iv)	Removal of fuel subsidies
(v)	Adoption of green tax on fossil fuel consumption
(vi)	Taxation of emission from industrial units
(vii)	Prevention of surface water pollution
(viii)	Geo-spatial data analysis for evidence based decision making

Source: PP2041, GED

The objectives for environ sector and the core objectives and targets are shown in Table 3.2.8 and Table 3.2.9.

Table 3.2.8 Perspective Plan 2021-2041 Objectives for Environmental Sector

I. Some 80 per cent of the population lives in urban areas and enjoys a quality of life that is comparable to those found in the present-day high-income economies.
II. There is a proper balance between ecology, the natural environment and needs of the population. In particular, the productivity of land is preserved, forest resources are conserved and enriched, biodiversity and air quality are improved, pollution level is decreased and water resources are properly managed to prevent flooding and water shortages.
III. Cities are normally flood free with proper drainage, modern sewerage, proper waste management and clean air.
IV. There is minimal incidence of absolute poverty; there are no slums and every household have a basic minimum housing quality.
V. The country is equipped to respond fully and quickly to any incidence of natural disasters.
VI. Environmental governance is such whereby there is a sound mix of incentives and regulatory policies including the application of the polluter pays principle and a decentralized implementation of environmental policies and programmes.

Source: PP2041, GED

Table 3.2.9 Core Objectives and Targets for Environmental Management

Objectives/Targets	2018 Base Year Values	FY2041 Values
Share of urban population in total population (%)	30	80
Urban households with tap water connectivity (%)	40	100
Urban households with water-sealed sanitary toilets (%)	42	100
Urban households with modern sewerage connection (%)	N/A	100
Rural households with tap water connectivity (%)	0	50
Rural households with water-sealed sanitary toilets (%)	0	50
Rural households with safe sewerage connection	0	100
Incidence of poverty (%)	24	<3
Percent of population living in slums (%) Percent of household living in slums (UN definition)	55	0
Percent of urban centers with wastewater treatment facilities	N/A	100
Core environmental spending (% of GDP)	1	3.5
Spending by environment coordinating entity (% of GDP)	0.005	0.5
Application of polluter pays principle (% of cases)	0	100
Carbon tax (% of fuel prices)	0	15
Green area for Dhaka-major cities (square meter per capita)	N/A	5-12
Disaster readiness (%)	N/A	100
Urban water bodies compliance with water quality standards (%)	0	100
Air quality (annual average, µg/m^3 PM 2.5)	86	10
Percent of cities flood free with proper drainage	0	100
Percent of land degraded	18	5
Area under forest cover (% of land)	15	20
Protection of Habitat and Biodiversity International Ranking	Bottom 5%	Top 30%
Environmental Performance Index International Ranking	Bottom 5%	Top 30%

Source: GED Projections. Base year values show most recent available data

3.2.2 The Eighth Five Year Plan: 8FYP

3.2.2.1 Overview

The Eighth Five Year Plan (8FYP, July 2020 - June 2025) is a flagship document which contains the philosophy of realizing the 'Golden Bengal'. The 8FYP is as the first in the series of Five Year Plans to complete the agenda of achieving the social and economic transformation visualized in PP2041. The 8FYP would also be instrumental in attaining SDGs, realizing BDP2100 for smooth transition following the LDC graduation. The 8FYP mainly centers on six core themes, which included:

i) Rapid recovery from COVID-19

ii) GDP growth acceleration, employment generation, and rapid poverty reduction with a broad-based strategy of inclusiveness

iii) A sustainable development pathway resilient to disaster and climate change

iv) Sustainable use of natural resources and successful management of the inevitable urbanization transition

v) Development and improvement of critical institutions, and

vi) Attaining SDG targets and coping up the impact of LDC graduation

In the last fiscal year 2019-20, the GDP growth rate was recorded 5.2 percent which was attributed to the negative impact of the COVID-19 pandemic. With proper execution of well-planned strategies, schemes, and policies the Government of Bangladesh (GoB) has set targets to achieve annual GDP growth at 8.51 percent and reduce the poverty rate from 20.50 percent in FY2019 to 15.60 percent in the last fiscal year of the 8FYP, FY2025.

3.2.2.2 Implications from the Seventh Plan

The overall positive record of Seventh Plan implementation and associated progress in development measured in terms of poverty reduction, employment, human development and growth in incomes suggests that the Seventh Plan strategy was on the right track. Important gains have been made in securing many of the targets of Vision 2021. In particular, Bangladesh has attained lower middle- income status earlier than in 2021 while also achieved the MDG targets in most areas, especially poverty reduction. This solid performance suggests that the Eighth Plan should stay the course of the Seventh Plan and focus on areas where there are important performance gaps remain. The approach would be to pursue much of the same strategy in a way that consolidates the gains while addressing the several implementation gaps identified above. Based on the results of the Seventh Plan, the issues are summarized as follows.

(1) Issues Articulated in the 8FYP – 1

The COVID-19 reinforces the importance of speeding up many of the reforms where a performance gap has emerged. This includes revenue performance, private investment climate, export diversification and domestic job creation. The tax performance of Bangladesh has been slipping over a long period of time and this must be reversed quickly with important tax reforms under the 8FYP. Similarly, export diversification and expansion of a diversified manufacturing base are of utmost importance. This will not be possible without substantial increases in domestic and foreign private investment. The 8FYP will focus utmost attention to improving the investment climate for domestic and foreign private investment with a view to offsetting the lack-luster private sector investment performance in the 7FYP. Finally, the short-term unemployment resulting from COVID-19 including retrenchment of overseas workers will present an immense challenge in the very first year of the 8FYP. Job creation accordingly will be a top priority of the 8FYP.

In addition to the short-term recovery to the COVID-19 losses, strategic changes will be needed in several areas relating to healthcare and social protection. Both systems were heavily tested under the COVID-19 pandemic and the performance was weak with large gaps. The 8FYP will emphasize the need for a complete overhaul of the healthcare system which showed huge performance gaps in physical facilities, access to healthcare and availability of quality healthcare staff. The COVID-19 has also reinforced the need for a universal healthcare system with a combination of public and private health insurance scheme. Regarding the social security system, the slow progress in implementing the NSSS and the inability to increase funding for social protection-related income transfers to the poor and vulnerable will need to be addressed speedily both as a response to offset the negative effects of COVID-19 but also to increase the growth elasticity of poverty as well as economic recovery.

(2) Issues Articulated in the 8FYP – 2

In addition to the above immediate priority reforms, there are four areas where the Eighth Plan would need to probe deeper and take a more focused and comprehensive approach than was possible in the Seventh Plan. The first concerns the need to build stronger institutions. The Seventh plan's efforts to build important institutions like the local government, the urban institutions, land administration, strengthening of the National Board of Revenue and the Public-Private Partnership did not take deep roots. These lowered the capabilities and services provided by these institutions. The strengthening of the judiciary, the Election Commission and other democratic institutions are also long-term challenges that require continued efforts.

Secondly, implementation capacity in public agencies and ministries remain limited that adversely affected the implementation of major public investment programmes and public policies in transport and social sectors. Thirdly, stronger policy focus is needed in the area of income inequality. In particular, reform of public finances that increases the equity of tax collection and public spending are of substantial importance. Especially, the equity aspects of public spending on education and health require considerable effort.

Finally, despite progress, the programmes in environmental management and climate change remain of low impact because they are not properly incorporated in the mainstream economic policy management. Strong implementation of the Bangladesh Delta Plan (BDP2100) for sound management of water resources, climate change, natural disasters and other environmental hazards will be a major focus for the Eighth Plan. The integration of climate change and environmental management issues in growth and fiscal policy management will be another high priority issue for the Eighth Plan.

In conclusion, adequate progress under the 8FYP is not only necessary to stay on track to achieve the targets of PP2041, but also essential to achieve the SDG targets.

Outlines of sectors related to disaster risk reduction in the 8FYP are summarized below.

3.2.2.3 Disaster Management

The 8FYP will build on the progress made during the 7FYP, while also internalizing the lessons of past experiences. Furthermore, in order to address the losses and damages from natural disasters and climate change more effectively, the Government will undertake specific activities to ensure that the management of the environment is sufficiently improved under the 8FYP. These measures are summarized in Table 3.2.10.

Table 3.2.10 Specific Activities for Better Disaster Management under the 8FYP

1. Institutionalization of DRR and CCA. **2.** Promote private sector resilience to disasters and climate change risks through improved public private partnerships. **3.** Develop adaptive research on disaster and climatic issues **4.** Adopt proven technologies **5.** Develop a vulnerability index which will help channelize equitable resources to the targeted districts. **6.** Develop a focused and specific DRR-CCA indicator in the overall performance tracking for the plans, programmes and projects. **7.** Increase the number of recipients of social welfare/safety net allocations after any disaster.

8. Improve business processes and initiate financial management reform in MoDMR and DDM and relevant GoB agencies.
9. Develop a better coordination mechanism within the ministry and across the government.
10. Increased investments in gender sensitive DRR and climate risk reduction to reduce the cost for response and recovery.
11. Support skill development by giving training to GOs, NGO officials and volunteers concerned in Disaster Management and develop greater partnership with NGOs to improve "cyclone preparedness" capacity.
12. Incorporate best practices and technology in Disaster Management of Bangladesh from around the world.
13. Improve guidelines for Road and Water Safety.
14. Improve guidelines for Industrial Safety.
15. Improve guidelines for Disaster Shelter Management.
16. Strengthen Disaster Impact and Risk Assessment Guidelines.
17. Improve Emergency Fund Management Guidelines.
18. Improve early warning systems through relevant technology adoption.
19. Increase investments in training emergency responders to cope with extreme events.
20. Increase afforestation through a major programme along all coastal areas of the country.
21. Strengthen Indigenous Coping Mechanism Guidebook.
22. Enhance Community Risk Assessment Guidelines.
23. Improve Emergency Response and Information Management Guidelines.

Source: The Eighth Five Year Plan

In addition, the figures shown in Table 3.2.11 and Table 3.2.12 below are the targets for the specific activities listed above.

Table 3.2.11 Indicators for DRR-related Fields in the 8th Five-Year Plan

National Priority	Outcome Statement	Indicators	No. of Indicators
Environment, Climate Change and Disaster Management (SDG-13, 14 & 15)	The natural environment is preserved and prevented from degradation, and disaster management strategy exists, as well ensuring climate change adaptation and mitigation	Climate change	2
		Environment protection	4
		Air quality	1
		Disaster management	4

Source: The Eighth Five Year Plan

Table 3.2.12 Detailed Indicators for DRR-related Fields in the 8th Five-Year Plan

SL	Performance Indicators (i)	Data Source (Institutions & Reports) (ii)	Lead Ministry/Division (iii)	Baseline (Year) (iv)	Target (2021) (v)	Target (2022) (vi)	Target (2023) (vii)	Target (2024) (viii)	Target (2025) (ix)	Remarks (x)
	National Priority: Environment, Climate Change and Disaster Management (SDG-13, 14 & 15)									
	Outcome Statement: The environment is preserved and prevented from degradation, and a disaster management strategy exists as well as ensuring climate change adaptation and mitigation									
74	Consumption of ozone depleting H-CFCs (Ozone Depleting Potential (ODP))	DoE	MoEFCC	65.35 (2016)	47.22	47.22	30.5	26.5	23.61	SDG. 13.2.2
75	Forest area as a proportion of total land area (based on periodic survey)	BFD	MoEFCC	14.1 (2015)	14.4	14.6	14.8	15.0	15.2	SDG. 15.1.1
76	CO2 emissions (tonnes per capita)	DoE	MoEFCC	0.91 (2011)	-	-	-	-	1.38	SDG. 13.2.2
77	Coverage of protected areas in relation to marine areas	DoF	MoEFCC	2.05 (2016-17)	4.73	-	-	-	7.94	SDG. 14.5.1
78	Percentage of wetland and natural sanctuaries maintained	MoFL	MoFL	1.51 (2014-15)	1.70	1.85	2.0	2.10	2.20	SDG. 15.1.2
79	Percentage of forests that are protected	BFD	MoEFCC	3.06 (2020)	3.20	3.25	3.30	3.35	3.40	
80	Mean urban air pollution of particulate matter (a) PM10 in $\mu g/m^3$ (b) PM2.5 in $\mu g/m^3$	DoE	MoEFCC	(a)145 (2017) b) 85 (2017)	140 83	135 81	130 78	125 75	120 73	
81	No. of usable cyclone shelters	DDM	MoDMR	4014 (2019)	4,047	4,247	4,447	4,647	4,847	
82	Developing Guidelines for Risk Reduction as Mentioned in revised SoD	DDM/ MoDMR	MoDMR	04 (2020)	07	10	13	16	19	SDG 1.5
83	Number of housing with disaster resilient habitats and communities assets	DDM	MoDMR	70,000 (2020)	1,50,000	2,30,000	2,90,000	3,40,000	3,80,000	SDG 11.b
84	Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population	BBS	MoDMR	Affected Persons: 12,881per 100,000 people (BDRS, BBS, 2015) Death person: 0.2045 (MoDMR, 2016)	6000	5000	4000	3000	2000	SDG. 13.1.1

Source: The Eighth Five Year Plan

3.2.2.4 Water Resource Management

The objectives and targets of the water sector for the 8th Plan have been set out in conformity with the 2041 and the BDP2100. The objective of the water sector in the 8th plan is to scale up existing good practices of water conservation and management and apply more widely integrated water management, including flood control and prevention schemes, flood early warning systems, irrigation improvement, and demand-side management as advocated in BDP2100. The strategic objectives include:

- ✓ Continuing and strengthen river dredging to enhance navigability and to facilitate water transportation;
- ✓ Increasing water use efficiency in crop production and enhance the utilization of surface water irrigation;
- ✓ Protecting riverbank from erosion through integrated long-terms measures;
- ✓ Ensuring conjunctive use of surface and ground water for sustainable irrigation, securing groundwater conservation;
- ✓ Strengthening regional and international cooperation for basin-wide water resources development and management of trans-boundary rivers;
- ✓ Preventing of saline intrusion through augmenting the freshwater flow in the southwest region including the Sundarbans;
- ✓ Developing modern early warning systems to minimize economic losses from flood and other disasters;
- ✓ Adapting of climate change mitigation strategies;
- ✓ Rain water harvesting;
- ✓ Implementing integrated coastal zone management strategies;

- ✓ Strengthening capacities of the institution in the water resource management;
- ✓ Mainstreaming Valuing Water into Public Investment Decision Making in collaboration with Planning Commission to allow for future investment decisions which further support sustainable water resources management and thus sustainable economic development;
- ✓ Identifying and demonstrating options to incorporate Valuing Water into private sector decision making in order to lead to more sustainable investment and operational choices.

The specific numerical targets for the water sector of the 8FYP based on the strategic objectives described above are shown in Table 3.2.13 below.

Table 3.2.13 Eighth Five Year Plan Targets for the Water Sector

Indicator	Targets (per year)
Bank protection work (km)	2,356
Embankment construction/reconstruction (km)	3,949
Coastal embankment construction (km)	1,043
Dredging of river (km)	2,817
Excavation/re-excavation drainage canal (km)	17,042
Excavation/re-excavation irrigation canal (km)	1,119
Water control structure/hydraulic structure (Nos.)	2,050
Coastal cross-dam (Nos.)	7
WMG/WMA/WMF formulation (Nos.)	363
WMG/WMA/WMF registration (Nos.)	581
Land acquisition (Hectare)	7159

Source: Ministry of Water Resources (MoWR) and Local Government Engineering Department (LGED), 8FYP.

The investment plan is broken down into suggested programmes for 8FYP and the 9FYP. The summary features of the proposed new delta investment programmes for the 8FYP by hotspots, program objectives and indicative aggregate cost measured in 2015 prices are shown in Table 3.2.14. The total new Delta investments proposed for the 8FYP amounts to 47 new projects involving a total cost of BDT 1400 billion or US$17.6 billion in 2015 prices. These convert to Taka 1940 billion in FY2021 prices (US$21.7 billion).

Table 3.2.14 Proposed Delta Public Investment Programmes (PIP) for the 8FYP (2015 Prices)

Hotspot	Programme Name / Coverage	Cost (billion)
Programme 1 Urban Areas	Flood Free Cities Improvement of Drainage Congestion, Canal Dredging and Flood Control for Dhaka, Chattogram, Barisal, Khulna Cities Investment Plan project codes: UA 1.2; UA 1.3; UA 3.1; UA 9.3; UA10.1; UA 11.1.	-- BDT 138.8 -- US$ $1.75
Programme 2 Barind and Drought Prone Area	Barind New Food Belt Revitalization and Rationalization of Hurasagar / Atrai Rivers and Kurigram Irrigation Project Investment Plan project codes: DP 1.2; DP 1.21; DP 1.3; DP1.4/1.5	-- BDT129.2 -- US$ 1.63
Programme 3 Chattogram Hill Tracts	Facilitating Living in the Hills Rationalization of polders, Development of Catchment Management Plans and Kaptai Lake Rehabilitation Study with Pilot Project Investment Plan project codes: CH 1.10; CH 1.11; CH 26.2; CH 26.1	-- BDT16.7 -- US$ 0.21
Programme 4 Coastal Zone	Safe and Resilient Coast Integrated Coastal Zone Management (West-Gopalganj; Bhabadha Area; Bhola Island) and Polder Rationalization (Baleswar-Tentulia Basin; Gorai Passur Basin; Gumti-Muhuri Basin) Investment Plan project codes: CZ 1.8/1.21; CZ 1.11/1.38; CZ 1.26; CZ 1.3; CZ 1.48; CZ 1.41; CZ 1.44; CZ 1.40; CZ 1.45; CZ 1.47; CZ 1.30; CZ12.8	--BDT358.6 -- US$ 4.52
Programme 5 Major Rivers	Stable and Lively Rivers River Stabilization and Enhancement of Char Land Investment Plan project codes: MR 1.1; MR 1.5; MR 1.46; MR 3.1; MR 12.1	-- BDT 205.1 -- US$ 2.6

Hotspot	Programme Name / Coverage	Cost (billion)
Programme 6 Haor Area	Restoring Haor Ecosystems Rationalization of Haors, Village Protection and Sustainable Wetland Management Investment Plan project codes: HR 2.1/2.2; HR 1.1; HR 14.1; HR 14.3; HR 15.4/5	-- BDT 23.6 -- US$ 0.30
Programme 7 Cross Cutting	Safe and Clean Water Supply Climate Resilient & Holistic IWRM, Piped Water Supply and Ground Water Management Investment Plan project codes: CC 1.4; CC 1.3; CC 12.37; CC 16.19; CC 9.10; CC 1.43; CC 1.45; CC 1.46; CC 18.5; CC9.17	-- BDT 527.7 -- US$ 6.65
Total		-- BDT 1399.7 -- US$ 17.63

Source: The Eighth Five Year Plan

3.2.2.5 Climate Change Adaptation

Looking into the future, policymakers aim to increase growth from 8.15% in FY19 to 8.51% in FY25 and sustain an average economic growth rate of 9% between FY21 to FY41 in order to attain a High-Income Country status by FY41. This long-term aspiration of development, however, necessitates that Bangladesh reconciles its strategies for growth and social development with renewed attention to nature, climate, and the underlying economic system that made our economy unsustainable and exposed to pollution, degradation of environment and ecosystem risk to climate and disaster risk. Therefore, the 8FYP recognizes Bangladesh’s commitment to Rio Convention, Paris Agreement and Sendai Framework on Disaster Risk Reduction and Sustainable Development Goals.

The Eighth Five Year Plan will focus on integrating economic progress, environment, climate change and disaster management concerns into planning and budgeting with the goal of attaining sustainable development. In this context, appropriate policy and institutional capacity building for sustainable water and land management, biodiversity conservation, climate resilient development and disaster management are crucial at all levels of government, especially with a greater emphasis at the local government level where most of the programmes are to be implemented. The Eighth Plan will also incorporate a strategy of green growth to harmonize economic growth for better environmental sustainability.

Sustainable development targets and strategies relating to environment, climate change and forest management in the 8FYP will essentially draw on the long-term goals and strategies articulated in the PP2041. Based on that, the core targets for environmental management under the 8FYP are summarized in Table 3.2.15.

Table 3.2.15 Core Targets for Environmental Management

Objectives / Targets	Base Year (2018)	Target (2025)
Per cent of urban centers with wastewater treatment facilities	N/A	50
Core environmental spending (% of GDP)	1	1.5
Spending by environment coordinating entity (% of GDP)	0.005	0.1
Application of polluter pays principle (% of cases)	0	40
Carbon tax (% of fuel prices)	0	5
Green area for Dhaka-major cities (square meter/million people)	N/A	1-4
Disaster risk reduction and management readiness (% of population)	N/A	50
Urban water bodies compliance with water quality standards (%)	0	50
Air quality (annual average, µg/m^3 PM 2.5)	86	60
Per cent of cities flood-free, with proper drainage	0	45
Per cent of land degraded	18	12
Area under forest cover (% of land) [base year 2015]	14.1	15.2
Protection of Habitat and Biodiversity International Ranking	Bottom 5%	Top 50%

Source: GED Projections. Base year values show most recent available data

3.2.3 Sendai Framework for Disaster Risk Reduction (SFDRR)

3.2.3.1 Background of SFDRR Adoption

In 1987, the UN designated the 1990s as the International Decade for Natural Disaster Reduction (IDNDR), in which a resolution was adopted to significantly reduce the damage caused by natural disasters[24]. In 1989, the General Assembly of the United Nations adopted a resolution to establish the International Day for Disaster Reduction, to promote international cooperation in the implementation of disaster prevention measures in countries around the world, and to establish a United Nations Secretariat. In 1994, World Conference on Natural Disaster Reduction was held in Yokohama in Japan. At this conference, the Yokohama Strategy and Plan of Action for a Safer World was adopted. In this strategy, basic recognition is written as; Sustainable economic growth and sustainable development cannot be achieved in many countries without adequate measures to reduce disaster losses, and there are close linkages between disaster losses and environmental degradation. During the conference, ten principles were identified such as risk assessment, disaster prevention, and environmental protection.

During the IDNDR up to 1999, country-level DRR initiatives were developed, and regional DRR cooperation mechanisms were enhanced, including the establishment of the Asian Disaster Reduction Center. Under this international trend, the UN General Assembly adopted the International Strategy for Disaster Reduction in December 1999 and established United Nations International Strategy for Disaster Reduction (UNISDR). The term Mainstreaming Disaster Risk Reduction (DRR) has been used since 2000, when UNISDR was launched. This term was used in the Implementation of the International Strategy for Disaster Reduction Report of the Secretary-General[25] in the context of sustainable development. In August 2002 living with risk: a global review of disaster reduction initiatives, the first UN white paper on DRR, was issued in cooperation with Japan, the US, European countries, and the Philippines.

The 2nd UN World Conference on Disaster Reduction was held in January 2005 in Kobe City, Hyogo, Japan. The Hyogo Framework for Action 2005-2015 (HFA) was adopted at this conference. UNISDR explains HFA as; Hyogo Framework for Action (HFA) is the first plan to explain, describe and detail the work that is required from all different sectors and actors to reduce disaster losses. It was developed and agreed on with many partners needed to reduce disaster risk -governments, international agencies, disaster experts, and many others - bringing them into a common system of coordination.

The HFA outlines five priorities for action and offers guiding principles and practical means for achieving disaster resilience. Its goal is to substantially reduce disaster losses by 2015 by building the resilience of nations and communities to disasters. This means reducing the loss of lives and social, economic, and environmental assets when hazards strike.

The great East Japan Earthquake and Tsunami occurred in March 2011. A high number of victims and enormous damage to the economy were caused by the subduction-zone earthquake of magnitude 9.0 and tsunami on the Pacific Ocean coast, Tohoku and Kanto regions. This large-scale, multiple-disaster was challenging even for Japan, a leading country in DRR with a long history of implementing a series of countermeasures.

Meanwhile, this disaster brought valuable scientific expertise in natural disasters and new lessons in DRR. In 2012, the Government of Japan hosted the World Ministerial Conference on Disaster Reduction in Tohoku in July and Sendai Dialogue: 2012 International Monetary Fund -World Bank Group Annual Meetings (co-hosted by the World Bank) in October. Discussion on the Mainstreaming of DRR was made in the two conferences. After that, in March 2015, the 3rd UN World Conference on Disaster Risk Reduction was held in Sendai City, an area affected by the Great East Japan Earthquake.

3.2.3.2 Contents of SFDRR

The Sendai Framework for Disaster Risk Reduction 2015-2030 (hereinafter referred to as "Sendai Framework") was adopted at the 3rd World Conference on Disaster Reduction in 2015. It is characterized by significant shifts to proactive disaster risk reduction from the disaster response. It also includes the

[24] UN General Assembly Resolution 44/236, 22 December 1989 (https://undocs.org/)
[25] UN General Assembly Economic and Social Council, 8 May 2001 (https://digitallibrary.un.org/record/443256?ln=en)

definition of seven global targets, goals focused on preventing new risk, reducing existing risk, and strengthening resilience, as well as a set of guiding principles including the primary responsibility of states. Building on previous guidelines, the SFDRR reflects new approaches and roles for practical disaster science to reduce risks in quantifiable ways with objective targets.

In line with the guiding principles of inclusivity and shared responsibility, the Sendai Framework recognizes and describes the critical role of all stakeholders, beyond states, in light of their competence and resources and thus potential contribution toward disaster risk management. This will open new opportunities for partnership and the strengthening of governance mechanisms to efficiently and effectively manage disaster risk.

Although the underlying mandate of the Sendai Framework is risk reduction to reduce damage, recovery features prominently in priority 4 as shown below, where strong connections are made between DRR, urban recovery, and development.

The framework is built on four priority areas of action which are integrated into the goals and activities:

Priority 1: Understanding disaster risk;

Priority 2: Strengthening disaster risk governance to manage disaster risk;

Priority 3: Investing in disaster risk reduction for resilience;

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

To support the assessment of global progress in achieving the outcome and goal of the Sendai Framework, seven global targets have been agreed upon. These targets will be measured at the global level and will be complemented by work to develop appropriate indicators. National targets and indicators will contribute to the achievement of the outcome and goal of the present Framework. The seven global targets are:

a. Substantially reduce global disaster mortality by 2030, aiming to lower the average per 100,000 global mortality rate in the decade 2020–2030 compared to the period 2005– 2015;

b. Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 in the decade 2020–2030 compared to the period 2005–2015;

c. Reduce direct disaster economic loss concerning to the global gross domestic product (GDP) by 2030;

d. Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030;

e. Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020;

f. Substantially enhance international cooperation with developing countries through adequate and sustainable support to complement their national actions for implementation of the present Framework by 2030;

g. Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030.

3.2.4 Sustainable Development Goals (SDGs)

Officially known as ‘Transforming our World: The 2030 Agenda for Sustainable Development, the Sustainable Development Goals (SDGs), is a set of 17 aspirational “Global Goals” with 169 targets between them. The SDGs were adopted at the UN Sustainable Development Summit in 2015, USA. The SDGs aim to place countries and the planet on a more sustainable path by 2030. These goals are the foundation of an ambitious new development agenda that seeks to end poverty, help the vulnerable, transform lives and protect the planet. The 17 SDGs are expected to guide policy and funding for the next 15 years. The SDGs build on the success of the Millennium Development Goals (MDGs). The MDGs helped establish measurable, universally approved objectives for eradicating extreme poverty and hunger, preventing deadly but treatable diseases, and expanding educational opportunities for all.

Disaster risk reduction for resilience is the foundation for achieving the SDGs. Each of the SDGs relies on reduced disaster impacts to meet its targets.

Several goals and targets can contribute to reducing disaster risk and building resilience, even if they are not explicitly stated concerning disaster risk reduction. These include targets related to promoting education for sustainable development; building and upgrading education facilities, and ensuring healthy lives, among others.

Reducing disaster risk and building resilience are interrelated thrusts of the 2030 Agenda for Sustainable Development and the Sendai Framework for Disaster Risk Reduction 2015-2030. This convergence offers unprecedented opportunities for building resilience.

The framework for the implementation of the 2030 Agenda and its linkages with the Sendai Framework for Disaster Risk Reduction 2015-2030 can help ensure that disaster risk reduction is mainstreamed across all sectors of sustainable development and climate change adaptation. In particular, disaster risk reduction and resilience-building are closely related to the following SDGs.

Table 3.2.16 SDG Targets Closely Relevant to DRR

Goal	Target
Goal 1. End poverty in all its forms everywhere	Target 1.5: By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters
Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture	Target 2.4: by 2030 ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters, and that progressively improve land and soil quality
Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	Target 9.1: Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all.
	Target 9.a: Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States.
Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable	Target 11.5: By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations
	Target 11.b: By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels
	Target 11.c: Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials

Goal	Target
Goal 13: Take urgent action to combat climate change and its impacts	Target 13.1: Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries
	Target 13.2: Integrate climate change measures into national policies, strategies and planning
	Target 13.3: Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning
Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	Target 15.3: By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world

Source: Prepared by JICA Survey Team based on UN Website (https://sdgs.un.org/goals)

CHAPTER 4 CURRENT SITUATION AND ISSUES IN DISASTER RISK REDUCTION SECTOR

4.1 DRR Governance

4.1.1 Initiatives by the Government of Bangladesh

4.1.1.1 Legislation, Organization and Budget for the DRR Sector

(1) Overview

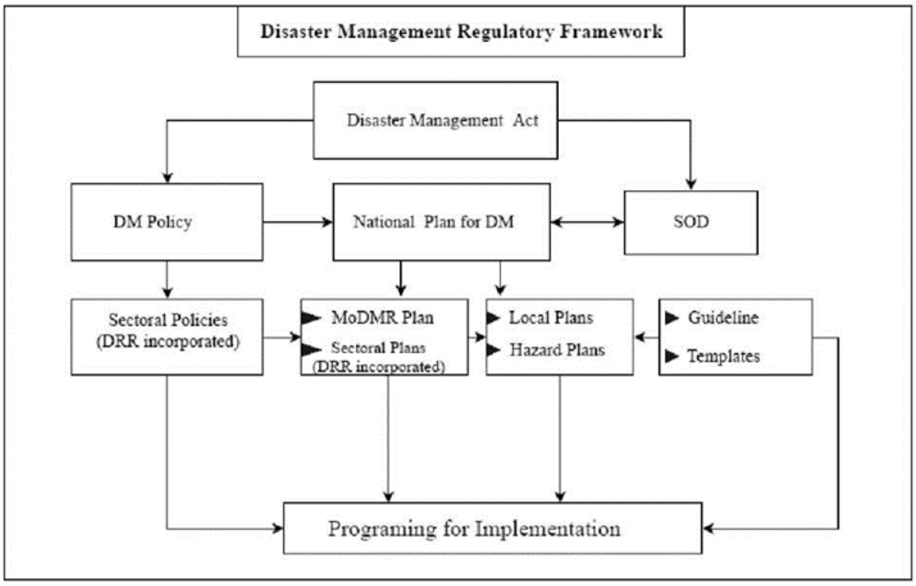
According to the Eighth Five-Year Plan, the government recognizes the proneness to disasters and has formulated various laws and plans to develop an effective response capacity to the threat of natural disasters. The Disaster Management vision of the government is to reduce the risk of people, especially the poor and the disadvantaged, to a manageable and acceptable humanitarian level. Also, the vision includes an efficient emergency response management system capable of handling large-scale disasters. Some of the notables are mentioned in Table 4.1.1. In particular, the central laws and action plans that guide policies and activities under disaster management are the “Bangladesh Delta Plan 2100”, “National Plan for Disaster Management 2016–2020 and 2021-2025” and “Standing Orders on Disasters 2019”. The overall objective of disaster management is to reduce the underlying risks and to promote adaption to the effects of climate change. This will result in a substantial reduction in the losses, of lives and in the social, economic and environmental assets of persons, communities and the country from disasters.

Table 4.1.1 National Legislations and Policies Related to Disaster Management

Category	Policy Document	Description
Law	Disaster Management Act, 2012	It establishes the legal basis for the structure, activities, and funding for the purpose of strengthening coordinated disaster management activities by relevant organizations and building an effective disaster management infrastructure that can respond to all types of disasters..
Policy	National Disaster Management Policy, 2015	It defines the national perspective on disaster risk reduction and emergency management, and describes broad national goals and strategies for disaster risk management in Bangladesh..
	Coastal Zone Policy, 2005	It is a policy guideline for comprehensive coastal zone management and sets out policy content in several sectors including disaster risk management, water resources management, and climate change countermeasures.
Plan	Bangladesh Delta Plan 2100, 2018	It is a long-term comprehensive development plan that focuses on economic growth, environmental conservation, and strengthening resilience to climate change.
	National Plan for Disaster Management (NPDM), 2016-2020	As a national DRR plan, it presents a vision, strategies, and priority areas for DRR activities over a five-year period. The emphasis is on flexibility and adaptability in light of new risks related to urbanization and climate change, the need for DRR for sustainable development, and the changing nature of risk.
	National Plan for Disaster Management (NPDM), 2021-2025	It is a revised version of the NPDM 2016-2020, presenting the vision, objectives, content of cross-sectoral arrangements, and changing risk situations for disaster risk management activities over a five-year period. It has been prepared taking into account the alignment with international disaster reduction policies, and in particular with the goals, priorities, and key activities of the SFDRR.
Regulation	Standing Order on Disasters (SOD), 2019	It defines the detailed roles and responsibilities of relevant ministries and departments, relevant agencies, communities, representatives of public institutions, residents, etc. with regard to disaster risk management.
Programme	National Adaptation Programme of Action, 2005	It outlines 15 priority actions for addressing climate change, including awareness raising, capacity building, and project implementation in vulnerable areas with a focus on agriculture and water resources.

Source: Prepared by JICA Survey Team based on The Eighth Five Year Plan

The disaster management regulatory framework is shown in Figure 4.1.1.



Source: Disaster risk governance for district-level landslide risk management in Bangladesh, International Journal of Disaster Risk Reduction, 2021[1]

Figure 4.1.1 The Disaster Management Regulatory Framework

In addition to the laws and plans listed in Table 4.1.2, there are other laws and regulations in place to address each disaster type separately. These significant laws related to disaster management are listed in Table 4.1.2 below.

Table 4.1.2 The Major Laws in Bangladesh Related to Disaster Risk Reduction

Disaster Management Acts (Bangladesh)
Disaster Management Act 2012
The Famine Insurance Fund Act, 1937 (Bengal Act) (ACT NO. III OF 1938)
Urban & Regional Planning Act, 2017
Bengal Rent Act 1859 The Alluvion and Diluvion Regulation, 1825 (Bengal Regulation XI of 1825) The Bengal Alluvial Lands Act 1920 The Bangladesh Inland Water Transport Corporation Order, 1972 (PRESIDENT'S ORDER NO. 28 OF 1972) The Protection and Conservation of Fish Act, 1950 (East Bengal Act) (ACT NO. XVIII OF 1950) The Territorial Waters and Maritime Zones Act, 1974 (ACT NO. XXVI OF 1974) The Inland Shipping Ordinance, 1976 (Ordinance NO. LXXII OF 1976)
BCA: Building Construction Act, established in 1952, revised in 2006 BCR: Building Construction Rules, established in 1953, revised in 2006 BNBC: Bangladesh National Building Code, established in 1993, revised in 2017 Dhaka Metropolitan Building Construction Rules, established in 1996, revised in 2008
Fire Prevention and Extinction Act, 2003 Fire Prevention and Extinction Rules, 2014
The Bangladesh Environment Conservation Act, 1995 (Act No. 1 of 1995)
The Forest Act, 1927 (ACT NO. XVI OF 1927)
Water Act 2013 The Embankment and Drainage Act, 1952 (East Bengal Act) (ACT NO. I OF 1953) The Irrigation Act, 1876 (ACT NO. III OF 1876)
Meteorological Act, 2018 (Act No. XXVIII of 2018)
Economic Zone Act in 2010

Source: JICA Survey Team

Bangladesh has many laws related to coastal and riverine lands, probably because of the high rate of land loss/formation due to river/coastal erosion.

[1] https://reader.elsevier.com/reader/sd/pii/S2212420921001862?token=DB945461A4CA0F87CCC146F9481D51545BA7B5022D5220DEE64876C61D501840E051FABA5DF5B793B20C3EACA4D81CCC&originRegion=us-east-1&originCreation=20220109025704

In addition, Bangladesh does not have any practical laws, ordinances, rules and regulations or requirements for disaster recovery assessment that exist in Japan (e.g., Disaster Relief Act, Act on National Treasury's Sharing of Expenses for Project to Recover Public Civil Engineering Works Damaged by Disaster, etc.).

(2) Disaster Management Act 2012

The Disaster Management Act of 2012, which became effective in September 2012, establishes the legal basis for structures, activities, and funds to strengthen coordinated disaster management activities by relevant organizations and to build effective disaster management infrastructure that can respond to all types of disasters. The Act stipulates the contents shown in Table 4.1.3 below.

Table 4.1.3 Outline of the Disaster Management Act

Chapter	Contents
1	Preamble
2	Organizational Structure of Disaster Management
3	Disaster zone declaration, participation of different forces, etc.
4	Disaster Management Fund, Relief vault, etc.
5	Offense, punishment, etc.
6	Miscellaneous

Source: JICA Survey Team based on the Disaster Management Act

This law also provides a legal basis for the implementation of Standing Orders on Disaster (SOD) and the formulation of disaster prevention plans at each level.

As a framework, this act provides a legal basis for Committees described in SOD such as the National Disaster Management Council (NDMC), the National Disaster Response Coordination Group (NDRCG), and the disaster management committees at each level. It also describes the outages and follow-ups of the Directorate of Relief and Rehabilitation (DRR) and the Disaster Management Bureau (DMB).

According to the Disaster Management Act, the NDMC, comprised of the Prime Minister as Chairperson, and the associated ministers, the ministry secretaries and the military (army, navy, air force) representatives as members, has been established as the agency with supreme responsibility for disaster risk management in Bangladesh. Under the NDMC, the Inter-Ministerial Disaster Management Coordination Committee (IMDMCC) is established at the national-level to formulate and implement policies, plans, and programs related to disaster risk mitigation and emergency response management. The IMDMCC is chaired by the Minister of MODMR, vice-chaired by the Chief Secretary of the Cabinet, and the secretaries of the relevant ministries and agencies as members, and is stipulated to be responsible for disaster management.

(3) National Disaster Management Policy 2015 (NDMP)

The National Disaster Management Policy (NDMP) was established in 2015 under Section 19 of the Disaster Management Act, 2012. The policy defines the national perspective on disaster risk reduction and emergency management, and describes broad national goals and strategies for disaster management in Bangladesh.

1) Goal

The goal of NDMP is to reduce the people affected by various types of disasters, including natural, environmental and human-made disasters, especially the poor and underprivileged. This goal also focuses on coping with large-scale disasters, improving the capacity of residents and preparing effective emergency response systems.

2) Strategy

The disaster risk management strategy for Bangladesh based on the NDMP is as follows.

✓ Establish the significance of disaster patience and strength, disaster preparedness and risk mitigation through knowledge improvement, technology application and education.

- ✓ Effective strategies and their application to address disaster risk through the effective participation of residents in disaster management policies.
- ✓ Establish effective disaster management policies by improving the organizational framework related to disaster risk mitigation.
- ✓ Encourage preparations for disaster prevention and start risk mitigation activities based on local culture and values.
- ✓ Develop effective risk and disaster management strategies by building partnerships between government and non-governmental agencies that contribute to the implementation of risk mitigation activities.
- ✓ Ensure media participation in disaster risk mitigation activities.
- ✓ Encourage community-level knowledge, community-specific technologies, and low-cost, sustainable methods to be incorporated into disaster risk reduction activities.
- ✓ Begin focus on the process of disseminating alerts in remote areas and to the community through the development of modern and effective disaster alerting and alerting systems.
- ✓ Empower local governments and encourage their active involvement in the process of implementing disaster risk mitigation activities. To build an efficient, technically superior, quick and effective response system. The Bangladesh Official Bulletin (Additional) dated September 14, 2015 states that this approach will be rolled out nationwide as part of disaster preparedness aimed at implementing disaster response activities that will lead to the formation of community-based disaster volunteer groups.
- ✓ A campaign that combines rehearsals and training is held once a year in collaboration with government agencies and non-government agencies that respond to risk management activities to give the responsible organization a sense of professionalism.
- ✓ Develop guidelines for international and regional cooperation in disaster response activities.

(4) Coastal Zone Policy 2005

The coastal areas in Bangladesh are vulnerable to natural hazards, which have a negative impact on people's livelihoods and the natural environment. These natural hazards are one of the factors slowing down the country's social and economic development. On the contrary, coastal areas have development potentials, where sustainable development is expected to contribute not only to poverty reduction but also to the development of the whole country. In order to promote efficient use of resources and optimal development of coastal areas, a participatory and holistic approach was necessary to reduce conflicts between stakeholders.

In this context, MoWR established the Coastal Zone Policy (CZPO) in 2005 with the aim of reducing poverty, protecting the environment, improving sustainable livelihoods, and creating an integrated development process for the country, including coastal zones. The CZPO is a general guideline for integrated coastal zone management, which requires all stakeholders to implement and manage coastal zone development projects in accordance with the CZPO policy. The targeted coastal areas are vulnerable coastal areas (19 districts) that are directly or indirectly affected by natural disasters such as saltwater intrusion due to cyclone/cyclone storm surges. This policy mentions a total of 48 Upazilas that are vulnerable to natural disasters.

The contents related to disaster management, water resources management, and climate change preparedness are shown below.

Table 4.1.4 Disaster Management, Water Resources Management and Climate Change Measures Defined in the Coastal Zone Policy

Disaster Management
• Reduction of vulnerability to natural disasters would be an integral aspect of the national strategies for poverty reduction; • The integration will be made with 'Comprehensive Disaster Management Plan' on aspects concerning the coastal zone; • Effective measures will be taken to enhance the coping capacity of the poor during the period of disaster and to initiate insurance schemes for improving their social security; • Effective measures will be taken for protection against erosion and rehabilitation of the victims of erosion; • Safety measures will be enhanced by combining cyclone shelters, multi-purpose embankments, killas, road systems, and disaster warning systems. It should include special measures for children, women, the disabled, and the old; • Sea dikes will be regularly maintained as the first line of defense against storm surges and afforestation on it according to the existing policy; • Earthquake management will be strengthened and the capacity to cope with earthquakes will be enhanced; • Adequate provisions will be made for the safety of livestock during disaster and post-disaster periods; • Programs shall be taken to encourage all tree plantations in a planned manner in the coastal zone. Emphasis will be given to social forestry and other forms of a plantations, plant care, and maintenance; • The asset base of the poor, with a special focus on women, shall be improved through ownership or access so that their coping capacity improves.
Water resources management
• Adequate upland flow shall be ensured in water channels to preserve the coastal estuary ecosystem threatened by the intrusion of soil salinity from the sea; • Small water reservoirs shall be built to capture tidal water in order to enhance minor irrigation in coastal areas. An appropriate water management system within the polder utilizing existing infrastructure will be established for freshwater storage and other water utilization; • Rainwater harvesting and conservation shall be promoted; • Ponds and tanks will be excavated for conservation of water and local technology for water treatment (such as pond sand filtering - P.S.F.) will be used for the supply of safe water; • The step will be taken to ensure sustainable use and management of groundwater.
Climate change adaptation
• Existing institutional arrangements for monitoring climate change in Bangladesh will continue. Steps will be taken to support the upgrading of technology and institutional strengthening to enhance their capacity for the generation of better data and more accurate long-term predictions and risk related to climate change; • Implementation of adaptive measures identified in relation to climate change for coastal zones and resources shall be gradually undertaken; • Efforts shall be made to continuously maintain sea dikes along the coastline as the first line of defense against predicted sea-level rise; • An institutional framework for monitoring/detecting sea level rise shall be made and a contingency plan for coping with its impact.

Source: Coastal Zone Policy 2005 (http://nda.erd.gov.bd/en/c/publication/coastal-zone-policy-2005)

(5) Bangladesh Delta Plan 2100: BDP2100

Bangladesh Delta Plan 2100 (BDP2100) is a long-term comprehensive development plan focusing on economic growth, environmental conservation, and climate resilience in view of the long-term challenges posed by climate change and natural disasters. The General Economics Division (GED) of the Planning Commission of the Government of Bangladesh has formulated the BDP 2100, with technical support from Dutch government in 2018 based on best practice of in delta management in the Netherlands. BDP 2100 aims to integrate and resolve long-term challenges of sustainable management of water, ecology, environment and land resources in the context of their interaction with natural disasters and climate change.

BDP 2100 sets a long-term vision for the further development of Bangladesh by the end of the 21st century, as well as the medium-term goals of Bangladesh to achieve upper middle income (UMIC) status and eliminate extreme poverty by 2030, and being a prosperous country beyond 2041 as steps toward reaching that vision.

BDP 2100 takes an adaptive approach in which strategies, policies, institutions, and investments to achieve the above goals will be reviewed and updated as appropriate in response to changing circumstances.

1) __

The Bangladesh Delta is variously defined in the literature. This report uses the most expansive definition of the delta that basically encompasses almost all districts of Bangladesh because they face numerous weather and climate change risks related to their location either around the sea, around major rivers or in water scarce zones. Hence, hydrology plays a major role in delineating the planning regions for the preparation of the BDP 2100. Using the eight hydrological zones as the starting point, the focus has been sharpened on the magnitude of the natural hazard vulnerabilities facing each of the hydrological regions. This has led to a modified grouping of districts and areas facing similar risks of natural hazards and climate change. These groups are called Hotspots that simply define a broad grouping of districts and areas facing similar natural hazard and climate change risks.

The Six Hotspots and number of districts covered are summarized below. Because of geographical overlap, some districts may fall in more than one Hotspot.

1. Coastal Zone (27,738 sq. km);
2. Barind and Drought Prone Areas (22,848 sq. km);
3. Haor and Flash Flood Areas (16,574 sq. km);
4. Chattogram Hill Tracts (13,295 sq. km);
5. River System and Estuaries (35,204 sq. km); and
6. Urban Areas (19,823 sq. km).

Table 4.1.5 Mapping of Districts to Hotspot Areas

Hotspots	No. of Districts	Name of District
Coastal Zone	19	Bagerhat, Barguna, Barishal, Bhola, Chandpur, Chattogram, Cox's Bazar, Feni, Gopalganj, Jashore, Jhalkati, Khulna, Lakshmipur, Narail, Noakhali, Patuakhali, Pirojpur, Satkhira, Shariatpur.
Barind and Drought Prone Areas	18	Bogura, Chuadanga, Dinajpur, Gaibandha, Joypurhat, Kushtia, Meherpur, Naogaon, Natore, Nawabganj, Nilphamari, Pabna, Panchagarh, Rajshahi, Rangpur, Satkhira, Sirajganj, Thakurgaon
Haor and Flash Flood Areas	7	Brahmanbaria, Habiganj, Kishoreganj, Moulvibazar, Netrokona, Sunamganj, Sylhet
Chattogram Hill Tracts	3	Bandarban, Khagrachhari, Rangamati
River Systems & Estuaries	29	Barguna, Barishal, Bhola, Bogura, Chandpur, Cumilla, Faridpur, Feni, Gaibandha, Gopalganj, Jamalpur, Kurigram, Lakshmipur, Lalmonirhat, Madaripur, Manikganj, Munshiganj, Narayanganj, Natore, Chapai Nawabganj, Noakhali, Pabna, Potuakhali, Rajshahi, Rajbari, Shariatpur, Sirajganj, Tangail, Khulna
Urban Areas	7	Barishal, Chattogram, Dhaka, Khulna, Rajshahi, Rangpur, Sylhet
Relatively Less Hazard Prone (RLHP) Areas	6	Gazipur, Jhenaidah, Magura, Mymensingh, Nilphamari, Sherpur

Source: BDP 2100 Analysis, GED, 2015 and ICZM Policy, 2005

Source: "Bangladesh Delta Plan 2100 Formulation Project" A project of the General Economics Division of the Bangladesh Planning Commission funded by the Government of the Netherlands

Figure 4.1.2 BDP 2100 Hotspots

2) Issues Recognized in BDP2100

The BDP2100 identified many issues in the Delta as shown below.

Table 4.1.6 Key Issues Identified in BDP2100

- Climate change
  - Temperature rise:
    1.4-1.90℃ increase by 2050, if extreme then 20℃ plus
  - Rainfall:
    Overall increase by 2030, but may decrease in Eastern and southern areas
  - Floods:
    About 70% area is within 1m from Sea Level
  - Droughts:
    Mainly agricultural drought
  - River Erosion:
    50,000 households on avg. become homeless each year
  - Sea Level Rise (SLR) and Salinity Intrusion
    By 2050 SLR may be up to 0.2-1.0 m; salinity increase by 1ppt in 17.5% & by 5ppt in 24% area
  - Cyclone and Storm Surges:
    Frequency and category will increase along with higher storm surges
- Trans-boundary Challenges:
  Impacts such as a decrease in river water volume and deterioration of water quality due to development activities in neighboring countries located in the upstream
- Water Quality
- Water Logging

Source: BDP2100

The climate change factors working through the geography of the Bangladesh Delta can have vast adverse effects on the country's development. The climate factors work through a large number of sectors that add up to substantial losses economy wide.

At the macro-level, the combined effects of climate change could range from a loss of 1.1% of GDP per year in a moderate climate change environment to 2.0% of GDP per year in an extreme climate environment. The projections made for BDP 2100 using a moderate climate change environment shows a loss of about 1.1% of GDP per year between 2017-2041 based on the government's target of achieving 9% annual average target. This is a huge negative impact and provides the basis for developing and implementing the Bangladesh Delta Plan. Indeed, if the Delta Plan is implemented along with suggested investment programmes, the Policy Scenario shows that the average growth rate can accelerate to 8.8% of GDP, which yields an average annual GDP gap of 1.9% between the BAU and the Policy Scenario.

In terms of loss of human welfare, district and sub-district level analysis shows that there is a strong positive correlation between incidence of poverty and the intensity of natural hazards. Some 70% of the 16 districts ranked as most exposed to natural disasters (intense risk category with ranking of 1) also show poverty rates that are higher than the national average using the upper poverty line for 2010. There is a similar high positive correlation between high-risk districts (risk ranking of 2) and poverty. Some 67% of these districts have poverty rates that are higher than the national average and 13% have poverty rates same as the national average.

3) Delta Opportunities

The delta opportunities are many. The soil and water combination of Bangladesh makes it a highly fertile land with multiple cropping opportunities. As well as the plentiful of rivers, fresh wetlands, and lakes provide ample scope for fisheries resources, etc. The opportunities in delta are shown in Table 4.1.7.

Table 4.1.7 Delta Opportunities

Highly fertile land - Agricultural land: 65% - Forest lands: 17% - Urban areas: 8% - Water and wetlands: 10%.
Plentiful rivers (more than 700 nos.) - Water bodies about 4.70 million ha
Open access to sea is a huge advantage - Could serve the needs of growing internal trade and commerce - Could become a regional hub for international sea transportation
Dynamic Inland Water Transport (around 6000 km) - Almost all districts are connected with each other - Industrial/growth centers nearby rivers
The Sundarbans - The largest natural mangrove forest - Unique ecosystem covers an area of 577,000 ha of which 175,400 ha is under water
Unique ecological settings - There are 2 Ramsar sites, 14 (13+1) Ecologically Critical Areas (ECAs), 17 National Parks, 28 Wildlife Sanctuaries, 8 Eco-parks and 2 Botanical Gardens. Over 800 species of wildlife identified in ECAs. - Important five ECAs are - Hakaluki Haor (18,382 ha) - Tanguar Haor (9727 ha) - Sonadia Island (4,916 ha) - St Martin’s Island (590 ha) - Teknaf Peninsula (10,465 ha)

Source: BDP 2100

4) Visions and Goals

BDP 2100 is a long term integrated and holistic plan on water resource management, climate change and environmental challenges with a view to supporting long term development of Bangladesh. The opportunities, risks and vulnerabilities emerging from the interface of water, climate change and environmental issues are long term in nature. The strategies, policies and programs must also be formulated with a long term perspective.

This is a major strategy challenge for the BDP 2100 which has been addressed by setting a clear vision and specific goals. The BDP 2100 approach is to first develop a broad based long term vision and also the mission about the likely changes of the Bangladesh Delta by the end of the 21st Century. Thus, an integrated, comprehensive and long term Delta Vision as well as Mission has been stated as shown in Table 4.1.8.

Table 4.1.8 Vision and Goals in BDP 2100

BDP 2100 approach to long term Vision:
The BDP 2100 approach is to first develop a broad based long term vision about the evolution of the Bangladesh Delta by the end of the 21st Century. Thus, an integrated, comprehensive and long term Delta Vision might be formulated as: “Achieving safe, climate resilient and prosperous delta”
Mission for BDP 2100 is formulated as:
“Ensure long term water and food security, economic growth and environmental sustainability while effectively reducing vulnerability to natural disasters and building resilience to climate change and other delta challenges through robust, adaptive and integrated strategies, and equitable water governance”.
BDP 2100 approach to long term goals:
This long term vision needs to be translated into specific goals or targets for implementing the Delta Vision. This is done by combining long term development outcomes in terms of country’s aspirations for economic growth and poverty reduction in the perspective of 2041 with targets for reducing long-term vulnerability from water and climate change related hazards plus targets for environmental protection. The BDP 2100 proposes 3 higher level national goals which have also been considered in upcoming Perspective Plan 2041 and 6 water, ecology and land use specific goals that contribute to these higher level goals.
Higher level goals:
Goal 1: Eliminate extreme poverty by 2030. Goal 2: Achieve upper middle income status by 2030 and Goal 3: Being a Prosperous Country beyond 2041.

BDP 2100 specific goals:
Goal 1: Ensure safety from floods and climate change related disasters; Goal 2: Enhance water security and efficiency of water usages; Goal 3: Ensure sustainable and integrated river systems and estuaries management; Goal 4: Conserve and preserve wetlands and ecosystems and promote their wise use; Goal 5: Develop effective institutions and equitable governance for in country and transboundary water resources management; Goal 6: Achieve optimal and integrated use of land and water resources.

Source: BDP 2100

5) Strategies for BDP 2100

The strategies are adaptive in the sense of periodic review and update in Five Year Planning cycle on the basis of situation and development needs. These are 'no regret' measures in terms of effectiveness and maximum benefit and offers integrated implementation with innovation, advanced information technology and strengthened institutional capacity. The water challenges and proposed strategies in BDP 2100 are built around addressing the fundamental problem of flooding that is a nation-wide challenge and addressing hotspot specific challenges of water shortage in drought-prone Barind Region; river erosion problems of the river and estuary region; coastal inundation and salinity problems of the Coastal region; flash-flooding and wetland management issues of the Haor region; water shortage, sanitation and drainage problems of the urban region; and the water shortage problem of the CHT region.

Table 4.1.9 Strategies for BDP 2100

Flood Risk (FR) Management Strategies
Flood risk management strategies have been developed based on 3 principles as follows: · Strategies conducive to economic development without degrading the environment; · Developing Climate change resilient Bangladesh through optimal use of natural resources; and · Climate resilient development through participatory process.
Strategy FR 1: Protecting Economic Strongholds and Critical Infrastructure
Sub-strategies include: · Sub-strategy FR 1.1: Protection by development and improvements of embankments, barriers and water control structures (incl. ring dykes) for economic priority zones & and major urban centers; · Sub-strategy FR 1.2: Construct adaptive and flood-storm-surge resilient building; · Sub-strategy FR 1.3: Adopt spatial planning and flood hazard zoning based on intensity of flood; · Sub-strategy FR 1.4: Improvement of Flood Early Warning System services (both basin and hotspot wise); and · Sub-strategy FR 1.5: Improvement of Drainage.
Strategy FR 2: Equipping the Flood Management and Drainage (FMD) Schemes for the Future
Sub-strategies include: · Sub-strategy FR 2.1: Management of 'submerged char' before taking any initiative for flood management and river flow management; · Sub-strategy FR 2.2: Drainage improvement inside FMDI schemes; · Sub-strategy FR 2.3: Restoration of water bodies and connectivity among and between FMDI schemes; · Sub-strategy FR 2.4: Restoration, redesign and modification of embankments and structures (where necessary); and · Sub-strategy FR 2.5: River management, excavation and smart dredging preceded by appropriate feasibility study.
Strategy FR 3: Safeguarding Livelihoods of Vulnerable Communities
Sub-strategies include: · Sub-strategy FR 3.1: Management of rivers and embankments with provision of fastest drainage of water during monsoon and flood; · Sub-strategy FR 3.2: Improved river management and better O&M of FMD schemes; · Sub-strategy FR 3.3: Extension and improvement of multipurpose cyclone shelters and its services along with emergency services; · Sub-strategy FR 3.4: Development of flood proof water supply and improved drainage system; · Sub-strategy FR 3.5: Flood and storm surge proofing of housing and other critical infrastructure supported by quick emergency services; · Sub-strategy FR 3.6: Social safety net and enhancement of rapid response recovery packages; · Sub-strategy FR 3.7: River management as well as improved flood management, drainage, O&M and flow management; · Sub-strategy FR 3.8: Protection of Chars and its population along with alternative livelihood arrangements.

Fresh Water (FW) Strategies
Strategy FW 1: Ensure Water Availability by Balancing Supply and Demand for Sustainable and Inclusive Growth
Sub-strategies include: · Sub-strategy FW 1.1: Ensure optimum water resource management in the country following basin wide management along with construction of necessary embankments; · Sub-strategy FW 1.2: New irrigation schemes for the major rivers of the country; · Sub-strategy FW 1.3: Excavation of local water reservoirs (canals, ponds and baors) for restoration of water and rain water harvesting; · Sub-strategy FW 1.4: Construction of Rubber dam preceded by appropriate feasibility study; · Sub-strategy FW 1.5: Enhancement of freshwater flows in urban and regional rivers; · Sub-strategy FW 1.6: restoration of natural reservoir and water bodies along with their biodiversity conservation; · Sub-strategy FW 1.7: Preserving ground water level by restriction on excessive extraction of ground water; and · Sub-strategy FW 1.8: Increase the fresh water flow in urban and rural rivers and control of river pollution.
Strategy FW 2: Maintaining Water Quality for Health, Livelihoods and Ecosystems
Sub-strategy includes: · Sub-strategy FW 2.1: Appropriate waste management and reduction of pollution in urban and rural areas; · Sub-strategy FW 2.2: Monitoring and control of pollution; and · Sub-strategy FW 2.3: Action research for improved ecosystem services.
Hotspot Specific Strategies
1) Coastal Zone
Strategies include: · Combating storm surge and salinity intrusion through effective management of existing polders; · Increase drainage capacity and reduce flood risks; · Balancing water supply and demand for sustainable growth; · Reclaim New Land in the Coastal Zone; · Sundarbans Conservation; and · Restoration of dead/low flowing rivers and basin wide management of cross boundary rivers for increasing supply of fresh water.
Tidal River Management (TRM)
2) Barind and Drought Prone Areas
Strategies include: · Balancing supply and demand for sustainable and inclusive growth ; · Management of cross-boundary water issues including river basin developments; · Minimizing losses due to floods and drainage congestion; · Ensuring water supply and sanitation; and · Encouraging excavation of ponds and digging well to retain rain water.
3) Haor and Flash Flood Areas
Strategies include: · Protect agriculture and vulnerable communities from floods; · Achieving fresh water security; · Management of River and water resources; · Sustainable management of Haor ecosystem and biodiversity; and · Integrated land and water resources management.
4) Chattogram Hill Tracts
Strategies include: · Protect economic zones and towns from floods and storm surges; · Ensure water security and sustainable sanitation; · Ensure integrated river management; · Maintain ecological balance and values (assets); and · Develop multi-purpose resources management system for sustainable growth.
5) River Systems and Estuaries
Strategies include: · Provide adequate room for the river and infrastructure to reduce flood risk; · Improvement of the conveyance capacity as well as stabilize the rivers; · Provide fresh water of sufficient quantity and quality; · Maintain ecological balance and values (assets) of the rivers; · Allow safe and reliable waterway transport in the river system; · Developing strategy for sediment management including a strong capital dredging and maintenance programme; · Strengthening river and estuaries management in the newly accredited lands; · Necessary arrangements for capital and maintenance dredging in important rivers such as the Padma, Meghna, Jamuna, Brahmaputra, Dharala, Arial Khan, Kushiyara, Gorai, Monu, etc; · Appropriate and effective measures for salinity management for the rivers in the southern zone during dry season; and · Formulating policy/guidelines for proper management of ‘Balu Mohal’, dredged materials/soils.

6) Urban Areas
Strategies include: · Increase drainage capacity and reduce flood risk and waterlogging at in urban areas; · Enhance water security and water use efficiency in the urban areas; · Regulate and monitor river and other water body pollution from industries and human sources; · Conserve and preserve urban wetlands and ecosystems and promote their wise-use; · Develop effective urban institutions and governance; · Integrated and sustainable use of urban land and water resources; · Improved urban services: water supply, sanitation, wastewater and solid waste management. Place special emphasis on management of disposal of medical, electronic and other hazardous waste/materials; and · Control and monitoring of water pollution caused by industry and other sources.
Strategies for Cross-Cutting Issues
1) Sustainable Land Use and Spatial Planning
Strategies include: · Develop effective policy guidelines and rules for the Balu Mahal and sediment management; · Preserve/conserve agricultural land from floods or erosion to sustain food grain production; · Prevention of salinity intrusion and desertification; · Management of newly accreted land in the Meghna Estuary; · Sustainable coastal land management for enhancing agriculture and non-agriculture land; · Development of Digital Land Resource Management System; · Reviewing and updating/enactment of Laws/Regulations relating to Alluvion and Diluvion to improve efficiency of land administration of accreting and reclaimed land; · Formulation of necessary laws and acts to form Land Zoning; · Increase climate change adaptation capacity for land management; · Spatial land use planning for urbanization; · Optimization of Land Use; · Formulation of Spatial Planning and Land Resource Management Act; · Enhance afforestation and plantation in the coastal zone for stabilizing land; · Restoration and protection of soil health, erosion and land loss; and · Integrated management of coastal water infrastructures to protect land
2) Agriculture, Food Security, Nutrition and Livelihoods
Strategies include: · Increasing resilience of agricultural production systems; · Diversification in agricultural output and livelihoods; · Lower emissions (GHGs) from agricultural land; · Encourage establishing commercial farms; · Introduction of Aquaponics farming system to culture fish and plants together; · Using Nanotechnology in agriculture for processing, distribution and packaging; · Introduce precision agriculture model ; · Encouraging solar power in irrigation; · Improved farm practices and technologies for mediating negative impacts of Climate Change; · Preservation of ecosystems for plant, wild animals, fishes, birds, etc. and encourage fruit tree plantation; · Improve Wetland Management in Haor Areas for development of fisheries; · Maintaining biodiversity to ensure long term fish availability; · Sustainable marine fisheries resources management ; and · Production of climate resilient Livestock;
3) Transboundary Water Management
Strategies include: · Development of action plan keeping the water usage of upstream countries in consideration; · Selection of prospective sites for the construction of embankments considering the water flow from upstream and with understanding and cooperation from upstream countries; · Multi-track water diplomacy to prevent or peacefully resolve conflicts; · Continuing efforts for signing of Treaty regarding the sharing of water for the Teesta and all other transboundary rivers; · Demand based common river basin management schemes have to be initiated; · Third party involvement (multilateral or bilateral development partner or country) to resolve transboundary water related issues; and · Improved basin-wide flood forecasting.

4) Dynamizing Inland Water Transport System
Strategies include: · Regular dredging activities for maintaining flow and transport in the rivers; · Develop reliable water system conditions for long term sustainable IWT through the capital and maintenance dredging of the rivers Padma, Meghna, Jamuna, Brahmaputra, Dharla, Arial khan, Kushiyara, Gorai, and Manu; · Regular dredging should also be considered for Ghashiakhali and other channels in the Sundarbans; · Ensure efficient and equitable use of sand through the regular shifting of the 'Balu-mahal' (sand quarry). The local administration should take necessary steps accordingly. Specific guidelines should be developed for the management of soil/sediment resultant from dredging; · BIWTA to cooperate and coordinate with BWDB to provide optimal levels of surface water for navigation; · Develop the navigation network according to the societal and economic demands; · Develop, maintain & operate inland river ports, landing ferry ghats and terminal facilities in ports or ghats; · Contribute to dealing with trans-boundary water aspects by ;developing mutual understanding and cooperation; · Development of riverine and maritime ports ; and · Initiatives for activating transboundary waterways.
5) Advancing the Blue Economy
Strategies for Blue Economy include: · Quick completion of multidimensional survey of marine resources; · Increase the number of sea going vessels and modernization and capacity building of the sea ports; · Increase both shallow and deep sea fishing; · Introduction of eco-tourism and private sector initiatives in sea cruise; and · Keeping the coasts and sea port pollution free.
6) Renewable Energy
Strategies include: · Develop long term renewable energy policy as well as strategies and formulate a master plan for at least 50 years to harness the potential of renewable energy resources in the country involving public and private sector investments ; · Promote research on the development of technology in the field of renewable energy in universities and research institutions as well as build capacity for its application; · Enhance Green Growth through research and development of renewable technologies including clean development mechanism (CDM); · Devise innovative financing packages for grant funding and low interest financing to address affordability for both grid and off-grid renewable energy projects; and · Target for at least 30% energy production from renewable sources by 2041 in the context of being a prosperous country.
7) Earthquakes
Strategies include: · Strengthen earthquake management and enhance the capacity to cope with earthquakes ; · Design earthquake-proof structures including barrages, regulators, sluices, embankments, cross-dams, roads, bridges, buildings in conformity with the Bangladesh National Building codes or any other approved standards ; · Formulate a proper land use plan for building construction in municipal areas ; and · Conduct a detailed study on identification of faults and epicenters.

Source: BDP2100

6) Macroeconomic Scenarios

The macroeconomic framework for BDP 2100 is the first attempt to quantify economic impacts of climate change by linking the real side (i.e., economic variables) to the environment or climate change parameters. The policy scenarios are built around three endogenous variables: economic growth, employment and poverty; two exogenous variables: natural hazards and climate change; and a large number of policy variables including: population and labor force, investment (public, private and total); sectoral investments including investments needed to offset the various climate change risks; macroeconomic policies; transboundary water dialogues; and institutional reforms and good governance.

In order to illustrate the role of BDP 2100 and its contribution to the long term development of Bangladesh, two scenarios based on selected policy options are considered as shown in Table 4.1.10.

Under the BAU option, the inclusion of environmental risks and subsequent loss in income causes substantial losses compared to the baseline. GDP growth goes on a downward slide, falling from around 7.2% in FY2017 to only 5.6% by FY2041. Owing to loss of capital stock and outputs in climate sensitive sectors, per capita nominal income would reach only US$ 10,540 in FY 2041, which would be US$ 3,837 lower than the DP scenario of US$ 14,377. On average, there is a loss of 1.3% of real GDP per year in this scenario over the government's target of achieving 9% GDP growth rate, which adds up to a cumulative loss of US$ 741 billion of income by FY 2041. This lower GDP growth and income levels have significant welfare consequences in terms of employment and poverty outcomes. Importantly, Bangladesh misses out on both UMIC and poverty targets in the BAU but achieves them in the DP Policy Option.

Table 4.1.10 Macroeconomic Scenarios and the Results

Option	Result		
	GDP growth rate per year in FY2017	GDP growth rate per year in FY2041	Per capita nominal income
Option 1: The First Option refers to the Business as Usual Policy Option (BAU). This is essentially a representation of the government's Vision 2021, Perspective Plan and the Seventh Five Year Plan. This is the business as usual policy environment of the present times where a coordinated effort to manage the delta risks and hazards does not exist.	7.2%	5.6%	US$ 10,540
Option 2: The Second Option is the Delta Plan (DP) Policy Option, which is the combination of the BAU with the adoption of the BDP 2100. Thus, this scenario incorporates the adoption of strong climate change and other delta related adaptation measures to achieve higher and sustainable growth trajectories in the face of the various weather-related natural hazards and risks.	7.2%	9.0%	US$ 14,377

Source: BDP 2100

7) Investment Plan

The Investment Plan consists of a total of 80 projects: 65 are physical projects, and 15 are institutional and knowledge development projects at the first phase up to 2030. Its total capital investment cost is BDT 2,978 billion (US$37 billion). All projects can be started within the next eight years, though given the scale and programmatic nature of some investments, construction in some cases will extend over decades.

Table 4.1.11 Hotspot wise Estimated Cost for the Investment Plan (2017-30)

Hotspot	No of Projects	Billion BDT	Billion USD
Coastal Zones	23	884.361	11.143
Barind and Drought-Prone	9	163.145	2.056
Haor and Flash Flood	6	27.982	0.353
Chattogram Hill Tracts	8	59.865	0.754
River System & Estuaries	7	482.610	6.081
Urban Areas	12	671.524	8.461
Cross-Cutting	15	688.787	8.679
Total	80	2,978.274	37.526

Source: BDP 2100

(6) National Plan for Disaster Management: NPDM 2021-25

1) Summary

National Plan for Disaster Management (NPDM) 2021-25 is the revised version of NPDM 2015-2020 implemented by the Ministry of Disaster Management and Relief (MoDMR), relevant other ministries and departments coordinated. NPDM 2021-25 is prepared in 2020 based on wider consultations with the relevant ministries, departments, donors, academic institutions, NGOs, research organizations, private sector and development partners.

NPDM 2021-25 is prepared based on the four key principles of Disaster Risk Management, adopted from the Sendai Framework for Disaster Risk Reduction (SFDRR, see Chapter 3) and Standing Order on Disaster (SOD, see this section (7)) as follows:

Preparedness to ensure that adequate arrangements are made at national, regional and at community levels to combat adverse situation.

Early Warning and Alert to prepare effective preparation in order to save life, property, valuables from the emerging hazards.

Emergency Response to attend the requirements in the areas affected by any natural hazard.

Rehabilitation, Reconstruction and Recovery to ensure that the adverse situation can be addressed in order to return to normal situation.

This plan provides context, legal background, implementation status of previous plans and likely situation of Bangladesh in the changing disaster risk context. Overall document is presented in two broad parts on planning context and on Targets for Implementation, and in five specific sections as shown below.

Table 4.1.12 Contents of the Five Sections in NPDM 2021-25

Section	Contents
Section 1	Background, legal ground and preparation process of the document
Section 2	Multisectoral engagement
Section 3	Changing risk context
Section 4	Vision, mission, goals
Section 5	Implementation strategy, financial mechanism, investment priorities

Source: Summarized by Survey Team Based on NPDM2021-2025

A number of activities are identified based on the above principles to be implemented during next five years. Inclusion of women, children, senior citizen, persons with disability, ethnic minorities are given high priority for all proposed activities.

NPDM 2021-25 will be implemented under the technical guidance and coordination of the Ministry of Disaster Management and Relief (MoDMR). Funding for the Activity/program identified under this plan will be from the concerned ministries and agencies as appropriate. Non-government agencies, donor and private sectors will also fund for program implementation.

2) Multisectoral Polices to be Considered for Implementation of NPDM 2021-2025

Disaster Management is a cross-cutting issue involving different sectors of governance. A large number of policies of these sectors have implications in disaster management. A list of these multi-sectoral policies is tabulated below.

Table 4.1.13 List of Multi-sectoral Policies

Ministry	Policy	Year
Ministry of Water Resources	National Water Policy 1999	1999
	National Water Management Plan 1995	1995
	Guideline of Participatory Water Management2001	2001
	Coastal Zone Policy 2005	2005
Ministry of Food	National Food Policy 2006	2006
	Food for Works Program	
Ministry of Power, Energy and Mineral resources	National Energy Policy 1996	1996
	Energy Policy 2004	2004
Ministry of Local Government, Rural Development and Cooperatives	Water Supply and Sewerage Authority Act 1996	1996
	National Policy for Safe Water Supply and Sanitation 1998	1998
	National Policy for Arsenic Mitigation 2004	2004
	National Strategy for Water Supply and Sanitation 2014	2014
Ministry of Agriculture	National Agricultural Policy 2013	2013
	New Agricultural Extension Policy 1996	1996
	National Seed policy 1998	1998
Ministry of Industries	National Industrial Policy 2016	2016

Ministry	Policy	Year
Ministry of Fisheries and Livestock	The National Fisheries Policy 1998	1998
	National Livestock Development Policy 2007	2007
	National Poultry Development Policy 2008	2008
	National Breeding Policy 2007	2007
	National Livestock Extension Policy 2013	2013
	New Fisheries Management Policy 1986	1986
	Livestock Policy and Action Plan 2005	2005
Ministry of Land	National Land Use Policy 2001	2001
	Khas Land Settlement Policy 1997	1997
	Non-agricultural Khas Land Settlement Policy1995	1995
	Balu Mohal and Sand Management Rules 2011	2011
	Chringri Mohal Management Policy 1998	1998
	Jal Mohal Management Policy 2009	2009
	Salt Mohal Management Policy 1992	1992
Ministry of Environment, Forest and Climate Change	National Climate Change Strategy and Action Plan 2009	2009
	National Environmental Policy 2013	2013
	National Forestry Policy 2016	2016
	Bangladesh Forestry Master Plan 1994	1994
	Bangladesh Climate Change Strategy andAction Plan 2009	2009
Ministry of Health and Family Welfare	National Health Policy 2011	2011
	National population policy 2004	2004
Ministry of Disaster Management and Relief	Standing Orders on Disaster 2019	2019
	Urban Volunteer Management Guideline 2019	2019
	Guidelines for Construction of DisasterResilience Houses	2019
	Guidelines for Flood Management at HAOR	2019
	National Plan for Disaster Management (2016-2020)	2016
	Dead Body Management Guideline 2016	2016
	National Disaster Management Policy 2015	2015
	Cyclone Shelter Construction, Maintenance and Management Policy-2011	2011
	Guideline for Humanitarian Assistance Program	2014

Source: NPDM 2021-25

3) Contents of NPDM 2021-2025

(a) Visions and Goals

The vision of the NPDM 2021-2025 is: “Winning resilience against all odds”.

With the aforementioned vision for the future, some goals and achievable targets are to be set which will stimulate actions for the next 5 years of the NPDM 2021-2025. National indicators are determined in alignment with the international framework SFDRR which are presented here:

i. Reduction of number of deaths, missing persons and directly affected people to 4000 per 100,000 population by 2025.

ii. Reduction of damaged land to 100,000 acres.

iii. Number of disasters affected households within 250,000 acres.

iv. Direct economic loss inflicted by disasters as a proportion of GDP has to stand at maximum 0.7% per cent in 2014.

v. Total damage and loss resulting from disasters should be brought down to 100,000 million BDT.

vi. In the past, a target was set to construct 5000 shelters in the coastal districts. 2000 additional shelter centers should be constructed.

vii. Flood related structural infrastructures like embankments should be designed providing adequate storm surge protection.

viii. Proper maintenance of polders/embankments. ix. Increase in urban volunteers and coastal volunteers by 100,000.

x. Replicate the design of resilient houses in other disaster-prone regions in the country. xi. Food silos in every house for food grain storage.

xii. Provision of safety equipment to volunteers in every ward.

(b) Investment priorities for the NPDM 2021-2025

To aid the planning process in terms of timeframes, the above priority actions are abbreviated to summary action statements that capture the key point of each action. The summary action statements are listed in Table 4.1.14 below corresponding to the SFDRR priorities (P1, P2, P3 and P4).

In addition, a total of 48 programs are listed in the annex of NPDM 2021-2025 for more specific activities. The lead ministry or department to undertake the responsibilities for activity implementation respectively are also listed in the annex. The activities and programs will be detailed out further during implementation stage. The programs identified can be adjusted

Table 4.1.14 Priority Actions in SFDRR and Priority Activities in NPDM 2021-2025

Priority Actions in SFDRR	Priority Activities in NPDM 2021-2025
P1: Understanding disaster risk	- Upgrade and strengthen national awareness. - Awareness raising and data products on earthquakes. - Contemporary technologies and innovations for improved weather and climate monitoring, prediction and forecasting. - DRM-related research and development activities on scientific and socio-economic issues. - Develop and implement tool for disaster impact assessment (DIA) by all sector - Risk repository for planning major investments - Strengthen regional and international DRM networks. - Studies on other hazards (e.g., cold wave, lightning, fire, chemical hazards, health hazard/biological hazard and oil spills).
P2: Strengthening disaster risk governance to manage disaster risk	- Risk proof public investments and inclusion of Disaster Impact Assessment. - Inter-ministerial coordination to develop sectoral policies and capacity building. - Review and update the National Earthquake Contingency Plan. - Strengthen the capacity of DMCs; activation of urban DMCs. - Strengthen formal institutional capacities and social protection institutions. - Guidelines for private sector investment for resilience. - Close gaps in institutional policies and programs on drought and cold wave hazards. - International and regional cooperation and knowledge/information sharing.
P3: Investing in disaster risk reduction for resilience	- Nationwide capacity building for resilience. - Physical works and structural measures for resilience. - DRM financial options - private sector, insurance and funding for social protection. - Resilience institutions - Research & Development Center, National Emergency Operations Center. - Strengthen flood management. - Strengthen cyclone management. - Follow an 'all-hazards' approach.
P4: Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction	- Strengthen forecasting and early warning systems. - Build capacity on emergency response. - Sector wise and critical facilities preparedness and emergency response measures. - Inclusive recovery and rehabilitation strategy. - Financial instruments e.g., recovery compensation or loans. - Business continuity. - Emergency preparedness and response to human-induced disasters. - Preparedness and response measures for slow-onset hazards.

Source: The Survey Team

(7) Standing Orders on Disaster 2019 (SOD)

1) Background to the revision of the SOD

The Standing Orders on Disaster in the current format was first published in Bangladesh in 1997. It was modified and translated into English in 1999. Since then, many events have taken place at national, regional, and global levels. Nationally, three catastrophic disaster events have taken place in Bangladesh: 1) the 2004 flood, 2) the 2007 flood and 3) Cyclone Sidr in 2007. The aftermath of the 2004 flood resulted in the organization of several workshops including the National Workshop on "Options for Flood Risk Reduction in Bangladesh." All of these exercises have emphasized the importance of disaster risk reduction as well as strengthening the emergency response system in the country.

At the regional and global levels, several disaster events, such as Orissa Cyclone 1999, Gujrat Earthquake 2001, Asia Tsunami 2004, the Kashmir Earthquake 2005, etc., have shaken up the very basis of disaster management. Consequently, the World Conference on Disaster Reduction 2005, held in Kobe, Japan, organized under the auspices of the UNISDR, has adopted the Hyogo Framework of Action 2005-15 (HFA), emphasizing disaster risk reduction and strengthening emergency response systems. Bangladesh is a signatory to the framework. Considering the fact that South Asia, with its population of about 1.3 billion, is one of the regions highly exposed to a variety of natural and human-induced hazards which pose a great development challenge for all SAARC countries, South Asian nations joined hands to develop the SAARC Framework of Action 2006-15 for comprehensive disaster management and emergency preparedness.

With this backdrop, it was felt necessary to review and revise the SOD 1999. The present edition is a substantial improvement over previous editions. New features introduced in this edition include, among others, the following items.

Table 4.1.15 Contents of SOD Revision in 2010

No.	Contents	No.	Contents
1	Better organized table of contents	7	Introduction of risk reduction roles and responsibilities for all committees and agencies
2	More comprehensive list of definitions	8	New outlines for local level plans
3	List of abbreviations	9	Revised storm warning signals
4	Outline of disaster management regulative framework	10	Report on cyclone shelter design
5	Introduction of core groups for emergency response at various levels	11	Revised Form D
6	New section on multi-agency disaster incident management system	12	Two new appendixes containing specific roles and responsibilities relating to earthquake and tsunami hazards

Source: Summarized by Survey Team Based on SOD

In Bangladesh's current context of development spree, it is very important to formulate and implement development plans taking into consideration the disaster risk management factors. With that aim, disaster risk management has been incorporated into all the development plans, including the Fifth Five Year Plan, Bangladesh Delta Plan 2100 (BDP2100), and National Strategic Plans. The SOD-2019 has taken into consideration and complies with the commitments pledged in the SDGs, the SFDRR, and other international agreements and charters.

2) Contents of the SOD

The SOD reflects Bangladesh's disaster-related standards and regulations and stipulates detailed roles and responsibilities of related ministries and agencies, departments, related organizations, communities, representatives of public organizations, residents, etc., regarding disaster risk management.

4.1.1.2 Organizations for Disaster Risk Management

Organizations related to disaster risk management are regulated by SOD 2019. Those are classified as central and regional levels.

Major organizations related to disaster risk management are as follows.

Source: Country Report 2020: Bangladesh, Asian Disaster Reduction Center

Figure 4.1.3 Organizations Related to Disaster Risk Management in Bangladesh

MoDMR is the main organization related to disaster risk management. MoDMR formulates policies and establishes laws/regulations as well as takes necessary actions for disaster risk management in corporations with related organizations.

(1) NDMC

NDMC is an organization regulated by Bangladesh Disaster Management Act 2012. Its chairman is the prime minister, and members are ministers/undersecretaries of the ministries. This is positioned as the most important organization related to disaster risk management in Bangladesh.

According to the SOD, NDMC is responsible for the following activities.

- ✓ Providing policies and guidelines on disaster risk mitigation and emergency response management.
- ✓ Reviewing the national disaster management system and providing strategic advice on disaster risk mitigation and emergency response management.
- ✓ Reviewing policies and plans on disaster risk management, and providing strategic advice.
- ✓ Providing and promoting coordination of related organizations' development plans and programs from the perspective of disaster risk management.
- ✓ Promoting awareness reform of policymakers regarding disaster risk mitigation.
- ✓ Providing evaluation and strategic advice on disaster prevention measures and emergency after a large-scale disaster.
- ✓ Evaluating response, recovery and reconstruction, presenting directions for improving systems and procedures.
- ✓ Promoting complex disasters related to disaster risk reduction and emergency response management and management coordination in multiple fields.

(2) IMDMCC

The Inter-Ministerial Disaster Management Coordination Committee (IMDMCC) is the national-level body responsible for formulating and implementing policies, plans, and programs related to disaster risk mitigation and emergency response management. The chairman of IMDMCC is the minister of MoDMR, and the members are undersecretaries of other ministries. This is in charge of working-level activities for the above NDMC, such as the preparation of policies and plans related to disaster risk reduction and emergency management, as well as the decision of implementation. The responsibilities and functions of IMDMCC are as shown in Table 4.1.16.

Table 4.1.16 Responsibilities and Functions of IMDMCC

Risk Reduction Functions
(1) Undertake activities as advised by the NDMC; (2) Recommend the NDMC for approval of laws, rules, policies, orders, and national level plans; (3) Review, amend, and finalize the contingency plans adopted by the primary responding agencies; (4) Ensure implementation of the activities as directed in the SOD; (5) Finalize the plans developed by the City Corporation, Division and District Disaster Management Committees; (6) Recommend for revision of disaster management frameworks to ensure effective implementation of disaster risk reduction, response preparedness, and recovery activities; (7) Finalization of the National Plan and Regional/Local programs on disaster risk reduction; (8) Undertake initiatives to mainstream disaster risk reduction into all development activities; (9) Evaluate disaster risk reduction programs and share the findings with the NDMC; (10) Review existing emergency preparedness and public awareness activities, and provide necessary assistance to enhance capacity; (11) Take necessary decisions based on the recommendations produced by the committee formed by the government to review floods, cyclones, storm surges, lightning strikes, landslides, earthquakes, chemical, and nuclear accidents; (12) Strengthen education and research activities related to disaster risk reduction and emergency response; (13) Advice local level disaster management committees on the appropriate application of laws, regulations, acts, rules, and ordinances on disaster risk management.
Emergency Response, Rehabilitation, Reconstruction and Recovery Functions
(1) Evaluate activities undertaken to enhance emergency response preparedness; (2) Finalize emergency response and recovery plans; (3) Assist in arranging mock drills and simulation exercises on safe evacuation, search & rescue. and training programs; (4) Ensure coordination in emergency response, humanitarian assistance, and recovery activities at all levels of the government; (5) Coordination of the disaster risk management approaches and practices adopted by various agencies and organizations; (6) Assist in the formation of search & rescue teams; (7) Advice all relevant agencies to formulate and implement short, medium and long-term recovery plans to overcome damage, and loss due to disasters; (8) Recommend the Cabinet Division to set up temporary offices (if necessary) by the concerned ministry/division in disaster-affected areas in the aftermath of a major disaster; (9) Recommend the Finance Division to increase the allocation for humanitarian assistance and recovery programs in disaster-affected areas for special cases; (10) Strength psycho-social support for disaster-affected people and primary responders involved in emergency response activities; (11) Undertake necessary skill training to ensure gender and social inclusion in emergency response preparedness activities.

Source: SOD 2019

(3) NDMAC

The chairman of NDMAC is also the minister of MoDMR, and the members are experts in the related fields. As well as the one in charge of working-level activities, mainly focusing on the provision of expertized advice.

(4) MoDMR

MoDMR is a focal organization for disaster risk management at the central government level, as shown in Figure 4.1.3 and organized to prepare Bangladesh Disaster Management Act 2012. Policies, laws and other required activities for disaster risk management decided by the higher-level organizations, are officially noticed to related organizations mostly through MoDMR.

As a result of the comprehensive revision of the Bangladesh Disaster Management Act in 2012, the MoFDM, which had been in charge of disaster management in Bangladesh, was split off from the

Ministry of Food (MoFOOD) to form the MoDMR. However, most of the organizational structure of the MoDMR was inherited from the MoFDM, and the DMB, which was in charge of disaster management as a subordinate organization of the MoFDM, was reorganized as the DDM and is currently in a position to lead the national disaster management administration.

In addition to the DDM, the MoDMR has jurisdiction over the CPP, which was organized in cooperation with the Bangladesh Red Crescent Society in response to the Cyclone disaster in 1970, which killed about 300,000 people.

The duties and personnel system under the jurisdiction of MoDMR are as shown below.

1) Jurisdiction Work

Mission

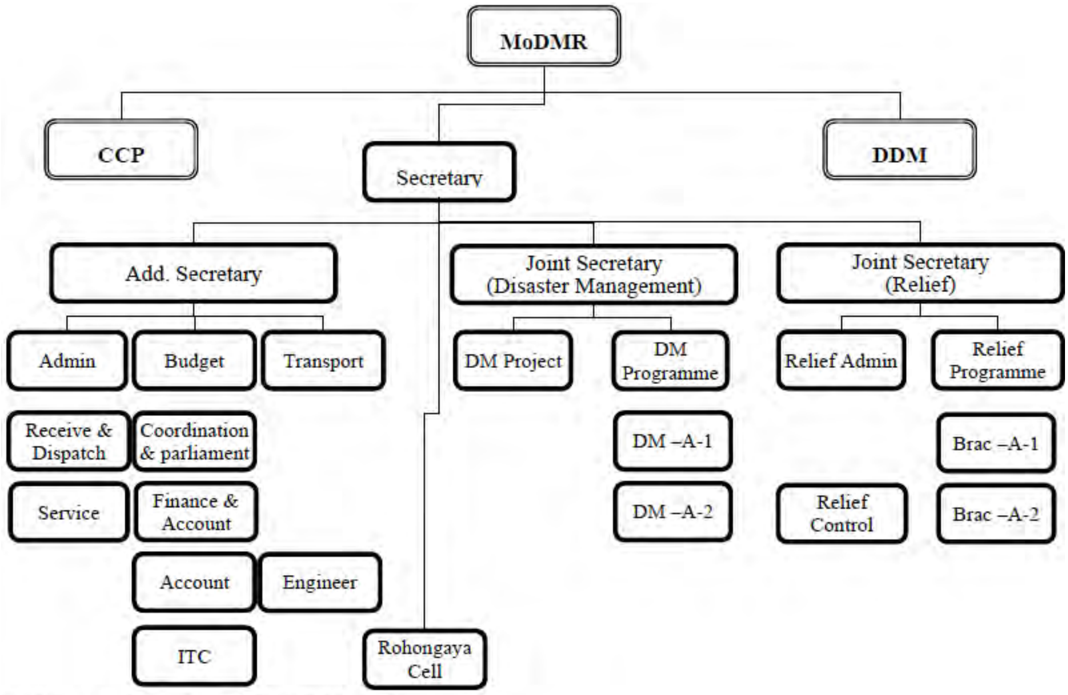
- ✓ Reduce the risk of disasters for the people by strengthening all disaster management capabilities and building an effective and possible emergency disaster response system assuming large-scale disasters. Pay particular attention to the poor and residents with social vulnerabilities.

Main business

- ✓ Formulation and implementation of laws, policies, and action plans for DRR, emergency response, and disaster management;
- ✓ Preparation of policies and plans to provide emergency humanitarian assistance and reconstruction programs and database of Social Safety Net program activities implemented by MoDMR;
- ✓ Humanitarian assistance for food security through Food for Work (local infrastructure development), Test Relief (maintenance and operation of local infrastructure), and other implementations;
- ✓ Securing employment opportunities for the poorest through annual risk mitigation activities;
- ✓ Coordinating and distributing the use of emergency food and other foreign humanitarian aid; and
- ✓ Implementation of programs on refugee issues and coordination with other domestic and overseas organizations

2) Organization / Personnel

As shown below, the organizational structure is divided into about 10 departments, with the Minister and Secretary at the top, and the Assistant Secretary or similar positions as chiefs. In terms of posts, 173 people (as of 2015) were in office.



Source: Final Report of Preparatory Survey on Disaster Response/Recovery System Strengthening Project in Bangladesh, JICA

Figure 4.1.4 MoDMR Organization Chart

Table 4.1.17 Personnel Composition of MoDMR

Sl. No.	Designation	Quantity
1st Class		39
1	Secretary	1
2	Additional Secretary	1
3	Joint Secretary	2
4	Deputy Secretary	6
5	Deputy Chief	1
6	Senior Assistant Secretary	11
7	Senior Assistant Chief	3
8	Others	14
2nd Class		36
3rd Class		68
4th Class		30
Total		173

Source: Final Report of Preparatory Survey on Disaster Response/Recovery System Strengthening Project in Bangladesh, JICA

3) Budget

MoDMR's recent activities include the operation of various programs related to disaster risk management while focusing on emergency response activities in the event of a disaster. It also includes humanitarian assistance related to refugee issues, in Myanmar, providing food, shelter, and medical facilities.

Table 4.1.18 Recent Expenditure Status in MoDMR

Unit: Taka in thousand

	Actual	Revised	Medium Term Expenditure Estimates			Total
	2017-18	2018-19	2019-20	2020-21	2021-22	
Operating expenses	627,011	346,707	354,300	392,365	419,240	2,476,894
Rescue and relief Activities	16,908,188	24,687,673	27,917,771	28,992,600	31,601,600	155,676,620
Implementation and operation of various programs including CPP	160,567	19,260,700	17,775,786	19,744,000	21,509,000	96,097,273
Development of basic infrastructure (water treatment plant, etc.)	14,283,541	7,221,700	7,779,100	8,250,000	9,100,000	54,361,641
Coordination with various meetings	0	81,700	51,000	81,200	100,000	394,700
Others	16,358,145	24,939,461	25,477,698	29,771,535	33,961,160	155,998,743
Emergency Multi-sector Rohingya Crisis Response Project	0	405,500	980,100	1,200,000	774,500	3,360,100
Total	48,337,452	76,943,441	80,335,755	88,431,700	97,465,500	468,365,971

Source: Summarized by JST Based on the Website of Ministry of Finance

(5) Department of Disaster Management (DDM)

DDM was established in November 2012 as a sub-organization of the MoDMR. The main role of DDM is to concretely implement the objectives of the Disaster Management Act in 2012, reduce all disaster vulnerability based on disaster risk reduction activities, and all government and non-governmental organizations related to disaster risk reduction and emergency response. It is the implementation of effective humanitarian assistance programs to improve poverty and social disabilities in line with the strengthening and coordination activities of the programs implemented. In addition, DDM makes requests and instructions to government agencies in formulating principles and plans for disaster management.

The duties and personnel system under the jurisdiction of DDM are shown below.

1) Jurisdiction Work

<u>Vison</u>

✓ DDM is an active body for mainstreaming disaster risk reduction (DRR) in disaster management programs. DDM reduces the vulnerability of all people, especially the vulnerable and poor, and develops knowledge, research and capacity in all disaster cycles based on the Disaster Management Act of 2012.

<u>Mission</u>

✓ DDM provides MoDMR with risk mitigation activities under the Disaster Management Act of 2012, strengthening and coordinating programs implemented by various stakeholders related to disaster risk reduction and management and effective response in the event of a disaster.

2) Organization / Personnel

The organization chart of DDM is as shown below. A more recent organizational chart has also been prepared but cannot be provided because it has not been approved.

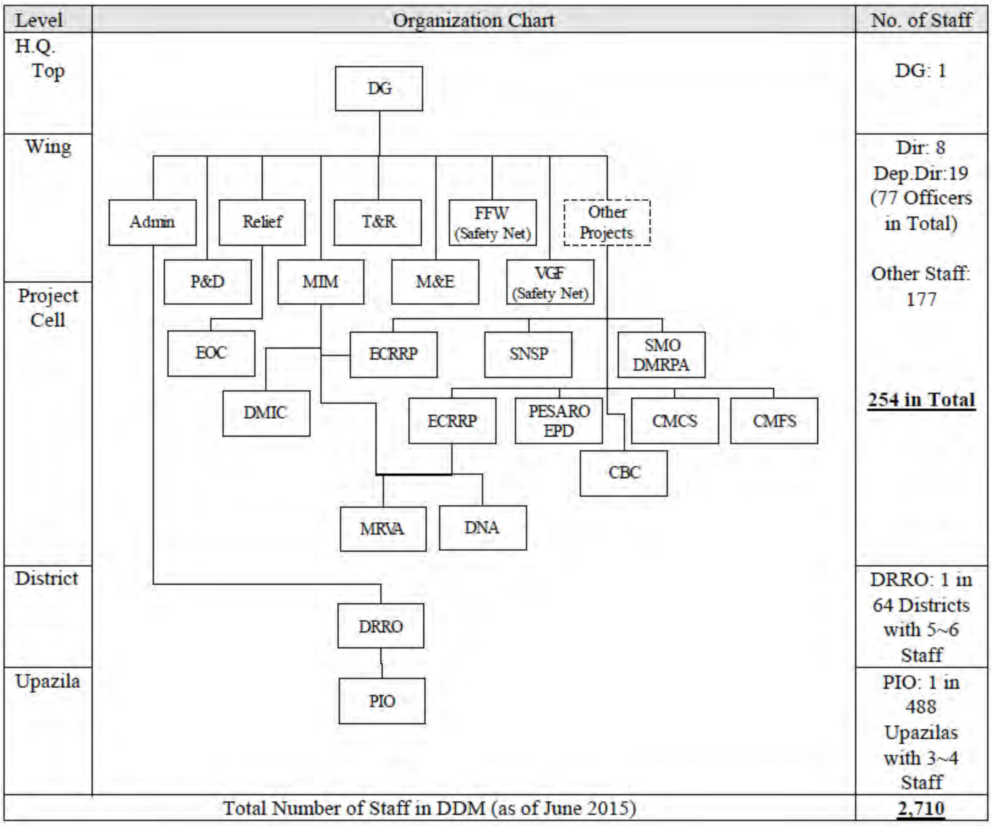


Abb & Acron.		Name	Abb & Acron.		Name
DG	:	Director General	EOC	:	Emergency Operation Center
Admin	:	Administration	ECRRP	:	Emergency Cyclone Recovery and Restoration Project
P&D	:	Planning and Development			
FFW	:	Food for Work	VGF	:	Vulnerable Group Feeding
MIM	:	Monitoring and Information Management	MRVA	:	Multi-hazard Risk Vulnerability Assessment
T&R	:	Training and Research	DNA	:	Damage Needs Assessment
M&E	:	Monitoring and Evaluation	PESAROEAOD	:	Procurement of Equipment for Search & Rescue Operation for Earthquake & Other Disaster
DMIC	:	Disaster Management Information Center			
CBC	:	Construction of Bridges & Culverts	CMCS	:	Construction of Multipurpose Cyclone Shelters
CMFS	:	Construction of Multipurpose Flood Shelters			

Source: Final Report of Preparatory Survey on Disaster Response/Recovery System Strengthening Project in Bangladesh, JICA

Figure 4.1.5 DDM Organization Chart

3) Budget

Recent DDM activities include the management and participation in disaster risk-related projects carried out by overseas donors, as well as participation in construction projects, such as shelters and bridges.

Table 4.1.19 Recent Expenditure Status in DDM

Unit: Taka in thousand

	Actual	Revised	Medium Term Expenditure Estimates			Total
	2017-18	2018-19	2019-20	2020-21	2021-22	
Operating expenses	1,057,144	1,489,468	1,585,500	1,744,100	1,918,600	9,284,812
Participation and management of various disaster risk management programs	282,285	1,236,300	1,942,800	2,040,900	2,129,500	11,405,785
Participation in basic infrastructure construction and maintenance projects	15,349,227	17,490,000	14,851,200	16,747,200	18,345,300	97,251,927
Others	0	18,200	0	0	0	18,200
Total	16,688,656	20,233,968	18,379,500	20,532,200	22,393,400	117,960,724

Source: Summarized by JST Based on the Website of Ministry of Finance

(6) Other Central Government Organizations Related to DRR Administration

In addition to the major organizations shown above, the following organizations are also engaged in activities related to DRR administration. The SOD stipulates the division of responsibilities and roles regarding disaster risk management of these national-level committees, councils, and groups. In addition, detailed responsibilities and roles are stipulated in SOD for disaster risk mitigation and emergency response (normal times, when a warning is issued, when a disaster occurs, at the time of reconstruction) related to disaster management of each ministry and agency.

Table 4.1.20 Other Central Government Organizations Related to DRR Administration

Organization Name	Role /Function
National Disaster Response Coordination Group	To coordinate assistance to the affected communities and to strengthen emergency response and early recovery.
Earthquake Preparedness and Awareness Building Committee	To ensure earthquake preparedness and raise awareness of earthquake risk management.
Cyclone Preparedness Programme （CPP） Policy Committee	To manage cyclone preparedness program policies.
CPP Implementation Board	To manage cyclone preparedness program implementation.

Source: JICA Survey Team

(7) Government Technical Organizations Related to DRR

In addition to the agencies and organizations responsible for the administrative field of disaster risk management in Bangladesh as described in (1)-(6) above, the central government also has agencies that technically carry out their original responsibilities. The heads of the higher-level ministries of these agencies are also members of the NDMC. The major technical agencies related to DRR are described below.

1) Bangladesh Water Development Board (BWDB）

BWDB is an active government agency whose mission is large-scale irrigation and drainage projects, urban flood protection projects, etc. and is a project implementation agency under the Ministry of Water Resources.

BWDB was named by its predecessor, the East Pakistan Water and Power Development Authority (EPWAPDA), in 1972, the year after the country's independence from Pakistan in 1971. It is an institution that was separated and born based on the Enforcement Ordinance (Presidential Ordinance. No. 59 of 1972; the Bangladesh Water and Power Development Boards Order 1972 (PO No. 59 of 1972) and has a long history.

The BWDB Act 2000 stipulates that BWDB's current mission will be carried out under the National Water Policy (NWPo) and National Water Management Plan (NWMP).

The duties and personnel system under the jurisdiction of BWBD are as shown below.

(a) Jurisdiction

BWDB's jurisdiction is shown in Table 4.1.21 below.

Table 4.1.21 BWDB's Jurisdiction

Type	Jurisdiction
Implementation of structural measures	i. Construction of dams, weirs, reservoirs, levees, water level/flow control structures, etc. for river improvement, flood control, drainage, surface irrigation, and drought prevention ii. Removal of estuary blockages, excavation, and removal of canal sediments to promote water flow or diversion to support fishing, shipping, forest management, wildlife utilization, and environmental improvement iii. Projects aimed at soil conservation, land accretion, reclamation, and estuary management iv. Land support activities for blocks, markets, and historically and publicly prominent places. River improvement and river embankment maintenance aimed at protecting from erosion disasters v. Construction of coastal levees and their maintenance vi. Prevention of saltwater infiltration and desertification vii. Securing water for irrigation, environmental protection, and drinking water supply
Implementation of non-structural measures	viii. Flood and drought warning ix. Water level monitoring in major river systems, collection of hydrological data, capacity building of Flood Forecasting & Warning Center x. Support activities for forestry and fisheries around BWDB jurisdiction for environmental conservation and improvement and poverty reduction xi. Organize water users and stakeholders and formulate, implement, operate and maintain their water business plans, and participate in and train long-term and sustainable cost recovery for beneficiaries of completed projects.

Source: Final Report of Preparatory Survey on Disaster Response/Recovery System Strengthening Project in Bangladesh

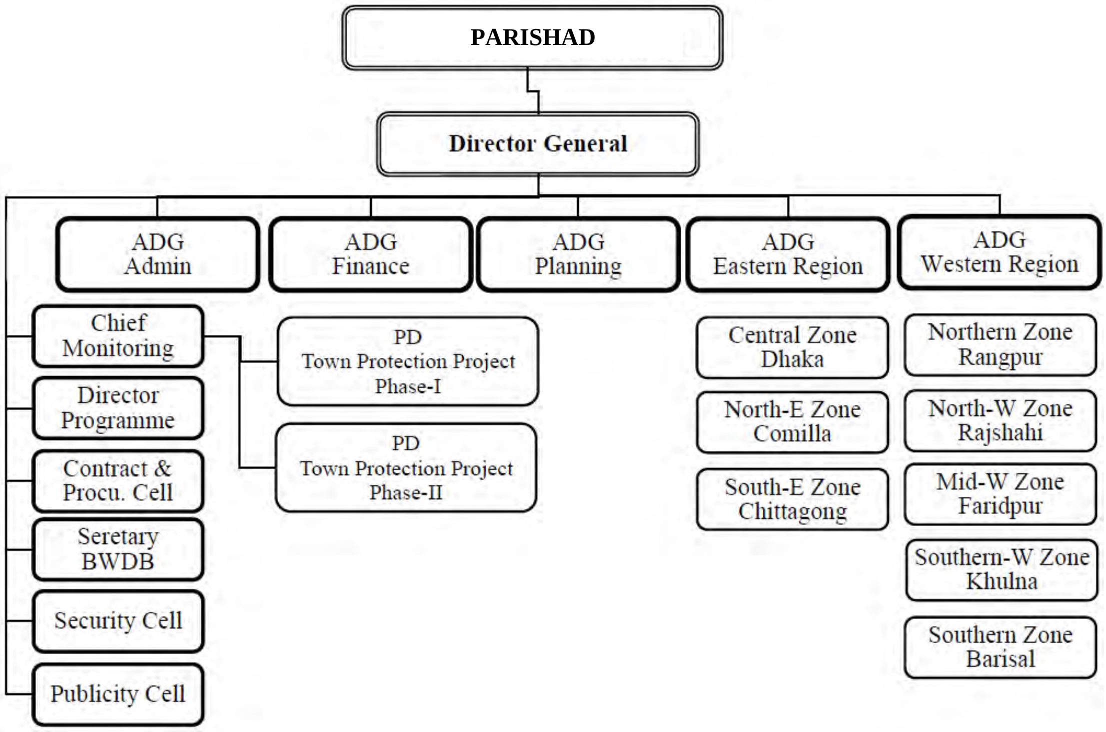
(b) Organization / Personnel

BWBD's work is carried out by dividing the country into eight areas, each of which has jurisdiction.

Under the Director General (DG), BWDB is divided into Administration Wing, Finance Wing, Planning Wing, and O&M Wing (Eastern Region / Western Region), and each department is under the jurisdiction of one Additional Director General (ADG) and assists the Secretary. Each department also has a plurality of departments.

BWDB includes national-level perspectives, technical inspections, and reexaminations of projects to prepare for a five-year development plan, planning wing, and prevention of damage to water management facilities from natural disasters. There are two O&M Wings that carry out operations related to assessment and emergency recovery. Each District-level office is positioned as a sub-organization under O&M Wings.

BWDB's organizational reforms have been implemented since the 1990s under the guidance of the World Bank (WB), and the number of BWDB staff was increased to 8,935 in 1998, but in 2015, mechanical equipment was used to reduce costs. The number was about 7,000, including the staff of & Dredger Directorate (ME & DD).



ADG: Additional Director General, PD: Project Director, Procu.: Procurement

Source: Final Report of Preparatory Survey on Disaster Response/Recovery System Strengthening Project in Bangladesh, JICA

Figure 4.1.6 BWDB Organization Chart

(c) Budget

BWDB invests mainly in river channel dredging, riverbank erosion control, embankment construction, and renovation. In particular, a large amount of the budget is invested in river channel dredging and riverbank erosion countermeasures.

Table 4.1.22 Recent Expenditure Status in BWDB

Unit: Taka in thousand

	Actual	Revised	Medium Term Expenditure Estimates			Total
	2017-18	2018-19	2019-20	2020-21	2021-22	
Operating expenses	9,286,004	16,067,406	16,181,200	17,819,266	19,616,623	93,283,004
River dredging works	1,299,374	6,567,000	7,550,300	10,650,900	20,800,000	52,734,174
Riverbank erosion countermeasure works	3,530,300	19,862,800	18,496,500	21,920,000	18,676,709	95,706,209
Embankment construction / repair works	2,521,250	2,215,100	2,350,100	1,600,000	550,000	12,386,450
Drainage measures works	36,000	2,150,000	1,950,000	4,000,000	3,000,000	13,736,000
Comprehensive flood management and water resource management projects by dredging, revetment, and embankment	10,092,648	24,836,400	24,907,400	22,400,000	24,350,000	131,649,148
Flood forecast warning related programs	0	390,000	840,000	900,000	1,000,000	3,814,100
Others	1,167,506	4,151,800	3,641,600	5,780,000	5,300,000	23,693,106
Total	27,933,082	76,240,506	75,917,100	85,070,166	93,293,332	427,002,191

Source: Summarized by JST Based on the Website of Ministry of Finance

2) Local Government Engineering Department (LGED)

LGED is an organization belonging to the Ministry of Local Government, Rural Development and Cooperatives (MoLGRDC) and is one of the largest government agencies in Bangladesh. Its role is mainly responsible for the development of rural infrastructure, planning related to small-scale water resources, and the implementation of its projects. LGED works closely with local stakeholders at all stages of the project implementation cycle to ensure public participation and bottom-up planning. LGED's goal is to improve the socio-economic status of the country as a whole and to strengthen the capacity of local stakeholders through the development activities mentioned above.

LGED creates more work opportunities by using local technology and raw materials to implement the project. The projects carried out by LGED span a wide range of fields, including the construction of roads, bridges, culverts, markets, etc., capacity building of residents, and environmental protection.

The duties and personnel system under the jurisdiction of LGED are as shown below.

(a) Jurisdiction

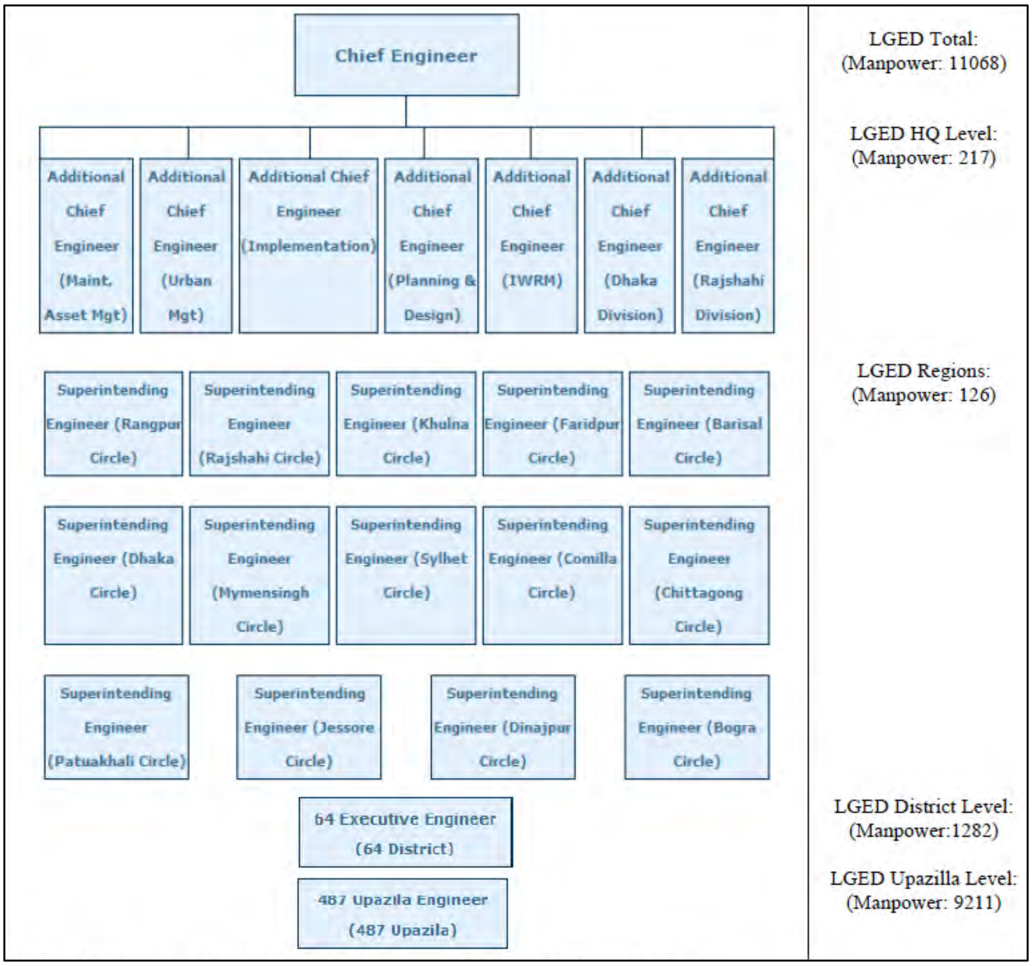
The jurisdiction of LGED is as shown below.

- ✓ Development of infrastructure related to rural areas, local cities, and small-scale water resources (irrigation of 1,000 ha or less)
- ✓ Maintenance of infrastructure related to rural areas, local cities, and small-scale water resources
- ✓ Technical assistance to Pourashava (Municipal Council) and City Cooperation
- ✓ Technical assistance to Zila (District Council)
- ✓ Technical assistance to the Upazila (Sub-District Council) and Union Council
- ✓ Technical assistance to other ministries
- ✓ Creation of development plan drawings, databases, technical specifications, and manuals
- ✓ Human resource development and capacity building of LGED, local governments, and other stakeholders

(b) Organization / Personnel

LGED currently has more than 10,000 employees nationwide. About 98% of the staff are located in District and Upazila level regions, and only about 2% are in Dhaka's headquarters.

The organization chart of LGED is as shown in Figure 4.1.7.



Source: Final Report of Preparatory Survey on Disaster Response/Recovery System Strengthening Project in Bangladesh, JICA

Figure 4.1.7 LGED Organization Chart

(c) Budget

Most of LGED's activities are in rural infrastructure development, but the budget for infrastructure development projects focusing on river management, water resource management and disaster management is estimated to be at most 29% of the total budget, although it varies from year to year. A large amount of the budget is invested in other general regional infrastructure development and road/bridge infrastructure projects.

Table 4.1.23 Recent Expenditure Status in LGED

Unit: Taka in thousand

	Actual	Revised	Medium Term Expenditure Estimates			Total
	2017-18	2018-19	2019-20	2020-21	2021-22	
Operating expenses	18,291,901	25,249,749	28,881,900	31,977,000	35,600,000	164,624,325
Basic infrastructure development project (general)	47,607,007	92,112,525	75,502,200	93,022,500	56,160,900	461,253,632
Basic infrastructure development project (roads / bridges)	4,747,736	9,026,800	16,831,900	20,313,500	18,227,000	77,594,536
Basic infrastructure development project (river / coast / lake management, water resource management)	1,086,433	4,731,700	4,988,600	5,918,000	51,660,000	74,781,933
Basic infrastructure development project (disaster recovery, shelter maintenance)	6,759	12,363,900	10,400,000	6,400,000	410,000	42,793,659
Basic infrastructure development business (others)	1,156,924	1,515,000	2,114,000	1,470,000	5,102,000	12,929,924
Various programs (disaster prevention / water resources related)	112,980	607,800	1,591,100	839,500	410,000	3,933,080

	Actual	Revised	Medium Term Expenditure Estimates			Total
	2017-18	2018-19	2019-20	2020-21	2021-22	
Various programs (other than disaster prevention and water resources)	1,175,750	10,757,100	22,024,000	8,340,000	10,964,000	63,980,250
Total	74,185,490	156,364,574	162,333,700	168,280,500	178,533,900	901,891,339
Total budget related to river management, water resources management, and disaster management out of the above	1,206,172	17,703,400	16,979,700	13,157,500	52,480,000	121,508,672
Percentage of total（%）	1.63%	11.32%	10.46%	7.82%	29.39%	13.47%

Source: Summarized by JST Based on the Website of Ministry of Finance

3) WASA

WASA is a public corporation that operates water supply and sewage services in major cities such as Dhaka, Chattogram, Khulna, and Rajshahi[3]. Like LGED, it is a project implementing agency under MoLGRDC.

Most of WASA's recent activities are related to a water supply. In addition, in Dhaka and Rajshahi, a substantial portion of the budget is spent on land acquisition related to the construction of water treatment plants.

Table 4.1.24 Recent Expenditure Status in WASA

Unit: Taka in thousand

	Actual	Revised	Medium Term Expenditure Estimates			Total
	2017-18	2018-19	2019-20	2020-21	2021-22	
Dhaka WASA						
Operating expenses	127,405	268,000	268,000	320,500	341,000	1,592,905
Water supply	1,554,900	4,415,000	4,696,200	6,650,000	8,680,000	30,982,800
Sewage / drainage	0	315,000	4,000,000	3,400,000	0	8,215,000
Water treatment / water environment	1,096,000	22,056,700	21,701,800	8,400,000	23,040,000	93,559,400
Others	550,000	782,500	0	0	0	1,332,600
Total	3,328,305	27,837,200	30,666,000	18,770,500	32,061,000	135,682,705
Chattogram WASA						
Operating expenses	43,629	50,000	54,400	70,000	80,000	348,029
Water supply	2,913,100	7,154,100	8,356,600	4,160,000	3,500,000	33,528,600
Sewage / drainage	0	2,400	400,000	500,000	0	902,400
Water treatment / water environment	0	0	0	0	0	0
Others	0	100	0	0	0	200
Total	2,956,729	7,206,600	8,811,000	4,730,000	3,580,000	34,779,229
Khulna WASA						
Operating expenses	141,000	155,000	155,000	175,200	184,800	956,000
Water supply	1,354,100	4,215,400	0	0	0	8,894,900
Sewage / drainage	0	500,000	463,700	0	0	1,463,700
Water treatment / water environment	0	0	0	0	0	0
Others	0	0	0	0	0	0
Total	1,495,100	4,870,400	618,700	175,200	184,800	11,314,600
Rajshahi WASA						
Operating expenses	160,000	240,000	240,000	260,000	275,000	1,415,000
Water supply	152,775	8,900	0	0	0	361,675
Sewage / drainage	0	0	0	0	0	0
Water treatment / water environment	0	6,571,100	8,783,900	5,200,000	0	20,555,000
Others	0	0	0	0	0	0
Total	312,775	6,820,000	9,023,900	5,460,000	275,000	22,331,675

Source: Summarized by JST Based on the Website of Ministry of Finance

4) PWD

The PWD is a subordinate organization of the Ministry of Housing and Public Works. The agency manages the design and construction of public buildings and other structures against disasters such as cyclones, floods and earthquakes. Most of PWD's budget is spent on building public structures. The table below shows the budget for seismic reinforcement of structures.

[3] After 2020, jurisdiction over drainage management projects is being transferred from WASA to the City Corporation. Details are provided in Section 4.3 of this chapter.

Table 4.1.25 Recent Expenditure Status in PWD

Unit: Taka in thousand

	2018-19 (Revised)	2019-20 (Revised)	2020-21 (Not Revised)
Operating Activity	13,379,150	14,905,074	16,008,183
Development Activity	15,157,600	12,600,000	11,430,000
Total	28,536,750	27,505,074	27,438,183
Of the above Development Activities, projects whose main purpose is DRR:			
Project on Promoting building safety for disaster risk reduction	10,800*1	48,900*2	5,000*2
Urban Building Safety Project	565,700*1	1,090,000*2	200,000*2

Source: Ministry of Finance
1: Revised Budget, 2 Medium Term Expenditure Estimates

5) BMD

BMD is a subordinate organization of the Ministry of Defense. Its responsibilities include weather forecasting and early warning announcements. The detailed breakdown of BWD’s budget cannot be confirmed, but its activities are generally related to DRR.

Table 4.1.26 Recent Expenditure Status in BMD

Unit: Taka in thousand

	2018-19 (Revised)	2019-20 (Revised)	2020-21 (Not Revised)
Operating Activity	82,73,61	88,08,28	98,59,55
Development Activity	48,82,00	37,78,00	119,02,00
Total	131,55,61	125,86,28	217,61,55

Source: Ministry of Finance

(8) Disaster Management Agencies at the Local Administrative Level

1) Disaster Management Committee (DMC)

As shown in Figure 4.1.3, under the central government organizations, disaster management committees have been set up at the local level in urban and rural areas, respectively. For example, the City Corporation Disaster Management Committee (CCDMC) has been established to manage disasters in urban areas. All related activities (disaster prevention, disaster mitigation, disaster preparation, emergency response/relief in the event of a disaster) are supposed to be implemented by CCDMC. The above-mentioned DMCs are to be established in each of the local administrative units listed in Table 4.1.27 below in accordance with the Disaster Management Act.

Table 4.1.27 Local Administrative Units in Bangladesh with Provision for the Establishment of DMCs

Name of Local Administrative Unit
City Corporation
Division
District
Upazila
Municipal
Union

Source: JICA Survey Team

Table 4.1.28 shows the responsibilities and roles of the CCDMC as an example of the DMCs' jurisdiction.

Table 4.1.28 Responsibilities and Functions of the City Corporation Committee

Risk Reduction Functions
(1) Organize seminars, workshops, and training programs regularly on disaster risk management, especially on earthquakes, fires, etc.; (2) Form volunteer groups for emergency response programs and take necessary steps to train them; (3) Identify and assess hazards, vulnerability, and risk in the City Corporation areas and conduct campaigns and simulations widely to inform those concerned; (4) Prepare contingency plans and organize drills/simulations on earthquakes along with different disasters such as fire incidents, chemical incidents, building collapses, urban flooding, waterlogging, etc. Also, include debris management in the contingency plans; (5) Identify specific safer places in open spaces where people would be able to take shelter during a disaster; (6) Prepare a contingency plan for implementation in collaboration with the Fire Service and Civil Defense, WASA, DSA, PDB, gas agency, BTCL, and other relevant service providers for effective rescue and evacuation of injured people, and other post-disaster management activities; (7) Identify the people at risk according to gender, age, persons with disabilities, social class, occupations, and economic status. Formulate short, medium, and long-term risk reduction action plans with the active participation of persons with disabilities, women, and children; (8) Review whether the construction of multi-story buildings, hospitals, clinics, community centers, shopping centers, cinema halls, restaurants, and factories are in accordance with an adequate setback, fire safety provision, and earthquake resistance as per the Bangladesh National Building Code. Impose appropriate penalty in the case of any deviation in the construction process; (9) Identify open spaces under the jurisdiction of the City Corporation to establish temporary hospitals for the treatment of the injured. Preserve various lifesaving medicines and other necessary items centrally at the City Corporation and ward level to use during the disaster time; (10) Ensure inclusion of disaster risk reduction in annual budgets/development programs of the City Corporation; (11) Prepare, update and maintain the list of volunteers based on wards and send it to the relevant agency; (12) Develop and maintain databases of volunteers, risk and resource maps on the City Corporation's website.
Emergency Response Functions
1 Alert/Warning Stage
(1) Disseminate warning and security messages, establish contact with rescue teams and take necessary steps to evacuate at-risk communities to safer places as per the evacuation plan; (2) Deploy agencies, volunteers, and associated personnel at the field level to the vulnerable community and disseminate forecasts and warning speedily and coordinate and monitor the program of overall safety and dissemination of warning messages; (3) Inspection of selected emergency shelters and ensure the preparedness of various organizations and volunteers engaged in necessary services and security work; (4) Ensure adequate numbers of hygienic toilets including provisions for safe water supply and sufficient lighting at designated locations near the shelter; (5) Prepare a checklist of the emergency tasks and ensure the necessary materials and manpower; (6) Undertake necessary measures for deploying rescue teams along with required vehicles, necessary tools, and equipment during a disaster; (7) Assist the people to transfer their valuables and important assets and goods to a safer place; (8) Take necessary steps to keep the emergency health service team ready.
2 Disaster Stage
(1) Conduct emergency rescue in coordination with primary rescue authorities; (2) Take urgent steps to prevent various water-borne diseases and diarrhea by purifying water and arranging provisions of oral saline; (3) Coordinate the government and non-government humanitarian assistance activities; (4) Ensure to provide accurate information among the people so that people do not panic due to rumors about the disaster; (5) Ensure safety and security for women, children, and persons with disabilities during a disaster in the shelter or other accommodation; (6) Provide support to the concerned agencies for transferring injured people to temporary health centers or hospitals, if needed; (7) Take appropriate steps for the quick funeral of dead bodies and prevent an environmental hazard by burying animal carcasses under the ground; (8) Assist in the work of the responding agencies for the removal of debris; (9) Assist people in transferring their precious and valuable assets to a safer place.

3 Rehabilitation, Reconstruction and Recovery Stage
(1) Collect disaster damage information in SOS form and send it to the Department of Disaster Management and Ministry of Disaster Management and Relief over the telephone, fax, e-mail, or wireless message within an hour;
(2) Conduct damage and loss assessment using the D-Form and send the information to the Department of Disaster Management and Ministry of Disaster Management and Relief in order to determine humanitarian assistance and rehabilitation activities on a priority basis;
(3) Distribution of humanitarian aid and resources that are arranged locally or received from the Ministry of Disaster Management and Relief or any other sources as per the actual needs of people and the instructions from the ministry;
(4) Maintaining the accounts of humanitarian and rehabilitation aid received from the government and development partners;
(5) Take necessary steps so that people can return to their own homes in the aftermath of the disaster;
(6) Take steps to keep the families in a temporary and permanent shelter with required facilities until the rehabilitation of their destroyed houses;
(7) Provide essential psycho-social support to disaster-affected people, with the assistance of specialist doctors or volunteers to overcome trauma;
(8) Provide first aid to injured people and, if required, send them to the hospital for better treatment;
(9) Take security measures for women, children, and people with disability in the disaster-affected communities;
(10) Identify and confirm the identity of the dead persons according to the deceased body management guidelines; provide the death certification and arrange funeral rites for the deceased body, if not claimed;
(11) Provide appropriate recommendations for future actions through workshops with the participation of concerned institutions and individuals for sharing of lessons acquired during disaster and post-disaster activities;
(12) Follow instructions from the Ministry of Disaster Management and Relief.

Source: SOD2019

2) Disaster Response Coordination Group

Like the DMCs above, DRCG is organized on a local government basis. The group is led by the head of the local government body shown in Table 4.1.27 and composed of officials from relevant agencies.

4.1.1.3 Capacity Enhancement of Disaster Risk Reduction Projects Implemented by GoB and the Disaster Risk Management Enhancement Project (DRMEP)

Strengthening the Ministry of Disaster Management & Relief Program Administration is implemented as a capacity enhancement of disaster risk reduction project by GoB as of March 2022. Table 4.1.29 shows the projects underway and planned for the financial year, 2021-2022 (financial year: July-June) in DDM. Main projects in DDM include small-scale bridge and culvert construction, community roads called Herring Bone Bond (HBB), flood shelters, killas and other construction projects. In the case of WB's URP (see 4.1.3.1) and UNDP's NRP, the budget size is small compared to other projects and there are few projects related to capacity building.

Table 4.1.29 Projects Implemented by DDM (FY 2021-2022)

No.	Name of Project	Period	Total Budget (BDT)	Budget 2021-22 (BDT)	Remarks
1	Construction of bridges/culverts up to 15 m in length on rural roads.	Jan 2019 – Jun 2022	65,782,000,000	3,500,000,000	GoB
2	Herring Bone Bond (HBB) for Sustaining Rural Roads (Phase II)	Jan 2019 – Jun 2022	33,472,372,000	3,076,110,986	GoB
3	Construction, renovation, and development of Mujib Killa	Jul 2018 – Dec 2021	19,574,900,000	300,000,000	GoB
4	Construction of flood shelters in flood-prone and river erosion areas	Jan 2018 – Jun 2022	15,074,300,000	3,850,000,000	GoB
5	Disaster Risk Management Enhancement Project (Component 2 & 3)	Apr 2017 – Jun 2022	6,202,200,000	2,060,000,000	JICA
6	Construction of multi-purpose cyclone shelters in coastal and cyclone-prone areas (2nd Stage)	Jul 2018 – Jun 2022	5,560,631,000	100,000	GoB
7	Strengthening of the Ministry of Disaster Management & Relief Program Administration (SMODMRPA)	Jan 2013 – Jun 2023	3,500,800,000	545,000,000	GoB

No.	Name of Project	Period	Total Budget (BDT)	Budget 2021-22 (BDT)	Remarks
8	Construction of District Relief Warehouse cum Disaster Management Information Center	Jan 2018 – Jun 2022	1,439,300,000	500,000,000	GoB
9	Urban Resilience Project (DDM Part)	Jul 2015 – Oct 2023	1,251,200,000	500,000,000	WB
10	National Resilience Program (DDM part)	Jan 2018 – Dec 2021	319,791,000	56,400,000	UNDP
11	Earthquake and other disasters search, rescue operations, and procurement of emergency communications equipment (Phase 3)	Nov 2020 – Oct 2023	22,759,910,000	150,000,000	GoB
Review of new projects of the Department of Disaster Management for the financial year 2021-22					
	Nationwide Lightning Disposal Framework Project to protect people from lightning strikes	July 2021- June 2024	4,470,000,000	-	GoB
	Construction, Operation and Maintenance of Cyclone Shelter for Multipurpose Rescue and Search Work (Phase 3)	January 2021-December 2024	299,500,000	-	GoB
List of unapproved new projects without allocation to facilitate foreign aid					
	Haor risk management project	July 2921-June 2024	16,664,400,000	-	

Source: November, 2021 Annual Development Program Progress Review Meeting of the Department of Disaster Management

Outlines of the projects of “No.1: Construction of bridges/culverts up to 15 m length on rural roads”, “No.4: Construction of flood shelters in flood-prone and river erosion areas”, and “No.11: Earthquake and other disasters search, rescue operations and procurement of emergency communications equipment (Phase 3)” in Table 4.1.29 are shown below as reference. Also the DRMEP funded by JICA which elaborated in the section 4.1.2.

(1) Construction of Bridges/Culverts up to 15 m in Length on Rural Roads

1) Outline of the project

The project involves the construction of two types of bridges of less than 15 m in length and culverts. The project is being implemented in 492 Upazilas and constructing 13,000 bridges and culverts.

2) Management of the project and method of implementation

The organization consists of about 530 people in total, including 1 Project Director (PD), 2 Deputy PD, 2 Assistant PD, 1 Treasurer, 3 Assistants, 6 Clerks, 15 Drivers, and 429 Upazila Work Assistants. Of these, only about 10 are engineers, and none of these engineers have a bachelor's degree.

The implementation of the project requires approval from the Upazila level and the Upazila Nirbahi Officer (UNO) is a member of the Committee and Chairman of the Parliaments and has full responsibility for the project.

Upazila Engineers are assigned to each Upazila according to the size of the project. After the construction plan is approved by the Committee, it moves on to Feasibility Study (F/S), which is handled by eight engineers. After the F/S is reviewed at the Upazila level, the results are reported to DDM, and the project scope is finalized. According to DDM staff, there are cases where projects are approved for implementation despite their low validity, and this applies to approximately 30-40% of all projects. This is due to the fact that the F/S review itself is not accurate. In addition, since the project is a small-scale bridge/culvert construction at the community level, it is assumed that the emphasis is on promptly providing services that contribute to the convenience of community life, rather than on a detailed evaluation of the adequacy of the project implementation. After the approval, design, drawing, and costing are carried out by consultants under the leadership of the DDM. The design follows the Building Code and the design water level is based on the existing maximum water level or 100-year return period.

3) Method of procurement

(a) Method of procurement in this project

After the completion of the design, bidding is conducted and Pre- Qualification (PQ) is conducted at the time of bidding. The e-GP system is not applied for bidding in this project. On average, more than 20 contractors participated in the bidding process. UNO submits the Notification of Award for the bidding results, and the agreement is signed.

(b) General method of domestic procurement system in Bangladesh

Regarding the procurement system, the Central Procurement Technical Unit (CPTU) was established in April 2002 as a division of the Implementation Monitoring and Evaluation Division of the Ministry of Planning. The CPTU is a permanent institution of the government, funded under the revenue budget and established for carrying out the purposes of Section 67 of the Public Procurement Act 2006 (monitoring compliance with and implementation of the Act, arranging for performance of the necessary functions and responsibilities, and performing any other responsibilities). The Public Procurement Rules 2008 have also been developed under the Public Procurement Act 2006. Public procurement has been centrally managed through e-procurement (CPTU, e-Government Procurement (e-GP) system) and various standard bidding forms (downloadable from CPTU website) have been prepared (similar to WB, ADB and FIDIC forms) depending on the bidding conditions. The tender and contract documents for both National Competitive Tendering (NCT) and International Competitive Tendering (ICT) are to be prepared in English. In this way, procurement is becoming more and more electronic.

4) Method of supervision

Construction supervision is conducted by UNO and PIO, and payment is made on a milestone basis, with 15%, 30%, etc. of the total work. After completion, the PIO inspects the project, and the final payment is made. Trainings of PIOs for the inspection are also conducted. The defect warranty period is one year.

5) Challenges of the project

The design assumes a 100-year life span, but in reality, there are many cases where disasters, and damage occur during that period.

DDM does not think that there are challenges in this project, but it is often difficult to obtain information from local areas.

(2) Construction of Flood Shelters (FS) in Flood-Prone and River Erosion Areas

1) Outline of the project

In Phase 1 of this project, 35 shelters have been constructed. The current project is Phase 2, which is a very large project with construction of 423 FSs, all under the GoB budget. FSs are 3- story buildings. The period of the project has been from June 2018 to June 2022; however, because of the COVID 19, the period has been extended to June 2023. However, there is no change in the budget of the project. There is no communication facility for the shelter, but a maximum 200-meter-long HBB road will be built to connect the FS and surrounding areas.

2) Management system of the project

There are more than 420 staff members, including 10 engineers. In the construction of the shelter, consideration is being given to women and the disabled, and gender considerations must be ensured.

3) Challenges of the project

According to DDM, the major challenge of the project is that there is no budget for repairs. They believe that they are constructing very good buildings, which will normally be used as a school. However, the project has only enough budget to build a shelter, and the school and shelter are not equipped with desks and other necessary facilities inside, which is a major challenge. Furthermore, after the construction, the management of the shelter will be transferred to the School Committee. However, the School Committee does not have the budget for maintenance and management, yet the old shelter needs to be repaired or reconstructed. The project only has a budget for construction and no budget for repair and maintenance, and as a result, none of the organizations have a budget for repair and maintenance. As for the schools, Madrasa, which teaches Arabic, Islam, Islamic history, etc., is often mixed with regular schools, which is also considered as one of the challenges.

(3) Earthquake and Other Disasters Search, Rescue Operations and Procurement of Emergency Communications Equipment (Phase 3)

1) Outline of the project

Earthquakes and other disasters such as floods, droughts, cyclones, etc., are targets of the project. The total budget is BDT 22,759,910,000 and the project period is from November 2020 to October 2023. Equipment is being provided to 10 agencies, Fire Department, Civil Defense, Military, Navy, Police, Coast Guard, Red Crescent, DDM, CPP, and the Ministry of Food (Vulnerable Group Development: VGD).

The Fire Department is provided with ladder trucks, ambulances, evacuation vehicles, and hovercraft. Hovercraft is also provided to the Navy and Coast Guard. For DDM, vehicles, sleeping bags, speed boats, tents, food, water, body bags, flashlights, shovels, etc.; are provided. For the police, emergency vehicles, etc.; for the CPP, megaphones, life jackets, etc.; and for the Red Crescent, almost the same equipment was provided to the CPP. Expensive equipment is imported from abroad.

2) Progress of the project

The projects are currently in the preparation stage, and the equipment is being reviewed as of March 2022. Negative impacts of COVID-19, such as steep rise in transportation costs or problems regarding the import of equipment, are not clear as of March 2022.

3) Scope of the project

The project only provides the equipment, and the agency in charge will manage the operation and maintenance costs after the equipment is handed over.

4) Method of procurement

For procurement, a Memorandum of Understanding (MoU) has been signed with Bangladesh Machine Tools Factory (BMTF), under the military, and the project has been entrusted based on the MoU. The procurement is carried out in accordance with the Public Procurement Rule. After reviewing the specifications and costs, if there is no problem, the contract is signed. The equipment to be procured is decided based on the application from each ministry.

5) Challenges of the project

Since Fire department and Armed Forces division are the First Responders, these two departments have the highest amount of provided equipment (Fire department: 433 crore BDT, Armed Forces division: 314 crores BDT). The challenge is that the budget is always inadequate in a developing country like Bangladesh.

4.1.1.4 Amount of DRR Investment in the National Budget

This section outlines the estimated ratio of DRR investment to the total national budget based on the budgets of major disaster management agencies outlined in section 4.1.1.2. In order to estimate the amount of DRR investment for the national budget, the following budget information is extracted and regarded as DRR project costs.

Table 4.1.30 Budget Considered as DRR Investment for the General Estimation

Organization	Budget Considered as DRR Investment for the General Estimation
MoDMR and DDM	Total project budget of MoDMR and DDM
BWDB	Total project budget of BWDB
LGED	Budget for water infrastructure development and disaster recovery
WASA	Budget for sewage and drainage projects
BMD	Total project budget of BMD

Source: JICA Survey Team

As shown in Table 4.1.31, it is estimated that the ratio of the budget for DRR projects to the national budget is about 2%.

Table 4.1.31 Estimated Amount of DRR Investment in the National Budget

Unit: Taka in crore

	Actual	Revised	Medium Term Expenditure Estimates	
	2017-18	2018-19	2019-20	2020-21
National Total Expenditure	547,252	609,262	760,143	842,705
BWDB DRR investment (Percentage of Total Expenditure)	2,793 (0.51%)	7,624 (1.25%)	7,592 (1.00%)	8,507 (1.01%)
LGED DRR investment (Percentage of Total Expenditure)	121 (0.02%)	1,770 (0.29%)	1,698 (0.22%)	1,716 (0.20%)
MoDMR DRR investment (Percentage of Total Expenditure)	4,834 (0.88%)	7,694 (1.26%)	8,034 (1.06%)	8,843 (1.05%)
WASA DRR investment (Percentage of Total Expenditure)	0 (0.00%)	82 (0.01%)	486 (0.06%)	390 (0.05%)
BMD DRR investment (Percentage of Total Expenditure)	-	132 (0.02%)	126 (0.02%)	218 (0.03%)
Total (Percentage of Total Expenditure)	7,748 (1.42%)	17,302 (2.84%)	17,935 (2.36%)	19,674 (2.34%)

Source: Summarized by JST Based on the Website of Ministry of Finance

4.1.2 JICA's Cooperation in DRR Governance

A summary of JICA's cooperation to date is given below. Projects that are strongly related to various types of disasters are described in more detail after clause 4.2.

(1) Overview of Cooperation to Date

Japan's cooperation related to disaster risk reduction with Bangladesh has generally been focused on water-related disasters. In particular, Japan has assisted in the field of floods, ranging from flood protection and drainage projects in urban areas to studies on flood protection in rural areas and flood forecasting and warning systems. In addition, other cooperation projects have been conducted, such as bank protection works, dispatch of experts for water resources management, construction of cyclone shelters, and weather radar through grant aid.

In recent years, in the field of the earthquake disaster in urban areas, through technical cooperation and Science and Technology Research Partnership for Sustainable Development (SATREPS), Japan has contributed to the improvement of the systematization of earthquake resistance technology and is currently implementing the earthquake resistance of public buildings through loan projects. Furthermore, in the field of disaster risk governance for MoDMR and DDM, Japan has dispatched advisors to coordinate the disaster risk reduction sector, developed local disaster risk reduction plans through technical cooperation, and supported disaster recovery funds through financial assistance.

In the field of DRR governance, JICA has cooperated in coordination with other organizations and donors through the Disaster Risk Management Sector Coordinating Advisor. In addition, JICA has been promoting the procurement of communications and rescue equipment and ships as well as the structure of disaster recovery funds through the Disaster Risk Management Capacity Enhancement Project and the Grant Aid for Rescue Capability Enhancement. In the phase of preliminary preparations and emergency responses, particularly in the area of water disasters, the coordination and practical operations have been carried out at a relatively high level, due to the substantial cooperation of JICA and other donors. On the other hand, in the phase of disaster prevention and recovery/reconstruction, the Ministry of Disaster Management and Relief and the Department of Disaster Management have not been able to sufficiently coordinate the development of comprehensive national disaster prevention measures, and no mechanism has been established to enable prompt budget execution for disaster recovery. In light of the current situation, it is important to develop structural measures, including disaster rehabilitation, that is suited to the actual conditions in Bangladesh, and to focus on strengthening cooperation between the local and central governments, based on lessons learned from ongoing yen loan and technical cooperation projects to strengthen disaster risk management capabilities.

Table 4.1.32 JICA's Major DRR-Related Surveys and Projects (After 2010)

Project	Scheme	Term
1) Water induced disaster		
River management advisor	Technical cooperation (Individual experts)	2010/9～2014/9
Integrated water resource management advisor	Technical cooperation (Individual experts)	2014/9～2016/9, 2019/7～2022/3
Water resources management policy and technical advisor	Technical cooperation (Individual experts)	2022/7-2025/6
The Project for Capacity Development of Management for Sustainable Water-Related Infrastructure	Technical cooperation (Development study type)	2013/7～2016/6
Research Project on Disaster Prevention/Mitigation Measures against Floods and Storm Surges	Technical cooperation (SATREPS)	2014/4～2019/3
Project for Planning Capacity Enhancement and Establishment of a Technology Adaptation Cycle on Comprehensive Nodi (River) Management	Technical cooperation	2020/5～2024/4
Haor Flood Management and Livelihood Improvement Project	Loan	2014/6～2023/4
Disaster Risk Management Enhancement Project (Maintenance of polders for storm surge)	Loan	2016/6～2023
Chattogram City Outer Ring Road Project	Loan	2015-
Development of Human Capacity in Operation of Weather Analysis and Forecasting	Technical cooperation	2009/9～2014/1
The Project for Improvement of Meteorological Radar System in Dhaka and Rangpur	Grant aid	2020/4～2023/11
Project for Operation and Maintenance of Weather System Capacity Enhancement	Technical cooperation	2022/3～2025/9
2) Urban earthquake disaster		
Project for Capacity Development on Natural Disaster-Resistant Techniques of Construction and Retrofitting for Public Buildings	Technical cooperation	2011/3～2015/2
Urban Building Safety Project	Loan	2015/12～2023/12
Building Safety Promotion Project for Disaster Risk Reduction（BSPP）	Technical cooperation	2016/2～2022/2
The Project for Technical development to upgrade the structural integrity of buildings in densely populated urban areas and its strategic implementation toward resilient cities	Technical cooperation (SATREPS)	2016/4～2022/7
Project for improvement of the quality of design and construction of private buildings	Technical cooperation/	2021/8～2026/3
Project for the assistance of capacity enhancement of urban community disaster risk reduction in Bangladesh	Technical cooperation	2016/4～2019/4
3) Strengthening disaster risk governance		
The Capacity Enhancement on Disaster Risk Reduction, Emergency Response and Recovery Project (Civil works as disaster risk reduction, disaster recovery fund, communication equipment procurement)	Loan	2016/6～2025/6
The Project for Capacity Enhancement on Formulation and Implementation of Local Disaster Risk Reduction Plan	Technical cooperation	2020/7～2024/6
Coordination adviser for disaster risk reduction sector	Technical cooperation (Individual experts)	2015/6～2022/7
The Project for Improvement of Rescue Capacities in the Coastal and Inland Waters	Grant aid	2018/3～2021/5
Support for Community Disaster Preparedness in Cyclone Prone Areas	Grassroots technical cooperation	2017/10～2021/9
Community Capacity Development for Disaster Risk Reduction by Community Radio	Grassroots technical cooperation	2013/2～2017/2
Study on a project for water-induced disaster measures through a river monitoring camera system using solar power and wireless communication	Study commissioned by the Ministry of Foreign Affairs (Small and Medium Enterprise Support Case Study)	2013/10～2014/2
Survey on Construction of Disaster Resilient Information-Sharing Based Community	Survey commissioned by the Ministry of Foreign Affairs (Need survey)	2013/9～2014/2
Project for National Geospatial Information Development	Technical cooperation	2019/8～2021/8

Project	Scheme	Term
4) Other projects		
Reassessment of cooperation in the field of earthquake disaster and consideration of future policies in priority areas	Project study	2020/11～2021/11
Systematization of Japan's core knowledge on water induced disaster measures to be provided to developing countries	Project study	2021/3～2021/12
Data collection survey on the global flood control sector disaster risk reduction investment project	Data collection survey	2021/1～2021/12
Data collection survey on the promotion of investment in disaster risk reduction for resilient cities against earthquake disasters	Data collection survey	2021/1～2021/12
Data collection survey on meteorological services and infrastructure	Data collection survey	2021/2～2021/12

Source: JICA Document Revised by the Survey Team

Table 4.1.33 JICA's Major DRR-related Surveys and Projects (Before 2010)

【Flood, Urban drainage】

Project	Scheme	Term
Project for the Improvement of the Storm Water Drainage System in Dhaka City	Grant aid	1989 - 1992
Greater Dhaka protection project of Bangladesh Flood Action Plan	Development research	Oct 1990 – Jun 1992
Flood Control and Drainage Plan in Northwestern Region	Development research	Jul 1991 – Jan 1993
Operation and Maintenance Study for Action Plan for Flood Control	Development research	Jul 1992 – Aug 1992
Action Plan for Flood Control	Research cooperation	Jul 1994 – Jul 1997
Long-term revetment and flood countermeasures for the Meghna River	Research cooperation	Apr 2000 – Mar 2002
Study on Flood adaptive livelihood improvement plan	Development research	Dec 2000 – Jul 2002
Study on Flood Forecasting and Warning System	Development research	Nov 2002 – Dec 2003
Project for the Improvement of the Storm Water Drainage System in Dhaka City Phase II	Grant aid	Feb 2007 – Aug 2009

【Revetment】

Project	Scheme	Term
Project for protecting revetment on the bank of Meghna River	Grant aid	Jun 1992 – Jan 1994
Project for improving revetment on the bank of Meghna River	Grant aid	Mar 1997 – Feb 1998
Long-term revetment and flood countermeasures for the Meghna River	Research cooperation	Apr 2000 – Mar 2002

【Policy】

Project	Scheme	Term
Advisor for Water Resources Development Policy	Technical cooperation	May 1999 – May 2002
Advisor for Water Resources Management Planning	Technical cooperation	Apr 2004 – Apr 2006

【Meteorology, others】

Project	Scheme	Term
Radar update plan for meteorological observation	Grant aid	1986
Meteorological microwave network maintenance plan	Grant aid	1992
Multipurpose cyclone shelter construction plan (Phase I to V)	Grant aid	Jul 1993 – Dec 2006
Natural disaster and weather warning improvement plan	Grant aid	1997
Project for the Improvement of the Meteorological Radar System at Cox's Bazar and Khepupara	Grant aid	Jul 2005 – Feb 2008
Project for the Establishment of the Meteorological Radar System at Moulvibazar	Grant aid	Jun 2007 – Mar 2009
Emergency Grant Aid (Emergency Disaster Relief)	Grant aid	2007
Emergency disaster recovery plan	Loan	2008 –

【Earthquake】

Project	Scheme	Term
Earthquake countermeasure strengthening project (short-term expert dispatch)	Research	2004

Source: JICA Survey Team based on “Preparatory Survey on Disaster management sector cooperation, JICA, 2010”

(2) Status of Operation of Disaster Recovery Fund of DRMEP

As shown in Table 4.1.32, in "Component 3: Disaster recovery fund for quick and effective recovery " of "Disaster Risk Management Enhancement Project (DRMEP)", a disaster recovery project using the Disaster Recovery Fund is under implementation.

The disaster recovery project is expected to be tendered and contracted in the financial year 2020-2021 (Government of Bangladesh Financial Year: 1 July 2020 to 30 June 2021). This component is intended for rapid post-disaster rehabilitation and covers infrastructure affected by the 2020 Super Cyclone Amphibian for BWDB and LGED and ageing flood-affected infrastructure for DDM. All applications were submitted by the district offices of BWDB, LGED, and DDM (regarding LGED, selected by the Dhaka Head Office). The summary is as follows, and results of site surveys conducted by the survey team are shown below.

1) DDM

Repairs are being made to restore embankment roads, approach roads before and after box culverts, HBB roads, pipe culverts, earth retaining concrete plate fences, and flood shelters that have suffered flood damage over time.

Table 4.1.34 Packages managed by DDM in DRMEP

Number of packages	15 packages / total 13 Districts 13District：Bogura, Dhaka, Faridpur, Gaibanda, Gopalganj, Jamalpur, Kurigram, Madaripur, Manikganj, Shariatpur, Sirajganj, Sunamganj, Tangail Gaibanda, Sirajgan: 2 packages in both Districts
Type of measures	1. Earthen Road （Community level embankment road with 3m width at the top of the embankment） 2. Bridge Approach（Approaches before and after the box culvert, practically of the same standard as Earthen Road） 3. HBB Road (This is a restoration of a two-layer brick pavement, the way of the arrangement of bricks is called “a Herring Bone Bond (HBB)”. 4. Pipe culvert 5. Palisading（Earth-retaining concrete plate fence） 6. Flood shelter （The type of the repair is unknown, but it is requested by DDM for a small sum.）
Supervisor	District Relief and Rehabilitation Officer in each district office of DDM（DRRO：Chief representative of DDM districts office）

As of 5 July 2021, contracts with contractors have been signed for all packages.

2) BWDB

Restoration of embankments damaged by Cyclone Amphan in 2020, as well as the installation of sandbags and emergency slope protection works, are underway.

Table 4.1.35 Packages managed by BWDB in DRMEP

Number of packages	20 packages BWDB Khulna O&M Division-1：1 package BWDB Khulna O&M Division-2：2 packages BWDB Satkhira O&M Division-1：5 packages BWDB Satkhira O&M Division-2：11 packages BWDB Pirojpur O&M Division：1 package
Type of measures	Re-sectioning of Embankment with Temporary Slope Protection by Geo-bag
Supervisor	Executive Engineer in each BWBD district office (Chief representative of BWDB district office） Khulna District： O&M Division-1, O&M Division-2 Satkhira District： O&M Division-1, O&M Division-2 Pirojpur District： O&M Division

As of 5 July 2021, 15 packages have been contracted to contractors. The 5 packages not yet contracted will be tendered in FY2021-22 (one of them will be re-tendered in FY2020-21).

3) LGED

Repair of simple paved roads and bridges damaged by Cyclone Amphan in 2020 is underway.

Table 4.1.36 Packages managed by LGED in DRMEP

Number of packages	6 packages LGED Khulna District Office：4 packages LGED Satkhira District Office：2 packages
Type of measures	Restoration of bituminous carpeting 15 m length bridge: 1 bridge
Supervisor	Executive Engineer in each LGED district office (Chief representative of LGED district office)

As of 5 July 2021, contracts have been awarded to contractors for four of the six packages for FY2020-21. Two uncontracted packages will be tendered in FY2021-22. The uncontracted Package No. W-DRMEP-KHUL-Digh-UNR/06 has two parts, Part A and Part B, which together constitute one package, making a total of six packages.

4) Results of site surveys: Component 3 (Disaster recovery fund, DDM Part)

The ongoing Component 3 (Disaster Recovery Fund) of DRMEP is being implemented by DDM, BWDB and LGED. For the DDM Part, site visits were conducted in Nawabganj Upazila sites near Dhaka. The local consultant for quality/quantity control of DRMEP accompanied the site visits and explained the project outlines. The PIO of Upazila also accompanied the site visits. The local Union leader participated in the survey to interview about the actual disaster situation and their requests. Outlines of the survey are shown in Table 4.1.37

Table 4.1.37 Outline of Site Survey

Scheme No.	Scheme Details	Affected Length (m)	Cost (BDT)
1(ii)(b)	From Tupiwala's house of Nayanshree UP to Shantinagar Mizan's shop to Shantinagar Primary School (HBB)	383m	2.91 Lac
2(v)	Soil filling at the approach of 16.00 feet bridge over the canal next to Mohabbatpur Funukaji's house	35m	0.25 Lac
4	The Road from Madhabpur Bridge to Madhabpur Cemetery is filled with soil and other works	1,800 m (Before construction)	66.6 Lac
10	Road repair from Gobindpur Madrasa to Jalal Byapari land	1,100m	10.56 Lac
21	Road repair from Mohanpur Daroga Bari to Roads and Highway via Daintala	1,150m	11.04 Lac
28	Roads from Hasnabad World Vision Office to Old Bandura to be filled	1,200m	11.52 Lac

Source: JICA Survey Team Prepared Based on the Documents Provided by the DRMEP

(a) Effectiveness of the project

The elevation of the roads for No.10 and No.21 was improved to 5-6 meters above sea level. The height of the road for No.21 was improved to 1.5-2.0 meters higher than the existing road, and Union leaders appreciated the improved accessibility, as they experienced no flooding last year. The area is flooded almost every year with the height of the existing road.

(b) Challenges of project

At the same time, it was strongly requested that the road be extended and upgraded to HBB road, as extending the road by 1km would further improve access to schools and markets. On the other hand, the height of the repaired road for No.10 is almost the same as that for No.21, but in No.10, the road is flooded up to the height of the repaired road almost every year. Last year, the road was flooded and students had to commute to school by boat. Union leaders have requested that the road be extended in this area as well, as an extension of about 500 meters would improve access to the school.

When repairing roads, each area has been designed with similar repair heights, but the probability of flooding has not been taken into consideration. It is important to understand the situation at the time of disaster and to consider the flooding level in designing the roads. The roads are made of embankment and the compaction is conducted manually; therefore inadequate. When agricultural machines such as tractors pass by, ruts are easily formed, requiring immediate repairs. In addition, in No.10, trucks are used to remove soil and sand for the construction of a pond along the road. Ruts caused by the trucks are also problems. Improving the design capacity of DDM, including the study of inundation heights, construction management skills and the management of compaction, is considered to be one of the most important issues to be addressed in the implementation of similar projects in the future.


Left: repairing ruts with just putting soils to the ruts without proper compaction works, Right: actual condition of the ruts.
Source: JICA Survey Team

Figure 4.1.8 Actual Conditions of Roads After Repair (left: No.21, right: No.10）

4.1.3 Cooperation with Other Donors in DRR Governance

In Bangladesh, the following projects related to disaster management administration are being implemented in cooperation with other donors. Projects with close links to individual disaster types are described separately in 4.2 and subsequent sections.

4.1.3.1 Projects by the World Bank

In the field of DRR-CCA, the World Bank is working on the wide range of programs, including coastal resilience, urban resilience, climate-smart agriculture, social protection and so forth. All the programs are within the scope of the WB's Country Partnership Framework (CPF). The document is available online. The 2023-2027 version of this framework is currently being updated.

The CCA-DRR team in the WB has several programs which amounts to about 1,3 billion dollars in total. Currently there are 7 on-going projects and 1 project under preparation. One of the main focus areas is on coastal resilience. These projects include Coastal Embankment Improvement Projects (CEIP), which aims to establish the polder system along the coast. Another project is Multi-purpose Disaster Shelter Project (MDSP) targeting the coastal area to provide people with disaster refugee facilities during Cyclone. The WB has two (2) projects relating to Rohingya response, in which DRR-components are incorporated, the name of the project is Emergency Multi-Sector Rohingya Crisis Response Project. Another project, Bangladesh Weather and Climate Services Regional Project, is targeting overall enhancement of hydro-met system in Bangladesh supporting BMD, DAE and BWDB. Another project is regional climate adaptation program. As the WB's new project under preparation, Resilient Infrastructure Building Project, is targeting local people living in flood-prone area to support with necessary infrastructure development.

The WB has no single project for DRR governance. The governance is embedded in all DRR projects. For example, in the urban resilience project, online construction permitting system has been developed. Before that, all the permitting process was paper-based. By introducing the electric permitting system, efficiency and transparency of the process will be improved.

The WB sees that the problem lies in the department's low capacity compared to other government organizations. One of the reasons is its high staff turnover. The situation is different from other technical agencies such as BWDB, where office staff stays until retirement. DDM recruits, low-skilled personnel making it difficult to set up strong technical teams to work with.

Regarding the idea to support of capacity development in DDM, the WB considers that a focus should be more on coordination rather than infrastructure development. About 10 years ago, UDNP conducted Comprehensive Disaster Management Program, in which DDM staffs were trained. However, the trained staffs did not stay in DDM.

The table below shows the on-going and planned projects by the WB.

Table 4.1.38 On-going and Planned Projects by WB

On-going Projects
(i) Urban Resilience Project (URP) (ii) Coastal Embankment Improvement Project I (iii) Multipurpose Disaster Shelter Project (iv) Bangladesh Weather and Climate Services Regional Project (v) Emergency Multi-Purpose Rohingya Crisis Response Project (EMCRP) (vi) EMCR Additional Financing (vii) Climate Adaptation and Resilience for South Asia regional project
Planned Project
Resilient Infrastructure Building Project

Source: Survey Team

Outline of representative projects by the WB, Urban Resilience Project (URP), Community Climate Change Project, Multipurpose Disaster Shelter Project and Climate Adaptation and Resilience for South Asia regional project are shown below.

(1) Urban Resilience Project

The Urban Resilience Project of Bangladesh has an objective to strengthen the capacity of Government of Bangladesh agencies to respond to emergency events and to strengthen systems to reduce the vulnerability of future building construction to disasters in Dhaka and Sylhet. The Project comprises five components.

Component A: Reinforcing the Country's Emergency Management Response Capacity (Cost $109.00 M)

It aims to operationalize an integrated emergency management system that will enable to plan and respond to both daily emergencies as well as major disasters in an organized and effective manner. The component is financing: (i) construction and/or refurbishment of decentralized facilities for emergency management and response; (ii) establishment of a communications network for these facilities to operate during emergencies; (iii) specialized search and rescue equipment; and (iv) training for emergency operations and response.

Component B: Vulnerability Assessment of Critical and Essential Facilities (Cost $15.70 M)

The objective of component B is to develop a consensus-driven analytical foundation required for longer-term investments to reduce risk in the built environment for Dhaka city. This is being carried out through two sub-components led by RAJUK, B1: Vulnerability assessment of critical and essential facilities; and B2: Development of a Risk-Sensitive Land Use Planning practice, including a Strategic Environment Assessment.

Component C: Improved Construction, Urban Planning, and Development (Cost $43.30 M)

The objective of Component C is to put in place the institutional infrastructure and competency to reduce long-term disaster vulnerability, addressing both the existing built environment as well as future development. The package under this component focuses on creating the Urban Resilience Unit (URU) to support DRR, Mainstreaming and improve Dhaka Urban Resilience. The implementation was largely based on the then proposed Bangladesh National Building Code which has since been approved and gazette was published on February 11, 2021.

Component D: Project Coordination, Monitoring, and Evaluation (Cost $5.00 M)

The objective of Component D is to provide necessary funding for project coordination, monitoring and evaluation. It will also ensure periodic evaluation of the investment program to highlight the outputs and outcomes in support of a longer-term investment program.

Component E: Contingent Emergency Response

Component E would allow the Government to request the Bank to reallocate project funds and designate them as Immediate Response Mechanism funds to be engaged to partially cover emergency response and recovery costs. This component could also be used to channel additional funds should they become available as a result of the emergency.

The project is scheduled to begin in March 2015 and end in October 2023. Total project cost is estimated at US$ 182.00 million4.

(2) Community Climate Change Project

The development objective of the Community Climate Change Project for Bangladesh is to enhance the capacity of selected communities to increase their resilience to the impacts of climate change. The project has three components.

Component 1. Community Climate Change Fund (appraisal cost US$10.40 million; actual cost US$11.04 million). This component would establish a US$10.40 million fund to finance community-based climate change adaptation projects to be implemented with the assistance of NGOs subsequently named project implementation partners (PIPs). The fund would be managed by Palli Karma-Sahayak Foundation (PKSF) through a separate Project Management Unit (PMU), to be set up and supported (with staffing, equipment, and operation costs) under Component 3. PKSF would invite project proposals from NGOs to address climate change impacts in (a) salinity affected coastal areas; (b) flood affected char-lands and river basins; and (c) drought affected or rainfall-scarce areas. Each project proposal had to be located within a vulnerable zone (a list of upazilas in these zones was provided in Annex 2 of the PAD), and would address at least one of the following six pillars of the Bangladesh Climate Change Strategy and Action Plan (see Section 3a below).

Component 2. Knowledge Management, Monitoring and Evaluation, and Capacity Building (appraisal cost US$ 0.44 million; actual cost US$0.45 million). This component would promote the sharing of lessons on best practices among the participating NGOs, as well as in the wider NGO community and in regional and global forums. This component would also support a structured learning process of capturing lessons and incorporating best practices into the design and implementation of community-based interventions, including the preparation of a toolkit and guidelines, and visits to adaptation activities in different vulnerable zones. This component would provide technical assistance to develop options for institutionalizing lessons learned.

This component would also: (a) build the capacity of NGOs to prepare eligible community based climate change adaptation sub-project proposals; (b) operationalize an M&E system to ensure effective monitoring of project outcomes at the project and community levels; and also to enable an independent third party monitoring and impact evaluation of financial system performance, and a comprehensive review and evaluation of outcomes at project completion; and (c) establish a grievance redress system to handle any issues raised by stakeholders about the implementation of the project or any sub-project.

Component 3. Project Management (appraisal cost US$1.66 million; actual cost US$1.51 million). This component would finance technical assistance to: (a) establish a PMU within PKSF to manage the project and monitor the implementation of subprojects; (b) finance the operating costs of the Fund, including equipment, financial management, procurement, technical assistance, and administrative expenses; (c) build the technical capacity of PKSF to appraise sub-project proposals submitted by NGOs; and (d) operationalize the procedures for Fund management outlined in the Operational Manual.

[4] Source: https://projects.worldbank.org/en/projects-operations/project-detail/P149493

The project was approved in July 2012 and completed in December 2016. The implementing agency is PKSF and the total project cost is estimated at US$ 12.50 million[5].

(3) Multipurpose Disaster Shelter Project

The objective of the Multipurpose Disaster Shelter Project (MDSP) for Bangladesh is to reduce the vulnerability of the coastal population in selected coastal districts of Bangladesh to natural disasters. The project has three components. (1) Reconstruction and improvement of multipurpose shelters component will finance the construction of around 552 new shelters, the rehabilitation of around 450 existing shelters, the construction and improvement of around 550 kilometers of rural roads to improve access and communication networks to shelters, the implementation of environmental and social management plans, and design and construction supervision. (2) Project management, monitoring and technical assistance and training component will support the government in implementing the project, and in coordinating all project related activities, monitoring, technical assistance and training. (3) Emergency contingent response component. In case of a major natural disaster, the government may request the Bank to re-allocate project funds to this component (which presently carries a zero allocation) to support response and reconstruction.

The project began in December 2014 and is scheduled to end in June 2023. The implementing agency is LGED and the total project cost is estimated at US$ 376.70 million[6].

(4) Climate Adaptation and Resilience for South Asia

The development objective of the project is to create an enabling environment for climate-resilient policies and investments in select sectors and countries in the South Asia Region (SAR)

The Project will enable and support national-level resilience objectives and contribute to regional outcomes. Governments in SAR will have access to (i) data and knowledge services provided by the regional program; and (ii) readily available technical assistance through the expertise and advisory services provided by regional entities, thereby strengthening the climate resilience of operations and expediting project preparation and implementation. This would enable a two-way information flow between the regional and the national levels and allow national-level activities to contribute to regional outcomes.

Geographical scope: All SAR countries will benefit from the regional activities focusing on dialogue and learning opportunities, and access to enhanced data, standards and guidelines. National level interventions under the proposed project will focus on a sub-set of countries in South Asia, in particular Bangladesh, Nepal and Pakistan in the first phase. Based on a mid-term review, the project would consult and explore expansion of the project to other SAR countries and thematic areas, based on evolving demand and the resource envelope.

Component 1: Promoting Evidence-based Climate Smart Decision Making: Preliminary assessments of regional and national data platforms and decision support systems were done in order to identify the key gaps that pose challenge to climate-informed decision making in various sectors. The assessment broadly highlighted that while there are portals that provide relatively good sectoral information, there is limited if any dynamic visualization/overlay or integration of weather/climate data with exposure and other sector-specific information for automated location-specific impact forecasting and response advisory generation. There is currently no DSS that integrates and processes a comprehensive amount of climate data (i.e., GCM, RCMs, satellite data, historical observation, global/regional NWP models, etc.) for multiple sectoral applications by various users. In terms of system functionalities, compatibility and sustainability, most portals and DSS that are currently available have relatively limited functionalities, generally do not have a mobile app feature, nor continued support ensuring bug fixes and system upgrades as technologies/systems advance.

Component 2: Enhancing Policies, Standards and Capacities: The objective of this component is to enable transformation of policies, standards and capacities for climate resilience and adaptation across

[5] Source: https://documents1.worldbank.org/curated/en/581201513954124522/pdf/ICRR-Disclosable-P125447-12-22-2017-1513954117580.pdf
[6] Source: https://projects.worldbank.org/en/projects-operations/project-detail/P146464

South Asia. This would be achieved through: (i) providing evidence base and guidance for mainstreaming climate risk management into national, local and sector development planning and policies.; (ii) sharing global and regional knowledge and best practices on adaptation and resilience; (iii) developing regional sector guidelines for mainstreaming climate risk management and modifying business-as-usual standards in sector planning and investment design and; (vi) providing technical support to critical national and provincial institutions as well as community-based organizations (e.g. cooperative societies, women groups, etc.) to implement climate resilient development actions.

Component 3: Project Management and Specialized Support: The objective of this component is to ensure the successful implementation of the activities carried out under the Project. This component will finance establishing and operating the Project Implementation Units (PIUs) of the Regional Integrated Multi- Hazard Early Warning System for Africa and Asia (RIMES) (US$2 million) and Asia Disaster Preparedness Center (ADPC) (US$3 million). In addition, the component will finance consultancies required for the preparation and supervision of specific activities, monitoring and evaluation, trainings, exposure visits, studies for knowledge generation and sector-specific climate impacts and related interventions and inclusive practices in climate resilient planning and investments.

The project was approved on May 2020 and is scheduled to be completed in August 2025. The implementing agencies are RIMES and ADPC, and the total project cost is estimated at US$ 36.0 million[7].

4.1.3.2 Projects by Asian Development Bank

ADB does not have a separate unit specific to addressing DRM or DRR related issues. Hence most of the disaster related aspects are incorporated into the existing ANR and urban projects. Projects related to flood and riverbank erosion management are implemented in urban-related projects and projects in the ANR sector. Details are provided in 4.2.3.3. All of these projects are scheduled to be extended.

ADB is proposing the “Climate Resilient Livelihood Improvement and Watershed Management in Chittagong Hill Tracts”. The project will focus on five of the seven operational priorities of the ADB Strategy 2030: (i) addressing remaining poverty and reducing inequalities; (ii) accelerating gender equality; (iii) tackling climate and building climate resilience; (iv) promoting rural development and food security; and (v) strengthening governance and institutional capacity.

The Climate and Disaster Resilient Small-Scale Water Resource Management Project proposes to improve productivity and profitability in agriculture through effective, participatory, and sustainable small-scale water management. The overall impact will be increased food security and rural livelihoods resilience to climate change-induced disasters amongst project beneficiaries. This impact will be achieved through three key outputs: (i) participatory subproject development; (ii) development of small-scale water resources infrastructure with climate and disaster resilient features; and (iii) Upazila- and water management cooperative association-level value chain development.

According to interviews with ADB conducted for this survey, ADB has not implemented any earthquake-related projects, nor has it implemented any projects with DDM.

4.1.3.3 Projects by United Nations Development Programme

The National Resilience Program (NRP) and National Adaptation Plan (NAP) primarily focus on Climate Change, Adaptation and Disaster Risk Reduction (DRR). The program includes various initiatives for climate change and adaptation, but with regards to DRR the initiatives are not as many. The DRR initiatives are mostly included within the frame of projects under climate change and adaptation.

UNDP provides support and guidance to the ministries and government agencies regarding DRR. Focuses are on risk informed development and risk informed investment from the private sector. UNDP also strives to provide humanitarian support for DRR in collaboration with the Government through various initiatives. UNDP has built shelter clusters and early recovery clusters to support rehabilitations. UNDP primarily

[7] Source: https://documents1.worldbank.org/curated/en/520211583341431628/pdf/Project-Information-Document-Climate-Adaptation-and-Resilience-for-South-Asia-P171054.pdf

supports the Government on building strategy, on forming policies and on building capacity. The UNDP has prepared a Nation Plan for DRR in Bangladesh.

Prior to recent times, earthquakes were not on the agenda of DRR for the Bangladesh Government. After an incident of tremors in Sylhet the government and local authorities ever since have included it in their priorities. UNDP is working closely with the Government and the local authorities to implement risk preventative measures.

Opinions regarding DRR from UNDP are shown below.

The focus of various initiatives is only confined to humanitarian issues. More initiatives regarding future DRM and long term plans need to be implemented. The different dynamics such as the scientific aspects should be taken into consideration.

More data is required in terms of sub-districts. The data currently is limited only to district level. The data also lacks information regarding real-time data, and updates of other dynamics revolving around the DRM.

The Government offices and overall systems in Bangladesh are still largely conventional. Data, Systems and Institutions need to be heavily modernized as well as digitized to increase efficiency while dealing with DRM as well as bridge the gaps.

With regards to vulnerable groups and gender, there is a disparity that presents while dealing with disasters. Better implementation and improvisation are needed to cater to these groups[8].

(1) Disaster Response and Recovery Facility (DRRF)

Project Description

The project was preceded by the Early Recovery Facility (ERF), which was implemented from 2011 to September 2018 with MoDMR and DDM as the lead implementing agencies and the Government of Bangladesh, UNDP, and other NGOs as implementing partners. Long-term livelihood improvement and shelter programs were implemented with the main objective of strengthening voluntary and sustainable disaster risk management capacity for recovery at the national level.

Building on successes of Early Recovery Facility project, the facility will continue to focus on rapid-scaling up and effective management of the SDGs and a developed county status by 2041. The proposed Facility will adopt an “economy-wide” approach and will primarily support the Ministry of Disaster Management and Relief and gradually expand its support to selected key sectors at all levels for enhancing national capacity and supporting policy making for resilient recovery.

Project objective

- ✓ Implement timely, appropriate and adequate response and recovery assistance to the households, community, businesses for quick return to sustainable development pathways & business continuity
- ✓ Work with Development Partners (DPs), the UN/Cluster systems to support the GoB for carrying out PDNA and mobilizing resources
- ✓ Support making appropriate policies, financial instruments, and technological innovation on preparedness for recovery through cluster coordination support
- ✓ Work as, when appropriate, a fund management facility for humanitarian and development agencies to foster cost effective and time efficient mechanism.

[8] Based on discussions with UNDP

Areas of Work

- ✓ Disaster Response and Recovery
- ✓ Strengthening National Capacity on Large Scale Disasters
- ✓ Policy Support
- ✓ Co-ordination
- ✓ Promoting Business Resilience

The project is scheduled to begin in October 2018 and end in December 2022. Contributions are estimated to be $ 32,112,954 USD[9].

(2) Comprehensive Disaster Management Programme II (CDMP-II)

The CDMP consists of CDMP-I and CDMP-II. CDMP-I was implemented between 2004 and 2009. The main activities of CDMP-I were implementation of disaster management training; earthquake risk assessment in three cities; establishment of a climate change database; and construction of the legal framework starting with the Disaster Management Act concerning disaster management in Bangladesh.

Donors were UNDP, United Kingdom Department for International Development (DFID), European Union (EU), Norwegian Agency for Development Cooperation (NADC), Swedish International Development Cooperation Agency (SIDA), and Australian Agency for International Development (AusAID). CDMP-II was implemented between 2010 and December 2014, and the executing agencies in Bangladesh were the MoDMR and DDM. The project cost is US$ 76.32 million and contents of each donor expense in CDMP are shown in Table 4.1.39.

The CDMP-II aims to reduce the vulnerability for natural disaster and human disaster includes the influence of climate change through technical support about risk reduction and comprehensive disaster management.

The program has the following five objectives:

1. Strong, well-managed and professional institutions capable of implementing a comprehensive range of risk reduction interventions;
2. Reduced risks to rural and urban populations through raising awareness and empowering communities;
3. Improved overall effectiveness and timeliness of disaster preparedness;
4. Improved and broadened measures to ensure government ministries' budget include disaster provisions;
5. Implemented community-level interventions to be best prepared from disaster risks from a changing climate.

The CDMP comprised activities in the following

1. The disaster and climate change vulnerability of over 3 million people under 40 most disaster vulnerable districts have been reduced by risk reduction schemes. These are selected from local Risk Reduction Action Plan (RRAP). These schemes are funded through Local Disaster Risk Reduction Fund modalities of CDMP and mostly implemented by Union/Upazila Disaster Management Committees.
2. CDMP financed ground breaking work to map the seismic vulnerability of nine of Bangladesh's biggest cities using the latest remote sensing and statistical analyses techniques.
3. CDMP in partnership with Bangladesh Teleltalk Ltd. (state-owned mobile phone company), Bangladesh Meteorological Department (BMD) and Flood Forecasting and Warning Centre (FFWC) introduced Interactive Voice Response based early warning system. CDMP in partnership

[9] Source: https://www.bd.undp.org/content/bangladesh/en/home/projects/disester-response-and-recovery-facility-drrf-0.html

with FFWC has extended flood forecast lead time from 3 to 5 days, potentially saving the lives, livelihoods and assets of 88 million people living in four river basin areas.

4. 17 universities comprises of both public and private and 11 training institutes including Bangladesh Public Administration Training Centre (BPATC) introduced certificate, diploma, honors and masters course in disaster management with support from CDMP. Establishment and operation support of Disaster Management Information Center (DMIC).
5. CDMP has financed pieces of research, operational guidelines, training manuals and related knowledge products.
6. CDMP supported Bangladesh Fire Service and Civil Defense in training and development urban community volunteers. These volunteers have successfully took part in search and rescue operation of fire, landslide and building collapse incidents. CDMP also supported CPP to expand their operation in South-West coast of Bangladesh through training and development of volunteers.

Table 4.1.39 Contents of Each Donor Expense in CDMP

Donor	US$ million
United Kingdom Department for International Development	$ 20
European Union	$ 17
Norwegian Agency for Development Cooperation	$ 16.88
Australian Agency for International Development	$ 8.48
Swedish International Development Cooperation Agency	$ 7.00
UNDP	$ 6.00
Government of Bangladesh	$ 0.96
Total	$76.32

Source: "THE PREPARATORY SURVEY ON THE CAPACITY ENHANCEMENT ON DISASTER RISK REDUCTION, EMERGENCY RESPONSE AND RECOVERY PROJECT, JICA, 2016", revised by the Survey Team

(3) National Adaptation Plan (NAP)

Recognizing that climate impacts are undercutting hard won human development gains, Bangladesh has already taken strides on adaptation planning over the last decade, by implementing the National Adaptation Plan of Action (NAPA), setting-up climate change trust funds, and pioneering community based adaptation approaches. However, institutional arrangements and a coordinated strategy for mid- and long-term climate change adaptation investment are not yet in place.

In order to meet this gap Formulation and Advancement of the National Adaptation Plan (NAP) Process is being executed by the Department of Environment and financed by the Green Climate Fund (GCF).NAP will allow Bangladesh to identify country-specific adaptation needs; develop and implement strategies to address the adaptation needs as well as help her decide on actions to protect vulnerable communities.

<u>Objectives</u>

NAP will gather and analyse information, develop risk scenario, generate experience and science-based adaptation strategies in line with Bangladesh's priorities outline in the SDGs, Delta Plan 2100, Perspective plan, five-year plan and its ambition to graduate from LDC to middle-income countries. Thus, the project has following two objectives;

1) To formulate the Bangladesh National Adaptation Plan with a focus on medium to long term adaptation investment, and
2) To enhance national capacity for integration of climate change adaptation in planning, budgeting and financial tracking process.

<u>Expected Outcomes</u>

The project's expected outcomes are;

Outcome 1: Strengthened institutional coordination and climate change (CC) information and knowledge management for medium- to long-term planning

Outcome 2: Adaptation options appraised and prioritized, and the National Adaptation Plan formulated

Outcome 3: Climate risk-informed decision-making tools developed and piloted by planning and budget departments at national and sectoral levels

Outcome 4: Nationally appropriate adaptation investments tracking mechanism set up and financial plan for mid- and long-term CCA implementation prepared.

Key Background of NAP Process

November 2005	:	Submission of National Adaptation Programme of Action (NAPA)
June 2009	:	NAPA Updated
September 2009	:	Bangladesh Climate Change Strategy and Action Plan (BCCSAP) Approved
September 2015	:	The Nationally Determined Contribution of Bangladesh (NDC -2015) Submitted
2015	:	Roadmap for Developing a National Adaptation Plan for Bangladesh Developed
December 2015	:	Inclusion of Climate change adaptation (CCA) in the Seventh Five Year Plan (2016-2020)
March 2017	:	Stocktaking for National Adaptation Planning (SNAP) Process Conducted
September 2018	:	Third National Communication of Bangladesh Submitted to UNFCCC
May 2019	:	Formulation and Advancement of the National Adaptation Plan (NAP) Process initiated

Project Beneficiaries

The Ministry of Environment and Forests, the Ministry of Finance, the Ministry of Planning and key personnel working on climate change adaptation relevant programming in water resources, agriculture and food security, coastal zones, and urban habitation (the “priority sectors”) will be the beneficiaries of this project.

The project began in January 2017 and is scheduled to end in December 2022. Project cost is estimated at $6,080,795 USD[10].

(4) Disaster Risk Management in Cox's Bazar Programme

The climate and topography of Cox’s Bazar creates an environment where local communities are exposed to multiple natural hazards, and experience recurring extreme weather events. Vulnerable Bangladeshi communities in the district have long borne the brunt of cyclones, landslides and flash floods. The Rohingya crisis has increased the size of the population at risk and is driving the creation of new risks due to deforestation, hill-cutting, and infrastructure pressure. To support government and humanitarian actors’ efforts to manage the seasonal and extreme weather events associated with the cyclone and rainy season, UNDP is implementing an area-based programme for strengthening Disaster Risk Management in Cox’s Bazar.

Project Objective

The objective of the project is to reduce the seasonal weather and disaster vulnerability of at-risk Rohingya and Bangladeshi host communities in Cox’s Bazar through effective multi-hazard risk management. The Project works to achieve this objective by supporting contingency planning in host communities and within the Rohingya response; improvement of forecasting and risk analysis; implementation of landslide and flash flood mitigation measures in underserved communities; technical support to humanitarian actors and local government; support to improve disaster risk literacy of duty bearers; and support to enhance local landslide search and rescue capacity.

Areas of Work

- ✓ Enhancement of local government preparedness for response
- ✓ Hazard and disaster risk analysis in Cox’s Bazar and Rohingya camps
- ✓ Community-based disaster risk reduction
- ✓ Support to humanitarian actors for mainstreaming of disaster risk management in refugee response
- ✓ Capacity enhancement for risk-informed development and residual risk management

The project is scheduled to begin in October 2018 and end in December 2022. Project cost is estimated at $32,112,954 USD[11].

[10] Source: https://www.bd.undp.org/content/bangladesh/en/home/projects/national-adaptation-plan--nap-.html

[11] Source: https://www.bd.undp.org/content/bangladesh/en/home/projects/disaster-risk-management-in-cox-s-bazar-programme0.html

(5) Community Recovery and Resilience Project

Community Recovery and Resilience project (C2RP) was designed to support the law enforcement agencies, judiciary, and relevant government agencies and to better protect host community including vulnerable groups and minorities of Ukhiya and Teknaf Upazila of Cox's Bazar. The project does so through activating the Union Legal Aid Committee (ULAC), Community Policing Forum (CPF), Mediation and youth forums as well supporting local level planning and development of Union Parishad plans to deliver better services to effected communities in order to maintain the peaceful co-existence and social cohesion

<u>Objective</u>

The project aims to increase access to justice, community security and protection of human rights of persons, affected due to sudden Rohingya influx in Cox's Bazar. The project supports capacities of women and youth community leaders to prevent the escalation of inter-communal tensions by strengthening local government capacity, reactivating women development forums, mediation forums, and work in partnership with other NGOs.

<u>Areas of Work</u>

- ✓ Social Cohesion and Preventing Conflict in Host Communities in Cox's Bazar
- ✓ Rule of Law and Access to Justice including for formal and informal mechanisms
- ✓ Support to establishment of National Human Rights Commission in Cox's Bazar
- ✓ Community Security and policing
- ✓ Local Governance for improved service delivery

The project is scheduled to begin in October 2018 and end in December 2022. Project cost is estimated at $35,425,351 USD[12].

(6) National Resilience Programme

As Bangladesh hopes to graduate from Least Developed Country (LDC) category by 2024, disaster risk reduction still remains a key priority of the Government of Bangladesh, which is also reflected in its 7th Five Year Plan and various national policies. Bangladesh has also adopted global frameworks such as the SDGs, the Sendai Framework etc. However, based on past achievements and lessons, Bangladesh has to maintain a holistic approach and to mainstream disaster risk reduction into development planning. The National Resilience Programme (NRP) is a unique partnership between Bangladesh Government and United Nations Development Programme (UNDP), UN Women and United Nations Office for Project Services (UNOPS), that will provide strategic support to develop national capacity to keep pace with the changing nature of disasters.

<u>Components</u>

- ✓ Improve national-level capacities for risk-informed, gender- responsive and disability inclusive development planning.
- ✓ Strengthen national capacities to address recurrent and mega- disasters in a gender-responsive, and disability inclusive manner.
- ✓ Improve the capacity of selected public institutions to achieve resilient outcomes through risk-informed, gender-responsive infrastructure systems.
- ✓ Enhance women's leadership capacities for gender-responsive nation and local disaster management decisions, investments and policies.
- ✓ Strengthen community-level preparedness, response and recovery capacities for recurrent and mega disasters.

The project is January 2017 and is scheduled for completion in December 2022. Project cost is estimated at $6,080,795 USD[13].

[12] Source: https://www.bd.undp.org/content/bangladesh/en/home/projects/community-recovery-and-resilience-project0.html
[13] Source: https://www.bd.undp.org/content/bangladesh/en/home/projects/national-resilience-programme.html

(7) Local Government Initiatives on Climate Change (LoGIC)

LoGIC, a multi-donor collaborative initiative of GoB, UNDP, UNCDF, EU and SIDA, aims to enhance the capacity of vulnerable communities, Local Government Institutions (LGI) and civil society organizations (CSO) for planning and financing climate change adaptation solutions in selected climate vulnerable areas. The Local Government Division (LGD) is the implementing lead of the project in partnership with UNDP and UNCDF. Project priorities will be addressed through three sets of core actions: capacity building, providing access to climate change funds and policy advocacy. The project is designed to support roughly 200,000 most vulnerable households in 72 unions in 7 districts.

<u>Project Objective</u>

Improved and inclusive local level planning and a strengthened financing mechanism for community-based climate change adaptation solutions through local government.

<u>Key Results</u>

- ✓ Community resilience fund operationalized to finance climate vulnerable community
- ✓ Capacity enhancement plan is developed and implemented
- ✓ Performance based climate resilient grants system is developed and implemented
- ✓ CCA-DRR financing at local level is enhanced by the active community participation
- ✓ Learning lessons at the local level and inform policy dialogue at the national level
- ✓ Climate Change Capacity Development of LGIs, households other local stakeholders.
- ✓ Established financing mechanism for implementing climate change adaptation measures
- ✓ Experience and evidence inform and contribute to further improvements in policies

The project began in July 2016 and is scheduled to end in June 2023[14].

(8) National Capacity Development for Implementing Rio Conventions through Environmental Governance

The Rio project aims to enhance the capacity of relevant policy and institutional stakeholders to enable compliance with the three Rio Conventions and other Multilateral Environmental Agreements (MEAs). Specifically, this will be carried out by targeted capacity building programmes for government staff at the local, regional and national levels on the provisions of Rio Convention as these apply to their roles and responsibilities to implement associated development interventions and policies. The expected outcome of the project ensures the identified best practices and innovative approaches meeting and sustaining Rio Conventions are available and accessible for implementation through national development policies and programmes.

This outcome is disaggregated into three components:

Component 1: Global environmental Conventions mainstreamed into vocational training and re-training structures for public institutions in Bangladesh

Output 1.1 Survey of public sector stakeholders
Output 1.2 Review of best practices to mainstream Rio Conventions
Output 1.3 Review of training needs to operationalize Rio Conventions
Output 1.4 Improved training programme and curricula on Rio Conventions
Output 1.5 Trainers are trained on best practices to operationalize Rio Conventions
Output 1.6 Training courses on Rio Convention implementation are carried out
Output 1.7 Cooperative agreement among training consortium members

Component 2: Global environmental Conventions mainstreamed into human resource development systems for sustainable development practitioners

Output 2.1 Rio Convention analytical framework

[14] Source: https://www.bd.undp.org/content/bangladesh/en/home/projects/local-government-initiatives-on-climate-change--logic-.html

Output 2.2 Integrated Rio Convention sectoral development plan
Output 2.3 Integrated global environmental and sustainable development roadmap
Output 2.4 Lessons Learned study

Component 3: Improved multi-sectoral environmental policies and programmes, and associated governance structures.

Output 3.1 Project Launch and Results Conference
Output 3.2 Public awareness implementation plan
Output 3.3 Public awareness and educational materials
Output 3.4 Awareness-raising dialogues and workshops
Output 3.5 Internet visibility of good practices for mainstreaming Rio Conventions obligation

The project started in July 2014 and ended in April 2018. Project cost is estimated at $14,978,762 USD[15].

(9) Inclusive Budgeting and Financing for Climate Resilience

The Inclusive Budgeting and Financing for Climate Resilience (IBFCR) project has been undertaken to rationalize the Public Financial Management (PFM) of climate finance and introduce a climate policy based focus to planning, budgeting and performance management of climate finance by implementing the CFF. The implementation of the project will include the recognition and development of climate policy dimension within the revised chart of accounts. The climate dimension in tracking budgets and expenditure will be a very helpful development to ensure that climate sensitive activity is recognized within the performance accountability architecture and the Medium-Term Budget Framework (MTBF).

The project intends to foster a sustainable basis for identifying, maximizing and managing sources and application of funds for financing climate resilient actions. It further intends to develop climate related capacity and expertise within Finance Division (FD) and develop stronger relationships and collaborative partnerships with other major climate stakeholders, but primarily with Economic Relations Division (ERD) and the National Designated Authority (NDA) of Bangladesh to the Green Climate Fund (GCF), Programming Division and General Economic Division (GED) of Planning Commission, Ministry of Environment and Forests (MoEF), Local Government Division (LGD), Ministry of Disaster Management and Relief (MoDMR), Ministry of Agriculture (MoA), Ministry of Fisheries and Livestock (Mo FL), Ministries implementing Social Safety Nets programmes in Climate vulnerable regions, Ministry of Women and Children Affairs (MoWCA), Office of the Comptroller and Auditor General (OCAG), Bangladesh Bank and the National parliament that will enable Bangladesh to maximize benefits of national and international climate finance.

<u>Overview of IBFCR</u>

The overarching philosophy of the project is to strengthen, build and promote the use of country systems to identify sources of climate finance (domestic and international) and manage climate response in Bangladesh in a transparent and effective way.

The CPEIR study was part of a broader effort by the Government of Bangladesh (GoB), supported by UNDP, to strengthen the capacity of national and local level institutions to manage the increasing flow of climate finance, which ultimately helped the development of the CFF by the FD. The CFF was necessary for Bangladesh to make the country system ready to generate domestic sources of climate finance and access international climate finance, and utilize the finances with highest transparency and accountability.

The introduction of a climate dimension in tracking budgets and expenditure will be a very helpful development to ensure that climate sensitive activity is recognized within the performance

[15] Source: https://www.bd.undp.org/content/bangladesh/en/home/projects/national-capacity-development-for-implementing-rio-conventions-t.html

accountability architecture and the MTBF. The CFF will take into account the potential role, risks and responsibilities of the institutions involved in climate response (including the private sector). Hence, the next important step will be to regularly update the CFF on the basis of detailed and estimated climate investments.

The focus of IBFCR project will be on the implementation of this national CFF, which will provide an incentive framework for climate change adaptation and mitigation. In doing so, it will also strengthen the PFM system for climate finance, particularly with regards to accountability and transparency, as well as to the flow of finances to line ministries, and to the local level. This will include activities to integrate climate into the medium term budget framework, introduce climate budget coding, bring existing climate funds on budget, and budget support for climate finance.

This project began in January 2014 and was completed in September 2021. Project cost is estimated at $2,340,108 USD[16].

(10) Integrating Community-based Adaption into Afforestation and Reforestation Programmes in Bangladesh

Bangladesh is one of the most climate vulnerable countries in the world. The country is frequently subjected to cyclones, floods, and storm surges due to the adverse impact of climate change. Around 35 million people who are living in 19 coastal districts of the country are in the highest level of climate risks. Experts suspected that due to global warming, 10-15% Bangladesh's land could be inundated by 2050, resulting in over 25 million climate refugees from the coastal districts.

To reduce vulnerabilities and hazards of such extreme weather events, UNDP has initiated a four year project called 'Integrating Community-based Adaptation into Afforestation and Reforestation (ICBA-AR) Programmes in Bangladesh.

<u>Components</u>

The objective of the programme is to reduce climate vulnerability of local communities through participatory planning, community-based management, integration of climate resilient livelihoods and diversification of species in afforestation and reforestation Programme. The project has following Components:

- ✓ Increase resilience of local communities through diversification of livelihood and species in coastal greenbelts;
- ✓ Strengthening community involvement in, and ownership of forestry-based adaptation and climate risk reduction activities;
- ✓ Protect communal livelihood assets from extreme weather events.

The project began in July 2015 and ended in June 2021. Project cost is estimated at $5,717,162 USD[17].

4.1.4 Issues in Current Efforts

4.1.4.1 Secure Budget for DRR Projects and Capacity Enhancement of Relevant Organizations

In BWDB, the main agency responsible for the development of water infrastructure throughout the country, large amounts of budget are spent on post-disaster emergency response, which limits the budget that can be allocated for future investments, as is discussed detail in Section 4.2. In addition, there is a lack of concrete investment plans and priorities for project implementation. As a result, it is difficult to secure sufficient funds to proceed with projects to reduce disaster risks. In the implementation of BDP 2100, a long-term water management plan, the lack of prospects for obtaining budgets for project implementation is pointed out as an issue during interviews with BWDB officials. The total budget for implementing the 80 projects proposed in BDP 2100 is approximately BDT 3 trillion. It is difficult for BWDB and other implementing agencies to digest and implement even if funding were available. In addition, there are only

[16] Source: https://www.bd.undp.org/content/bangladesh/en/home/projects/inclusive-budgeting-and-financing-for-climate-resilience--ibfcr-.html
[17] Source: https://www.bd.undp.org/content/bangladesh/en/home/projects/integrating-community-based-addaption-into-afforestation-and-ref.html

a limited number of contractors who are capable of constructing such a large amount of work, making it very difficult to implement the project in practice. In this regard, it is expected that financial cooperation from Japan and other international partners can promote the implementation of some of the important DRR projects conceptualized in BDP2100.

As for earthquake countermeasures, as described in detail in section 4.6, the government of Bangladesh is currently limited in the number of projects it can implement because of the huge amount of funds necessary to improve the seismic resistance of existing structures. For the time being, it is necessary to utilize financial cooperation from international organizations and promote seismic retrofitting of critical infrastructure and buildings that need to be addressed on a priority basis.

As for projects related to capacity enhancement of disaster risk management implemented by own country's budget, a management capacity building project for MODMR has been implemented, however the number of projects is limited, and projects related to capacity enhancement projects are mainly cooperated by international institutions. As mentioned in section 4.1.4.3 above, there is a need to improve the capacity of staffs of DDM. Furthermore, DDM itself has indicated that it expects JICA to cooperate in structural countermeasures and capacity enhancement, and it is necessary to increase the number of DDM capacity enhancement projects, including DRMEP's ongoing capacity enhancement for structural countermeasures, with funds from own country budgets and donor agencies.

4.1.4.2 Unclear Segregation of Duties of Disaster Recovery Activities and Method of Securing Budget for Disaster Recovery

The Bangladesh Disaster Management Act is considered to be almost equivalent to the "Disaster Countermeasures Basic Act" in Japan and provides the basic policy for all activities in the disaster management cycle. Therefore, in accordance with this act, the MoDMR and DDM are required to implement disaster management activities based on the jurisdiction of each organization in each of the four disaster management phases. In addition, the MoDMR and DDM conduct disaster management activities in accordance with the Standing Orders on Disaster (SOD 2019) described in Section 4.1.1.1, which were developed in accordance with this Disaster Management Act. However, one issue that has been identified for activities pertaining to the MoDMR and DDM legislation and planning is the "lack of clarity on the segregation of duties for disaster recovery activities and lack of a method to secure budget for disaster recovery activities". Both the Disaster Management Act and the SOD provide for recovery activities, and according to section 4.3.1, the NRP by UNDP is supporting this effort (currently under preparation) under the section "Preparation of a concept paper on recovery and rehabilitation strategies".

The activities of DDM under the Disaster Management Act and SOD 2019 include training of volunteers and DMC (disaster risk reduction and mitigation (pre-investment)) and early warning such as weather services (preparedness), as indicated in section 4.1.1.2. However, it is not clear how the roles of other infrastructure management agencies such as BWDB, and LGED in disaster recovery activities and the use of the Disaster Management Fund as described in the Disaster Management Act will be determined and implemented in the future.

As for DDM, the SOD does not include disaster rehabilitation activities, and the District Relief and Rehabilitation Officer (DRRO) and the Project Implementation Officer (PIO) are supposed to repair damaged roads, bridges, culverts, and shelters. However, no laws and regulations equivalent to Japan's "Act on National Treasury's Sharing of Expenses for Project to Recover Public Civil Engineering Works Damaged by Disaster" and "Enforcement Order of the Act" have been enacted to ensure that rehabilitation activities are carried out on time, and no system for prompt budget execution has been established. Instead, Bangladesh's Disaster Management Act states the establishment of a Disaster Management Fund and a Relief Vault, but it does not clarify how the funds will be used for rehabilitation projects and works, and only distributes solatia to disaster victims. To resolve these issues, although Bangladesh does not meet the criteria for Post Disaster Stand-by Loan by JICA at the moment, it will be necessary to clarify the segregation of duties and establish a mechanism to secure the budget by providing support such as Post Disaster Stand-by Loan when Bangladesh meets the criteria of the Loan in the future.

The "Disaster Management (Fund Management) Regulations, 2021" was issued in the Official Gazette in

May 2021. Although the new regulations clearly stipulate the use of the National and Local Disaster Management Funds as described in the Disaster Management Law, the effectiveness of the regulations remains to be seen.

4.1.4.3 Capacity Enhancement of DRR Administrative Agencies

One of the issues related to the organization and system of the DDM is that the Disaster Management Bureau (DMB), which was in charge of policies and legal systems, and Relief and Rehabilitation, which was in charge of relief, were merged into the DDM with the enactment of the Disaster Management Act 2012. However, the two bureaus are different in nature, and it is difficult to carry out their work under the same department; therefore, there are ongoing discussions within the DDM to return to the original two departments.

In addition, DDM also conducts implementation of design, repair and improvement works of small infrastructure related to disaster risk reduction, such as box culverts, bridges and community roads. However, there are no design standards in place and a lack of capacity regarding civil engineering techniques. Capacity enhancement of construction of these facilities is considered one of the challenges of the DDM.

While UNDP's CDMP was a major project, there are currently few projects dedicated to this area, and most of them are being implemented as part of project components or in limited areas. The results and future issues are to be confirmed corresponding to disaster recovery through the current yen loan project (DRMEP) as well as the current technical cooperation on local disaster risk reduction plans. At the same time, the content of future cooperation will be examined, including the development of technical cooperation down to the Union level and the strengthening of cooperation between the central and local governments. In addition, support for resolving issues in the projects currently being implemented by DDM will also be considered.

As for the technical staff of the DDM, it does not have the authority to hire engineers with university degrees. Instead, the DDM hires engineers with more than high school degrees. Although the DDM is making efforts to increase the number of technical staff, it has not been able to achieve the goal due to problems with the quota of civil servants and the budget of Bangladesh as a whole.

According to DDM, there are about 500 engineers with bachelor's degrees in civil engineering nationwide. The number has been increasing in the last 10 years, with about 500 at the Upazila level, about 150 at the District level, and about 700 on a project basis. The number of technical staff is increasing who have obtained the degree while working in DDM.

As a result of interviews with the BWDB, LGED, and other related agencies, all of them recognized that the main task of DDM is to provide relief after a disaster. In addition, it was pointed out that DDM does not have enough experience in design and cost estimation for the construction of community roads, small bridges (less than 15 meters), and culverts, which are projects that they have recently started to take charge of. It is necessary to discuss the details of future cooperation by confirming what needs to be done to increase the number of engineers; improve the capacity of engineers in design and cost estimation, and use the electronic bidding system.

Component 3 (Disaster Recovery Fund) of the ongoing "The Disaster Risk Management Enhancement Project (DRMEP)" is being implemented by BWDB and LGED in addition to DDM. The BWDB and LGED have been involved in a number of dike/embankment and road rehabilitation projects and are experienced in electronic bidding, so there are no procurement problems. DDM, on the other hand, has been involved in the rehabilitation of community-level roads, small bridges, and culverts, which are not the responsibility of LGED. However, the number of civil engineering staff of DDM is limited, with only about 40 staff at the headquarters, and the number of civil engineering staff is insufficient. Therefore, compared to BWDB and LGED, there are fewer opportunities to access the CPTU e-Government Procurement (e-GP) system, and the number of staff who can use it is very limited.

According to the DDM Part engineers, the e-GP system is not used in the DDM Part. Until recently, DDM has been using a manual procurement system and the e-GP system has not been in operation, but DDM staff are currently receiving training on the e-GP system and it is expected that they will improve their capacity and use of the e-GP system in the future.

4.1.4.4 Lack of DRR Functions at Local Level

The Disaster Management Act states that disaster management plans should be developed. Although national disaster management plans have been developed, in many cases disaster management plans at the Upazila level have not been developed. In this regard, JICA has just launched a project to strengthen the capacity of local governments to formulate and implement local disaster management plans, which is expected to be completed in the near future. In the project, a pilot site in Cox's Bazar district is Cox's Bazar Sadar Upazila. Sadar Upazila is the district seat. There is also Pourashava, an independent administrative municipality located within Sadar Upazila. However, for the sake of comprehensiveness and unity of the local disaster management plan, the framework of the Disaster Management Committee of Sadar Upazila is utilized, and activities related to the formulation of the local disaster management plan are conducted in the presence of representatives of Pourashava. The project is expected to formulate a local disaster management plan covering both Sadar and Pourashava.

As for the organizational structure, the District Relief and Rehabilitation Officer (DRRO) is posted at the District level and the Project Implementation Officer (PIO) at the Upazila level, but no officers from ministries and agencies, including DDM, are directly assigned at the Union level, as they are mainly responsible for parliamentary functions. In order to strengthen disaster risk governance, it is important to strengthen the functions of the Disaster Management Committee at Union level. However, it is difficult to support all the Unions and Wards to strengthen their functions uniformly because the number of Unions and Wards is quite large and they are ad-hoc committees that are convened as needed.

Also, DDM intends to set up a Disaster Management Information Center down to the Union level. In the meantime, the DDM would like to set up office space and photocopiers down to the Upazila level. DDM is also looking forward to cooperation with JICA in setting up these facilities, as 64 Districts have only secured buildings but they have not set up other facilities yet. It is preferable to consider the strengthening of the Union/Ward-level disaster risk reduction capacity in conjunction with the setting up of these equipment.

4.1.4.5 Lack of Disaster Countermeasures in the Bangladesh Economic Zone

In Bangladesh, many Economic Zones (EZs) have already been developed or are under development, and it is considered important to take measures to protect/conserve investment in these economic activity priority areas in the future. In NRP, which is being supported by UNDP, formulation of BCP for some special economic zones was conducted on a pilot basis, aiming to reduce secondary damage, such as securing the supply chain in the event of a disaster. However, in order to prevent direct damage caused by disasters or to reduce the damage as much as possible, it is required to take comprehensive measures to ensure and improve safety, such as infrastructure development, information system development, and formulation of evacuation plans. It cannot be said that DRR measures are sufficiently implemented. In addition, although disaster risk assessments and necessary countermeasures are being considered individually at the planning stage of each EZ, standard guidelines for this purpose have not yet been developed.

The Bangladesh Economic Zone Authority (BEZA), which is responsible for the development of EZs, recognizes the need to formulate a comprehensive disaster prevention plan for EZs, and is currently developing or planning to develop EZs. There is a strong demand for assistance in formulating disaster management plans for individual EZs, which are targeted at high-priority EZs in the field of DRR. In discussions with BEZA, the following 6 EZs or Tourism Parks have been selected as high-priority locations based on the current status of planning and development of EZs, their economic importance, and the risk of disaster occurrence. From the results of the disaster risk analysis conducted in this study (see Chapter 5), all locations are included in areas with a high risk of disaster occurrence due to storm surges and river floods.

Table 4.1.40 Economic Zones with High Priority in Formulating Disaster Management Plan

No.	EZ with high priority	District	Upazila	Disaster risk in the (planned) development area
1	Bangabandhu Sheikh Mujib Shilpa Nagar (BSMSN)	Chattogram	Mirsarai	Located on the coastline, the risk of storm surge disasters is extremely high.
2	Moheshkhali Economic Zone-3, Dhalghata	Cox's Bazar	Moheshkhali	Located on the coastline, the risk of storm surge disasters is extremely high.
3	Sabrang Tourism Park	Cox's Bazar	Teknaf	It is planned to be developed as a tourist resort that takes advantage of the natural environment. Located on the coastline, the risk of storm surge disasters is extremely high.
4	Naf Tourism Park	Cox's Bazar	Teknaf	It is planned to be developed as a tourist resort that takes advantage of the natural environment. An entire sandbank-like island near the mouth of the Naf River is being developed, and the risk of storm surges and river floods is extremely high.
5	Nawabganj Economic Zone	Dhaka	Nawabganj	It is planned to be developed in an area of more than ten kilometers southwest of the center of Dhaka. It is close to Dhaka and has high economic importance, and the risk of river flooding is high because it is a low-lying land along the Dhaleshwari River.
6	Tangail Economic Zone	Tangail	Bhuapur	It is planned to be located approximately 100 km north of the center of Dhaka, on the left bank (east side) of the Jamuna River, and approximately 10 km upstream of the Bangabandhu Bridge. It is highly convenient in terms of logistics, however, the project site has branch river channels of the Jamuna River, and currently the area is submerged during the rainy season when the Jamuna River's water volume increases. Sufficient countermeasures are required not only for river floods but also for river bank erosion.

Source: The JICA survey team added information on economic zones selected by BEZA with high priority in terms of disaster management.

Source: Created by the Survey Team based on information from BEZA

Figure 4.1.9 Location of Economic Zones with High Priority in Formulating Disaster Management Plan

4.1.4.6 Other Issues

(1) Construction of National Training and Research Institute

DDM had anticipated building a National Training and Research Institute with international financial assistance, and had already acquired a site near the airport in Dhaka City. However, the policy was changed within DDM and GoB budget will be used for the construction of institute.

(2) Development of Standard Operation Procedures (SOP) to Provide Disaster Management Activities of Relevant Agencies

In accordance with the Disaster Management Act, the Standing Orders on Disaster (SOD) has been prepared, in which the roles and responsibilities of disaster management agencies are defined. The SOD only describes the roles and responsibilities of each agency but does not contain "detailed instructions, such as Standard Operating Procedures (SOPs), describing the work to be done and the procedures to be followed in order to maintain the quality and uniformity of the work. Therefore, it is considered necessary to prepare SOPs to fulfil the roles and responsibilities described in the SOD. However, DDM does not consider the SOP is necessary at the moment, therefore this is not an urgent issue.

In Japan, under the "Disaster Countermeasures Basic Act", the "Disaster Management Plan specifies the roles of each disaster management organization in the Common Measures Section and 14 disaster types. In addition, based on these basic plans, each disaster management agency/organization formulates a "Disaster Management Work Plan". In this way, it is expected that the relevant agencies and organizations responsible for disaster management will begin to implement a sound four-stage disaster management cycle by clarifying the activities and projects that they must implement and carry out on their own, based on the relevant laws, systems, and plans.

(3) Development of Relevant Laws and Regulations to Implement Road Disaster Management

No issues related to disaster countermeasures for roads, bridges, and other infrastructures were raised by the Government of Bangladesh. However, road disaster countermeasures such as road slope protection and emergency disaster response, etc. need to be developed in Bangladesh, since they have not been developed in Bangladesh.

Regarding roads, bridges, and other infrastructure, the Highways Act, 1925 (ACT NO. III OF 1925) provides the basic laws and regulations for roads under the jurisdiction of the Government of Bangladesh. Subsequently, the Road Transport Act 2018 came into force in 2019, but it is primarily a law pertaining to road safety, and not about the structure of infrastructure, etc. With regards to the structure of roads, the design of roads conforms to the "Geometric Design Standards for RHD (Road Highways Department) (2000)" and, unless otherwise stated in the RHD standards, AASHTO (The United States Government Association of State Highway and Transportation Officials) is used as a reference. In principle, the pavement design criteria also conform to the "Pavement Design Guide for RHD (2005)" and AASHTO is used as a reference standard. For bridge structures, in addition to the RHD standards listed below, AASHTO and Indian standards are also used as references.

- ✓ RHD Bridge Design Standards for RHD 2004
- ✓ Bangladesh National Building Code 2020 (BNBC)
- ✓ RHD Geometric Design Standards for Roads 2000 (Geometric Design Standards for RHD)

Another seismic design is in accordance with the BNBC mentioned above. In the future, it will be necessary to assist in technical cooperation to develop relevant laws, standards, and manuals related to these road disaster countermeasures, or to install countermeasure works in high-priority areas through Yen Loan projects.

(4) Clarification of Segregation of Duties of Agencies/Organizations in Charge of Landslide, Development of Institutional Systems and Capacity Enhancement for Landslide

In the kick-off meeting of this survey with the Government of Bangladesh, there were comments that it is difficult to implement landslide countermeasures in the Chattogram Hills Tracts area due to the lack of laws on landslide risk reduction and disaster response methods. In Japan, the "Act on Promotion of Sediment Disaster Countermeasures for Sediment Disaster Prone Areas" has been enacted including basic policies for reducing the risk of landslide damage and basic guidelines for establishing warning and evacuation systems, separately from other disasters. However, Bangladesh does not have similar laws. Therefore, it is not clear how to take countermeasures and responses in the MoDMR and DDM. In addition, technical landslide response policies have not yet been developed, and research for landslide has not progressed.

4.2 River Planning, River Management and Flood Forecasting and Warning

4.2.1 Initiatives by the Government of Bangladesh

4.2.1.1 Laws and Regulations for River Planning, River Management and Flood Forecasting and Warning

(1) Water Act

The Government of Bangladesh enacted the Water Act in 2013 as a framework for integrating and coordinating domestic water resource management. The law aims to implement appropriate policies for water resource management, redistribution, water utilization, conservation, water storage, and comprehensive development of water resources, and the contents of each chapter are as follows.

Chapter 1: Preliminary (general matters such as water rights)
Chapter 2: National Water Resources Council and its Powers and Functions
Chapter 3: Executive Committee and its Duties, Responsibilities, and Powers
Chapter 4: Control of Water Resources Development and Management
Chapter 5: Control on Water Use and Protection and Conservation of Water Resources
Chapter 6: Offence, Punishment, and Trial (on water resources development and its use)
Chapter 7: Miscellaneous (water pricing, information technology on water use)

Chapter 5 includes river management and activities related to flood control and stipulates the maintenance of flood protection embankments, the setting of flood protection and control areas, and the securing of the water course of rivers.

(2) National Water Policy

The National Water Policy (NWP) is a comprehensive policy that aims to position water as an important national resource and to promote its comprehensive use. It serves as a guideline for all relevant ministries, agencies, departments, and local administrative agencies involved in water resources management, including national water resources development, maintenance and management, and water supply services. The NWP was formulated in 1999 with the goal of 6 items, such as economic development, poverty reduction, food security, public health and security, improvement of living standards, and protection of the natural environment, at the national level. Under these goals, 16 priority items in the water sector (Table 4.2.1) are listed and the contents of each policy are presented. In addition, it has positioned the response to floods and water shortages as the most important issues, promoted decentralization of water management and has a plan to shift the operation of facilities in each region from the jurisdiction of the central government to the local government, community, and private sector.

Table 4.2.1 Priority Items on the National Water Policy

No.	Priority Items	No.	Priority Items
1	River Basin Management	9	Water and Fisheries and Wildlife
2	Planning and Management of Water Resources	10	Water and Navigation
3	Water Rights and Allocation	11	Water for Hydropower and Recreation
4	Public and Private Involvement	12	Water for the Environment
5	Public Water Investment	13	Water for Preservation of Haors, Baors, and Beels
6	Water Supply and Sanitation	14	Economic and Financial Management
7	Water and Agriculture	15	Research and Information Management
8	Water and Industry	16	Stakeholder Participation

Source: NWP (1999)

Among the priority items, the outline of the description related to water management and disaster prevention is shown below:

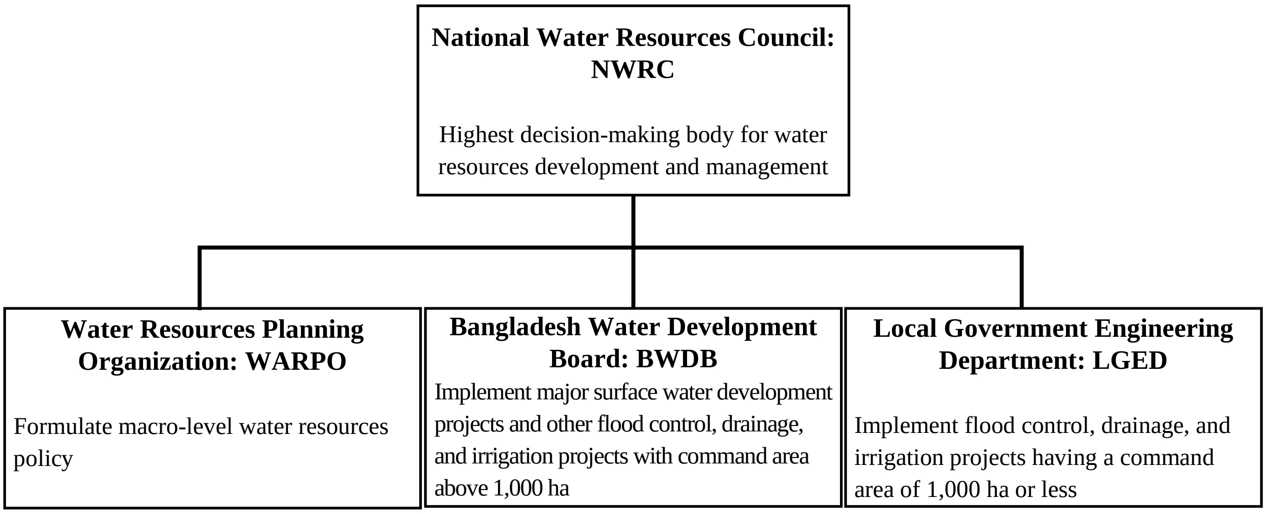
“River Basin Management”

- ✓ Since it is located at the downstream end of the large basin of international rivers, it is important to manage the basin in cooperation with neighboring countries related to the basin.

“Planning and Management of Water Resources”

- ✓ The government must establish the Water Resources Planning Organization (WARPO). WARPO develops a National Water Management Plan and updates it regularly.
- ✓ BWDB will implement major surface water development projects and flood control, drainage and irrigation projects over 1,000 ha.
- ✓ Each responsible agency will implement integrated development and management of major rivers through structural and non-structural measures.
- ✓ Each responsible agency will develop an early warning system and a flood control system for the management of natural disasters such as floods and droughts.
- ✓ Each responsible agency will identify flood risk areas and take appropriate measures to protect and conserve human lives, assets, important facilities, agricultural land and wetlands at expected levels.

The NWP defines the organizational system related to water policy as shown in Figure 4.2.1.



Source: NWP

Figure 4.2.1 Outline of Organizational System Related to Water Policy

(3) National Water Management Plan

The National Water Management Plan (NWMP) was formulated in 2001 as a concrete implementation plan for the policies presented in the NWP and approved by the National Water Resources Council in 2004. NWMP is divided into three phases: short-term (2001-2006) immediate planning, medium-term (2006-2011) indicator planning, and long-term (2011-2025) outlook planning. It will be updated regularly to include new priorities and issues in the water sector in the plan. The plan is a framework for project ministries to define strategies and guidelines for staff responsible for maintaining, providing, and developing water and water-related services in Bangladesh.

Against the background of social and natural environments such as population growth, concentration in urban areas, arsenic pollution of water sources, and increased risk of floods and droughts due to climate change, the following three central issues are set up.

- ✓ Rational management and wise use of Bangladesh’s water resources
- ✓ People’s quality of life improved by equitable, safe and reliable access to water for production, health, and hygiene
- ✓ Clean water in sufficient quantities for multipurpose use and preservation of the aquatic and water-dependent ecosystem

In addition, as shown in Table 4.2.2, 84 individual programs are divided into eight clusters for deployment, and flood countermeasures are positioned among multiple clusters.

Table 4.2.2 Clusters and Programs in the NWMP

Cluster	Nos Program	Major Program
Institutional Development	10	Creating a framework for regulation and decentralization in the water sector, rationalizing hydraulic facilities, strengthening the capacity of water resource-related organizations such as BWDB and WAPRO, etc.
Enabling Environment	13	Legal development for private activities, creation of guidelines, empirical survey of participatory management model, research related to water resource management, etc.
Main Rivers	12	Implementation of comprehensive development aimed at multipurpose and fair use of major rivers, river management and rehabilitation in the region; improvement of drainage network of surface water in the beneficiary area of the Ganges River, promotion of dredging for navigation, etc.
Towns and Rural Area	8	Arsenic reduction measures in local cities and rural areas, water supply system development, local water and sewage systems, flood countermeasures, etc.
Major Cities	17	Water supply /drainage system maintenance, water and sewage maintenance, **flood countermeasures**, etc. in major cities
Disaster Management	6	Development of cyclone shelters, construction of flood-adaptive facilities, **flood countermeasures** for major roads and railways, prevention of drought damage in rural areas, etc.
Agriculture and Water Management	8	Irrigation development by using surface water and groundwater, establishment of water management system at local government and community level, water resource management for increasing production of major agricultural products, protection and tree planting of coastal areas, etc.
Environment and Aquatic Resources	10	Formulation of environmental measures plan, establishment of environmental monitoring system, formulation of fishery master plan, implementation of water quality monitoring, etc.

Source: JICA Report on Detail Planning Survey for The Project for Capacity Development of Management for Sustainable Water Related Infrastructure

The target figures for disaster reduction activities in the NWMP are shown in Table 4.2.3 below.

Table 4.2.3 Targets on DRR Sector in National Water Management Plan

DISASTER MANAGEMENT		**People's quality of life improved by the equitable, safe and reliable access to water for production, health and hygiene**
Immediate Objective DM 01		***Lives, livelihoods and national infrastructure protected or mitigated against inundation damage by structural and non-structural measures***
DM 001	Cyclone Shelters and Killas	775 multi-purpose shelters and 1,369 killas constructed in cyclone-prone areas
DM 002	Bari-level Cyclone Shelters	43,776 bari-level cyclone shelters
DM 003	Flood Proofing in the Charlands and Haor Basin	3,500,000 charland and haor basin inhabitants in flood proofed dwellings
DM 004	National, Regional and Key Feeder Roads – Flood Proofing	100% of all national and feeder roads raised by 1m in high and .5m in low risk areas; 20% of feeder and rural roads raised by 1m in high risk areas
DM 005	Railway Flood Proofing	100% of all high risk railways raised by 1m and 100% of low risk railway raised by .5m
DM 006	Supplementary Irrigation and Drought Proofing of Rural Water Supplies	Increased quality of life in target areas

Source: ADRC Visiting Researcher Programme, FY2020, Country Report: Bangladesh

Of the 84 programs mentioned above, BWDB is the implementing body for 23 programs, which is the largest number among NWMP implementing agencies (Table 4.2.4). However, there is no BWDB-supervised program for disaster management.

According to interviews with WARPO conducted in this survey, the most recent version of the

NWMP was approved in 2004. WARPO is currently developing an updated version of the National Water Resources Plan, which is expected to be completed in December 2022.

Table 4.2.4 Program Handled by BWDB

Cluster	No.	Title of Program	Outline of Program
Institutional Development	ID 003	FCD and FCD/I Management Rationalisation	Rationalize FCD and FCD/I management
	ID 004	BWDB Regional and Sub-regional Management Strengthening	Structuring BWDB's internal organization and capacity building to plan, develop and manage the river improvement program
	ID 010	BWDB Capacity Building	Plan for BWDB capacity building
Enabling Environment	EE 002	Field Testing of participatory Management Models	Testing the efficacy of the model proposed to date as well as other potential options to be identified based on of comprehensive stakeholder consultation
Main Rivers	MR 002	Main River Abstraction Projects	Increasing irrigated areas, environmental health, navigability, and other conditions
	MR 003	Ganges Barrage and Ancillary Works	Increasing dry season water availability in the Ganges Dependent Area
	MR 004	Meghna Barrage and Ancillary Works	Increasing dry season water availability in the north-east and south-east regions
	MR 005	Brahmaputra Barrage and Ancillary Works	Increasing dry season water availability in the north-west, north-central, and south-west regions
	MR 006	Regional River Management and Improvement	Sustainable river development and management works
	MR 007	Ganges Dependent Area Regional Surface Eater Distribution Networks	Increasing dry season water availability in the Ganges Dependent Area
	MR 008	North East and South East Regional Surface Water Distribution Networks	Increasing dry season water availability in the north-east and south-east regions
	MR 009	North Central and North West Regional Surface Water Distribution Networks	Increasing dry season water availability in the north-west and north-central regions
	MR 010	Main River Erosion Control at Selected Locations	Minimizing socio-economic impacts of erosion
Towns and Rural Area	TR 007	Large and Small-Town Flood Protection	Protection of all large and small towns from 100-year floods
Major Cities	MC 010	Dhaka Flood Protection	Protection of Dhaka from 100-year floods
	MC 012	Chittagong Flood Protection	Protection of Chittagong from 100-year floods
	MC 014	Khulna Flood Protection	Protection of Khulna from 100-year floods
	MC 016	Rajshahi Flood Protection	Protection of Rajshahi from 100-year floods
Agriculture and Water Management	AW 002	Improved Performance of Existing Public Surface Water Irrigation Schemes	Increasing returns per unit of water and labor in public irrigation areas
	AW 003	New Public Surface Water Irrigation Schemes	The increasing area under public surface water irrigation
	AW 007	Rationalisation of Existing FCD Infrastructure	Increasing returns per unit of water and labor in public irrigation areas
	AW 008	Land Reclamation, Coastal Protection and Afforestation	Undertaking studies for reclamation of land from estuary region and sea
Environment and Aquatic Resources	EA 005	National Fish Pass Programme	Sustainable increase in floodplain fish catches, in terms of both numbers and diversity

Source: JICA Report on Detail Planning Survey for The Project for Capacity Development of Management for Sustainable Water Related Infrastructure

In addition, the division of duties for the water sector as indicated in the NWMP is shown on the following Table 4.2.5.

Table 4.2.5 Division of Duties in the Water Sector

Ministry	Organisation	National/Regional								Regional/Sub-Regional								Local Rural/Semi-Rural								Urban		
		Policy	International river basins	National/regional planning & coordination	Laws, regulations, rules, guidelines etc	Economic instruments	Research/service/education	Flood warning dissemination	Data collection	Programme planning and coordination	Standards monitoring	Major river maintenance & erosion	Barrages and transfers	Management of medium/large FCD	Regl river maintenance & erosion	Coastal Protection	Large scale irrigation projects	Local area development planning	Rural/village water supply and sanitation	Management of small water bodies	Minor irrigation	Maintenance of local drainage	Flood proofing	Management of small FCD	Promotion/education/awareness raising	Urban development planning	Town water supply and sanitation	Flood protection/proofing and drainage
Inter-Ministerial	National Water Resources Council	■			■																							
	Executive Committee of NWRC	■			■																							
	National Economic Council					■				■																		
	Executive Committee of NEC					■				■																		
MoWR	Water Resources Planning Organisation	■		■	■	■																						
	Joint Rivers Commission		■																									
	River Research Institute						■																					
	Surface Water Modelling Centre [1]						■																					
	Environment and GIS Project [2]						■																					
	B'desh Water Development Board							■	■	■	■	■	■	■	■		■				■	■	■	■				■
	B'desh Haor & wetland Development Board							■		■	■																	
MoA	B'desh Agricultural Development Corporation								■												■	■						
	Dept of Agricultural Extension								■												■				■			
	Soil Resources Development Institute						■				≈																	
	B'desh Agricultural Research Council	≈					■																					
	B'desh Agricultural Research Institute						■																					
	B'desh Rice Research Institute						■																					
LGRD&C	Local Government Division																	■										
	Local Government Engineering Dept.								■									■				■	■	■				■
	Dept of Public Health Engineering								■									■	■						■		■	
	Dhaka Water Supply and Sanitation Authority																									■	■	
	Chittagong WASA																									■	■	
Works	Rajdhani Unnayan Katripakha																									■		
Science & Tech	Space Research & Remote Sensing Org						■																					
MoEF	Dept of Environment				■				■		■																	
	Department of Forest									≈						■		≈							≈			
Communications	Dept of Roads and Highways													≈										≈				
MoPS&IWT	B'desh Inland Water Transport Authority								■						■													
MoFL	Dept of Fisheries								■	■								■		■		■						
MoPlan	Planning Commission			■	■	■				■																■		
	B'desh Institute of Development Studies [1]	≈				■			■																			
	B'desh Bureau of Statistics								■																			
MoL	Ministry of lands				■															■								
MoI	Ministry of Industry				■													■								■		
MRDM	Disaster Management Bureau							■															■					
Other organisations																												
	LGI: Paurashava																	■								■	■	
	LGI: Parishads																	■	■	■		■	■		■			
	Community Based Organisations													■			■		■	■	■	■	■	■				
	Non-Government Organisations	■	■	■	■	■	■	■											■	■	■		■	■	■			
	Co-operatives																		■		■							
	Private Sector [3]						■												■		■				■			

Notes : [1] *Established as a not-for-profit trust*
[2] *At present a project, due to become a trust in 2001*
[3] *Excluding consultants and contractors*
≈ *Indirectly related to water sector activities*

Source: National Water Management Plan, December 2001

(4) Flood Preparedness Plan of Bangladesh

The Flood Preparedness Plan for Bangladesh was formulated in July 2014 with the support of UNDP, the Australian Government and the Swiss Government. This emergency response plan aims to strengthen the government's existing capacity to lead and secure effective, timely and coordinated responses to mitigate flood risk and mitigate flood impacts on communities. It can be implemented at all national, local and government levels and plans to address current needs and issues that cover all stages of humanitarian response and recovery.

4.2.1.2 Review of Higher Level Plans for River Planning, River Management and Flood Forecasting and Warning

(1) The Eighth Five-Year Plan

The 8th Five-Year Plan (8FYP) was formulated and implemented for the period 2020-2024 and is set to address multiple challenges faced after graduating from middle-income status in 2024. 8FYP is divided into 13 sectors, and disaster risk mitigation measures are described in both "Housing and Community Amenities" as the 9th sector and "Social Protection" as the 14th sector.

Items related to river planning and river management are described in the 4th agricultural sector, water resources management and the 14th disaster management sector. The goals in the water sector are listed in Table 4.2.6.

Table 4.2.6 Targets for the Water Sector in the 8FYP

Indicator	Targets (per year)
Bank protection work (km)	2,356
Embankment construction/reconstruction (km)	3,949
Coastal embankment construction (km)	1,043
Dredging of river (km)	2,817
Excavation/re-excavation drainage canal (km) Excavation/re-excavation irrigation canal (km) Water control structure/hydraulic structure (Nos.)	17,042 1,119 2,050
Coastal cross-dam (Nos.)	7
WMG/WMA/WMF formulation (Nos.) WMG/WMA/WMF registration (Nos.) Land acquisition (Hectare)	363 581 7,159

Source: 8FYP

One of the strategies in the water resource management in the 8FYP is "Protecting riverbanks from erosion through integrated long-term measures." The plan for riverbank protection is 2,356 km per year in order to achieve 7,159 hectares land acquisition per year from 2020 to 2025. The following Table 4.2.7 shows quantitative indicators for riverbank protection in the 8th National Development Pan.

Table 4.2.7 Quantitative Objectives and Indicators for the Riverbank Protection from 2020~2025

Sub-indicator	Quantity	2016-2018	By 2025
Length of bank-line erosion	Percent of total river length	15%	8%
Erosion vulnerable people	Nos. in million	1	0.5
Area eroded along Jamuna	ha/year	1750	1050
Bank Protection Work	2,356 km per year (2020 to 2025)		

Source: 8FYP

(2) National Plan for Disaster Management 2021-2025

As explained in Section 4.1.1.1 (6), NPDM 2021-2025 is a comprehensive disaster management plan that has been established for medium- to long-term disaster management in Bangladesh. Indicators particularly related to river planning and river management are as follows:

1. Reduction of the number of deaths, missing persons, and directly affected people to 4000 per 100,000 population by 2025.
2. Reduction of damaged land to 100,000 acres.
3. The number of disasters affected households within 250,000 acres.
4. The direct economic loss inflicted by disasters as a proportion of GDP has to stand at a maximum of 0.7% percent in 2014.
5. Total damage and loss resulting from disasters should be brought down to 100,000 million BDT.
6. Flood-related structural infrastructure like embankments should be designed to provide adequate storm surge protection.
7. Proper maintenance of polders/embankments.
8. Increase in urban volunteers and coastal volunteers by 100,000.
9. Replicate the design of resilient houses in other disaster-prone regions of the country.

(3) BDP2100

As described in Section 4.1.1.1 above, in 2020, with the cooperation and support of the Netherlands government, the Bangladesh Delta Plan 2100 (BDP2100) was formulated for the entire country. The government has decided to proceed with national management in line with BDP2100, and it is expected that changes will be made to the existing content in the fields of river management, river planning, and flood control. The target figures related to the water sector in the BDP 2100 are shown in Table 4.2.8 below.

Table 4.2.8 Targets for the Water Sector

No.	Indicators	Sub-Indicators	Quantity	2016-2018	Target for 2025
(Goal 1: Ensure safety against water and climate change related disasters)					
1A	Risk zone susceptible to natural hazards	Average flood extent	% of total area of Bangladesh	30	20
		Extreme flood extent	"	50	30
		Cyclone damage extent	"	10	2
		Average drought extent	"	9	9
		Extreme Drought Extent	"	47	20
		Dry season saltwater intrusion	% of total coastal area	40	30
		Water logging extent	"	2.5	0.25
		Length of bank-line erosion	% of total river length	15	8
1B	Population vulnerable to natural disasters	Flood vulnerable people	Nos. in million	88	40
		Cyclone vulnerable people	"	8	5
		Erosion vulnerable people	"	1	0.5
		Water logging vulnerable people	"	0.9	0.1
(Goal 2: Ensure water security and efficiency of water usages)					
2A	Dry season water availability	-	% of total flow	15	30
2B	Dry season irrigation coverage	-	million ha	6	6.5
2C	Irrigation water efficiency	-	% of supplied water	30	40
2D	Urban domestic water efficiency	-	% of supplied water	67	75
2E	Internal Renewable Water Resources	-	cumec/ person	714	1,300
2F	Surface water sources polluted by industrial wastes	-	% of total river areas	11	6
2G	Surface water sources polluted by other wastes		% of total river areas	10	5
(Goal 3: Ensure integrated river systems and estuaries management)					
3A	Erosion along major rivers	Area eroded along Jamuna	ha/year	1,750	1,050
3B	Area of reclaimed lands	-	Ha	N/A	35,500
(Goal 4: Conserve and preserve wetlands and ecosystems and promote their wise use)					
4	Habitat protection	Area of perennial aquatic habitat	Ha	13,200	13,200
		Area of seasonal aquatic habitat	"	30,880	30,880
		Area of marine habitat	"	32,300	32,300
(Goal 5: Develop effective institutions and equitable governance for intra and trans-boundary water resources management)					
5A	Rural people with adequate capacity for WRM	-	% of rural population	20	40
5B	Equitable share of water among users	-	Qualitative judgment	Poor	Moderate
(Goal 6: Achieve optimal use of land and water)					
6A	Flood control, drainage and irrigation capacity	Area under irrigation schemes	Ha	672	900
6B	Sectoral use of water	Surface water used for irrigation	km^3	6.62	15
		Groundwater used for irrigation	"	24.88	22
6C	Navigation capacity	Wet season navigation course	km	5,968	5,968
		Dry season navigation course	"	3,865	5,500

Source: Bangladesh Delta Plan 2100

(4) Efforts in Water Management of International Rivers

Bangladesh has 57 transboundary rivers, 54 of which are shared with India. Bangladesh is the world's largest delta formed by the confluence of the Padma, Brahmaputra, and Meghna rivers and their tributaries and is highly sensitive to upstream development. Any development in neighboring countries that affects river flows, sediment dynamics, and water quality could exacerbate the vulnerability to flooding and water scarcity that Bangladesh is currently facing if not properly coordinated. Cooperation on river management with India, Nepal, Bhutan, Myanmar, and China is important for the future sustainable development of Bangladesh.

A framework agreement on international river basin management and joint development of hydropower was reached in September 2011. Official visits by India and Bangladesh in 2010, 2011, and 2015 led to the establishment of the Joint Working Group (JWG) for the joint management of the Ganges and Brahmaputra rivers, with the participation of Nepal, Bhutan, India, and Bangladesh. This joint initiative is in its early stages, but promises future development through enhanced cooperation in the management of shared rivers and exploring the possibilities of watershed management for mutual benefit. In addition to ensuring cooperation on flood protection and forecasting, it also provides the necessary support to enhance the navigability and accessibility of river routes and ports. In March 2021, an Indo-Bangladesh Water Resources Secretary-level meeting was held under the above framework. At this meeting, both sides agreed to expand cooperation across the full spectrum of water management, including frameworks for river water sharing, pollution mitigation, riverbank erosion control, flood management, and watershed management.

4.2.1.3 Projects Related to DRR by the Government of Bangladesh for River Planning, River Management and Flood Forecasting and Warning

(1) Past Major Project Plans

1) Krug Mission

The development of water resources in Bangladesh began in 1952, before independence when the then government planned three water resources development projects. These were: i) Karnaphuli Multipurpose Project in the Chattogram hills (for power generation in Chattogram and adjoining areas, and flood control of the Karnaphuli River), ii) Ganges-Kobadak (G.K) project (for irrigation in then Kushtia and Jessore districts), and iii) Cross Dam No. 1 (for land reclamation in Noakhali district). The main characteristic of water projects during this period until the 1970s was the emphasis on large-scale measures for flood control and protection of agricultural lands. The report of the Krug mission was the first major study to address flood control and water resource development issues in the country.

2) IECO Master Plan

The first Water Management Plan was prepared in 1964 by an American consultant, IECO, and proposed the implementation of 58 major flood, drainage and irrigation projects to be carried out over the period of 20 to 25 years from 1955 to 1980. Its objective was to develop the country's resources as quickly as possible in order to promote the welfare of the people, provide adequate living standards and social services, equalize opportunities, and achieve the widest and most equitable distribution of income and property. In accordance with this plan, the construction of large-scale flood, drainage, and irrigation projects began in earnest. All water resource development up to this time was, in most cases, aimed at increasing agricultural production and achieving national self-sufficiency. Flood control and drainage, and irrigation to a limited extent, were the main targets. Approaches were sectoral and communication between sectors was limited.

3) Flood Action Plan (FAP)

After the two major floods in 1987 and 1988, a comprehensive study of water resources was conducted with the help of the international society, which resulted in the implementation of the Flood Action Plan (FAP), which was implemented from 1989 to 1995, with some extensions to 2000. The FAP was a five-year plan to be implemented over a future period of 20-25 years and was to be reviewed every two years. The FAP included 26 major components (11 major components and 15 supporting activities under different plans) and a macroeconomic study. An organization named the Flood Planning Coordination Organization (FPCO) was established to manage these FAP studies.

The FAP was implemented through the coordination of various donor agencies, including the World Bank, ADB, UNDP, the United States, Canada, Japan, and other European countries. As such, project formulation under the FAP was donor-driven. An important component of the FAP was the regional study. Bangladesh was to be divided into six regions (North West Region, North Central Region, South West Region, South East Region, and North East Region) with the rivers as the main boundaries and considering topographical and agro-ecological characteristics to prepare the FAP.

One of the main concerns regarding the FAP was that it focused too much on controlling floods and lacked a broader perspective. Relying on levees as a flood protection measure was thought to have the following consequences.

- ✓ Embankments are under-designed for cost considerations. These embankments break down when faced with huge events such as floods and storm surges, causing damage to expensive human lives, settlements and crops.
- ✓ Inside the embanked areas, the riverbed rises, causing waterlogging problems.
- ✓ In morphologically dynamic countries such as Bangladesh, river embankments become unusable due to changes in river flow paths.
- ✓ Poor landless people may settle on the embankments. They build temporary houses on top of the levees, threatening the safety of the levees.
- ✓ When the river water exceeds the danger level and enters the village, the local people break the dike to solve the local flooding problem.
- ✓ Stagnant water in the settlements causes health diseases such as diarrhea and malaria, and pollution from sewage disposal.
- ✓ Water transportation is blocked by dikes. Therefore, it is necessary to build sluices and locks to allow ships to pass through. However, the construction of locks requires high costs and maintenance.
- ✓ Fish movement and freedom of movement are restricted, and fish growth is inhibited. For this reason, capture fishery is not practiced and aquaculture is necessary, but fishery experts are strongly opposed to aquaculture from the viewpoint of environmental protection.

In the FAP, the Integrated Water Resources Management (IWRM) approach was not fully adhered to. Thus, although flood protection was achieved, issues of environmental sustainability and social considerations could not be taken into account. However, in the environmental assessment of the FAP, land-water interactions (e.g., availability of surface and groundwater, impacts of extreme climate change) are considered in detail. In line with the FAP study, it has since become mandatory for all environmental and commercial projects to conduct an EIA.

4) National Water Management Plan (NWMP)

As mentioned in 4.2.1.1 , the National Water Management Plan (NWMP) provides a framework for the development, management, and use of water resources and services in Bangladesh. The NWMP was a very comprehensive and integrated planning document that covered all sectors of the country. But it was only a framework plan, so implementing agencies were supposed to develop their own projects based on the program. However, in the absence of clear guidance, it was not possible for each implementing agency to develop its own project. In addition, the implementation program was not prioritized in the NWMP, and the responsibility for prioritization rested with the implementing agencies, but they were not able to implement it.

(2) Status of Implementation and Results

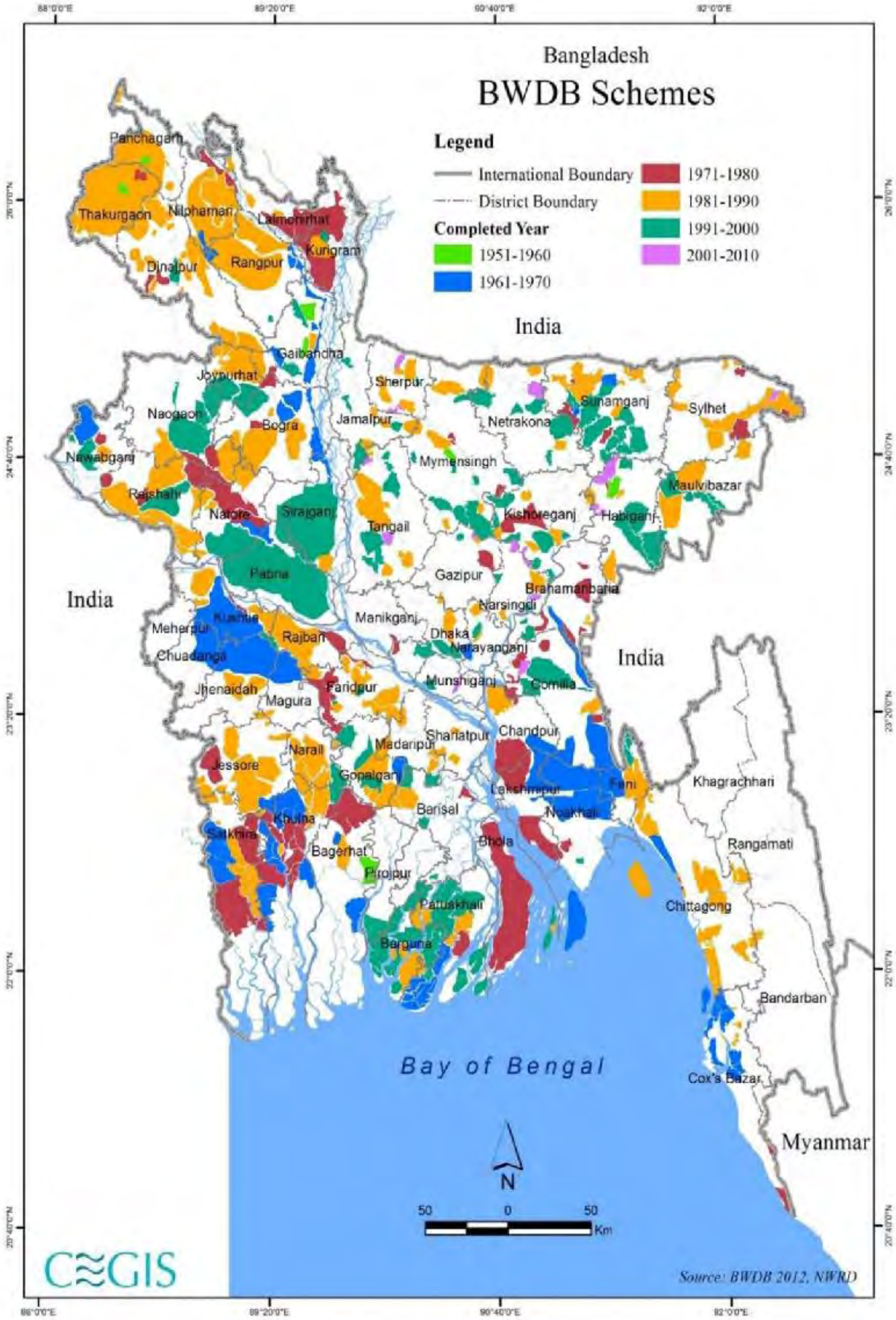
The implementation status of projects including their objectives, project content, duration, cost, and funding sources is summarized by DRM phase. Also, the results and issues of the projects are analyzed.

1) Prevention and Mitigation

Since the first water management plan was formulated in 1964, more than 910 river management and flood control projects have been implemented by BWDB. These include 133 polder projects, the construction of embankments totaling more than 16,450 km, and four weir projects. The status of the projects by year to date is shown in Figure 4.2.2.

The status of major projects implemented by BWDB in recent years is shown in Table 4.2.9.

Recently, BWDB has invested mainly in river channel dredging and river bank erosion control. The flood situation has improved in recent years with the improvement of embankments, excavation of drainage channels, and construction and rehabilitation of necessary infrastructure. According to the BWBD, 653,000 hectares of land have been protected from flood damage due to the recent development of facilities. Dredging operations are also being carried out on 470 km of various rivers in the country. It is also reported that 16.5 km^2 of land has been rehabilitated through the construction of four cross-dams on the Jamuna River to prevent erosion. In addition, about 150,000 tons of Boro crops have been protected from pre-monsoon floods by repairing/reconstructing about 375 km of submerged embankments at 727 locations in the Haor area.



Source: BWDB, from the NWRD 2012

Figure 4.2.2 Changes in Project Implementation by BWDB

Table 4.2.9 Major Recent Projects by BWDB in River Planning, River Management, and Flood Forecasting and Warning

Unit: Thousand Tk

	Project Name	Project Cost (2017-2022)
1	Re excavation of small river, khals & water bodies in 64 districts (phase-1)	17,450,900
2	Haor Flood and Livelihood Improvement Project (BWDB Part)	13,835,493
3	Dredging/Re-excavation of Bangali-Karotoa-Fuljor-Hurasagor River System with Bank Protection	11,010,000
4	Mirsarai Bangladesh Economic Zone Area Flood Control, Road Cum Embankment Protection & Drainage Project in Chit	9,760,000
5	Flood and Riverbank Erosion Risk Management Investment Program (Tranche-1)	9,471,043
6	Southwest Area Integrated Water Resources Planning & Management Project – 2nd Phase	7,823,755
7	Protection the Right Bank of Padma River at Naria and Janjira Upazila of Shariatpur district	6,950,109
8	Re-excavation of Arialkha River, Haridoya River, Brahmaputra River, Paharia River, Meghna Branch River and Old Brahmaputra Branch River Project under Narsingdi District	6,000,000
9	Irrigation Management Improvement Project (IMIP) (For Muhuri Irrigation Project)	5,618,936
10	Dredging and Bank Protective Work along the Left Bank of Padma River from Majhir Char to Moksedpur via Narishabazar at Dohar Upazila under Dhaka District	5,300,000
11	Protection of Khudbandi, Singrabari and Shuvagacha area of Kazipur upazila in Sirajganj district erosion of the Jamuna River	4,900,000
12	Buriganga River Restoration project	4,741,200
13	Protection of Lord Hardinge and Dholigournagar Bazar of Lalmohon Upazilla from the erosion of the Meghna River in Bhola District.	4,400,000
14	Protection from Bokshi launchghat to Badurhat launchghat area from the Erosion of Tentulia River including Dredging Work and Flood Protection Protection in Kukri-Mukri Island at Charfession upazila under Bhola District.	4,336,600
15	Protection of different infrastructures from the right bank erosion of Jamuna River at Gaibandha Sadar &Fulchari Upazila including Ganakabor in Gaibandha District.	4,287,500
16	Protection of Proposed Economic Zone and Development of Reclaimed Land from Jamuna River in Sirajganj district.	3,952,000
17	Flood Control & Drainage Improvement Project for Removal of Drainage Congestion in Noakhali Area	3,898,300
18	Protection of Embankment of Polder No. 56/57 from erosion of the Meghna River at Daulatkhan & Borhanuddin Upazila in Bhola District	3,850,000
19	Strengthening Hydrological Information Services and Early Warning Systems (Component: B)	3,814,100
20	Re-excavation of Connectiong Rivers, development of Irrigation Facilities and Fish Culture project of Gazner Beel area under Sujanagar Upazila in Pabna district	3,743,000
21	Border Rivers Bank Protection and Development Project, Phase-2	3,700,000
22	Re-Excavation of 83 Rivers/Khals and Increase Navigation of Mongla-Ghasiali Channel in Bagerhat District	3,660,000
23	River Bank Protection work for protection of Tajumuddin upazilla sadar in Bhola District from erosion of the Meghna River	3,620,000
25	Early flood prevention and disposal project in Haor area	3,500,000
26	Bank Protective work against Erosion of the Meghna River at rajapur and east ilisha union of Bhola sadar upazilla in bhola district	3,350,000
27	Bank Protection Work of the Sangu and Dalu Rivers in Satkania and Lohagara Upazilas of Chattogram District.	3,350,000
28	Land Development, Wave Protection and River Bank Protection Work for Proposed Mithamain Army Installations at Mithamain Upazila of Kishoregonj District.	3,160,000
29	River Bank Protection Work to Protect herbaria Area from the Erosion of Kirtonkhola River at Barishal SadarUpazila in Barishal District.	3,150,000
30	Gorai River Dredging & Bank Protection Project	3,100,000
31	River Bank Protection of Arujuna area from erosion of Jamuna River in Gopalpur Upazila of Tangail District.	3,050,000
32	Kolni - Kushiara River Management Project	3,000,000

Source: Prepared by JICA Survey Team Based on MOF

In addition, for small-scale water management and drainage infrastructure at the local level, LGED has been implementing a lot of projects. Recent projects implemented by LGED are shown in Table 4.2.10.

Table 4.2.10 Major Recent Projects by LGED in River Planning, River Management, and Flood Forecasting and Warning

Unit: Thousand Tk

	Project Name	Project Cost (2017-2022)
1	Haor Flood Management and Livelihood Improvement Project (LGED Part)	26,038,595
2	Sustainable Small Scale Water Resources Development Project	11,620,000
3	Small Scale Water Resources Development Project (2nd Phase)	8,331,400
4	Participatory Small Scale Water Resources Development Project	761,927
5	Char Development and Settlement Project-4, LGED	150,773

Source: Prepared by JICA Survey Team Based on MOF

2) Flood Forecasting and Warning

(a) Past Activities

(i) Flood Forecasting and Warning Center (FFWC)

The Flood Forecasting and Warning Center (FFWC) of BWDB provides flood forecasting and warning services. After the devastating floods of 1987 and 1988, the need for the introduction of flood forecasting based on river modeling was deeply recognized. Since then, a flood forecasting model based on the simulation model MIKE11 developed by the Danish Hydraulic Institute (DHI) has been developed and is being operated by the FFWC. Flood forecasting and warning are prepared by calculating the expected state of water levels at a particular future date using a hydraulic model simulation that takes into account the general conditions of weather, rainfall, and water levels in a river. Currently, advance flood forecasting is done for periods of up to five days at 54 stations on 29 rivers.

The current projections have a lead time of up to 5 days, but to improve disaster risk management, the lead time needs to be extended to more locations on more rivers. The lead time for projections can be extended using climate projections, and the Climate Forecast Applications in Bangladesh (CFAB) project is developing in this area.

Since 2013, pilot-based flood forecasting has been introduced to monitor flood conditions along with specific infrastructure. The infrastructure facilities covered under these initiatives are; (a) Dhaka - Maowa section road, (b) right bank embankment of Jamuna River, (c) Pabna irrigation embankment, (d) Embankment of Meghna Dhanagoda irrigation project. A five-day forecast is being made for these facilities.

(ii) Flash Flood Forecasting

A three-day flash flood forecasting system for the pre-monsoon period of April-May in northeast Bangladesh has been piloted since 2017. The system is being developed as part of a programme implemented by Haor Infrastructure and Livelihood Improvement Project (HILIP).

In addition to the hydrological stations normally operated in the northeast, 10 water level stations and 11 rainfall stations have been added for flash flood monitoring and forecasting. This brings the total number of water level monitoring sites to 36 and the number of rainfall stations to 28. A key feature of the forecasting system is that it is coupled with the Bangladesh Meteorological Department's (BMD) Weather Research and Forecasting (WRF) numerical model, and rainfall runoff from this model is linked to the MIKE11 hydraulic model to generate water level predictions.

(iii) Prediction of Riverbank Erosion

Center for Environmental and Geographic Information Services (CEGIS) has developed a unique tool for predicting riverbank erosion of the Jamuna, Ganges and Padma rivers based on satellite imagery during the dry season. This prediction is a probabilistic approach and CEGIS has been predicting vulnerable erosion sites along both banks of these rivers since 2004 for three different probabilities (30%, 50% and 70%). The overall accuracy of this tool is said to be in the range of 70% to 80%.

(b) Implementation Status of Projects in Recent Years

(i) Modernization of Hydrological Network

In accordance with the recent project implementation on flood forecasting and warning, a state-of-the-art data center/hydrological network has been set up in Dhaka under the Water Management Improvement Project (WMIP). It has been reported that the hydrological network managed by the BWDB Hydrological Department remains mainly manual. Through the World Bank-supported Bangladesh Weather and Climate Services Regional Project (BWCSRP) component B: Strengthening Hydrological Information Services and Early Warning Systems, the BWDB is improving hydrological service delivery in Bangladesh by modernizing its network and strengthening its hydrological observation, forecasting, and early warning systems. In addition, the development of flood shelters in flood-prone areas by DDM is also underway.

(ii) Improvement in the Accuracy of Water Level Prediction at Floodplain

The flood forecasting system of the FFWC currently issues station-based forecasting information. This station-based forecast information is further incorporated into the countrywide flood map for spatially continuous flood forecast information by comparing the water surface with a digital elevation model (DEM). However, due to the low resolution of the current DEM, some spatial accuracy has to be compromised. Moreover, recent land use changes and other dynamic features are often unobtainable to incorporate into the DEM, which further decreases the spatial accuracy of the FFWC flood map to some extent.

Intending to overcome these limitations using the latest available satellite-based technology but within a limited budget, a pilot project in collaboration with Google is ongoing. Google has developed a satellite based improved DEM with higher spatial resolution using machine learning techniques, wherein the recent land changes are also being incorporated. Currently, the flood-prone districts of Bogra of Sirajganj along the Jamuna River are set as the pilot area for the initiative. The FFWC will provide the real-time water level, as well as forecast data to Google, based upon which they will generate the flood map for the pilot area. Hopefully, this will aid in better flood management activities at the local level in the future.

3) Flood Response and Relief

Response and emergency activities in case of disasters are carried out by the MoDMR. Although the detailed activities specific to floods are not available, the MoF publication confirms that 15,590,471 thousand Taka in 2017 and 21,117,673 thousand Taka in 2018 have been allocated for response activities.

4) Flood Disaster Recovery and Reconstruction

Regarding post-disaster rehabilitation and reconstruction projects, repair of embankments and polders is carried out by the BWBD, while rehabilitation of roads and drainage infrastructure damaged by floods is carried out by the LGED. The rehabilitation and reconstruction projects implemented in recent years are shown in Table 4.2.11. Regarding the BWDB projects, most of them are concentrated in the southern coastal areas, and the rehabilitation of damage caused by storm surge disasters has been the main focus in recent years.

Table 4.2.11 Recent Projects for Rehabilitation and Reconstruction in River Planning, River Management, and Flood Forecasting and Warning

Unit: Thousand Tk

	Agencies	Project Name	Project Cost (2017-2022)
1	BWDB	Rehabilitation of Erosion Prone area With Slope Protection Work in Polder no-72, Sandwip, Chattogram	3,514,500
2	BWDB	Rehabilitation of Bhutiar Beel and Barnal-Salimpur-Kolabashukhali Flood Control and Drainage Project Khulna District (Phase-II)	2,422,400
3	BWDB	Rehabilitation of Damaged Polders under the District of Cox's Bazar	2,350,000
4	BWDB	Rehabilitation of Polder No. 36/1 in Bagerhat District	2,195,000
5	BWDB	Rehabilitation of BWDB infrastructures Damaged by Natural Disaster in the Coastal Area of Polder No. 64/1A/64/1B & 64/1C at Banskhali Upazilla in Chit	1,848,850
6	BWDB	Rehabilitation of Polder's (67/A, 67, 67/B & 68) along border river of Naf for Improving Bangladesh-Myanmar security at Ukhia & Teknaf Upazilla in Cox's Bazar District.	1,550,000
7	BWDB	Rehabilitation of BWDB infrastructure for erosion Protection Drainage and Irrigation improvement in the Coastal Area of Polder No. 61/1 (Sitakunda), (Mirersarai) & 72 (Sandwip) in Chattogram District	972,200
8	BWDB	Rehabilitation of Satla-Bagda Project Polder in Barishal District	325,100
9	BWDB	Rehabilitation and Drainage Improvement of Polder No, 64/2A (Puichari Part) of Puichari Union Under Banskhali Upazilla of Chittagong District	110,000
	LGED	Flood and Disaster Damage Rural Road Infrastructure Development Project	19,000,000
	LGED	Chowmuhani Paurashava Post Flood Infrastructure Development and Rehabilitation Project	108,898

Source: Prepared by JICA Survey Team Based on MOF

4.2.1.4 Status of Hazard Map Development

In this section, the information on hazard maps that have been conducted and produced so far in Bangladesh is summarized. The results of a more detailed hazard and risk analysis are presented in Section 5.1.3 of Chapter 5.

(1) MRVAM: Multi-Hazard Risk and Vulnerability Assessment, Modeling and Mapping

One of the hazard maps that has been developed at the national level is the hazard map prepared by Multi-Hazard Risk and Vulnerability Assessment, Modeling and Mapping (MRVAM) (See 5.1.3.1). Flood maps prepared in Bangladesh in the past have been based on individual disaster events by BWDB and FFWC, but MRVAM is the first to conduct a systematic scientific analysis of probability-based flood maps. For floods, the model was constructed based on the Regional Model built in the past. Flood simulations have been analyzed using five existing hydrological regional models (Northwest Regional Model, North Central Regional Model, Northeast Regional Model, Southwest Regional Model, and Southeast Regional Model). Simulations have been conducted based on available historical data, and these models have been validated before being applied.

The flood model used in this analysis is built on MIKE11 and consists of two modules: hydrological and hydraulic. The hydrological module runs simulations of rainfall and runoff phenomena using rainfall and evapotranspiration data as input conditions. As an output, the runoff volume is calculated as an input condition for the hydrological module. In the hydrological module, the river discharge and water level in the river network are calculated. Flood simulations for the past 26 years (1986-2011) were used to calculate the river levels at 7617 locations. Frequency analysis is then performed at these locations to obtain the 25-, 50-, 100-, and 150-year probability of annual flood levels. These flood levels are processed in ArcGIS software to produce flood hazard maps using a DEM based on the following equation

Flood depth (m) = Flood level (m PWD) - Ground elevation (m PWD)

Note: PWD (Public Works Datum) is a horizontal datum utilized for public works in Bangladesh

However, this DEM is a 300-meter resolution model based on topographic data obtained from surveys conducted in the 1950s and 1960s. Since then, the topography of the land has undeniably changed significantly due to massive population growth, development pressure on agricultural land and flood plains, and drastic changes in land use patterns due to changes in water bodies, forests, and land areas, which may limit the accuracy of flood depth calculations.

The MIKE11 flood model is essentially a one-dimensional flow analysis model, which does not take into account cross-sectional water flow in the floodplain. The calculation of flood levels in the floodplain between river networks is done by interpolation of river water levels. Therefore, it should be noted that the model may overestimate the flood levels at some locations between river networks, especially in large areas between river networks.

(2) A Study on Flood Hazard Assessment under CDMP (2013)

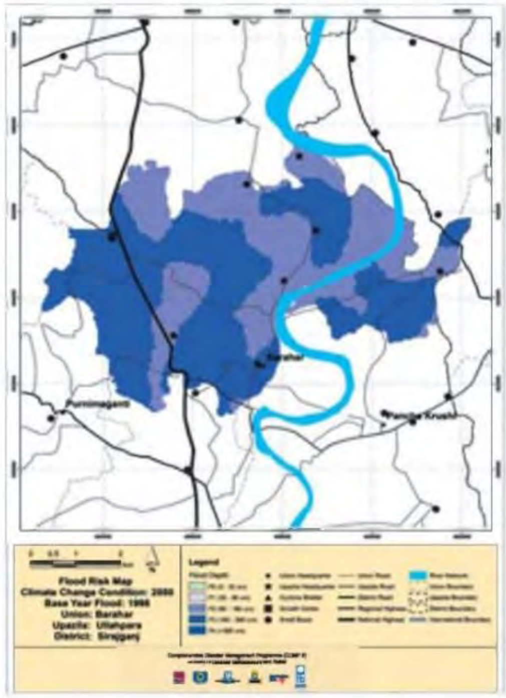
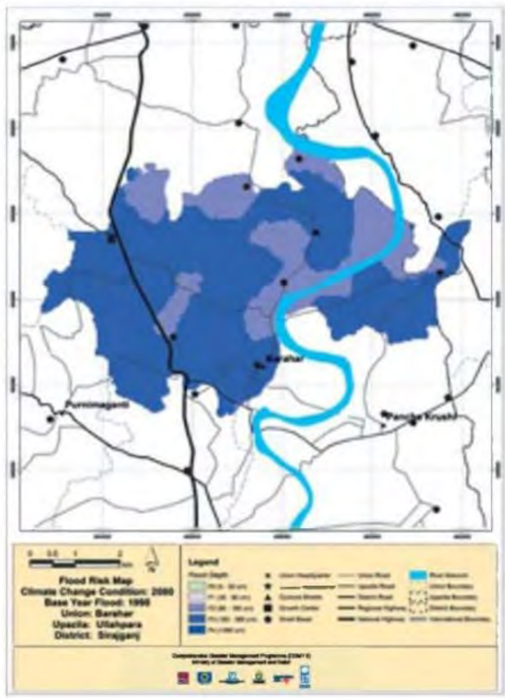
In this study, Union-level flood maps have been prepared for various flood events, probability magnitudes such as 10-year and 20-year probability periods, and climate change for the years 1988, 1998, 2004 and 2007. Flood events are selected based on historical data on maximum water level, maximum flow, flood duration, and damage. Flood maps have also been prepared based on the impact of climate change. MIROC is used to predict the change in rainfall due to climate change, and the model results predict an increase in rainfall at all rainfall observation sites in 2050. This increase in rainfall was added to each rainfall data and the river hydrological model was simulated based on the increased rainfall data.

The Ganges-Brahmaputra-Meghna (GBM) watershed model developed by the FFWC of BWDB in 2005 was used in this study. The model includes 133 sub-watersheds, of which 79 are in the Ganges River basin, 47 in the Brahmaputra River basin, and 7 in the Meghna River basin. The model also takes into account snow melt in the Hindu Kush Himalayan region, although it is still under development. The functioning of the storage facilities (reservoirs and dams) in the Indian domain has also been incorporated into the model.

Inundation maps for 34 districts have been prepared for the 1998 and 2004 floods, and inundation depth maps for 26 districts have been prepared for the 1988 and 2007 floods. The findings from the study are summarized as follows:

- ✓ Severe monsoon floods occur every three to five years in Bangladesh.
- ✓ Increased precipitation due to climate change, increased water flow from upstream areas across the border, and sea level rise are estimated to increase the depth and extent of flood inundation, exposing rural communities to higher hazard risks.
- ✓ According to flood maps, during major floods (1988, 1998, 2004, 2007), significant areas of various Upazilas within the 40 flood-prone districts will be submerged.
- ✓ Simulation results of flood events under climate change conditions in 2050 and 2080 show that areas such as Rajshahi, Natore, Lamphur, Bogra, Netrakota and Sylhet districts are likely to be submerged with higher inundation depths.

Flood maps of Barahar Union under Ullapara Upazilla of Sirajganj District for 2050 and 2080 are shown in the following figure.

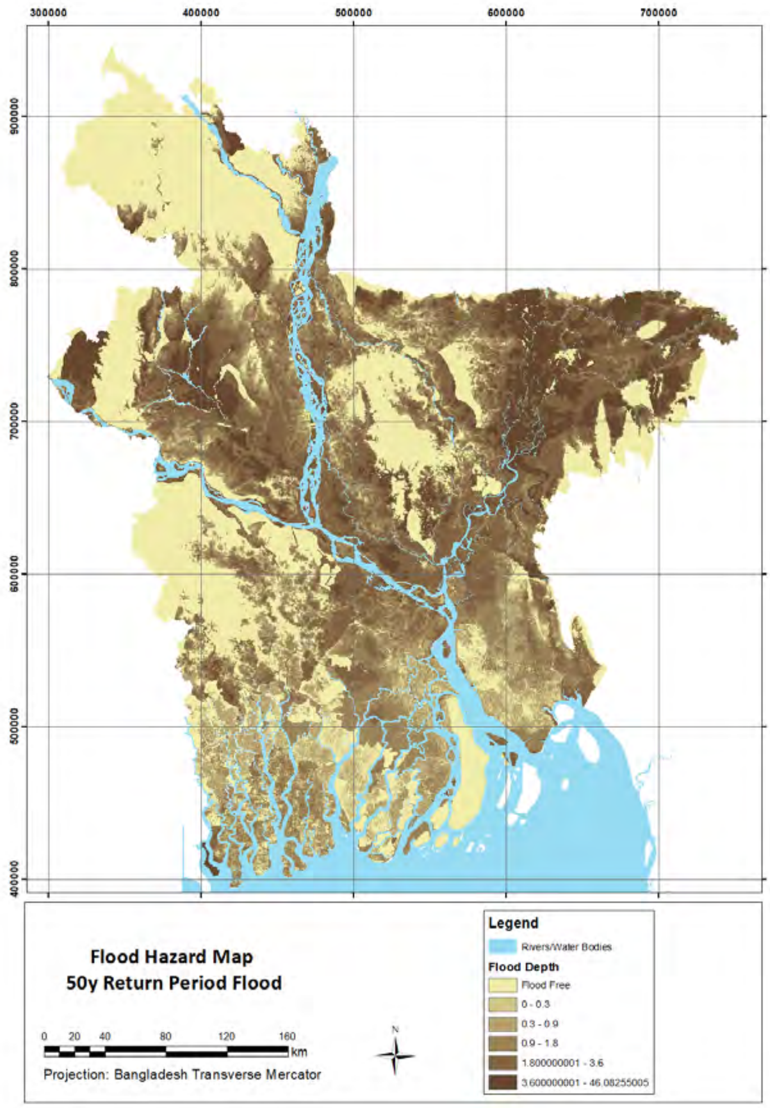
	
Year 2050	Year 2080

Source: CDMP

Figure 4.2.3 Union Level Flood Hazard Maps Prepared by CDMP

(3) IWM's Flood Simulation

Water depth maps were made by the IWM for floods with different return periods. The maps were developed using the 1D MIKE11 model in combination with GIS. The water depth map was made by interpolating all the river water levels computed at grid points. The digital elevation model of the country was subtracted from this interpolated water level map to obtain water depths.



Source: IWM

Figure 4.2.4 Flood Hazard Map Prepared by IWM (50-year Return Period)

(4) Flood Map by FFWC

FFWC publishes an annual report on the occurrence of floods, which provides details on the major flood events for each year. In this report, inundation maps are produced for the major floods (see 5.1.3.1). These flood maps are generated from the output of rainfall-runoff and hydraulic simulations using the customized MIKE 11 GIS model. It should be noted that the DEM used in this is a 300 m resolution model based on survey results conducted decades ago.

4.2.2 JICA's Cooperation

JICA's cooperation to date in river planning, river management, and flood forecasting and warning is shown in Table 4.1.32 and Table 4.1.33. In terms of river management, Japan's cooperation has been focused on the upper Meghna River Basin. In the past, Japan has provided grant assistance and research cooperation, mainly for riverbank protection, and is currently implementing a flood management project to improve livelihoods. On the other hand, no large-scale project on river management and flood control has been undertaken in recent years for the Jamuna and Padma rivers, since the ADB and the World Bank have already implemented several projects.

Bangladesh is located at the downstream end of huge rivers that flow through the continent, and the loss of land due to riverbank erosion is a long-standing issue. In terms of riverbank erosion countermeasures, cooperation has been carried out in the past to establish countermeasures against bank erosion on the banks of large rivers. Currently, as part of the Comprehensive River Management Technical Cooperation Project, efforts are being made to establish a practical river channel management methodology.

In the major rivers of Bangladesh, flooding and riverbank erosion caused by the world's largest sediment runoff and heavy rainfall in the basin have become a major problem. JICA has been conducting basic research on sediment dynamics of large rivers through SATREPS “Research on Disaster Prevention / Mitigation measures against Flood and Storm Surges in Bangladesh”, while other development partners such as ADB and the World Bank are developing experimental reinforcement technologies. However, the technology has not been systematized to the level that can propose comprehensive countermeasures for the entire river channel (See 4.2.3.1, 4.2.3.3, and 4.2.4.5). The establishment and dissemination of river channel management technology through fundamental solutions against riverbank erosion will be important for the sustainable growth of Bangladesh and continued technical cooperation toward the establishment of a river channel management methodology will be important.

From the perspective of flood control, JICA has provided cooperation for the implementation of flood control projects focused on the upper Meghna River basin. The main problem in the Haor region, the reduction of the damage caused by flash floods before the rainy season, which affects the harvest of boro rice, seems to be realized by the construction of submerged embankments. However, due to the lack of sufficient strength in materials and construction methods of the levee body, and due to the awareness of residents and related organizations based on the assumption of breakage of a certain scale, some submerged levees break after construction. JICA has also developed manuals and provided technical guidance on the design, construction, and maintenance of levees through the Water Infrastructure Development Capacity Improvement Project and the Water Resources Management Advisor, but the dissemination of these manuals has not yet progressed. It is considered important to explore the establishment and dissemination of strong embankments in cooperation with Bangladesh.

In Bangladesh, there a few river management plans for each river basin, and the concept of flood risk reduction in a comprehensive view of river basins has not been widely accepted. JICA is currently providing technical cooperation for the formulation of integrated upstream and downstream river planning through the “Project for Enhancing Planning Capacity and Building Technology Adaptation Cycles for Comprehensive River Management”, and it is important to establish good practices through the implementation of the project.

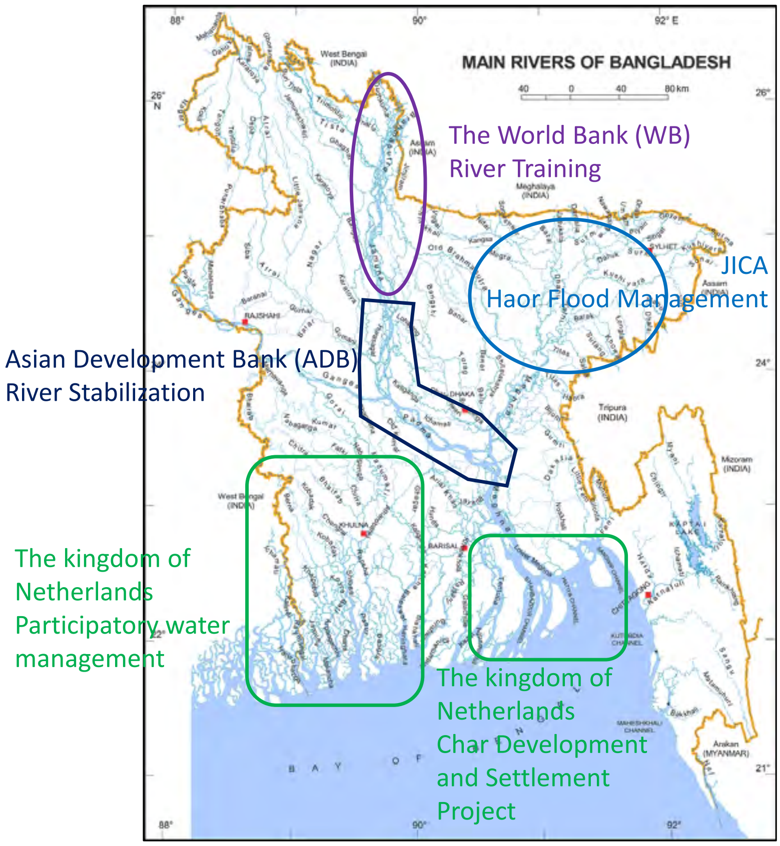
4.2.3 Cooperation with Other Donors

The following table shows the major cooperation projects implemented by other donors in river planning, river management and flood forecasting and warning in recent years.

Table 4.2.12 Major Cooperation Projects of Other Donors in River Management, River Planning, and Flood Forecasting and Warning

Year	Project Name	Project Field	Amount of Project Fund
World Bank			
1995-2001	River Bank Protection Project	Flood protection, riverbank erosion control	US$ 121.90 million
2007-2015	Water Management Improvement Project	Restoration of water infrastructure facilities, improvement of facility management systems and institutions	US$ 101.47 million
2016-2022	Bangladesh Weather and Climate Services Regional Project	Meteorological and hydrological observation, forecasting and warning	US$ 127.80 million
2021-	Jamuna River Economic Corridor Development Program	Flood control, riverbank erosion control, sediment management	-
Achievements and issues: Support for emergency response and recovery projects after disaster has been the main focus of the past projects. Emphasis has been placed on disaster risk management other than infrastructure development, such as expansion of weather forecasting and warning services and capacity building of organizational systems. In the area of river management, cooperation for riverbank erosion control has been continued, particularly for the Jamuna River, but no fundamental solution has been reached.			
UNDP			
2010-2014	Comprehensive Disaster Management Programme II	Early Warning System	US$ 69.47 million
Achievements and issues: The project have mainly focused on capacity building of communities and provision of equipment for disaster response, and little support has been provided for pre-investment mainly in structural measures.			
ADB			
2003-2011	Jamuna and Meghna River Erosion Mitigation Project	Riverbank Erosion Control	US$ 41.17 million
2014-2021	Flood and Riverbank Erosion Risk Management Investment Program	Flood control, riverbank erosion control	US$ 288.30 million
2006-2016	Southwest Area Integrated Water Resources Planning and Management Project	Water management planning, water management infrastructure rehabilitation Support for the establishment of water management organizations	US$ 84.50 million
2009-2020	Participatory Small-Scale Water Resources Sector Project	Flood and drainage control, irrigation	US$ 87.00 million
2006-2012	Secondary Towns Integrated Flood Protection Project	Flood and drainage control, urban environment	US$ 95.00 million
Achievements and issues: Efforts have been made to control riverbank erosion in the Jamuna, Padma and Meghna rivers through the implementation of several projects. The projects aim to establish an inexpensive and adaptive approach to riverbank protection, but there are still issues to be addressed in terms of strength and maintenance systems. The ADB's cooperation is also focusing on the development and improvement of water management infrastructure and capacity building of organizations in rural areas, including small-scale urban integrated flood projects and small-scale water resource development projects.			
Government of the Netherlands			
2010 -2022 (Phase IV)	Char Development Settlement Project (CDSP) (Phase I ～ IV)	River management and sediment management	US$ 139.15 million (Phase IV)
Achievements and issues: The BDP 2100 needs to be continuously reviewed and updated to ensure the validity of the projects to be implemented in the future, as well as the detailed target areas and implementing agencies.			

Source: World Bank Project Site (https://projects.worldbank.org/en/projects-operations/projects-summary?countrycode_exact=BD)
CDMP (http://www.undp.org/content/dam/undp/library/crisis%20prevention/Bangladesh%201.pdf)
ADB Project Site (https://www.adb.org/projects/country/ban/sector/agriculture-natural-resources-and-rural-development-1057/sector/water-and-other-urban-infrastructure-and-services-1065)
CDSP (https://www.ifad.org/en/web/operations/-/project/1100001537)



Source: Prepared by the Survey Team Based on BWDB Documents

Figure 4.2.5 Main Project Areas for Water Management Projects by Major Donors

4.2.3.1 World Bank (WB)

(1) Past Achievements

1) River Bank Protection Project

During 1995-2001, the River Bank Protection Project was conducted to prevent the erosion of riparian land at two locations on the west bank of the Jamuna by the construction and maintenance of improved river-bank protection works which will: 1) protect Sirajganj town's built-up and semi-urban areas from major damage and cumulative destruction; and 2) prevent the merger of the Jamuna and Bangali Rivers in the vicinity of Sariakandi and consequential increased regional flooding. A further objective is to assist the Government of Bangladesh (GOB) in developing permanent institutions for improved water sector planning, preserving the institutional capacity developed under the Flood Action Plan (FAP) and making multi-disciplinary planning part of Bangladesh's normal water sector planning processes. The project's components were:

1) Rehabilitation and construction of river-bank protection works at two sites on the Jamuna River's west bank;
2) Land acquisition and a program of resettlement for people displaced by project works;
3) Technical assistance for implementation supervision and maintenance of works constructed under the project;
4) Establishment and initial funding of a specialized operations and maintenance Unit in the BWDB;
5) Institution building technical assistance to WARPO; and
6) Institutional capacity building technical assistance to BWDB.

2) Water Management Improvement Project

The WMIP primarily aims to incorporate and strengthen the public participatory approach to the operation and maintenance of water-related facilities constructed by the BWDB. Composed of the four components shown in the following table, it was scheduled to be implemented between September 2007 and June 2015. The main executing agencies are BWDB and WAPRO. The project cost is US$ 123.26 million.

Table 4.2.13 Outline of the WMIP Components

Component	Contents
1. System Improvement and Management Transfer	This aims to introduce and strengthen the public participatory process adopted by the government to operation and maintenance. It includes construction of a database and introduction of GIS and a numerical model.
2. O&M Performance Improvement	This entails introducing techniques aiming for the sustainable operation and maintenance of facilities based on public participation. This is conditional on the target areas not requiring large-scale rehabilitation works and there are already functioning WMOs or equivalent civilian organizations.
3. Institutional Improvement	This aims to conduct organizational strengthening of the BWDB and WARPO, which are the main agencies with control over water resources. This includes capacity building, training, monitoring and evaluation, and introduction of IT devices and equipment.
4. Flood DamageRehabilitation	This entails implementing of rehabilitation works for infrastructure damaged in the floods of 2007 and by Cyclone Aila in 2009.

3) Bangladesh Weather and Climate Services Regional Project

The development objective of the project is to strengthen Bangladesh's capacity to deliver reliable weather, water, and climate information services and improve access to such services by priority sectors and communities. The project comprises of the following components:

Component A: Strengthening meteorological information services by strengthening BMD's meteorological monitoring network, forecasting capacity and delivery of weather and climate services. It has three sub-components: (i) modernization of meteorological observation systems and forecasting; (ii) technical and institutional capacity strengthening, regional collaboration, project management, monitoring and evaluation; and (iii) strengthening weather services, early warning systems, and climate services delivery.

Component B: Strengthening hydrological information services and early warning systems to improve hydrological observation, forecasting, and early warning systems. It consists of three sub-components: (i) strengthening hydrological observation network and forecasting; (ii) technical and institutional capacity strengthening, regional collaboration, project management, monitoring and evaluation; and (iii) strengthening hydrological services and flood early warning systems.

Component C: Agrometeorological information systems development to provide agro-meteorological services to farmers in order to increase agricultural productivity and assist them in coping with weather and climate extremes. It consists of the sub-components of: (i) establishment of the Bangladesh agrometeorological information system (BAMIS); (ii) training, capacity building, project management, monitoring and evaluation.

Component D: In this component, following an adverse natural or man-made event or that causes a major disaster, the Government may request WB to re-allocate project funds as Immediate Response Mechanism (which presently carries a zero allocation) to support response and reconstruction.

Table 4.2.14 Outline of the BWCSRP Components

No	Component	Implementing Agency	Sub-Component
A	Strengthening Meteorological Information Services	Bangladesh Meteorological Department (BMD)	Strengthening Meteorological Monitoring and Forecasting
			Technical and Institutional Capacity Strengthening, Regional Collaboration, Project Management, Monitoring and Evaluation
			Strengthening Weather Services, Early Warning Systems and Climate Service Delivery
B	Strengthening Hydrological Information Services and Early Warning Systems	Bangladesh Water Development Board (BWDB)	Strengthening Hydrological Observation Network and Forecasting
			Institutional Capacity Strengthening, Project Management and Monitoring and Evaluation
			Strengthening Hydrological Services and Flood Early Warning Systems
C	Agrometeorological Information Systems Development	Department of Agricultural Extension (DAE)	Establishment of the Bangladesh Agrometeorological Information System (BAMIS)
			Training, Capacity Building, Project Management and Monitoring and Evaluation
			Agricultural Disaster Risk Management through agrometeorological information dissemination
D	Contingent Emergency Response		No sub-component

Source: "Bangladesh Weather and Climate Services Regional Project Environmental Management Framework, BMD, BWDB, DAE, December 2015*", partially added by JICA Survey Team

4) Jamuna River Economic Corridor Development Program

The project objectives are to enhance resilience of Jamuna River's riverbanks to flooding and erosion. They will support activities in the Jamuna River that invest in riverbank protection, navigation channel development, and stronger river institutions, with nature-based solutions (NBSs) as a guiding principle.

The Program will use NBSs in riverbank protection, combining building-with-nature solutions with cost-effective, innovative hard engineering structures. In addition, the concept of dynamic navigation that allows 'room for the river' will be deployed in the Program, which lets the river dynamically meander and naturally carve out multiple channels during the monsoon season and then seeks the best navigation routes at the start of the dry season, without coercing permanent navigation channels.

To achieve its objectives, the program will invest US$1.3 billion across the following five components:

Component 1: Riverbank protection and river training (US$940 million). This component will invest in river training structures that will help preserve the shoreline by absorbing the energy of incoming water and control the river flow to reduce the risk of riverbank erosion and flooding. Innovative river training structures, such as permeable groynes and permanent top-blocked semipermeable spurs, will be studied and piloted as well.

Component 2: Navigation channel development (US$300 million). This component will create navigation channels that are 50–100 m in width and 2.5–3.0 m in draft, allowing for heavy cargo vessels sailing both ways day and night for much of the year. Investments will be made on all three elements of dynamic navigation. Support for planning and institutional frameworks will also be extended.

Component 3: Disaster risk financing (US$40 million). Risk financing solutions with clear triggers and pre-identified disbursement channels will be developed.

Component 4: Institution building and project management (US$20 million).

Component 5: Contingent emergency response component (CERC) (US$0 million). This component is included for rapid reallocation of credit proceeds from other project components during an emergency.

(2) Summary

While support for post-disaster emergency response and recovery projects has been implemented, there have been few pre-investment projects aimed at damage prevention and mitigation. Emphasis has been placed on disaster risk management other than structural measures, such as expansion of weather forecasting and warning services, capacity building of organizational systems, and introduction of green infrastructure.

In river management, continuous support has been provided for riverbank erosion, especially in the Jamuna River, but this has not led to fundamental solutions. Innovative methods are being developed but only on a pilot basis and the methodologies are not yet established.

4.2.3.2 UNDP

(1) Past Achievements

UNDP's support for river management and flood forecasting and warning includes the Comprehensive Disaster Management Programme (CDMP). The CDMP was implemented over two phases with support from the UK Department for International Development (DFID), the European Union (EU), the Norwegian International Development Agency (NID), the Swedish International Development Agency (SIDA), and the Australian Agency for International Development (AusAID). The project provided technical assistance, training and equipment for comprehensive disaster management with the objective of reducing vulnerability to natural hazards such as cyclones, floods, storm surges, earthquakes and tsunamis, including the effects of climate change, as well as man-made hazards such as avian influenza, fires, and toxic and chemical spills.

The main outputs of CDMP-I were training on disaster management and establishment of a climate change database covering three cities, while CDMP-II was undertaken in partnership with Bangladesh Teleltalk, BMD and FFWC to establish an early warning system and reduce the lead time for flood forecasting.

(2) Summary

The main focus has been on capacity building of communities and provision of equipment for disaster response, and little support has been provided for pre-investment, mainly in structural measures.

4.2.3.3 ADB

(1) Past Achievements

1) Jamuna and Meghna River Erosion Mitigation Project

The objective of the Project is to sustain and enhance the incomes and poverty reduction in Pabna Irrigation and Rural Development Project (PIRDP) and Meghna-Dhonagoda Irrigation Project (MDIP) areas through reliable, cost-effective and sustainable riverbank erosion mitigation measures comprising adaptive riverbank protection works and a range of non-structural instruments to adapt to the morphological processes of the Jamuna and the Meghna rivers. It is implemented from October 2002. The Project scope comprises the following three parts:

Part A: Riverbank Protection Works:

7.0 km and 4.4 km of geotextile bag launching revetment in PIRDP and in MDIP, with technical verification of the design and implementation approach for revetment using sand-filled geotextile bags.

Part B. Nonstructural Erosion Impact Mitigation

(i) Improved DPMP; (ii) Affected persons resettled, and living standard improved for households living on the embankments and along the riverbank

Part C. Institutional Strengthening

(i) Capacity development of participating agencies and stakeholders, and project management at project level and central level; (ii) Operational riverbank erosion information management, including monitoring, forecasting, and warning of riverbank erosion

2) Flood and Riverbank Erosion Risk Management Investment Program (FRERMIP)

FRERMIP is a project with BWDB and DDM as implementing agencies for community-based flood risk management measures. The program is implemented in two tranches: Tranche 1(2014-2021), Tranche 2 (2021-2024). FRERMIP aims at sustaining incomes and livelihoods of people living along the fore-mentioned three main rivers by enhancing resilience to flood and riverbank erosion.

The project area of FRERMIP comprises about 244,316 ha of which approximately 15% consists of water bodies. The Project will cover the length of around 60.00 km of the Jamuna, around 20.00 km of the Ganges, and around 100.00 km long Padma reach. The hydrology of the area is dominated by the three major rivers: Jamuna, Ganges and Padma. The project will cover a total population of 10.50 million (2011 census) in 40 upazilas and 431 unions, with an average population density of nearly 1,600 persons per km^2 of floodplain land. Figure 4.2.6 shows FRERMIP study areas. After initially protecting critically eroding riverbanks at priority sites (Tranche 1), the program moves to more systematic riverbank stabilization in Tranche 2, which will potentially be contributing towards river-reach stabilization to be completed in following projects with a time horizon of 2040. The Tranche 2 interventions are planned to finish by 2024. The following is a brief introduction to the achievement of FRERMIP in Tranche 1 from 2014 to 2021 and key data for the project in Tranche 2 project until June 2024.

(a) FRERMIP Tranche 1 (2014-2021)

Proposed interventions under Tranche 1 fall into three categories: (i) riverbank protection, (ii) new and rehabilitated flood protection embankments, (iii) drainage regulators. The Tranche-1 is already being implemented. The main components of tranche-1 as shown in the Figure No. 4 are:

(a) Riverbank Protection work at Chauhali, Dist. Sirajgonj: 7.00 km

(b) Riverbank Protection work at Zaforganj, Dist. Manikganj: 2.00 km

(c) Riverbank Protection work at Harirumpur, Dist. Manikganj: 8.80 km,

(d) Construction/Reconstruction of Embankment along the left bank of Jamuna River and right bank of Baral-Hurashagar river from Kaijuri to Verakhola u/s Reach, Upazila-Shahjadpur, Dist. Sirajganj: 21.30 km,

(e) Construction of Regulators in Upazila-Shahjadpur, Dist. Sirajganj: 4 Nos.

(f) Embankment slope protection piloting works in Upazila-Shahjadpur, Dist. Sirajganj: 3.10 Km

(g) Riverbank slope protection piloting works at Harirumpur, Dist. Manikganj: 1.20 Km.

(b) FRERMIP Tranche 2 (2021-2024)

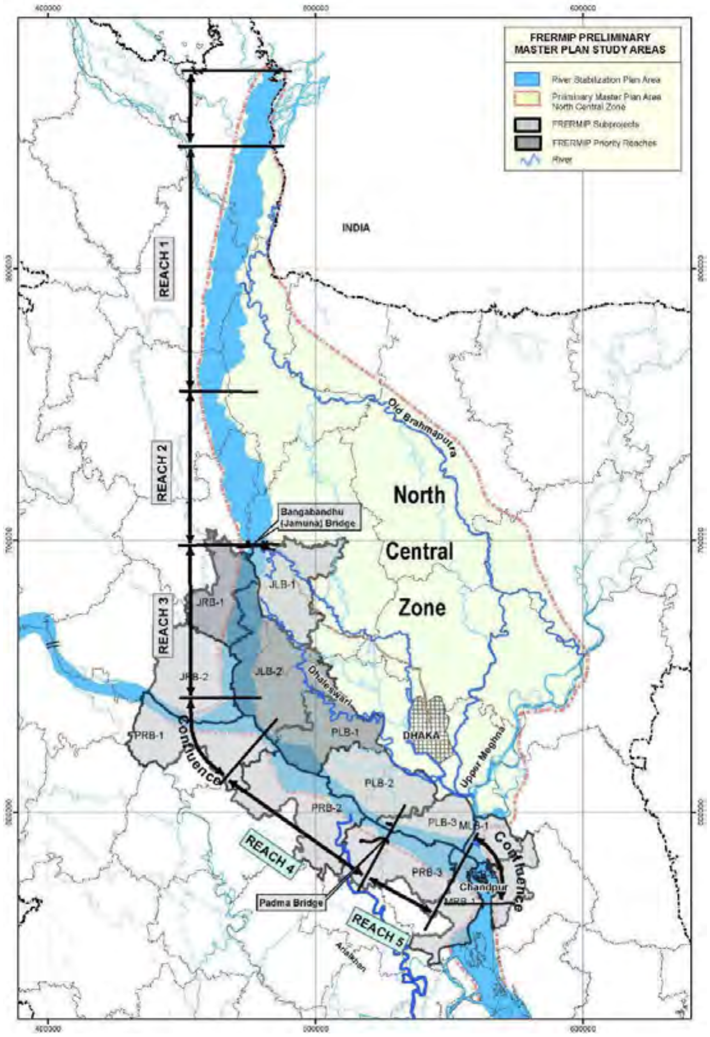
Project outputs from Tranche 2 will (i) strengthen the flood and riverbank erosion management system, and (ii) establish, at priority erosion sites, sustainable, integrated nonstructural and structural risk management measures. Interventions under Tranche 2 will build on the previous achievements in Tranche 1 in the following areas:

(a) Stabilization of the bifurcation through the construction of riverbank protection at Enayetpur (JRB-1) and upstream Chauhali (JLB-2)

(b) Reduction of an eroding channel and reclamation of charland at Solimabad (JLB-2)

(c) Halt ongoing erosion at Benotia (JRB-1) and upstream of Harirampur (PLB-1)

The financial arrangements for the Tranche2 comes from the Asian Development Bank (US$ 157 million), Government of Bangladesh (US$ 37.91 million) and the Government of the Netherlands (US$ 17.89 million). Focus of works are along the Jamuna-Padma River corridor, from Jamuna bridge to confluence with Meghna River at Chandpur (Reaches 3, 4 and 5 as in Figure 4.2.7). The following Table 4.2.15 shows key specifications of the Tranche 2.



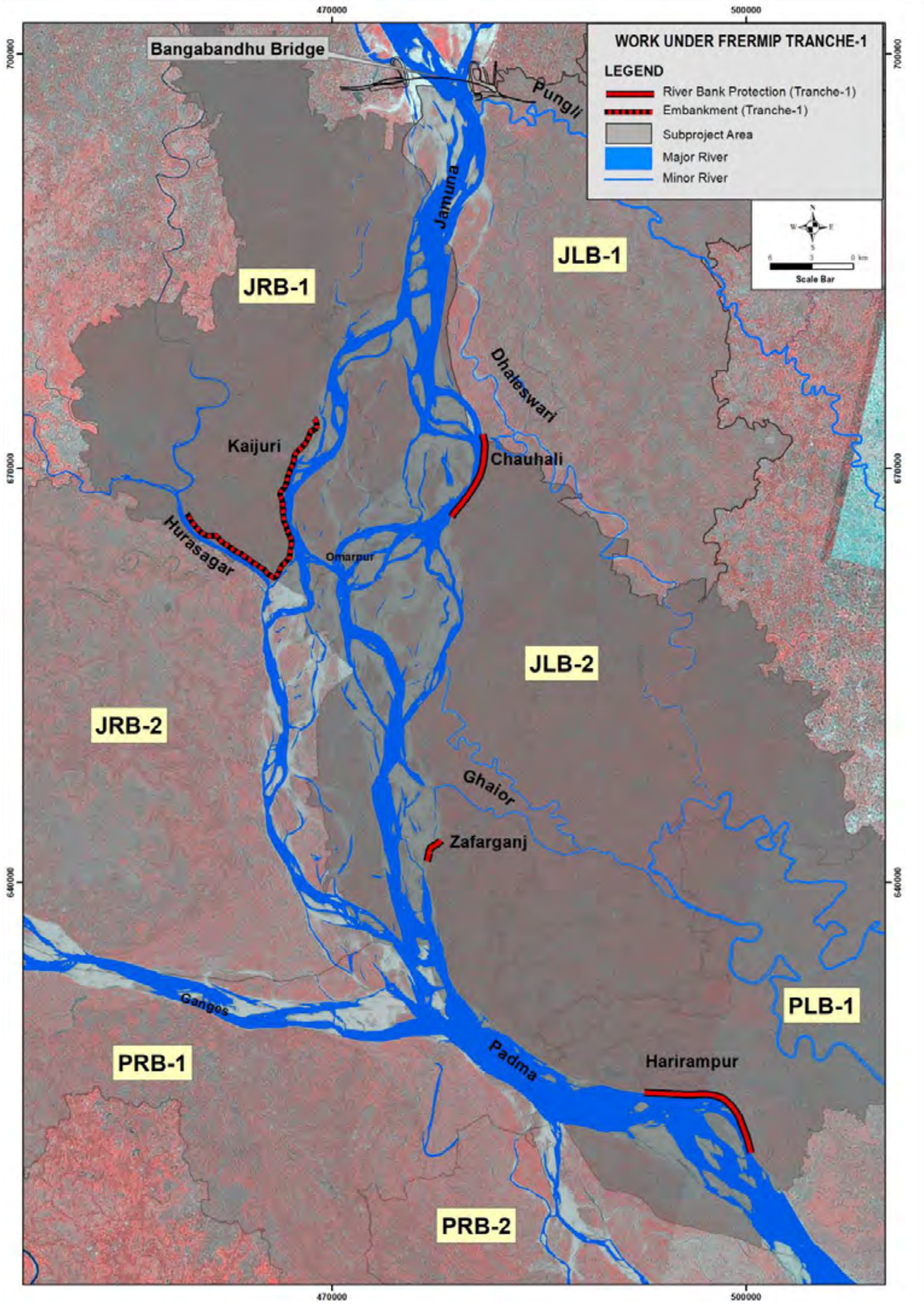
Source: Flood and Riverbank Erosion Risk Management Investment Program Project-2, Document No. FRERMIP-T2-ES-P-EIA-05, Prepared by BWDB, ADB, NHC-EMV

Figure 4.2.6 FRERMIP Study Area

Table 4.2.15 Key Specifications of the FRERMIP Tranche 2

	km^2	ha
Total Area of all Sub Projects	9,292.3	929,230
FRERMIP SPs (JRB1, JLB2): Total Area	1,794.1	179,409
FRERMIP SPs: Agricultural Benefit Area	317.8	31,779
FRERMIP SPs: Population		2.6 million
FRERMIP SPs: Population Density		690/ km^2
FRERMIP SPs: No. of Households		2.03 million
FRERMIP SPs: Average HH Size		5.2
Master Plan Total Area	15,950.0	1,595,000
Master Plan Agricultural Benefit Area (flood risk mitigated)	5,000.0	500,000
Land Reclamation Area in River Corridor, Total	1,500.0	150,000
Land Reclamation Area in River Corridor, FRERMIP	660.0	66,000

Source: Flood and Riverbank Erosion Risk Management Investment Program Project-2, Document No. FRERMIP-T2-ES-P-EIA-05, Prepared by BWDB, ADB, NHC-EMV



Source: ADB/BWDP Semi-annual Environmental Monitoring Report for Project No. 44167-014 June 2019

Figure 4.2.7 Location of Interventions of the project FRERMIP, Tranche- 1

3) Southwest Area Integrated Water Resources Planning and Management Project

ADB has provided finance for participatory water management projects for small-scale schemes since 1995. The schemes have demonstrated success in improved infrastructure performance through beneficiary participation. To extend integrated and participatory water management to large-scale FCDI schemes, in 2005 ADB approved a $20 million equivalent loan for the current Southwest Area Integrated Water Resources Planning and Management Project. The project also received co-financing from the Government of the Netherlands. The project supports the establishment of participatory water management organizations (WMOs) with the inclusion of socially disadvantaged groups; integrated water resources management planning; infrastructure renovation; and coordinated support services for WMOs in the two pilot subprojects, comprising the Narail and Chenchuri Beel FCDI schemes with a total area of 57,000 hectares (ha). The expected outputs of the projects are as follows:

Output 1: WMOs" capacity for sustainable water resources planning and management in the subproject areas strengthened

Output 2: Infrastructure facilities of FCDI schemes in the subproject areas are restored

Output 3: Institutional capacity for sustainable participatory integrated water resources planning and management strengthened

4) Participatory Small-Scale Water Resources Sector Project

The project will develop 230 subprojects in the areas of flood control, drainage, and irrigation. It will strengthen the capability of agencies overseeing the sector, and develop water management cooperative associations that will undertake the day-to-day operations of small-scale water services. The project is in the third phase since 2009.

The Project builds on lessons from previous ADB investments in the small-scale (less than 1,000 hectare) water resources sector; specifically, the Small-Scale Water Resources Development Sector Project (SSW 1), which was implemented from 1996 to 2002 and developed 280 subprojects in the western part of the country. Also, the Second Small-Scale Water Resources Development Sector Project (SSW 2), which commenced in 2002 and is due to be completed in 2009. This has developed 275 subprojects in 61 of 64 districts of Bangladesh.

The Project will support the development of inclusive water management cooperative associations (WMCAS) that include landowners, land operators, women, fishers, and other vulnerable groups. The Project will have three outputs:

Output 1: Institutional Strengthening: Enhanced institutional capacity and capability of government agencies at all levels that support SSWR development

Output 2: Participatory Subproject Development: Refinement of subproject development process for sustainable WMCA that are performing well.

Output 3: Small-Scale Water Resources Infrastructure and Project Implementation Support: Construction and maintenance of small scale water resources subprojects

5) Secondary Towns Integrated Flood Protection Project

The Project for integrated flood protection covers nine secondary towns in Bangladesh: Brahmanbaria, Gaibandha, Jamalpur, Kushtia, Manikganj, Munshiganj, Mymensingh, Rajshahi, and Sunamganj. The selected towns are prone to river flooding, river erosion, waterlogging, and flash floods. The poorer income groups, especially recently settled dwellers, are the most vulnerable to disaster. The integrated approach, combining river protection works with drainage and basic sanitation services, is appropriate for the urban areas in Bangladesh, which are prone to frequent river flooding, particularly in low-lying areas with poor drainage systems. The project started in 2006 and scheduled for completion in 2012.

Output: Flood protection facilities, Improved drainage systems, Urban environmental improvements, Improvement of basic amenities in urban slums, and Urban governance improvement through UGIAP implementation

6) Climate and Disaster Resilient Small-Scale Water Resources Management Project

This proposed project aims at enhancing the climate and disaster resilience of small-scale water resources infrastructures and services and introducing agricultural value chains.

The project beneficiaries will be small-scale farmers who will benefit through increased yields and adoption of climate resilient crop varieties/management practices provided by the project. The project will improve agricultural productivity and profitability through effective, participatory, and sustainable SSWR management within the selected project locations with the following outputs and interventions.

Output 1: Participatory subproject development improved

Output 2: Small-scale water resources infrastructure with climate and disaster resilient features developed or enhanced

Output 3: Upazila- and WMCA-level value chain development activities prepared and implemented

7) Climate Resilient Livelihood Improvement and Watershed Management in Chittagong Hill Tracts Sector Project

The proposed project will take a holistic approach to improve livelihoods and sustainable use of natural resources in the Chittagong Hill Tracts (CHT). It will do so by addressing selected deficiencies in all five forms of capital that are lacking in the CHT. Specifically, the project will address physical capital by improving roads and bridges, water supply and sanitation and irrigation schemes, market facilities, and providing agricultural equipment. It will build human capital by improving vocational skills in the rural non-farm sector related to agriculture value chains and developing capacity of the CHT institutions and stakeholders. Social capital will be improved by strengthening the local government institutions to continue the system of participatory planning and implementation of subprojects that has been established under the Second Chittagong Hill Tracts Rural Development Project.

(2) Summary

ADB has been working on riverbank erosion control of the Jamuna, Padma and Meghna rivers through the implementation of several projects. ADB has been trying to establish a cost-effective and adaptive approach using geotextiles as a bank protection method, but it is not yet fully established due to remaining issues in terms of strength and maintenance system.

On the other hand, in rural areas, in addition to implementing projects for flood protection and drainage improvement in nine cities across the country under the Integrated Flood Project for Small Cities, small-scale water resource development projects are being implemented on an ongoing basis, focusing on the development and improvement of water management infrastructure and capacity building of organizations in rural areas.

4.2.3.4 Government of the Netherlands

(1) Past Achievements

Since the independence of Bangladesh, the Government of the Netherlands has provided various development assistance to the country in the form of technical cooperation and infrastructure development in flood management, river management, coastal management, water supply, water sanitation, and land conservation along water bodies in the context of IWRM. In terms of river management, the Netherlands Government has made a contribution in Bangladesh in the field of land reclamation and development of char. The result is delivered through CDSP-I, CDSP-II, CDSP-III and CDSP-IV. These projects have benefitted thousands of landless people through rehabilitation. They also provide a great contribution in the formulation of Bangladesh Delta Plan 2100.

(2) Summary

Initially, the field of cooperation was mainly focused on infrastructure projects such as embankment and polder construction in coastal areas, but in recent years, it has gradually shifted to technical capacity building and organizational strengthening. According to the interviews conducted in the survey, water management projects that are linked to the improvement of agricultural productivity were mentioned as a future prospect, and responses to climate change were also mentioned as a direction that should be addressed as a priority. Therefore, it is assumed that projects in line with these directions will be implemented as a priority in the future.

BDP 2100 is an extremely important achievement from the perspective of setting a long-term direction for water management in Bangladesh. However, it needs to be continuously reviewed and updated in light of the lack of detailed consideration of the appropriateness of future projects, target areas, and implementing entities, as well as its adaptive approach to review the plan according to climatic conditions and the progress of infrastructure development.

4.2.3.5 Other Donors

(1) Danish International Development Agency: DANIDA

Danish International Development Agency (DANIDA) has been assisted the development of flood forecasting and warning system in Bangladesh through several projects. During the period 1989 and 1994, a hydrological and hydraulic approach was applied under the FAP10 project named ‘Extension of Flood Forecasting and Warning Services’. In this project, the MIKE 11 modeling technique, which is still currently core of the flood forecasting system in Bangladesh, was applied and 16 water level forecasting points were established for its operation. During the period between 1995 and 1999, another DANIDA project was conducted with the aim of 1) development of MIKE11 supermodel with GIS, 2) expansion of water level forecast points, 3) arrangement of flood warning manual, and 4) staff training for the operation of the flood forecasting model.

In 2000, a further DANIDA-funded project ‘Consolidation and Strengthening of Flood Forecasting and Warning Services (CSFFSP) Phase-II’ was launched. The expected outputs were 1) expansion of flood forecast to all flood prone areas in Bangladesh, 2) improvement of accuracy and lead time of the forecasting model, 3) improvement of dissemination, 4) technology transfer, and 5) making suggestions for establishment of sustainable institutions.

(2) USAID

The Climate Forecast Applications in Bangladesh project was supported by USAID/OFDA. Under the project, the medium range probabilistic flood forecast with 10-days lead time was initiated to a limited number of places (18 stations) on experimental basis. After the termination of the support from the USAID-CARE, this has been continued with technical support from RIMES. Another initiative was started in July 2012 to expand the number of points for medium range 10-days probabilistic flood forecast with a view to increase the areal coverage, along with a long range seasonal flood forecast at 5 places on experimental basis with support from USAID through CARE-Bangladesh under SHOURHARDO-II programme with technical support from RIMES. Currently FFWC is experimentally generating medium range 10-days probabilistic flood forecast in 37 stations during monsoon and disseminating on a limited basis.

(3) UK Government

The UK Government has been assisting the Government of Bangladesh via projects in the aspect of DRM through its agency known as Department for International Development (DFID).

In 2011, through the Climate Change Programme in Bangladesh DFID allocated a budget of £75 million for DRM relevant aspects. The programme contributed in building resilience through improving early warning systems. It furthermore increased awareness amongst local communities. DFID supported communities by providing cyclone shelters, raising homes above flood level and trialing new ways of producing food to protect people’s livelihoods. In a follow-up report published in July 2013, it is noted that DFID had allocated an additional £123 million to funding Bangladesh’s response to climate change. DFID’s objective for this finance was that the ‘number of people with increased resilience to climate change and improved ability to respond to and recover from natural disasters’ would be at least 15 million by 2015.

In June 2020, the UK government announced that DFID and the Foreign and Commonwealth Office would be merged into the Foreign, Commonwealth and Development Office (FCDO).

In 2021, the UK announced its commitment to supporting Bangladesh along with other countries in the aspect of Disaster Resilience and Risk Management. It announced a package of new UK support for this approach. The Package involves:

- ✓ £1.8 million for funds in Bangladesh to help national and international NGOs anticipate and react to disasters.
- ✓ £1.3 million to the Start Network for civil society projects to develop disaster risk finance systems.
- ✓ Technical Support to the Centre for Disaster Management to assess levels of pre-arranged finance ahead of crises, and to identify opportunities for future growth in this sector.

(4) NORAD

Norway is assisting Bangladesh through collaborative efforts with multiple agencies. The assistance usually is on an emergency basis during disasters. Since 2018, NORAD (Norwegian Agency for Development Cooperation) has been providing funds for a UN Joint Project. It aims to address cooking fuel needs, environmental degradation and food security for populations affected by the Rohingya crisis. The Government of Norway has signed an agreement to provide NOK 92.0 million (about USD 14 million) worth of assistance for the project.

In 2007, Norway had offered a grant of about 3.27 million US dollars for the cyclone victims of Bangladesh. In 2010, it had committed 100 million Norwegian Kroner (about USD 15 million) towards the Comprehensive Disaster Management Programme for 2010-2014.

(5) SDC

Swiss Agency for Development Corporation (SDC) has conducted several technical and financial projects in Bangladesh in the field of DRR-CCA. In 2007, the Swiss government and charities sent aid to the survivors of the cyclone in Bangladesh. The total aid valued at 850,000 Swiss francs (about 760,000 USD). It was to support efforts by the local Red Crescent Society to provide those in need with food packets, drinking water and medicine. In 2012 Switzerland provided a grant of USD 8.6 million for the Bangladesh Climate Change Resilience Fund (BCCRF) in order to help Bangladesh better cope with the adverse impacts of climate change, and to carry out climate change adaptation and mitigation measures. The objective behind this support was to help Bangladesh to implement the Bangladesh Climate Change Strategy and Action Plan (BCCSAP), which aims to build a climate resilient and low carbon economy (See 4.7.1.2).

SDC plans to contribute towards a more robust policy and legal frameworks that are implemented in a participatory manner. Its activity will cover better information management, higher awareness as well as stronger capacities to adapt to climate change, reduce disaster risks and improve both water resources and solid waste management.

(6) SIDA

Sweden has provided development assistance to Bangladesh since the country became independent in 1971. Swedish International Development Cooperation Agency (SIDA) primarily collaborates with local agencies in Bangladesh or through programs under major development agencies. The primary type of assistance SIDA provides are monetary funds as well as technical support through professional expertise.

In 2007, during cyclone Sidr, SIDA provided financial assistance to NGOs (SEK5 million (about 700,000 USD)), UNICEF (SEK2 million (about 300,000 USD)), and Swedish Red Cross (SEK10 million (about 1,300,000 USD)) to support humanitarian relief efforts. Sweden has supported the implementation of UNDP's CDMP in Bangladesh. The programme aimed to reduce vulnerability to hazards and extreme events, including impacts of climate change.

Sweden's current cooperation strategy for Bangladesh covers the period 2021–2025 and comprises a total of SEK 1.75 billion (about USD 230 million). Climate change, disaster risk management and environmental issues have been a top priority for SIDA.

4.2.4 Issues in Current Efforts

4.2.4.1 Lack of a Basin-wide Flood Management Approach

As shown in 4.2.1.3, through river management efforts from the Krug Mission in the 1950s to the National Water Management Plan in 2004, the concept of water management has shifted from the development of large-scale structures with a primary focus on flood control and irrigation to more comprehensive water management that takes into account the impact on multiple sectors. However, although the National Water Management Plan stipulates the priority programs in water policy from a macro perspective, there is no description of specific project plans to be undertaken. Since Bangladesh is located downstream of the huge river basins of Padma, Jamuna, and Meghna, it is affected by the implementation of projects in neighboring countries such as India and other countries, and changes in hydrological and climatic conditions. Therefore, it is difficult to prioritize projects and systematically assess their manner.

Given the above background, Bangladesh has so far emphasized the approach of forming and implementing projects based on the needs that emerged from the situation at the time, rather than planning the projects to be implemented. In consultation with the BWDB, it has been confirmed that the process of selecting specific projects is mainly based on reports and recommendations from residents and local representatives, understanding of the situation through maps and satellite photos, and field verification of vulnerable areas, damaged sites and critical infrastructure. As a result, there is a possibility that the embankment construction and dredging projects conducted in one location may increase the risk of damage in another location. This is also pointed out in BDP 2100. For example, when the clogging of drainage channels becomes a problem in coastal plains, sediment dredging at the point in question is carried out, but the underlying problem may be an excessive supply of sediment from hilly areas in the upstream region.

In order to resolve this situation, the importance of a planned water management approach has been highlighted in the FR2 management strategy of BDP 2100. Particularly in the hilly areas of Chattogram, the planned water management approach on a catchment basis has been identified as a priority issue, and it states the need to develop a basin-wide management plan that takes into account integrated sediment erosion control, reforestation, and integrated management of rivers and hilly areas.

The necessity of comprehensive basin-wide management planning for the Chattogram region has been identified as a key issue for the Government of Bangladesh, and integrated river management in the Chattogram hills has been proposed in the management strategy of BDP 2100. Basin-wide management plans for the Karnaphuli, Sangu, and Matamuhuri river basins are currently being developed. However, in the formation of the current flood control and riverbank erosion control projects, there is a lack of objective prioritization of each project in the watershed and a quantitative perspective to examine the mutual impact of each project from a scientific and engineering perspective. The characteristics of steep river basins in the Chattogram hills are similar to those of river basins in Japan, and there is a possibility to utilize the river planning theory practiced in Japan, such as the consideration of flood control facilities based on the definition of the design flow rate at each point in the basin and its distribution.

Under the "Project for Strengthening Planning Capacity and Technology Adaptation Cycle for Comprehensive River Management" currently being implemented by JICA, one river basin will be selected from the above-mentioned three basins and its flood management plan will be developed as a pilot activity. Establishing good practices for implementing projects based on flood management plans with an integrated view of the basin will be beneficial for future water management in Bangladesh.

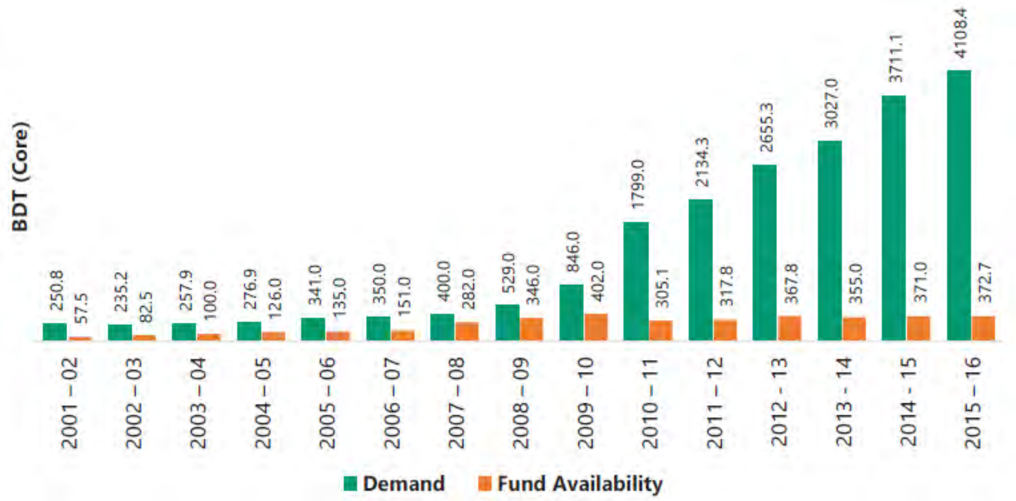
4.2.4.2 Vicious Circle in Construction, Rehabilitation and Repair of River Structures

One of the major problems in water management in Bangladesh is the failure to reduce repeated damage despite investing a large amount of budget in the rehabilitation and repair of embankments damaged during floods. If river structures such as embankments are constructed strongly, the possibility of damage should be low, but although guidelines have been established, they are not always followed. As a result, river structures with low durability are constructed, damaged by floods, and then inadequately repaired due to a lack of budget to ensure strength during restoration, resulting in a vicious cycle of repeated damage.

One of the reasons for the problem of not being able to ensure the durability of river structures is that there is widespread awareness that facility specifications are determined at the discretion of the site since the location of embankments is not properly set at the time of planning taking into account the local building and land use conditions. There is also a lack of awareness of the need to comply with the guidelines. In addition, there is no mechanism for managing the construction process, making it difficult to ensure durability. This will be explained further in 4.4.4. In addition, the current difficulty in predicting changes in the river channels of the three major rivers has led to large-scale riverbank erosion and bank failure.

BWDB is also aware of the lack of regular maintenance activities targeting the embankments, and the reason for this is the lack of funds to cover the inspection and maintenance of the large length of embankments in Bangladesh. BWDB has developed seeveralinfrastructures across the country over the years, but for these infrastructures to continue to function, they need regular monitoring and proper maintenance. Even though it is obvious that a considerable amount of funds are required every year for proper maintenance and management, Figure 4.2.8 shows that BWDB has only been able to secure about 10% of the required funds. Most maintenance activities are suffering from a shortage of funds, resulting in a situation where structures deteriorate and become increasingly damaged, requiring more funds for further major repairs.

The cycle of spending more on post-disaster repairs is similarly problematic for submerged levees used in flash flood-prone areas in the northeast. The purpose of submerged embankments is to protect Boro Rice from flood damage during the pre-monsoon season, and because the design external forces are set lower than those of full embankments, construction is based on the assumption that a certain degree of overtopping damage will occur during the monsoon season. In addition, submerged embankments are sometimes artificially cut to draw in water for agriculture and securing transportation routes by boats, which causes deterioration in the strength of the embankment. Thus, the durability of the levees cannot be ensured due to the structure assuming overtopping damage during the monsoon season and artificial modification of the structure, resulting in repeated damage and repairs in the next flood season, and a large budget is spent every year.



Source: BDP2100

Figure 4.2.8 Required and Actual Budgets for Maintenance Activities in BWDB

In Bangladesh, co-existence with floods is the underlying principle, and the concept of flood management is based on the assumption that damage will occur to some extent. This has sometimes resulted in a situation where levees have not been constructed according to standards and quality has not been ensured. Improving this situation and ensuring high-quality facility design and construction has the potential to significantly reduce human and economic damage, as well as save huge amounts of structural maintenance and repair costs. One factor that could improve the quality of levees is the management of the compaction process. Details are discussed in 4.4.4.3.

As a measure to strengthen levees to cope with flash floods that occur in rivers along the northern and eastern borders, there is room to consider applying the revetment type introduced in Moulvibazar District under the past JICA technical cooperation project "Capacity Building for Sustainable Water-related Infrastructure Development" to small and medium-sized rivers in other regions after confirming its effectiveness in preventing erosion. In the said project, conventional concrete block revetments were modified on a pilot basis to reduce flow velocity and minimize the impact on the land behind the revetment.

The BWDB Water Resources Management Advisor (JICA expert) conducted a field survey in 2022 for the Manu River and found that the embankment revetments installed at that time were generally in good condition. At the same time, however, the following points are noted:

- ✓ Vegetation growth on embankment and revetment
- ✓ Lateral and vertical displacement of concrete blocks
- ✓ Formation of char upstream of the construction site
- ✓ Embankment settlement exceeding expectations

Based on the results of the above study, it is recommended that the effectiveness of the erosion control measures be confirmed through a more detailed evaluation of the safety of the embankment and a comparative study with conventional forms of the revetment. After that, it is desirable to identify issues and then consider the implementation of necessary improvement measures and deployment to other areas. If the advantages can be clarified through the comparative study process, it is expected to motivate the relevant organizations to ensure the quality of construction and compliance with the guidelines.

Also, in the submerged embankments adopted for flood protection during the pre-monsoon season in the region, there is room for further study on the optimal structural form based on durability against repeated inundation from the perspective of reducing maintenance costs.

In addition, it is expected to save budget and human resources by reducing the number of damage cases. River maintenance management in Japan has been developing and introducing new technologies in line with the rapid development of ICT technologies. For example, drones can be used to patrol rivers, three-dimensional point cluster data can be used to understand the shape of embankments, laser surveying can be used to determine sediment deposition in river channels, and tablet terminals can be used to record and create databases of patrol and inspection details.

4.2.4.3 Lack of Understanding of Future Risk Areas and Prior Investment

Bangladesh has been experiencing remarkable economic growth in recent years, with the development of new areas and the establishment of industrial parks in the coastal areas, especially in the Big-B initiative area. On the other hand, the development of flood management measures for these new areas has not yet been fully developed. As indicated in 4.2.4.2 above, the main reason for this is that the budget and manpower to deal with the immediate repair and restoration works are overwhelming, making it difficult to secure funds for future investments in risk areas. Based on the coordination with SFDRR, Bangladesh is in the process of shifting its disaster management policy from relief-oriented disaster response to proactive disaster risk reduction. However, the process of instilling the concept of proactive investment into the existing water management practices of living with floods and allowing them to occur is still in its early stages. In addition, future risk areas have not been identified and investment priorities have not been organized.

A comprehensive disaster risk analysis is required to prioritize priority areas for future investment in risk areas, and the disaster risk analysis conducted in this survey falls under this process and will help in the consideration of future investment plans. In the future, it will be desirable to secure funds for prior investment based on the country's budget due to Bangladesh's economic development, but for the time being, it is necessary to promote the introduction of disaster risk reduction in key areas of economic development by utilizing funds from international development agencies.

4.2.4.4 Difficulty of Implementation of River Management Projects in Urban Areas

In urban rivers, there are some cases of embankment projects along urban areas, but their implementation has not progressed. For example, in Cox's Bazar in 2020, a flood control project was implemented for the

Bakkhali River, which consisted of a 28 km dredging project and a total of 4.6 km of bank protection works. Initially, the construction of embankment was also included in the scope of the project, but its implementation has been postponed due to lack of funds for land acquisition. In Chattogram, the need to construct levees for flood protection in the urban section of the lower Karnaphuli River has been recognized by the relevant agencies. However, although CDA has made progress in the construction of levees in some sections (Kalurgat Bridge to Chaktai Khal) (see Figure 4.3.4 below), no progress has been made in the sections downstream of that. According to the BWDB-Chattogram office, the embankment project has been conceived, but land acquisition has been a bottleneck and construction has not been feasible. A basic survey of BDP 2100 indicated that there are no laws or ordinances in Bangladesh that envisage the process of consultation with affected communities, and that there is no clear rationale or policy regarding compensation and resettlement. In the case of financial cooperation projects supported by overseas donors, even if the laws and ordinances in Bangladesh are unclear as described above, resettlement may proceed by compensating for land acquisition in accordance with the stipulated guidelines. Even in this case, however, the burden on local residents due to resettlement is significant.

As a fundamental solution to the above-mentioned land acquisition problems, it is desirable to improve the system for compensation and resettlement. However, given the lack of progress in improving the situation despite the recognition of the problem, early improvement is not expected. On the other hand, flood risk management in urban areas, where assets are increasingly concentrated, is an urgent issue. Therefore, in implementing river projects in urban areas, it is necessary to explore the possibility of introducing technologies that take into consideration the impact on land acquisition. As an example, it may be effective to install specific embankments using steel sheet piles, which are used in the construction of urban rivers in Japan and other countries, to ensure the durability of river banks and the cross-section of the river channel while reducing land acquisition.

4.2.4.5 Establishment of Effective Methodologies for River Channel Management in Large Rivers

In Bangladesh, sediment runoff from the vast upper reaches of the three major rivers and riverbank erosion caused by heavy rainfall in the basin have been long-term problems, and although it is necessary to carry out fundamental river channel stabilization in parallel with the implementation of flood control measures, it is extremely difficult to stabilize and control the river channel and to identify the location of riverbank erosion due to the large size of the rivers and the lack of clarity on the mechanisms of channel dynamics.

Even when strong embankments are constructed, they collapse from their foundations. Due to technical difficulties, no effective countermeasures have been established at present, and much expense has been spent on repairing the river banks after erosion has become apparent.

Most areas along the three major rivers are affected by riverbank erosion and sedimentation, but the northern areas near the Indian border are particularly severely affected. Kurigram district, which is located in an area surrounded by Brahmaputra and Teesta Rivers, is highly vulnerable to riverbank erosion. Residents are heavily dependent on traditional agriculture for their livelihoods, but many of them suffer greatly from the loss of land along the river channel as well as frequent flooding, and the area is considered to have one of the highest poverty rates in the country. According to the field survey, the Teesta River has been shifting its channel to the left bank year by year, threatening the livelihoods of local residents with riverbank erosion. In this area, large sediment inflows from India have exacerbated flood damage by raising the riverbed. On the other hand, the river has a higher velocity due to the higher gradient of the riverbed compared to the downstream section in the southern part of the river, making it more prone to large-scale riverbank erosion.

Erosion situation on the left bank of Teesta River in Kurigram District (River bank approaching residential area)	Erosion situation on the left bank of the Teesta River in Kurigram district (Emergency restoration is being done with geobags)
	
Erosion situation on the left bank of Teesta River in Kurigram district (Damage to concrete block revetment)	Erosion of the left bank of the Teesta River in Kurigram District (Threatened loss of farmland due to riverbank erosion)
	
Erosion situation on the right bank of the Jamuna River in Kurigram district (Emergency restoration is being done with geobags)	Sedimentation in Jamuna River channel, Kurigram District (In some cases, residents who lost their land due to riverbank erosion have settled in the river channel and are engaged in agriculture)
	

Figure 4.2.9 The Situation of Bank Erosion Along Teesta and Jamuna Rivers (Taken on February 20, 2022)

Also, in the field survey along the Jamuna River, it was confirmed that emergency repairs using geo bags were widely carried out in the affected areas, but this did not provide a fundamental solution to control erosion, and there is a possibility that the damage will be repeated during the next monsoon season.

Erosion of the left bank of the Jamuna River in the Shivalaya district	Erosion of the left bank of the Jamuna River in the Shivalaya district (Geovags are being used for temporary repairs, but erosion appears to be progressing.)
	
River bank erosion near Paturia Ferry Terminal, Shivalaya District	Erosion of the left bank of the Jamuna River in the Shivalaya district (There is a collapse near the surface of the water at the site repaired by Geobags.)
	

Figure 4.2.10 The Situation of Bank Erosion Along Jamuna River (Taken on November 7, 2021)

While it is widely recognized that riverbank erosion is a major problem, drastic measures have not been established so far, including by other donors, due to the technical difficulties in finding a fundamental solution. However, in addition to the protection of vulnerable communities along the river, the stabilization of the river channel is an important issue that should be addressed with priority in order to avoid wasting investments in further land use development and future DRR projects.

A paper published[18] recently on 27 October 2020 by a BWDB official and two other coauthors from a lead consultant company involved in FRERMIP (See 4.2.3.3) reviewed "A Century of Riverbank Protection and River Training in Bangladesh". Challenges of Training Rivers and Protecting Riverbanks in the Bangladesh Delta have been summarized in the paper as follows:

(1) Hydrogeology and Seismology

- ✓ Bangladesh is a downstream country and covers less than 10% of the Ganges Brahmaputra basin with less influence on upstream basin areas. Moreover, Bangladesh is strongly affected by sea level rise and tidal effects.
- ✓ The huge fluctuation of river flow in monsoon and dry seasons. River discharges can change by 20-fold or more during the monsoon season, and water levels can rise by up to seven meters during the

[18] http://dx.doi.org/10.3390/w12113018

dry season.

- ✓ Bangladesh is affected by seismic activities in the eastern Himalayas. Lots of sediment load has been transported to Bangladesh due to the big earthquake in Assam. No major earthquake has hit Bangladesh in the last 70 years. However, this may happen anytime.

(2) Planning and Budget

- ✓ Bangladesh river morphology is difficult to predict, and future channel latitude and longitude profiles are not easy to determine. So, there is a high possibility that a planned location for riverbank protection needs to be shifted hundreds of matters downstream or upstream due to river course changes. There are sometimes long processing periods between identifying an erosion-prone site and the construction. While the location of the riverbank protection is fixed in all official documents, in such a lengthy period, the river continuously changes.
- ✓ Only about 10% of the required budget is allocated for operation and maintenance as well as monitoring, evaluation, and adaptation of constructed riverbank protections.

(3) Design and Implementation

- ✓ Lack of rocks and large stones for riverbank protection works. There is only one granite mine that extracts limited amounts of rock from hundreds of meters below ground level and it is too small for riprap and armor layers.
- ✓ Soil particles are fine and easily washable. The soil structure is the result of different deposition layers, mainly a mix of poorly graded sands, silts, and some mica. There is a high potential for liquefication of topsoil during an earthquake and riverbank slope failure is a common phenomenon. There is not much accurate and reliable information on subsoil due to an inadequate number of scattered boreholes.
- ✓ A low-velocity river could wash away fine bed and bank materials. So, high flow velocities during flood seasons could be more destructive and cause much deeper scouring of up to 30m of the riverbed in a vertical direction in a single flood event. Flood waves are typically limited to approximately 1 m in height.
- ✓ The technical paradox of heaviness and thickness of the riverbank protects and destabilizes slopes, particularly on weaker soils. The challenge is to design riverbank protection that is flexible enough and at the same time heavy enough to resist high flow or wave loading. A heavy protective layer is favorable in withstanding high-flow forces but could cause slope failure due to its heavy load.
- ✓ The difficulty of proper design and building a toe apron is one of the most critical components in the performance of riverbank protection. Aprons add an element of uncertainty due to the nature of flow and soil conditions, considering they are designed to protect geotechnically stable slopes.
- ✓ There is a limited time frame during dry season for project implementation. Even during the low flow season, the rivers remain morphologically dynamic and there might be a change in the construction site as mentioned in item 4 above.

(4) Monitoring and Evaluation

- ✓ There is a lack of proper survey and observations necessary for monitoring and evaluation of riverbank protections. Most of the surveys are concentrated on water levels and bathymetries. River discharge and sediment data are not collected regularly.
- ✓ Monitoring the deep and fast-flowing rivers remains challenging. The available data are acceptable for scour depth and underwater slopes studies, but not enough for risk-based designs. There is a need for systematic and regular scuba-diving investigations to understand the vast majority portion of the riverbank protection which are underwater.

(5) Learning by Doing and Adaptive Approach

- ✓ A flexible design approach for dynamic rivers is recommended considering "Knowledge-Based

Development to Drives Change" and "Learning by Doing" for studying major rivers in Bangladesh. A period of intensive knowledge-based development can produce new technologies and trigger significant changes.

- ✓ The Adaptive Approach for Sustainable Riverbank Protection is important and the followings are 8 main elements of the suggested adaptive approach:
  - Predicting river behavior in order to facilitate the planning process
  - Multi-year allocation of funds to river reaches
  - Design is driven by geotechnical considerations
  - Construction as per actual river requirement
  - Preparation of as-built drawing to document the initial construction of the works
  - Monitoring and evaluation
  - Adequate funds for adaptation works to be constructed
  - Maintenance for the long-term sustainability of the works

On the other hand, through the "Project for Strengthening Planning Capacity and Technology Adaptation Cycle for Comprehensive River Management", JICA aims to establish a river channel management approach to mitigate damage by understanding the mechanism of erosion in advance and controlling its occurrence by utilizing the natural features of the river channel, instead of the conventional post-disaster response. WB is also working to establish a vegetation-based revetment method based on the concept of nature-based solution (NBS) for the Jamuna River and will seek to establish a countermeasure method from a practical approach based on the experimental installation and improvement of semi-permeable water control systems. ADB has been cooperating in the riverbank erosion countermeasures for the Jamuna River since the 2000s. The first phase of the ongoing riverbank erosion and flood countermeasures project has been completed with 65 million USD, and now the second phase with 157 million USD is being prepared to start. The riverbank erosion countermeasures in this project are mainly based on the use of geotextile bags, which, as mentioned earlier, cannot drastically control erosion, but it is considered that they are seeking countermeasures based on an adaptive approach that follows the changes in the shape of the river channel.

In this way, it is important to consolidate the knowledge of river engineering from Japan and other countries, and to establish, disseminate, and deploy river channel management methods that are adapted to the characteristics of the river characteristic in Bangladesh. However, this is not an easy task and may require long-term efforts. Therefore, it is necessary to continue to share the engineering knowledge on river channel erosion, scouring, and sediment transport that Japan has cultivated through river management, as well as the effects and considerations in the application of water-control works, and to seek solutions through technical cooperation.

4.2.4.6 Inadequate River Management to Cope with Increasing External Forces Caused by Climate Change

In June 2022, the northeastern districts of Sylhet and Sunamganj were hit by floods of a magnitude rarely seen in recent years. The flood damage was mainly caused by overflows from major rivers such as the Surma and Kushiyara. The river flows in the region are largely influenced by rainfall in the upper portion of river basins located within Indian territory. On June 15, 2022, Cherrapunji rainfall station in the Meghalaya state of India recorded a rainfall of 972 mm/day, which is considered to be the third largest in the last 122 years. The three-day rainfall from June 15 to 17 was 2,456 mm/day.

The occurrence of such extreme rainfall events is attributed to changes in rainfall patterns due to climate change and thus it is expected that intense rainfall events of unprecedented magnitude such as this one will continue to occur in the future. In order to reduce the risk of flood damage from possible future large-scale floods, it is essential to properly manage existing river structures, including river channels, to maximize their capacity. In particular, river channels need to be widened, dredged, embanked, or short-cut to increase their capacity to convey water from the perspective of flood risk reduction.

In this effort, it is necessary to establish measures that are effective and sustainable in accordance with the hydrologic and hydraulic characteristics of the target area.

In the northeastern region where flood damage occurred this time, it is desirable to consider future river management measures based on the study of channel shape to prevent sediment deposition, the possibility of installing sediment trapping facilities, and the impact on the flow regime of major rivers by natural and human-induced intervention into Haor areas.

4.2.4.7 Difficlty of Improving Flood Forecasting System in Accuracy and Lead Time

Flood forecasting and warning services in Bangladesh are provided by FFWC under BWDB. The FFWC has built a monitoring and flood warning system covering about 80,000 km^2, almost two-thirds of the country. After the devastating floods of 1987 and 1988, the need to introduce flood forecasting based on river modeling was deeply recognized, and since then, flood forecasting models based on the MIKE 11 simulation model developed by the Danish Hydrological Institute (DHI) have been built and operated by the FFWC. The flood simulation is analyzed using five existing hydrological regional models (Northwest region model, North Central region model, Northeast region model, Southwest region model and Southeast region model). In the Chattogram region in the southeast, only a hydrological monitoring system has been established, and no flood prediction system has been established. However, a hydraulic model has already been developed to implement flood forecasting in the region, and FFWC plans to introduce a forecasting system in the future.

In this system, out of all water level observation data of 354 points, data of 110 points are used for flood prediction. In terms of rainfall, data from 74 out of 274 locations are used for flood forecasting. With these as input conditions, 61 forecast points are loacted. Monitoring sites will be increased at the request of local residents and representatives. The water level data are collected 5 times a day (every 3 hours between 6:00 and 18:00) from 86 stations during the rainy season from April to September, and rainfall information is collected once a day (9:00 daily). Data collection is done by SMS transmission by the observer, and the observation result is transmitted to the center. Water level prediction results are provided in the form of deterministic forecasts every 24 hours for up to 5 days in the future and probabilistic forecasts for up to 10 days in the future, with the former providing water level determinations based on real-time observations. The latter provides a range of values (Max, Min, Mid) based on ensemble predictions.

Given the above situation, the basic framework of the flood forecasting system has already been established, and the BWDB-FFCW will continue to improve itself in terms of expansion of lead times and enhancement of observation networks, and it is considered that it has the foundation to solve technical problems. Bangladesh, on the other hand, is located in the lower reaches of major rivers. Of the 1.70 million km^2 catchment area of the giant rivers of Ganges, Brahmaputra, and Meghna, only 8% is covered by Bangladesh. In order to improve the accuracy of flood predictions, cooperation of hydrological information with countries outside Bangladesh is essential. Since 1972, there has been an arrangement between India and Bangladesh for the sharing of flood data in Bangladesh, and in accordance with this arrangement and subsequent meetings at various levels between the two countries, Bangladesh continues to receive flood-related data from India on its transboundary rivers. The current arrangement stipulates that Bangladesh receives data sent by e-mail twice a day during the monsoon season.

Also, as explained in 4.2.1.3, a flash flood forecasting system for the pre-monsoon period of April-May in northeast Bangladesh has been piloted since 2017. This system has been developed as part of the program implemented by HILIP. The addition of facilities for flash flood monitoring and forecasting to the existing hydrological stations normally operating in the Northeast brings the number of water level stations and rainfall stations that can be reflected in flood forecasting to 31 and 25, respectively. The main feature of the prediction system is that it is coupled with the Bangladesh Meteorological Department's (BMD) Weather Research and Forecasting (WRF) numerical model, from which the rainfall-runoff is linked to the MIKE 11 hydraulic model to generate water level predictions. 25 sites are predicted. The system outputs predicted water levels at 12-hour intervals for the future 72 hours.

As described above, an early warning system for flash floods in the Northeast has been constructed on a trial basis, but issues remain in ensuring lead time, and accuracy. Because of the characteristics of steep river basins that cause flash floods, flood flows reach downstream areas in a short time, resulting in abrupt water level rise, it is important to obtain hydrological information on upstream areas occurring outside Bangladesh in order to improve the accuracy of forecast results and ensure lead times. As mentioned above, Bangladesh has an agreement with India, which provides water level data for some points and provides them as input conditions for prediction models. India, like Bangladesh, conducts manual observation and obtains data twice a day. However, considering the characteristics of flash floods, it is desirable to obtain rainfall observations more frequently, but at present, only one rainfall observation per day is obtained.

To extend the lead time and improve the accuracy of the flood forecasting and warning system, it is necessary to expand the coverage area of hydrological observations and increase the frequency of observation data acquisition, especially the collection of hydrological observations information outside Bangladesh territory. As stated above, although there are arrangements for sharing water level information between Bangladesh and India, the number of stations used for data sharing is very limited for large catchment areas, as shown below, and more gauge data is needed to improve existing flood forecasting systems and initiate basin-level flood forecasting. However, coordination for information sharing with neighboring countries is expected to take time, so a possible solution is to supplement the lack of spatial information by using radar rainfall, satellite rainfall, and other information to supplement areas where observation networks are insufficient. It is also desirable to install automatic flow measurement systems at the inflow points of border rivers to obtain observation information at a high frequency and early stage. However, the WB's ongoing projects are expected to improve the automation and frequency of hydrological observations. In addition, to extend the boundaries of the computational domain of the flood forecasting model to the upper reaches of the river, information on river channel cross-sections as well as water levels is necessary. These enhancements are expected to improve the accuracy and lead time at all existing sites.

For flash flood forecasting, which is currently being developed only in the Northeast region, consideration needs to be given to other areas where flash floods occur, particularly the Chattogram hills. As mentioned above, a hydraulic model has already been developed, but the Southeast region is deficient in terms of rainfall observation network compared to other regions, and it would be effective in the future to compensate for the lack of ground observation network by upgrading and updating the meteorological radar at neighboring Cox's Bazar station.

Table 4.2.16 Sharing of Water Level Observation with India

Basin	River Name	Station Name	Currently Shared Data
Brhamaputra	Brhamaputra	Dhubri	Water Level
		Goalpara	Water Level
		Pandu	Water Level, Discharge
		Guwahati	Water Level
	Dharla	Jaldhaka	Water Level
	Dudhkumar	Ghughumari	Water Level
Teesa	Teesa	Domohoni	Water Level, Discharge
		Gazoldoba	Water Level
Ganges	Ganges	Farakka	Water Level
		Sahibganj	Water Level
Meghna	Barak	Badarpurghat	Water Level
		A.P.Ghat	Water Level
	Manu	Kailashahar	Water Level
	Gumti	Amarpur	Water Level

Source: BWDB

4.2.4.8 Low Accuracy of Inundation Area Prediction

Since MIKE 11 adopted in the present flood prediction system is essentially a one-dimensional model, it does not have a function to analyze the flood phenomenon in the low-lying land of Bangladesh, so the water level prediction of the floodplain and its reproduction are carried out by interpolation. The national-level inundation map provided by FFWC is a macro-level product that provides an overview of common flooding across the country based on a coarse-resolution DEM. It should be noted that the DEM used in this report is a 300 m resolution model created based on survey results conducted decades ago. The output has not been validated, causing errors in some areas. Since the cause of this error is due to the accuracy and resolution of the DEM, it is expected to improve the accuracy of the inundation map by reflecting a more detailed resolution and a more recent DEM. The FFWC flood prediction model was developed more than 10 years ago, but subsequent changes in catchment characteristics, river morphology, and weather conditions have not been incorporated into the model. Therefore, in the present inundation map, some places are underestimated or overestimated.

In order to improve the prediction accuracy of the inundation area, it is necessary to update the flood prediction system and its input DEM. At present, the development of the geographic information system implemented in the SOB is being promoted under the technical cooperation of JICA, and it is expected that the accuracy of the inundation map will be improved in the future by further deepening the cooperation with the SOB and other related organizations and continuously updating the DEM and other geographic and topographical information.

At present, the flood forecasting system forecasts water levels at river water level observation points, but given the actual conditions of land use in Bangladesh, which tolerates flooding and coexists with flooding, it is desirable for the forecasting service to extend the prediction points to the flood plain in order to properly grasp the impacts on crops, houses, and livestock. In the future, BWDB plans to expand the functions of the current flood prediction system to analyze the spread of two-dimensional flooding. The BWDB and related organizations such as the Institute of Water Modeling (IWM) are already equipped with the technical capabilities for this expansion, and in the future, it is considered possible to expand flood forecasting to floodplains, but in doing so, it will be necessary for the future to enhance the computing environment to cope with a large increase in the computational load. It is also necessary to expand water level monitoring facilities in flood plains.

4.3 Urban Flooding and Inland Water Inundation

4.3.1 Initiatives by the Government of Bangladesh

4.3.1.1 Relevant Plans for Urban Flooding and Inland Water Inundation Disasters

(1) The Eighth Five-Year Plan (8FYP)

The occurrence and challenges of urban drainage and inland flooding are clearly distinguished from river floods, which are described in the above section 4.2. It is described as water issues in the "Housing and Community Amenity" sector in the 8th Five-Year Plan (8FYP) as mentioned in 3.2.2 of Chapter 3. Water Supply and Sanitary Authority (WASA) and City Corporation are the main implementing bodies for municipalities or large cities in each city to deal with and take measures against urban drainage issues and inland waters inundation.

(2) BDP 2100

It is also taken up in BDP2100 and is recognized as a serious issue that causes a great deal of economic loss. WASA and City Corporation in each city already have drainage plans, and projects are underway with the support of the Government of Bangladesh and international donors.

4.3.1.2 Specific Projects by the Government of Bangladesh for Urban Flooding and Inland Water Inundation

Table 4.3.1 summarizes the projects implemented in each city and shows the implementation status of drainage management projects taken by the organizations in charge of urban flooding and inland waters inundation countermeasures such as BWDB, LGED, and City Corporation of each city or WASA.

Table 4.3.1 Recent Projects by Related Agencies (Urban Flooding/Inland Water Inundation)

No.	Agency	Project Name	Project Cost (2017-2022)
1	BWDB	Drainage Improvement of Dhaka-Narayangonj-Demra (DND) Project (Phase-2)	9,826,000
2		Drainage Improvement and sustainable water Management of Bhairab River basin	3,410,000
3		Drainage Improvement of Upper Bhadra river, Horihar river, Buri-Bhadra River & adjacent khals in Monirampur & Keshebpur Upazilla, District- Jashore.	500,000
4	LGED	Gopalganj Paurashava Drainage Improvement Project (GPDIP)	204,349
5	DWASA	Land Acquisition and excavation and re-excavation of Hazaribagh, Baisteki, Kurmitola, Manda and begunbari canal	6,065,000
6		Expansion of Drainage Network and Development of Canal in Dhaka City	2,150,000
7	CWASA	Project for Establishment of Sewerage System in Chattogram Metropolitan (Phase-1)	902,400
8	KWASA	Land Acquisition for the construction of Drainage system in Khulna city	1,463,700

Source: Prepared by the Survey Team based on MOF Documents

4.3.1.3 Status of Disaster Hazard Mapping

Hazard maps for the disaster of urban flooding and inland water inundation are included in the flood hazard maps prepared as flood countermeasures indicated in Section 4.2.1.4. The flood hazard maps are prepared in order of priority cities.

In addition, the study also includes an inland flood hazard analysis for urban flooding and inland flooding hazards for major cities in Bangladesh. The results of these analyses, including the results of previous studies, are presented in Section 5.1.3.2.

4.3.2 JICA's Cooperation

JICA's cooperation in the field of urban flooding and inland water inundation countermeasures, together with the previous section on river flooding, is shown in Table 4.1.32 and Table 4.1.33 in Section 4.1.2. JICA's support for urban flooding and inland waters inundation countermeasures have been implemented mainly in Dhaka (Table 4.1.33), and rainwater drainage facility development plans have been formulated and updated. In the Storm Water Drainage System Improvement Project in Dhaka City and the metropolitan area of Dhaka, 10 drainage zones in the city were defined and new drainage pumps, gates, channels, and pipes were proposed to be improved in the assigned zones to JICA. Finally, by the construction of a pumping station and the introduction of sludge dredging equipment, the regional function of the rainwater drainage in the target area has been successfully improved. After the implementation of these measures, drainage management of the west side of Dhaka City is at a certain level. However, due to the ongoing development of land without sufficient consideration for disaster risk reduction, many issues remain to be addressed in reducing flood risks, such as the deterioration of drainage and water retention functions in cities and the expansion into low-lying areas with high inundation risk. On the other hand, in major urban areas such as Dhaka and Chattogram, the relevant organizations in Bangladesh have formulated project plans based on the same recognition and issues. Therefore, JICA needs to promote project implementation through financial cooperation and technical cooperation in urban drainage.

In addition, in the Northern Bangladesh Integrated Development Project (NOBIDEP), financial cooperation was provided for urban infrastructure development projects targeting local cities in the northern region of Bangladesh, which includes a drainage system development project in Rangpur.

4.3.3 Cooperation with Other Donors

The donors other than JICA also have implemented projects related to urban drainage and inland water inundation measures, as shown in Table 4.3.2. Primarily supported by the World Bank (WB) and the Asian Development Bank (ADB), WB implements drainage planning projects in large cities (Dhaka and Chattogram) as part of a comprehensive project for water supply and sanitary management. On the other hand, ADB has been implementing projects such as flood control and drainage system improvement for 9 cities (Secondary Town) nationwide in the Secondary Towns Integrated Flood Protection project. A preparatory survey for an urban infrastructure improvement project (in the Narayanganj district near Dhaka) is underway.

Table 4.3.2 Major Projects of Support from Other Donors (Urban Flooding/Inland Water Inundation)

Donor	Name of Project	Counterpart Agency	Period of Implementation
WB	Chattogram Water Supply Improvement and Sanitation Project	Chattogram Water Supply and Sewerage Authority (CWASA)	2010 - 2020
	Dhaka Water Supply and Sanitation Project	Dhaka Water Supply and Sewerage Authority (DWASA)	2008 - 2016
ADB	Strengthening the Resilience of the Urban Water Supply, Drainage, and Sanitation to Climate Change in Coastal Towns (TA 7890-BAN)	LGED	2011 - 2013
	Urban Infrastructure Improvement Preparatory Facility (Loan 6019-BAN)	Department of Public Health Engineering (DPHE), Narayanganj City Corporation	2019 - present
	Secondary Towns Integrated Flood Protection (Phase 2) (Loan 2117-BAN)	BWDB, LGED	2004 - 2012

Source: WB and ADB

4.3.4 Issues in Current Efforts

In the field of urban flooding and inland water inundation, each municipality is responsible for planning and implementing the project. Information related to urban flooding and drainage measures was not aggregated by national-level organizations, and it was necessary to investigate the situation in each city and grasp the actual situation. Among the seven cities designated as hotspots for urban flooding in the BDP2100, the survey was focused on five cities, Dhaka, Chattogram, Khulna, Sylhet, and Barisal, which are considered to have a relatively high risk due to urban flooding. Based on information obtained through surveys and discussions with each organization, the current status of damage due to urban flooding and inland water inundation and efforts to address those issues in these urban areas are summarized as shown in Table 4.3.3.

Table 4.3.3 Current Status of Damage and Efforts Caused by Urban flooding and Inland Water Inundation in Each City

Item	City				
	Dhaka	Chattogram	Khulna	Sylhet	Barisal
Cause	River overflow/ Poor storm water drainage	River backwater/ Poor storm water drainage	River overflow and backwater/ Poor storm water drainage	River backwater/ Poor storm water drainage	River backwater/ Poor storm water drainage
Implementing agency	DNCC/DSCC	CDA/Chattogram City Corporation	Khulna City Corporation	Sylhet City Corporation	Barisal City Corporation
Related agencies	BWDB (River management) DWASA (Sewage) RAJUK (Urban planning)	BWDB (River management) CWASA (Sewage)	KWASA (Sewage)	BWDB (River management)	BWDB (River management)
Planning status(M/P)	Formulated (2015)	Formulated (2017)	Formulated (2011)	Only F/S conducted (2017)	Unformulated
Current status of facility maintenance	Existing (pumping station and gate) Feasibility study conducted	Under construction (embankment, pumping stations and gates)	Detailed design completed (pumping station and gate), cost estimated	Planned (pumping station and gate)	No facility

Item	City				
	Dhaka	Chattogram	Khulna	Sylhet	Barisal
Project planned (Large scale)	Flood countermeasures in Eastern Dhaka (funds have not been secured yet for embankments, pumping stations, etc.) Facility development in 13 drainage zones	Gate construction at major canals along Karnaphuli River (procurement stage)	Rampur Pumping station construction (stagnation after detailed design)	The Pumping station and gate construction at Goali Khal (only planning)	Embankment development without a masterplan
Confirmed Issues	✓ Problem with pumping station operation ✓ Insufficient management ability of City Corporation ✓ Urban flood countermeasures in eastern Dhaka have not progressed (land acquisition, huge cost required) ✓ Insufficient capacity of existing retention pond (for land acquisition) ✓ Poor drainage due to illegal waste dumping ✓ No information accumulation	✓ O & M system of a large number of pumping stations to be completed is unclear ✓ Waste management	✓ Delay in the progress of implementation ✓ Poor drainage due to illegal waste dumping ✓ Waste management ✓ Lack of funds	✓ Delay in the progress of implementation ✓ Poor drainage due to illegal waste dumping ✓ Waste management ✓ Lack of funds ✓ Dredging of the Surma River has not progressed	✓ Comprehensive plan (M/P) not yet formulated ✓ Unclear priority of measures for drainage improvement and flooding measures in the pilot project ✓ Poor drainage due to waste dumping ✓ Waste management ✓ Insufficient roadside drainage

Source: JICA Survey Team

The challenges of efforts to counter urban flooding and inland water inundation in Bangladesh are shown below.

4.3.4.1 Development of Drainage Facilities that Cannot Keep up with Urban Development

In the areas where urban flooding and inland water inundation occur, economic and citizens' life is hindered by chronic inundation, although it does not cause significant damage (for example, in areas with frequent inundation of Chattogram, flooding occurs from 20 to 24 times per year). Since it is rare for a serious situation such as a life-threatening situation or a loss of a house to occur, an emergency project as a follow-up measure is not taken. However, due to its high frequency, in Chattogram, for example, the average annual economic losses are 1 billion Taka and the maximum is 5.1 billion Taka[19]. Damages caused by urban flooding and inland water inundation include deterioration/damage of transportation infrastructure (mainly road surface), obstruction of citizens' life (temporary loss of living space, need for evacuation, deterioration of houses and household goods, etc.), opportunity loss due to traffic disturbances, delays in emergency transportation, pollution of drinking water, the spread of infectious diseases due to deterioration of sanitation, etc. To prevent or reduce these damages, it is necessary to practice an appropriate land use based on the plan and prior investment. However, there is no coordination among the projects implemented by the various agencies, and projects are being undertaken without an overall framework for urban development. In addition, private development activities and economic development have been given

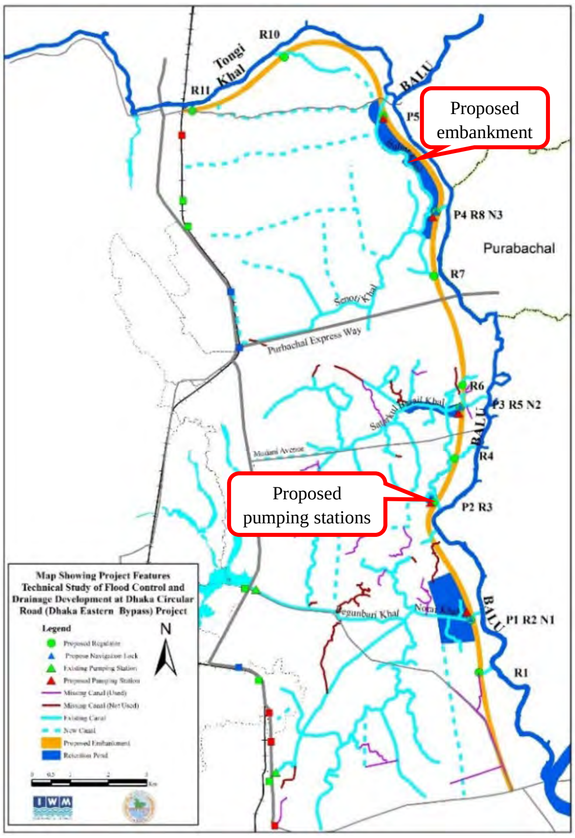
[19] Multi-Hazard Contingency Plan for Chattogram City Corporation (2021)

priority, and laws and ordinances related to development and construction have not been complied with. For these reasons, the countermeasures and facilities against flooding or waterlogging have not been able to keep up with the speed of urbanization, which has hindered the subsequent drainage management. Since urban development is not always controlled, the current situation is that it requires a lot of effort and budget to respond to it. Comprehensive measures should be taken that incorporate flood control and drainage management into urban planning and urban development projects.

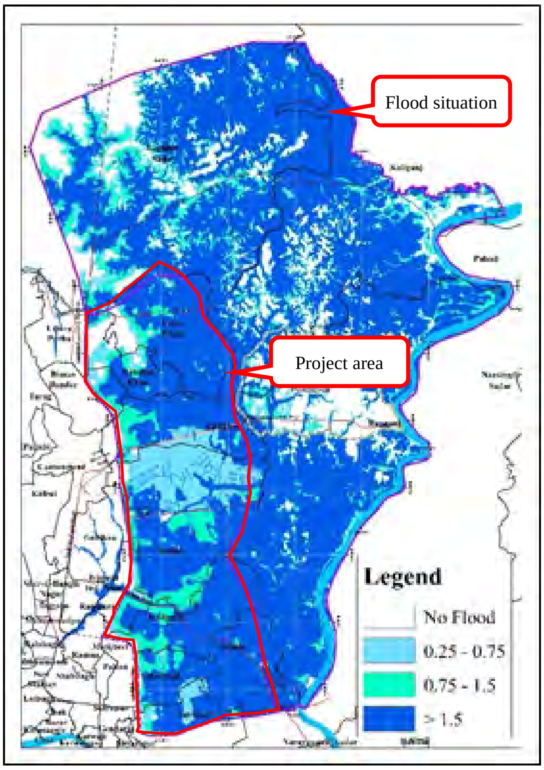
The current situation in target urban cities is that stormwater management measures have been delayed due to poor control of urban development and land use. To solve this issue, based on the future land use classification defined in the urban design, the land (drainage channel, pumping station, regulating reservoir, etc.) of the facilities necessary for drainage management in the area must be secured. Then, the flood control and drainage management project will be implemented in conjunction with the urban development project. In the eastern part of Dhaka, flood countermeasures have not been taken sufficiently at present, while residential land development and road construction are in progress (Figure 4.3.1). As urbanization is progressed in Dhaka city, urban planning and regional development should be implemented in consideration of flood countermeasures and drainage countermeasures before overdevelopment.

In addition, it is necessary to plan and implement measures that can quantitatively (peak discharge) and temporally (timing of peak discharge) control how to manage stormwater drainage in the entire catchment area. To implement appropriate drainage management by reducing the flow load on the pumping station at the downstream end of the catchment area, comprehensive drainage measures for the entire basin are required.

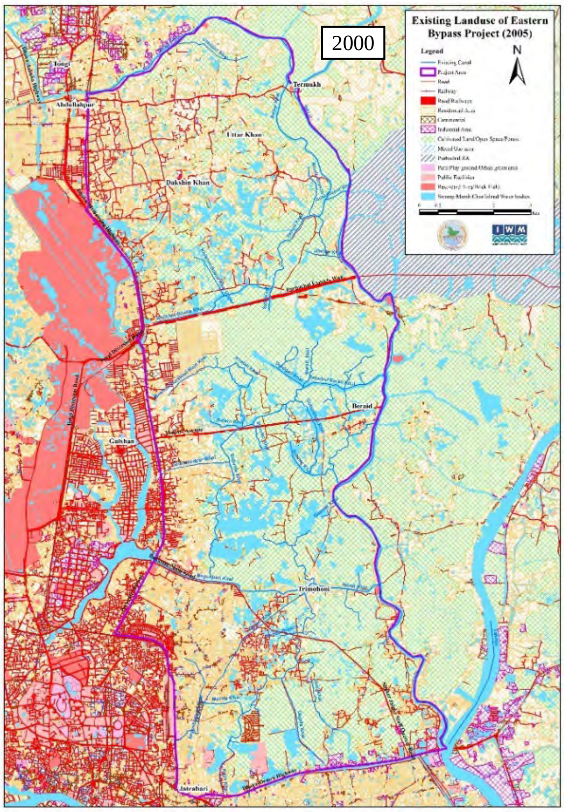
In the case of large-scale urban development, measures to control stormwater runoff will also be taken actively. Therefore, it is also effective to reduce and delay the runoff peak to the drainage channel and not to generate excessive rainwater inflow, that is, by storing rainwater temporarily in the retention pond or collecting rainwater received on the building roof and infiltrating it into the subsurface. In addition to formulating guidelines for the installation of a retention ponds and rainwater infiltration facilities, it is necessary to devise institutional measures such as establishing rules for the introduction to newly developed areas or buildings (mandatory, subsidy system, incentive setting, etc.).

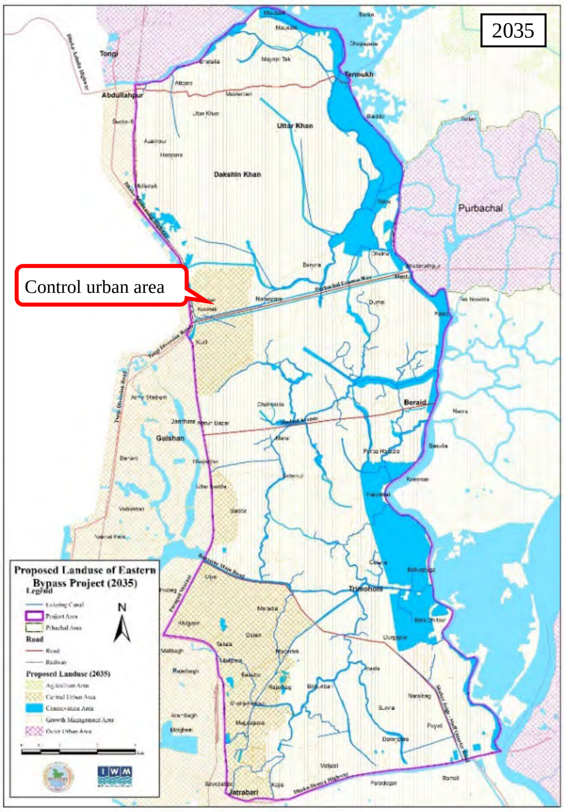


Outline of Proposed Project by BWDB



Assumed Inundation Situation (1998 flood level)





Source: BWDB, Technical Study of Flood Control & Drainage Development at Dhaka Circular Road (Dhaka Eastern Bypass) Project (2021)

Figure 4.3.1 Land use Change and Proposed Flood Control Project in the Dhaka Eastern Region

In addition to the above issues, another issue is that the inability of the authorities to take measures such as waste removal is contributing to the occurrence of inland water inundation. If urban waste management does not function properly, no matter how much the drainage facilities are improved and expanded, the problem will not be solved. Although it is not under the jurisdiction of the disaster prevention sector, it is necessary to promote waste management measures at the same time to comprehensively solve urban flooding and inland water inundation. The fact that the drainage management in large cities was transferred to City Corporation seems to be a result of the consideration given to the fact that under such circumstances, it would be easier to take measures to cooperation and linkage between the two if the drainage management projects were also managed by City Corporation, responsible for waste management, based on the reflection of the past.

In Chattogram, a project to strengthen the waste management capacity was implemented by JICA, and technical support was provided for proper management of waste collection and transportation provided by Grant-in-aid for Cooperation, 3R activities, and public awareness activities. As a result, proper waste management was promoted, and the waste collection rate was improved. While utilizing the results of such projects, new multi-sector stormwater drainage management improvement and capacity-building projects are needed. In Chattogram, drainage management was transferred as described above after the formulation of the drainage master plan in 2017, and large-scale drainage facility development is currently underway. Since City Corporation will be responsible for all of the waste management system, operation, and maintenance of drainage channels and drainage pump stations soon, it is a good opportunity to carry out a capacity-building project.

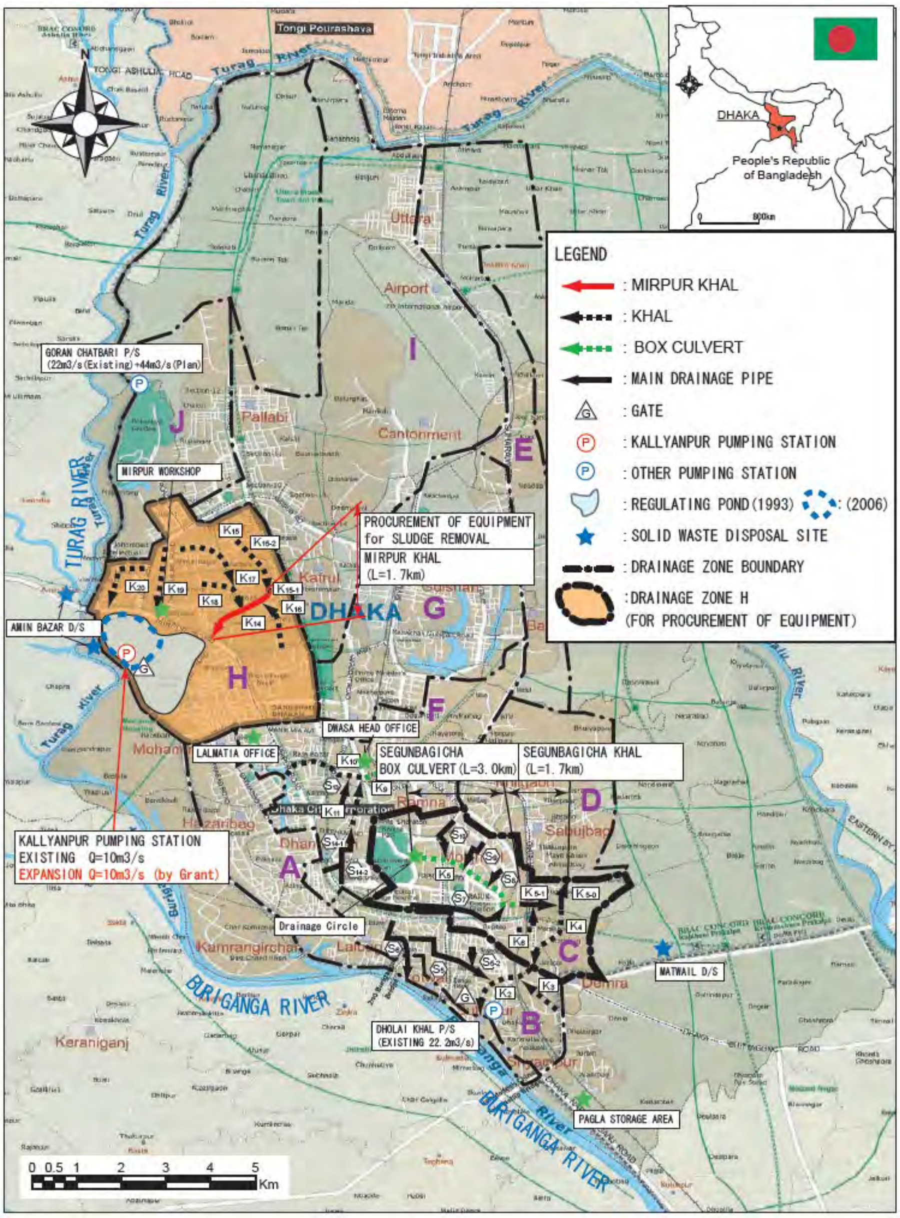
4.3.4.2 Delays in Project Implementation and Difficulty in Securing Land Due to Land Acquisition Problems

In Chattogram, construction of a river embankment with a total length of 8.5 km and accompanying 10 regulators and pumping stations are ongoing on the right bank of the Karnaphuli River in the eastern part of the city, all of which were built by embankment in the wetlands of the river. The implementation proceeded relatively smoothly because there were no problems with the relocation of residents or land acquisition. On the other hand, at the Kallyanpur drainage pump station in Dhaka, constructed with the cooperation of JICA, the land for the retention pond could not be secured due to illegal development and encroachment according to an inadequate legal system formulation in Bangladesh. Even at present, the retention pond area (storage volume) is insufficient, which may reduce the effectiveness of the facility.

In an urban area where buildings such as houses and factories have been dense and land use has already advanced, there is little space for effective maintenance of drainage facilities. A huge land acquisition budget is required to be secured, and it is very difficult to secure land for the construction of drainage management facilities. The larger the urban drainage infrastructure, the more important it becomes, and the land acquisition problem is a major obstacle to project progress.

In Dhaka and Chattogram, the economic centers of Bangladesh, urban and inland flood control measures have already been completed or progressed to some extent, but there are still some areas where measures have not been fully implemented. As mentioned in 4.2.4.3, these economic centers should aim to shift from conventional flood management that allows a certain amount of flooding to damage prevention, which requires measures for areas with residual flood risk. In order to address the issue of land expropriation, which is the biggest challenge in implementing projects in these large cities, it is desirable to establish a good practice of land expropriation and prevention of unplanned development and illegal settlements based on the lessons learned from past cases.

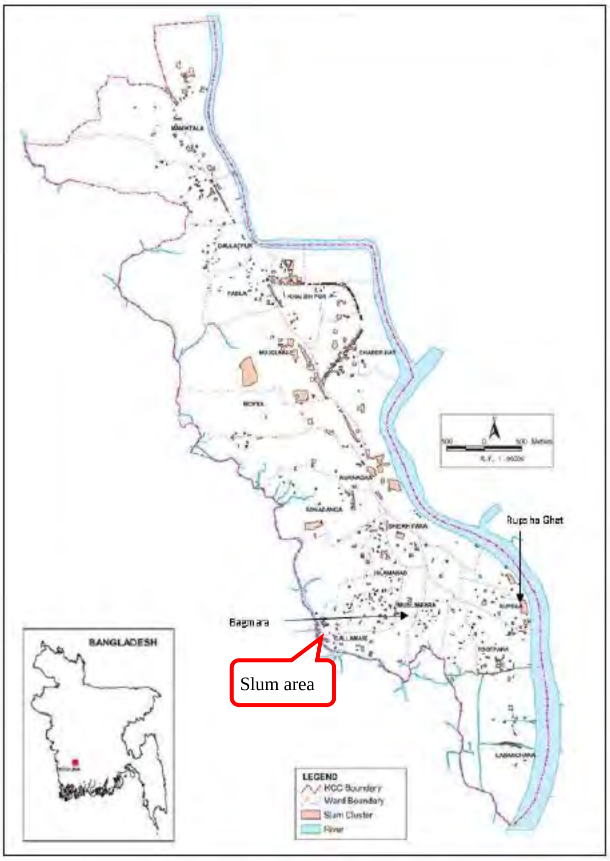
The problem of land expropriation has not been solved for the retention pond for the Kallyanpur pumping station (Figure 4.3.2), and the project area has not yet been secured. Currently, there is a plan to comprehensively develop the area around the Kallyanpur drainage pump station and the retention pond as an Eco Park. The management responsibility has been transferred from DWASA to Dhaka North City Corporation (DNCC), and there is a plan to expropriate the land with the intervention of the army. The idea is to promote the project efficiently and comprehensively by making the area an urban park while ensuring the urban drainage function. Taking such a complex development plan into consideration, some funds for securing land will be procured, and the overall plan will be implemented.

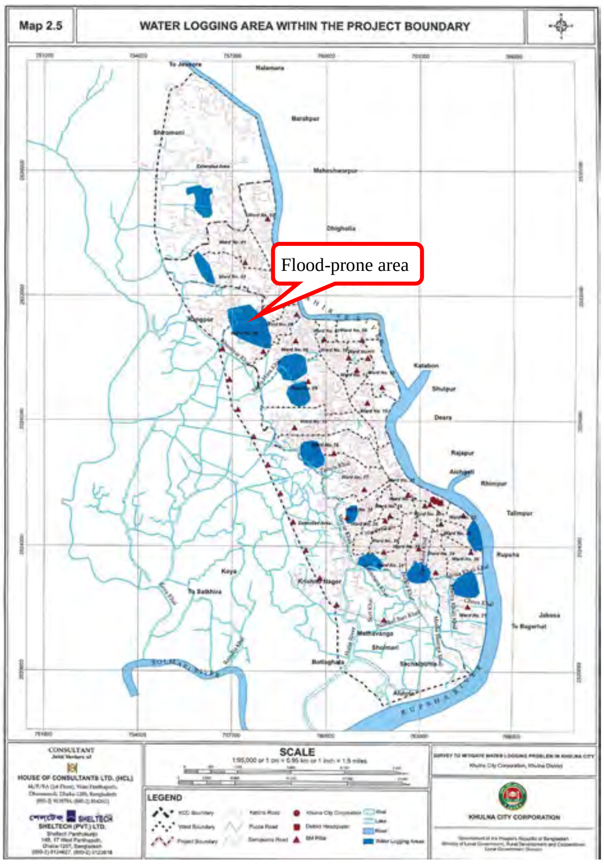


Source: JICA, Basic design study report on the project for improvement of storm water drainage system in Dhaka City (phase II) (2006)

Figure 4.3.2 Areal Map for Kallyanpur Pumping Station and Retention Pond in Dhaka City

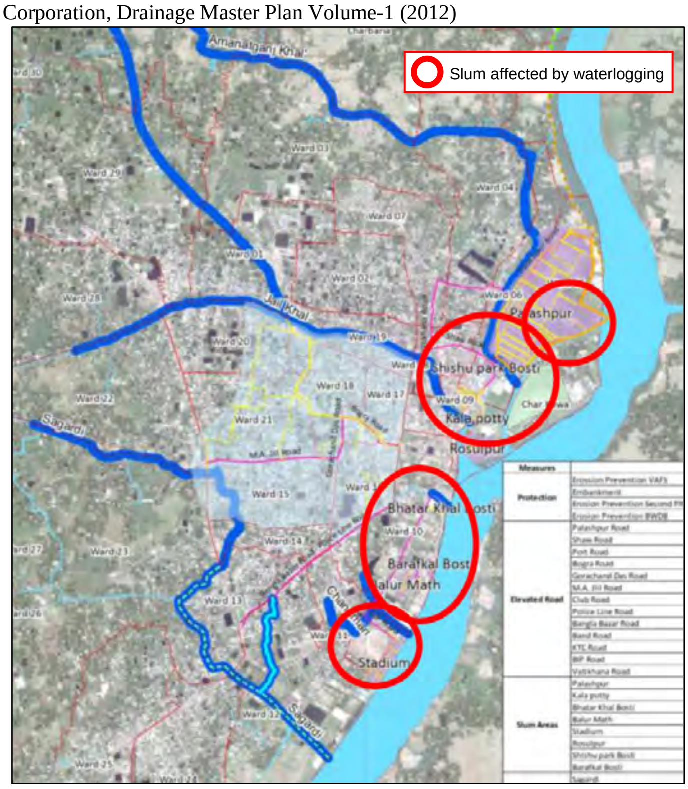
From the viewpoint of public hygiene, the protection of houses, livelihoods, and property of vulnerable groups and slum dwellers (poverty groups) on the periphery of the city should not be left behind. In any urban city, slums often exist in flood-prone areas (Figure 4.3.3), so it is desirable that projects not only cover the urban assets, infrastructure, economic activities, and transportation functions but also cover a wide range of the poverty group. Farmers and fishermen who lost their houses and land due to riverbank erosion in the upstream areas often settled in slums where they arrived by boat, and many of these areas are severely affected by waterlogging (the fact obtained through the interview). As the priority of the implementation target area in each city, it is necessary to make a selection based on the magnitude of the flood risk, that is, the magnitude of the vulnerability to inundation, and set the target area and the project content.





Khulna

Source: Roy et al., Community and institutional responses to the challenges facing poor urban people in Khulna, Bangladesh in an era of climate change (2012), and Khulna City Corporation, Drainage Master Plan Volume-1 (2012)



Barisal

Source: Barisal City Corporation, Climate Change Adaptation Investment Project for Barisal City Corporation (2016)

Figure 4.3.3 Location of Slum and Waterlogging Area in Urban Cities

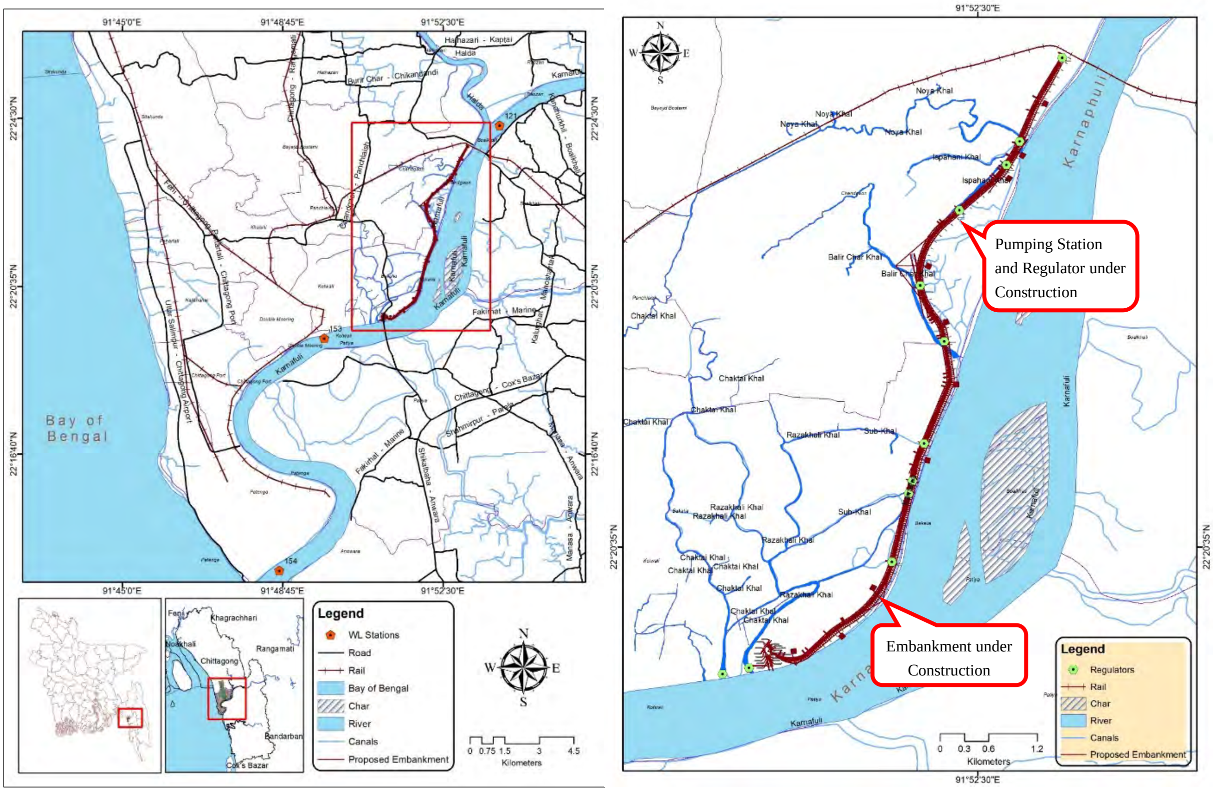
4.3.4.3 Jurisdictional Transfer of Drainage Management and Lack of Maintenance Capacity of Implementation Agency

In Dhaka and Chattogram, WASA has formulated their respective stormwater drainage management master plans, but the jurisdiction of the drainage management and implementation has been transferred from WASA to City Corporation. In the case of Dhaka (transferred in December 2020), the responsibility for managing the three existing pumping stations under the control of DWASA was also transferred at the same time, including personnel changes. City Corporation might be able to directly deal with the blockage of flow, which is mainly caused by the dumping of waste into the drainage channel, as the biggest issue in drainage management, from the aspect of waste management.

However adequate capacity transfer has not been carried out, and it is recognized that drainage facility management capacity is insufficient, such as the reduction of the maintenance budget and the outsourcing of operation at the pumping station. The existing master plan content has not been well received by City Corporation staff and the planned projects have not progressed. In addition, City Corporation has hardly proceeded with the examination of priority projects for drainage management (according to interviews with DNCC and DSCC). While the City Corporation, which has jurisdiction over waste management, has become easier to formulate comprehensive measures, by taking measures to curb the dumping of waste into drainage channels, mechanisms for improving staff capacity, such as taking over know-how and assigning full-time staff to important facilities, have not been developed. In Dhaka and Chattogram, another organization (i.e., BWDB, CDA) responsible for project implementation is involved in the prevention of urban flooding, but in Khulna, Barisal and Sylhet, City Corporation needs to take measures including project implementation, especially on the construction of large-scale drainage facilities, requires external financial and technical cooperation.

In order to improve the situation described above, it is necessary to implement and strengthen the maintenance capacity of existing, under construction, and planned pumping stations and sluice gates. Although each city is in a different stage of urban flood control and drainage management measures, each city does not have sufficient capacity to maintain and operate drainage facilities while the project implementation is being carried out in line with their drainage M/P. Considering the maintenance and operation status of the existing pumping station (Dhaka) and the need for future maintenance and operation of multiple pumping stations and regulators (Chattogram) currently under construction, appropriate maintenance and management of facilities in collaboration with related organizations must be carried out first. Moreover, neither city has been able to eliminate drainage interference caused by waste dumping and sedimentation. To prevent the current frequent flood damage, strengthening maintenance and management capacity for drainage facility management will be necessary. Not only the operational capacity (timely operation of pumping stations and gates) but also the observation and prediction capacity of rainfall, water level, and flow rate, which are the operation conditions, are insufficient and necessary to strengthen in many cities. Furthermore, a system and mechanism will be established for regular and continuous maintenance at the implementing agency.

In Chattogram, a river embankment and 10 regulator pumping stations on the right bank of the Karnaphuli River are being constructed simultaneously (Figure 4.3.3). City Corporation is assumed to be the responsible organization of these facilities; however, they do not have enough experience in the operation and maintenance of large-scale and multiple drainage facilities. Some regulators also have lock gates, and dedicated operators must be assigned to properly maintain and update each facility's equipment, and strengthening the management capabilities of the organization is an urgent issue.



Source: CDA, Hydrological & Morphological of Study Report, Construction of Road along the Bank of Karnafuli River from Kalurgat Bridge to Chaktai Khal (2021)

Figure 4.3.4 Construction of River Embankment and Drainage Facilities in the Right Bank of Karnaphuli River in Chattogram

4.3.4.4 Lack of Balance in Drainage Facility Development

City Corporation, the main implementation agency of each city, is promoting a relatively small-scale drainage improvement project. Most of them are limited to the installation or raising of retaining walls of secondary and tertiary drainage channels, dredging, re-excavation, and waste removal in the channel. However, the construction of large-scale facilities, such as a sluice gate and pumping station between the connecting river, which is the final drainage destination, has not progressed. Improvement of small-scale facilities that are easy to budget will inevitably be carried out. It should be avoided that the improved facilities which preceded the medium- to long-term plan will deteriorate quickly due to insufficient maintenance and will lose the original function. Since securing a budget and land expropriation issues are major concerns in delays in implementation, cooperation is needed to ensure sufficient coordination among stakeholders in advance.

4.3.4.5 Disharmony between Riverine Flood Control and Urban Flooding and Inland Water Inundation Countermeasures

It is necessary to completely protect urban areas from river flooding, and at the same time, take countermeasures against the increased risk of inland water inundation. The cause of inundation is not only the inundation caused by heavy rain and poor drainage but also the invasion of river water into canals and drainage channels by backwater induced by the rise of river water level during flooding or high tide. It is necessary to take drainage (inland water inundation) measures integrated with flood measures in large cities where development is in progress, especially implementation cooperation by related agencies in the remaining unprotected areas.

In Sylhet, sediment transport from the upper reaches of the canal (tributary river) is active, and sediment causes the blockage and narrowing of the Surma River, which is a factor in the rise in river water level that causes urban floods. Although the city of Sylhet has requested excavation of river channels to secure the river cross-sectional area, it may be a trigger for riverbank erosion, and implementation by BWDB has not progressed. BWDB will implement embankment/protection and river channel excavation to promote river flood countermeasures, and City Corporation will develop a silt trap in the canal to control sediment runoff, and excavate drainage channels/canals, dredging, and remove solid wastes. Then, by promoting the installation of pumping stations and gates according to the master plan, reduction of the inundation risk by implementing integrated measures against river floods and inland water inundation.

4.3.4.6 Enhancement of Dissemination and Public Awareness of Inundation Information

As indicated in 4.2.1.4, flood hazard maps have been developed in MRVAM, but they are basically based on river flood analysis, and they do not clearly distinguished between the river flood water and inland water. Apart from this, a flood hazard map prepared by the Governmental Agency has not been created that specializes only in inland waters or that intentionally shows the distinction between riverine flood waters and inland waters.

It is necessary to organize not only basic information on the damage situation of urban floodings, such as the location and extent of inundation, but also information on the items affecting it, the amount of damage, and specific buildings (public facilities: schools, hospitals, stations, fire departments, police, etc., private facilities: large-scale commerce, supermarkets, factories, etc.) so that it can be used for the formulation of future drainage planning, and inputs to urban planning. In addition, it is necessary to collect and map information such as routes that are not affected by waterlogging and to distribute and disseminate them to citizens, shops, and companies.

4.3.4.7 Absence of Guidelines and Manuals for Urban Drainage Management Planning

Although there is no description of specific infrastructure facility planning and design in the legal system for water management, specific design standards are described in several manuals and guidelines, mainly the design standards prepared by the BWDB in 1996 (see Table 4.4.13). On the other hand, for drainage facilities, there is no legal system or standard for facility planning and design; for example, in the drainage planning study for Dhaka City (WB, 2015), the size of facilities was considered based on overseas experience and local practices. It is desirable to develop a unified guideline or manual that shows the know-how in the formulation of urban drainage management plans, such as the scale of protection or damage risk reduction through urban flooding and inland water inundation countermeasure, complex coordination among the many agencies involved, and how to reflect this in land regulations and higher-level plans (e.g., urban planning).

Every city in Bangladesh faces the issue of insufficient organizational structure, manpower, and budget for drainage management. One of the reasons for this is that the need for an adequate organizational structure is not recognized by the government. The formulation of guidelines and manuals on drainage management planning will specify the scale and basic contents of projects and operations, which are needed to plan and implement drainage management. This is expected to provide a rationale for the need to strengthen the organizational structure and make it easier to secure budgets for drainage management. Since there are cases (e.g., Dhaka City M/P) where manuals formulating design standards and planning strategies are organized for individual projects, it is desirable to upgrade the manual from a project-based response to a unified guideline for drainage management planning to ensure effective horizontal expansion.

4.4 Storm Surge

4.4.1 Initiatives by the Government of Bangladesh

4.4.1.1 Legal System for Storm Surge Countermeasures

In Bangladesh, BWDB, a subordinate organization of MoWR, is the main body for the development of storm surge countermeasure facilities (storm surge embankments, sluice gates, etc.). The following are related laws, regulations, and outlines.

(1) Disaster Management Act 2012

The details of this law are shown in Section 4.1.1.1 (1). Cyclones, sea high tides, abnormal tides, and erosion of coastal areas are listed as storm surge-related hazard types.

(2) National Water Policy 1999

It is a guideline for the development of rivers (including international rivers) in Bangladesh. Details are given in 4.2.1.1(2). With regard to storm surge countermeasures, the policy includes investment in salinity prevention and preservation of coastal ecosystems, in addition to the development of polder (ring dike).

(3) National Water Management Plan

It outlines basic development directions related to water in Bangladesh, and the details are shown in 4.2.1.1(3). In the field of storm surge, the main implementation items are embankment construction and afforestation in the southern coastal areas. While the BWDB is in charge of coastal embankments, the Forestry Department is in charge of coastal reforestation.

(4) Coastal Zone Policy 2005

It is a general guideline for integrated coastal zone management. Details are given in 4.1.1.1 (4).

(5) Coastal Development Strategy 2006

It is a strategy for the development of the coastal areas of Bangladesh, developed and approved by the MoWR based on the previously mentioned "Coastal Zone Policy: CZPO".

The CDS sets nine strategic priorities for the specific implementation of the CZPO: (i) ensuring fresh and safe water availability, (ii) safety from man-made and natural hazards, (iii) optimizing the use of coastal lands, (iv) promoting economic growth emphasizing non-farm rural employment, (v) sustainable management of natural resources: exploiting untapped and less explored opportunities, (vi) improving livelihood conditions of people; especially women, (vii) environmental conservation, (viii) empowerment through knowledge management, and (ix) creating an enabling institutional environment.

Table 4.4.1 Strategic Priorities in the Coastal Development Strategy

Strategic Priority	Type of intervention	Targets
Ensuring fresh and safe water availability	Strengthening Sanitation and Safe Water Supply Programs in Arsenic and Salinity Affected Areas (in selected 10 upazilas of the coastal zone).	- 2006: Decision on proposed water supply & sanitation project and 2007: implementation
	Ground Water Management in the CZ of Bangladesh.	- 2007: formulation of a groundwater management plan - 2008: start implementation of groundwater management mechanisms
	Integrated water resource management of Greater Noakhali.	- 2006: regional IWRM strategy developed - 2007: start investments and implementation of management structure - 2006: start of investment on Gorai River restoration
Safety from manmade and natural hazards	Strengthening and rehabilitation of sea dykes	- 2006: planning and design of sea dykes completed - 2007: start investments on new dykes and routine maintenance
	Reduction of a severe vulnerability in the Coastal Zone through multi-purpose cyclone shelters- including coping mechanisms	- 2005: inventory completed - 2006: design & plan completed - 2007: coping mechanism program implemented - 2008: new constructions

Strategic Priority	Type of intervention	Targets
Optimizing use of coastal lands	Development and settlement of accreted land. Integrated management of coastal water infrastructures. Coastal land zoning. Development of coastal agriculture in Bangladesh	- 2007: management mechanism agreed - 2008: guidelines published - 2007: A project on management of coastal water resources infrastructure: pilot project in 5 polders - 2009: start CDSP-IV - 2008: two feasibility studies on new chars completed - 2006: detailed zoning initiated - 2006: zoning law promulgated - 2008: long term plan for detailed zoning - 2007: comprehensive plan for coastal agriculture completed - 2008: start implementation
Promoting economic growth emphasizing rural non-farm employment	Enhancement of coastal livelihoods through enterprise development. Tourism development in the CZ for improvement of livelihoods and poverty reduction.	-2006: design of enterprise development support & training -2007: implementation of support to selected trades -2006: design of economic opportunities in tourism & training -2007: implementation
Sustainable and equitable management of natural resources	Environmental and socially responsive shrimp farming in 4 selected Upazilas. Introduction and expansion of solar, tidal, and wind energy in remote coastal areas. Marine Fisheries & Livelihoods Development Program.	- 2006: zoning concluded - 2007: extension - 2006: energy utilization & generation planning - 2007: unit establishment - 2009: expansion - 2006: assessment of marine and coastal fisheries completed - 2008: start implementation
Improving livelihood conditions of people, specially women	Enhancement of livelihoods in coastal chars areas. Integrated development of remotely located island (Urir Char & Rangabali chars). Capacity building of female fish processors in Cox's Bazar district. Cox's Bazar Comprehensive Rehabilitation Program for Erosion Victims of Coastal Zone of Bangladesh. Improvement of Livestock services in the Coastal Zone.	- 2006: design and plan of char & island livelihoods completed - 2007: implementation of basic provisions - 2008: development linked to LGIs - 2009: livelihoods program implemented - 2007: Char development plan completed - 2008: feasibility assessment and possible proposal for other special area development plans -2006: groups formed -2007: training imparted - 2008: input support provided -2006: identification of present and predicted erosion prone areas completed -2007: implementation of rehabilitation program -2009: socio-economic opportunities implemented -2006: design and plan completed -2007: poultry development plan implemented -2008: veterinary services introduced -2009: income opportunities in livestock initiated and strengthened
Environmental conservation	Marine and Coastal Environmental Development Strengthening of Coast Guard for Improvement of Coastal Safety and Security, Coordination with Other Law Enforcing Agencies	-2006: International, regional agreements and national responses monitoring -2006: identification and planning -2007: implementation

Strategic Priority	Type of intervention	Targets
Empowerment through knowledge management	Knowledge management, dissemination, and social communication Regional/ framework studies Capacity Building & Training	-2006: initiate action -2010: action continues -2007: Guidelines prepared, -2010: project data base linked to national data base
Creating an enabling institutional environment	Set up a PCU for coordination and harmonization among the line agencies Operationalization at the district and local level of ICZM. Empowerment of Women Members / Commissioners of LGIs of the CZ. Establishment of IT-supported model Unions in a sea facing Upazilas Capacity Building of the Local Government Institutes (Union Parishads and Paurashavas) for Integrated Coastal Resource Management.	-2005: structure agreed, established and PCU operationalized -2006: PCU operational at both national and local Level - -

Source：Coastal Development Strategy (2006)

The CDS was implemented from 2006 to 2010 under the management of a Project Coordination Unit (PCU). These PCUs were established at the national (central) and local (district and Upazila) levels. The PCU at the national level consisted of a steering committee of relevant ministries, a technical committee, and a focal point group. The PCU acted as facilitators and coordinators of the Integrated Coastal Zone Management (ICZM) process. On the other hand, at the district and Upazila levels, the District Development Coordination Committees (DDCCs) and the Upazila Development Coordination Committees (UDCCs) were responsible for a local level to promote development and effective resource management, with NGOs, community organizations, and other stakeholders acting as partners to facilitate the CDS.

4.4.1.2 Review of High-Level Plans for Measures Against Storm Surges

The high-level plan sets a number of specific goals for cyclone countermeasures. The number of embankments, dredging, and shelters to be added has been formulated as structural countermeasures. The outline of each plan is described below.

(1) Eighth Five-Year Plan

The contents of the 8FYP are detailed in section 3.2.2 of this report. In the storm surge field, the number of cyclone shelters, disaster-resistant houses, and community facilities is listed as a specific index. In addition, the target value of the number of annual embankment projects is also listed.

As per the current performance of the Local Government Division (LGD), LGD constructed 21 cyclone shelters in urban areas and 455 cyclone shelters in rural areas in the Seventh (7th) Five -Year Plan. From 2016 to 2018, cyclone-affected areas were set to 10% of the country; however, as a target by 2025, the rate should be reduced to 2% and the number of affected people also should be reduced from 8 million to 5 million. (See Table 4.4.2)

Table 4.4.2 Cyclone-related Targets by 2025

No.	Indicators	Sub-Indicators	Quantity	2016-2018	Target for 2025
1A	Risk zone susceptible to natural hazards	Cyclone damage extent	Percent of total area of Bangladesh	10	2
1B	Population vulnerable to natural disasters	Cyclone vulnerable people	Nos. in million	8	5

Source: https://oldweb.lged.gov.bd/UploadedDocument/UnitPublication/1/1166/8FYP.pdf

(2) National Plan for Disaster Management (2021-2025)

Details of this plan are described in Section 4.1.1.1(6) of this report. The following are agreed as specific target values of the plan:

- ✓ Reducing direct victims (including dead and missing) to 4000 per 100,000 population
- ✓ Add 2,000 buildings to the past target of 5,000 cyclone shelters construction
- ✓ Flood control structures such as embankments should be designed from the viewpoint of storm surge damage. The table below shows the main goals for the storm surge of the plan.

Table 4.4.3 shows the Plan's main goals regarding storm surges.

Table 4.4.3 Targets for Storm Surge

Activities	Targets	Lead (Ministry/ Dept.)	Associate (Ministry/ Dept.)	2021	2022	2023	2024	2025
Scaling up/ Institutionalization of Flood Preparedness Programme (FPP)	10 districts are implementing FPP through its programme	MoDMR	MoWR and Associated ministries	1	2	2	3	2
Develop a strategy for sustainable embankment management including maintenance, recovery, and reconstruction	Strategy developed	MoWR	MoDMR, BWDB		1			
Enhance navigability of rivers, canals, and water reservoirs	Dredging of 20 routes connecting canals with river	MoWR/BIWTA	MoDMR, LGD	3	4	5	4	4
Innovating models for forecasting and warning systems (e.g., flood, landslide)	2 models are being implemented and institutionalized	MoDMR, BMD, FFWC	DDM, CPP	1	1	-	-	-
Develop a location-specific community based early warning system for flash flood	Early warning system developed	BMD, BWDB/ FFWC, MoDMR	MoDMR	1				

Source: National Plan for Disaster Management (2021-2025)

(3) Bangladesh Delta Plan 2100

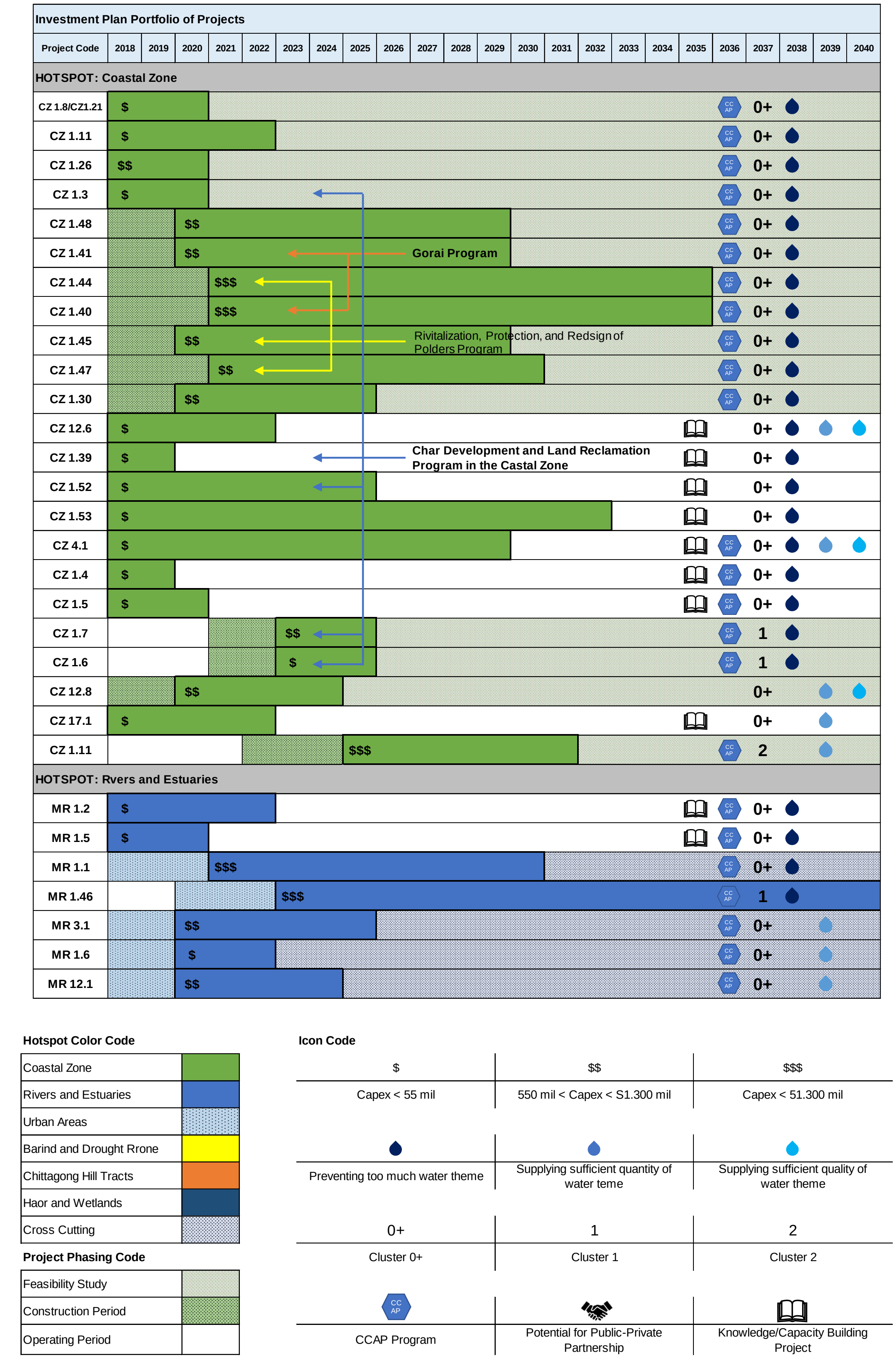
Details of this plan are provided in Section 4.1.1.1(5) of this report.

Short- and medium-term storm surge-related projects, such as water resources management and polder (embankment) rehabilitation, are being planned/implemented, including the following projects.

Table 4.4.4 List of Investment Projects in Coastal Areas

Investment Plan Portfolio of Projects			Total Capital Costs	
Project Code	Name	Description	BDT (mil)	US$ (mil)
HOTSPOT: Coastal Zone				
CZ 1.8/1.21	West Gopalganj Integrated Water Management Project	Protect the West Gopalgonj area against flash floods and increase agricultural production through improved drainage and irrigation capacity, implementing flood control measures, and developing an integrated water management plan in the West Gapalgonj area	2,735	34
CZ 1.11	Improved Drainage in the Bhabadha Area	Reduce drainage congestion and floods through several river management interventions; rehabilitate the Bhabadha regulator to increase drainage capacity; involve the local community in the project; construct an embankment along the river.	1,557	20
CZ 1.26	Development of Water Management Infrastructure in Bhola Island	Protect the Location 4 area from flooding, storm surges, salinity, erosion and loss of land due to sea level rise; develop an Erosion Early Warning System for the Bhola district.	14,651	185
CZ 1.3	Char Development and Settlement Project- V	Protect the inhabitants of newly accreted chars in the Noakhali District from erosion, floods, and surges, and ultimately to reduce the poverty and hunger of poor people living there.	1,138	14
CZ1.48	Program for Implementation of Rationalized Water Related Interventions in Gumti - Muhuri Basin	Rationalize water resources management by improving infrastructure through modernization of existing water infrastructures with institutionalized participatory schemes cycle management process and ADM principles.	13,988	176
CZ1.41	Program for Implementation of Rationalized Water Related Interventions in Gorai-Passur Basin	Manage the water resources in an integrated, holistic way; rationalize water resources management by modernizing existing water infrastructures with institutionalized participatory schemes cycle management process and ADM principles.	14,570	184
CZ1.44	Rationalization of Polders in Baleswar - Tentulia Basin	Reducing loss of assets, crops and livestock from cyclone and storm surges; reducing salt water intrusion in the polders; ensuring fresh water flow in the rivers and canals; reducing agricultural production loss by protecting the lands from erosion.	158,502	1,997
CZ1.40	Rationalization of Polders in Gorai-Passur Basin	Reduce the loss of assets, crops and livestock; reduce vulnerability loss; reduce salt water intrusion; increase agricultural production; improve drainage congestion situation; improve institutional setting.	106,604	1,343
CZ1.45	Program for Implementation of Rationalized Water Related Interventions in Baleswar-Tentulia Basin	Manage the water resources in an integrated, holistic way; rationalize water resources management by modernizing existing water infrastructures with institutionalized participatory schemes cycle management process and ADM principles.	8,800	111
CZ1.47	Rationalization of Polders in Gumti - Muhuri Basin	Reduce the loss of assets, crops and livestock; reducing salt water intrusion into the polders; reduce salt water intrusion; increase agricultural production.	64,328	811
CZ1.30	Rehabilitation of Water Management Infrastructure in Bhola District	Protect the citizens of Bhola against flooding, salinity and loss of land due to sea level rising; increase river flows and erosion; increase strength of seasonal typhoons.	23,419	295
CZ12.6	Integrated Coastal Zone Land use Planning in Bangladesh using GIS and RS Technology	Guide the development of different land use in the Costal Zone in line with the BDP2100, SDG and ICZMP; ensure planned development with special focus on the urban area; promote 'Action area' focused development for specific areas such as ecologically sensitive areas, islands, ports, etc.	899	11
CZ1.39	Morphological Dynamics of Meghna Estuary for Sustainable Char Development	Better understand the overall hydraulic and morpho dynamic processes in the estuary; increased sustainability of char development; define remedial measures for the erosion at Char Nangulia and Caring Char	72	1
CZ1.52	Land beyond Land, Efforts to Reclaim lands at near Coast; Preparatory Surveys and Studies	Reclamation of lands at near coast to support activities for economic use and growth; generate new surveys, studies, modelling required to develop detailed engineering design of land reclamation considering risk from rising sea level and possible earthquake.	927	12
CZ1.53	Structural interventions for managing sea level rise: preparatory surveys & studies	Enhance Bangladesh security against sea level rise by building elevated (multi-purpose) sea dykes and river barriers.	1,024	13
CZ4.1	Development of Climate Smart Integrated Coastal Resources Database (CSICRD)	Provide up to date information of the coastal zone; provide information related to climate change impacts and vulnerability; aid the decision makers in project planning, implementation and management.	122	2
CZ 1.4	Study on Integrated Management of Drainage Congestion for Greater Noakhali	Collect information on drainage congestion in the Greater Noakhali area; determine optimal solutions for problems identified; build structural interventions; identify silted up canals and canals that need dredging to enhance navigability.	16	0.20
CZ 1.5	Study on Tidal River Management	Determine environmental and social impacts of the Tidal River Management (TRD) programme; devise the TRM programme; determine institutional capacity gaps; and recommend actions to bridge gaps.	1,250	16
CZ1.7	Urirchar-Noakhali Cross Dam Project	Reclaim land through the construction of a cross dam between Urir Char and Char Maksumul Hakim; provide a road connection between Urir char and the Noakhali mainland.	4,353	55
CZ 1.6	Integrated Land Reclamation Project of Hatiya-Dhamar Char-Nijhum Dwip	Reclaim land through construction of a 1,250-meter cross-dam between Hatiya and Nijhum Dwip; resettle people rendered landless by river-erosion.	550	7
CZ12.8	Southern Agricultural Improvement Project (SAIP)	Increase agricultural productivity through better management and utilization of land and water resources, and promotion of climate smart technology in the southern region of Bangladesh.	39,184	494
CZ17.1	Exploration of the Production Potential of Coastal Saline Soils of Bangladesh	Research characterization, identification, and severity of saline soil and water in Bangladesh; Screening of salt tolerant rice and non-rice crop cultivars in salt-affected area; Identifying suitable salt tolerant limit of rice and wheat crop cultivars.	98	1
CZ 1.1	Construction of Ganges Barrage and Ancillary Works	Increase the irrigation facilities, restore the ecological balance, and increase the livelihood opportunities of the Ganges DEPENDENT Area (GDA); manage use of water to be available under the Ganges water sharing Treaty of 1996.	408,713	5,150
HOTSPOT: Rivers and Estuaries				
MR 1.2	Pre-Feasibility Study on Integrated River System Management and Protection of Accreted Land	Build knowledge on hydrological and socio-economic processes, and on the Integrated River Management (IRM) of the river systems of Bangladesh; gather insight on policy options, institutional arrangements, and institutional funding potential.	3,854	49
MR 1.5	Study for harnessing the waters of the Brahmaputra River	Provide insights on the hydro-morphological dynamics of the Brahmaputra River; provide insights for relevant policy instruments.	435	5
MR 1.1	River Bank Improvement Program	Improve the socio–economic development in greater Dhaka; provide safety against floods for vital infrastructure of Dhaka and adjacent areas by strengthening and creating a reliable flood embankment with roadway.	140,694	1,773
MR 1.46	Integrated Jamuna-Padma Rivers Stabilization and Land Reclamation Project	Stabilize the Jamuna-Padma river corridor; reclaim land; reduce flood risk; restore distributaries; restore navigation; increase land-based productivity; protect the environment.	289,800	3,651
MR 3.1	Sustainable Restoration of Connectivity of Major Navigation Routes	Improve the navigability of 24 river routes by dredging; open up around 2500km of waterways for smooth and year-round plying of waterways; increase the water flow of the respective rivers.	22,948	289
MR 1.6	Development of Chandona-Barasia River Basin System	Increase sweet water flow by dredging/excavation of the off-take canals; provide irrigation facilities to a gross area of 29,155ha, net 22,050ha for increasing agricultural production; have a sweet water reservoir into the Chandana-Barasia River for domestic purposes.	461	6
MR12.1	Enhancement of Agricultural Productivity towards Food Security in Char Lands	Ensure food security, improve nutritional status and reduce the poverty of marginal and small farmers and their families living in the Char lands through boosting agricultural production and improving income generating	15,039	189

Source: BDP 2100



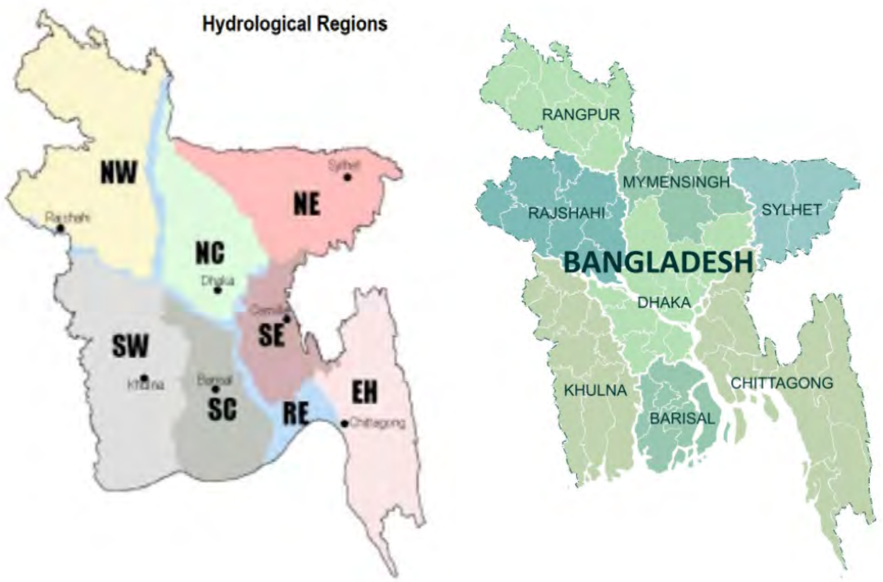
Source: Bangladesh Delta Plan 2100

Figure 4.4.1 Coastal Project Implementation Schedule

(4) National Water Management Plan

Details of this plan are described in Section 4.2.1.1(3) of this report.

As for storm surge countermeasure, shelter construction, transportation infrastructure protection, and water resource management projects are planned. In addition, it touches on the need for coastal conservation, reclamation, and tree planting as an agricultural business. In addition to the administrative district, the hydrological divisions are divided into eight regions as the following map. The plan organizes into eight fields: industrial development, environmental preservation, principal rivers, rural areas, urban areas, disaster management, agricultural management, and water resources. The table below shows the target value of disaster management in the plan and provides the specific number of constructions of cyclone shelters.



SW: South West, NE: North East, NC: North Central, NW: North West,
SC: South Central, SE: South East, EH: Eastern Hill, RE: River & Estuary
Source: National Water Management Plan (http://www.warpo.gov.bd/site/page/3ef03f49-080e-4b33-94d2-0f0b9cc9bb51/-)

Figure 4.4.2 Hydrological Area Division (Left) and Administrative District (Right)

4.4.1.3 Bangladesh Government Disaster Management Projects for Storm Surge

(1) Prior Investment

As detailed in 4.2.1.3, many embankments and storm surge countermeasure projects have been implemented by BWDB since the first flood management plan was formulated in 1964.

(2) Early Warning

Cyclone Preparedness Programme (CPP) was undertaken in 1972 by MoDMR and Bangladesh Red Crescent Society (BDRCS), and as of 2018, the program still has been operated in 13 coastal areas with over 50,000 volunteers. Standing Order on Disasters (SOD) gives CPP the authority to provide cyclone early warnings, operate shelters, search for and rescue victims, respective organizations coordination, train CPP volunteers, and conduct disaster awareness activities. Therefore, CPP volunteers can provide alerts/warnings based on information by BMD with the following protocol illustrated below.

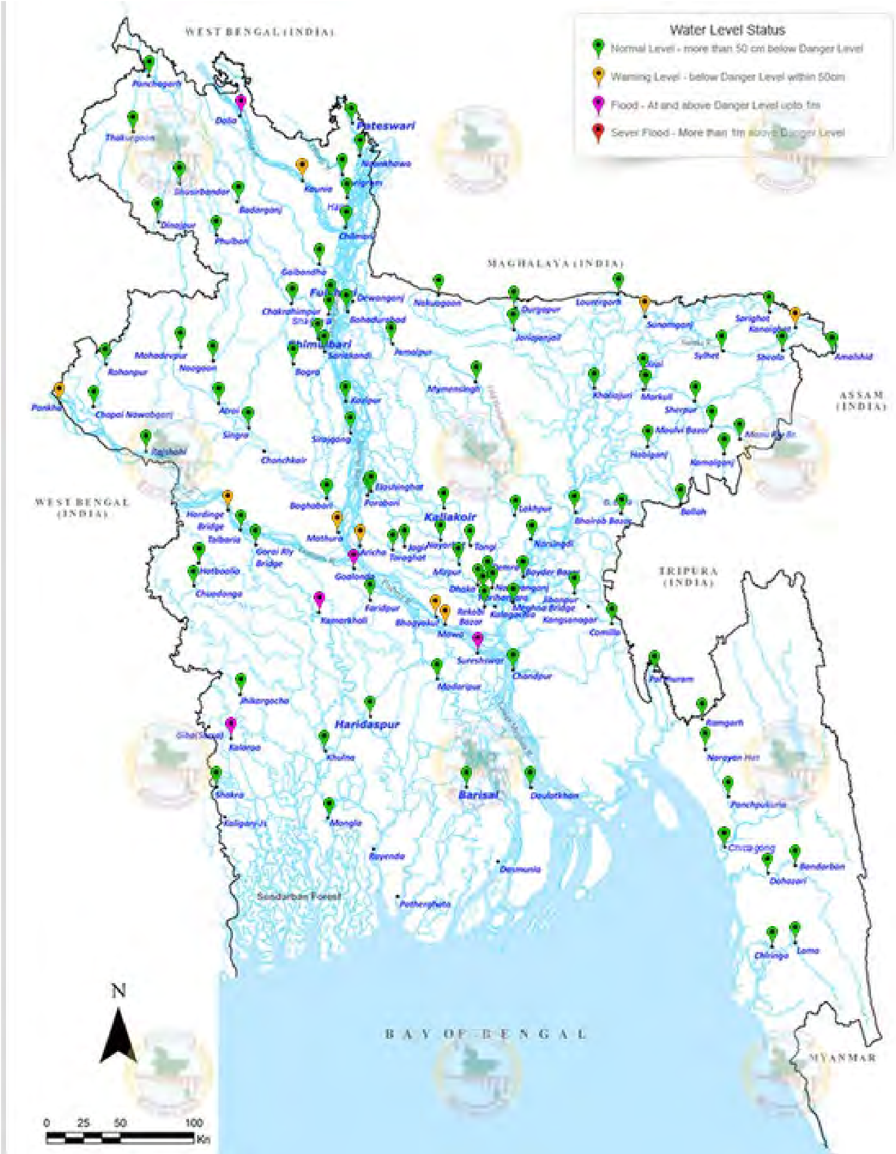
Source：CPP Document

Figure 4.4.3 Protocol of CPP for Warning Dissemination

Source: 2018 Cyclone Preparedness Lessons Learnt
https://www.bd.undp.org/content/bangladesh/en/home/library/crisis_prevention_and_recovery/extreme-weather-and-disaster-preparedness-in-the-rohingya-refuge.html）

Figure 4.4.4 CPP Paramedic Training at a Muslim Refugee Camp Inflowing from Rakhine State, Myanmar (2018)

The tide level is observed by BWDB at the position shown in the figure below, and the dangerous water level can be seen on the website.



Source：FFWC Website

Figure 4.4.5 Location of Water Level Station

(3) Emergency Response

Response and emergency activities in the event of a disaster are carried out by MoDMR, and the outline is shown in 4.2.1.3 (2). However, the detailed activity status specific to floods is unknown.

(4) Disaster Recovery and Reconstruction

Similar to river floods, recovery, and reconstruction against storm surge damage will be carried out by BWDB (embankments/gutters) and LGED (roads/bridges). As an emergency restoration, the Bangladesh Army is implementing (ordering) embankment projects in some places.

In addition, as an emergency restoration, local residents often work together to restore the embankment manually.

4.4.1.4 Status of Disaster Hazard Mapping

Hazard maps for the storm surge sector have been prepared for coastal areas in the MRVAM and other studies detailed in Section 4.2.1.4. These results are shown in section 5.1.3.3.

4.4.2 JICA's Cooperation

4.4.2.1 The Bay of Bengal Industrial Growth Belt: BIG-B

Although this concept is not a development concept directly aimed at storm surge countermeasures, it is a collaborative concept between the Japanese and Bangladeshi governments that is closely related to the study of storm surge countermeasures in this research and is outlined here.

(1) Background

Japan-Bangladesh leaders need to strengthen cooperation and cooperation in the formation and implementation of projects through policy dialogue and the direction of economic cooperation that both countries should pursue under the Bay of Bengal Industrial Growth Zone (BIG-B) Initiative. The two leaders shared their intention to cooperate in areas such as 1) improvement of transportation network, 2) stable supply of electricity, 3) urban development such as special economic zone development, and 4) private sector development such as promotion of financial accessibility. While paying attention to the three pillars of the BIG-B initiative: 1) development of economic infrastructure, 2) improvement of investment environment, and 3) improvement of connectivity, the two leaders said that the BIG-B initiative is highly efficient. They shared the hope that the maximum use of Japan's advanced technology, such as coal-fired power generation, would contribute to mutual benefit and prosperity between the two countries.

(2) Summary

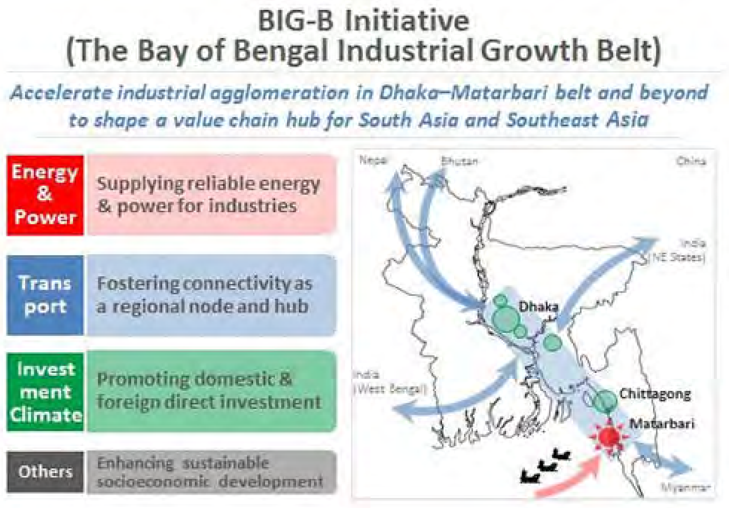
During their summit talks in Tokyo in May 2014, H.E. Shinzo Abe, Prime Minister of Japan, and H.E. Sheikh Hasina, Prime Minister of the People's Republic of Bangladesh agreed to further strengthen bilateral cooperation through the "Japan-Bangladesh Comprehensive Partnership." On this occasion, Prime Minister Abe announced to provide 600 billion Yen (approximately US$6 billion), mainly in ODA loans, in 4 to 5 years.

Bangladesh is located with embracing the Bay of Bengal from the sea point of view, and in-between South Asia and South-East Asia from the land point. Under the current global economic power shift toward the Indo-Pacific Ocean region, this geographical advantage will provide a unique opportunity for the country to play a node and hub role in regional as well as inter-regional matters. This also suggests Bangladesh's renewed focus on the "Look East" policy exploits the vibrant economic growth from the Pacific to the Indian Ocean.

The BIG-B initiative is to accelerate industrial agglomeration along the Dhaka-Chattogram-Cox's Bazar belt area and beyond, encompassing developing economic infrastructure, improving the investment environment, and fostering connectivity. The two Prime Ministers also expected the initiative, with maximum use of Japan's advanced technologies and socioeconomic development experiences, to yield mutual benefits and prosperity to both countries.

BIG-B foresees Bangladesh transcending its national borders to become the heart of the regional economy and providing a gateway for both South Asia and South-East Asia to step into closer inter-regional relations, so that she may reshape herself as a sparkling trading nation deeply incorporated into inter-regional and global value chains.

BIG-B is not incompatible with other existing vital frameworks for regional cooperation. Rather, it aims to supplement and reinforce them for the maximization of the benefit for Bangladesh.



Source: JICA website

Figure 4.4.6 Overview of Big-B Initiative

4.4.2.2 Cooperation to Storm Surge Countermeasure by JICA

Japan's grant aid in storm surge countermeasures is shown in Table 4.4.5. These are mainly for equipment provision and shelter construction with an emphasis on evacuation and emergency response.

As shown in Table 4.4.6, two technical cooperation projects related to storm surge countermeasures have been implemented. They correspond to hardware measures and software measures, respectively. According to the on-site hearing, the capacity was improved in the "Capacity Improvement Project for Sustainable Water-related Infrastructure Development". However, the manual is not recognized as the official manual of BWDB because it includes analysis using software that is not known in Bangladesh. In addition, the research conducted in the "Research and Development Project for Storm Surge and Flood Damage Prevention and Mitigation Technology in Bangladesh" has been taken over by the University of Bangladesh, and future research is expected to develop.

For yen loan projects related to storm surge countermeasures, as shown in Table 4.4.7, the following two cases have been implemented. The disaster risk management enhancement project is still underway, and component 3 supports disaster response to the 2020 cyclone Amphan.

As structural measures, JICA has cooperated in the provision of cyclone shelters and maintenance of polders. Previous cooperation has been aimed at vulnerable groups, mainly in rural areas, selected with an emphasis on disaster hazards. Given Bangladesh's remarkable economic development in recent years, cooperation to protect economic development is considered necessary in the future.

In the aspect of non-structural measures, JICA has been engaged in the development of weather radars, the transfer of technical skills, and support for storm surge research. However, the situation is not sufficiently developed yet, and at the same time, existing facilities and systems need to be updated. Therefore, it is necessary to strengthen and update the system by incorporating the latest knowledge.

Table 4.4.5 Achievements of Grant Aid by Japan (Storm Surge)

Year	Project Name	Project Cost	Outline
2018～	The Project for Improvement of Rescue Capacities in the Coastal and Inland Waters	2.729 billion Yen	Four 20m rescue boats and 20 10m rescue boats were provided. In addition, the necessary funds for equipment operation/operation proficiency training necessary for maintenance and operation will be provided. The counterpart is BCG: Bangladesh Coastal Guard.
2008~2010	The Program for Construction of Multipurpose Cyclone Shelters in the Area Affected by the Cyclone Sidr	1.178 billion Yen	Support was provided for the development of multipurpose cyclone shelters (36 locations) and incidental deep wells for the Khulna Division and Barisal Division. The counterpart organization is LGED.

Source: JICA Survey Team

Table 4.4.6 Achievements of Technical Cooperation by Japan (Storm Surge)

Year	Project Name	Project Cost	Outline
2013～2017	The Project for Capacity Development of Management for Sustainable Water-Related Infrastructure	0.35 billion Yen	The capacity was improved through the design, construction, and maintenance manuals for river embankments. The counterpart organization is BWDB.
2016~2019	Research Project on Disaster Prevention/Mitigation Measures Against Floods and Storm Surges	0.30 billion Yen	Experts such as flood analysis were dispatched to raise awareness of disaster prevention and improve the capacity of local research institutes through joint research on flood hazard maps. The counterpart is the Institute of Water and Flood Management, IWFM.

Source: JICA Survey Team

Table 4.4.7 Achievements of Loan Project by Japan (Storm Surge)

Year	Project Name	Project Cost	Outline
2010～2017	Chittagong Ring Road Construction Project	9.0 billion Yen	A ring road applied to high tides was constructed in Chattogram City. The counterpart organization is Chattogram Development Authority.
2016～	Disaster Risk Management Enhancement Project	16.9 billion Yen	River structure construction (embankment/gutter gate), road bridge restoration, and emergency disaster response will be carried out mainly in the high tide-prone areas in southwestern Bangladesh. The counterparts are DDM, BWDB, and LGED.

Source: JICA Survey Team

4.4.3 Cooperation with Other Donors

4.4.3.1 World Bank

(1) Emergency 2007 Cyclone Recovery and Restoration Project (ECRRP)

The ECRRP was implemented for over six years from November 2008 to June 2014 with the objectives of restoring and rebuilding structures and livelihoods destroyed by Cyclone Sidr, and building a setup for long-term disaster countermeasures and a management setup. The main executing agencies are LGED and BWDB. The project cost was US$ 221 million and the target areas were the coastal areas excluding the east of the country. Outlines of the ECRRP components are shown in the following table.

Table 4.4.8 Outline of ECRRP Component

Component	Outline
1. Agricultural Sector Recovery and Improvement Program	- Support for the agricultural products subsector - Support for the fisheries subsector - Support for the livestock subsector - Promotion of community support and component management
2. Reconstruction and Improvement of Multipurpose Shelters	- Construction of new shelters - Improvement of existing shelters - Improvement of the shelter network - Consulting services for the above
3. Rehabilitation of Coastal Embankments	- Rehabilitation of coastal embankments - Consulting services for the above
4. Long-Term Disaster Risk Mitigation Program	- Capacity building via multi-hazard modelling and evaluation activities - Improvement of embankments on Brahmaputra River and in CEIP - Preparations for the construction of new shelters and improvement of existing local roads
5. Monitoring and Assessment of Project Effects	- Compilation of the project inputs, outputs, and numerical indicators of achievements by the consultants
6. Project Management, Technical Support, Strategic Review, Training, Emergency Support for Future Disasters	- Project Coordination and Monitoring Unit (PCMU) - Consulting services regarding post-disaster reconstruction financing - Strategic examination of re-insurance subscription, etc. - Technical support and training concerning disaster management - Emergency support in response to disasters that may occur during project implementation

Source: "THE PREPARATORY SURVEY ON THE CAPACITY ENHANCEMENT ON DISASTER RISK REDUCTION, EMERGENCY RESPONSE AND RECOVERY PROJECT, JICA, 2016"

(2) Coastal Embankment Improvement Project (CEIP)

This project mainly involves the construction of storm surge embankments and sluice gates, as well as the necessary environmental and social considerations, monitoring, and capacity building.

The project costs of CEIP-1 are shown in the following table.

Table 4.4.9 CEIP-1 Project Cost

Component	Project Cost
1. Polder rehabilitation cost	US$291 million
2. Environmental and social consideration costs	US$56 million
3. Execution supervision and monitoring costs	US$32 million
4. Project management and technical cooperation	US$21 million
Total project cost	US$400 million

Source: CEIP Document

As of June 2015, a detailed design has been completed for four of the five reclaimed lands (Phase I) subject to CEIP-I (numbers 32, 33, 35/1, and 35/3). And construction is in progress in 2021. Concerning the CEIP embankment height, upon implementation of the probability scale, separate simulations (1/10, 1/25, 1/50, 1/100-year probabilities) based on the assumption that global warming will cause the sea level to rise by 50 centimeters, tropical low-pressure intensity to rise by 10%, air temperature to rise by 2 degrees and precipitation to rise by 20% by 2050, it was decided to adopt the 25-year probability. As a result, the height of the embankment is E.L.6.0m. In addition, the embankment is protected by CC blocks (revetment work) and geobags (bank toe protection work).

The CEIP aims to strengthen the resilience of coastal populations to natural disasters and climate change by

1) Reduce damage to human life, property, crops, and livestock caused by natural disasters

2) Reduce the time required for recovery and reconstruction from cyclones and other natural disasters

3) Restore and improve the safety of coastal embankments to limit the inflow of seawater into the embankments due to climate change. Improve and restore the coastal polder system.

The objectives of the First Phase of the CEIP for Bangladesh are;

(a) increase the area protected in selected polders from tidal flooding and frequent storm surges, which are expected to worsen due to climate change

(b) improve agricultural production by reducing saline water intrusion in selected polders; and

(c) improve the Government of Bangladesh’s capacity to respond promptly and effectively to an eligible crisis or emergency.

The project also consists of five components.

(1) Rehabilitation and improvement of polders component will finance activities that aim to increase community resilience to tidal flooding and storm surges.

(2) Implementation of social and environmental management frameworks and plans component will support consultation with and strengthening of polder stakeholders and beneficiaries.

(3) Construction supervision, monitoring, and evaluation of project and coastal zone monitoring component will cover consulting services for (i) surveys, designs of remaining polders to be included in the project and, (ii) construction supervision of rehabilitation and improvement of coastal embankments; (iii)continuously monitoring project activities and providing feedback to the government and the implementing agency on the project’s performance.

(4) Project management, technical assistance, training, and strategic studies components will support Bangladesh Water Development Board in implementing the project.

(5) Contingent emergency response component will be contingent upon the fulfillment of the

following conditions: (i) the Government of Bangladesh has determined that an eligible crisis or emergency has occurred and the Bank has agreed and notified the Government; (ii) the Ministry of Finance has prepared and adopted the Contingent Emergency Response (CER) Implementation Plan that is agreed with the Bank; (iii) Bangladesh Water Development.

Table 4.4.10 CEIP Polder Categories

Item	Detailed Design Targets	F/S Targets
Polder No.	32, 33, 35/1, 35/3, 39/2C	14/1, 15, 16, 17/1, 17/2, 23, 34/3, 47/2, 48

Note: The location of the polders is shown in Figure 4.4.10
Source: "THE PREPARATORY SURVEY ON THE CAPACITY ENHANCEMENT ON DISASTER RISK REDUCTION, EMERGENCY RESPONSE AND RECOVERY PROJECT, JICA, 2016"、https://documents1.worldbank.org/curated/en/748531468209052823/pdf/744820PAD0P1280disclosed060701300SD.pdf

Source：JICA Survey Team

Figure 4.4.7 Storm Surge Bank Under Construction (Polder No.35/1)

(3) Emergency 2007 Cyclone Recovery and Restoration Project

As a post-disaster support project by Cyclone Sidr that occurred in November 2007, in addition to financial support for farmers, we implemented capacity building for the construction of cyclone shelters and embankments and disaster risk management. The table below shows some of the projects implemented.

Table 4.4.11 Support by the Project

No.	Item	Qt.	Note
Component B: Reconstruction and Improvement of Multipurpose Shelters			
B1	Construction of new shelters	50	
B2	Improvement of existing shelters	250	
Component C: Rehabilitation of Coastal Embankments			
C1	Rehabilitation of coastal embankments	100 km	Coastal

Source: PROJECT INFORMATION DOCUMENT for Emergency 2007 Cyclone Recovery & Rest Pr October 30, 2008
https://documents.worldbank.org/en/publication/documents-reports/documentdetail/857731468207266497/bangladesh-emergency-2007-cyclone-recovery-and-restoration-project

4.4.3.2 ADB

(1) South-West Area Integrated Water Resource Planning and Management Project (SAIWRPMP)

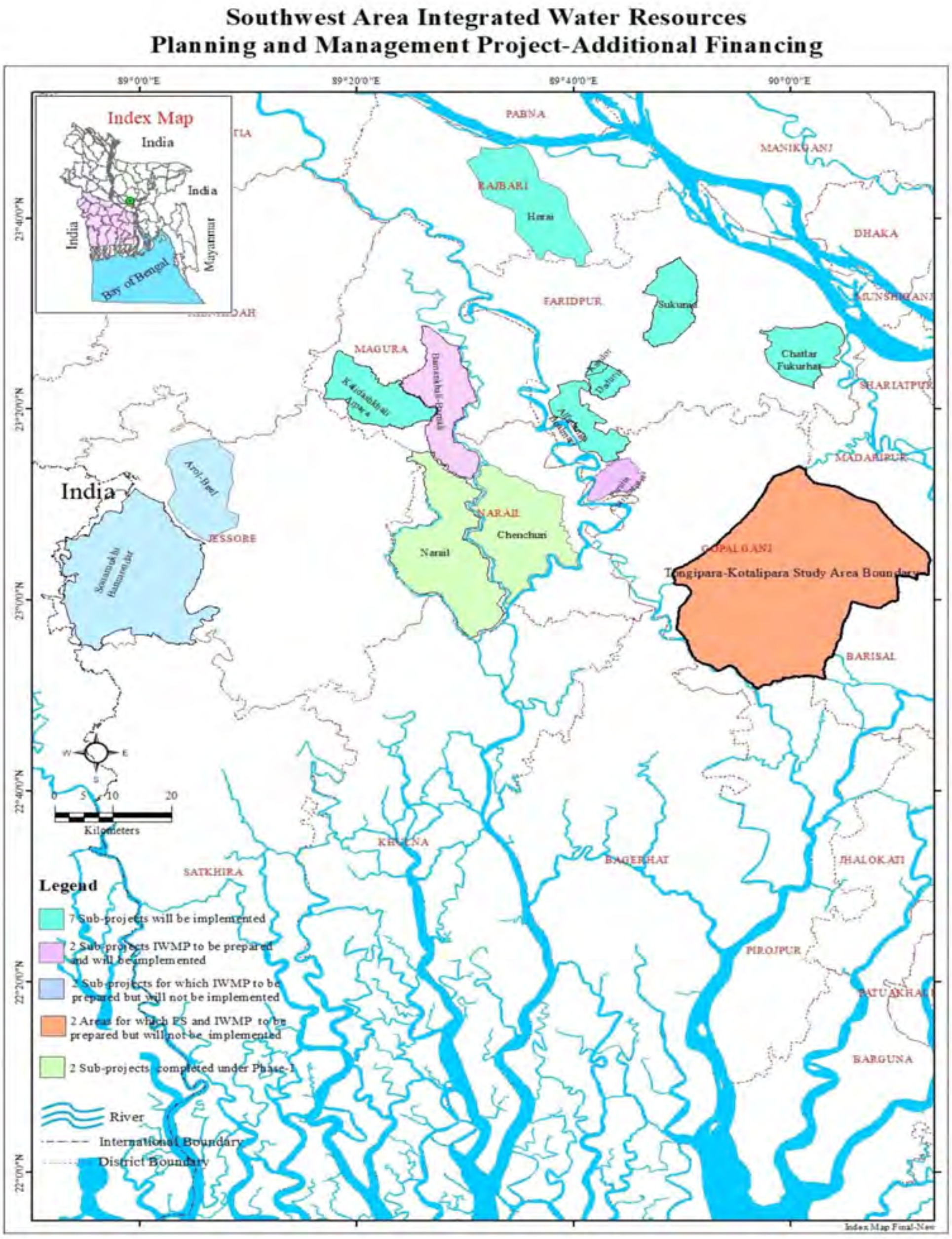
SAIWRPMP entailed compiling a comprehensive water management plan based on public participation and constructing a productive and sustainable water resources management system based on the plan. The main targets were the Chenchuri Beel Sub-project and the Narail Sub-project over an area straddling Jessore District and Narail District in the southwest, and the reconstruction of polders that were damaged by Cyclone Aila in Khulna District and Sathkira District. The project executing agency is BWDB. This project was implemented from August 2006 to 2013 for US$43 million.

SAIWRPMP was composed of the following components:

1. Compilation of a comprehensive water management plan based on public participation;
2. Construction of water management infrastructure;
3. Support for agriculture and fisheries development services and improvement of livelihoods;
4. Support for the construction of a sustainable maintenance system; and
5. Guidelines, framework, and organizational capacity building geared to the provision of effective services.

(2) South-West Area Integrated Water Resource Planning and Management Project Additional Financing (SAIWRPMP-AF)

This is the second phase of the SAIW RPMP project in the previous section, which started in 2020 and is currently underway. The target area has not changed.



Source：SAIWRMPMP-AF report

Figure 4.4.8 Project Area of SAIWRPMP-AF

4.4.3.3 Dutch Government

(1) Char Development and Settlement Project-IV (CDSP-IV)

The Ganges-Brahmaputra-Meghna delta has newly emerged ‘char’ islands resulting from the deposition of sediment. These mighty rivers flow into the Bay of Bengal, which is continuously changing. Satellite pictures show that each year about 52 km^2 of newly formed land accretes, and about 32 km^2 erodes from the coasts. Hence, the result is a net 20 km^2 /year deposition of sediments carried by the Padma (Ganges), the Meghna, and the Jamuna (Brahmaputra) from the Himalayas to the Bay of Bengal.

By law, the newly acquired coastal land belongs to the Ministry of Land, Government of Bangladesh, and is entitled ‘khas’ land. Institutionally, the new char lands are virgin territory where service deliveries by government agencies are rarely present. Living conditions on the chars are harsh; the land is completely inaccessible and can only be reached by boat and on foot. The people living there are exposed to nature and the land is flooded regularly. There is no safe drinking water, health services, or sanitation; no agricultural inputs, and no education. As a result, coastal chars are reigned over by so-called ‘jotdars’ and ‘bahinis’/’mastans’ the local power holders who provide temporary protection to poor char dwellers in return for illegal money.

The Government of Bangladesh intends to bring coastal chars under a productive human settlement with the goal of a better economic situation for the char dwellers. To reduce the social, institutional, and environmental vulnerability faced in char areas, the Government initiated the Land Reclamation Project (LRP) which was implemented by BWDB during 1979-91 with grant support from the Government of the Netherlands.

The Char Development and Settlement Project (CDSP) was the successor of this project; CDSP-I was formulated based on the experience of LRP and successfully implemented during 1994-99. Since then, the development of newly accreted chars through polder development and providing secure land titles to poor landless char dwellers have become the core development approach of CDSP.

CDSP became a multi-agency integrated project with BWDB as the lead agency and the participation of the Ministry of Land, Local Government Engineering Department, Department of Agricultural Extension, Forest Department, and Department of Public Health Engineering. The first three phases of CDSP were implemented solely with grant support from the Government of the Netherlands and the Government of Bangladesh. In the fourth phase of the CDSP, the United Nations International Fund for Agriculture Development (IFAD) came forward with credit support for the Government of Bangladesh. In July 2019, a new phase of bridging (Additional Financing) was initiated and will be completed by June 2022. CDSP B (AF) has these characteristics: The overall objective of CDSP is to reduce poverty and hunger for poor char dwellers living on newly accreted coastal chars, which is being achieved via improved and more secure livelihoods.

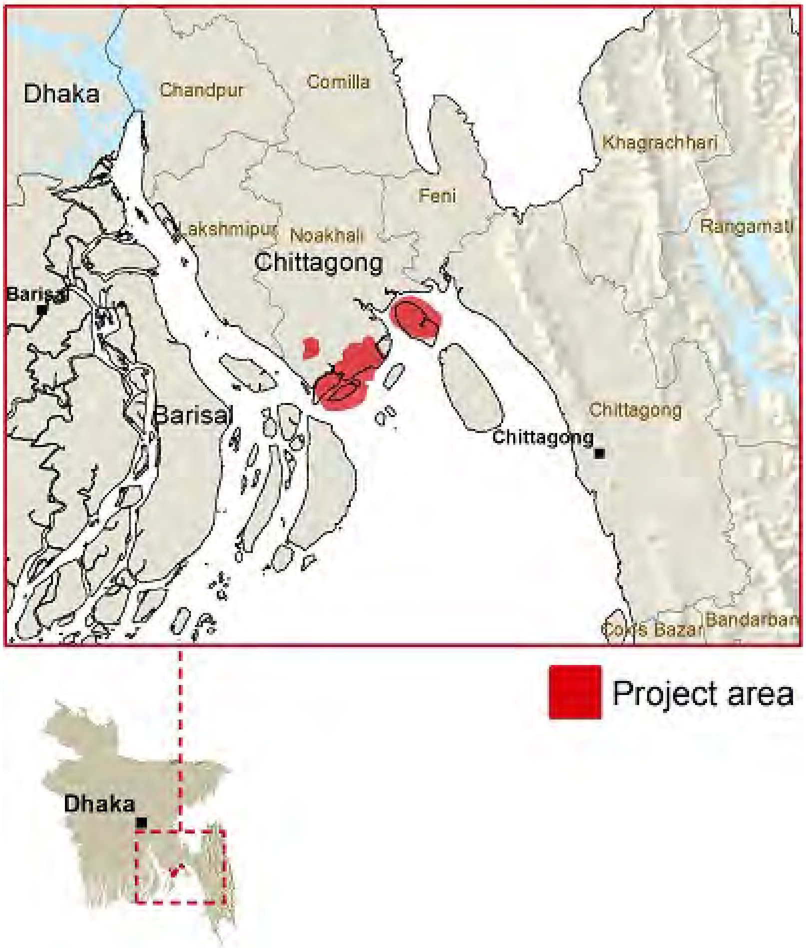
The first specific objective of the Project is to consolidate the achievements of the earlier CDSP phases I-IV. The Project continues to support CDSP I, II, III, & IV areas with operation and maintenance activities and land settlement. Security for people and livelihoods has already been provided during these phases via climate-resilient infrastructure and by providing poor households with legal title to land. The following six project components are implemented in these areas.

1. Effective management of water resources, protection against tidal and storm surges, improved drainage
2. Climate resilient internal infrastructure for communication, markets, cyclone shelters, provision of potable water, and hygienic sanitation
3. Provision to the settlers of a legal title to land
4. Improved livelihoods and household resilience
5. Institutional development to create an enabling institutional environment
6. Knowledge management through undertaking and disseminating surveys and studies and by learning from and contributing to ICZM efforts. The purpose of the ICZM is to improve and enhance the security of the livelihoods of the settlers in the coastal areas.

A second specific objective of the Project is the preparation of future investments in char development in the South Eastern delta.

The project was approved in April 2010 and is scheduled to run through 2022. The total project cost is estimated at $139.15 million[20].

[20] Source: https://cdsp.org.bd/, https://www.ifad.org/en/web/operations/-/project/1100001537



Source：CDSP-IV Report

Figure 4.4.9 Project Area of CDSP-IV

(2) Blue Gold Programme

The overall objective of the Blue Gold Programme is to reduce poverty for 150,000 households living in 160,000 ha area of selected coastal polders by creating a healthy living environment and generating sustainable socio-economic development.

Programme Components

1. Community mobilization and institutional strengthening: As the starting point of the program, communities in the polders are organized into Water Management Groups (WMGs) at the village level and Water Management Associations (WMAs) at the polder level, with an aim to create effective cooperatives that are in a position to formulate community priorities. The capacity development of the cooperatives will build on the training approach and toolkit developed in the IPSWAM and Southwest Area projects. At least 30% of women's participation is ensured as general as well as executive committee members in the WMGs/WMAs which is a breakthrough in women empowerment.

2. Integrated water resources management: This component enhances flood protection in polders by rehabilitation of the embankments and water intakes and outlets and by improving the water distribution and drainage systems; it fine-tunes and rehabilitates the infrastructural works of selected polders, and creates an effective operational partnership between government agencies and community groups (WMG/WMA). Planning, design, and implementation of civil works are based on the principle of participatory water resource management.

3. Food security and agricultural development: This component organizes Farmer Field Schools (FFS). FFS are linked to the WMGs in the polders to educate and assist male and female farmers to increase productivity in crops, aquaculture, and livestock. The scope for increased productivity is created through improved water management (polder rehabilitation) and strong WMGs (responsible for operation & maintenance in the polders). The FFS and the introduction of Polder Development Plans bring higher agricultural production, resulting in an improved supply of nutritious foods at lower prices at local retail markets; improved food security and food use through greater awareness and behavioral change in the polder communities.

4. Business development and private sector involvement. A Business Development Plan for each polder is developed for the production and marketing of selected farm products. The Business Development Plans assist the WMGs/cooperatives to further professionalize and diversify. This component focuses on field crops or other agricultural products, for which value chain analyses are made and private sector linkages are established for well-defined services as input for the Business Development Plans. It supports the food security component.

5. Livelihood improvement and cross-cutting issues. Cross-cutting issues that are firmly incorporated in the program relate to good governance, gender (its importance will be reflected in the inclusion of Gender Action Plans as part of the community action plans and polder development plans), climate change/disaster risk reduction (DRR) and technological innovation.

The program was approved in March 2013 and runs through December 2021. The total cost is estimated at EURO 75.9 million[21].

4.4.4 Issued in Current Efforts

4.4.4.1 Large Gaps between the Vast Areas to be Protected from Disasters and the Insufficient Budget

International cooperation by various donors, including Japan, is proceeding with the development of coastal embankments (polders), but the long coastline is still not fully protected. For this reason, there are some places where local residents have restored the embankment on their own. Such embankments are extremely vulnerable without revetments. These were destroyed with each cyclone, and restoration was repeated each time.

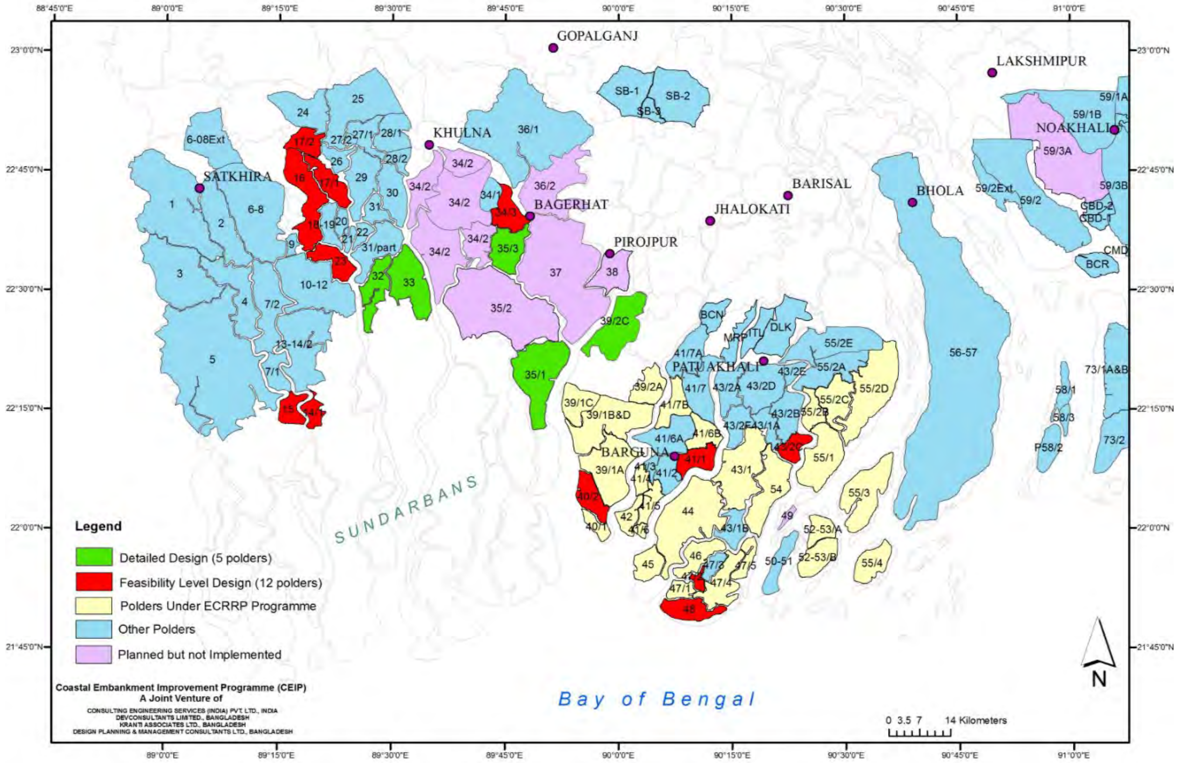
International cooperation has so far focused on rural areas vulnerable to storm surges. Currently, the Disaster Risk Management Enhancement Project (DRMEP) funded by JICA is being implemented in the southwestern part, and the Coastal Embankment Improvement Project (CEIP) is being implemented by WB in the southwestern part to the southern part.

Considering the status of development in Bangladesh, large-scale development, urbanization, and population growth are expected in the southeastern part of Bangladesh in the future. It is also important to cooperate for the implementation of storm surge countermeasures in the area to be developed in the future.

The BWDB also understands this situation and is considering the construction of a coastal embankment (Super Dike: 500 km) in the coastal area of the Big-B area (Chattogram district) in southeastern Bangladesh. The estimated value is 275,000 million Bangladesh Taka (BDT).

However, the budget for the BWDB was 93,293 million BDT in FY 2021, of which 24,900 million BDT was for bank improvement projects including river projects (See 4.1.1.2 (7)). The BWDB budget is more than 10 times less than the estimated amount of coastal embankment in the Big-B area.

[21] Source: http://www.bluegoldbd.org/what-we-do/about-blue-gold/, https://www.netherlandsandyou.nl/binaries/netherlandsandyou/documents/publications/2017/04/30/bangladesh-blue-gold-fs/Bangladesh_Blue+Gold+FS.pdf



Source: CEIP

Figure 4.4.10 Area Covered by CEIP in Southwestern Bangladesh

Table 4.4.12 Storm Surge Mitigation Projects in Southeastern Bangladesh Considered by BWDB

Proposed Project name	Tentative cost (in 1,000 BDT)	Major components	Project area
Construction of Super dyke from Mirer Sarai, Chattogram to Cox's Bazar	275,000,000	Construction of Super Dyke-430.00km., Construction of interior Dyke- 70.00km, Construction of Regulators- 64 nos, Construction of Bridge- 07 nos & Beach management	Mirsarai to Cox-Bazar, Sandip, Kutubdia, Dholghat, Moheskhali,
Construction of super dyke along Laxmipur-Noakhali-Feni coastline	206,360,000	Construction of Super Dyke-126.00km., River Bank Protection-126.00 km., Construction of Regulators- 08 nos, Closures/Cross Dam- 14 Nos and Construction of Connecting Bridge- 33 Nos.	Laxmipur-Noakhali-Feni Coastline

Source: Data provided by BWDB (excerpt)

It is necessary to promote advanced investment in areas where economic development is expected in southeastern Bangladesh. However, the coastline without embankments is so long that it requires huge amounts of money to exceed BWDB's annual budget. In order to solve this, assistance from donors such as JICA will be essential in the future.

In addition, when providing support, it is desirable to propose measures against storm surges that utilize Japanese technology and have BWDB understand the measures against storm surges that can exert their maximum functions. At the same time, it is desirable to aim at reducing maintenance costs.

4.4.4.2 Bias Toward Restoration and Reconstruction Projects in Storm Surge Countermeasure Projects

Previous BWDB projects and donor assistance tended to be reactive after the disaster. This is thought to be because disaster recovery cannot keep up with the storm surge damage that occurs every year. Of course, it is important to take measures after the disaster, but it is also necessary to provide cooperation with a focus on pre-disaster investment for disaster risk reduction. In order to do so, it is necessary to formulate a nationwide plan for measures against storm surges and to implement projects in order of priority. However, at present, the concept of advance investment based on the plan is not widely accepted. It is also desirable to consider the effects of climate change.

4.4.4.3 Low Awareness of Compliance with New Storm Surge Protection Related Guidelines

There are several design manuals in BWDB. The 1996 manual is the most effective. However, in the actual design work, the "manual" is adhered to, but the "guidelines" created by the new knowledge after that are not very conscious of compliance.

For reference, the following are the features of various manuals.

- ✓ BWDB Design Guidelines for River Bank Protection (2021):
  Guideline summarizing the design policy of the embankment of BWDB. The design policy of river structures such as sluices is not described.
- ✓ BWDB Criterion for Determining the Crest Level of Flood Control Embankment (2020):
  Minutes summarizing the determination policy of levee height based on the examination of the coastal levee improvement project (Coastal Embankment Improvement Project: CEIP) (World Bank). (Internal Data)
- ✓ BWDB Design Guidelines for River Bank Protection (2010):
  This manual is a detailed summary of basic knowledge, design, and construction policy of rivers in Bangladesh prepared by the Bangladesh Institute of Technology (Bangladesh University of Engineering and Technology: BUET). The contents are more academic and detailed than the 1996 manual.
- ✓ BWDB Standard Design Manual (1996):
  A manual that covers policies and standards for river planning and design. It is the basis of the current manual and guidelines. It is the basis of current manuals and guidelines and is the most effective.
- ✓ JICA Design Manual for River Embankment in Bangladesh (2017):
  A manual on river banks was prepared by the Project for Capacity Building for Sustainable Water Infrastructure. It is stated that it is not for the coastal levee. The author is not a BWDB but a project, many descriptions that push Japanese standards to the fore. For this reason, it is recognized as a "reference material" from the BWDB side and is not well known in BWDB. In addition, this manual is not well known because it was distributed only to some parties.

Table 4.4.13 Comparison of Manuals/ Guidelines

Contents	BWDB Revetment Design Guidelines 2021	BWDB Revetment Design Guidelines 2010	BWDB Standard Design Manual 1996	JICA Manual 2017 (Reference)
River Planning Theory	Brief Description.	Described in Detail.	Brief Description.	Brief Description.
Embankment shape (slope, etc.)	Described.	Same left.	Same left.	Content equivalent to the BWDB manual
Revetment	The selection of CC blocks, geobags, geotextiles, etc. is described in detail.	Same left.	Same left.	Japanese style revetment with protrusions and Japanese style revetment foundation are used.
Embankment Height	Consider the wave height.	Same left.	Same left.	Content equivalent to the BWDB manual
Examination of consolidation settlement (examination of surplus)	No description.	The phenomenon is mentioned, but there is no specific description.	There is a brief description.	Complies with Japanese standards. (To be confirmed by general value or consolidation calculation)

Contents	BWDB Revetment Design Guidelines 2021	BWDB Revetment Design Guidelines 2010	BWDB Standard Design Manual 1996	JICA Manual 2017 (Reference)
Stability Calculation (Circular Slip)	No description.	Written. However, it is described in the item of "General" and is not necessary for design.	There is a brief description.	Consideration recommended.
Seismic (liquefaction)	No description.	Written. However, it is described in the item of "General" and is not necessary for design.	No description.	Described as reference.
Projects for which guidelines have been developed.	Projects within BWDB (the Coastal Embankment Improvement Project of the WB is considered to have a significant contribution to the giudeline.)	ADB, "Jamuna Meghna River Erosion Mitigation Project"	Project within BWDB (United States Bureau of Reclamation's criteria are mainly referenced.)	JICA "The Project for Capacity Development of Management for Sustainable Water Related Infrastructure"

Source: JICA Survey Team

The following is a summary of the technical issues related to the storm surge guidelines.

(1) Design Stage

1) Embankment Design

[Revetment installation range on the embankment]

According to Japanese standards, storm surge embankments are protected by revetments from the front slope to the top to the back slope. In addition, a Parapet wall will be installed at the top of the embankment.

However, in Bangladesh, it is common to install revetments up to the high tide level on the surface slope, and there are few cases of installing Parapet walls.

Therefore, at the time of overtopping, the part without revetment is eroded by running water and the embankment is gradually destroyed. When designing the embankment, it is desirable to set the revetment range in consideration of the influence of waves.

[Embankment specifications]

The existing embankment is smaller than the size stipulated in the latest guidelines 2021, because it is built according to old standards. Embankment specifications for new construction and emergency restoration tend to follow the size of existing embankments around them and past practices. This is because if a large-sized embankment is constructed, construction costs and resident relocation costs will increase significantly.

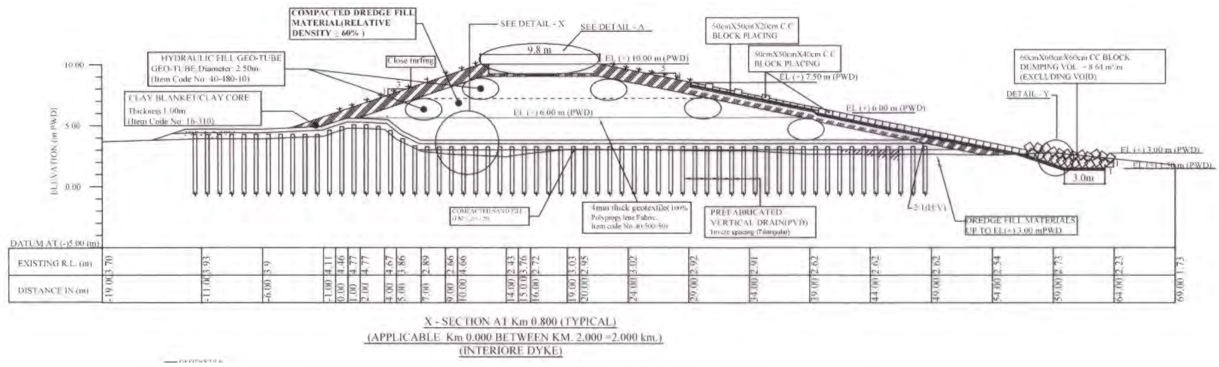
In the future, it is desirable to design into consideration of the latest guidelines and climate change in order to respond to the expected rise in sea level due to climate change. In addition, in the design manual, the amount of consolidation settlement is to be calculated when designing the embankment, but in some cases, it is not actually calculated.

[Embankment Alignment]

The BWDB Standard Design Manual provides a simplified description of the setting of embankment alignment. In practice, they are sometimes set without considering the scientific basis (e.g., erosion potential), but by taking into account land use and building placement. Therefore, it is recommended that the scientific consideration policy should be organized in detail in the manual.

[Technology not described in the manual]

In the existing drawings, there are some empirical techniques that are not described in the manuals and other documents. (Geotubes for earth retention in embankments, geotubes for both temporary closure and embankment foot protection, leaving about 2 months for embankment compaction, etc.) Such techniques may be proprietary to a particular engineer and should be systematically organized in manuals or other documents.



Source: BWDB

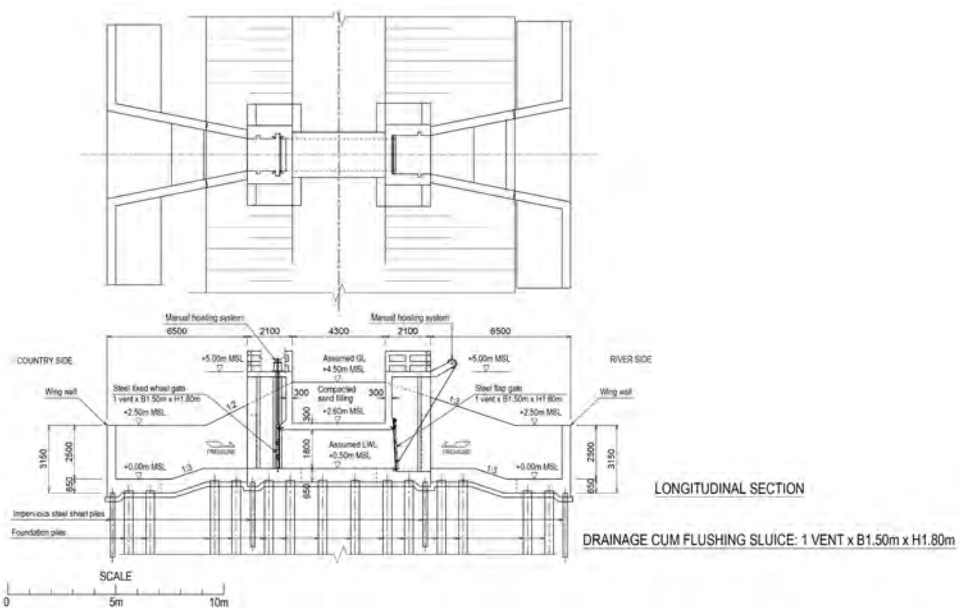
Figure 4.4.11 Example of Standard Cross-Sectional Drawing by BWDB (Matarbari Area)

2) Regulator Design

There is only one design standard for the regulator (sluice gates). The size of the gate is unified with 1.5 meters in width and 1.8 meters in height. For wide river width, the number of gates is increased horizontally. Due to the flat nature of Bangladesh's coastline and the almost identical size of its embankments, no major problems appear to have arisen with a single design standard. Rather, it has the advantage of being easy to design and construct because the standard is fixed.

However, Bangladesh’s regulators are relatively small in size and have low drainage capacity. For this reason, there are concerns about an increase in flooding time due to poor drainage and an impact on the riverbank due to an increase in flow velocity during drainage.

It is expected that the size of the levees will increase to cope with climate change. Since sluice gates and sluice gates also correspond to the above requirements, it is considered necessary to establish standards for flexible design.



Source: BWDB

Figure 4.4.12 Standard Design of Regulator (Sluice Gate)

(2) Construction Stage

The quality of construction is always a problem when constructing Storm Surge embankments. Especially, the compaction of the embankment is the part that greatly affects the strength of the embankment. At the time of design, the design is performed in accordance with the contents described in the BWDB manual, etc., and a fixed compaction rate is specified. However, due to insufficient monitoring at the time of construction, the required compaction rate is not met, and embankments with lower strength than expected are often formed. This point has already been pointed out in the JICA Capacity Building Project for Sustainable Water Infrastructure Development (Technical Professionals) and is included in the manual. This compaction management needs to be made more effective.

There are three main reasons why quality cannot be ensured.

- ✓ Sand is hard to obtain along the sea, and the quality of dredged soil is poor. In addition, it is difficult to control the water content of the embankment because the embankment is built by mixing clay and sand.
- ✓ Insufficient tools and knowledge for compaction tests. Only major contractors possess the technology for compaction management. Local small and medium-sized contractors are not possible.
- ✓ Because the dry season is as short as 5 months and the deadline for the project is short, the construction period is limited, and the contractors and supervisors are inevitably rushed to do the construction, resulting in insufficient compaction.

This point has already been pointed out in JICA's "The Project for Capacity Development of Management for Sustainable Water-Related Infrastructure" and is included in its manual. It is necessary to make compaction management more effective in the future.

(3) Operation and Maintenance

Metal structures in coastal areas, such as sluice gates, are susceptible to corrosion. Most of the structures in Bangladesh were installed in the 1960s and 1970s, and many of them are already damaged due to poor maintenance budgets. It is desirable to consider the maintenance and management of newly constructed or rehabilitated facilities in the future and to consider corrosion countermeasures for the structures.

(4) Summary of Issues

At present, BWDB is systematically implementing the project to some extent. Considering the future development of Bangladesh, it is necessary to aim for a higher technological level. As mentioned above, within BWDB, there are issues at each stage of planning, design, and construction. In the future, it will be necessary to build strong embankments and structures (regulators, etc.) to respond to climate change over a wide area, especially in coastal areas, so it is necessary to cooperate to build a stronger organizational system.

4.5 Meteorological Warning and Forecasting

4.5.1 Initiatives by the Government of Bangladesh

4.5.1.1 Legal System for Meteorological Warning and Forecasting

In Bangladesh, MoDMR is the ministry in charge of disaster management and BMD is the agency responsible for issuing weather forecasts and warnings regarding storm surges and cyclones.

The Meteorological Act 2018 deals with meteorological phenomena, terrestrial phenomena, and hydrological phenomena including climate change and prescribes the structure of BMD and BMD has responsibility for meteorological observation and issue of alerts and warnings. The act restricts to issue alerts/warnings except for BMD and specifies BMD transmits meteorological alerts/warnings to relevant ministries mass-media, however, the order of alerts/warnings regarding earthquake and any disasters originated from an earthquake (flooding, tsunami, etc.) should be coordinated by BMD[22].

4.5.1.2 Review of High-Level Plans for Meteorological Warning and Forecasting

As for the review of the higher level plans covering cyclone preparedness and response, it is shown in 4.4.1.2.

4.5.1.3 Concrete Disaster Management for Meteorological Warning and Forecasting

(1) Prior Investment and Prevention Plans

As activities for meteorological warning and forecasting play a part in disaster prevention phase 4, prior investment and prevention plans on the field are a measure for capacity building in the realm. Therefore, concrete activities are summarized in section (2).

(2) Current Situation of Meteorological Waring and Forecasting

1) Outline of Surface Observation, Observation Equipment, and Forecasting

BMD has 43[23] manned surface observation stations. These 43 stations basically report observation data every three hours, and these data are transferred to headquarters (SWC: Storm Warning Center) via their own software and internet line. Forecasters use the data from the 43 stations to generate SYNOP (Surface Synoptic Observations) codes. BMD has 61 Automatic Weather Stations (AWSs) but there are cases in which data cannot receive from around 24 stations of them. SWC is not using AWS data for forecasting, while they use 43 manned stations and observation data around Bangladesh, which is obtained through Global Telecommunication System/WMO (GTS). BMD does not have any plans to replace manned observations with AWSs for securing data accuracy.

Maintenance at the manned stations has been implemented once every two to three years without a specific maintenance schedule. This maintenance has been reported by email.

As for equipment verification, the JICA technical cooperation project provided the following equipment in 2013.

Table 4.5.1 Meteorological Observation Equipment for Calibration Work Procured in JICA Technical Cooperation project in 2013

Items	Quantity
General Equipment	
digital barometer	1
double-tube thermometer	1
Working Standards for Operation and Maintenance	
digital barometer	3
double-tube thermometer	3
Other Verification Facility	1

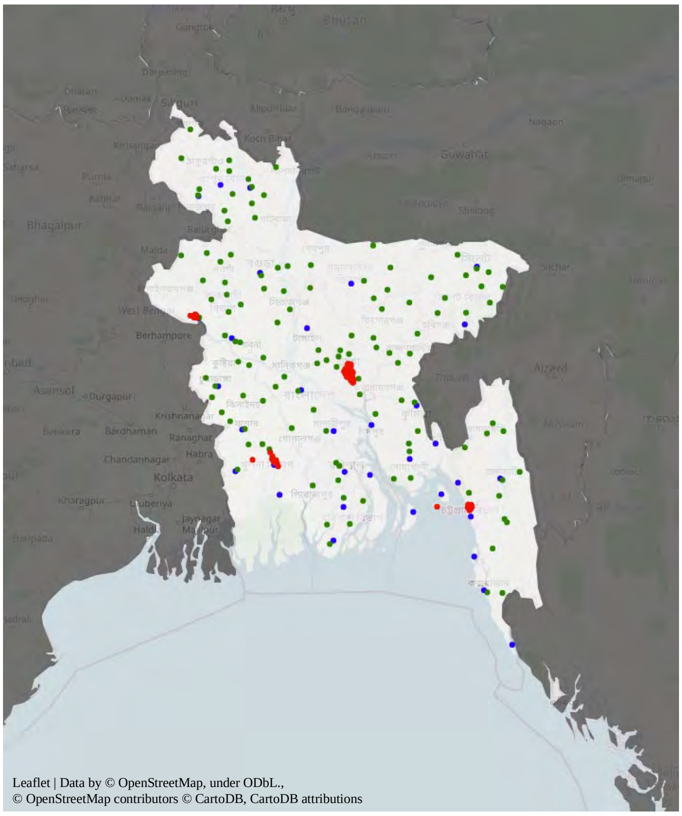
Source: JICA Survey Team

22 Source: Meteorological Act 2018, Authentic English Text dated on 23 December 2019 (http://live3.bmd.gov.bd/p/Met-Act-English/)
23 Actual number of stations has not been confirmed because each staff mentioned a different number.

The national standards were calibrated at RIC Tsukuba during the project. However, although BMD recognizes the necessity of the verification, these standards have not been calibrated since then. BMD conducts equipment verification in the maintenance mentioned above and atmospheric pressure seems not to have errors at most synoptic stations according to WDQMS (WIGOS Data Quality Monitoring System)[24]. WB project intended to provide some calibrator to BMD, however, the details are unfixed. As for the wind tunnel, which was planned to install under the WB project, was rejected due to budgetary problems. Each observation data has been sent to headquarters, the data passes through filtering by forecasters as first data-check and data-check by climate department as second data-check, then finally it will be official and provided through the website and so forth. These official surface-observation data have been stored in BMD's server.

All six AWSs and 12 ARGs provided by JICA between 2009 and 2013 are not functioning at the time of this survey. The cause is due to a number of system problems, however, BMD cannot check and mend them at the site due to the COVID-19 pandemic situation.

WB plans to provide 35 AWSs, 65 ARGs, and 125 Agri-met stations by end of 2021 under the WB project (Figure 4.5.1). This project had temporarily been suspended due to COVID-19 but procurement has been done and some parts of construction work were started as of April 2022.



(Blue: AWS 35 stations, Red: ARG 65 stations, Green: Agro-met 125 stations)

Source: JICA Survey Team drew based on WB Project Dosument; Procurement of Supply and Installation of Automatic Weather Stations (AWS) and Automatic Raingauges, 2020/1/27

Figure 4.5.1 Planned Installation Site of AWS, ARG and Agri-Met of WB Project

2) Weather Radar

(a) Outline of the Radar

BMD operates five weather radars which were all provided by JICA as shown in Figure 4.5.2,

[24] Only barometer corresponds to the numerical model. Some stations observed different pressure from the value the model calculated, but the difference might come from wrong altitude data, which is officially registered.

however, only three radars (Dhaka, Cox's Bazar, and Moulvibazar) of them are currently operated. These radars are regularly operated intermittently as 06UTC, 09UTC, 12UTC for Dhaka, 03UTC, 09UTC for Cox's Bazar, and 00UTC, 12UTC for Moulvibazar so that radars can constantly be operated when a cyclone is developed. Currently, a processing PC for Dhaka radar failed in February 2022, thus only Cox's Bazar and Moulvibazar radars generate echo images, which are uploaded on the BMD's website. Echo images are generated in processing PCs installed at each site and uploaded from each site through the internet. Each radar condition as of 2021 September is listed in Table 4.5.3.

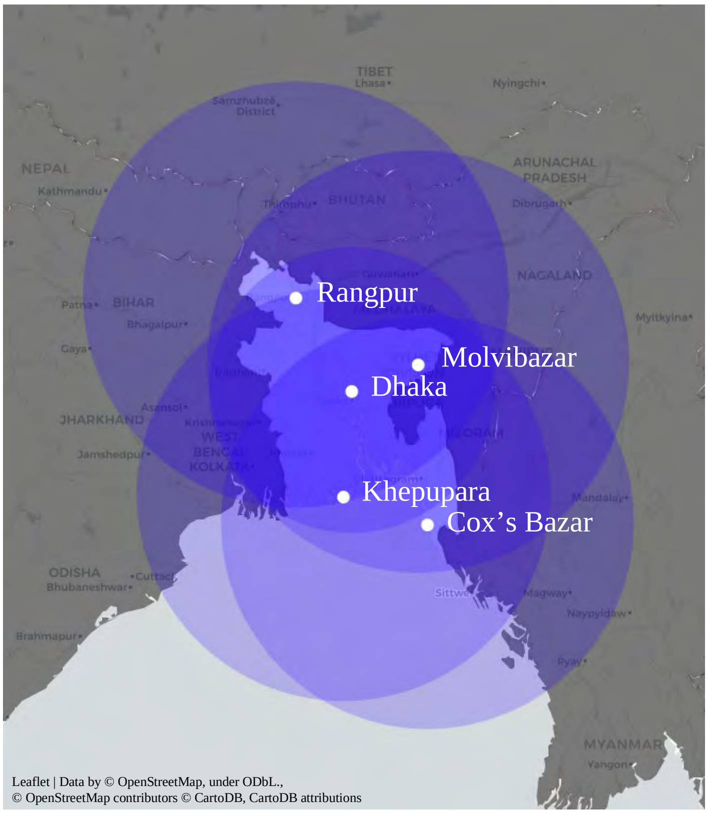
Khepupara radar has been out of operation since 15 July 2018 due to driving system failure. Cox's Bazar also had another problem at the same time, BMD radar engineer therefore investigated them and sent emails to a manufacturer directly in August 2019 to seek repair parts and their support. Only Cox's Bazar had been repaired but it was out of operation again on 17 June 2021. However, the radar was reoperated in November 2021 because the manufacturer could provide some parts for repair.

Replacement of Dhaka and Rangpur radars has progressed, and Dhaka radar is expected to be in operation in June 2023 and Rangpur is in February 2025 respectively according to a construction report as of March 2022.

Radar image composition had been conducted for weather forecasts before. Currently, as mentioned above, the radar image is generated at each site and not sent to Headquarters in raw data, therefore, QPE cannot be conducted. QPE is highly demanded in BMD.

The Doppler data is retrievable from Cox's Bazar, Khepupara, and Moulvibazar, however, BMD is not currently using the data.

Bangladesh Air Force (BAF) also operates two weather radars manufactured in the US in Chattogram and Jshor bases. These radars are used for aviation control and BAF has not shared the data with BMD yet. Difference of use as forecasts/warning for BMD and aviation control for BAF respectively, BMD does not plan to use the radar as an alternative so far. As BAF radar images are uploaded on BAF website, SWC uses the images for reference, but BAF radar also does not remove clutter and the quality is not good.



Source: JICA Survey Team

Figure 4.5.2 Weather Radars of BMD

Table 4.5.2 Weather Radar Specification of BMD

Sites	Cox's Bazar Khepupara Moulvibazar	Dhaka Rangpur	Dhaka (Planned) Rangpur (Planned)
Owner	BMD	BMD	BMD
Band	S	S	S
Beam Width	1.7 deg	1.7 deg	
Frequency	2.7 - 2.9 GHz	2.7 - 2.9 GHz	2.7 - 2.9 GHz
Occupied Frequency Bandwidth	20 MHz (Center Frequency +/-10MHz)	60 MHz (Center Frequency +/-30MHz)	10 MHz
Range (Intensity)	Radius 440km	Radius 300km	Radius 450km
Range (Velocity)	Radius 200km	-	Radius 200km
Data Grid	0.625km	2.5km	0.625km
TX Type	Klystron (tube)	Magnetron (tube)	GaAs/GaN FET (Semi-conductor)
TX Power	500kW	500kW	10kW
RX Type	Digital		
Polarization	Single		
Manufacturer	JRC	Mitsubishi	-
Installation Year	2007~2009	2000	Planned
Note	Doppler	-	Doppler

Source: JICA Survey Team

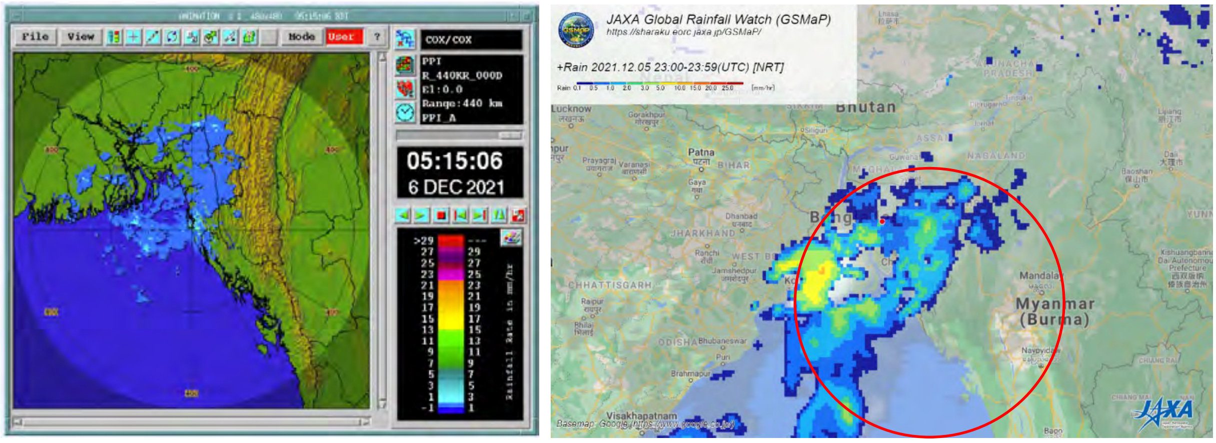
Table 4.5.3 Current Radar Condition

Dhaka	Running, but radar image cannot be generated due to processing PC failure
Cox's Bazar	Running, but VSAT system and Flywheel UPS are out of operation.
Khepupara	Not running due to the faulty antenna driving system, etc.
Moulvibazar	Running. Processing unit has some troubles.
Rangpur	Not running due to short of spare parts.

Source: JICA Survey Team

(b) Comparison between Radar Echo and GSMaP

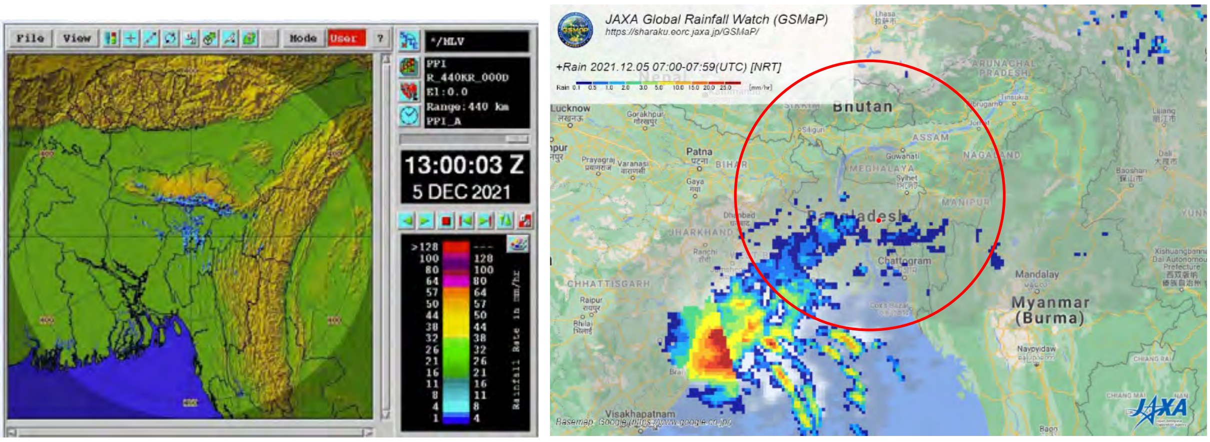
Each processing PC generates radar images at each site, but the images are provided from radars without proper elevation angle nor clutter map. It cannot conclude, but comparing between radar echo of Cox's Bazar and Moulvibazar which are uploaded on BMD's website and satellite image (GSMaP from JAXA), the radar echo of Cox's Bazar seems to correspond, but Moulvibazar cannot find the significant correspondence.



2021/12/6 05:15BST (2021/12/5 23:15UTC), Retrieved Date and Time：2021/12/6/ 08:35BST

Source: Prepared by JICA Survey Team Based on BMD Website

Figure 4.5.3 Cox's Bazar Radar Echo and Satellite Image



2021/12/5 13:00BST (2021/12/5 07:00UTC) , Retrieved Date and Time：2021/12/6/ 08:35BST

Source: Prepared by JICA Survey Team Based on BMD Website

Figure 4.5.4 Moulvibazar Radar Echo and Satellite Image

(c) Personnel Arrangement for Radar

As for repair and spare parts replacement for radar, it is well conducted by radar engineers of BMD. Moreover, BMD secures budget for purchase required parts for radar operation. On the other hands, radars in Bangladesh have installed for around 15 years and manufacture cannot provide only alternative parts, BMD cannot take responsibility for radar operation. Therefore, BMD is requesting radar experts for radar repairs, as BMD cannot replace any alternative parts without the support of JICA experts.

BMD's Electric and Instruments Department where four radar engineers work has in charge of radar maintenance. Four staff are placed at each radar site to operate but it is difficult to maintain the radar properly only with the number of staff, therefore they have not recorded their work on maintenance records since 2018 in Cox's Bazar. The E&I department requires at least ten staff for each site for appropriate radar operation. Meanwhile, according to BMD heads, the lack of staff in BMD has been recognized five years ago but it will be solved soon because of the transformation of the organogram among the other ministries.

A maintenance manual (troubleshooting) has been shared and daily maintenance is recorded at each site. Weekly, monthly, bi-yearly, and yearly maintenance are conducted at Dhaka only. Khepupara had recorded weekly to yearly maintenance until 2018. However, untrained maintenance work such as radome cleaning has not been done.

Radar observation data has been stored on digital media such as CDs. However, recent observation data are saved only image data, raw observation data has not been stored at headquarters nor observation sites. These data have not been checked with surface observation data.

3) Warning and Forecasting Types and Distribution

(a) Publication Procedure for Forecasting

BMD provides weather forecasts every day in Bengali and English as shown in Table 4.5.5. SYNOP, radar, satellite, and numerical forecasts are used for weather forecasts and warning issues. A surface weather map is drawn every three hours and upper air weather maps are drawn twice a day. Forecast assistant tools are DIANA (Digital Analysis) and Tseries (Time Series) from Norway, which use ECMWF model. Satellite data is obtained by SATAID and others such as Korean system. Forecast models SWC uses are WRF and NHM. SWC strongly recognizes data assimilation into these models is important but has not been realized yet.

Table 4.5.4 Weather Forecast Schedule

Contents	Time (BST)
Regular Forecast	
Morning	
Forecast for Hon'ble Prime Minister (Bengali & English)	10:00
Weather forecast for Dhaka and N/Hood	12:00
Bangladesh morning inferefce	11:30
Bangladesh daily weather summary	15:00
Weather forecasts for farmers>after 7 days once	14:00
Evening	
Weather forecast (Chittagong & hill tracts)	15:30
Night	
Bangladesh evening Inference	22:00
Weather forecast for Dhaka and N/Hood	00:00
Weather forecast for farmers	05:30
River and Marin Forecast	
Morning	
Inland riverport warning	10:30
Sea bulletin	10:30
Weather FC for fishing trawlers	10:45
Evening	
Weather F/C for Bangladesh south of lat. 24 N & North of 21 N	15:00
Inland riverport warning	16:00
Night	
Sea bulletin	22:00
Inland river warning	22:00, 05:30
Weather forecast for Chittagong – Sandwip	05:00

Source: "Development of Meteorological Service in Bangladesh" by Mr. Akatsu (JICA) survey in 2019

Table 4.5.5 Weather Forecast on BMD's Website

Item	Target Area	Frequency of Announcement
Daily forecast (24 hours) Today, tomorrow, the day after tomorrow	8 regions, 43 cities	
NWP output (WRF 12km)	64 cities	
Weekly forecast5 days ahead	Ditto	
Monthly forecast	JMA TCC product	Once a week > once a month
3 months forecast	JMA TCC product	Once a month and once after 3 months

Source: BMD Website

(b) Warning Types and Publication Method for Warning

Warnings issued by BMD are Cyclone Warning, Kalbaishakhi (Nor'wester) Warning, Heavy Rain Warning, Heat Wave Warning, Cold Wave Warning, and Fog Warning. These warnings are provided through not only BMD's website but also social media, and government bodies and relative organizations receive the warnings directly by fax and email. After issuing any warnings, some approvals will be skipped to avoid delay. Table 4.5.6 to Table 4.5.11 show criteria for warning issues from BMD.

As for the cyclone warning, it has the same criteria in wind speed at V to VII and VII to X. These differences are positions relative to the cyclone, for example, in the western semicircle of the cyclone is V, on the traveling direction is VI, and in the eastern semicircle is VII. This reason is a cyclone basically blows stronger wind on the right side from the traveling direction than the left side. Heavy rain warning criteria have only 24 hours criterion, but SWC issues the warning even before the criterion was observed but after a discussion referred to a tendency of observation value and results of numerical forecasts.

Table 4.5.6 Cyclone Warning Criteria (Maritime Ports)

Signals	Meanings
Distant Cautionary Signal No. I	I) There is a region of squally weather (wind speed of 61 kms/hour) in the distant sea where a storm may form.
Distant Warning Signal No. II	II) A storm (wind speed of 62-88 kms/hour) has formed in the distant deep sea. Ships may fall into danger if they leave harbour.
Local Cautionary Signal No. III	III) The port is threatened by squally weather (wind speed of 40-50 kms/hour).
Local Warning Signal No. IV	IV) The port is threatened by a storm (wind speed of 51-61 kms/hour) but it doesn't appear that the danger is as yet sufficiently great to justify extreme precautionary measures.
Danger Signal No. V	V) The port will experience severe weather from a storm of slight or moderate intensity (wind speed of 62-88 kms/hour) that is expected to cross the coast to the south of Chittagong port or Cox's Bazar port and to the east of Mongla port.
Danger Signal No. VI	VI) The port will experience severe weather from a storm of slight or moderate intensity (wind speed of 62-88 kms/hour) that is expected to cross the coast to the north of the port of Chittagong or Cox's Bazar and to the west of the port of Mongla.
Danger Signal No. VII	VII) The port will experience severe weather from a storm of light or moderate intensity (wind speed of 62-88 kms/hour) that is expected to cross over or near the port.
Great Danger Signal No. VIII	VIII) The port will experience severe weather from a storm of great intensity (wind speed of 89 kms/hour or more) that is expected to cross the coast to the south of the port of Chittagong or Cox's Bazar and to the east of the port of Mongal.
Great Danger Signal No. IX	IX) The port will experience severe weather from a storm of great intensity (wind speed of 89 kms/hour or more) that is expected to cross the coast to the north or the port of Chittagong or Cox's Bazar and to the west of the port of Mongla.
Great Danger Signal No. X	X) The port will experience severe weather from a storm of great intensity (wind speed of 89 kms/hour or more) that is expected to cross over or near the port.
Failure of Communication No. XI	XI) Communications with the Storm Warning Center have broken down and local officers consider that a devastating cyclone is following.

Source: BMD Website

Table 4.5.7 Cyclone Warning Criteria (Inland River Ports)

Signals	Meanings
Cautionary Signal No. I	I) The area is threatened by squally winds (wind speed of 60 kms/hour) of transient nature. This signal is also hoisted during nor'westers.
Warning Signal No. II	II) A storm (wind speed of 61 kms/hour) or a nor'wester (wind speed 61 kms/hour or more) is likely to strike the area (Vessels of 65 feet and under in length are to seek shelter immediately.
Disaster Signal No. III	III) A storm (wind speed of 62-88 kms/hour or more) is likely to strike the area soon (all vessels will seek shelter immediately).
Great Danger Signal No. IV	IV) A violent storm (wind speed of 89 kms/hour or more) will strike the area soon (all Vessels will take shelter immediately).

Source: BMD Website

Table 4.5.8 Storm Criteria (Inside of Bold Frame is Warning Criteria)

Types	Wind speed
Gusty wind	30-40 km/hr
SquallyWind	41-60 km/hr
Light nor'wester/ Kalbaishakhi	61-90 km/hr
Moderate nor'wester/ Kalbaishakhi	391-120 km/hr
Severe nor'wester/ Kalbaishakhi	121-149 km/hr
Tornado	150 km/hr or more

Source: BMD Website

Table 4.5.9 Heavy Rain Criteria (Inside of Bold Frame is Warning Criteria)

Types	Amounts of Rainfall
Light Rain	1-10 mm /24 hr
Moderate Rain	11 – 22 mm /24 hr
Moderately Heavy Rain	23 – 43 mm /24 hr
Heavy Rain	44 – 88 mm /24 hr
Very Heavy Rain	≥ 89 mm /24 hr

Source: BMD Website

Table 4.5.10 Heat Wave Warning Criteria

Types	Temperature
Mild Heat Wave	36 ~ 38 degC
Moderate Heat Wave	38 ~ 40 degC
Severe Heat Wave	40 ~ 42 degC
Very Severe Heat Wave	> 42 degC
When temperature of an area of about 10,000 square km raises to 36 degrees C or more, which stays for at least three consecutive days and it remains above than normal by at least 2 degrees C is treated as a heat wave condition and warnings are issued.	

Source: BMD Website

Table 4.5.11 Cold Wave Warning Criteria

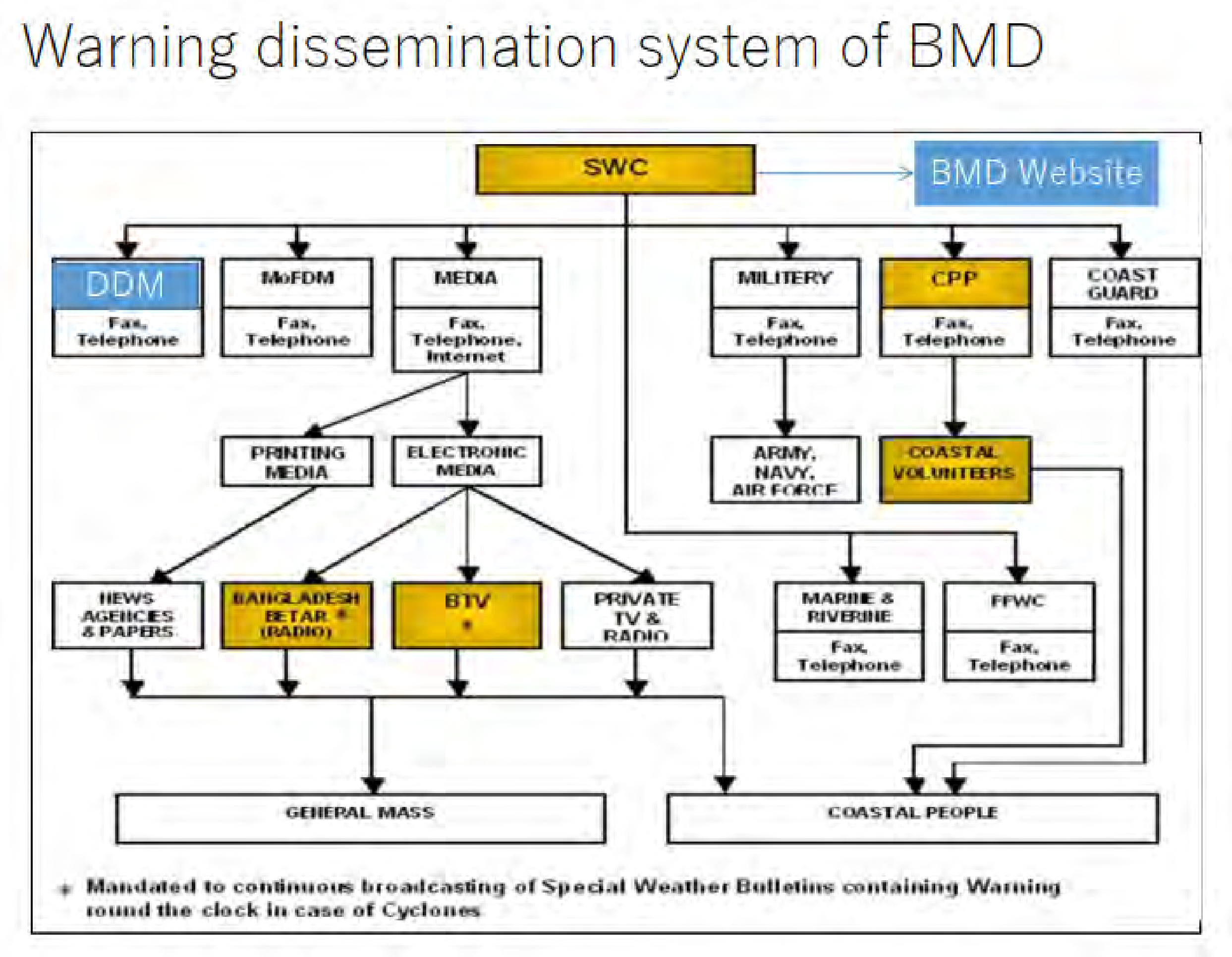
Types	Temperature
Mild Cold Wave	08 ~ 10 degC
Moderate Cold Wave	06 ~ 08 degC
Severe Cold Wave	04 ~ 06 degC
Very Severe Cold Wave	< 04 degC
When temperature of an area of about 10,000 square km lowers to 10 degrees C or less, which stays for at least three consecutive days and it remains below than normal by at least 2 degrees C is treated as a Cold Wave condition and warnings are issued.	

Source: BMD Website

(c) Procedure of Warning Issue

Warning from BMD is distributed according to the procedure shown in Figure 4.5.5. TV and radio have obligation to broadcast issued warnings. Dialing to 1090 or 10941 and 1 to 5 (1: Maritime Warning, 2: River Port Warning, 3: Weather Forecast, 4: Cyclone Forecast/Warning, 5: Flood Warning), weather information is provided 24/7 by an interactive voice recorder.

Official BMD's Android app has been released. The apps are two types that provide current observation value and notice the latest weather forecasts, however, this information was not provided as far as checked in April 2022.



* Email is also used as a communication tool
Source: Prepared by JICA Survey Team Based on BMD's Document

Figure 4.5.5 Warning Dissemination System of BMD

4.5.2 JICA's Cooperation

As for Japan's grant aid in the meteorological warning and forecasting, the cooperation started with The Project for Improvement of the Meteorological Radar Systems at Cox's Bazar and Khepupara, which was completed in 1988, and as mentioned in the table below, a total of five meteorological radars (Cox's Bazar, Khepupara, Dhaka, Rangpur, Moulvibazar) are provided in the project.

As a post-evaluation of the above radar installation, in the Cox's Bazar and Khepupara Meteorological Radar Development Plan, the operating time was far below the target, but the rainfall detection distance was as good as the target, and the quality of cyclone information, warnings and weather forecasts. It was evaluated that the improvement was seen. In the Moulvibazar weather radar installation plan, it was evaluated that the immediacy of warnings was improved by making it possible to observe rainfall in the mountainous areas on the Indian side and throughout Bangladesh.

The technical cooperation project in the meteorological warning and forecasting has supported in the practical use of radars listed in the above table. As one of the outputs of technical cooperation project, an animation for children was provided for disaster awareness as shown in Figure 4.5.6. The animation can be downloaded from the BMD website.

Table 4.5.12 Achievements of Grant Aid by Japan (Meteorological Warning and Forecasting)

Year	Project Name	Project Cost	Outline
1986 ~ 1988	The Project for Improvement of the Meteorological Radar Systems at Cox's Bazar and Khepupara	636 million Yen	Two S-band radars were procured and installed in Cox's Bazar and Khepupara.
1992 ~ 1994	The Project for Establishment of Microwave Link for Meteorology in the People's Republic of Bangladesh	841 million Yen	Microwave Link for transmit of radar images generated by two radars to Dhaka and radar sub-radar-operation system were procured and installed.
1997 ~ 2000	Improvement of the Natural Disasters Weather Warning Project in the People's Republic of Bangladesh	1.473 billion Yen	Radar tower was constructed and two S-band radars, composite radar image system, satellite data receiver, satellite data transmitter, meteorological data computing system, automatic weather observation, and weather data communication system were procured and installed.
2005 ~ 2007	The Project for the Improvement of the Meteorological Radar System at Cox's Bazar and Khepupara (1/2)	866 million Yen	Radar tower was constructed and one S-band radar, weather radar data image system, weather data transmit system, satellite weather data communication system, and satellite data receiving system were procured and installed.
2006 ~ 2008	The Project for the Improvement of the Meteorological Radar System at Cox's Bazar and Khepupara (2/2)	803 million Yen	Radar tower was constructed and one S-band radar, weather radar data image system, weather data transmit system, and satellite weather data communication system were procured and installed.
2007 ~ 2009	The Project for Establishment of the Meteorological Radar System at Moulvibazar	1.00 billion Yen	Radar tower was constructed and one S-band radar, weather radar data image system, satellite weather data communication system, and updating existing radar system were procured and installed.
2015 ~ on going	The Project for Establishment of the Meteorological Radar System at Dhaka and Rangpur	2.881 billion Yen	Radar towers are constructed and two S-band radars, weather radar data image system, satellite weather data communication system, and updating existing radar system are procured and installed.

Source: Post-evaluation report on "The Project for the Improvement of the Meteorological Radar System at Cox's Bazar and Khepupara"
Post-evaluation report on "The Project for the Establishment of the Meteorological Radar System at Moulvibazar"

Table 4.5.13 Achievement of Technical Cooperation by Japan (Meteorological Warning and Forecasting)

Year	Project Name	Project Cost
2009～2014	The Project on Development of Human Capacity on Operation of Weather Analysis and Forecasting in the People's Republic of Bangladesh	The most important task is to properly operates all equipment provided by Japan and to provide appropriate information or alert/warnings to people so that BMD contribute to disaster prevention more effectively. To achieve the task, this project aimed to organize a structure that allow long-term operation of the equipment, secure traceability (automatic weather station, rain gauge), and train engineers for weather services.

Source: JICA Survey Team

Source: Preparatory survey report on the project for establishment of meteorological radar system in Dhaka and Rangpur in the people's Republic of Bangladesh

Figure 4.5.6 Website for Disaster Awareness created in Technical Cooperation Project

4.5.3 Cooperation with Other Donors

4.5.3.1 World Bank

(1) Bangladesh Weather and Climate Services Regional Project (BWCSRP)

Since 2016, a project to support the observation network and others has been implemented to improve the weather forecasting capacity of BMD. The table below shows the equipment to be procured for the project.

Table 4.5.14 Equipment procured by BWC SRP

No.	Item	Qt.	Note
A1.1: Modernization of surface, ocean and upper air monitoring networks and ICT systems			
(1)	Synoptic Stations (Existing)	35	Upgrading
(2)	Agricultural Automatic Weather Stations	(440?) 200	
(3)	Automatic Rain Gauge	65	
(4)	C/X band Doppler Weather Radars	3	
(5)	Aviation Weather Observation System	3 intl. apt.	
(6)	Coastal-Marine Automated Network	-	
(6)	Coastal Marine Stations	40	
(7)	Buoy Stations	5	
(8)	Digital Elevation Map and Bathymetric Survey	-	
(9)	Portable Hydrogen Generators	11	
(10)	Existing Equipment Maintenance, Repair, and Calibration Equipment at BMD		Upgrading
(11)	BMD ICT and Data Center with Computer Servers and Software	-	Upgrading
(11)	GTS/WIS	-	Upgrading
(11)	Dedicated and reliable high speed internet communications between BMD offices in Dhaka and Rangpur, Sylhet, Barisal Khulna, Rajshahi and Chattogram	-	
A1.2: Improving Infrastructure for Forecasting			
(12)	Nowcasting Workstations (hardware and software)	5	
(13)	Weather Workstations (hardware and software)	7	
(14)	HPC to improve weather and oceanographic forecasting	1	
(15)	Perform digitization and data rescue	-	Consultation
(16)	Design and implementation of forecast verification system	-	Consultation
(17)	WRF as applied to the BMD HPC system	-	Consultation
(18)	Storm surge and wave models as installed on HPC	-	Consultation

Source: https://projects.worldbank.org/en/projects-operations/project-detail/P150220
Source: INTERNATIONAL DEVELOPMENT ASSOCIATION PROJECT APPRAISAL DOCUMENT FOR A BANGLADESH WEATHER AND CLIMATE SERVICES REGIONAL PROJECT, May 13, 2016 (https://documents.worldbank.org/en/publication/documents-reports/documentdetail/990771467995624739/bangladesh-weather-and-climate-services-regional-project)

(2) Building Resilience to Climate Change

The table below shows the summary of climate change-related projects by WB.

Table 4.5.15 Overview of Projects Related to Climate Change by WB

Works	Qt. Beneficiaries
Build solar irrigation pump	320 pumps for 8,000 farmers
Block from flooding and saline intrusion	17,500 ha block plantations and 2,000 km strip plantations
Basic adaptive service	40,000 families
Trainings on alternative livelihoods	6,000 poor households in 200 communities
Construct cyclone shelters and embankment	224 shelters, 387 km embankment
Publish research analyzing impact of CC in urban areas	
Provide solar home system	3.95 million remote households
Provide electricity	7 mini-grids for 2,000 rural businesses and shops
Distribute clean, energy-efficient cook stove	750,000 women
Provide electricity transfer	Haripur, Siddhirganj and Narayanganj regions

Source: https://www.worldbank.org/en/results/2016/10/07/bangladesh-building-resilience-to-climate-change

4.5.3.2 Chinese Government

In the meteorological warning and forecasting, the following two meteorological projects are supported.

Table 4.5.16 Support from Other Donors (Meteorological Warning and Forecasting)

FY	Institution	Project	Amount	Scheme	Overview
2006	China Meteorological Administration	PCVSAT System Granted	-	Granted	Providing satellite communication data receiving equipment for receiving meteorological satellite images and meteorological information broadcast from China FY-2 meteorological satellites.
2011	China Meteorological Administration	PCVSAT System Update	-	Granted	China FY-2 Update of satellite communication data receiving equipment for receiving meteorological satellite images / data, meteorological information, numerical weather prediction products, etc. (not used)

Source: Preparatory survey report on the project for establishment of meteorological radar system in Dhaka and Rangpur in the people's Republic of Bangladesh

4.5.4 Issues in Current Efforts

4.5.4.1 Insufficient Ground-based Weather Observations to Issue Accurate Weather Forecasts and Warnings

AWS data has not been used at all and real-time data has also not been obtained yet. Therefore, QPE (Quantitative Precipitation Estimation) has not been developed and the accumulated precipitation estimation cannot be obtained accordingly.

Although observation sensors have been calibrated, because the calibration of national standards has not operated, BMD cannot secure the accuracy (traceability) of SYNOP and AWS data. As for the rain gauge, if BMD conducts QPE with AWS and ARG, the QPE value might not estimate true value because BMD does not have a calibrator for the rain gauge.

Consequently, BMD is seeking to install a system that provides real-time data and calibration to secure its traceability. Issues and solution policies for surface observation are listed in Table 4.4.9.

Table 4.5.17 Issues and Solution Policy for Surface Observation

Issues	Solution Policy
AWS data has not been used and real-time data has not been obtained accordingly.	To develop a maintenance system for AWS by comparative observation between the manned station and AWS. To obtain real-time data from AWS by a data center, which enables data control.
Calibration has not been conducted.	To calibrate instrument BMD has in RIC Tsukuba et al. to establish national standards.
Regular maintenance with manual has not been conducted.	To develop a periodical maintenance manual that uses working standards provided at each regional observatory. To prescribe permissible range for comparative observing. (Some other instruments should be prepared to avoid missing data during instrument exchange) To develop a regular maintenance schedule and maintenance system.
Calibrator for the rain gauge has not been installed.	To prepare a precise mass scale for a manned station that uses tank type or self-recording type. To prepare a portable rain gauge checker for AWS which uses tipping-bucket type. (AWS data would basically be compared with SYNOP near the station for data check)

Source: JICA Survey Team

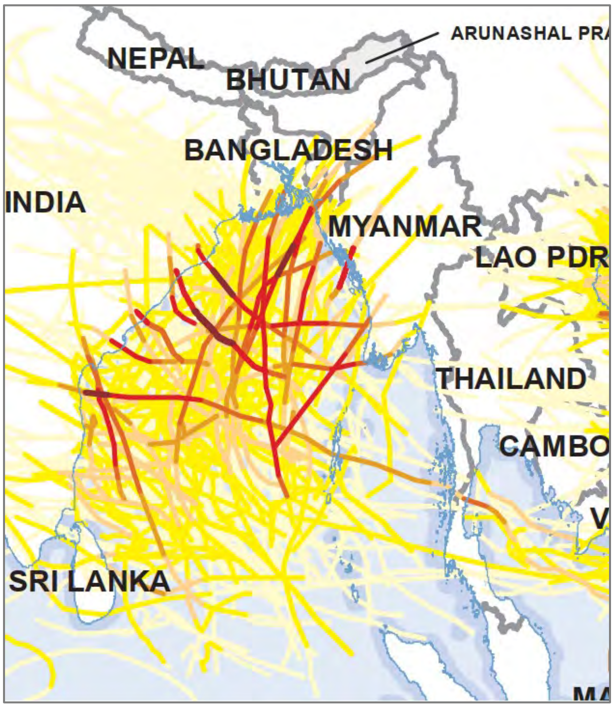
4.5.4.2 Insufficient Appropriate Repair and Upgrading of Weather Radars and Radar Observation Analysis Techniques

The life of the radar is expected to be 15 to 40 years according to WMO. However, most radars were out of operation before their lifetime. Radars require regular maintenance and component replacement, as well as proper operational planning and operational budgets, as the accuracy and quality of radar cannot be maintained due to aging of electrical components.

BMD installed five radars throughout the country, however, they have not shown radar images except Cox’s Bazar and Moulvibazar. Noise reduction and calibration by rain gauge have not been conducted, and provided data is only radar echo images at some limited specific time, therefore, estimation of precipitation is not accurate nor useful for weather forecast and disaster management. In comparison with the GSMaP, there is no good correspondence. This difference could be caused by their unique observation methods; however, it is difficult to find the reason nor to evaluate them because current radar echo has not been controlled its quality. On the other hand, the quality control and calibration with rain gauges are technical matters, and they can be improved through technical cooperation projects. Meanwhile, SWC uses numerical forecast models for weather forecasts, but they cannot improve the model accuracy because the data has not been provided in raw data (numerical data) that enables the model to be assimilated. Thus, technical support for data assimilation is also needed. As for the Doppler data, this can also be a technical matter because the BMD has not used it yet. Since the Doppler data cannot be observed without rainfall and utilization of the data is limited, the priority is lower than the precipitation, however, understanding of the data and consideration of the utilization also should be proceeded by the technical cooperation project as well.

Radar staff is secured for each site and the radars are maintained; however, proper radar operation has not been conducted as mentioned above. They have been trying to contact manufacturer through Japanese trading company to purchase radar parts, but manufacturer’s staff has not received any contacts from BMD yet, consequently, the contact line between BMD and manufacturer is currently unclear. Because 15 years have passed since installation, the manufacturer might not be difficult to provide the same parts that were used at installation. For this matter, radar installation and its operation should consider a long-term operation involving handling of alternative parts. On the other hand, BMD prepares the budgets for spare parts, and they actually have fixed the radar by themselves. Namely, BMD has the basic capacity and technical skills for radar operation, however advanced skills such as the use of alternative parts need to be provided. Since BMD recognizes the cause of radar failure as listed in Table 4.5.2, BMD could repair radars if they receive non-alternative parts but JICA/BMD should invite radar manufacturers to Bangladesh to solve the problems if the manufacturer can only provide alternatives.

As shown in Figure 4.5.7, Bangladesh is prone to be suffered from cyclones developing and coming from the Bay of Bengal mostly in the rainy season which cause storm surges or floodings. Therefore, BMD should keep watching the cyclone and estimate precipitation for timely warning and disaster preparation when realizing proper disaster management. Thus, the priority of radars that need to be mended is radars located in the southern-coastal area; Cox's Bazar and Khepupara except for radars that have light problems for operating. For watching Nor'wester (strong north-western wind), Rangpur radar requires to be replaced and become Doppler radar as soon as possible. Each issue is listed in Table 4.5.18.



Storm Category	Pressure (mb)	Wind (mph)	Wind (kmh)	Surge (ft)
Tropical Depression	-	<39	<63	-
Tropical Storm	-	39-73	63-117	-
Category 1	>980	74-95	118-153	4-5
Category 2	965-980	96-110	153-177	6-8
Category 3	945-965	111-130	178-209	9-12
Category 4	920-945	131-155	210-249	13-18
Category 5	<920	>155	>249	>18

Source: Last 50 Years Tropical Storm in Asia-Pacific, OCHA 2018

Figure 4.5.7 Cyclone track from 1966 to 2017 in Bay of Bengal

Table 4.5.18 Issues on Weather Radar and Solution Policy

Issues	Solution Policy
Only two radars upload the image and upload interval is quite long.	Since vacuum tube (Magnetron and Klystron, which generate microwaves) is consumables, it will be a long-life operation if the running hour is made short. However, without continuous running to accumulate observation data, radar observation cannot be improved nor realize data assimilation and QPE. Therefore, to replace radar transmitter to a solid-state that realizes low power consumption and to accumulate observation data. In parallel, to provide technical assistance in radar product.
Raw observation data (not radar image) has not been stored and not been transmitted to headquarters. Data accumulation is not realized.	To provide technical assistance in radar data accumulation and utilization. To consider data transmission method (VSAT, internet, mobile, etc.) and data format (Grib2, NetCDF, etc.) with SWC who uses the radar data.
Quality control in radar data has not been done.	To provide technical assistance that conducts quality control such as eliminating ground clutter. Parameters such as beam angle also need to be checked.
QPE by surface observing data has not been conducted.	To provide technical assistance that develops a data table of calibrated SYNOP and AWS to calibrate radar. Training for QPE needs to be provided.
Specific forecasts and warnings using QPE have not been developed.	To discuss the relation between precipitation data and disaster or countermeasures with BMD and relative organizations.
Radars become out of operation shorter than the life expected.	To conduct regular maintenance and replace any parts required even if it is not a failure. To keep a budget for regular replacement of the parts. Moreover, when alternative parts are provided after the guarantee period, technical assistance or assurance of the current system with the alternative parts is required.

Source: JICA Survey Team

4.5.4.3 Insufficient Weathr Forecasting Skills

Each warning is issued by SWC to relative organizations. However, BMD cannot estimate specific precipitation or wind speed with current techniques, so these warnings might not be working properly. This is because observing value is only SYNOP data obtained every three hours, and radar data is also obtained at some very limited time and not assimilated into numerical models.

Table 4.5.19 Issues on Weather Information and Solution Policy

Issues	Solution and Policy
Heavy rain warning criteria cannot issue timely because it depends on 24-hour accumulated precipitation.	To develop a system using not only SYNOP but AWS and Radar data to obtain precipitation data in real time. To develop new criteria with these short-term data under technical cooperation project. (Impossible to issue a proper warning with only numerical forecast)
Mach information on BMD's website is unlinked and not well explained.	To recheck linking page. To coordinate important information from all information BMD has and uploaded. To put explanation for citizen.
Weather forecasts provide to eight divisions and does not provide maximum/minimum temperature and precipitation (chance of rain).	To introduce weather guidance under technical cooperation project.

Source: JICA Survey Team

4.6 Earthquake

4.6.1 Initiatives by the Government of Bangladesh

The initiatives of the Bangladesh government for earthquake disaster risk reduction are mainly focused on the soft measures, such as seismic risk assessment, emergency response and community capacity strengthening, etc., as promoted in the 8th Five Year Plan, which has been described in detail in 3.2.2, and BDP2100 and National Plan for Disaster Management (NPDM 2021-2025), which are described in 4.6.1.3. The roles and responsibilities of each ministry/department on disaster risk management, covering emergency response and recovery and reconstruction, are stipulated in the Standing Orders on Disaster (SOD). For risk reduction of buildings, the enforcement of national building code BNBC is promoted for new constructions and, at the same time, the technology and capacity building on seismic diagnosis and retrofitting for existing buildings have been also enhanced by the assistance of JICA.

4.6.1.1 Building Regulation

There is no laws or regulations specific for seismic disaster risk reduction in Bangladesh. Since the main seismic risks, especially human casualties, are strongly correlated to building damage, it is very important to secure the seismic performance of buildings through regulations. The main regulations pertaining to building safety are as below.

- ✓ Building Construction Act (BCA, enacted in 1952, latest revision in 2006)
- ✓ Building Construction Rules (BCR, enacted in 1953, latest revision in 2006)
- ✓ Bangladesh National Building Code (BNBC, developed in 1993, latest revision in 2020)
- ✓ Local BCR (e.g. Dhaka Metropolitan Building Construction Rules, enacted in 1996, latest revision in 2008)

The Building Construction Act was first enacted in 1952. The main objectives of the regulation then were the setback from road and height restriction, etc., for buildings in urban areas and construction and excavation prevention outside the urban planning area. There were no provisions on structural design. The first national building code, BNBC, was developed in 1993, but there were few cases of compliance because of no legal binding, no guidelines and manuals for practical use, low awareness of building owner on building safety and cost saving. Although the revision of the Building Construction Rules in 2006 stipulated the enforcement of BNBC to clarify its legal status, the compliance of the building code is still not sufficient due to the building permit system as well as the reasons mentioned before. Because of the short history of seismic design regulation in Bangladesh, many existing buildings, including critical public buildings, are not seismically designed and do not meet the seismic performance requirements of the current standards. On the other hand, there is no law or promotion policy (like the Act for Promotion of Renovation for Earthquake Resistant Structures in Japan) regarding seismic retrofitting of vulnerable existing buildings.

A major revision on BNBC was made in 2020. Compared with that of 1993, the following three points are especially worth to be noted in terms of seismic performance assurance.

1) Establishment of Bangladesh Building Regulatory Authority (BBRA, PART II Chapter 2). The BBRA, as an organization under MoHPW, is under the progress of its establishment now. BBRA will be composed of experienced experts in civil engineering, architect, planner, judge or legal practitioner and civil service. Its responsibility, among others, covers the establishing regulatory framework for building design and construction with efficient and effective compliance mechanism, developing building check and control procedures for ensuring a high degree of regulatory compliance in planning and the code requirements, developing an effective licensing system, forming a National Council for Licensing of Building Professionals (NCLBP) and require the owner of an existing or under construction high risk building, which have major impacts on public safety for inhabitants within and near the building, to carry out the review of design and construction by licensed professionals.
2) Update of seismic hazard map. The hazard map used since 1993 was updated. The new hazard map changed the seismic zonation from three to four and new seismic design ground motion is assigned. The detail on the hazard map is given in 4.6.1.5 (1).

3) Introducing the provisions for maintenance and renovation, especially for seismic retrofitting and reconstruction (PART VII Chapter 5). Although there is no detail regulation about technical aspects on seismic diagnosis and retrofitting, the principles for seismic retrofitting are given, which are strengthening of columns and/or walls to secure horizontal strength, strengthening of joints between roofs, walls and floors for structural integration and uniform stress distribution, elimination of horizontal and vertical irregularity and prevention of shear failure of structural elements, etc. A guideline for seismic retrofitting and reconstruction is also provided from the viewpoint of cost, i.e., if the cost of seismic retrofitting is within 50% of that of reconstruction, seismic retrofitting is recommended and, otherwise, reconstruction is recommended. It also points out that the reconstruction should be avoided for historical buildings and those buildings having social and cultural importance.

4.6.1.2 Building Permit System

(1) Design of Public Buildings

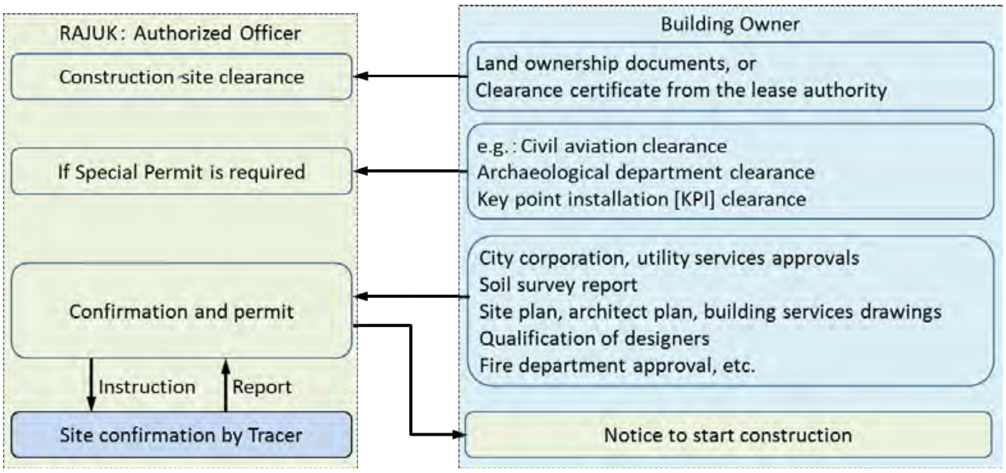
Almost all ministry-related public buildings, except for the school buildings designed by the Ministry of Education (MoE) and Local Government Engineering Department (LGED), hospital buildings with less than 100 beds designed by the Ministry of Health and Family Welfare (MoH&FW), are designed by the Department of Architecture (DOA) and the Department of Public Works (PWD). DOA is responsible for architectural design and PWD for structural design. In the case of local government buildings, it may be designed by their own architects and engineers, but, more often, by outsourcing to design companies.

(2) Construction of Public Buildings

In the design process, DOA first makes the architectural design in consultation with the user ministries to fulfill their requirement and, then. PWD proceeds for structural and equipment design, such as electrical, mechanical, piping, etc. For fire protection, DOA may have to consult with Department of Fire Service and Civil Defense (FSCD). During construction, PWD and DOA are responsible for inspecting the construction on whether or not the construction is carried out as designed. PWD and DOA may also make the inspection for the construction of local government buildings.

(3) Application and Permit System of Private Buildings

Building permits for private buildings is the responsibility of local development authorities. In the Dhaka metropolitan area, the Capital Development Authority of the Government of Bangladesh (RAJUK) is the main player for the development planning, real estate, land allocation and building permits for public and private buildings. The procedure for examination and approval by RAJUK is as follows. First, the building owner submits the documents required for the application to the RAJUK regional office. The application documents include the application form, geological survey report and architectural drawings and application fee, etc. The documents, then, will be confirmed by the authorized officer, qualified by MoHPW and responsible for approval. In order to confirm whether the planned building meets the site constraints, the Tracer will visit the construction site to check the situation and take the photos. The RAJUK procedure ends with the decision of approval by the authorized officer. The general approval flow is shown in Figure 4.6.1.



Source: JICA Survey Team

Figure 4.6.1 General Flow of Building Permits of Private Buildings

It has been observed that, due to the large number of application and the limited staff working on the permit, the examinations by RAJUK are not sufficiently carried out. There are about 5,400 applications per year and only have 114 qualified staff against the 288 staffing levels. This situation also appears in other regions, which means that the building permit system may not be always functioning well due to the lack of technical capacity and human resources. Another issue is the building examination in permit process mainly focuses on the building usage and setback, etc., while the structural calculation is rarely checked. Now, RAJUK is trying to improve the structural calculation examination system by introducing the Professional Accreditation Programme for Engineers Architects Planners (PAPEP), which allows the private qualified engineers to participate in the system for an efficient structural calculation examination.

4.6.1.3 National Earthquake Risk Reduction Policy

(1) Eighth Five Year Plan

The 8th Five Year Plan, aiming at sustainable development, includes the integrated national strategies and policies on disaster risk reduction and management and climate change adaptation, which has been described in 3.2.2 in detail. There are no specific policies or plans for earthquake risk reduction. The contents related to earthquake risk reduction are considered mainly to be covered by the contents as shown below (chapter and section No. are the original No. in the plan for easy reference).

Chapter 9 Urban Development Strategy

9.8.5 Urban Environmental and Disaster Management strategies

- ✓ Strengthen City Disaster Management Committee (CDMC) involving other stakeholders such as the private sector, research institutes, national agencies and utility companies.
- ✓ Strengthen monitoring and evaluation of the existing mechanisms for compliance and enforcement of laws, regulations etc. through conducting regular capacity building workshops of city personnel. Sensitize legislations, regulations and codes in relation to Climate Change (CC) and Disaster Risk Reduction (DRR).
- ✓ Promote close coordination and cooperation among national disaster management and environmental management agencies (i.e., Department of Environment (DoE), Department of Disaster Management (DoDM)), urban local bodies (City Corporations and Paurashavas), nongovernmental and private sector organizations.
- ✓ Integrate city CC-DRR policies and plans in national preparedness and response system. Strengthen partnerships with relevant organizations for technical assistance, research and techno-environment projects.

- ✓ Prepare and implement integrated, environmentally-sound urban planning and management incorporating environmental and disaster related information and reflecting environmental and disaster management policies and standards. Considerations will also be given to spatial, inter-sectoral, inter-temporal and environmental media related factors with special attention to key aspects of land and water-use planning.
- ✓ Review and update the city's transportation plan to include disaster risk reduction measures (providing accessibility to and linkages with risk-prone areas). Integrate CC-DRR in all key sectors through multi-stakeholder and participatory workshops.
- ✓ Establishment of a comprehensive information system that identifies and assesses the risks involved in disaster-prone areas and integrate it into urban planning and design.

Chapter 14 Social Security, Social Welfare and Social Inclusion

14.4 Disaster Management

- ✓ Reducing the risks of disaster is a multi-sector endeavor. It is not possible for the Government to tackle disasters alone unless strong collaboration among all the relevant stakeholders, such as the Government, the NGOs, researchers, scientists, the civil society, the private sector, the media etc. are established and maintained. Collaborative efforts will be undertaken to strengthen the activities for preparedness at all levels and reduce the impact of disasters.
- ✓ Development of better societal resilience to disasters requires that we ensure the delivery of basic services like health, education and water, even during disasters. To this end, the Government will draw lessons from the international community to develop a more effective Disaster Response Framework.
- ✓ The Government will invest in Management Information Systems (MIS) to strengthen the monitoring of climate change and vulnerability to earthquakes, etc.
- ✓ Assessments of the risks of disaster and climate change are still at the normative level, often suffering from ambiguous quantification. This is making it impossible to estimate the social and economic value of the disaster and the risks of climate change, the required investments, the losses from adverse events. Hence, the Government will form a technical team led by the Ministry of Planning, to undertake a rigorous risk accounting, and determine the baseline, benchmarks and targets – that will improve Bangladesh's resilience against natural disasters and various manifestations of climate change.

(2) National Plan for Disaster Management (2021-2025)

The National Plan for Disaster Management was enacted by MoDMR in 2020, the detail of which has been described in 4.1.1.1 (6).

1) Seismic risk considered in NPDM 2021-2025

The strategies and activities for earthquake risk management of NPDM are based on the following risk awareness.

Seismic risk recognized in NPDM 2021-2025 (extract) Bangladesh is possibly one of the most vulnerable countries to potential earthquake threat and damage, given its geographical location in a seismically active region. An earthquake of even medium magnitude on the Richter scale can produce a mass graveyard in major cities of the country, particularly Dhaka, Sylhet and Chattogram. Rapid and unplanned urbanization increases the risks for earthquake as well as other man-made disasters like fire, building collapse, industrial hazards etc. Although there have been no major earthquakes in Bangladesh in the last several decades, it is likely that they could be affected by strong earthquakes in the near future in view of the earthquake environment and historical earthquakes.

2) Targets and activities in NPDM 2021-2025 for seismic risk reduction.

There are a total of 48 activities listed in the plan as the main goals of disaster risk management. Most of the activities are multi-hazard oriented and the activities mainly related to earthquake risk reduction are picked up as follows (the numbers are the original numbers of the plan). These activities are mainly focused on the soft measures, such as risk assessment, preparedness, emergency response and education and training for capacity building.

1 Reviewing and sharing result of existing multi-hazard Risk Assessment and Plans for Earthquake Preparedness and Response Programme.

15 Update and expand hazard, vulnerability and risk assessment for earthquake and flood.

16 Expanding earthquake preparedness programmes integrating national and local contingency plans.

20 Establishing seismology and earthquake engineering disciplines in universities.

21 Integrating seismicity & earthquake engineering modules in private and public universities.

25 Reviewing/updating/developing all guidelines for preparedness and response as per SOD.

27 Invest in construction of resilient rural housing.

30 Capacity building of the professional (planner, designer, architecture/structural engineer) on earthquake resilient building construction system.

35 Develop sector wise Business Continuity Plan (BCP) for different industrial sectors.

41 Develop resilient infra-reinforcement of national building code BNBC.

(3) BDP2100

The details of BDP2100 are described in 4.1.1.1 (5)

In the sector strategies of BDP2100, earthquake is one of the important sectors and the strategies for earthquake risk reduction is as follows.

- ✓ Strengthen earthquake management and enhance the capacity to cope with earthquakes.
- ✓ Design earthquake-proof structures including barrages, regulators, sluices, embankments, cross-dams, roads, bridges and buildings in conformity with the Bangladesh National Building codes or any other approved standards.
- ✓ Formulate a proper land use plan for building construction in municipal areas.
- ✓ Conduct a detailed study on identification of faults and epicenters.

In BDP2100, 80 projects were announced as priority investments up to 2040. Among the 80 projects, the projects directly related to earthquake risk reduction cannot be found. It means earthquake disaster reduction has not been included in the priority investment projects at the moment.

4.6.1.4 Undertakings by the Government of Bangladesh for Seismic Risk Reduction

(1) Prior Investment

For seismic disaster risk reduction, the ex-ante investment on public buildings and infrastructures are important, but has not been affirmatively promoted so far. For the building safety of both public and private, the effort has been limited to the creation of regulations, manuals and hazard map, which are depicted in 4.6.1.1 and 4.6.1.2. The future plan and activities are described in 4.6.1.3.

As the national strategy of building safety for seismic disaster risk reduction stipulated in BDP2100 "Design earthquake-proof structures including barrages, regulators, sluices, embankments, cross-dams, roads, bridges and buildings in conformity with BNBC or any other approved standards" and NDMP "Develop resilient infra-reinforcement of BNBC", BNBC2020 requires the establishment of

BBRA as a key organization for the enhancement of nationwide building code compliance. Its major responsibilities include the establishing regulatory framework for building design and construction with efficient and effective compliance mechanism, developing building check and control procedures for ensuring a high degree of regulatory compliance in planning and the code requirements, developing an effective licensing system and requiring the owners of an existing or under construction high risk building, having major impacts on public safety for inhabitants within and near the building, to carry out review of design and construction by licensed professionals. BBRA is affiliated to MoHPW and is under the establishment process now.

(2) Early Warning System

There is not an earthquake early warning system existing now in Bangladesh.

(3) Emergency Response

Although there was no strong earthquakes happened in Bangladesh in recent years, the system for emergency response, evacuation and search and rescue have been gradually created with the support of international organizations. The CDMP project financed by UNDP has supported the establishment of the Disaster Management Information Center (DMIC) and the training of the Department of Fire Service and Civil Defense (FSCD). Also, the contingency plan for earthquake at central and local levels, such as National Earthquake Contingency Plan and Contingency Plan for Earthquake Response in Major Urban Centres, etc., have been developed.

(4) Recovery and Reconstruction

Since there was no strong earthquake in recent years, there was no experience of recovery and reconstruction for seismic disaster. However, the SOD has clearly stipulated the role and responsibilities of each government organizations for preparedness, emergency response as well as recovery and reconstruction for disaster risk management.

4.6.1.5 Status of Seismic Hazard Map Development

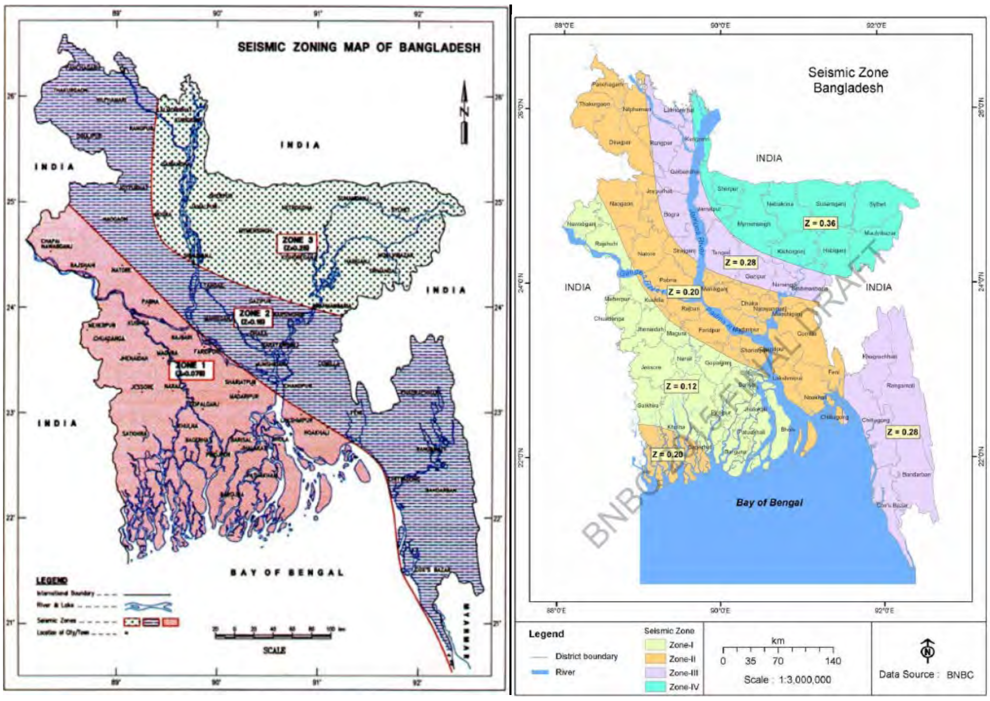
The first national seismic hazard map of Bangladesh was created by GSB in 1979 and it is adopted by the first national building code BNBC in 1993. As the results of the researches on active faults, earthquake catalog, seismicity, hazard analysis method, the seismic hazard map was updated along with the revision of BNBC in 2020. Besides, the other institutes and researchers also conducted seismic hazard analysis for different purposes. Among them, the project of Seismic Hazard Assessment of Dhaka, Chattogram and Sylhet City Corporation Area (CDMP), supported by UNDP, estimated the earthquake ground motions of Dhaka, Chattogram and Sylhet from five scenario earthquakes. Another one is the Multi-Hazards Risk and Vulnerability Assessment, Modeling and Mapping (MRVAM) project carried out by MoDMR, which created the seismic hazard map by probabilistic seismic hazard analysis. Since the seismic hazard map of MRVAM will be used for seismic risk assessment in 5.4.2.6, the method and results of MRVAM project is briefly examined here, together with two recent researches: Seismic Source Modeling and Probabilistic Seismic Hazard Analysis for Bangladesh (2020) and Towards Improved Probabilistic Seismic Hazard Assessment for Bangladesh (2019).

Comparing MRVAM with the two recent researches, they have the similar results that the seismic hazard is higher in the east and northeast than that in the west and southwest. The results are generally harmonious because the similar earthquake sources, like plate boundary sources and active faults, were used and the major differences were the different consideration on seismicity, attenuation formula and logic tree. Since there are big uncertainties in seismic hazard analysis, it is not difficult to understand the different results among the different researches because the uncertainties are dealt with differently.

(1) Seismic Hazard Zone Map Used in BNBC

The hazard map used in 1993 version of BNBC divided Bangladesh into three seismic zones and assigned the seismic coefficient (peak ground acceleration, PGA) for each zone. The new hazard map, having four zones instead, was created based on the probabilistic analysis and engineering judgement, which reflected the latest research results on active faults and seismicity with a state-of-the-art analysis method. The hazard map of 1993 and 2020 are shown in Figure 4.6.2. The main differences between the two maps are (i) the country is divided into three zones in the 1993 map while it has four zones in the 2020 map, (ii) the seismic coefficients in the 1993 map are Zone 1 = 0.075g, Zone 2 = 0.15g and Zone 3 = 0.25g and those in the 2020 map are Zone 1 = 0.12g, Zone 2 = 0.20g, Zone 3 = 0.28g and Zone 4 = 0.36g. It should be noticed the 2020 map is based on the concept of Maximum Considered Earthquake (MCE, 2% exceedance probability in 50 years) and the effective design seismic coefficient is designated as 2/3 of the value in the hazard map. With this in mind, the seismic coefficient used in actual design becomes Zone 1 = 0.08g, Zone 2 = 0.13g, Zone 3 = 0.19g and Zone 4 = 0.24g, which are almost in the same with that of 1993. But for a specific site, the coefficient may become larger or smaller depending on the location of the site due to the change of zone boundary.

According to the new hazard map, Dhaka is in Zone 2 with effective seismic coefficient of 0.13g, Chattogram is in Zone 3 having effective seismic coefficient of 0.19g and Sylhet is in Zone 4 having effective seismic coefficient of 0.24g. Since the response coefficient of 2.5 is used in the code, the ground motion used for seismic design (may be different for different site condition and individual building) for Dhaka is 0.13*2.5 = 0.325g, Chattogram is 0.475g and Sylhet is 0.6g. Comparing to the level 2 design ground motion of Japan, which is 1.0g, the seismic load, generally speaking, is about 30% for Dhaka, 50% for Chattogram and 60% for Sylhet.



Source: BNBC (1993, 2020)

Figure 4.6.2 Seismic Zonation Map Used in BNBC (Left: 1993, Right: 2020)

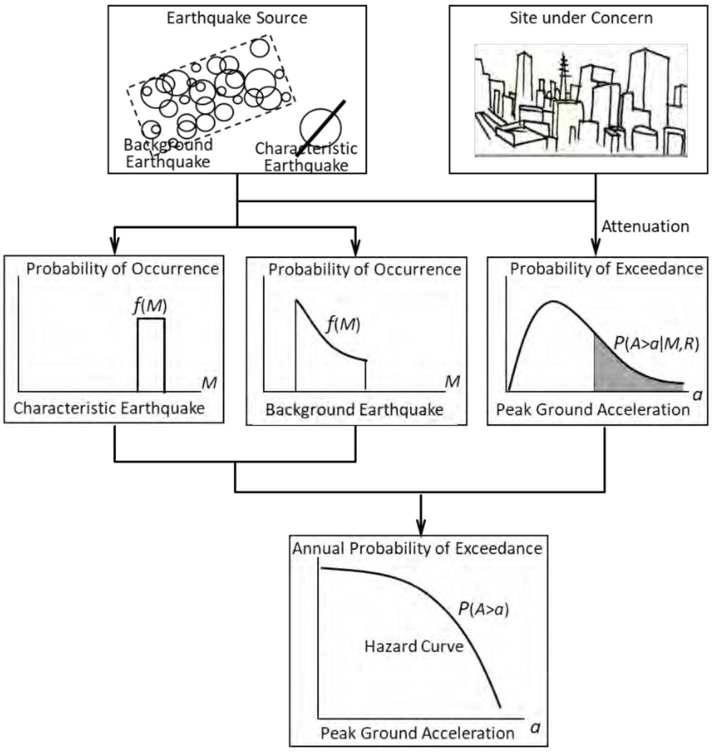
(2) Seismic Hazard Assessment of MRVAM

1) Approach of seismic hazard assessment

There are mainly two approaches for seismic hazard analysis, i.e., deterministic method and probabilistic method. While the deterministic method is often used to estimate the hazard from scenario earthquakes for the risk assessment like structure damage, life loss and affected people, the probabilistic method is generally used to determine the ground motion for seismic design. To specify a scenario earthquake, it requires reliable information on historical earthquakes and active faults to determine the exact location and magnitude, etc. Since the deterministic method provides the seismic hazard from a specific earthquake, it has a clear physical meaning and is easy understand. The probabilistic method, not for a single specific earthquake, takes into account all possible earthquakes for a concerned site with defining the probability of each earthquake occurrence and the probabilistic distribution of ground motion. In this regard, the seismic hazard results are not coming from a specific earthquake, but the results of all possible earthquake sources. Since the seismic hazard is estimated probabilistically, it is easy to set a target hazard which has the occurrence probability required for different purposes.

It should be pointed out that both deterministic and probabilistic methods involve big uncertainties in seismic hazard estimation. The uncertainties can be aleatory uncertainties due to the insufficient data to determine the location, magnitude, mechanism as well as attenuation, etc. and epistemic uncertainties coming from the incompletion of the theoretical knowledge. In this circumstance, different results are usually obtained by different researchers depending on how they interpret the existing data and deal with the uncertainties. Therefore, it is important to understand the uncertainties in hazard and risk assessment when applying the results for disaster risk reduction.

The basic flow of probabilistic seismic hazard analysis is shown in Figure 4.6.3.



Source: JICA Survey Team

Figure 4.6.3 Flowchart of Probabilistic Seismic Hazard Analysis

The main parameters for probabilistic seismic hazard analysis are the location of earthquake source (characteristic earthquake and background earthquake), magnitude range (maximum and minimum magnitudes) of each source, the frequency of occurrence, and the distance from the site to source, etc. Although not shown in Figure 4.6.3, the logic tree is commonly used for dealing with the uncertainties quantitatively.

The seismic hazard analysis of MRVAM was conducted with the following conditions.

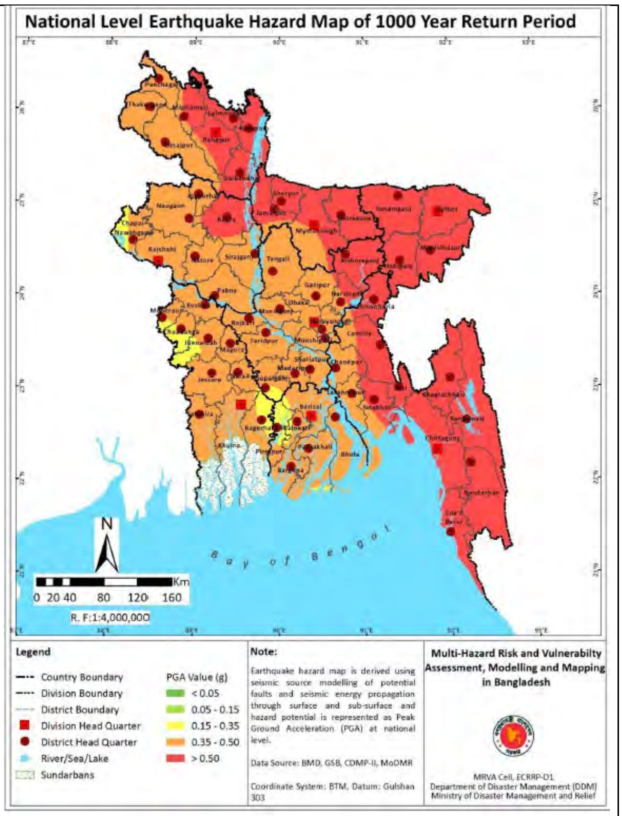
- ✓ Earthquake sources: Three kinds of earthquake sources are used, i.e., background earthquakes (could occur anywhere in the area without clear fault presence), plate boundary earthquakes and intraplate active fault earthquakes. The seismicity of background earthquakes is represented by the Gutenberg-Richter relationship, which defines the relationship between the magnitude and the cumulative number of earthquakes greater than a given magnitude. The plate boundary earthquakes and intraplate active fault earthquakes are dealt with as characteristic earthquakes and their seismic activities are defined by the return period.

- ✓ Attenuation: Since there is a lack of strong motion records, there is no specific attenuation formula in Bangladesh. On the other hand, there are a big number of attenuation equations in the world mainly based the strong motion records from US and Japan. MRVAM selected the attenuation formulas according to the different source types of background earthquakes, plate boundary earthquakes and intraplate active fault earthquakes.
- ✓ Uncertainties: The uncertainties of maximum magnitude and attenuation are considered by the logic tree method. Three branches are set up for the maximum magnitude (MC), i.e., MC - 0.2, MC, and MC + 0.2 with the weights of 2/10, 6/10, and 2/10, respectively. For the uncertainties of attenuation, three attenuation equations are used, which are the equations from Boore and Atkinson (2008), Campbell and Bozorgnia (2008) and Chiou and Youngs (2008), and even weight of 1/3 is defined.

2) Results of seismic hazard assessment

MRVAM seismic hazard analysis provides the ground motion of PGA and response spectrum for 50-year, 100-year, 200-year, 500-year and 1000-year return periods. Figure 4.6.4 shows the PGA distribution with 500-year return period. It can be seen that the seismic hazard is higher in the east and northeast than that in the west and southwest.

500-year return period



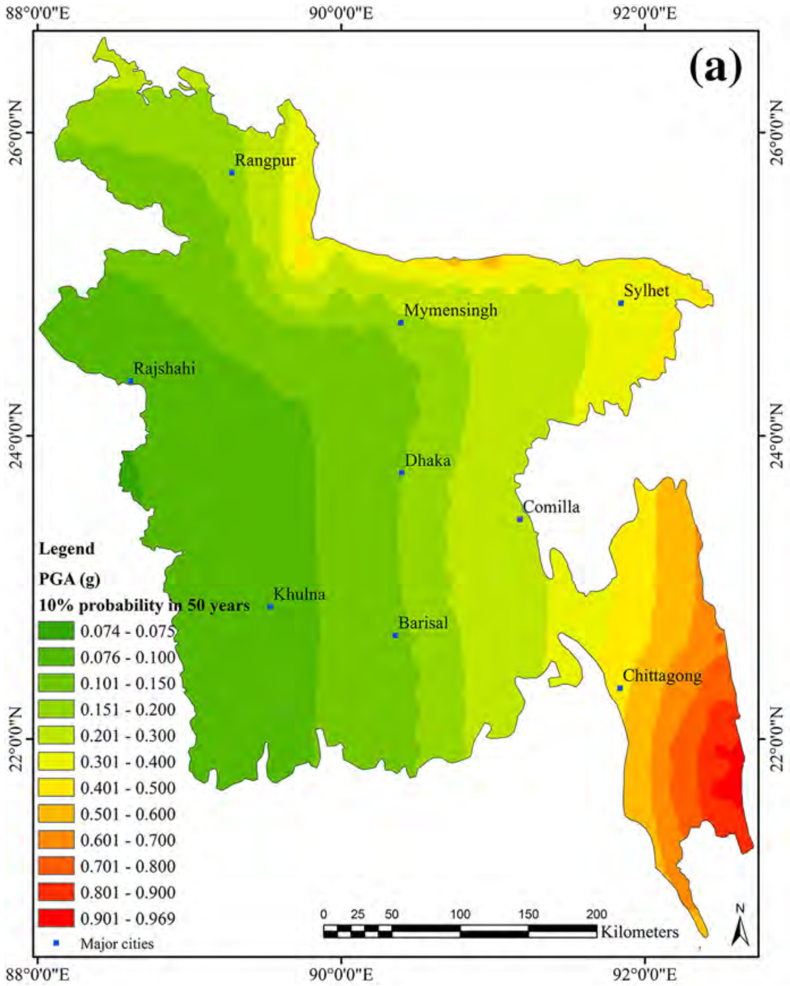
1000-year return period

Source: MRVAM

Figure 4.6.4 Distribution of PGA with 500 Year Return Period of MRVAM

(3) **Seismic Source Modeling and Probabilistic Seismic Hazard Analysis for Bangladesh**

In this paper, probabilistic seismic hazard analysis was carried out with different consideration on seismicity, attenuation and logic tree. The result for the distribution of PGA with 500-year return period is shown in Figure 4.6.5.

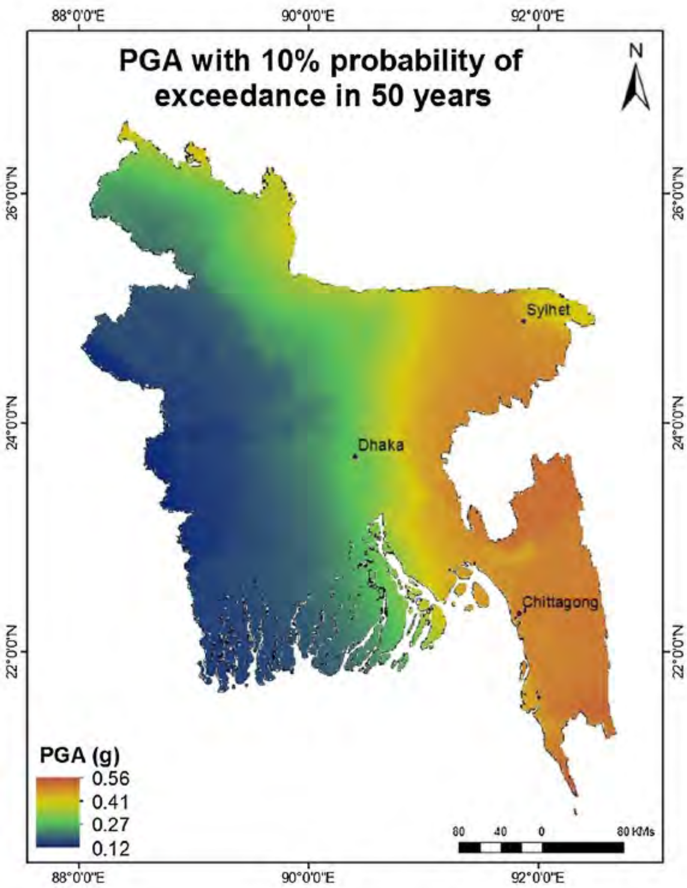


Source：Md. Zillur Rahman, et al.

Figure 4.6.5 Distribution of PGA with 500 Year Return Period of Md. Zillur Rahman

(4) **Towards Improved Probabilistic Seismic Hazard Assessment for Bangladesh**

This paper also conducted seismic hazard analysis by probabilistic method. Figure 4.6.6 shows the result of PGA with 500-year return period.



Source：Dewan Mohammad Enamul Haque, et al.

Figure 4.6.6 Distribution of PGA with 500 Year Return Period of Dewan Mohammad Enamul Haque

4.6.2 JICA's Cooperation

The cooperation of JICA for seismic disaster risk reduction has continued for more than 10 years. In addition to technical cooperation projects, the project for the new construction of the main office building of the Department of Fire Service and Civil Defense (FSCD) and the seismic retrofitting of existing fire department are being implemented by Yen loan project, which also supports the building safety of garment factories. The seismic strengthening for the existing important infrastructure (e.g., bridges) and important public buildings (e.g. critical government buildings, hospitals, evacuation facilities and schools) is an urgent issue and the continuous support of JICA is considered necessary on the seismic diagnosis, seismic retrofitting and the capacity building.

The projects JICA has implemented are as below.

1) The Project for Capacity Development on Natural Disaster Resistant Techniques of Construction and Retrofitting for Public Buildings (CNCRP, 2011/3-2015/1)

The objective of the project is to strengthen the capability of PWD for the construction and retrofitting of public buildings for seismic disaster risk deduction. In addition to creating a public building inventory in Dhaka, the project developed, with the cooperation of PWD, a series of manuals, which are i) Manual for seismic design of reinforced concrete buildings, ii) Manual for seismic evaluation of existing reinforced concrete buildings, iii) Manual for seismic retrofit design of existing reinforced concrete buildings, and iv) Manual for retrofit construction and supervision of reinforced concrete buildings. Based on these manuals, PWD implemented a pilot project for the seismic retrofitting of a fire department building with its own budget.

2) Urban Building Safety Project (UBSP, 2016/6-2023/6)

The objective of the project is to strengthen the building safety in Dhaka Metropolitan Area and Chattogram City by financial support for retrofitting, rebuilding and relocation of private buildings (garment factories) and improving the building performance for public buildings (fire department buildings). The new construction of FSCD office building is the first building in Bangladesh with seismic isolation structure. Nine fire department buildings were planned to be retrofitted. After the field survey, however, it is found that two of the nine buildings were appropriate for retrofitting and the remaining seven were changed to be reconstructed because of the difficulty of the retrofitting method and high cost.

3) Technical Development to Upgrade Structural Integrity of Buildings in Densely Populated Urban Areas and its Strategic Implementation towards Resilient Cities in Bangladesh (TSUIB, 2016/4 - 2022/7)

There are four components in this project, which are i) Fundamental field survey to collect fact data on building stock in Dhaka, ii) Development of performance evaluation methodologies for buildings before/during earthquake, iii) Development of retrofit schemes for collapse prevention of low performance buildings, and iv) Development of efficient and effective urban planning strategies to make cities safer and more resilient against disasters. One of the main achievements is the establishment of a simple and quick seismic evaluation method by Visual Rating (VR) technology based on the design and construction customs of Bangladesh. For the future utilization of the technology, the manual for VR method, manual for seismic diagnosis, technical sheet for seismic retrofitting method and procedure for retrofitting construction were created.

4) Building Safety Promotion Project for Disaster Risk Reduction (BSPP, 2016/2-2022/2)

The purposes of the project are i) Strengthening the education system for the engineers both in public and private sectors regarding building safety, and ii) Improving the implementation capacity on seismic diagnosis, seismic design, retrofitting and construction management. The activities for i) was the development of training manuals and curriculums for seismic design technology targeting PWD training academy and that for ii) was implementation of OJT (on-the-job-training) for PWD technical staff. Within the project, in addition to the retrofitting pilot project of project budget, the retrofitting works for radio center and BMD building were also implemented by the Bangladesh government funding.

5) Project for Improvement of Design and Construction Quality of Private Buildings (2021/8-2026/3)

The objectives of the project are improving the design and construction quality of private buildings in the Dhaka metropolitan area. The main achievements are i) Establishment of the confirmation process for the structural design of new private buildings and enhancement of the capacity of RAJUK staff involved in the process, ii) Improvement of the inspection and supervision process for the construction of new private buildings and strengthening the capacity of RAJUK staff, and iii) Raising awareness of each stakeholder (architects, engineers, associations, etc.) regarding various methods for improving building safety.

6) Project for Supporting Capacity Improvement on Disaster prevention of Urban Community in Bangladesh (2016/4-2019/4)

This grassroots project aimed to improve the emergency response capabilities of local residents by creating a mechanism for the community to continuously carry out disaster prevention activities in northern Dhaka. The project enhanced the awareness of the staff of North Dhaka city, the ward mayor, 12 community leaders as well as local residents on disaster risk reduction through the creation of disaster risk management plan and the implementation of the activities in the plan.

Through the above technical cooperation projects as well as SATREPS, since 2011, JICA has promoted cooperation for the systematization of earthquake-resistant technology that matches the characteristics of buildings in Bangladesh. To implement this technology, the seismic strengthening of public buildings such as fire stations is being practiced. In addition, some projects are being conducted with the World Bank to improve the building approval process and disseminate technology to private engineers to construct earthquake-resilient private buildings, which make up most buildings. On the other hand, seismic reinforcement of existing private buildings is not enforceable, and it is difficult to achieve a fundamental solution, and it is still difficult to secure a national budget for seismic reinforcement of public buildings. In the short term, it is important to provide technical cooperation to establish a practical licensing system for new private buildings.

Regarding earthquake-resistant design and construction, JICA has cooperated in the development of Metro rail and important bridges and has cooperated in the implementation of earthquake-resistant design and construction. The existing core infrastructure developed by the Government of Bangladesh, especially the transportation infrastructure, is insufficiently earthquake-resilient, collapses in the event of an earthquake, and is not useful for emergency transportation, and is highly likely to cause secondary disasters. At the time of new construction, it is necessary to evaluate the seismic force properly and design the bridge, and it is necessary to carry out the seismic reinforcement of existing bridges, but the systematization for this purpose has not advanced. In the future, it will be necessary to strengthen the earthquake resistance of important transportation infrastructures such as bridges and viaducts in the planned Big-B area and other important economic zones.

For river and coastal structures, seismic shaking equivalent to the level 1 earthquake ground motions in Japanese standard is considered in the design of concrete structures and steel structures. It is necessary to consider liquefaction rather than seismic design for an embankment because of its nature of easy reconstruction.

4.6.3 Cooperation with Other Donors

The assistances of WB and UNDP for the seismic risk reduction cover a wide range for disaster resilience, such as the capacity strengthening on emergency response, seismic hazard and risk assessment, updating seismic standards, establishment of building quality control system and improving construction technology, etc. While JICA technical cooperation and Yen loan project emphasize on the improvement of seismic performance by both structural and non-structural measures, the assistance of other donors is mainly focused on the non-structural measures.

4.6.3.1 World Bank

(1) Past Projects

1) Bangladesh Urban Resilience Project (URP, 2015-2023)

   The project objectives are to strengthen the capacity of Government of Bangladesh to respond to emergency events and to strengthen systems to reduce the vulnerability of future building construction to disasters in Dhaka and Sylhet. The project comprises five components, which are A: Reinforcing the country’s emergency management response capacity, B: Vulnerability assessment of critical and essential facilities, C: Improved construction, urban planning and development and D: Project coordination, monitoring and evaluation (refer 4.1.3.1 for details).

2) Bangladesh Urban Earthquake Resilience Project (BUERP, 2012-2015)

   This project aims to provide the core elements in developing the earthquake risk reduction and management plan for Dhaka. In conjunction with the Dhaka Profile and Earthquake Risk Atlas, this project developed supplementary components that address strategic elements in the understanding of the risk profiles and disaster risk management parameters governing the country as well as Dhaka. These elements are: Hazards, Vulnerability, and Risk Assessment (HVRA); Legal and Institutional Arrangements (LIA); Risk-Sensitive Land Use Planning (RSLUP); GIS Road Map; and Information, Education, and Communication (IEC) Action Plan.

(2) Direction of Future Cooperation

URP is scheduled to be completed by October 2023 and a next project URP II is under preparation. The contents of URP II has not been decided yet and it is envisaged to be fixed within 2022 based on the requirements of Bangladesh government.

4.6.3.2 UNDP

(1) Past Projects

1) National Resilience Programme (NRP, 2017-2021)

The objective of the project is to sustain the resilience of human and economic development in Bangladesh through inclusive, gender responsive disaster management and risk informed development. The project has five outputs, which are described in 4.1.1.3 (6).

2) Comprehensive Disaster Management Programme (CDMP, 2004-2014)

There are two phases of this project, CDMP I and CDMP II (see 4.1.3.3 and 4.2.3.2). The main results of CDMP I include capacity building for disaster management, earthquake risk assessments for Dhaka, Chattogram and Sylhet, and the development of a climate change database. The main outputs of Phase II are shown in Table 4.6.1.

Table 4.6.1 Main Outputs of CDMP II

No.	Outputs
i	Implementation of risk reduction action plan in 40 prefectures (for about 3 million people) vulnerable to natural disasters
ii	Creation of earthquake vulnerability map for 9 cities
iii	Construction of early warning system and shortening lead time of flood forecasting
iv	Support for establishment and operation of Disaster Management Information Center (DMIC)
v	Financial support for purchasing search and rescue equipment
vi	Development of operation guidelines and training manuals
vii	Support for training of the Fire Services and Civil Defense

Source: JICA Survey Team

(2) Direction of Future Cooperation

The future support will be placed on the risk informed development and investment, development of long-term plans, improvement of a correct and efficient disaster information collection system, awareness of disaster risk reduction.

4.6.4 Issues in Current Efforts

Although the seismic strengthening for existing infrastructure, like bridges, and critical public buildings, such as important government buildings, base hospitals, evacuation facilities and schools, is progressed under the support of JICA and other donors, the challenges remain for the large number of vulnerable structures. The continuous support is necessary for the technology strengthening on seismic diagnosis and retrofitting, capacity building of related organizations and construction of a disaster resilience promotion system. The major challenges are as below.

4.6.4.1 Enhancement of Building Permit System for Securing Building Safety

The seismic hazard of Bangladesh is mainly due to Indian-Myanmar plate boundary fault and Himalayan Frontal fault including Dauki fault. The seismic risk is primarily coming from the short history of seismic design and poor construction quality. The seismic risk assessment was carried out in the project of CDMP in 2009 for Dhaka, Chattogram and Sylhet for three possible scenario earthquakes. The results of damage of hospitals, schools and other critical buildings are shown in Table 4.6.2 and the estimated fatality and injury are given in Table 4.6.3.

Table 4.6.2 Damage of Hospital, School and Other Critical Buildings by Scenario Earthquake

Sceanrio Earthquake	Hospital	School	EOC	Police station	Fire station
Dhaka City Corporation Area					
Total No. of Facility	600	2,737	18	62	10
Madhupur fault (Mw7.5)	241	1,173	8	30	4
Plate boundary fault-2 (M8.0)	22	99	7	1	0
Background earthquake (Mw6.0)	364	1,567	9	39	6
Chattogram City Corporation Area					
Total No. of Facility	162	1,033	11	11	12
Plate Boundary Fault-1 (Mw8.5)	158	1,011	11	11	12
Plate Boundary Fault-2 (Mw8.0)	13	78	0	1	1
Background earthquake (Mw6.0)	65	471	3	6	6
Sylhet City Corporation Area					
Total No. of Facility	87	211	9	6	2
Dauki Fault (Mw8.0)	47	111	3	4	0
Plate Boundary Fault-3 (Mw8.3)	3	5	2	0	0
Background Earthquake (Mw6.0)	47	111	2	4	0

Source: CDMP, 2009

Table 4.6.3 Death and Injury Estimation by Scenario Earthquake

Sceanrio Earthquake	Casualty at Occurrence of 2:00 AM		Casualty at Occurrence of 2:00 PM	
	Injury	Death	Injury	Death
Dhaka City Corporation Area				
Madhupur fault (Mw7.5)	148,457	88,503	163,977	61,288
Plate boundary fault-2 (M8.0)	91,471	58,858	87,027	36,195
Background earthquake (Mw6.0)	154,479	95,267	152,947	58,862
Chattogram City Corporation Area				
Plate Boundary Fault-1 (Mw8.5)	170,050	95,183	131,137	73,212
Plate Boundary Fault-2 (Mw8.0)	23,165	13,932	17,676	9,993
Background earthquake (Mw6.0)	73,033	40,453	55,448	29,771
Sylhet City Corporation Area				
Dauki Fault (Mw8.0)	18,408	9,506	12,183	6,151
Plate Boundary Fault-3 (Mw8.3)	1,626	892	1,260	667
Background Earthquake (Mw6.0)	9,254	4,723	6,421	3,242

Source: CDMP, 2009

Seismic hazard cannot be reduced by human intervention. Different from water related disasters, which emphasizes hazard reduction through river bank and watershed management, the only way to reduce seismic disaster risk is to reduce the exposure and vulnerability by securing the safety of buildings, infrastructure and lifeline facilities. It is important to secure the seismic performance of both new buildings by seismic design and construction quality management in order not to create new risk and retrofitting and reconstruction of existing vulnerable critical buildings to reduce the current disaster risk.

The Bangladesh National Building Code BNBC was first developed in 1993. The effectiveness is then limited because of no legal binding and, at the same time, not accompanied by guidelines and technical manuals for practical use and the lack of awareness on seismic design and code compliance of building owners. The legal status was granted when it was revised in 2006 and the latest version of BNBC was published in 2020. BNBC2020 has already been applied to the public buildings designed by PWD nationwide. For private buildings, it will be adopted in Dhaka soon, but it will take time for the local authorities to comply with the latest code.

The current building permit system carries out examinations mainly focusing on city planning and architectural design. Although structural design is supposed to be checked, it is not practically implemented in reality. Besides, the completion examination is also not functioned. This phenomenon is considered attributing to the lack of technology, budget, political commitment as well as technical staffs of the local development authority. For improving the building permit system and construction quality control, WB and JICA are supporting RAJUK for capacity strengthening through the loan projects of Urban Resilience Project and technical cooperation project of Improvement of Design and Construction Quality of Private Buildings, both of which are currently underway. Through the projects, the building permit system is progressively improving in Dhaka. But it remains an urgent issue for building code compliance nationwide, especially for the high seismic hazard areas designated in the building code, such as Chattogram, Sylhet and Mymensingh, etc. Since building permits are the responsibility of local development authorities, it is necessary to develop an effective mechanism for promoting building code compliance and strengthening the capacity of local development authority. For construction quality control, because large-scale buildings are mostly contracted with major companies, the construction quality is generally guaranteed by using ready-mixed concrete and conducting sample tests. However, for small-scale construction, since concrete, in most cases, is mixed in situ and low-skilled workers are usually employed, the quality of concrete cannot be guaranteed and poor construction quality can commonly occur.

In order to understand the construction status of building, the construction site of a 13-story RC office building in Dhaka was visited (Figure 4.6.7). The construction period of the building is two years and a site manager is stationed for quality management during the whole construction period. Steel formwork is used for concrete placement and ready-mixed concrete is used with 14-day curing. The construction quality is good from visual inspection. However, according to the site manager and building designer, the situation of compliance of building code largely depends on the intent of the building owner. There are cases that the building owner might like to hire a young designer with little experience and even require to deviate from building code for cost cutting. There are also cases that the completed building is different from the original application. This is considered to happen due to the lack of awareness of the building owner to comply with building code and the effective check mechanism in building administration.

(a) General view of construction

(b) Curing of concrete

(c) Hoop bent-up (135 degree)

Source: JICA Survey Team

Figure 4.6.7 Observation of Construction

In order to ensure the safety of new buildings, it is an urgent issue to enhance building code compliance by improving the building permit system and the system of quality control by interim and completion inspection. The technical assistance for promoting building code compliance based on the results of the JICA Project for Improvement of Design and Construction Quality of Private Buildings and utilizing the building administration experience of Japan could be considered effective and provide synergy for improving building safety in Bangladesh.

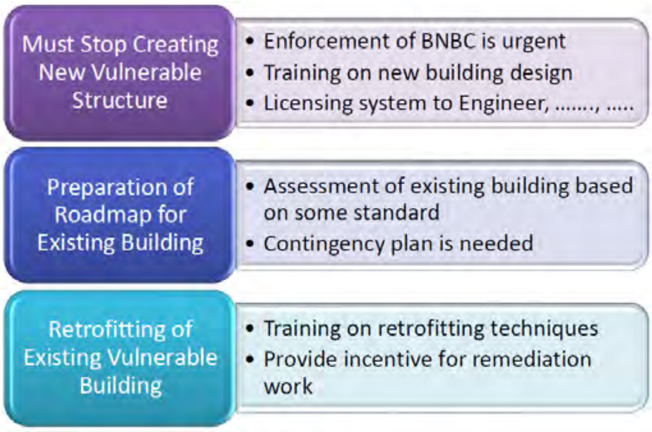
4.6.4.2 Understanding on Seismic Disaster Risk

In order to improve the safety of existing buildings, it is necessary to conduct, at first, safety assessment and set up priority buildings because of the large stock of existing buildings. The capacity enhancement is also important for both the public and private sector. In the Dhaka metropolitan area, RAJUK has conducted Rapid Visual Assessment (RVA) for 3,252 buildings and out of which 579 were subjected to Preliminary Engineering Assessment (PEA). There is also a plan to carry out Detailed Engineering Assessment (DEA) for 200 buildings by June 2022. There is no fixed seismic retrofitting plan yet at this moment. According to RAJUK, there are a total of about 2 million buildings within the RAJUK jurisdiction. It is estimated that 70% of them are the 1- or 2- story buildings and about 10-15% of the remaining 30% (60,000-90,000) buildings need to be strengthened. JICA has supported PWD for seismic diagnosis, retrofitting design and construction management and the capacity building through the technical cooperation projects of CNCRP and BSPP and the Yen loan project of UBSP. As the next step towards existing building strengthening, PWD is planning to conduct the building safety assessment and make a masterplan for building safety of public buildings for the whole country, based on the results of CNCRP, which focused on the knowledge and capacity building, and BSPP, the main activity of which was knowledge dissemination. In order to meet the needs and establish a mechanism for promotion of the safety of existing buildings with the synergy of the past projects, the continuous effort is important for both building safety assessment and seismic retrofitting implementation on the critical public buildings.

Seismic disaster risk reduction has been recognized as one of the major issues of Bangladesh. MoDMR has a vision to complete building safety for all critical buildings by 2041 and to make an earthquake resilient nation up to 2071, as shown in Figure 4.6.8. In order to reach the goal, the policy and measures, shown in Figure 4.6.9, are suggested to be a) stop creating new vulnerable buildings by enforcement of BNBC and licensing system, b) preparation of a roadmap for strengthening existing buildings based on the vulnerability assessment, and c) retrofitting of the vulnerable buildings, which harmonized with the abovementioned future cooperation direction.

Source: JICA/MoDMR

Figure 4.6.8 Roadmap Towards Earthquake Resilient Nation



Source: JICA/MoDMR

Figure 4.6.9 Policies and Measures for Building Safety

4.6.4.3 Improvement of Seismic Safety of Critical Structures

The emphasis for seismic disaster risk reduction has been mainly placed on the emergency response, such as search and rescue, evacuation and relief, etc. There is no long-term plan and budget allocation from the Bangladesh government for the seismic strengthening of important existing infrastructures and public buildings, except for the pilot projects promoted by donors. The challenges for new construction is the enhancement of building code compliance and construction quality assurance and, for existing structures, the promotion of seismic strengthening. Due to the large number of building stocks, the seismic strengthening of existing facilities requires enormous funds and a long time. Therefore, it is important to prioritize the important infrastructure and public buildings for effective utilization of limited financial resources.

While Bangladesh has high earthquake hazard, it has not suffered major earthquake damages for more than 100 years. Awareness and priority for earthquakes is relatively low compared to the other disasters like flooding and typhoons that occur frequently. For the awareness of seismic risk, the project CDMP (2004-2009), supported by UNDP, carried out seismic risk assessment for Dhaka, Chattogram and Sylhet and pointed out that the vulnerabilities in buildings and infrastructure could possibly cause enormous damages from future earthquakes. In order to reduce the seismic disaster risk, JICA started technology transfer and capacity building to PWD for building safety, such as seismic design, seismic diagnosis and retrofitting for important public buildings through the technical cooperation projects of CNCRP and BSPP and Yen loan project of UBSP (ongoing). In addition, in response to the collapse of a garment factory building, JICA also supported the building safety of the garment factory, which is of high importance on the local economy. In CNCRP and BSPP projects, the pilot projects of seismic retrofitting for fire departments, the PWD main building and meteorological department building were implemented, and the seismic retrofitting of radio center and regional core hospital were carried out by Bangladesh funds (see Figure 4.6.10). Through these seismic retrofitting projects, PWD has acquired enough knowledge and technology for seismic diagnosis, seismic design and construction management. However, the number of engineers who have sufficient skills is far smaller than the number needed considering the big stock of vulnerable buildings throughout the country. On the other hand, an issue is that PWD is actually responsible for the maintenance and management of public buildings. However, since they are owned by different ministries, PWD alone cannot implement seismic retrofitting unless each ministry recognizes the need for it. Due to the lack of a national policy, there is no system that allows for inter-ministerial coordination to develop a plan to promote earthquake resistance. In addition, there is no system in place to sequentially implement seismic reinforcement starting with more vulnerable and more important buildings.

Source: CNCRP and BSPP

Figure 4.6.10 Seismic Strengthening Facilities by CNCRP and BSPP

4.6.4.4 Risk-informed Urban Planning and Infrastucture Development

In addition to individual building safety, it is also important for seismic disaster risk reduction by urban planning and land use regulation to prevent excessive densification and secure the emergency road and parks for evacuation space, based on multi-hazards, such as soft site condition, liquefaction and sediment-related disasters, etc. It is important for transportation infrastructure such as roads, bridges, airports and seaports and lifeline facilities such as water, electricity and communications to keep their function after an earthquake for efficient emergency response, relief and quick recovery and reconstruction. Therefore, it is essential to follow the design standards and assure construction quality for new constructions. For existing facilities, it is essential to carry out risk assessment at first and take necessary measures based on the risk assessment. For this purpose, a national promotion policy is necessary and the capacity building on risk assessment and structural strengthening for the business operator of each facility is needed. Since transportation infrastructure plays a key role in emergency search and rescue, it should be given the priority for risk assessment and taking countermeasures under the limited resources. In particular, it is an urgent issue for safety assessment and collapse prevention for the bridges on the major emergency roads. In addition, from the viewpoint of strengthening city resilience, it is also considered necessary to make land readjustment in old vulnerable built-up urban area through urban redevelopment.

4.7 Cross-Cutting Issues Common to Each Disaster that Needs to be Addressed

4.7.1 Climate Change Adaptation

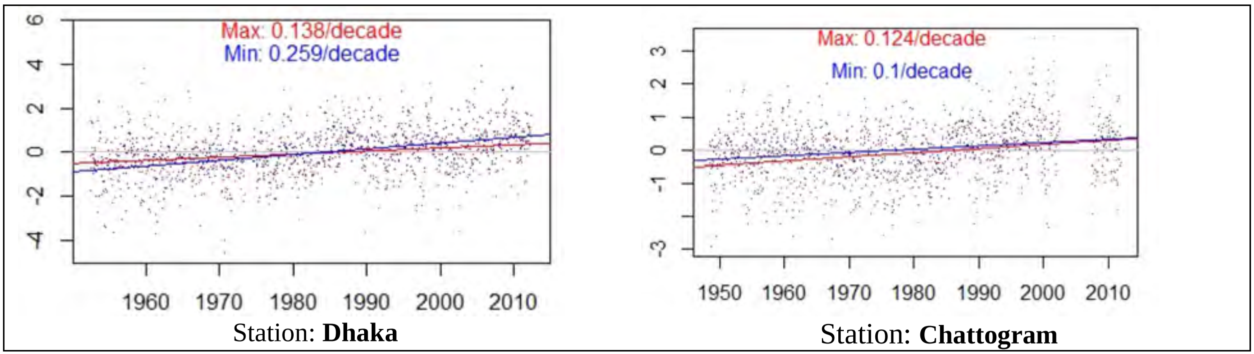
Climate change in Bangladesh is a critical issue as the country is one of the most vulnerable to the effects of climate change. The Climate Risk Index (CRI) analyses to what extent countries and regions have been affected by impacts of weather-related loss events (storms, floods, heatwaves, etc.). In the 2020 edition of the Global Climate Risk Index, Bangladesh ranked seventh in the list of countries most affected by climate calamities during the period 1999–2018.

Bangladesh's vulnerability to climate change impacts is due to a combination of geographical factors, such as its flat, low-lying, and delta-exposed topography, and socio-economic factors, including its high population density, levels of poverty, and dependence on agriculture. In this section, the future projection of climate change, its impacts, and policy and institutional arraignments for mitigation and adaptation have been reviewed. JICA survey team collected and analyzed available reports such as IPCC's Assessment Reports (AR3/2001, AR4/2007, AR5/2014, and AR6/2021), information and analysis in the World Bank Climate Change Knowledge Portal[25] and other studies and reports such as Climate Change Profile: Bangladesh drafted by Ministry of Foreign Affairs of the Netherlands in 2018 and Bangladesh Delta Plan 2100 (BDP2100, 2018) as well as official reports drafted by different Bangladesh Government agencies.

4.7.1.1 Climate Change Impacts and Future Projections

Out of 34 synoptic stations studies in Bangladesh, the maximum temperature of 31 stations shows increasing trend and only 3 stations show negative trend during the available observation period at each of the station. Table 4.7.1 summarizes the names and locations of all 34 stations. Analysis also reveals that the rates of increment of the stations located over the southern part of country are higher than that of the stations located over north and northwestern parts of the country. Similarly, minimum temperatures of almost all the stations shows increasing trends except 6 stations where trends are decreasing. The trends of the deviations of maximum and minimum temperatures of the available period at each of the stations are collected but the trends at Dhaka and Chattogram are shown in Figure 4.7.1.

According to the Intergovernmental Panel on Climate Change (IPCC) 3rd Assessment Report (AR3, 2001), there is "evidence that the peak intensity may increase by 5% to 10% and precipitation rates may increase by 20% to 30%". Cyclone-induced storm surges are likely to be exacerbated by a potential rise in sea level of over 27 cm by 2050. The time between rainy days is expected to increase.



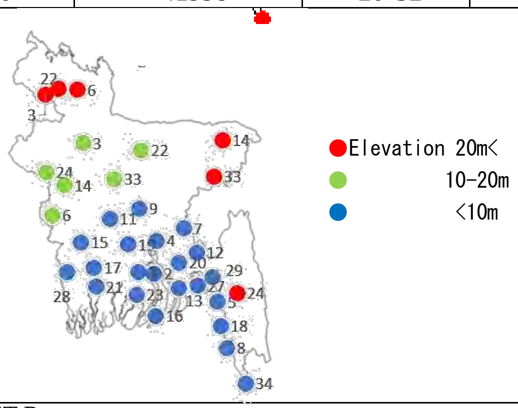
Source: Climate of Bangladesh, MET Report No. 08/2016, Date: 2016/5/31, ISSN 2387-4201, P 46

Figure 4.7.1 Trends of the Deviations of Maximum and Minimum Temperatures in Dhaka and Chattogram Stations

[25] https://climateknowledgeportal.worldbank.org/country/bangladesh

Table 4.7.1 List of Observation Stations

No.	Location	Operating Time	International Number	Latitude (N)	Longitude (E)	Elevation (m)
1	Barisal	1883	41950	22°43'	90°22'	2.10
2	Bhola	1965	41951	22°41'	90°39'	4.30
3	Bogra	1884	41883	24°51'	89°22'	17.90
4	Chandpur	1964	41941	23°14'	90°42'	4.88
5	Chattogram MMO	1937	41978	22°13'	91°48'	5.50
6	Chuadanga	1986	41926	23°39'	88°49'	11.58
7	Comilla	1883	41933	23°26'	91°11'	7.50
8	Cox's Bazar	1908	41992	21°27'	91°58'	2.10
9	DhakaPBO	1949	41923	23°46'	90°23'	8.45
10	Dinajpur	1883	41863	25°39'	88°41'	37.58
11	Faridpur	1883	41929	23°36'	89°51'	8.10
12	Feni	1973	41943	23°02'	91°25'	6.40
13	Hatiya	1965	41963	22°27'	91°06'	2.44
14	Ishwardi	1963	41907	24°09'	89°02'	12.90
15	Jessore	1867	41936	23°12'	89°20'	6.10
16	Khepupara	1973	41984	21°59'	90°41'	1.83
17	Khulna	1921	41947	22°47'	89°34'	2.10
18	Kutubdia	1977	41989	21°49'	91°51'	2.74
19	Madaripur	1976	41939	23°10'	90°11'	7.00
20	Maijdee Court	1883	41953	22°52'	91°06'	4.87
21	Mongla	1988	41958	22°28'	89°36'	1.80
22	Mymensingh	1883	41886	24°44'	90°25'	18.00
23	Patuakhali	1973	41906	22°20'	90°20'	1.50
24	Rajshahi	1883	41895	24°22'	88°42'	19.50
25	Rangpur	1883	41859	25°44'	89°16'	32.61
26	Rangamati	1957	41966	22°22'	92°09'	68.89
27	Sandwip	1966	41964	22°29'	91°26'	2.10
28	Satkhira	1877	41946	22°43'	89°05'	3.96
29	Sitakunda	1977	41965	22°38'	91°42'	7.30
30	Srimangal	1905	41915	24°18'	91°44'	21.95
31	Syedpur	1980	41858	25°45'	88°55'	39.60
32	Sylhet	1952	41891	24°54'	91°53'	33.53
33	Tangail	1982	41909	24°15'	89°56'	10.20
34	Teknaf	1976	41998	20°52'	92°18'	5.00

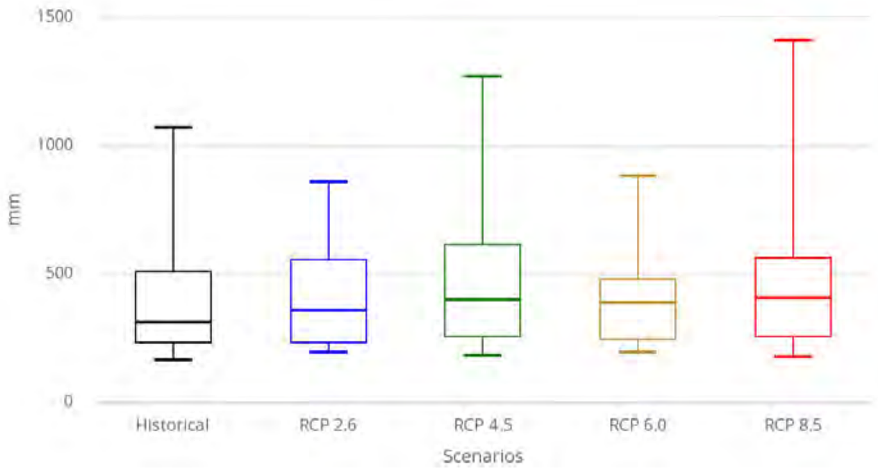


Source: Prepared by Climate of Bangladesh, MET Report

The following are major climate change profile and future projection according to IPCC-5th Assessment Report (AR5, 2014) and other studies:

- **Temperature:** Mean temperatures across Bangladesh are projected to increase between 1.4°C and 2.4°C by 2050 and 2100, respectively. This warming is expected to be more pronounced in the winter months (December-February). Average monsoon season maximum and minimum temperatures show an increasing trend annually at the rate of 0.05°C and 0.03°C, respectively.

- **Rainfall:** Annual precipitation will rise by 74.03mm (-304.45mm to 499.79mm) in 2040-2060 based on CMIP5 result and high emission scenario (RCP 8.5, Ensemble). The time between rainy days is expected to increase. Peak 5-day rainfall intensity (a surrogate for an extreme storm event) is projected to increase as in Figure 4.7.2. The 5-day cumulative rainfall indicator shown in Figure 4.7.2 focuses on the maximum rainfall amount that is expected over a 25-yr return period. Any changes can have significant impacts on infrastructure and endanger life and property through direct physical effects and potentially through water quality issues.



Source: https://climateknowledgeportal.worldbank.org/country/bangladesh/climate-sector-water

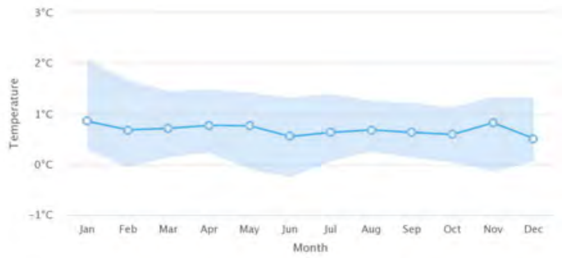
Figure 4.7.2 5-Day Rainfall with 25 years return period from 2040 to 2060

- **Sea-level rise and Cyclone:** Significant sea level rise has been measured in Bangladesh. Sea level rise has been one of the factors that led to an increase in soil salinity in Bangladesh. Sea-level rise and consequent salinity intrusion increase by 1ppt in 17.5% & by 5ppt in 24% area of Bangladesh. Significant increasing trends have also been observed in the cyclone frequency during November and May, which are the main months for cyclone activity in the Bay of Bengal. Cyclone-induced storm surges are likely to be exacerbated by a potential rise in sea level of over 27 cm by 2050. In addition, there are concerns about the deterioration of drainage functions in estuarine areas due to the progression of saltwater intrusion, resulting in more severe flooding damage[26].
- **River Bank Erosion and Sediment:** River bank erosion could lead to 50,000 households on avg. become homeless each year. Speeding melting GLOF in Himalaya may cause more runoff and sediment transport to downstream. This will add to already complicate transboundary challenges.

Coupled Model Intercomparing Project, Phase 5 (CMIP5) models included in the IPCC's Fifth Assessment Report (AR5, 2014) is the most widely global climate change model. The following Figure 4.7.3 is summary of future climate change projection for two scenarios of low and high emissions.

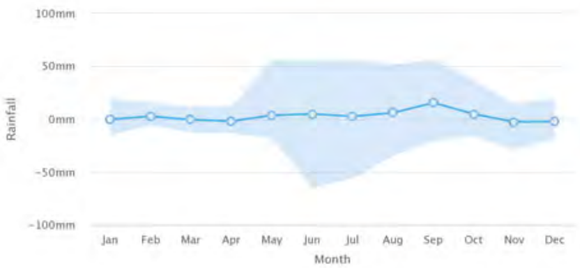
[26] Climate change-induced challenges to sustainable development in Bangladesh, M A Mojid, 2019

Low Emission Scenario （RCP 2.6） High Emission Scenario （RCP 8.5）



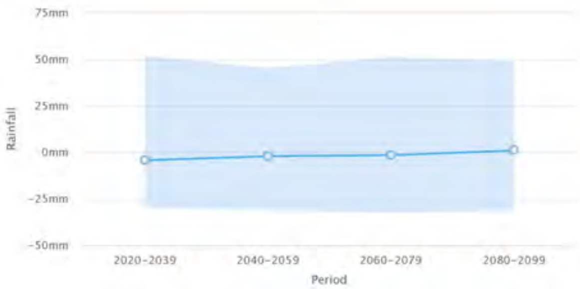
Projected Change （anomaly） in Monthly Temperature from 2020 to 2040 using Ensemble GCMs results

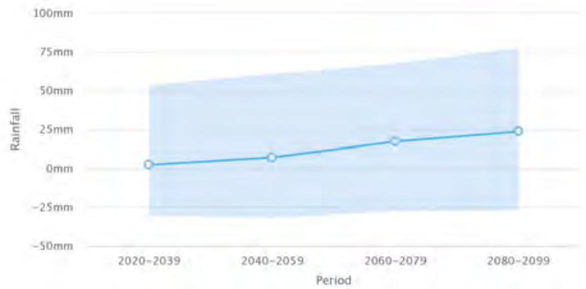
Low Emission Scenario （RCP 2.6） High Emission Scenario （RCP 8.5）



Projected Change （anomaly） in Monthly Precipitation from 2020 to 2040 using Ensemble GCMs results

Low Emission Scenario （RCP 2.6） High Emission Scenario （RCP 8.5）





Projected Change （anomaly） in Max. Daily Rainfall from 2020 to 2100 using Ensemble GCMs results

Source: World Bank Climate Change Knowledge Portal

Figure 4.7.3 Projected Anomaly in Temperature and Precipitation Using Ensemble Climate Model Results for Two Scenarios of Low and High Emission

A climate change profile drafted by Ministry of Foreign Affairs of the Netherlands in 2018 is suggesting the effects of climate change will differ per region in Bangladesh:

- ✓ The northwest will suffer most from temperature increase and drought;
- ✓ The center and northeast of the country will suffer from increased frequency and intensity of floods;
- ✓ The coastal area and islands will experience effects of sea level rise and salinity intrusion, as well as increased cyclone frequency and intensity, while urban coastal areas will suffer from drainage congestion

Bangladesh is identified as being at particular risk from climate change as it is in a low-lying coastal region with regular cyclones. The World Bank links sea level rise with cyclonic activity, saying, cyclone induced storms are likely to be exacerbated by a potential rise in sea level of over 27cm by 2050. The following are most important highlights regarding Bangladesh climate change impact in the IPCC 5th Assessment Report (AR5-2014) and 6th Assessment Report (AR6-2021):

- ✓ Vulnerability to cyclones is expected to increase, but there are opportunities to adapt. Together, Bangladesh and India have the rarest and most severe tropical storms categories in the world. In the

Report, it is estimated that Bangladesh lost an estimated 5.9% of its GDP to storms and 7.5 million people affected from 1998 to 2009. According to the latest IPCC report AR6, extreme weather events with intense heat waves and high humidity can occur frequently in South Asia, including Bangladesh. The report states that global warming will reach 1.5 ° C about 10 years earlier than previously predicted, and South Asia is particularly affected by extreme weather events (humidity and thermal stress), where wet-bulb temperatures become extremely high.

- ✓ Sea level rise leads to salinity and saltwater intrusion, which negatively affects conditions for crop cultivation and decreases availability of freshwater resources for consumption and production. Pumping of fresh groundwater in coastal aquifers, to adapt to salinization, further accelerates saltwater intrusion and degradation of water quality, thus creating a vicious circle. Increase of soil salinity is expected to vary from 26% up to 55% in most affected areas, by 2050. Saltwater intrusion due to sea level rise since 1980~; shift from agriculture to shrimp farming; loss of agricultural livelihoods.
- ✓ According to AR6, coastal aquifers with very low hydraulic gradients, such as the Asian megadelta, are theoretically susceptible to rising sea levels. The Ganges-Brahmaputra-Megna basin can be more severely and extensively affected by changes in upstream river runoff. AR6 reports that storm surge flooding has the most local effects in this basin.
- ✓ By 2050 Bangladesh will face incremental cost to flood protection （against both sea and river floods） of US$2.6 billion initial costs and US$54 million annual recurring costs. Bangladesh's population at risk of sea level rise is predicted to rise to 27 million in 2050, more than double since 2008.
- ✓ Climate change impacts also pose a threat to health. Diseases like cholera and diarrhea have been linked to high temperatures. A study in Dhaka reported increased rates of hospital due to dengue with both high and low river levels. In some circumstances, it is apparent that heavy precipitation favors the spread of dengue fever, but drought can also be a cause if households store water in containers that provide suitable mosquito breeding sites. Climate disasters also affect mental health, causing stress and tension. Based on an 18-year climate record for Bangladesh, it is reported cholera outbreaks at ENSO events. As predicted by AR6, if the humid heat stress phenomenon becomes more intense and more frequent, it could be a "major health problem" for South Asian societies in the 21st century. In order for the human body to release heat to the environment through the skin, a temperature difference between the human body and the environment is necessary. When the wet-bulb temperature of the surrounding environment becomes high, it cannot be cooled by heat release, which is fatal.
- ✓ Domestic displacement of population is accelerating due to climate change in Bangladesh. 22% of households affected by tidal surge floods, and 16% affected by riverbank erosion, moved to urban areas.
- ✓ Climate change is affecting wildlife and natural ecosystem. It is predicted a 96% decline in tiger habitat in Bangladesh's Sundarbans mangroves with a 28 cm sea level rise if sedimentation does not increase surface elevations. Rising winter temperatures are expected to result in poleward expansion of mangrove ecosystems. Coastal freshwater wetlands may be vulnerable to saltwater intrusion with rising sea levels, but in most river deltas local subsidence for non-climatic reasons will be more important. Current trends in cyclone frequency and intensity are unclear, but a combination of cyclone intensification and sea level rise could increase coastal flooding and losses of coral reefs and mangrove forests would exacerbate wave damage.
- ✓ AR6 states that in the Ganges and Brahmaputra basins, massive droughts were recorded during the simultaneous occurrence of El Nino and the positive Indian Ocean Dipole (IOD), and floods occurred during the La Niña and negative IODs.
- ✓ Climate change also poses risks for food security in Bangladesh. The report says under a scenario of low crop productivity, Bangladesh could experience a net increase of poverty of 15% by 2030. In terms of heat stress for rice crops, current temperatures are already approaching critical levels during susceptible stages of the rice plant during March-June.
- ✓ The particular vulnerability of women to climate change was highlighted. For instance, often women do not learn to swim and so are more vulnerable to flood risks. In coastal areas, an increase in hypertension (blood pressure) has been identified in pregnant women. This can be linked to the intrusion of salty water which could worsen in future.

4.7.1.2 Climate Change Initiatives by the Government of Bangladesh

(1) Policies, Institutions and Budgets Related to Climate Change

The IPCC defines adaptation as the "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities". The government of Bangladesh is working on a range of specific climate change adaptation strategies and development of the relevant agencies.

Bangladesh has ratified the Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. Bangladesh signed the Paris Agreement in April 2016. It has prepared two National Communications for the UNFCCC and a National Action Plan for Adaptation (NAPA). The NAPA was developed between 2003 and 2005 with support from GEF and was updated in 2009. The 2009 update identified 38 adaptation measures.

In 2008, adaptation priorities from the NAPA were updated and embedded in a new Bangladesh Climate Change Strategy and Action Plan (BCCSAP). As a cross-sectoral policy document, it was a 10-year programme (2009-2018) to build the capacity and resilience of the country to meet the challenge of climate change. Its main purpose was to articulate a strategy to manage climate change and its impacts in Bangladesh leading towards an action plan of programmes addressing the needs for substantive interventions with a definitive timeline for their implementation. The Action Plan comprises 44 immediate, short, medium and long-term programmes based upon six pillars:

- ✓ Food security, social protection and health
- ✓ Comprehensive disaster management
- ✓ Infrastructure
- ✓ Research and knowledge management
- ✓ Mitigation and low carbon development
- ✓ Capacity building and institutional

The framework for enactment of the BCCSAP is Bangladesh’s Vision 2021 and its concretization in the 7th Five Year Plan. These documents also contain chapters on climate change and the National Planning Commission integrates climate change into the Annual Development Programme in the sectors agriculture, transport, rural development, and water. Although the 7th five-year plan mentioned that the BCCSAP should be updated, an update has not yet occurred.

Priorities for climate change adaptation and mitigation are also elaborated in a number of sector policies and plans, including BDP2100, SOD-2019, the NPDM 2021-2025, the National Water Policy, the National Strategy for Water Sanitation and Hygiene, the National Sustainable Development Strategy, the National Adaptation Programme of Action, the Coastal Zone Policy, the Master Plan for Agricultural Development in the Southern Region of Bangladesh, the National Agricultural Policy, and the Food Policy’s Plan of Action. In most of these, the focus is on adaptation.

In the implementation of these policies and strategies, various institutions are involved. One of the key elements of Bangladesh on adaptation of climate change is a complicated institutional setup. The Ministry of Environment and Forests (MoEF) is the focal ministry for climate change and led the development of the NAPA, BCCSAP, the Climate Change and Gender Action Plan (CCGAP: Bangladesh) and the National Determined Contribution (NDC). Bangladesh has established the Bangladesh Climate Change Trust Fund (BC-CTF) and the Bangladesh Climate Change Resilience Fund (BC-CRF). The BC-CTF within the MoEF coordinates the Climate Change Cells that were placed within relevant ministries. A study on the network of finance and activities around climate change in Bangladesh found that this network is highly centralized, with a small number of core players, being MoEF, MoFDM (Ministry of Food and Disaster Management) and UNDP.

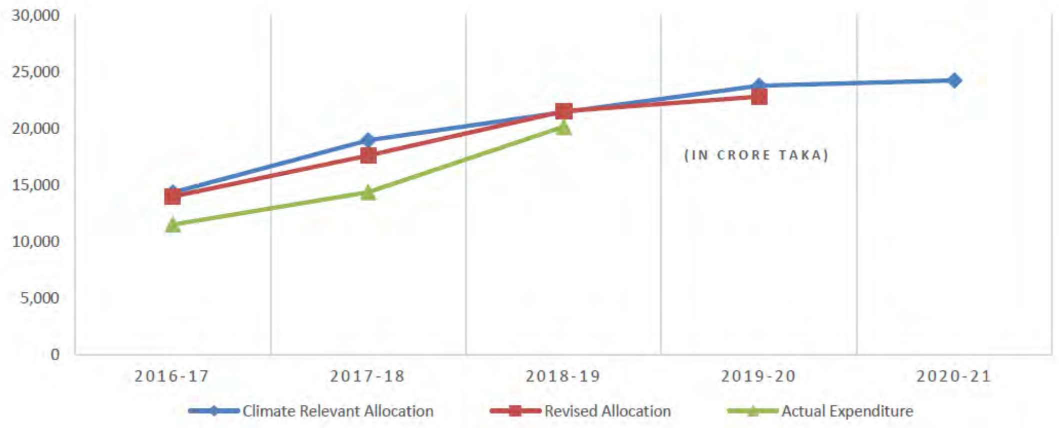
Other actors of influence on climate change activities were found to be Bangladesh Meteorological Department （BMD）, Ministry of Agriculture (MOA), Department of Agricultural Extension (DAE), FAO and UNDP. An All-Party Parliamentary Group (APG) on climate change and environment was established in 2009 as a cluster of MPs, representing all major parties in the country. NGOs play an important role, both in development of the BCCSAP but also as implementing entities under the BC-CRF and BC-CTF.

Country Investment Plan for Environment Forestry and Climate Change (CIP-EFCC) 2016-2021 is launched in December 2017, provides a strategic framework for planning and coordination of national and international investments for environment, forestry and climate change (EFCC) sectors in Bangladesh. It also specifies the actions and targets that the Government has submitted to the UNFCCC in pursuance of the Paris Agreement. The total cost of the CIP has been estimated at US$11.7 billion.

In general, Bangladesh is adopting a two-fold strategy against climate change impacts. The main focus of Bangladesh's activities is on increasing resilience to the impacts of climate change. At the same time, the country is also pursuing the agenda of lower greenhouse gas (GHG） emission. As part of this agenda, Bangladesh has prepared a ten-year Implementation Roadmap for the Nationally Determined Contribution （NDC） for 2016-2025 to manage growing emissions without compromising the required development and to allow Bangladesh to play its role in global efforts to limit temperature rise to two degrees or preferably 1.5 degrees above pre-industrial levels. [Source: https://www.adaptation-undp.org/projects/NAP-Bangladesh-GCF]

Effectiveness of the institutions involved in climate change adaptation is often hampered by limited capacity, lack of coordination, and limited participation of stakeholders such as small farmers and fishers in planning.

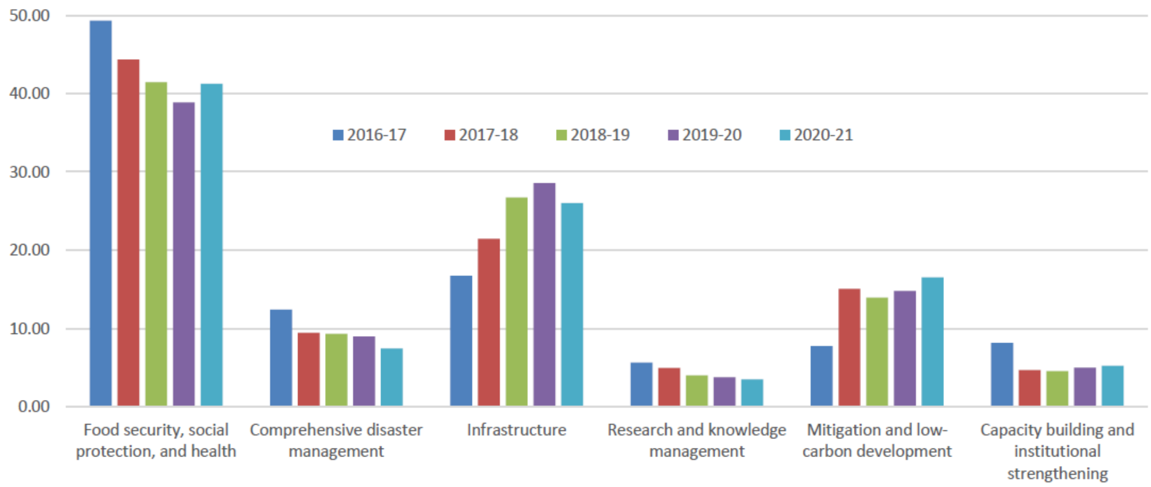
Figure 4.7.4 shows the trend of climate relevant allocations and expenditure since FY2016-17 for the selected 25 Ministries/Divisions in Crore Taka (x107 Taka). The total climate relevant allocation shows an increase from FY2016-17 to FY2020-21 by about 70%.



Source: Finance Division, Ministry of Finance, Budget Report 2019-2020

Figure 4.7.4 Trend of Climate Relevant Allocations and Expenditure Since FY2016-17 for the Selected 25 Ministries/Divisions

Figure 4.7.5 shows the climate related allocation as percentage of the budget of selected 25 Ministries/Divisions according to BCCSAP thematic areas since FY2016-17. Among the thematic areas, maximum allocation was made to Food Security, Social Security and Health followed by Infrastructure. This is worth mentioning that climate allocation in 'infrastructure' and 'mitigation and low-carbon development' shows an increasing trend.



Source: Finance Division, Ministry of Finance, Budget Report 2019-2020

Figure 4.7.5 Climate Related Allocation as Percentage of the Budget of Selected 25 Ministries/Divisions According to BCCSAP Thematic Areas

At the global level, Bangladesh chairs the Climate Vulnerable Forum (CVF) and the V20 Group (Vulnerable Twenty: V20) in 48 countries. Bangladesh served as the third chair of the CVF from 2011 to 2013. Bangladesh has established CVF's first trust fund. Bangladesh, as the Presidency of the CVF, has announced that all countries will act as supporters of urgent strengthening of climate change measures. Bangladesh also emphasized its aim to promote the following key priorities[27]:

- ✓ Promoting international cohesion for the success of the 2021 Climate Summit (UNFCCC COP26)
- ✓ Strengthening efforts to adapt to climate change and accelerating adaptation behavior
- ✓ Strengthening the protection of human rights threatened by climate change
- ✓ Expand efforts to address losses and damages and assist those evacuated due to climate threats, and establish international responsibility for evacuation compensation.
- ✓ Contribution to raising public awareness and expanding scientific knowledge
- ✓ Facilitating progress towards CVF's vision for renewable energy production and access
- ✓ Further strengthening the organizational capabilities of partnerships, outreach, CVF and V20
- ✓ Creation of a new CVF / V20 fund
- ✓ Possibility of a new special rapporteur on climate change
- ✓ Appointment of CVF Thematic Envoys and Climate Change Envoys
- ✓ Publication of the 3rd edition of "Climate Vulnerability Monitor"

In 2019, the Prime Minister of Bangladesh attended COP25 in Madrid. Bangladesh will chair the CVF from 2020. Under the Global Commission on Adaptation (GCA), a regional Climate Adaptation Center was established in Bangladesh to facilitate the process. The Prime Minister of Bangladesh was awarded the United Nations Environmental Award in 2015 for his leadership in climate change.

Bangladesh supports Paris Agreement stat "Article 6" on carbon markets and other international cooperation. The establishment of the "Santiago Network on Loss and Damage" is welcomed as a positive achievement for the Government of Bangladesh on the issue of loss and damage that is important for climate-sensitive developing countries such as Bangladesh. The Bangladesh Representative of the United Nations Headquarters is actively working on climate change and environmental issues, emphasizing Bangladesh's vulnerability to climate change. This is one of the Secretary-General's priorities convened as a partner country of the SUMMIT Alliance on Adaptation and Recovery at the Climate Action Summit held on September 23, 2019. At the above-mentioned Climate Action Summit, Prime Minister Sheikh Hasina has launched a multi-party initiative called the Risk-Informed Early Action Plan (REAP)[28].

[27] Source: https://www.v-20.org/our-voice/news/press-releases/bangladesh-chair-of-vulnerable-twenty-group

[28] Source: https://bdun.org/bangladesh-priorities-at-the-un/climate-change/

The COP26 was held in Glasgow in October 2021. The conference adopted the Glasgow Climate Pact, which states that efforts will be pursued to limit the temperature increase from pre-industrial times to 1.5°C. It also called for review of NDCs for 2030 by the end of 2022. In addition, it clearly states the losses that developing countries will suffer due to climate change, and it also clarifies that financial assistance will continue to be provided to developing countries, while requesting them to take environmental measures. Bangladesh has expressed its commitment to reduce its carbon emissions by 22% compared with 2012 levels by 2030.

(2) Eighth Five Year Plan

The following are a list of activities to be undertaken by the government of Bangladesh according to the 8th five-year development plan to address climate change:

- ✓ Mobilizing Resources for Climate Change Trust Fund
- ✓ Utilizing the Green Climate Fund (GCF)
- ✓ Increased Oversight of the Climate Change Trust Fund
- ✓ Formulation and Advancement of Bangladesh National Adaptation Plan (NAP) Process
- ✓ Technology Transfer on Adaptation and Mitigation
- ✓ Increased Commitment to Forestry and Biodiversity
- ✓ Improved Understanding of Climate Change in the Local Government
- ✓ Increased Partnership with the NGOs and Civil Society Actors
- ✓ Developing Gender-Inclusive Climate Change Response Framework
- ✓ Addressing Climate Change Induced Migration
- ✓ Gender Focus of Climate Action

Moreover, the following table is to identify indicators for the “Goal 1: Ensure safety against water and climate change related disasters” according to the 8th five-year development plan:

Table 4.7.2 Identified Indicators and Targets for 2025

No.	Indicators	Sub-Indicators	Quantity	2016-2018	Target for 2025
(Goal 1: Ensure safety against water and climate change related disasters)					
1A	Risk zone susceptible to natural hazards	Average flood extent	% of total area of Bangladesh	30	20
		Extreme flood extent	"	50	30
		Cyclone damage extent	"	10	2
		Average drought extent	"	9	9
		Extreme Drought Extent	"	47	20
		Dry season saltwater intrusion	% of total coastal area	40	30
		Water logging extent	"	2.5	0.25
		Length of bank-line erosion	% of total river length	15	8
1B	Population vulnerable to natural disasters	Flood vulnerable people	Nos. in million	88	40
		Cyclone vulnerable people	"	8	5
		Erosion vulnerable people	"	1	0.5
		Water logging vulnerable people	"	0.9	0.1

Source: The Eighth Five Year Plan

(3) Related Projects by BWDB

BWDB has submitted a Development Project Proposal (DPP), entitled “Rehabilitation of Coastal Polder 31” developed by Khulna WDB, for a project worth TK 1,545.53 crore (approximately US$180 million) on 26 July 2020 to address the adverse effects of climate change and develop the current socio-economic situation in Polder 31, Dacope, Khulna District. The DPP includes the rehabilitation and protection of embankments, protection of riverbanks, rehabilitation of drainage infrastructure, re-excavation of canals and rivers, and other works necessary for the rehabilitation of Polder 31 as in the reference in footnote[29].

The above project is beside a World Bank Project so called "Coastal Embankment Improvement

[29] Source: https://archive.dhakatribune.com/bangladesh/nation/2020/12/30/megaproject-proposed-to-address-climate-change-in-khulna

Project - Phase I (CEIP-I)" from 2013 to 2023 involving Polders 32, 33, 35/1, and 35/3 in Package 1 and Polders 39/2C, 40/2, 41/1, 43/2C, 47/2 and 48 in Package 2. The objectives of the project are to (a) increase the area protected in selected polders from tidal flooding and frequent storm surges, which are expected to worsen due to climate change; (b) improve agricultural production by reducing saline water intrusion in selected polders; and (c) improve the Government of Bangladesh's capacity to respond promptly and effectively to an eligible crisis or emergency.[30]

(4) Recent Development in Climate Change-related Tool

An automated tool 'Digital Risk Information Platform (DRIP)'[31] has been developed by the National Resilience Programme (NRP) of the Planning Commission to conduct Disaster Impact Assessment (DIA) in all 64 districts. The NRP has funded by UNDP.

As specialized software application, DRIP aims to strengthen the institutional capacity of the Government of Bangladesh for assessing, understanding and communicating disaster and climate related risks, with the goal of integrating disaster risk information into development planning & budgeting, policies and programs.

A web-based Climate Projection Map has been developed as DRIP contents[32]. The climate projection map gives a projection based on the climate considering several factors for historical precipitation and temperature and annual and seasonal anomaly using IPCC RCP 4.5 and 8.5.

On October 6, 2021, a draft guideline was approved by the Ministry of Planning, aiming to make DRIP verification mandatory in the process of DIA while conducting feasibility studies on the development project proposals (DPPs) for all projects.

(5) Current Situation for Climate Change Adaptation in Meteorological Warning and Forecasting

BMD has Climate Division that manages climate change, and the division checks and stores the observing data. The data are stored approximately 70 years from 1948 to the present but some of the data has not been digitalized yet. BMD seeks techniques to JMA for digitalization from the paper record. The number of observation stations has been 35 since 1948, and a total of 43 since 1972 until now. They are calculating the 30-year average (1991-2020), but it has not been completed yet because of restrictions by COVID-19.

Climate Division uses PRECIS (GB) for the projection of daily precipitation from 2030 to 2050. CLISYS (FR) is also used for climate change analysis. WRF (US), GFS (US), ECMWF (EU), CMA (CH), and JMA-GSM (JP) are used for weather forecasts Climate Division plans downscaling by WRF.

Some stations obtain CO2 observations and predictions, but environmental measurement is not operated because it is out of BMD's scope.

Research on climate change is being conducted in collaboration with some universities in Bangladesh. BMD also conducts downscaling around the Bangladesh area under the CORDEX (Coordinated Regional Climate Downscaling Experiment) of WCRP (World Climate Research Programme), in which WMO involves.

4.7.1.3 JICA's Cooperation

The major projects of JICA's cooperation on climate change in Bangladesh are summarized in the table below.

[30] Source: https://projects.worldbank.org/en/projects-operations/project-detail/P128276
[31] http://drip.plancomm.gov.bd/
[32] http://drip.plancomm.gov.bd/BasicMap/DistProjectionMap

Table 4.7.3 JICA Projects on Climate Change in Bangladesh

Project Name	Detail	Year
Information Collection and Confirmation Study on Disaster Resilience Enhancement in Cyclone Prone Areas, Bangladesh	(1) Identify the measures taken by donors and NGOs in the southwestern coastal areas of Bangladesh after the disaster (target areas, budget, target sectors, etc.), the status of repair of structures such as levees and seawalls, and the status of restoration of houses, fields, and public facilities within the ring dykes, as well as issues related to disaster preparedness for cyclones and storm surges in the area. (2) Propose specific measures (not limited to JICA assistance) to strengthen the disaster management capacity of the area. (3) Based on the analysis of (2) above and the current status of support by other donors and NGOs, present the direction of JICA's support, including future scenarios and proposals for priority areas and sectors.	2012
Climate change policy information collection and confirmation survey for Asian developing countries	In addition to the literature review, we invited officials in charge of planning and implementation of climate change measures from target countries and held seminars. We also participated in the 19th Conference of the Parties (COP19) to the United Nations Framework Convention on Climate Change (UNFCCC) to hold dialogues and gather information from relevant parties in Asian developing countries, and at the same time, made recommendations based on the latest situation of international climate change negotiations.	2013
Detailed Planning Study for Research and Development Project on Storm Surge and Flood Damage Prevention and Mitigation Technology in Bangladesh	(1) Identify the current status and issues related to observation, research, and countermeasures related to storm surge, flooding, riverbank erosion, and the spread of toxic sediment after a flood disaster and confirm the positioning and significance of this project. (2) Explain the systems and frameworks related to scientific and technological cooperation, discuss the basic plan and implementation system of the project, reach a consensus with the relevant organizations of the recipient, and confirm the consensus in the Minutes of Meeting (M/M). (3) Explain the contents of the minutes of discussion (R/D), focusing on the items to be borne by the counterpart and the items to be addressed, to the counterpart organizations to obtain their understanding.	2016

Source：JICA Survey Team

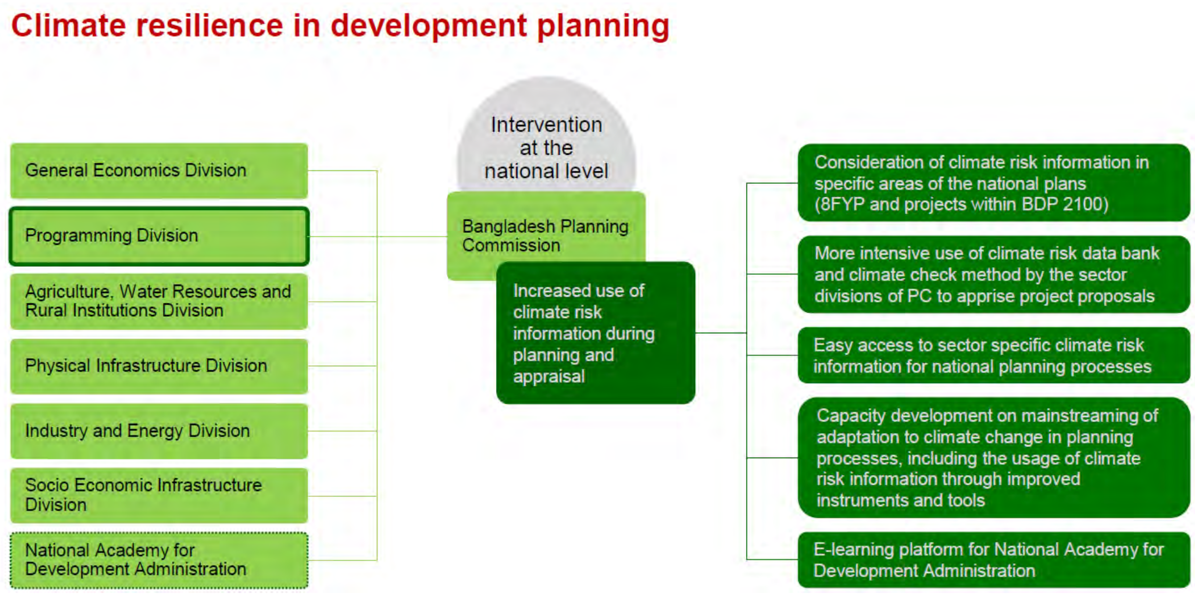
4.7.1.4 Cooperation with Other Donors

The German Development Programme identified a main problem of Uncoordinated, inefficient and insufficiently implemented national strategies to adaptation and mitigation to the effects of climate change. In response The German development Program has a project on Adaptation to Climate Change into the National and Local Development Planning II (ACCNLDP II). The project from July 2019 to June 2023 and it will cost 4 million Euro.

The project aims at the systematic consideration of climate change impacts on development and investment planning, as well as improving the access to and use of geospatial information. The following are three major project components:

- ✓ Optimum use of climate risk information in national planning
- ✓ Improved examination of climate risks in the context of project appraisals
- ✓ Enhanced individual and organizational capacity

The following image shows the project details.



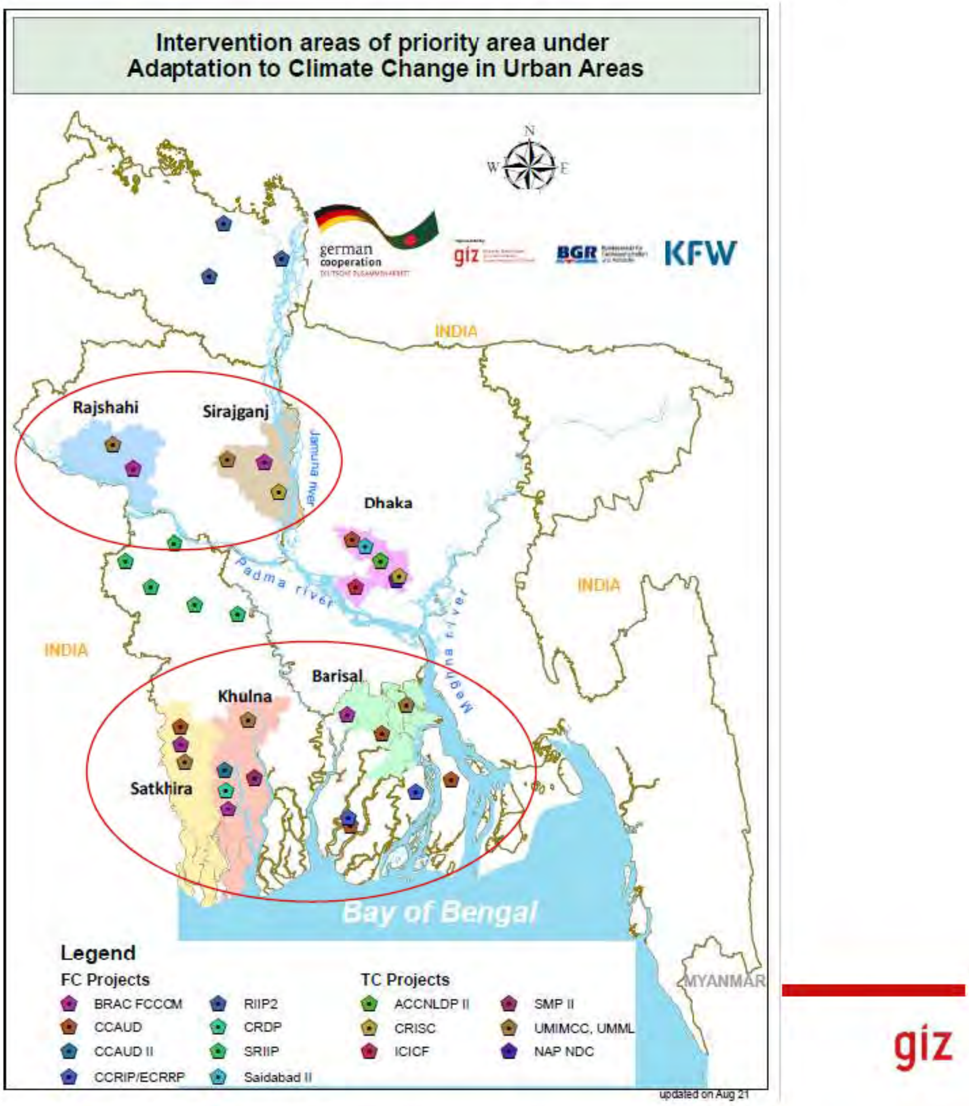
Source: Prepared by JICA Survey Team Based on GIZ's Document

Figure 4.7.6 Overview of GIZ's Climate Change Adaptation Program

Moreover, German Development program has a few other climate changes related project such as:

- ✓ **National Adaptation Plan and Nationally Determined Contribution Support Programme (NAP NDC):** The Ministry of Environment and Forests (MoEF) and the Ministry of Agriculture consider climate risks within and national adaptation goals in their strategic sector planning as well as in the project planning from January 2019 to June 2022 (3 million Euro).
- ✓ **Improved Coordination of International Climate Finance (ICICF):** Enhancing competences of national and local actors in the field of climate finance in combination with achieving the SDGs from January 2019 to May 2023 (3.5 million Euro).
- ✓ **Climate Resilient Inclusive Smart Cities (CRISC):** The planning of selected cities for urban development, including corresponding investment projects, considers local needs for adaptation to the consequences of climate change, especially for women, girls and vulnerable groups from Nov. 2019 to October 2022 (5 million Euro).
- ✓ **Management of the Sundabarns Mangrove Forests for Biodiversity Conservation and Increased adaptation to Climate Change (SMP II):** SMP (II) is aiming to make the governance system of the Sundarbans more equitable and to strengthen different instruments for sustainable conservation and use of the world's largest mangrove forest from May 2019 to April 2022 (4 million Euro).

The following image shows interventions areas by the German development program:



Source: GIZ

Figure 4.7.7 Target Areas for Climate Change Adaptation Programs by GIZ

4.7.1.5 Key Issues Related to Climate Change Adaptation and Direction for Resolution

(1) Lack of Data and Information to Understand Disaster and Climate Change Risks

Limitations are found in incorporating disaster and climate change risks into all stages of development planning. This extensive linkage between disaster and development generates an urgency to establish a risk information platform/interface to access disaster and climate risk information and tools for risk-informed planning and investment. At present, the available databases for managing development project life cycles, and climate risk screening tools are quite fragmented and lack contextual data and information on disaster and climate change risks.

(2) Project Implementation Plans without Consideration for Disaster and Climate Change risks

Databases related to development planning and management located within the Government of Bangladesh do not supply necessary data and information for DPP preparation addressing disaster and climate change risks, rather mainly focusing on DPP submission to implementation, budget management and monitoring. In order to understand climate change risks and reflect them in development planning, it is desirable to enhance systems for aggregating and managing climate change-related data, as well as to introduce research and tools for further understanding.

BMD has staff who are involving downscaling and cooperates with some universities. Since downscaling data and d4PDF data calculated by Japanese researchers are available, it is possible to cooperate in climate change adaptation through the JICA technical cooperation project.

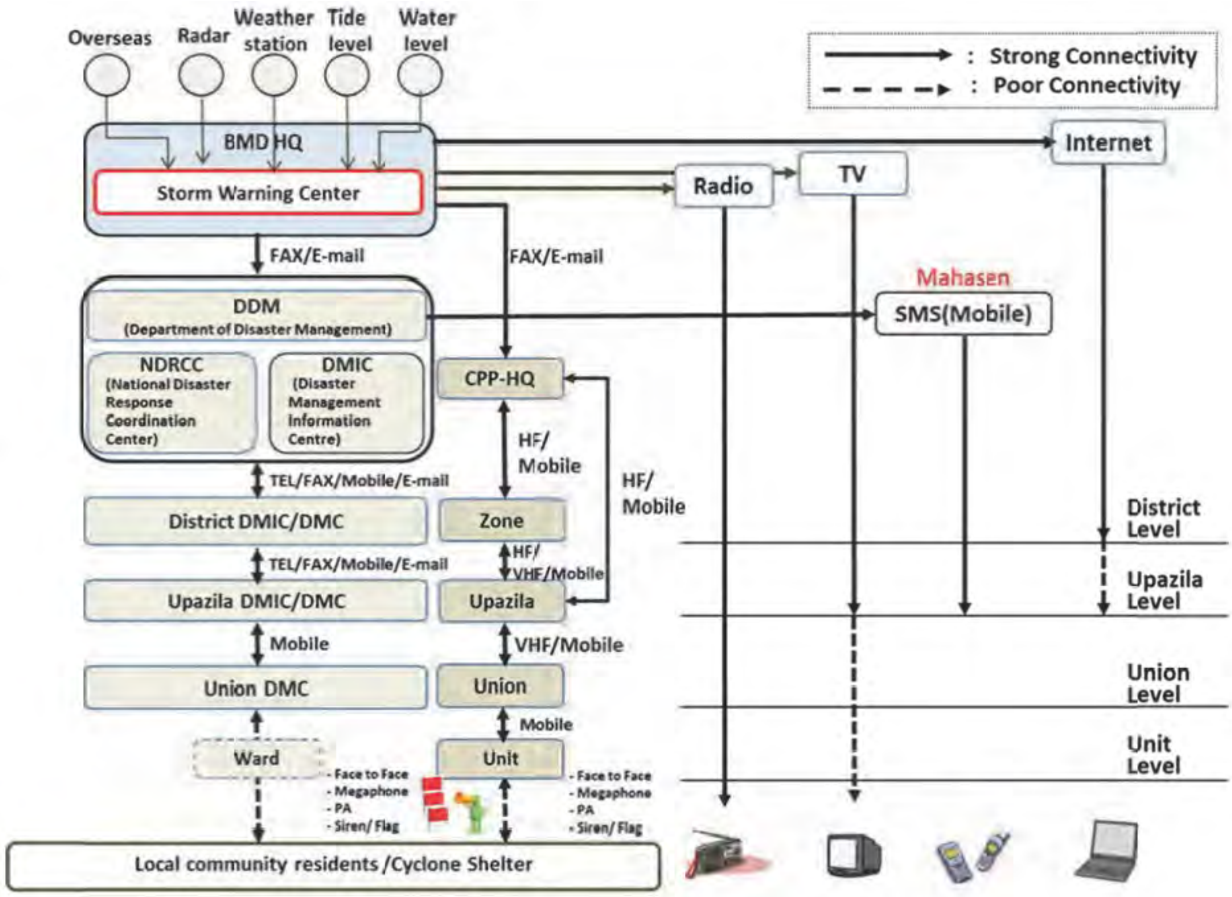
4.7.2 Communication and Awareness of DRR Information

In order to efficiently reduce disaster risks, both structural and non-structural measures must be continuously carried out equally. In terms of non-structural measures, that is, soft component activities, appropriate communication of disaster risk reduction (DRR) information, and raising of public awareness about DRR, i.e., improvement of DRR literacy, are important.

4.7.2.1 Situation of Communication of DRR Information

The current communication flow of disaster information is illustrated below. The DRR information detected by BMD and BWDB is disseminated from central public organizations to local public organizations through dedicated organizations such as DDM, DMIC, and DMC.

Especially for cyclones, the CPP headquarters disseminate early warning information to local public organizations, through another independent communication line.



Source: JICA Data Collection Survey on Early Warning and Disaster Information System in Coastal Area Final Report, July 2013

Figure 4.7.8 Flowchart of Early Warning and Disaster Information

The communication system had been established as shown in the above figure. However, its functional effectiveness, such as the accuracy and reliability of the related information, and the certainty and quickness of the related communication, seems to be not enough as expected as time has passed since its establishment.

The following have been recognized as the issues to be solved:

- ✓ Communication systems between related organizations are fragile.
- ✓ Communications are sluggish between the organizations, especially local organizations.

- ✓ Transmissibility of information to a rural area is inadequate.
- ✓ Education and training of related personnel are insufficient.

In recent years, the situation related to the above issues has been considerably improved through activities and programs regulated by SOD (2019) and also information communication tools such as mobile phones. However, the issues to be solved to achieve the objective of SOD remained.

Bangladesh has experienced a lot of disasters until now, and various countermeasures such as the system shown in the above figure and the regulations stipulated by SOD are already in place. There have already been many concerned parties and officials involved in those systems, so drastic changes to the systems will not be appropriate to avoid unnecessary confusion.

As a further direction, in terms of the communication of DRR information, solving the abovementioned identified problems and improving the existing system would be realistic and reasonable by utilizing the existing systems that have already worked to some extent.

Practically, the main measures will be to solve each problem of the existing system and its improvement or upgrading by making the most of the existing system.

In addition, disaster prevention measures and digital technology have a particular affinity, and therefore, digital technologies applicable for disaster prevention measures are rapidly developed especially in recent years coinciding with the development of digital technologies.

Through a lot of disaster experiences in its history, Japan has abundant knowledge about DRR and various kinds of advanced digital technologies to be utilized for DRR as well.

In accordance with the specific needs of Bangladesh, some of the Japanese knowledge and technologies related to DRR should come in useful. Applicable Japanese technologies and technical cooperation are mentioned in Chapter 8.

4.7.2.2 Improvement of DRR Literacy

From the viewpoint of the local people, the above 4.7.2.1 is a passive measure by public organizations, and awareness of DRR information, that is, improvement of DRR literacy, is substantially an active measure by the local people themselves.

In recent years, the Government of Bangladesh emphasizes awareness change for disasters and carries out the following activities as dissemination and improvement of disaster-related knowledge:

- ✓ Disaster-related education for local leaders through the program of dissemination and improvement of disaster-related knowledge.
- ✓ Compulsory lecture on disaster-related knowledge for government officers for at least 2 hours in a year.
- ✓ Disaster-related education for senior students through the school curriculum.

In addition, activities raising awareness of DRR knowledge among the public have been carried out through a part of the project financed by international aid agencies and various assistances by NGOs.

Even though such efforts have been carried out for years, it seems that people's perceptions about DRR are still within the sense of passive measures. Therefore, more passive activities at the community level by the local people are expected through the following activities. In order to realize the situation, more smart systems inducing active activities need to be established at most of the local level:

i) Establishment of a dedicated committee to examine how to communicate DRR information.

ii) Development of local DRR leaders and volunteers; their tasks may include education and holding events related to awareness of DRR.

iii) Holding of periodical disaster-related meeting.

iv) Establishment of a cooperative fund for DRR.

Out of the above activities, ii) Development of local DRR leaders and volunteers, iii) Holding of periodical disaster-related meetings, and iv) Establishment of cooperative fund for DRR has already started and their continuous and timely execution is expected.

4.7.2.3 Information Obtained through Field Survey

Through the project, a hearing survey on disaster management with the related organizations and site reconnaissance in the northern and southern areas (Rampur and Khulna) have been carried out. In terms of the "Communication and Awareness of DRR Information," the obtained information is summarized below.

(1) Experience of NGO

The DRR-related experiences of the NGO (Shapla Neer) have been shared below.

- ✓ At the province, district, and Upazila levels, many of the DMC do not work as designed even though those DMC have been established in accordance with SOD. Holding periodic meetings and establishing disaster prevention plans have not been done even if these are stipulated in SOD.
- ✓ At the village level, there are problems at the time of evacuation such as people cannot decide what should accompany them, there is no support for evacuation even if necessary, people cannot reach shelters because of the bad condition of the access, and problems of shelters, e.g., water and toilet are not available, facilities are not clean, and there is no consideration for woman and children.
- ✓ i) Government organizations do not recognize the essential needs of the local community and then public help is not efficient. ii) There is no system of mutual help in communities. iii) There is no link between the public and mutual help. iv) People are unconscious of self-help.
- ✓ In order to improve the above situation, grassroots and steady activities are necessary.

(2) Situation of Rural Area

<u>Teesta River Area at Northern Ranpur</u>

The definition of a flash flood in Bangladesh is an increase of water level of more than 1 m in 24 hours at fixed reference points[33]. For the severe flash flood that occurred on October 9, 2021, at midnight, on the Teesta River where the water level increased by 2 m in 12 hours, the field investigation was carried out and the obtained important information is as follows.

- ✓ The main cause of the flash flood was severe flooding within the Indian territory and their gate operation due to the flood.
- ✓ There is an international protocol for sharing the water level information between India and Bangladesh but it is only at fixed times and there is no protocol for such an urgent situation. At the time of the above flash flood, there was no prior notice from the Indian to the Bangladeshi side.
- ✓ Even though PIO/BWDB officers have informed local people to evacuate to a safer place, many of them stayed at their houses and did not evacuate as requested.

The reason why people did not evacuate at that time was their feeling of not wanting to leave the place and leave their belongings and livestock. Based on the hearing, livestock is considered their essential property, and its value is almost the same as human life.

Fortunately, there were no casualties. However, relief activities after the disaster were quite hard because the evacuation was not conducted properly.

<u>Polder Area at Southern Khulna</u>

The obtained important information through the field investigation in this area are as follows.

- ✓ Because the area is frequently damaged by cyclones and the damages are heavy, local offices of the related central government organizations (DDM/BWDB, etc.), local governments, and local

[33] Information from BWDB

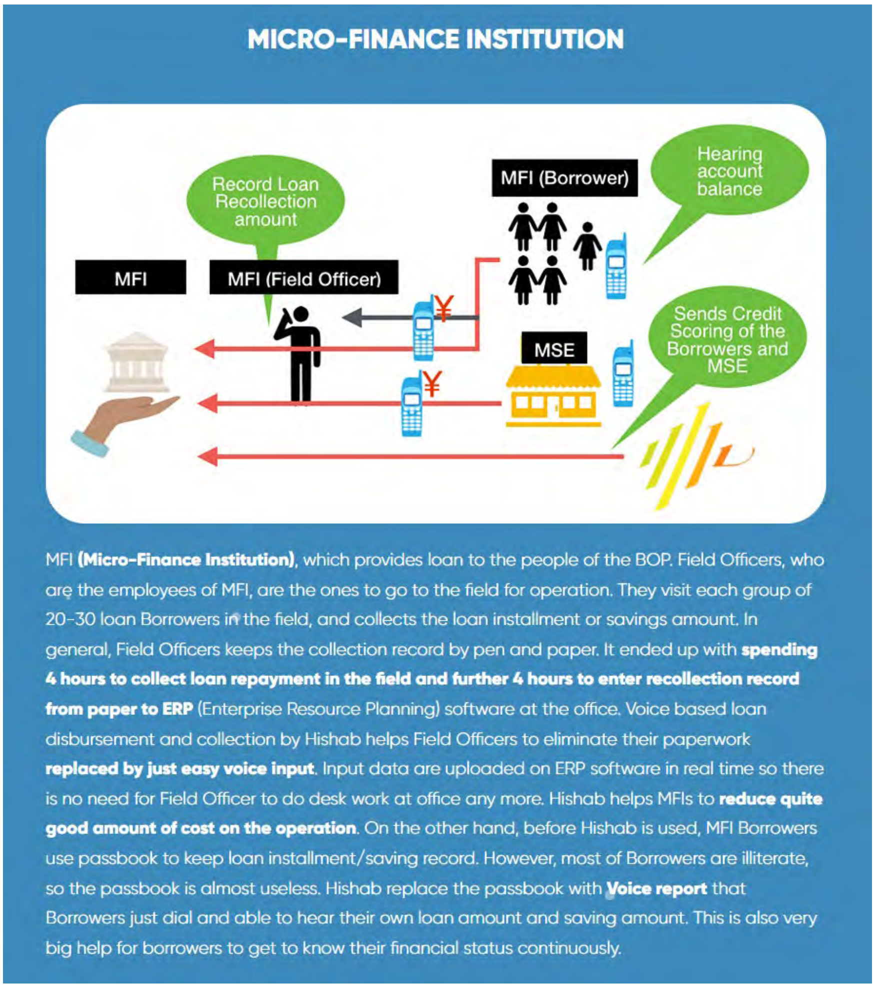
people understand well the importance of DRR.

- ✓ At the time of a cyclone, people and their livestock evacuate to human and livestock shelters, respectively, as instructed.
- ✓ Disaster damage and recovery have been recurrent for a long time and hard measures such as sustainable dikes for the medium to long term, for which local people are keen, have not been conducted.

(3) Digital Technology Related to DRR Measures

Considering the affinity between disaster prevention measures and digital technology, the following information was obtained from an AI technology company (Hishab Ltd.).

- ✓ They provide technical solutions for various services through their voice recognition technology using AI.
- ✓ The following is one of their solutions useful for people with low IT literacy.



Source: Hishab Ltd. (https://hishab.co/voice-based-data/)

Figure 4.7.9 Application of Speech Analysis System in Microfinance Business

- ✓ In rural areas of Bangladesh, there are still many people who speak their own language and are unable to read or write. Using their AI technology, there is a possibility that important DRR information can be delivered through a one-stop and tailor-made service to people with low IT literacy.

4.7.2.4 Direction to Solve Issues in Current Efforts

As described above, the existing related information were scrutinized and additional information were collected through hearing survey from the various related organizations. As a result of examination, the issues to be solved especially on the communication and awareness of DRR information have been compiled in terms of DRR literacy as follows.

(1) Existence of the Area with Lower DRR Literacy

Based on the result of site reconnaissance in the northern and southern areas where characteristics of disaster are different, it was analyzed that the situation of the receiver of DRR information (acquiring disaster-related knowledge by residents) should be carefully taken into consideration rather than that of a provider of DRR information (proper communication of DRR information).

Issues related to the communication and awareness of DRR information are:

- ✓ Some residents do not evacuate even if they are informed of the possibility of a serious disaster.
- ✓ Some residents do not understand the danger of disaster.
- ✓ Some residents are not aware of what should be prepared.

That is, those are the issues with DRR literacy.

In order to reduce further disaster risks, proactive investment in structural measures is expected in more areas. However, it is not realistic to install necessary structural measures in all areas, especially in rural periphery areas, because of the limited budget. Therefore, non-structural DRR measures should also be taken to save valuable people's lives in general.

In the rural and poor areas, it should be noted that effective measures coinciding with the mentality of the local people should be taken because there is a possibility that the information dissemination focusing primarily on saving a life is not effective enough to encourage residents to take actions. Therefore, a bottom-up approach through grassroots activities will be required.

(2) Lack of Understanding on DRR Infrastructures

In areas such as cyclone-prone areas, structural measures are conceivable such as river channel dredging, building durable levees, building shelters, and, in southern cyclone-prone areas, building disaster-resistant forests. However, residents who do not understand the purposes of those preventive measures may not take appropriate actions on DRR information and communication even though the related information is provided to them.

In the southern area, which is frequently damaged by cyclones, people's level of DRR literacy is relatively higher than in other areas. Even in the area, there are still issues to be solved, such as the missing of proper operation and maintenance of the related facilities and the difficulty of the prompt evacuation of local residents. Therefore, further improvement of DRR literacy of residents is important, especially in terms of communication and awareness of DRR information.

In areas with high DRR literacy, residents are expected to take appropriate actions based on the information provided to them, and proper communication should be established in a well-balanced manner between push (active) and pull (passive) types of communication methods.

(3) Insufficiency of Information and Communication System by Government Organizations

As described in section 4.7.2.1, even though the communication system had been established, the following issues have been pointed out by the related organizations:

- ✓ Communication systems between related organizations are fragile.
- ✓ Communications are sluggish between the organizations, especially local organizations.
- ✓ Transmissibility of information to rural areas are inadequate.
- ✓ Education and training of related personnel is insufficient.

A certain and prompt communication of the forecasting and warning information to be provided by BWDB and BMD may mitigate damage due to various disasters. Moreover, accurate and prompt communication of damage information after the event of a disaster from local government organizations also may lead to establishing a proper and effective plan for restoration and reconstruction. Therefore, theestablishment of more advanced and economical communication systems by government organizations is required. Especially for poor people in rural areas, it is necessary to formulate not only top-down but also bottom-up DRR measures in terms of effectiveness. In particular, special consideration should be given to vulnerable groups.

4.7.3 Response for Vulnerable Groups in DRR Sector

4.7.3.1 Initiatives by the Government of Bangladesh

(1) Gender Gap in Bangladesh

According to the Global Gender Gap Report 2021 released by the World Economic Forum in March 2021, Bangladesh's Gender Gap Index is 0.719 (65th in the world), which is higher than the South Asian region average.. However, it is said that there is a big gender gap in many respects.

Table 4.7.4 Gender Gap Index in Bangladesh

Sector	2006		2021	
	Rank	Score	Rank	Score
Global Gender Gap Index (overall)	91	0.627	65	0.719
Economic participation and opportunity (economy)	107	0.423	147	0.418
Educational attainment (education)	95	0.868	121	0.951
Health and survival (health)	113	0.950	134	0.962
Political empowerment (politics)	17	0.267	7	0.546

Source: Global Gender Gap Report 2021, World Economic Forum

In Bangladesh, the head of state of women has been in office for the longest time in the world, and the ratio of female parliamentarians, which was 10% in 1990, has exceeded 20%, and Bangladesh is ranked 7th in the world in the political rankings. Although improvements are progressing in the fields of education and health, their relative rankings are declining compared to other countries. In the economic field, the employment rate of women is 38.5%, which is less than half that of men, and the proportion of women in managerial and professional positions has declined, so the gap is widening. It can be said that women are still facing challenges, partly because of the high proportion of women among the unemployed and those with vulnerable employment patterns.

Some women still do not have equal rights to trials, inheritance, access to property such as land, and divorce, and 45.2% of women aged 15-19 are married as children. It is said that 53.3% of women experience violence in their lifetime. Although the gap in the health sector in terms of sex ratio at birth and life expectancy is relatively small, there is a need to improve women's safety and health.

According to the Statistical Yearbook Bangladesh 2020, changes in life expectancy, literacy rate, and gender differences in primary and secondary school enrollment rates in recent years are as follows:

Life Expectancy dary School Enrollment (NER): Between 2005 and 2018, males increased from 84.6% to 97.55% and females from 90.1% to 98.16%, with girls continuing to be higher than boys. ancy: Between 1996 and 2019, males increased from 59.1 to 71.1 and females from 58.6 to 74.2, with women living longer than men.

Adult literacy rate: Between 2001 and 2011, males increased from 50.3% to 54.1% and females from 41.8% to 49.4%, with females remaining lower but the gender gap narrowing.

Table 4.7.5 Changes in Life Expectancy, Literacy Rate, and Gender Difference in Primary and Secondary School Enrollment Rates

Life expectancy

2.26 Estimates of Life Expectancy at Birth in Bangladesh

year		Life expectancy at birth		
		Both sex	Male	Female
1996	National	58.9	59.1	58.6
	Urban	61.2	61.7	60.9
	Rural	58.2	58.0	58.2
1997	National	60.1	60.5	59.7
	Urban	62.3	62.7	62.0
	Rural	59.4	59.6	59.2
1998	National	61.5	61.7	61.2
	Urban	63.2	63.5	63.1
	Rural	60.2	60.2	60.3
2002	National	64.9	64.5	65.4
	Urban	67.2	67.0	67.3
	Rural	64.4	63.9	65.0
2003	National	64.9	64.3	65.4
	Urban	67.6	67.3	67.9
	Rural	64.3	63.4	65.5
2004	National	65.1	64.4	65.7
	Urban	67.8	67.5	68.1
	Rural	64.3	63.4	65.5
2005	National	65.2	64.4	65.8
	Urban	67.9	67.6	68.1
	Rural	64.5	63.5	65.6
2006	National	65.5	65.4	67.8
	Urban	68.1	67.7	68.7
	Rural	65.9	64.7	67.6
2007	National	66.6	65.5	67.9
	Urban	68.1	67.7	68.7
	Rural	66.0	64.7	67.6
2008	National	66.8	65.6	68.0
	Urban	68.3	67.9	68.8
	Rural	66.2	64.8	67.7
2009	National	67.2	66.1	68.7
	Urban	68.7	68.2	69.2
	Rural	66.9	65.6	68.3
2010	National	67.7	66.6	68.8
	Urban	68.9	68.3	69.5
	Rural	67.4	66.4	68.6
2011	National	69.0	67.9	70.3
	Urban	69.9	68.9	71.1
	Rural	68.6	67.4	69.8
2012	National	69.4	68.2	70.7
	Urban	71.5	70.8	70.3
	Rural	69.2	68.8	70.0
2013	National	70.0	68.8	71.2
2014	National	70.7	69.1	71.6
2015	National	70.9	69.4	72.0
2016	National	71.6	70.3	72.9
2017	National	72.0	70.6	73.5
2018	National	72.3	70.8	73.8
2019	National	72.6	71.1	74.2

Literacy rate

12:42 Literacy Rate for Persons Aged 7 Years and Above by Sex and Zila 2001 & 2011

Sl: No:	Name of Zila	2001			2011		
		Both Sexes	Male	Female	Both Sexes	Male	Female
	BANGLADESH	**46:15**	**50:27**	**41:80**	**51:77**	**54:11**	**49:44**

Primary and secondary school enrollment rates

12:13 Gross and Net Enrolment Rate in Primary Education, 2005-2018

Year	GER (%)			NER (%)		
	Boys	Girls	Total	Boys	Girls	Total
2005	91.2	96.2	93.7	84.6	90.1	87.2
2006	92.9	103	97.7	87.6	94.5	90.9
2007	93.4	104.6	98.8	87.8	94.7	91.1
2008	92.8	102.9	97.6	87.9	90.4	90.8
2009	1001	107.1	103.5	89.1	99.1	93.9
2010	103.2	112.4	107.7	92.2	97.6	94.8
2011	97.5	105.6	101.5	92.7	97.3	94.9
2012	101.3	107.6	104.4	95.4	98.1	96.7
2013	106.8	110.5	108.6	96.2	98.4	97.3
2014	104.6	112.3	108.4	96.6	98.8	97.7
2015	105	113.4	109.2	97.1	98.8	97.7
2016	109.3	115	112.1	97.01	98.8	97.96
2017	108.10	115.40	111.70	97.66	98.29	97.97
2018	110.32	118.30	114.23	97.55	98.16	97.85

Source-DPE (APSC 2018), *BANBIES, 2018*

Source: Statistical Yearbook Bangladesh 2020

(2) Efforts to Address the Gender Gap in Bangladesh

Bangladesh has a constitution that states gender equality and has ratified a treaty on the elimination of all forms of discrimination against girls. In addition, as a follow-up to the World Conferences on Women in Beijing, the National Committee for Women's Development was established in 1995, and the national policy for improving the status of women was adopted at the first conference in 1997. In addition, the Fifth Five-Year Plan stipulates that gender issues should be integrated into human resource development and poverty reduction, and has promoted the advancement of women in terms of the policy. In addition, as a concrete policy of the government, scholarships are provided to female students and the environmental facilities of schools are improved, and the total enrollment ratio of elementary and secondary education for girls is higher than for boys. On the other hand, the efforts in the disaster risk reduction field are as follows.

In Bangladesh, the limitations and harmful effects of disaster countermeasures consisting of civil engineering flood control and a large amount of relief after a disaster have been pointed out in the wake of the floods that continued in 1987 and 1988. Participatory regional disaster prevention has become mainstream since the 2000s, with disaster risk reduction.

At the local level, disaster prevention, warning transmission/evacuation guidance, and management of evacuation facilities were carried out by the government and residents. The Standing Order on Disaster in 1997 (revised in 2010 and 2019) introduced disaster management committees at each level of local autonomy as a mechanism to promote regional disaster prevention. The Union Disaster Management Committee (UDMC) was formed in the terminal administrative division Union. Standardized Community Risk Assessment (CRA) and disaster risk reduction planning methods have been introduced, and funds have been secured for planning and implementing risk reduction activities. These efforts encouraged women's participation in UDMCs and community-based disaster risk reduction organizations, reflecting women's perspectives on local disaster risk assessments and disaster risk reduction plans. It is believed that the female members of the disaster prevention committee and volunteers who transmitted warnings directly sent warnings to women and guided them to evacuate, which greatly contributed to creating a situation in which female residents could easily evacuate.

In recent years, the human damage to the scale of hazards in Bangladesh has been reduced. It is said that the biggest factors are the improvement of the human development situation represented by the improvement of basic social indicators related to education and health and the improvement of the poverty rate, accompanied by the elimination of gender disparities, and the development of basic infrastructure in rural areas.

(3) Consideration for Gender and Vulnerable Groups in the NPDM 2021-2025

In the previous section, the status and issues of dealing with gender and vulnerable groups in the disaster risk reduction sector in Bangladesh are summarized. It has organized how the latest national disaster prevention plan is supposed to tackle such situations and issues. The following is a summary of the description of consideration for gender and vulnerable groups in the National Plan for Disaster Management 2021-2025, which has just been formulated for the five years from 2021.

(Evaluation of NPDM 2016-2020)

NPDM 2016-2020 is shifting from disaster response centered on relief to active disaster risk reduction and is drawn from regional and global frameworks such as the Sendai Framework for Disaster Risk Reduction (SFDRR) and SDGs. NPDM 2016-2020 set 34 goals for departmental ministries and other agencies, including disaster risk management including disability, and gender, and the provision of safety nets, and in its assessment, most of the 34 goals are substantive. It is said that good results have been obtained. Mandatory provisions to involve NGOs in DRR activities, to take the lead in ensuring access to shelters and markets for persons with disabilities, the elderly, and pregnant women, and to address the problems of people with special needs. However, it was not clear how to implement gender and disability mainstreaming across all 34 indicators. Also, no specific indicators of gender and disability inclusion and no monitoring and assessment framework to identify progress were made under gender-related efforts.

MoDMR has been receiving intensive support from the Advocacy Group on Disability, inclusive Disaster Risk Management (DiDRM) and Bangladesh and National Task Force on Disability, inclusive Disaster Risk Management since 2017 and has developed a psychosocial care system related to disaster risk mitigation (DRR). The government has trained more than 100 employees for psychosocial care in DRR. Advocates for DiDRM have taken a number of initiatives toward the inclusion of persons with disabilities in reducing disaster risk.

In particular, the Ministry of Women and Children Affairs (MoWCA), with the technical assistance of MoDMR, has included risk reduction issues in consideration of including women, children, the elderly, and persons with disabilities in all of the ministry's development programs and plans. The Municipal Sector (LGD) also works closely with MoDMR to consider disaster risks, including women, children, the elderly, and people with disabilities, in preparing all development plans and infrastructure.

(Disability and disaster risk management)

Disasters threaten the well-being of people in all areas, but disproportionately affect women, children, and persons with disabilities. People with disabilities are particularly vulnerable in the event of a disaster because they are experiencing socio-economic adverse effects such as rising poverty rates as well as aspects of disability. Persons with disabilities and organizations of persons with disabilities (DPOs), on the other hand, have valuable knowledge, experience, and expertise in how to adapt disaster risk management activities to their needs. The 2020 pandemic COVID-19 enhances the vulnerability of persons with disabilities who require services from both sides: i) humanitarian assistance and ii) socio-economic recovery of resilience and inclusive reconstruction.

(International efforts by Bangladesh for the participation of persons with disabilities in disaster prevention)

Bangladesh is a pioneer country that has adopted inclusive disaster risk management for persons with disabilities in line with the Sendai Framework for Disaster Risk Reduction. Bangladesh hosted the first International Conference on Disability and Disaster Risk Management in December 2015, and the outline of the conference was declared the "Dhaka Declaration". In 2018, the 2nd International Conference on Disability and Disaster Risk Management was held, and the result document is the "Dhaka Declaration 2015+". The 6th Global Platform for Disaster Risk Reduction (GPDRR), held in Geneva in 2019, evaluated Bangladesh's efforts to promote and expand disaster risk management, including disability.

Major Actions in Dhaka Declaration 2015+

i. Ensure the meaningful participation, inclusion and leadership of women men, girls and boys with disabilities and Disabled People's Organizations (DPOs) within disaster risk management at local, national, regional and global levels.
ii. Enhance collaboration among Governments at all levels, development agencies, UN, NGOs, CBOs, persons with disabilities, DPOs, professionals, active citizens, academic institutions, private sector and other key stakeholders to work together and ensure the effective implementation of inclusion within the Sendai Framework at all levels to reduce vulnerabilities and prevent and reduce the consequences of disasters for persons with disabilities.
iii. Ensure that governments and other stakeholders establish effective mechanisms and guidelines to collect sex, age and disability disaggregated data at all stages of DRM.
iv. Support inclusive community-based disaster risk management initiatives, risk analyses and data banks to facilitate and inform local, national and regional level early warning systems, disaster preparedness plans and social protection programs that are accessible by all.
v. Strengthen the self-reliance of persons with disabilities and care-givers at local and national levels through removing all kinds of barriers (cultural, social, economic, procedural, physical, communication and attitudinal), engaging private sector, guided by 'build better' approach and resilient universal design and support to replicate Information, Communication and Technology (ICT) based tools, equipment, devices and intermediate technology for inclusive humanitarian response and disaster risk reduction.
vi. Take necessary actions to report against the Dhaka Declaration 2015 and this declaration of 2018 and include the sein the development of national, regional and global road maps, action plans, indicators and terminologies for the implementation of the Sendai Framework.
vii. Declare a focal point for inclusive DRR at the national level in coordination with governments, national and regional DPOs, organizations working on disability and DRR with a priority intention to review progress achieved against this declaration and progress towards inclusive implementation of the Sendai Framework.

(Achievement status of disaster risk management in which vulnerable groups participate)

The main initiatives and achievements of disaster risk management aimed at the participation of vulnerable groups are as follows:

i. A National Task Force was established under MoDMR to carry out, implement and monitor disaster risk management activities, including persons with disabilities, consisting of representatives of relevant ministries, departments, persons with disabilities, and disaster risk mitigation organizations.
ii. Standing Orders on Disaster Management (SOD)-2019 has directed various committees on disaster management to include persons with disabilities and/or representatives of their organizations.
iii. We have training modules for capacity building in disaster risk management, including persons with disabilities, and training for field and national staff. It provides training to key responders/volunteers to evacuate persons with disabilities through effective communication in the event of a disaster.
iv. Evacuation vessels have been built by the ministry to allow all flood-affected people, including persons with disabilities, to move their homes and livestock during the flood.

v. Building a cyclone/flood shelter designed/built for people with disabilities to be safe and easily accessible.

vi. Working on developing a live data platform to make the data readily available. A damage assessment format called D-Form, which represents data sorted by disability, gender, and age, helps design and practice comprehensive response and reconstruction with a "Build Back Better" approach.

vii. Disability-friendly early warnings such as cyclones and floods are being disseminated before disasters to improve access in compliance with COVID 19 risk-aware hygiene regulations.

viii. During the Cyclone Amphan period, Bangladesh provided about 10,500 additional shelters in addition to the existing 4,171 shelters and accommodated 2.4 million people in COVID 19 with social distance. Prioritized the evacuation of persons with disabilities to ensure safety.

ix. With the second wave of COVID-19 in mind, an emergency response plan has been developed to prepare for and respond to all types of disasters.

(Issues and future policy)

Given the pandemic situation and future risks associated with disasters, the following challenges need to be emphasized for risk mitigation and reconstruction.

i. Adopt a twin-track approach to include persons with disabilities in all stages of response (relief and humanitarian assistance, recovery, and reconstruction, resilience). Ensure multiple means of involvement, expression, and empowerment based on Universal Design for Learning (UDL) principles.

ii. Communicate risk exposure and risk information in a way that can be understood and acted upon. Early warnings and other necessary information need to be widely available to end users, especially people with disabilities, in multiple languages and in multiple accessible formats.

iii. The effects of disasters can be catastrophic. COVID19 could be a learning example for integrating disability-friendly risk mitigation and reconstruction, such as improving accessibility to services and improving lifestyle skills through self-help approaches and networking.

iv. Improve infrastructure resilience and accessibility, and set up programs to actively hire people with disabilities in recovery and reconstruction planning and practice processes.

In the DRM policy and program, and the practice of NPDM 2021-2025, the following policy is set forth to give due consideration to people with vulnerabilities (gender, age, disability, etc.).

i. During the implementation of the program, the establishment of effective mechanisms and guidelines for collecting fragmented data on gender, age, and disability at all stages of DRM will be emphasized.

ii. During the implementation of the program, meaningful participation and leadership of women, men, girls, boys, persons with disabilities, and disability organizations (DPOs) in disaster risk management at the national, district, and Upazila levels will be ensured.

iii. It is important to remove barriers to the participation of persons with disabilities and to act on a decision-making process for risk mitigation, response, and reconstruction. Physical or virtual sites for meetings and consultations need to be barrier-free, accommodations such as sign language interpreters and Braille materials are provided as needed, and guaranteed to provide information in an accessible format. There is.

iv. It is important to include the risk of failure in the design, implementation, and monitoring of disaster risk mitigation activities. This is also an important aspect of developing knowledge and developing professionals for comprehensive disaster risk management for the improvement of persons with disabilities.

v. Shelters and services designed to address ensuring accessibility for persons with disabilities create the need to improve new and existing infrastructure.

vi. Guarantee-compatible applications with tools, devices, and devices that utilize information and communication technology (ICT) for humanitarian response and disaster risk mitigation.

(Goals for the participation of vulnerable groups shown in National Disaster Prevention Plan 2021-2025)

The 48 goals newly set in the National Disaster Prevention Plan 2021-2025 and the ministries and related organizations in charge are as shown in the table, and the goals related to the participation of vulnerable groups such as gender and persons with disabilities are as follows.

Table 4.7.6 Goals for Participation of Vulnerable Groups Set Forth in the National Disaster Prevention Plan 2021-2025

No.	Activities		Lead (Ministry/ Department)	Associate (Ministry/ Department)
14	Enhancing gender-responsive and disability inclusive DRM in all phases	NPDM target activities and programs	MoDMR, MoWCA	LGD and other Associated ministries
23	Developing & implementing National DRM Capacity Building Plan including disability-inclusiveness and CPM-MH issues	At least 500 responders received Psycho-social management training and provide field services in disaster	Modder,	MoSW, MoWCA

NPDM: National Plan for Disaster Management
MoDMR: Ministry of Disaster Management and Relief
MoWCA: Ministry of Women and Child Affairs
LGD: Local Government Division
CPM-MH: Crisis Preparedness and Management for Mental Health
Source: NPDM 2021-2025

(4) Roles of Related Organizations Specified in SOD 2019

The SOD, which stipulates the role of central ministries, local governments, and related organizations in disaster prevention, was revised in 2019. The revised SOD states that it is important to participate in disaster prevention efforts for vulnerable groups such as gender and persons with disabilities, and has clarified extensively the roles of the related organizations.

The roles of each institution defined in relation to vulnerable people in SOD 2019 are summarized as follows:

Table 4.7.7 Roles Related to Dealing with Vulnerable Groups of Related Organizations Specified in SOD 2019

Disaster Risk Management Coordination at the National Level	
Inter-Ministerial Disaster Management Coordination Committee (IMDMCC)	• Undertake necessary skill training to ensure gender and social inclusion in emergency response preparedness activities.
Disaster Risk Management Coordination at the Local Level	
City Corporation Disaster Management Committee	• Identify people at risk according to gender, age, persons with disabilities, social class, occupations, and economic status. • Formulate short, medium, and long-term risk reduction action plans with the active participation of persons with disabilities, women, and children.
Upazila Disaster Management Committee	• Assist the Union Committee in identifying people at risk based on gender, age, disability, and social and economic status;
Municipal Disaster Management Committee	• Identify people at risk and their vulnerability in accordance with gender, age, persons with disabilities, social status, occupations, and financial condition;
Municipal Ward Disaster Management Committee	• Identify the people at risk considering gender, age, persons with disabilities, geographical locations, occupations, and socio-economic status; • Keep women and children in separate rooms in the shelter and assist the shelter management committee in providing safe water and food at the shelter and undertaking necessary steps to prevent gender-based violence;
Union Disaster Management Committee	• Undertake and implement awareness-raising programs in the light of gender and social inclusion at the family and social levels; • Inform the local people about measures to reduce disaster risk in the light of gender and social inclusion at family and social levels and enhance capacity and support to implement such measures; • Identify communities at risk, based on gender, age, physical ability (disability), geographical location, socio-economic status, and occupation; • Keep women and children in separate rooms in the shelter and assist the shelter management committee in providing safe water and food at the shelter and undertaking necessary steps to prevent gender-based violence;
Union Parishad Ward Disaster Management Committee	• Identify people at risk based on gender, age, disability, geographical location, socio-economic status, and occupation; • Keep women and children together in separate rooms in shelters and provide safe water and food to the shelter management committee, and take necessary steps to prevent gender-based violence;

Local Level Disaster Response Coordination Group	
City Corporation Disaster Response Coordination Group	• Coordinate and manage disaster response and rapid recovery activities by assessing the disaster situation in the light of gender and social inclusion;
City Corporation Ward Disaster Response Coordination Group	• Coordinate and manage disaster response and rapid recovery activities by assessing the disaster situation in the light of gender and social inclusion;
Pourashava (Municipal) Disaster Response Coordination Group	• Coordinate and manage disaster response and rapid recovery activities considering the disaster situation in the light of gender and social inclusion;
Pourashava Ward Disaster Response Coordination Group	• Coordinate and manage disaster response and rapid recovery activities by considering the disaster situation in the light of gender and social inclusion;
Responsibilities and Functions of the Ministries, Divisions, Departments and Agencies for Disaster Risk Management	
Ministry of Disaster Management and Relief Department of Disaster Management	• Undertake initiatives to prepare and update guidelines on humanitarian assistance programs, gender and disasters, psycho-social services, and other issues based on the guidance of the ministry; • Undertake proper steps for disaster risk reduction, alternative livelihoods of disaster-affected people, inclusive disaster risk management relating to gender and persons with disabilities, and conduct related research work;
Bangladesh Police	• Resist gender-based violence;
Statistics and Informatics Division	• Take initiatives to update disaster statistics (considering gender, age, and disabilities); • Develop a database on gender, age, disabilities, and other factors;
©Bangladesh Bureau of Statistics	• Formulate and update the community and sectoral (considering gender, age, and disabilities) disaster statistics reports; • Formulate a detailed database on gender, age, disabilities, and professions;
Ministry of Women and Children Affairs	• Formulate and implement a gender and social inclusion work plan for disaster risk management; • Incorporate gender and social issues in the training curricula on disaster preparedness, risk reduction, humanitarian and psychological aid being conducted by the ministry;
Education Engineering Department	• Follow the BNBC and incorporate gender and disability issues in designing for new educational institution building;
Ministry of Cultural Affairs	• Undertake special planning for women, children, persons with disabilities, and people of non-binary gender.
Field Level Officials, Representatives of Local Government and Humanitarian Agencies	
National and International Development Agencies	• Integrating/mainstreaming disaster risk reduction in the organization's policies, strategies, and priorities in the light of gender and social inclusion principles; • Assist local disaster management committees technically to prepare disaster risk reduction action plans following the community risk assessment/ urban risk assessment process and in the light of gender and social inclusion; • Preparation of contingency plans for all non-government organizations at all levels, incorporating gender and social concerns;

National Disaster Emergency Coordination	
Coordination of Humanitarian Response Activities in the Cluster System Gender-Based Violence (GBV) Cluster	• Identify gender risks during disasters and provide recommendations to carry out necessary measures for protection; • Undertake advocacy to implement the Gender Safety Policy;

Source: Prepared by JICA Survey Team

In addition, at SOD 2019, "GENDER RESPONSIVE' GUIDELINES FOR DISASTER RISK MANAGEMENT" was also presented. The following are measures to ensure gender responsiveness at each stage of disaster risk management as outlined in that guideline.

Table 4.7.8 Measures Indicated in the Gender Responsive Guidelines for Disaster Risk Management

1. Pre-Disaster Preparedness	
Collecting and Preserving Sex, Age, Disability Disaggregated Data (SADDD)	· Collecting and preserving sex, age, and disability disaggregated baseline data in coordination with the Bangladesh Bureau of Statistics (BBS), Ministry of Disaster and Relief, and Ministry of Women and Children Affairs. · Formulate a policy for who, how, and what information to collect regarding sex, age, and disability disaggregated data. · A well-trained group should be prepared to collect sex, age, and disability disaggregated information so that they can collect data even in the post-disaster period. Balance and equal participation of women and men in this group are essential.
Gender-Responsive Contingency Plan	· Ensure balanced and equal representation of women and men in primary respondent teams from local to national levels as part of disaster response. The team members must have training on their roles in addressing gender in disaster and post-disaster situations. · Ensure balance and equal representation of women and men in community volunteer mechanisms as part of disaster response. The team members must have training on their roles in addressing gender in disaster and post-disaster situations. · Must include food, clothing, and menstrual hygiene materials considering the needs of women and adolescent girls into contingency stocks managed by governmental and non-governmental agencies.
Identify Gender-Specific Risks	· Include risks that are specific to women through using gender-sensitive tools when undertaking community-based risk assessments. · Ensure balanced and equal representation of women and men during community-based risk assessments.
Gender-Sensitive Risk Reduction Strategies & Community Contingency Plan	· Ensure balanced and equal representation of women and men. · Ensure inclusion of the needs and opinions identified by women during the formulation of work plans. · Ensure the participation of women leaders from community-based women-led organizations and local government.
Raise Gender-Responsive Capacity & Awareness in Community	· Create awareness within the community on the kinds of adversities that women experience, how they deal with disasters and how women play a role with their capacities during disasters. · Ensure the presence of women members from the local government and other women leaders from the community to raise awareness in the community.

<table>
<tr><td>Gender-Sensitive Disaster Early Warning and Reach-Out to Women</td><td>· Consider reaching out to women with disaster early warning signals and messages.
· Ensure the participation of women in the early warning dissemination groups.</td></tr>
<tr><td>Formulation of Gender Responsive Post-Disaster Needs Assessment Tools</td><td>· Ensure inclusion of gender issues into Damage and Needs Assessment Tools.
· Ensure the participation of Gender Equality Advisors during the development of Damage and Need Assessment Tools.
· Ensure balanced and equal representation of men and women into trained teams for needs assessments.</td></tr>
<tr><td colspan="2">2. Assessing Post-Disaster Damage and Needs</td></tr>
<tr><td colspan="2">· Collect sex, age and disability-disaggregated data on damage and needs within the next 72 hours after a disaster.
· Ensure gender analysis of the data collected. The first thing to do is to check pre-crisis data and information, analyze that and decide what other data and information are needed to be collected in a post-disaster situation to identify the gaps, impacts, and needs.
· Separate Gender Analysis and Impact Assessment can be done separately, so it is advisable to do so within at least one month immediately after a disaster. If not possible, it has to be done within 2 months through active participation and leadership of the ‘Gender in Humanitarian Action Group’.
· Through analyzing data and information from the needs assessments, it is necessary to design response targets and priorities that reflect the needs of women and men. Necessary to address women’s needs in the selection of disaster relief items and packages.</td></tr>
<tr><td colspan="2">3. Post-Disaster Humanitarian Response Planning, Strategies and Resource Mobilization</td></tr>
<tr><td colspan="2">· Include gender issues to determine the activities and strategies of various clusters of emergency humanitarian assistance (food, shelter, water, sanitation, etc.). Ensure the leadership role of women in decision-making, especially in the formulation of support activities as per the needs of women, and equal participation of women and men in support assistance activities.
· Gender issues must be included in a log frame with indicators under the proposal or action plan for the humanitarian assistance program. Ensure that humanitarian assistance activities address the need to bring a positive impact on the equal rights of women and men, and that is reflected when setting the project objectives and log frame.
· Ensure an equal and balanced number of women and men in human resources assigned for the management and implementation of humanitarian response. The code of conduct that is mandatory for all humanitarian officials and staff must include equal respect towards women and avoidance of any form of sexual violence and harassment.
· Include prevention of and protection against gender-based violence in humanitarian assistance programs. Humanitarian assistance programs must include steps to raise awareness within the community against gender-based violence as well as the link to a referral system to protect women from gender-based violence in humanitarian settings.
· Ensuring gender budgeting in humanitarian assistance programs. To do this, it needs to be mentioned how proportionately the program intervention and budget will be allocated to address the specific needs of women as well as bring equal respect to women.
· If needed, can collect separate resources to meet the special needs of women. In this regard, the government needs to draw special attention to international organizations as well as the UN and development partners.
· Ensure the leadership of women-headed agencies/organizations including the Ministry of Women and Children Affairs in managing humanitarian assistance activities. Take effective steps, including training on skills enhancement when needed.</td></tr>
<tr><td colspan="2">4. Implementation and Monitoring</td></tr>
<tr><td colspan="2">· Proper arrangements need to be made to ensure the safety and dignity of women in humanitarian aid distribution centers/camps, such as keeping a separate queue for women in the distribution of humanitarian assistance and selecting the appropriate time for distribution of humanitarian assistance based on the opinion of women.
· To measure the extent to which gender sensitivity is being considered in conducting humanitarian assistance programs, create some unanimous criteria, and in the light of this, undertake the gender audit of the humanitarian assistance programs.</td></tr>
</table>

· To ensure accountability and transparency for disaster victims, especially women, it is possible to know whether they are satisfied or have any feedback on gender sensitivity in conducting humanitarian assistance programs. Ensuring a consistent monitoring system to collect information on gender-based violence, humanitarian assistance workers, and any sexual abuse or harassment, while maintaining the privacy and confidentiality of informants.
5. Evaluation and Lessons Learned
· Select and promote gender-responsive 'best practices' and 'case studies.' This can be accomplished through the engagement of women in a participatory manner. Take the assistance of print and electronic media for effective participation and promotion of women in this regard. · Emphasize positive progress/changes that have been achieved in establishing equality for women and men, and identify learnings through evaluation of humanitarian assistance programs. Especially, changes in gender equality must be included in the national reports prepared for the Sendai Framework for Disaster Risk Reduction. · In addition to collecting, analyzing, and publishing information, assess whether a new gender issue has emerged in the post-disaster situation.

Source: Prepared by JICA Survey Team Based on "Gender Responsive Guidelines for Disaster Risk Management"

4.7.3.2 JICA's Cooperation

(1) JICA's Efforts

JICA has set the following five priority development issues for gender equality and women's empowerment, and has been working on these priority development issues toward the realization of SDGs Goal 5 "Achieve gender equality and empower all women and girls".

- ✓ Women's Economic Empowerment
- ✓ Women's Rights and Security (Protection from conflicts, natural disasters, gender-based violence, and trafficking in persons)
- ✓ Women's Education and Lifetime Health
- ✓ Gender Responsive Governance
- ✓ Gender Responsive Infrastructure

For Bangladesh, JICA set the Country Development Cooperation Policy for the People's Republic of Bangladesh in February 2018, and has been contributing to the achievement of SDGs such as poverty, hunger, education, health, gender, and water and sanitation in order to become a middle-income country, with the basic policy (major goal) of "Accelerating sustainable and equitable economic growth and removing poverty" and the priority field (medium goal) of "Overcoming social vulnerabilities".

Based on this policy, JICA has been working on promoting the empowerment of women and girls, such as support for maternal and child health and education for girls, response to violence against women and girls, and independence support. At the same time, in various other fields such as agriculture, natural environment conservation, disaster risk reduction, governance, and infrastructure development, JICA is implementing projects by incorporating a gender perspective into the outputs and activities that should be achieved through the projects.

(2) Issuance of Gender Bond

Although it is not a Bangladesh-specific project, JICA issued "Gender Bond" in September 2021, aiming to strengthen efforts to address gender issues that have become even more apparent in the wake of the Covid-19 crisis in promoting gender equality and women's empowerment in developing countries.

The bond proceeds will be allocated to JICA's Finance and Investment work for projects which meet gender equality project criteria as defined by the OECD-DAC. This includes projects 1) where the main objective is gender equality and women's empowerment, and also 2) where gender equality is an important and deliberate objective, but is not the principal reason for the project. The bond proceeds will not be knowingly allocated to any activities related to coal-fired power generation.

As examples of businesses whose main purpose is gender equality and women's empowerment in 1), financial access improvement projects for female business owners, girls' education, etc. are envisioned. And as examples of businesses whose main purpose is gender equality where gender equality is not the principal reason for the project, the installation of women-only vehicles, security cameras, and women's toilets in the urban railway construction business are envisioned. In the future, it is expected that it will be utilized in the field of disaster prevention, such as the enhancement of women-only facilities in evacuation centers.

4.7.3.3 Cooperation with Other Donors

Many donors, including the World Bank and the Asian Development Bank, are also supporting the realization of SDG’s Goal 5 “Achieve gender equality and empower all women and girls” similar to JICA. However, most of the individual projects are carried out with consideration for gender and vulnerable groups, and there are few projects developed with a focus on " Achieve gender equality and empower all women and girls "

Among them, UNDP's National Resilience Program (NRP) in Bangladesh focuses on supporting gender and other vulnerable groups in strengthening its capacity for disaster risk reduction and disaster risk reduction.

NRP is a unique partnership between the Government of Bangladesh and the United Nations Development Program (UNDP), United Nations Women, (UN Women) and the United Nations Office for Project Services (UNOPS). NRP improves the capabilities of government and public agencies to formulate development plans, including response to vulnerable groups in the field of DRR, and to strengthen women's leadership capabilities and capacities for preparation, response, and recovery in the field of disaster risk reduction at the community level. The project, which started in January 2017, is scheduled to end in December 2022.

According to UNDP Bangladesh, which was interviewed in the field survey, the response to gender and other vulnerable groups in Bangladesh has made remarkable progress in recent years, but there are still disparities. The cause is that the policies formulated at the national level are not properly implemented. Although various policies related to DRR exist and are implemented, and they seem to be effective statistically, it is said that much effort and work is still required to deal with the vulnerable layer including gender-related issues.

The National Resilience Programme (NRP) is a unique partnership between the Government of Bangladesh and the United Nations Development Programme (United Nations Development Programme: UNDP), the United Nations Women, and the United Nations Project Services Agency (United Nations Office for Project Services: UNOPS) to provide strategic support for developing national capacity amidst the changing nature of disasters. The project, which began in January 2017, is scheduled to end in December 2022.

UNDP Bangladesh, which was interviewed in the field study, said that while remarkable progress has been made in addressing gender and other vulnerable groups, gaps still exist. The reason for this is that the policies formulated at the national level are not properly implemented, and various disaster management policies exist and are implemented, and statistically appear to be effective. However, a great deal of effort and work is still needed to deal with gender and other vulnerable groups.

Review of Current Practices in Uses of Gender Responsive Guideline for DPP: Lessons Learned and Way Forward, a research report compiled in March 2021 as part of the NRP, reviews the 2009 Gender Response Guidelines and summarizes the following issues:

- ✓ Lack of awareness of the Guidelines
- ✓ Lack of supervision or oversight of the use of the Guidelines
- ✓ Lack of leadership of the lead agency
- ✓ Lack of capacity-building efforts

It also recommends the following to solve the problem.

- ✓ Revision of the 2009 Gender Response Guidelines
- ✓ Effective role of lead agency
- ✓ Institutional capacity building based on the Guidelines
- ✓ Participation of all stakeholders in the revision of the Guidelines

4.7.3.4 Challenges in Current Efforts and Direction of Improvement

(1) Examples of Research on the Gender Gap in the Field of DRR in Bangladesh

Based on the following research cases (thesis) that analyzed gender and consideration for vulnerable groups in the field of disaster prevention in Bangladesh, the situation and issues were summarized.

- ✓ *"Narrowing the Gender Gap of Vulnerability through Community-Based Disaster Risk Management: A Case Study of Cakaria Upazila, Bangladesh", Keiko Ikeda, Journal of environmental sociology 17 (0), 111-125, 2011, the Japanese Association for Environmental Sociology*
- ✓ *"Gender mainstreaming of disaster risk reduction: from the case of Bangladesh", Keiko Ikeda, Journal of Gender Studies No. 15, 2012, PP73-85, Institute for Gender Studies Ochanomizu University*
- ✓ *"A Study on Building Resilience in a Cyclone-Prone Area in Bangladesh: Developing Gender Sensitive Cyclone Shelter Management Guidelines through Community Participation", Yoko Saito and Masuki Murosaki, Studies in disaster recovery and revitalization, June 2012*
- ✓ *"How can promoting women's participation and responding to their needs improve disaster risk reduction? Case from post-disaster reconstruction projects in the Philippines and Sri Lanka", Yumiko Tanaka and Atsuko Nonoguchi, September 2016, JICA Ogata Sadako Research Institute for Peace and Development*

1) Selected Issues in "Narrowing the Gender Gap of Vulnerability through Community-Based Disaster Risk Management"

According to Ikeda, the cyclone-induced storm surge that killed 138,000 people in 1991 had higher mortality rates for women of all ages, and female mortality rates between the ages of 20 and 49 reached 4 - 5 times for males. The cause was that it was difficult for women to be alerted and that women hesitated to go to shelters, which are often regarded as public (i.e., men's) spaces. In addition, since the division of gender roles is likely to be strengthened in the event of a disaster, the labor burden on women will increase as it becomes difficult to collect drinking water and fuel and care for families, and access reconstruction resources such as housing and employment is disadvantageous for women. It has also been reported that violence against women and girls increases. However, recent data on flood damage reports that there are more male victims, although there are differences depending on the disaster area.

2) Selected Issues in "Gender Mainstreaming of Disaster Risk Reduction"

Tanaka also states that information on cyclones and early warnings of floods is transmitted from men to men in public places, and in most cases, it does not reach women directly in Bangladesh, which kills more women than men. The causes of women's tendency to suffer are largely due to gender-based division of roles and cultural norms/systems. In addition, women are generally physically weak and have poor health and nutritional status even before the disaster, resulting in poor health and nutrition. She also states that it is related to their relatively weak physical strength.

3) Selected Issues in "A Study on Building Resilience in a Cyclone-Prone Area in Bangladesh"

Saito and Murosaki cite the accurate transmission of information and the Cyclone Preparation Program (CPP) as factors that have significantly reduced the number of deaths due to cyclone damage in 2007, compared to previous damage. It has been proved that life can be surely saved by educating both male and female residents and calling for thorough evacuation. The CPP is a volunteer cyclone warning transmission program started in 1972 by the International Federation of

Red Cross and Red Crescent Societies (IFRC) and the Bangladesh Red Crescent Society (BDRCS) in response to the 1970 cyclone damage. If a cyclone occurs and the condition becomes serious, the Bangladesh Meteorological Agency will send information to the CPP headquarters, and the information will be sent to the district and Upazila (county level) wireless stations. Information is then sent to high-risk areas. Upon receiving the information, CPP volunteers use handheld microphones and sirens to call on other residents to evacuate.

Saito and Murosaki also stated in the 2006 International Center for Diarrheal Disease Research, Bangladesh (ICDDR, B) survey on the issue of violence against women. Of the 3,130 women, about 60% of women between the ages of 15 and 49 experience physical and sexual domestic violence. In addition, two-thirds of them did not tell anyone about the violence because they were 1) socially common, 2) afraid of further husband violence, and 3) social stigma. Women are socially responsible for their gender-specific roles, such as marriage, childbirth, and caring for children and their families, and women are not advancing in society. In particular, gender roles in rural areas remain severe, and in some areas, it is difficult for many women to go out alone.

4) Selected Issues in "How Can Promoting Women's Participation and Responding to Their Needs Improve Disaster Risk Reduction?"

Tanaka said that in order to promote disaster risk reduction (DRR) from a gender perspective, it is essential to regard disaster risk reduction as an opportunity to change unequal gender relationships.

5) Flood Damage Situation Based on "Statistical Yearbook Bangladesh 2020"

Many of the research cases organized above capture issues based on the actual conditions of the cyclone disasters that occurred in the 1990s and 2000s, so there is a possibility that they do not reflect the recent actual conditions.

Table 4.7.9 shows the flood damage area and the affected population shown in the Statistical Yearbook Bangladesh 2020. A detailed explanation of the year of the data is not shown, and the source "Disaster Report-2014 (draft), Department of Disaster Management" is not available, but as far as this data is seen, the disaster population cannot be said that the ratio of women is particularly high. Although there are differences depending on the district, there are many males, and the total values after deducting the number of children are about 55% for males and about 45% for females.

Table 4.7.9 Flood Affected Area and People

No.	Districts Affected	Area (sq km)	Affected Households	Affected People Affected				Disabled People
				Male	Female	Children	Total	
1	Gaibandha	485.00	37,786	46,890	50,381	37,359	134,630	2,015
2	Nilphamari	8.10	4,100	4,800	5,200	5,705	15,705	0
3	Kurigram	1339.65	92,148	123,553	124,862	53,232	301,647	3,341
4	Bagura	340.76	140,939	147,500	137,700	167,520	452,720	0
5	Lalmonirhat	204.29	12,987	17,679	15,082	12,518	45,279	0
6	Rangpur	134.37	665	1,580	480	0	2,060	0
7	Jamalpur	1211.00	108,202	319,407	172,776	24,682	516,865	4,556
8	Tangail	182.05	63,891	104,412	96,779	20,981	222,172	459
9	Sirajganj	772.00	100,500	800	300	100	1,200	710
10	Faridpur	312.23	6,277	26,368	28,964	23,797	79,129	260
11	Netrokona	612.91	12,320	3,273	2,802	470	6,545	0
12	Sunamganj	1849.65	37,588	26,055	28,698	8,620	63,373	3,056
13	Rajbari	252.50	13,920	22,268	22,086	7,371	51,725	868
14	Munshiganj	74.79	2,139	9,635	6,170	26	15,831	0
15	Sylhet	359.00	16,823	73,251	58,601	14,650	146,502	0
16	Manikganj	143.64	7,666	17,017	17,247	778	35,042	44
17	Madaripur	39.00	1,063	2,573	2,503	239	5,315	432
18	Shariatpur	102.35	14,122	22,268	22,071	8,271	52,610	0
Total		8423.29	673,136	969,329	792,702	386,319	2,148,350	15,741
(%)				45%	37%	18%	100%	

Source: Disaster Report -2014 (draft), Department of Disaster Management (The survey team corrected a part of the total value part)

(2) Issues Clarified in Recent Disasters

The "SHAPLA NEER-Citizens' Overseas Cooperation Association", which works to solve the poverty problem in Bangladesh, carried out emergency relief activities in an Upazila in Khulna District, which was severely damaged by Cyclone Amphan in 2020. In 2022, we are carrying out restoration and reconstruction support activities such as raising roads, wells, and toilets and improving shelters.

SHAPLA NEER confirmed the situation in the target area by interviewing households (865 households with women, children, persons with disabilities, and the elderly) who are most vulnerable in the event of a disaster, and also discusses the needs and issues of residents.

According to SHAPLA NEER, the results of the survey revealed the following challenges:

- Residents in the target area have little knowledge about general disaster prevention actions and are not fully prepared for peacetime.
  Ex.: Only 16% of households have a high foundation in their homes in case of a disaster.
- When a disaster occurs, appropriate evacuation actions are not taken sufficiently.
  Ex.: 58% of households are evacuating with the whole family, and only 15% are evacuating first by helping people in need of assistance in the event of a disaster.
- Government and other disaster prevention actors do not play that role.
  Ex.: Although the disaster management committee of each union holds emergency meetings in the event of a disaster, the rate of regular meetings is as low as 26%.
- Insufficient resilience of infrastructures such as cyclone shelters, toilets, and wells to disasters, especially vulnerable groups such as women find it inconvenient.
  Ex: 51% of the wells surveyed have some problems that need to be repaired. Water fetching has traditionally been the role of women, forcing women to go to distant wells to secure daily drinking water.

Source: https://www.shaplaneer.org/support/cyclone_prevention/211222_bangla_dec/

(3) Issues in the Current Efforts and Direction of Improvement

From the efforts of the Bangladesh government and donors, past research cases, and issues identified in the recently disaster-stricken areas, the issues related to dealing with gender and other vulnerable groups in the disaster prevention field of Bangladesh are organized in the following table.

Table 4.7.10 Current Issues of Disaster Risk Management Considering Gender and Vulnerable Groups

Points of issues	Specific issues
Maintenance of shelters with consideration for gender and vulnerable groups	Construction and maintenance of cyclone shelters and flood shelters are proceeding at a rapid pace, but it is not yet sufficient. Although measures are being taken in consideration of gender and vulnerable groups, it is necessary to develop shelters that consider gender and vulnerable groups, such as installing women's toilets and ensuring access.
Women's participation in DRR activities in the community	Of the roles traditionally regarded as men's roles such as early warning and search and relief, women's roles may be effective in disaster prevention and countermeasures. It is necessary to encourage the participation of men and women in early warning and search and relief.
Establishing implementation system to promote DRR from a gender perspective	In many countries, lessons learned from past disasters, disaster risk reduction (DRR) legislation, and systems have been put in place and organized for implementation. A similar approach is being taken in Bangladesh, incorporating gender and vulnerable perspectives into legislation and institutions. However, the environment and systems such as concrete efforts to promote it are insufficient, such as the government and other disaster prevention actors not fully fulfilling their roles.

Points of issues	Specific issues
Violence against women and children	Gender-based violence (GBV), especially domestic violence (DV), is still perceived as a serious gender problem in flood-prone areas.
Vulnerabilities based on strongly fixed gender roles	The literacy rate of women has increased, and women's social advancement has progressed to some extent, but in reality, women are facing difficulties due to traditional gender norms that are deeply rooted in society and culture and the fixed concept of roles for men and women.

Source: JICA Survey Team

Among the issues related to dealing with vulnerable groups including women and children, those caused by traditional gender norms and fixed concepts of roles of men and women and problems related to violence require reform of awareness of both men and women. It will take a long time to improve them.

Except for them, NPDM2021-2025 and SOD2019 and the gender response guidelines already indicate the direction of response. The Government of Bangladesh is also actively working to deal with the vulnerable groups, and related organizations and departments will promote information sharing and cooperation to achieve the goals, and appropriately fulfill their assigned roles. It is important to carry it out. In particular, proper implementation at the community level is required.

In addition to the above issues, in the section of “Communication and Awareness of DRR Information” in 5.7.1, the planning and implementation of effective measures based on a bottom-up approach are presented as an issue in line with the livelihood and mentality (mental tendency) of residents in rural poor areas with low disaster prevention literacy. At the same time, it has been pointed out that it is necessary to give special consideration to vulnerable people (vulnerable groups).

4.7.4 DRR Considerations in Development Plans

Information on DRR considerations in development plans such as important infrastructure, land use plans, existing urban/regional master plans, and BIG-B plans is collected. In addition, from the perspective of mainstreaming DRR, the status of consideration for DRR in regulations, plans, and implementation by laws and regulations, including design manuals, are summarized and the issues are analyzed.

4.7.4.1 Initiatives by the Government of Bangladesh

In NPDM 2021-2025, the Local Government Division, in close collaboration and support with MoDMR, considers disaster risk in developing all development plans and infrastructure. The Local Government Division also works with City Corporation and Pourashava to build heliports for disaster response in coastal areas, create blueprints for development considering all current and future risks, especially earthquakes and regional characteristics, and emergency response plans. It is supposed to be created.

Bangladesh also supports the development of climate change and disaster-resistant infrastructure in its Perspective Plan 2021-2041 (PP-2041), which aims to achieve 100% disaster preparedness by 2041.

The 8th Five-Year Plan announced in 2020 will prioritize the development, operation, maintenance, and development of local road networks in Bangladesh, and will develop a local transportation network that is resistant to the effects of climate change and disasters. The goal is to build a two-lane local road with a total of 16,000 km by 2025 with a robust design. Bangladesh's government's efforts to eradicate poverty through strengthening local roads not only improve connectivity and accessibility to remote areas but also provide a reliable infrastructure for people living in rural areas in the event of a disaster.

In this way, especially in rural areas, it is required to develop infrastructure that is resilient to the effects of climate change and disasters, and to consider disaster risk at the stage of formulating development plans and infrastructure development plans. Here, the following two materials (manuals and guidelines) are published as guides for considering the effects of climate change and disaster response at the stage of formulating development plans for important infrastructure in Bangladesh, etc. The outline of the contents has been summarized.

- Development Project Proforma/Proposal (DPP) Manual (Instructions for Preparing Development Project Proposal), March 2014, General Economics Division (GED), Planning Commission, Ministry of Planning

- Planning Guidelines for Rural Road Master Plan (Guideline on GIS Application for Rural Road Development）, Strengthening of Activities in Rural Development Engineering Center Project (RDEC-2), Local Government Engineering Department (LGED), GIS Unit, December 2010

(1) Development Project Proforma/Proposal (DPP) Manual

This DPP manual, published by GED in March 2014, provides a way to prepare development project proposals and design development projects for climate change, disasters, and environmental issues to meet the demands of the public sector planner level, and explains how to integrate. It also comes with the indicators and references needed to assist in the planning process.

The DPP Manual requires that risks such as disasters and dangerous aspects at the implementation and operation stages of development projects be identified from the perspectives of climate change, disasters, and environmental issues and that mitigation/safety measures be proposed. Also, when designing a project, consider various technical alternatives, adopt the most rational approach for choosing the right technology, and when designing the environment built by the project. It requires that its specifications include aspects to ensure resilience to the effects of climate change and disasters.

Table 4.7.11 shows the table of contents of the documents that should be compiled as a result of the analysis and evaluation of climate change, disaster, and environment-related risks as examples of the contents required for risk analysis. After analyzing the risks related to climate change, disasters, and the environment and their impacts in the area related to the development project, it is required to evaluate the policies/systems and implementation system and to consider cost-effectiveness.

Table 4.7.11 Contents of Climate Change, Disaster and Environmental Risk Assessment Shown in the DPP Manual

CONTENTS

1. INTRODUCTION TO RISKS ASSOCIATED WITH CLIMATE CHANGE, DISASTERS & ENVIRONMENT
    - 1.1 Introduction to climate change related effects and responses
    - 1.2 Background of climate change related risks assessment
    - 1.3 Scope of the Climate Change Risks Assessment
    - 1.4 Description of the proposed project
2. DEFINING RISKS FOR THE PROJECT
    - 2.1 Climate Change related risks in the project areas
    - 2.2 Risks associated with hazards and disasters in the project areas
    - 2.3 Risks to environmental sustainability
3. CDE ASSESSMENT FRAMEWORK
    - 3.1 Enabling Policy and Legal Aspects
    - 3.2 Current institutional framework
    - 3.3 Potential Impacts of climate change on project outcomes & related deliverables
    - 3.4 Potential impacts of hazards/disasters on project elements and functioning
    - 3.5 Potential impacts of environmental risks on project elements and functioning
4. MANAGEMENT AND RELATED ISSUES
    - 4.1 Assessing Response Measures
    - 4.2 Governance aspects of CDE issues
    - 4.3 Cost-Benefit Analysis of response measures
    - 4.4 Sourcing and Phasing of Finance
    - 4.5 Overall resulting impacts of CDE concerns on the project functioning
5. GENERAL RECOMMENDATIONS AND WAYS FORWARD
6. INTEGRATED ASSESSMENT SUMMARY TABLE FOR THE PROJECT

Source: DPP Manual

(2) Planning Guidelines for Rural Road Master Plan

Planning Guidelines for Rural Road Master Plan, published by LGED in 2010, helps to develop a local road master plan. It helps to create a master plan at the district level and collect and facilitate matching the various types of information needed for review by the central government. It also aims to provide uniformity and transparency to the road planning process under LGED.

LGED, under the Local Government Division of the Ministry of Local Government, Rural Development and Cooperatives (MOLGRDC), is responsible for the construction and maintenance of Upazila, Union, and Village Roads, along with the Local Government Institution (LGI). It contributes to job creation and poverty reduction by developing transportation networks, growth centers, and local market infrastructure.

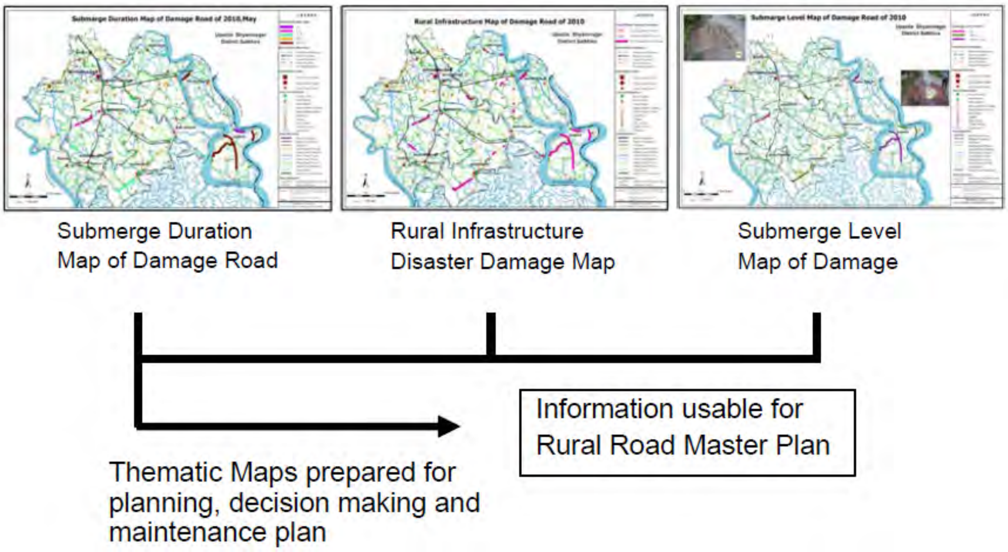
Roads in Bangladesh are classified as shown in Table 4.7.12, and the responsibility for construction, development, and maintenance of these roads rests with RHD and LGED, respectively. According to the classification, LGED will work with the municipality (LGI) to build, develop and maintain three classes of roads named Upazila Road, Union Road, and Village Road.

Table 4.7.12 Classification of Roads in Bangladesh

No.	Class	Definition	Owner, responsibility
1	National Highway	Highways connecting the National capital with Divisional HQs or seaports or land ports or Asian Highway	RHD
2	Regional Highway	Highways connecting District HQs or main river or land ports or with each other are not not connected by national Highways.	RHD
3	Zila Road	Roads connecting District HQ/s with Upazila HQ/s or connecting one Upazila HQ to another Upazila HQ by a single main connection with National/ Regional Highway, through the shortest distance/ route.	RHD
4	Upazila Road	Roads connecting Upazila HQ/s with Growth Center/s or one Growth Center with another Growth Center by a single main connection or connecting Growth Center to Higher Road System, through shortest distance/route.	LGED/LGI
5	Union Road	Roads connecting union HQ/s with Upazila HQs, Growth Centers, or local markets or with each other.	LGED/LGI
6	Village Road	a) Roads connecting Villages with Union HQs, local markets, farms, and ghats, or with each other. b) Roads within a Village.	LGI

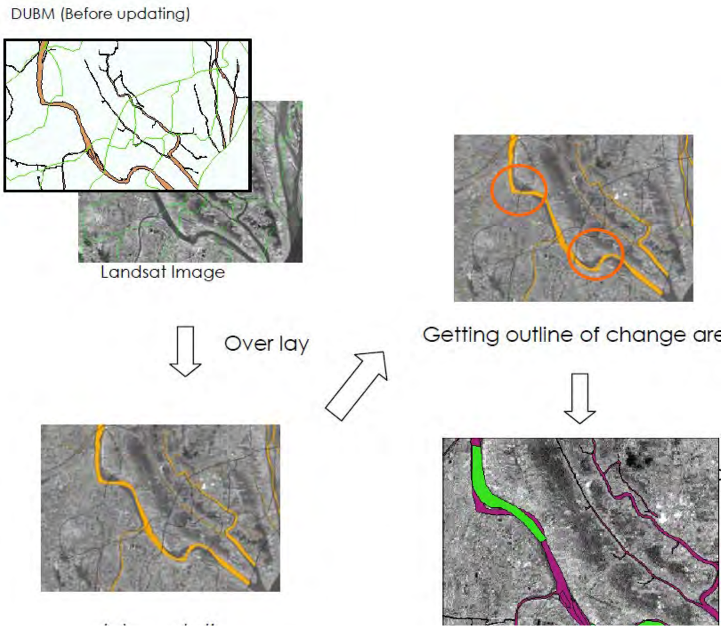
RHD: Roads and Highways Department
LGED: Local Government Engineering Department (LGED)
LGI: Local Government Institutions
Source: Prepared by JICA Survey Team Based on "Planning Guidelines for Rural Road Master Plan"

In the guideline of the local road master plan, when creating the master plan, data such as the past road disaster situation, road embankment damage situation, structure damage situation, etc. are collected and registered using the disaster damage database with GIS function. Therefore, it is recommended to create a disaster damage map of local infrastructure, a submerged level map of damaged roads, and a submerged period map of damaged roads. By managing the past damage situation together with the map information, it is possible to easily grasp the risks to be taken at the stage of creating the master plan. In addition, this guideline also establishes a method for grasping the movement status of river channels and the distribution status of assets using satellite image (LANDSAT) data.



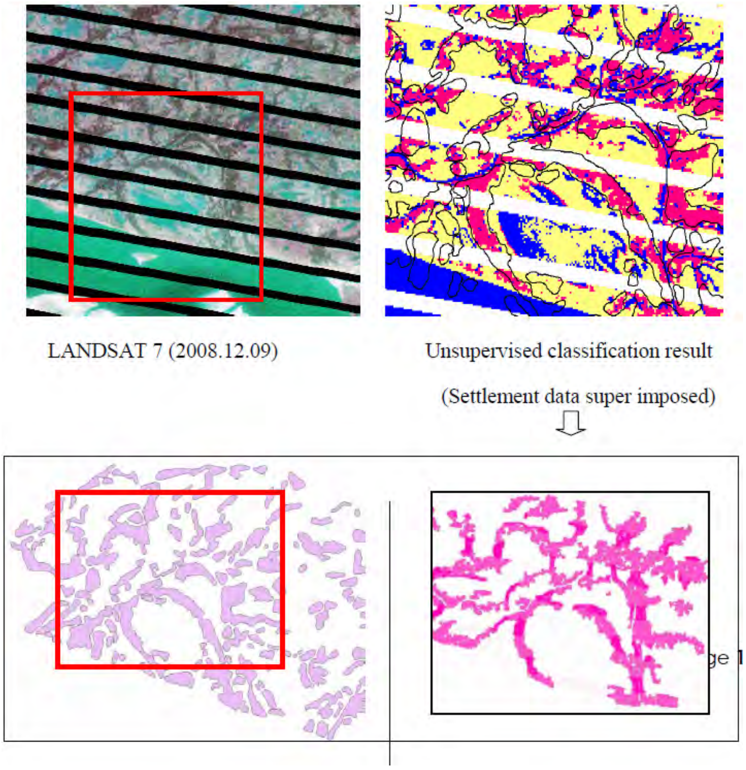
Source: Planning Guidelines for Rural Road Master Plan

Figure 4.7.10 Evaluation of Disaster/Damage Risk Using Disaster Damage Database



Source: Planning Guidelines for Rural Road Master Plan

Figure 4.7.11 Understanding the Transition Status of River Channels Using LANDSAT Satellite Images



Source: Planning Guidelines for Rural Road Master Plan

Figure 4.7.12 Understanding the Transition Status of River channels using LANDASAT Satellite Images

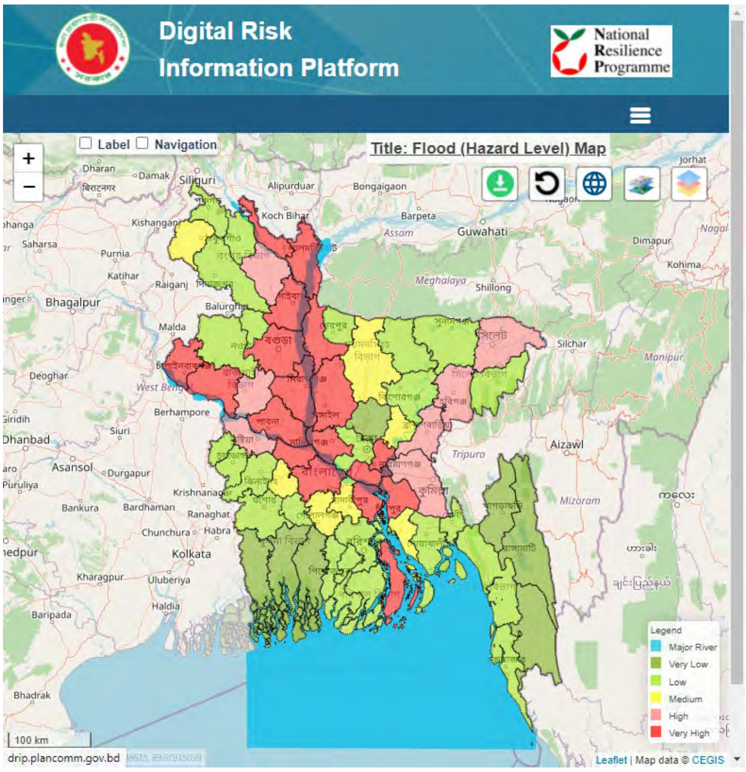
4.7.4.2 Cooperation with Other Donors

As explained in 4.7.1, the Digital Risk Information Platform (DRIP) was developed as part of UNDP's ongoing NRP project to facilitate DRR considerations in development plans, especially disaster risks in and around the planned area.

DRIP is a platform that facilitates access to risk information in order to develop a development plan for DPP for projects based on risk information.

To date, databases related to development planning and management within the Government of Bangladesh have not provided the data and information needed to prepare DPPs for dealing with disaster and climate change risks. Primarily they focused on the stages for implementation, budget management, and monitoring. The platform provides data and information on disaster and climate risk and vulnerability assessments, potential climate change adaptation options, and disaster risk mitigation measures to address identified risks and vulnerabilities. It can facilitate access to risk information available in different departments and assist planners in different ministries.

However, at this stage, existing disaster risk information can be confirmed and used on the platform, but who and how to update and maintain the risk information in the future remains an issue.



Source: DRIP Webside

Figure 4.7.13 DRIP screen (Example of Flood Hazard)

4.7.4.3 Issues in the Current Efforts and Direction of Improvement

Information was collected on the status of DRR considerations in Bangladesh's domestic development plans, and the following points were clarified.

- ✓ NPDM 2021-2025 requires the Local Government Division to consider disaster risk in all development plans and infrastructure development in close cooperation and support with MoDMR.
- ✓ GED has published a DPP manual that explains how to prepare proposals for development projects and how to integrate climate change, disasters, and environmental issues into the design of development projects. The DPP Manual requires that risks such as disasters and dangerous aspects at the implementation and operation stages of development projects be identified from the perspectives of climate change, disasters, and environmental issues and that mitigation/safety measures be proposed.
- ✓ The guidelines for creating a local road master plan published by LGED recommend that past disaster information be stored in a database to facilitate plan creation and examination.
- ✓ DRIP was developed as a tool to facilitate access and confirmation of various disaster risk information during the development of DPP. However, there are still issues regarding future data updates and maintenance.

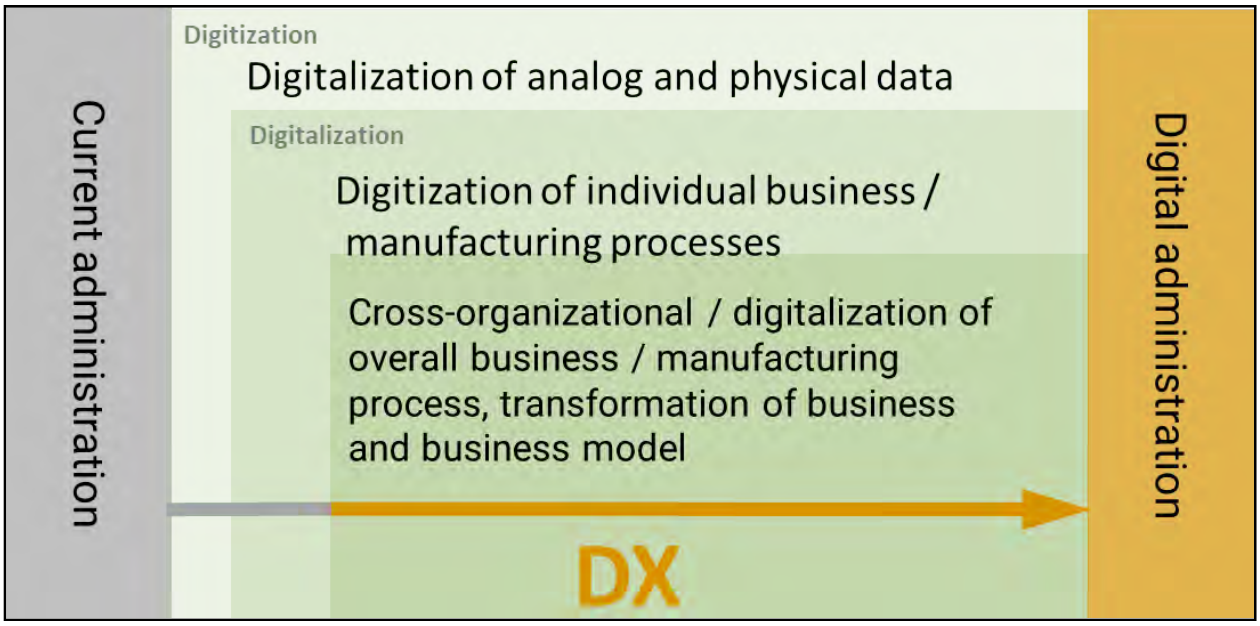
In Bangladesh, it is mandatory to submit a DPP to the Planning Commission at the stage of planning the project, and the DPP needs to identify the disaster risk in the target area and describe it, including mitigation measures. In this way, consideration for disaster prevention is required from the stage of formulating a development plan, and a manual for that purpose is also provided.

The risk assessment at this stage is based on the results conducted and published by other research institutes, etc., and cannot be said to be sufficient in terms of accuracy. Therefore, a more detailed risk assessment will be required at the implementation stage after DPP approval, but it will be necessary to develop and share standard data with sufficient accuracy and resolution for detailed risk assessment, such as ground height data. think.

4.7.5 DX Promotion in DRR Sector

4.7.5.1 Phase-based Implementation of DX Promotion

DX (Digital Transformation) is the process leading up to becoming a digital enterprise, and the promotion of DX is not just the digitization of individual operations and physical data, but the cross-organizational digitization and transformation of overall operations. In fact, the process consists of three stages: Digitization, Digitalization and Digital Transformation (DX). The promotion of DX in Bangladesh so far has not reached the third stage of overall transformation, and it is considered that the national administrative organization is in the stage of needing digitization and digitization.



Source: Made by survey team using an original diagram from METI-Japan

Figure 4.7.14 Three Stages of DX (Digital Transformation)

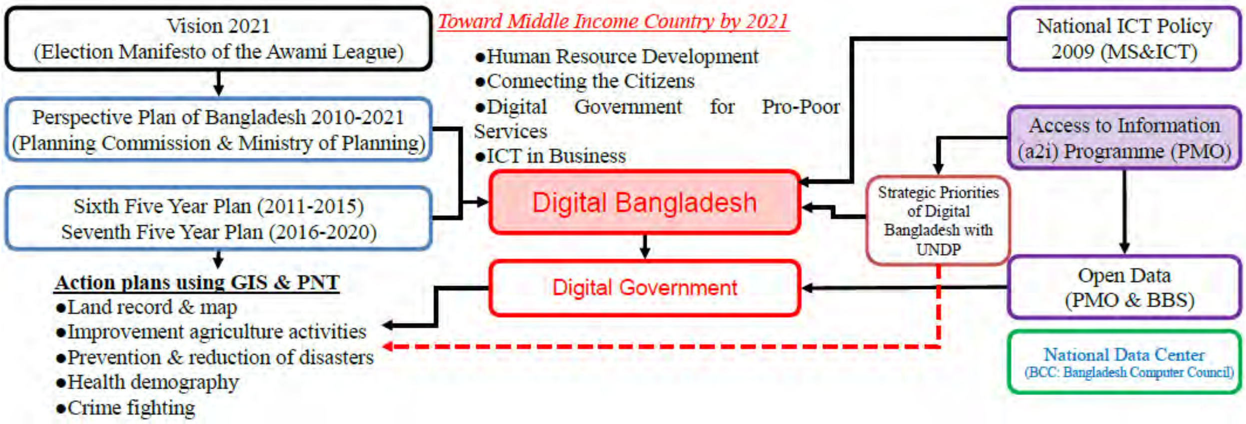
4.7.5.2 Current Situations in Bangladesh

(1) National Plans, Policies, and Institutional Arrangements

1) Digital Bangladesh

In Bangladesh, “Digital Bangladesh” is a national policy. Based on Digital Bangladesh policy, these four processes are in progress[34]:1) Government digitization, 2) Utilizing ICT in business, 3) Spread of ICT to whole nation, 4) Human resources development. As the main core of “Digital Bangladesh”, under the a2i program (Access to Information Program), UNDP provides support and submits disaster prevention-related action plans as priority measures.[35]

[34] https://www.jetro.go.jp/ext_images/theme/bop/precedents/pdf/marketcondition-DigitalBD-Vision2021_201601_bd.pdf
[35] JICA report (In Japanese), Mapmaking Capacity Enhancement Project for Building Digital Bangladesh



Source: JICA report (In Japanese), Mapmaking Capacity Enhancement Project for Building Digital Bangladesh

Figure 4.7.15 Relation of National Development Plan and Digital Bangladesh and a2i Program

Despite the great progress in having deep reginal connection through information and communication technology, gap between urban and rural areas still exists in terms of communication technology and data availability.

Many of the duty of the Bangladesh Ministry of Disaster Management and Relief (MDMR) can be improved by the use of advanced technology and DX. For example, the following activities are excerpted from MDMR's business implementation policy:

- ✓ Establish, strengthen, and improve the national disaster response mechanism.
- ✓ Establish, manage, and operate Disaster Management Information Centers (DMIC) at national and local levels including Emergency Operation Centers (EOCs)
- ✓ Expanding prevention and preparedness measures across a broader range of hazards such as earthquake, infrastructure collapse, Tsunami, firer and events causing mass casualties.

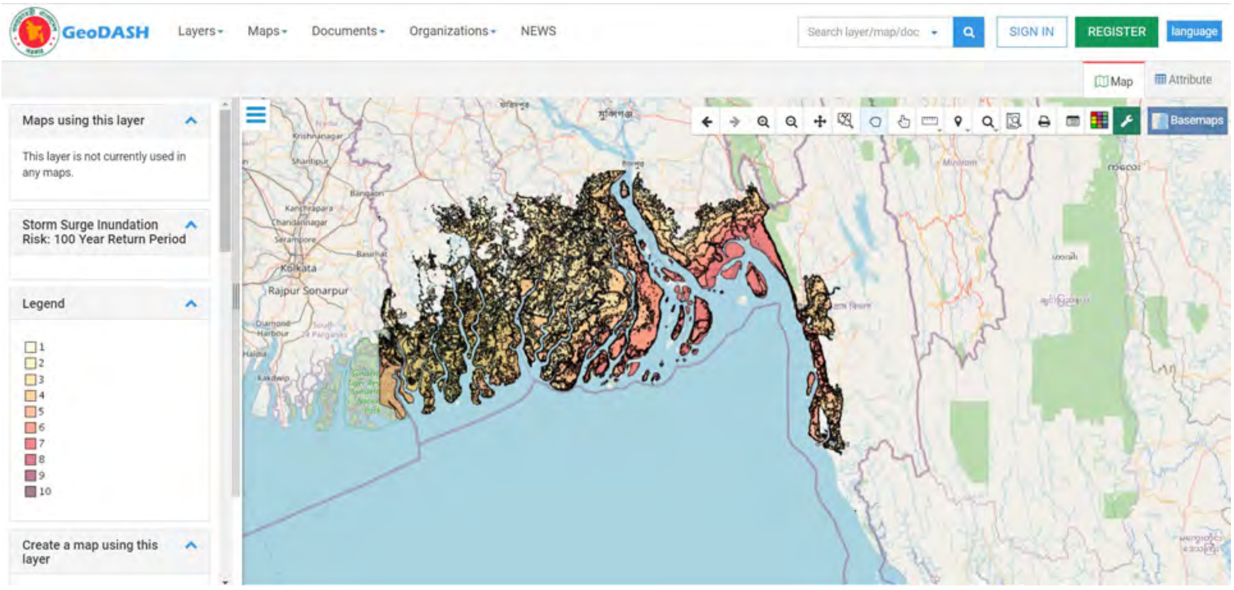
2) Bangladesh Computer Council (BCC)

In 1983, National Computer Council was established by the Government of Bangladesh. In 1990, the name was changed to Bangladesh Computer Council (BCC) by the Bangladesh Computer Council regulations. BCC is the highest legal institution for domestic ICT development which is under the Information and Communication Technology Division (ICTD) of the Ministry of Posts, Communications and Information Technology of the Government of Bangladesh.

BCC operates and manages National Data Center (NDC) of Bangladesh to achieve the goal "Digital Bangladesh". NDC was established in 2010 and offer many services which are categorized in three sections. NDC offers various services and mainly divided into three categories: IaaS (Infrastructure as a Service), PaaS (Platform as a Service), SaaS (Software as a Service)[36].

GeoDASH platform has supported by the World Bank Global Facility for Disaster Reduction and Recovery (GFDRR). The platform was transferred to Bangladesh Computer Council (BCC) in December 2015, allows cross-referencing of geo-information data and maps from various institutions. GeoDASH is focusing on utilizing the geospatial data, the renovation of public buildings, the review of land use plans, and the revision of building standards. In addition, ICT infrastructure development for multi-stakeholder collaboration is in progress in large cities. As of June 2021, more than 4,000 users representing 55 public-private and civil society groups are sharing data, and from road network maps and building footprints to water, gas and public facility locations, 740 datasets are now available on a secure platform. All of these datasets are open to the public in different formats[37]. The content of the datasets includes layers of urban structures, land use, infrastructure development, disaster, etc.

36 Source: https://ndc.bcc.gov.bd/?page_id=106
37 World Bank report (in Japanese), World Bank Enhances Risk Data for Urban Resilience in Bangladesh



Source: https://geodash.gov.bd/

Figure 4.7.16 Example of GeoDASH Available Aps (Risk of Flooding due to Storm Surge)

GeoDASH could be utilized in disaster risk management as in the following examples:

- ✓ Bangladesh's Local Government Technology Department created the cyclone risk map by using the geospatial information and set it as a guideline for investment planning for cyclone shelters in urban and rural areas of Bangladesh.
- ✓ Used for the first phase of the design of Coastal Embankment Improvement Project (CEIP) by the IDA World Bank and the Climate Investment Funds (CIF). This project aims to improve 10 fragile coastal reclaimed land in Bangladesh with coastal levees, irrigation structures and conservation works.
- ✓ Used by the Department of Primary Education in Bangladesh to assess 35,000 schools for the type of infrastructure, water and sanitation, access to roads, and overall capacity for natural disasters.
- ✓ Used for geospatial data analysis in the ongoing "Urban Resilience Project". The project aims to strengthen the capacity of government agencies in Dhaka and Sylhet to respond to emergencies and reduce the vulnerability of future buildings to disasters[38].

The research team conducted a field survey in Bangladesh and interviewed related organizations in the field of disaster management. Among them, the following are the results of the interviews with the Bangladesh Space Research and Remote Sensing Organization (SPARRSO), Survey of Bangladesh (SOB), BWDB and FFWC on the promotion of DX.

3) Available Geospatial Information

Geospatial information in Bangladesh is managed and maintained by various government organizations. The major organizations are as follows.

Table 4.7.13 Available Geospatial Information in Bangladesh[39]

Name of organization	Data base contents
Survey of Bangladesh (SOB)	Electronic reference point results and observation data (GNSS CORS Data) are available on the web for a fee.
Bangladesh Computer Council (BCC)	Building a geospatial information sharing system (GeoDASH) to centrally manage and share disaster information.
Bangladesh Local Government Engineering	Base-map and thematic maps of administration, road network,

[38] https://www.worldbank.org/en/news/feature/2021/04/19/deploying-digital-tools-to-withstand-climate-change-in-low-income-countries
[39] JICA report (In Japanese), Mapmaking Capacity Enhancement Project for Building Digital Bangladesh

Name of organization	Data base contents
Department (LGED)	etc. are available through GIS Portal.
Bangladesh Bureau of Statistics (BBS)	Maintain thematic maps of the subregion and these are available on the web.
Bangladesh Navy Hydrographic Department (BNHD)	Possessing charts, graphs, etc., and these are available on the web.
Bangladesh Space Research and Remote Sensing Organization (SPARRSO)	Possessing thematic maps and published on the web by Geoportal.
Geological Survey of Bangladesh	Possessing thematic maps and published on the web.

Source: JICA Survey Team

(2) Central Government Agencies Situation and Activities

1) SPARRSO Situation and Activities

SPARRSO is a statutory organization for interdisciplinary research and peaceful use in the field of space science and technology in Bangladesh. SPARRSO aims to contribute to the improvement of people's living standards and national development through the acquisition of knowledge on space science and technology and its peaceful use.

Landslides are frequent in the hilly areas of Bangladesh, especially during the rainy season. SPARRSO aims to indirectly reduce these problems and uses satellite imagery and GIS for its research.

Satellite imagery is mainly done using existing satellites in Bangladesh. Ongoing projects related to disaster monitoring are:

- ✓ Establishment of remote sensing-based operational flood monitoring system
- ✓ Establishment of an remote sensing-based integrated river monitoring system
- ✓ Mapping of changes in mangrove forest ecosystems using satellite sensor data
- ✓ Monitoring of long-term changes in Sundarbans mangroves due to coastal erosion: analysis of indicators and causes (Phase-2)
- ✓ Geomorphological and meteorological conditions for landslides in the southeastern hills of Bangladesh
- ✓ Trends of rainfall related cyclones in Bangladesh

According to the SPARRSO staff, they have also been monitoring flooding in recent years. At Bhutia Beel in Khulna district, SPARRSO is monitoring inundation in an area of 8000 hectares using GIS technology.

SPARRSO acknowledges the inefficiencies of the current monitoring system and hopes to share experiences through international support. SPARRSO needs support especially in the area of damage assessment. SPARRSO is also aware of the limitations of the capabilities of existing satellites, and it is hoped that the introduction of new satellites will improve its technical capabilities.

2) SOB Situation and Activities

SOB is working on the National Spatial Data Infrastructure (NSDI) project with the support of JICA. The details of this project are described below.

3) BWDB Situation and Activities

The FFWC monitors flow rate, rainfall, and water level in rivers. As shown in 4.2.4.7, Water levels are monitored every three hours during 6AM to 6PM. In this case, if flood occurs at night, it may not be captured. In the event of a cyclone, the frequency of observations may be adjusted at some locations.

As for rainfall, BWDB, as explained in 4.2.4.7, observes rainfall nationwide. It uses the method of manually measuring the rainfall once a day for 24 hours. Flow rate observation is conducted once or twice a week at about 120 locations. Although there is no problem in observing monsoon-type floods, the problem is that it is not possible to respond to the peak of flash floods in rivers around Sylhet.

Even if the observation timing is adjusted to capture the peak as much as possible, it will be difficult for small and medium-sized rivers because the peak flow occurs soon after rainfall.

For flow velocity observation, velocity meters are used in small rivers, while ADCP is used in large rivers and tidal rivers. Water levels are observed using ultrasonic waves at about 1,300 points. All observation equipment is owned by BWDB.

In addition, river channel cross-sectional surveys are carried out at 700 to 800 points one to four times a year. River channel topography and channel erosion are also observed.

Using the collected observation data, BWDB is building a flood forecasting and warning system. The system calculates water levels for 12 days (7 days in the past and 5 days in the future) at hourly intervals, completing the 12-day calculation in about 15 minutes. The past 7 days are used for calibration, and the future 5 days are used for prediction. The calculated water levels can be interpolated across the country, and the DEM can be used to calculate the inundation area (see 4.2.1.4). Warnings are issued when water levels are predicted to rise, via the web, email to 600 agencies, fax, phone, and IVR (1090). It also has a partnership with Google to provide high-resolution information through machine learning, which can be viewed on Google Maps, although only during the flood season.

The BWDB is working with the WB on the project for strengthening the hydrological information service and early warning system. The overall objective of this project is to improve access to reliable meteorological, water and climate information services by strengthening the BWDB's capabilities. Specifically, the objectives of the project are as follows:

- ✓ Comprehensive support to BWDB to modernize its hydrological monitoring network and operations.
- ✓ Procurement of hydrological related equipment.
- ✓ Improving flood forecasting throughout Bangladesh, including flash floods and floods caused by storm surges and cyclones.
- ✓ Development of hazard prediction and forecasting services for other water-related disasters.
- ✓ Diversification and downscaling of forecasting content.
- ✓ Build up cross-cutting knowledge in hydrology.

The specific activities of this project are as follows:

- ✓ Assisting the Water Resources System Integrator (WRSI) consultant to assess, design, prepare technical documents on instrument operation and support the implementation of key BWDB project activities.
- ✓ Upgrading 315 manual water level gauges, 257 rain gauges and 3 meteorological stations for automated data collection and real-time reporting.
- ✓ Implement 905 groundwater stations and an automated reporting system for measurements.
- ✓ Purchase of four catamarans and four survey vessels for coastal waterway surveys and river observations.
- ✓ Installation of 40 onshore coastal storm surge inundation stations.
- ✓ Provision of 15 hand-held TDS meters and 8 total stations (to assist in river morphological surveys), 12 RTK-GPS, 6 DGPS beacon receivers, 4 primary digital levels, and 2 5-10m through-bottom profilers.
- ✓ Maintenance, repair and upgrading of BWDB's existing hydrographic survey equipment and calibration facilities.

(3) Status of DX Promotion in DRR

The result of a National Council workshop is described In National Plan for Disaster Management (2016-2020). In the report, proposals for DX-related activities and the development and application of new technologies are organized by disaster type as in the below table.

Table 4.7.14 DX related Activities and Proposals in NPDM

Disaster	Main Activities	Main Govt. Agencies	Other Govt. Agencies	Progress (Feb. 2022)
Cyclone, Salination, Flooding	Strengthening hydro-meteorological monitoring and forecasting, improve early warning and using space technology	BMD	SPARSO	Slow progress due to lack of financial and human capacity
	Establishing scientific observational network for surface, upper air, ocean atmosphere	BMD		Slow progress due to lack of financial and human capacity
	Including weather data in Bangabandhu Satellites	BMD	ICT	Planning Stage
	Damage and loss assessment and establish a database through online process	DDM	PC, WARPO and other Ministries/Departments	A Disaster Risk Information Platform has been developed[40]
Lighting, Fire, Dangerous Chemicals	Introducing and using technology for prediction of spread of oil/gas spill (2018-2020)	BMD	DOE/Power Ministry	Not implemented due to lack of budget and human resources
	Technology transfer from developed countries (e.g., Japan, China, UK), (2016-2020)	MoDMR	BMD	Completed to some extent but will be continued in the future.
	Developing database, Area based Forecasting	MoDefence	BMD	Ongoing
	Ensuring real time data sharing and dissemination	MoDMR	BMD, DDM, ADPC, others	Planning Stage
Earthquake	Backup support digital data	MoDMR/BCC	RAJUK and other relevant organization	A World Bank project is ongoing by BCC from 2020 to 2025 on "Enhancing Digital Government & Economy (EDGE) Project"
	Establish national disaster volunteer networks and online database for quick deployment, disaster prevention, response, and mitigation; country wide urban volunteer training	CC, Municipalities, DMC	MoDMR, FSCD, BDRCS, CPP	Progress has been slow due to COVID-19 Pandemic
Floods, Flash Floods, Riverbank Erosion	Creating national database with disaggregated data (gender, age and disability disaggregated) of displaced population	BBS	DDM	A national database is available
	Establishing regional data hub for sharing information on flood forecasting	FFWC	IWM	Hub has been established
	Digitizing social safety net program	MoDMR	Mol, Sectoral Ministries/dept. and BCC	A World Bank project is ongoing by BCC from 2020 to 2025 on "Enhancing Digital Government & Economy Project"
Drought, Cold wave	Developing and strengthening early warning dissemination systems	MoDMR	BMD	Slow progress due to lack of financial and human capacity
All Hazards	Compatible application of Information, Communication and Technology (ICT) based tools, equipment, devices for humanitarian response and disaster risk reduction	BCC	MoDMR and other agencies	Various projects are ongoing by BCC. However, the progress is slow due to lack of human resources.

Source: JICA Survey Team

[40] http://drip.plancomm.gov.bd

(4) Future DX Development

A National Plan for Disaster Management (2021-2025) has been drafted in March 2020 by the Government of Bangladesh. "Awareness of disaster risk" is set as the first priority, and it is stated " Utilize modern technology and innovation to improve meteorological and climate observation, forecasting, and warning, including upgrades such as the use of satellite images and automation of data collection at current stations." In addition to hydro-meteorological hazards, information systems and models to monitor other hazards such as landslides and riverbank erosion to be developed." Moreover, in this priority another action for disaster risk management is "To promote real time access to reliable data, make use of space and in situ information, including geographic information systems (GIS), and use information and communications technology innovations to enhance measurement tools and the collection, analysis and dissemination of data".

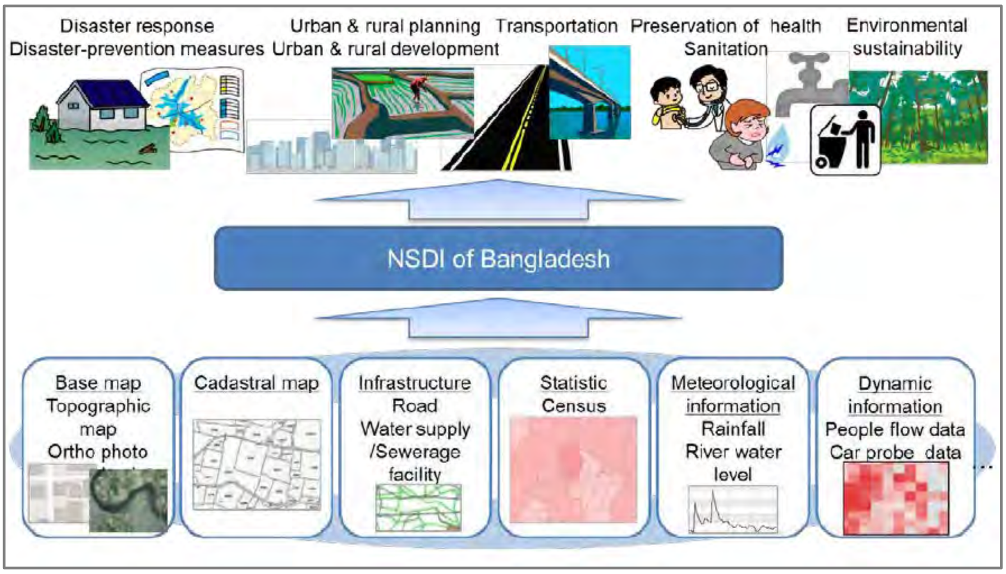
4.7.5.3 Cooperation by JICA and Other Japanese Organizations

(1) National Spatial Infrastructure Data (NSDI) Development Project

In Bangladesh, survey results are not published, and the procedures for using maps are complicated. To solve this situation and promote the use of data, JICA conducted the technology cooperation project" Mapmaking Capacity Enhancement Project for Building Digital Bangladesh, People's Republic of Bangladesh" (Phase 1 implementation period: July 2018 - June 2021). In this project, in order to promote the development of the National Spatial Data Infrastructure (NSDI) in Bangladesh, the following activities were carried out: (1) development of platform, (2) preparation of a roadmap for the development of the NSDI, (3) development and updating of NSDI, and (4) Capacity building on using DEM, GIS and NSDI.

The project aims to consolidate all the data into one platform so that the data can be easily accessed. 1:25,000 maps have been produced with the most recent data being updated in 2015. Development of maps at Upazila (county) level using available data is ongoing. 1:5,000 map of the entire Dhaka is being produced using drones in June 2020. Other maps of various scales, such as 1:50,000 and 1:250,000, are also being created, which will play an important role in assessing disasters in particular. There are also future plans to survey large rivers with a resolution of 0.05m.

Progress on the NSDI project has been slow due to the COVID-19 pandemic, but the SOB expects the data to be available by June 2022.



Source: Report of the project to enhance mapping capacity for building digital Bangladesh, JICA, 2017

Figure 4.7.17 Illustration of NSDI System

This project was implemented in following phase:

1. Preparation period

Period	Until June 2018
Objective	Required preparation work for NSDI Development
Main activities	• Development of Geo-Portal site (prototype version) • Enactment of Survey Act (including required detailed regulations) • Promotion NSDI Act (including required details regulations) • Determination the scope and method of disclosure of geographic information owned by the SOB • Enhancement of the electronic reference point • Completion of digital topographic maps (scales 1:25,000 and 1:5,000) • Preparation for the establishment of the NSDI Committee

2. The first term (Foundation formation period)

Period	July, 2018~ June, 2021
Objective	Development of NSDI and solve various issues
Main activities	• Development of NSDI platform • Enactment NSDI Act (including required detailed regulations) • Establishment of NSDI Committee and Activities of working group (Activities to solve various issues) • Creation the main theme data and demonstration • Enhancement the electronic reference points • Update and release of digital topographic map of Dhaka city • Study on the method of updating base maps • Organizational changes in the SOB and development of human resources and management systems

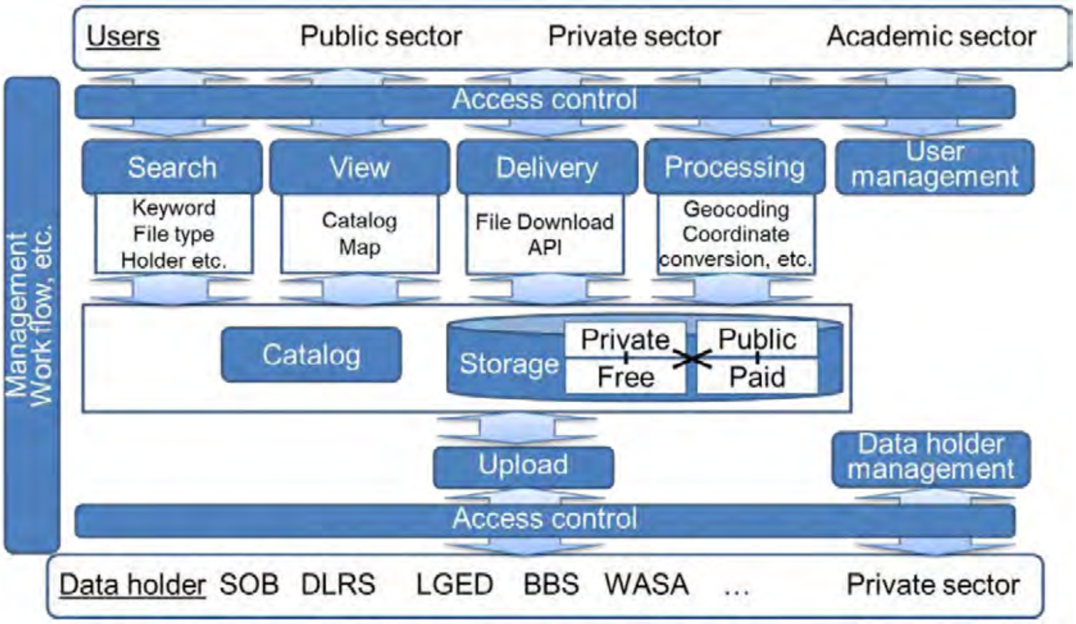
3. The Second term (Mid-term plan)

Period	July, 2021~June 2026（Period of the 8th Five-Year Plan）
Objective	Promotion of the use of NSDI
Main activities	• Periodical updates of base map • Development and updates the highly important subject data • Creation and publishing the digital map of main local city • Development and dissemination of geographic information standards, etc. • Enhance and expand NSDI platform • Operation, dissemination, and promotion of the use of electronic reference points • Continuing the working group activities • Consideration of new business creation using GIS and satellite positioning

4. The forth term (long-term plan）

Period	July, 2026~June, 2031（Period of the 9th Five-Year Plan）
Objective	Stable operation of NSDI
Main activities	• Promotion of NSDI and human resource development in each ministry and agency • Updates NSDI platform • Expanding the use of NSDI to local government agencies • Creation of new businesses using GIS and satellite positioning

The following figure shos functional operation of NSDI. The progress of the National Spatial Data Infrastructure (NSDI) will be reviewd in this study to undrestand prospects and challenges for its future use in disaster prevention.



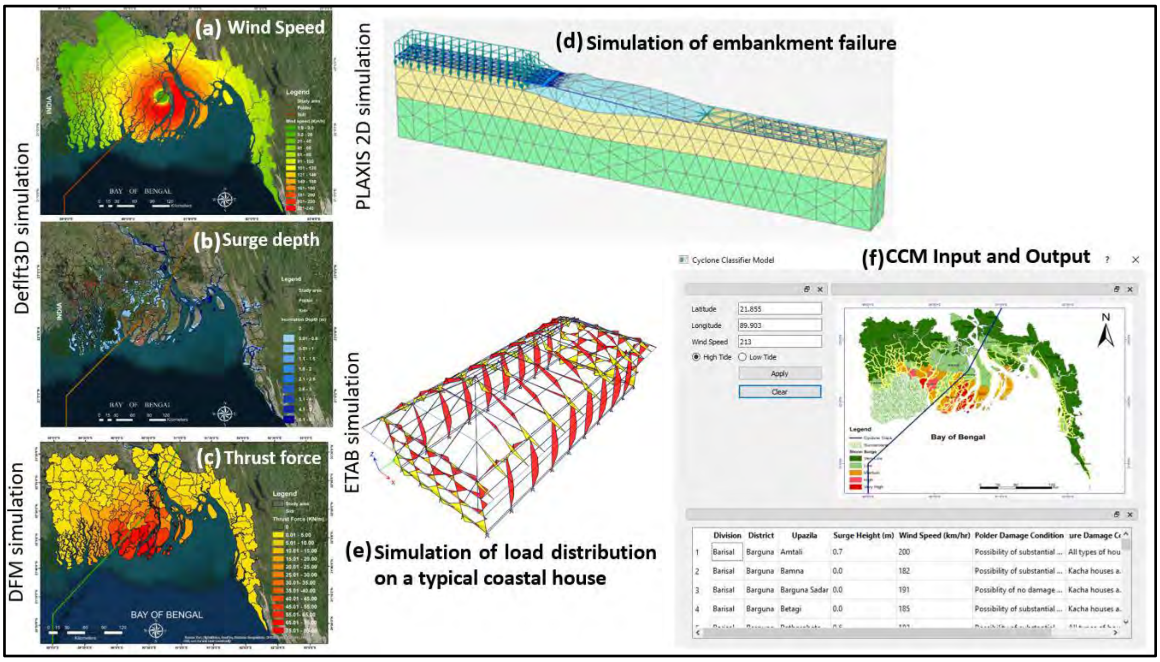
Source: Report of the project to enhance mapping capacity for building digital Bangladesh, JICA, 2017

Figure 4.7.18 Functional Diagram of NSDI Platform (Tentative)

(2) Project of "Research and Development of Technology for Prevention and Mitigation of Storm Surge and Flood Damage in Bangladesh"

The Japan Science and Technology Agency (JST) conducted an international collaborative research project on "Research and Development of Technology for Prevention and Mitigation of Storm Surge and Flood Damage in Bangladesh" from April 2014 to the end of March 2019 using the latest disaster prevention science and technology in Bangladesh. In this project, research on flood, storm surge, riverbank erosion and regional disaster prevention have conducted in five research themes as follows:

1) Research and development on flood risk assessment
2) Development of an improved storm surge evacuation prediction and warning system for coastal areas
3) Disasters related to riverbank erosion and riverbank breaches and their mitigation measures
4) Research on the spread of toxic chemical and its mitigation by flood inundation
5) Disaster management for building a society with regional disaster resilience



Source: Research and Development of Technology for Prevention and Mitigation of Storm Surge and Flood Damage in Bangladesh, JST

Figure 4.7.19 Simulation of Strong Winds, Flooding and Impact on Buildings due to Cyclone (Research Item 2)

The results of each research item and the status of social implementation are shown in the table below (as of 2019).

Table 4.7.15 Implementation Status of International Collaborative Research in Bangladesh

Research Items	Results of Implementation	Status of Implementation
Flood risk assessment	Create hazard map and risk map	Proposed disaster prediction method based on the results
Development of an improved storm surge evacuation prediction and warning system for coastal areas	Improve the warning system	Warning signal implemented with support from BMD
Disasters related to riverbank erosion, breaches and mitigation measures	Conducted experimental study (completed)	The erosion protection installed at the site was washed away.
Research on the spread of toxic chemical and its mitigation by flood inundation	Develop a tool to visualize the diffusion of hazardous substances	Annual surveys were conducted, and local agencies conducted their own simulations
Disaster management for building a society with regional disaster resilience	Conducted detailed survey (Completed)	Delivered the deliverables to the partner universities

Source: JICA Survey Team

4.7.5.4 Cooperation with Other Donors

"Weather and Climate Services Project" by the WB, as mentioned above in 4.1 DRR Governance, is one of the projects by other donors. This project plans to automate the existing water level gauges managed by BWDB for early warning and disaster risk communication. Outcome of the project will enable continues real-time data instead of the current manual observation at every six hours. The project will also automate the rain gauge and other observation network managed by the Bangladesh Meteorological Department (BMD), and modernize the ICT system at the same time. The project also includes capacity building component.

4.7.5.5 Future DX Opportunities, Challenges and Solutions

(1) Future DX Opportunities

It is expected that technological innovation will greatly improve disaster management. Disaster prediction and prevention supported by advanced technologies such as ICT and remote sensing will be more effective and cheaper than other methods. Remote sensing and satellite images have proven to be very effective in disaster monitoring, early warning, and emergency response efforts. DX offers opportunities to improve disaster management and climate change risk. The current status and future potential of DX and advanced technologies to improve disaster risk management in Bangladesh are summarized below.

1) Observation, monitoring, and forecasting: Development of access to data by remote sensing technology, observation/images at ground level, connected mobile devices, geographic information at the community level, etc. These new technologies have the potential to contribute to more sophisticated and accurate risk assessments.

2) Progress in data processing and machine learning: Cloud computing platforms, big data analytics, machine learning, and data processing and analytics with AI can be utilized for disaster management.

3) New technology for disaster risk communication: Increased broadband capacity for transmitting risk and risk management information, improved internet access, mobile access, continuous improvement in data transfer speeds, etc.

(2) DX Promotion Challenges

However, in order to implement the application of the latest technologies as above, it is necessary to investigate and examine the investment of the Bangladesh government and analyze the following issues:

1) Reliability of Communications Infrastructure

Fast and secure access to the internet and other information technologies are necessary for many new technologies. However, in Bangladesh, the situation is not such that reliable communications can be ensured even in the event of a disaster.

2) Lack of Technicians at Relevant Institutions to Ensure State-of-the-art Technology and Knowledge

Advanced data processing technologies such as machine learning, AI, and big data analysis require a high degree of specialized technicians but may not always be fully staffed in government agencies and private companies.
In disaster management using DX and new technology, sufficient recognition of the use of these advanced technologies, understanding, and trust are essential.

3) Restricted Access to Data and Monitoring

Remote observation and full coverage of Bangladesh's geographic area by connecting mobile devices and sensors are costly due to scattered human settlements and may be restricted by rules and regulations, privacy protection, religious considerations, etc.

4) Inadequate Systems for Incorporating New Technologies and Innovations into Disaster Management Administration

It is essential to have higher-quality data for algorithm construction. Strategic approaches and institutional arrangements are needed to integrate these tools into disaster risk management.

In order to overcome the challenges described above, it is essential that Bangladeshi Government take initiative to develop laws, take budgetary measures, reform and reorganize its organization, and develop human resources. At the same time, JICA and other donors could provide support capacity building activities. Moreover, the same as what has been done for "mainstreaming disaster risk reduction" as well as "gender balance", it is suggested to always keep DX promotion in mind and incorporate it into all technical assistance projects.

4.7.6 DRR Measures Contributed to the Economic Growth of Japan and Southeast Asian Countries

In this section, the DRR measures that contributed to Japan's economic growth are summarized. In addition, current DRR policies at the national and local levels in the Philippines, one of the leading countries in Southeast Asia in terms of DRR investment, are reviewed. Based on the above, points to be considered in DRR policies and measures that should be taken into account in Bangladesh to continue its economic growth and become a middle- and high-income country in the future are summarized.

4.7.6.1 DRR Measures Contributed to Japan's Economic Growth

(1) Japan's Economic Growth and Infrastructure Development

After the end of World War II in 1945, Japan achieved dramatic economic growth after more than 10 years of postwar reconstruction, while recovering and reconstructing the scars caused by the war.

Due to the rapid increase in population centered on Tokyo during the period of high economic growth, the expansion of cities, and the progress of motorization, various infrastructure developments have become an urgent issue. Starting with the large-scale infrastructure development centered on Tokyo, triggered by the 1964 Tokyo Olympics, Japan's affluent living infrastructure will continue to expand from the period of high economic growth to the present.

An overview of postwar infrastructure development, which is closely related to Japan's economic growth.

1) Flood Control Projects

From the latter half of the 1940s to the 1950s, large typhoons such as the Kathleen typhoon struck devastated land after the war, causing great damage. With the 1959 Isewan Typhoon as an opportunity, a long-term plan (10-year plan or 5-year plan) for flood control projects based on the law was formulated for the first time. In response to repeated flood damage, the importance of flood fighting works and activities and countermeasures for sediment-related disasters has come to be recognized in addition to flood control projects. Furthermore, in order to respond to the dramatic increase in demand for industrial water and urban water accompanying economic development, water resource development was promoted by the construction of multipurpose dams that have both the purposes of flood control and water utilization.

In addition, the rapid progress of urbanization, such as the serious water shortage during the period of high economic growth and the rapid increase in sediment-related disasters, has caused various problems related to rivers. Water supply restrictions have been significantly reduced in recent years due to the development of dam reservoirs, which have been promoted as a countermeasure against serious water shortages. Furthermore, comprehensive flood control measures have been sequentially implemented, such as measures for storage and infiltration of rainwater in combination with river maintenance and measures for warning and evacuation systems in combination with measures for debris flow.

2) Major Road Development

With the reconstruction of the socio-economy after the war, the promotion of road policy was an issue, so the "Act on Special Measures concerning Road Construction and Improvement " was enacted in 1952, and the toll road system in Japan was started. In 1953, the "Act on Temporary Measures Concerning Financial Resources for Road Construction and Improvement" was enacted, and the volatile oil tax was used as a road-specific financial resource. It was decided to promote road construction and improvement systematically, and the Road Improvement Five-Year Plans had been formulated up to the 11th of 1997, and the level of road maintenance in Japan improved dramatically.

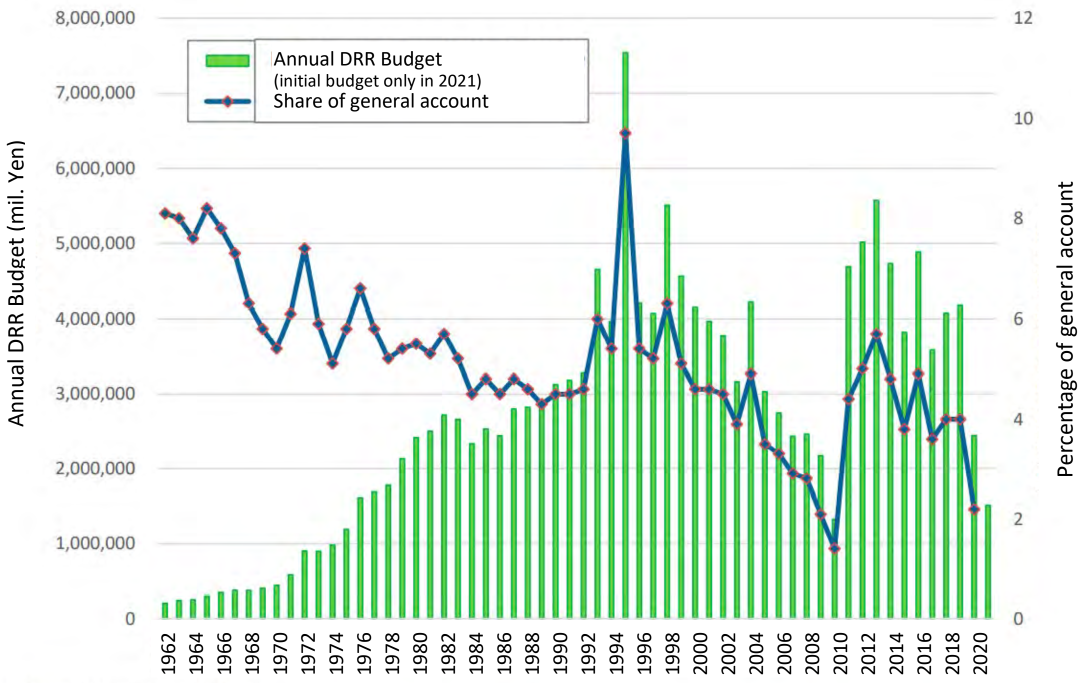
3) Comprehensive National Development Plan

The Comprehensive National Development Plan presents a medium- to long-term national land plan to build desirable land while responding to the regional issues faced and the new era. Since its first formulation in 1962, it has been reviewed every 7 to 10 years, with medium- to long-term plans, large-scale industrial zone development, and construction, and international trading ports centered on Tokyo Bay, Osaka Bay, and Ise Bay. Infrastructure development was carried out in line with the times.

As described above, after World War II, Japan implemented large-scale development of social infrastructure, which is the basis of current life, such as disaster prevention projects represented by flood control projects and the development of transportation networks, to support not only people's lives but also the economy.

4) Budget Changes in DRR Sector

In Japan, the "Basic Act on Disaster Management" was enacted in 1961, and since then, comprehensive and systematic disaster prevention systems have been developed. The figure below shows the changes in Japan's disaster prevention-related budget and its ratio to the general account budget since 1962. The ratio of disaster prevention-related budgets was initially around 8% and remained at around 5% or more until around 2004. After that, it decreased to about 2%, but after 2011, it increased to about 5%. This is due to a significant increase in the budget for recovery from the Great East Japan Earthquake that occurred in March 2011.

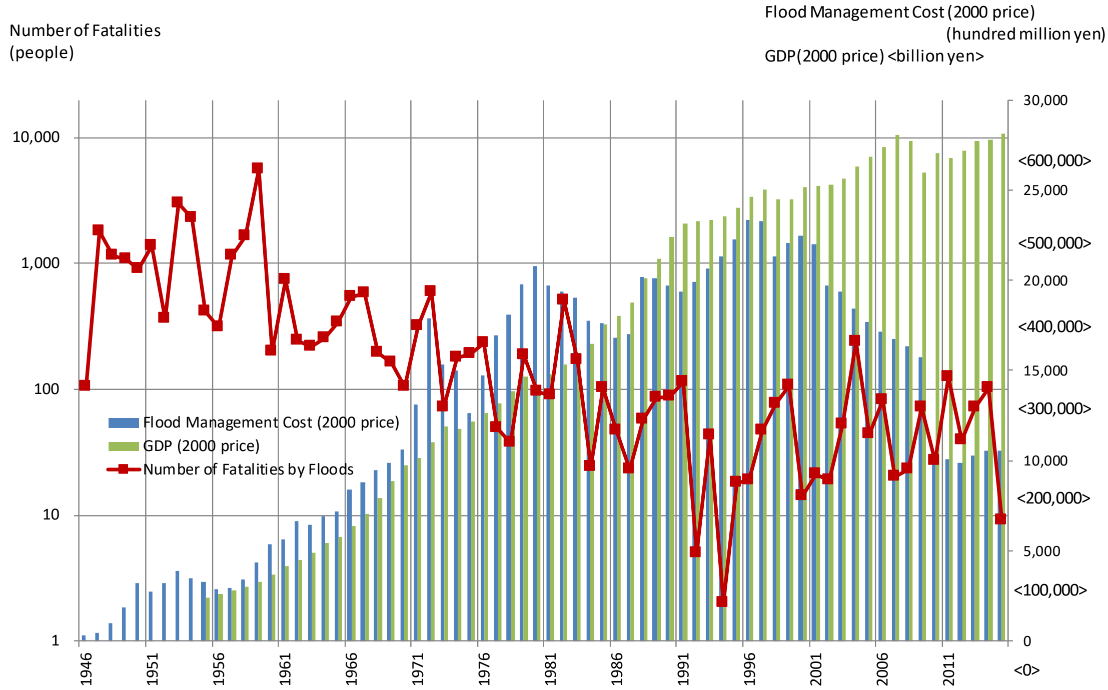


Source: White Paper on Disaster Management, Annex 33

Figure 4.7.20 Japan's Annual DRR Budget and Its Share of the General Account Budget

The figure below shows the secular variation in Japan's flood control project costs, GDP, and the number of deaths due to floods, according to a survey by the Ministry of Land, Infrastructure, Transport and Tourism. From this figure, it can be seen that the number of deaths due to floods has decreased significantly each year as a result of continuous flood control projects since the end of the war. In the ten-odd years immediately after World War II, around 1000 casualties were reported every year, but the number of deaths had decreased since then, and by around 1990, the number of casualties fell below 100, and it will decrease to 10 levels. However, since around 2000, the cost of flood control projects has been on a downward trend, and the number of deaths due to floods has not decreased, and about 10 to 100 casualties have been reported.

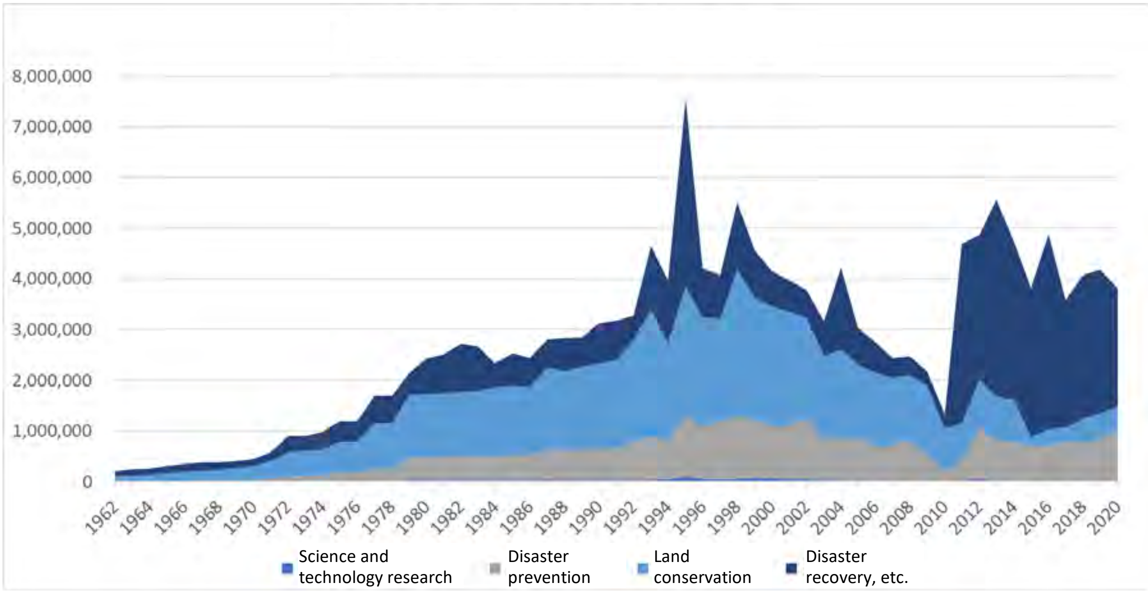
In this way, even if the population in the assumed inundation area increases along with the rapid increase in the population along with the economic development, the number of victims can be significantly reduced by expanding or maintaining the flood control project cost every year. However, in the recent era of low growth for about 20 years, the cost of flood control projects has decreased, and the decreasing trend of the number of deaths has stopped due to the increase of heavy rains and intensified typhoons that are thought to be the effects of climate change.



Source: Report on measures to promote mainstreaming disaster risk reduction based on the latest international trends, March 2018, MLIT, Japan

Figure 4.7.21 Flood Deaths, GDP and Hydraulic Project Costs (in 2000 price)

In addition, the following figure shows the transition of the breakdown of Japan's annual DRR budget into four categories: 1) science and technology research, 2) disaster prevention, 3) national land conservation, and 4) disaster recovery. 1) to 3) are positioned as a prior investment for DRR. In the years when a major disaster occurs, the budget for disaster recovery increases and the ratio of prior investment decreases, but it can be said that the average ratio up to 2010 is about 80%. Since 2011, when the Great East Japan Earthquake struck, project cost for reconstruction has increased significantly, so the ratio of prior investment to the DRR budget is 30-40%.



Source: JICA Survey Team drawing with the data in White Paper on Disaster Management, Annex 33

Figure 4.7.22 Japan's Annual DRR Budget (Breakdown)

According to the results of a survey on the budget allocation (investment ratio) to the central government's pre- and post-measures in the field of DRR from the country-specific progress report summarizing the achievement status of the implementation of the five HFA priorities up to 2015, of the 136 countries that submitted the report, only 36 countries had traceable budget allocation data and responded, with an average of 44% for proactive measures and 56% for post-measures[41].

(2) Examples of Japan's Efforts in Infrastructure Development (Embankment Development)

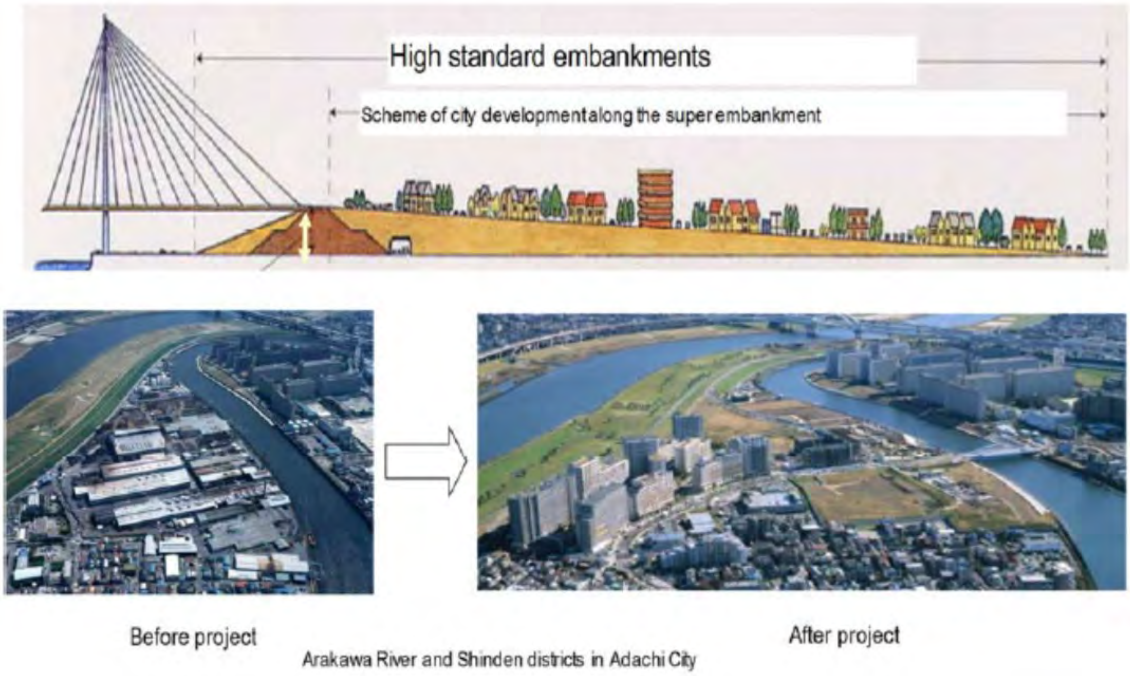
Although it is different from the efforts during the period of rapid economic development in Japan, as an example of efficient efforts to promote infrastructure development, cooperation with other sectors and the private sector is shown below.

1) Embankment Maintenance in Collaboration with Other Sectors

Super levee (high standard embankment) is being constructed in some sections of rivers that flow around large cities in Japan.

The super levee project jointly implements river projects and private development (urban / housing projects), leading to a reduction in project costs by the central government. Furthermore, with the conversion of land use, it is expected that the disaster risk reduction of densely populated urban areas will be improved and the urban functions will be improved by reorganizing the urban areas, such as improving the urban environment. For example, as shown in Figure 4.7.23, when redeveloping the area along the levee where factories used to be located, as a private enterprise, levee will be made into a super levee to reduce the risk of flooding. At the same time, it is possible to improve the living environment through the construction of collective housing and to develop various facilities such as parks and public facilities to improve the living environment in an integrated manner, thereby enhancing the urban functions of the development area.

[41] Source: Report on measures to promote mainstreaming disaster risk reduction based on the latest international trends, March 2018, MLIT, Japan

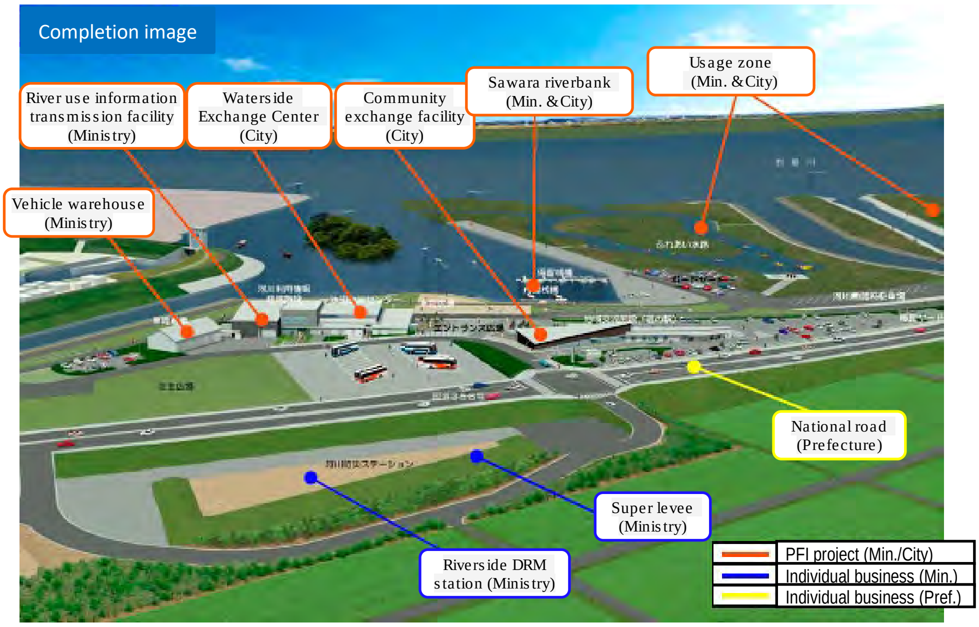


Source: MLIT, Japan

Figure 4.7.23 Development of Super Levee (High Standard Embankment) in Collaboration with Other Sectors

2) Utilization of Private Funds in Infrastructure Development

In the Sawara district on the right bank of the lower reaches of the Tone River, a wide-area exchange base as a disaster prevention base, waterside utilization base, cultural exchange base, and transportation base was established on the high-standard embankment of the river as the first PFI project in the river project under the direct control of the country. The Private business operator has been carrying out maintenance and operation for 15 years since 2010.



Source: MLIT, Japan

Figure 4.7.24 Example of Utilization of Private Funds in Infrastructure Development (Sawara Wide Area Exchange Center PFI Project)

4.7.6.2 Infrastructure Development and DRR Measures in the Philippines

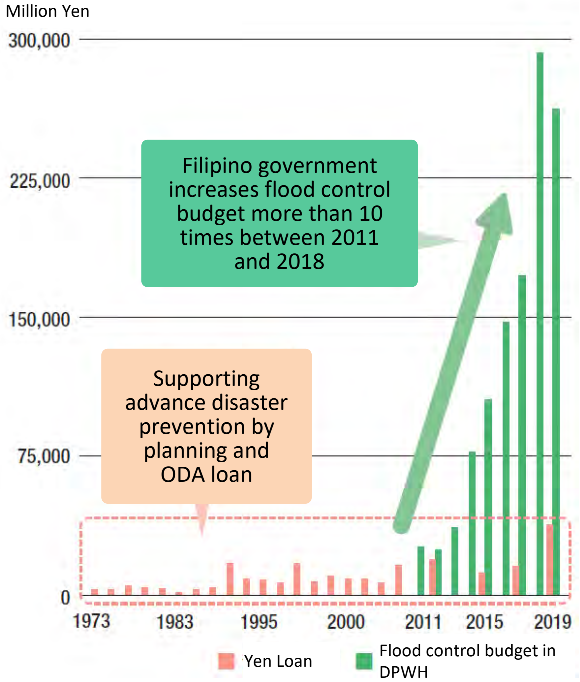
In the wake of a major disaster that occurred in recent years, the efforts in the Philippines that are actively promoting measures to reduce disaster risks, such as promoting infrastructure development and prior investment for disaster risk reduction, are summarized below.

(1) Prior Investment in Infrastructure Development and DRR

In the World Risk Index, which ranked the risks of natural disasters around the world released in 2018, the Philippines was ranked as the third highest risk in the world. Between 2005 and 2014, a total of 75 million people were affected by natural disasters in the country.

In the recovery and reconstruction of the disaster caused by the typhoon Haiyan that hit the Philippines in 2013, JICA aimed to build a more disaster-resistant society in preparation for the next disaster based on Japan's experience (Build Back Better), and it was encouraged and reflected in the Philippines' reconstruction policy. It is also said that understanding the need for prior investment has been progressing.

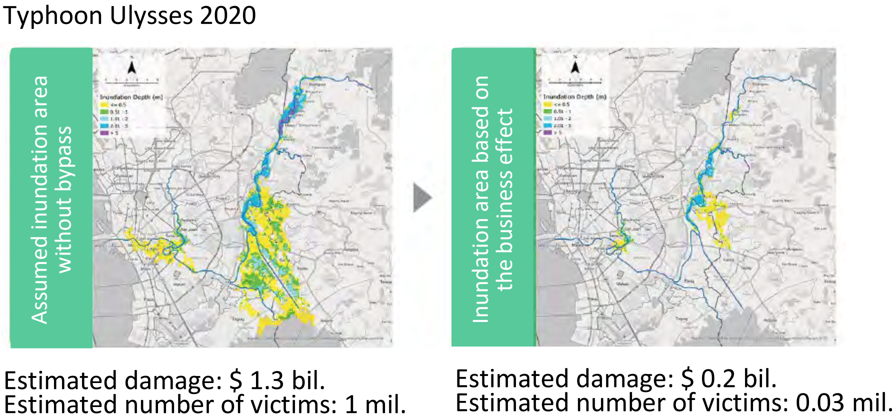
It was President Benigno Aquino at the time who understood the importance of disaster prevention seriously and took action. After that, the Duterte administration, which was inaugurated in 2016, announced the comprehensive socio-economic guideline "Duterte Nomics" consisting of 10 items such as macroeconomic policy, tax reform, national land conservation, and human resource development. In particular, the "Build-Build-Build Infrastructure Plan" was formulated to eradicate poverty, and economic growth, and to eliminate congestion in Metro Manila. The plan has more than doubled its infrastructure investment over the last 50 years from 2.4% of its GDP to 5.4%. Understanding that prior investment as a disaster prevention measure is efficient, the disaster risk reduction budget from 2017 to 2022 has been quintupled, and efforts are being made to prevent disasters in advance.



Source: JICA Global Agenda 20, 20 business strategies to tackle the challenges of developing countries, Disaster risk reduction through disaster prevention and reconstruction

Figure 4.7.25 Changes in the Amount of Prior DRR Investment in the Philippines

The Mangahan Flood Bypass, which was constructed with the cooperation of JICA, has greatly reduced flood damage in central Manila and has become the cornerstone of subsequent urban development. The typhoon Ulysses that occurred in 2020 also suffered great damage in the Philippines, but it is estimated that the damage expected by the construction of the Mangahan Flood Bypass in central Manila could be reduced by about 85%.



Source: JICA Global Agenda 20, 20 business strategies to tackle the challenges of developing countries, Disaster risk reduction through disaster prevention and reconstruction

Figure 4.7.26 Estimated Effect of Mangahan Flood Bypass for 2020 Typhoon Ulysses

In developing these infrastructures, the previous Aquino administration was trying to focus on PPP using private funds to reduce the financial burden, while the Duterte administration uses both public investment funded by the government and loans from ODA, shifting the focus to the hybrid system. In addition to continuing support from Japan, the United States, Australia, etc., which are the largest support countries, the Philippines also receives support from China[42].

(2) Disaster Risk Management Budget Measures by Local Governments

The central governments of many countries have budgetary measures and DRR funds that can be implemented promptly in the event of a disaster, but the countries in which local governments have them are limited, one of which is the Philippines.

In the Philippines, the National Disaster Risk Reduction and Management Framework (NDRRMF) is established at the national level, and the Local Disaster Risk Reduction and Management Framework (LDRRMF) is established at the local level. 30% of each can be used in the event of a disaster, and the remaining 70% can be used for disaster risk reduction and management activities other than in the event of a disaster. With regard to LDRRMF, 5% or more of the annual budget of each local government (LGU) is to be allocated, and in using it, it is essential to formulate and align with the local government disaster risk reduction and management plan (LDRRMP).

However, in reality, most of the NDRRMF is used for recovery costs for major disasters such as typhoon Yolanda. In addition, many LDRRMFs are mainly LGUs whose budgets are not large, and many LGUs are prepared for a post-disaster response without using LDRRMF as a proactive measure[43].

(3) Private Sector Involvement in Disaster Risk Management

In response to growing awareness that disaster risk endangers not only the community but also businesses and markets within the community, actions are being taken to reduce disaster risk in the private sector as well. Companies are moving beyond traditional corporate social responsibility (CSR) activities to support local disaster risk mitigation measures through their own schemes or dedicated community organizations. Among the developing countries in the Asia-Pacific region, the Philippines

[42] Source: IDI Information, November 2019 (in Japanese) (http://www.idi.or.jp/wp/wp-content/uploads/2019/12/201911_875.pdf)
[43] Source: Financing Disaster Risk Reduction in Asia and the Pacific, A Guide for Policy Makers, December 2020, ADB

is one of the countries where the private sector is highly involved in disaster risk management.

For example, the Philippine Business for Social Progress, a non-governmental organization led by a company, provides financial support to disaster victims. It also provides dedicated disaster risk mitigation and management relief support under an environmental program that promotes post-disaster recovery and response initiatives. Meanwhile, the Philippine Disaster Recovery Foundation has launched the first National Private Sector Emergency Operations Center to coordinate and build capacity for disaster prevention, mitigation, preparation, response, recovery, and rehabilitation activities. It also has a dedicated knowledge and learning resource center that promotes areas of resilience to build business continuity management, disaster risk mitigation, and climate change adaptation[44].

4.7.6.3 Lessons Learned from the Cases of Japan and the Philippines

Based on the above review, lessons learned from past DRR policies and measures in Japan and the Philippines are that "strong promotion of DRR investment" and "build back better after the disaster" has made a significant contribution to supporting economic growth.

In addition to them, it is confirmed that Japan and the Philippines have introduced efficient mechanisms to promote investment in DRR through "budgetary measures in local governments" and "collaboration with the private sector. Based on these cases and in light of the current situation in Bangladesh, points to be considered in DRR policies and measures that should be promoted in the future are summarized in the table below.

Table 4.7.16 Points to be Considered in DRR Policies and Measures in Bangladesh Based on the Case Studies of Other Countries

Items	Points to be Considered in DRR Investment Based on the Case Studies and the Current Situation in Bangladesh
Strong promotion of DRR investment	In Japan, large pre-investment budgets have been continuously maintained over a long period of time. In addition, when major floods have occurred and caused extensive damage, Japan has responded by revising its flood management plans and implementing measures such as river improvement, dams, retarding basins, and other necessary measures with the necessary budgets secured regularly. This has contributed greatly to economic development by increasing the resilience of the region and significantly reducing damage and deaths from flooding. In recent years, the Philippines has adopted a hybrid approach that combines public investment and ODA loans. It continues to focus on DRR investment by significantly extending its own infrastructure development budget while continuing yen loans in a long run. On the other hand, the concept of disaster management that accepts a certain scale of damage based on coexistence with floods has been the mainstream in Bangladesh so far. Therefore, efforts to prevent damage through pre-disaster investment and to strengthen post-disaster resilience have not progressed sufficiently at present. Since budgetary constraints are a major factor in this situation, it is considered important for Bangladesh, as in the Philippines, to utilize financial cooperation from foreign governments, including yen loans, to support continued investment in DRR for the time being. In order to promote DRR investment, it is also important to further deepen the understanding of the economic benefits of prior investment among decision-makers in projects and policies. Furthermore, it is desirable to establish examples of regions that have developed successfully due to the protection of economic activities brought about by prior investment.
Budgetary measures in local governments	In the Philippines, there is a provision in local budgets for a percentage of the total amount to be used for specific purposes, whereas in Bangladesh there is currently no such provision. It is important to fully incorporate the concept of prior investment in the development of DRR planning and to reflect it in local government budget planning. On the other hand, even if the importance of prior investment is understood conceptually, in practice, local governments cannot be expected to significantly increase the share of their budgets for prior investment by updating their plans and regulations only, due to severe budgetary constraints. Relevant government agencies must establish and promote technologies that can reduce rehabilitation and maintenance costs for permanent disasters, especially water-related disasters, in cooperation with international organizations.

[44] Source: Financing Disaster Risk Reduction in Asia and the Pacific, A Guide for Policy Makers, December 2020, ADB

Collaboration with private sector	In Japan, joint implementation of private sector development (urban and housing projects) has reduced central government project costs and improved the efficiency of infrastructure maintenance and management costs through the use of private sector funds. In the Philippines, there is a case where the private sector has provided relief assistance and established an emergency operation center. In order to promote similar activities in Bangladesh, the government and the private sector must share the awareness that disaster risk reduction and management is not only economically advantageous in the long term but also has various advantages in terms of improving the corporate brand image. Possible measures include the provision of subsidies from the government to the private sector and active information dissemination on the understanding of DRR.

Source: JICA Survey Team

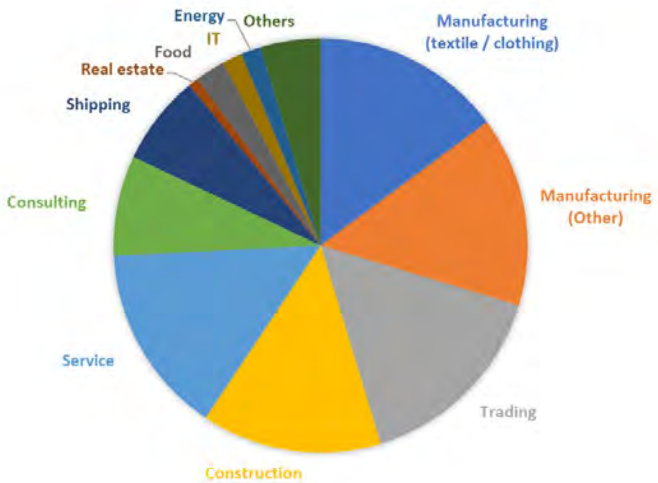
4.7.7 Issues for Japanese Companies Expanding into Bangladesh

From the results of a questionnaire survey for Japanese companies expanding overseas conducted by the Japan External Trade Organization (JETRO), the problems and issues in the business environment and business operations that the companies expanding into Bangladesh were organized. The JICA Survey Team conducted interviews with the JETRO Dhaka Office, Dhaka Japan Chamber of Commerce and Industry, and several Japanese companies operating in Bangladesh to hear about the preference for selecting the location of business establishments and factories, geographically high priority areas, and expectations in the field of disaster risk management.

4.7.7.1 Trends of Japanese Companies Expanding into Bangladesh

According to a survey by the JETRO Dhaka office, there were 310 Japanese companies[45] operating in Bangladesh as of the end of December 2019. Among these companies, as of June 2022, 122 companies (including 3 special member groups) are members of the Dhaka Japan Chamber of Commerce, an organization whose members are Japanese companies operating in Bangladesh. The distribution of industry types of member companies is shown in the figure.

The manufacturing industry is the most common, and half of them are textile and clothing-related companies. Next, trading companies, construction, and services are about the same number.



Source: Prepared by JICA Survey Team based on the information from the Dhaka Japan Chamber of Commerce (https://jciad.com/)

Figure 4.7.27 Industry Distribution of Dhaka Japan Chamber of Commerce Member Companies (119 Companies Excluding 3 Special Member Groups)

According to the JETRO Dhaka office, most of the Japanese companies operating in Bangladesh are ODA-related companies (infrastructure-related), accounting for about half. In recent years, the number of companies related to product inspection and logistics is increasing. In addition, shortly before the COVID-19 pandemic, companies aiming to develop business for the market in Bangladesh have begun to enter.

45 Source: https://www.jetro.go.jp/biz/areareports/special/2020/0201/b98c26392a3bc27f.html

According to the "FY2019 JETRO Survey on Business Conditions of Japanese Companies Operating Overseas (Asia and Oceania)" in November 2019, about 70% of Japanese companies in Bangladesh answered that they would "expand their business in the future in Bangladesh." This figure is the highest among the 20 countries/regions surveyed, and the results show expectations for the future of Bangladesh. In anticipation of Bangladesh's high growth potential, many companies are highly motivated to expand their business.

4.7.7.2 Issues for Companies Expanding into Bangladesh

(1) Issues Obtained by JETRO Survey

JETRO conducts the "Survey on Business Conditions of Japanese Companies Operating Overseas (Asia and Oceania)" every year. This survey is a questionnaire survey for Japanese companies expanding into the Asia-Oceania region and summarizes the latest information on trade/overseas expansion initiatives and the business environment of each country in the region.

The 2019 survey provided findings on the challenges of the business environment in each country. The results are shown in Table 4.7.17. The number of responding companies in Bangladesh is smaller than in other countries, but half or more of the companies in Bangladesh responded the issues such as "Infrastructure (electricity, transportation, telecommunications, etc.) is underdeveloped", and "There is a problem on political risk, social situation and security", " and "The legal system is underdeveloped and there is a problem in operation". In particular, 10 out of 11 companies cited the issue of "Underdeveloped infrastructure (electric power, transportation, communications, etc.)".

27.3% of the companies cited the issue of "Problems with natural disaster risk or environmental pollution", which is a little lower than the above three issues, but this ratio is the highest among the target countries along with Myanmar. Compared to other Asian countries, it can be said that Japanese companies have anxiety about natural disaster risks or environmental pollution in developing their business.

Table 4.7.17 Problems and Issues in Business Environment in Each Country

Country	No. of companies responded	Money order	Trading partner		Labor force		Infrastructure	Procedures / Systems				Politics / Society			None
		High foreign exchange risk	Related industries are not concentrated and developed	Risks and problems in collecting payment	Labor costs are high and rising	Labor shortage / difficulty in hiring appropriate human resources	Infrastructure (electric power, transportation,	Underdeveloped legal system and problems in operation	Problem in protecting intellectual property rights	Complicated tax system and tax procedures	Complicated administrative procedures	Problems with political risks, social conditions, and security	Problems with natural disaster risk or environmental pollution	Others	Not aware of any particular risks / problems
China	2,123	14.9	1.2	35.0	37.8	8.6	3.3	18.5	40.7	18.5	28.7	42.9	12.8	1.9	5.0
Taiwan	1,005	4.8	2.1	6.9	12.2	3.3	0.4	1.9	4.4	3.3	6.8	13.5	4.3	1.8	46.3
South Korea	849	9.4	0.8	8.6	11.5	3.4	0.1	4.8	9.5	2.8	6.9	61.2	1.9	4.5	14.6
Singapore	737	3.4	2.7	5.4	30.3	9.2	0.3	0.7	1.1	2.2	3.1	2.0	0.3	1.4	51.7
Thailand	1,002	10.1	2.3	10.0	23.6	10.3	5.4	7.1	4.4	7.0	11.8	18.2	11.5	1.6	31.6
Indonesia	797	16.3	7.8	17.7	12.3	4.1	22.6	19.4	6.0	14.6	21.8	22.3	16.1	1.3	26.0
Philippines	588	8.7	11.4	19.2	6.8	2.6	24.0	12.2	6.5	7.7	11.6	27.6	15.1	0.5	28.6
Vietnam	1,107	8.5	10.7	18.5	15.3	7.7	20.0	19.8	8.0	13.9	22.4	9.4	6.3	1.4	25.4
India	629	11.1	9.4	27.0	5.4	4.0	32.0	21.0	10.2	19.2	24.0	20.3	183	2.5	21.1
Myanmar	47	34.0	19.1	25.5	6.4	10.6	72.3	63.8	21.3	29.8	51.1	55.3	25.5	2.1	0.0
Malaysia	34	5.9	8.8	8.8	26.5	23.5	2.9	8.8	0.0	17.6	11.8	2.9	2.9	2.9	38.2
Hong Kong	24	0.0	0.0	4.2	12.5	9.4	0.0	0.0	0.0	6.3	21.9	3.1	0.0	6.3	37.5
Bangladesh	11	9.1	18.2	36.4	0.0	9.1	90.0	45.5	18.2	27.3	18.2	63.6	27.3	0.0	0.0

■ : Issues with a response ratio of 25% or more

Source: "FY2019 JETRO Survey on Business Conditions of Japanese Companies Operating Overseas (Asia and Oceania), JETRO

In this survey, management issues are also investigated every year. Looking at the results for the last three or four years, the following points are listed as the top management issues faced by Japanese companies operating in Bangladesh.

- ✓ Difficulty in local procurement of raw materials and parts
- ✓ Customs clearance takes time
- ✓ Power shortage/power outage
- ✓ Undeveloped logistics infrastructure
- ✓ Employee quality

Although the ranking of the response ratio varies from year to year, the issues shown above are ranked high every year. Recently, an increasing number of companies have answered not only the issue of "Employee quality" but also the issue of "Increase in employee wage".

Among the problems raised here, it can be seen that underdeveloped economic infrastructure, such as "Power shortage/power outage" and "Undeveloped logistics infrastructure," are also regarded as major management issues.

(2) Issues Obtained by the Survey of the Japan Business Council for Trade and Investment Facilitation

The Japan Business Council for Trade and Investment Facilitation (JBCTIF) has surveyed for Japanese private companies in the same way as the JETRO survey. This survey also summarizes the issues of operating a business in Bangladesh.

JBCTIF is a consultative body consisting of Japanese industrial groups and companies established in April 1997 and examines various issues related to trade and foreign direct investment that Japanese companies face in their overseas business activities. Furthermore, JBCTIF summarizes the opinions of the Japanese industry and requests the Japanese and foreign governments to improve their trade and investment systems. The Japan Machinery Center for Trade and Investment (JMC) serves as the secretariat.

From the results of the "Questionnaire survey on trade, investment, and local production problems" conducted by JBCTIF in 2021, the following points were pointed out as trade and investment problems in Bangladesh, such as underdeveloped logistics infrastructure:

Underdeveloped logistics infrastructure: Due to the underdeveloped port of Chattogram, large cargo ships cannot enter the port, and cargo from East Asia is forced to be transshipped to Singapore. In addition, due to low port cargo handling capacity, it takes two weeks for imported raw materials to arrive at the shipping destination after the ship arrives.

Severe traffic congestion: Severe traffic congestion in urban areas has forced inefficient operations and schedules, which is a hindrance to investment for foreign companies.

Short delivery time has become a global trend, and these shortcomings above can hinder the growth of sewn product exports, which are the most important export item. It is necessary to urge the Bangladesh government to urgently develop the necessary infrastructure.

In this way, as in the JETRO survey, underdeveloped logistics infrastructure is considered to be the biggest issue in business development in Bangladesh.

4.7.7.3 Interviews with Japanese Companies

Interviews were held with the Japan External Trade Organization (JETRO) Dhaka Office, the Dhaka Japan Chamber of Commerce and Industry, and Japanese companies operating locally. In the interviews, opinions were heard on the taste of location selection, such as factories, geographically high priority areas, and expectations in the disaster prevention field.

Interviews with JETRO Dhaka Office, Dhaka Japan Chamber of Commerce and Industry, and Japanese companies operating locally. In the interviews, opinions were heard on the preference of location selection of offices or factories, geographically high priority areas, and expectations in the field of disaster risk management.

(1) Preference for Selecting Location of Business Establishments and Factories

According to the hearing at the JETRO Dhaka office, many Japanese companies considering expanding into Bangladesh are worried about the land developed by Bangladesh regarding the ground strength and infrastructure safety. For companies that like to secure large-scale land for the construction of factories, they prefer to be located in economic zones or export processing zones, which can provide sufficient land, basic infrastructure, and tax incentives. It seems that economic zones and export processing zones are considered to have taken some measures against disaster risks such as floods.

There is a great deal of interest in the Bangladesh Special Economic Zone (BSEZ), which is currently under development east of Dhaka with the support of Japan. All the lots of the existing economic zones and export processing zones near Dhaka are occupied, so there is no choice but to BSEZ.

The companies that set up and operate the factories pointed out the following points as reasons for selecting the location.

- The location of the factory was decided in 1991 in the Dhaka Export Processing Zone. The reason is that it is convenient for overseas exports, and the export processing zone receives preferential treatment for taxes, which is advantageous for overseas investors. The factory started operation in 2002, but it has not been checked for disaster risk in particular. It might be considered that the minimum checks have been made because it was an export processing zone. In fact, there is no experience of disaster in and around the factories.
- No new selection has been made because the operation started at the factory owned by the local partner company. A basic survey was conducted on the location, but no problem with disaster risk was reported. At that time, the situation of flood inundation was confirmed, but no particular confirmation was made regarding the earthquake. There have been no floods in the area for the past 30 years.

On the other hand, the JETRO Dhaka office pointed out that it would be beneficial for companies wishing to enter the market to obtain information on infrastructure and the status of disaster prevention measures inside and outside economic zones and export processing zones. There should be a need to know what the expected disaster risks and disaster risk reduction plans and initiatives are in each economic zone and export processing zone.

Most of the Japanese companies operating in Bangladesh have offices and sales offices in one area of office buildings and condominiums in the center of Dhaka where the population is concentrated. Therefore, in interviews with such companies, awareness of the risk of floods and inundation is low, and there is no experience of actual damage. On the other hand, although awareness of the risk of earthquakes is relatively high, the scale and frequency of earthquakes experienced in the past do not mean that there is concern about the risk of earthquake disasters. Business establishments that have offices in office buildings and condominiums are worried about the outbreak of fire and evacuation in the event of a fire. It seems that the anti-theft measures have been emphasized and the buildings are often surrounded by iron bars and there is only one exit from the building in Bangladesh. It is likely to be an obstacle when an evacuation is required in the event of a fire.

<Development of the Bangladesh Special Economic Zone (BSEZ)>

Sumitomo Corporation, a Japanese trading company, has signed a joint venture agreement with the Bangladesh Economic Zone Agency (BEZA) for the development of the "Bangladesh Special Economic Zone" (BSEZ) in 2019.

BSEZ is located about 20 km east of the center of Dhaka. Construction began in August 2020, and landfill construction was first carried out to prevent damage caused by floods by utilizing the ODA loan. From November 2021, infrastructure development work started in the area of 83ha of the advanced development area out of the total development area of about 190ha, and sales of the advanced development area has started in March 2022.

The BSEZ site is surrounded by a 5.5m high (+ 8.0m above sea level) embankment, which protects it from floods that occur in the surrounding area. BSEZ is Bangladesh's first special economic zone with world-class infrastructure developed by Japanese companies.

Figure 4.7.28 Landfill in the BSEZ Development Site

Source: JETRO https://www.jetro.go.jp/biz/areareports/2021/cd072b90aa735644.html, https://www.jetro.go.jp/biznews/2022/03/aa601ae6777faf3c.html

(2) Geographically High Priority Area

According to the hearing at the JETRO Dhaka office, many companies prefer Dhaka and its suburbs from the viewpoint of logistics access, followed by the Chattogram area where the port is located. Other districts are in a disadvantageous situation due to the lack of road development, and the logistics infrastructure must be in place. The main logistics route is land transportation between Dhaka and Chattogram, and sea transportation from Chattogram. The depth of the river is not sufficiently secured, large ships cannot enter Dhaka, and the Chattogram port is used for most of the sea transportation.

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(3) Desired DRR Measures

In interviews with companies operating in Bangladesh, opinions were heard on measures that should be strengthened and expanded in the field of disaster prevention, which should be implemented by the government in Bangladesh. In hearing the opinions, the following measures were presented as options.

Disaster prevention measures that should be strengthened and expanded by the government in terms of business operations (options):

i. Infrastructure development and strengthening to reduce flood damage (river embankment maintenance, riverbank erosion prevention, drainage channel maintenance, drainage pump reinforcement, etc.)

ii. Improvement of transportation infrastructure and enhancement of safety (road maintenance, securing of a road network that can be used in an emergency, etc.)

iii. Promotion of earthquake resistance of private buildings (cost subsidy, etc.)

iv. Promotion of flood control measures for private buildings (flood control measures, etc.)

v. Providing forecasts, warnings, etc. at appropriate timing

vi. Securing safe evacuation areas (including disseminating information on evacuation shelters and promoting stockpiling)

vii. Quick recovery/reconstruction after the disaster

viii. Implementation of drills by the government, promotion of cooperation with residents and companies

ix. Others

None of the companies interviewed this time had any experience of being damaged by a disaster in the past, and the disaster had almost no impact on their businesses. Although awareness of disaster risk is not high, many of the above options emphasize "ii. Improvement of transportation infrastructure and enhancement of safety". It can be said that there is a need for measures related to the "underdeveloped logistics infrastructure" pointed out in the questionnaire survey on business environment and management problems for companies expanding into Bangladesh. Not only expectations for the development of large-scale infrastructure such as roads and harbors, but also emergency response and fire extinguishing in the event of a disaster in a situation where traffic congestion occurs on a daily basis in urban areas. It seems that there is a great deal of anxiety about delays in response.

One of the companies interviewed expressed expectations for ii, iii, iv, v, vi, and vii among the above options, and in particular, "iii. Promotion of earthquake resistance of private buildings" and "vii. Quick recovery/reconstruction after the disaster". Recovery/reconstruction was mentioned as the most necessary measure. The factory of this company was built by a Japanese construction company in accordance with Japanese building standards, and its safety against earthquakes is extremely high. In general, the frequency of earthquakes is low, and it cannot be said that awareness of earthquake disaster risk is high in Bangladesh, but expectations for earthquake resistance measures for buildings may increase as the population concentrates in urban areas and cities expand. On the other hand, although we recognize the need to strengthen earthquake countermeasures, for example, even if we promote earthquake resistance of buildings since there is no public assistance system, as an individual (business owner), we can hardly pay for the countermeasures. It was also pointed out that it is necessary to introduce a subsidy system in consideration of future economic development.

On the other hand, the following points were also pointed out. Although we recognize the need to strengthen earthquake countermeasures, for example, even if we promote earthquake resistance of buildings, since there is no public assistance system, individuals (business owners) cannot afford to pay and countermeasures hardly proceed. Considering future economic development, it is necessary to introduce a subsidy system.

(4) Expectations for Japan's Support

Expectations for support from Japan include earthquake countermeasures and the development and improvement of drainage systems in urban areas. Although the scale of disasters such as storm surges caused by cyclones is large, it is recognized that support from Japan has been promoted so far, and it can be said that support for disaster risk reduction by other disasters is required.

Awareness of the risk of earthquake disasters is still low, but as the population growth and concentration in urban areas such as Dhaka and Chattogram accelerate in the future, as the economy develops, urban congestion and the risk of earthquake disasters are very likely to increase.

In connection with earthquake disasters, it is also desired to strengthen measures against fires, especially in urban areas. In addition to fire countermeasures for buildings, measures that lead to the reliable implementation of safe and appropriate emergency responses, such as the development of road networks, are required.

All of the companies interviewed are expanding their businesses in urban areas, and although there are requests for the development of drainage systems in urban areas, there were no requests for strengthening responses to river floods. In urban areas, roads are frequently flooded due to poor drainage in some areas, leading to worsening traffic congestion and affecting businesses. There is also a great demand for the prevention of road flooding that occurs frequently.

In addition to the above, as a disaster prevention issue in Bangladesh. Some companies mentioned measures against flash floods in the north and the dredging of rivers. In particular, flash floods in the north occur almost every year, and in June 2022, heavy rains over several days caused great damage. Also, in northern Bangladesh, there are many rivers flowing from India, and many dams are being constructed upstream of India. There was also concern that if a large amount of water was suddenly released from these dams during heavy rains, the impact on Bangladesh downstream would be great.

In addition to the above, some companies cited measures against flash floods in the north and dredging of rivers as disaster prevention issues in Bangladesh. In particular, flash floods in the north occur almost every year, and in June 2022, heavy rains over several days caused great damage. Also, in northern Bangladesh, there are many rivers flowing from India, and many dams are constructed upstream of India. There is another concern that if a large amount of water were suddenly released from these dams during heavy rains, the impact on Bangladesh downstream would be great.

4.7.7.4 Issues Obtained from Interviews with Japanese Companies

Against the background of the rapid economic development of Bangladesh in recent years, companies that have already expanded into Bangladesh are highly motivated to expand their business in the future, and the number of companies aiming to develop business for domestic demand in Bangladesh is increasing. The issues obtained from the results of the above interviews with Japanese companies and related surveys are summarized as follows:

Table 4.7.18 Issues and Needs Obtained from Interviews with Japanese Companies

Category	Issues / Needs
Underdeveloped logistics infrastructure and serious traffic congestion	According to a questionnaire survey of Japanese companies expanding overseas, many Japanese companies expanding into Bangladesh said, "Infrastructure (electricity, transportation, telecommunications, etc.) is underdeveloped" and "There are problems with political risks, social conditions, and security.", and "The legal system is underdeveloped and there is a problem in operation". In a similar survey, underdeveloped logistics infrastructure and serious traffic congestion were mentioned as issues, and there are high demands for the development and improvement of economic infrastructure related to logistics.
Anxiety about natural disaster risk	In the same survey for Japanese companies expanding overseas, the percentage of companies that cited the issue of "problems with natural disaster risk or environmental pollution" in Bangladesh is higher than in other Asian countries, and there are concerns about natural disasters in terms of business development.
Lack of information on disaster risk assessment and DRR plan for economic zones	If a company aiming to develop a business for domestic demand in Bangladesh needs to secure large-scale land for setting up a factory, there is a tendency to prioritize the location in economic zones, export processing zones, etc. due to tax incentives. It is expected that disaster risk assessment and safety assurance will be ensured in these development areas. Information on infrastructure inside and outside economic zones and export processing zones and the status of disaster prevention measures would be useful for companies wishing to enter the market.
Insufficient earthquake disaster countermeasures	Awareness of the risk of earthquake disasters is still low, but as the population growth and concentration in urban areas such as Dhaka and Chattogram accelerate in the future, as the economy develops, urban congestion and the risk of earthquake disasters are very likely to increase.
Inadequate drainage system in urban areas	In urban areas, large-scale inundation damage has almost disappeared, but in some areas, roads are frequently flooded due to poor drainage, leading to worsening traffic congestion and impacting businesses. There is also a great demand for the prevention of road flooding that frequently occurs.

Source: JICA Survey Team

4.8 Summary of Issue Analysis

The issues for each field and disaster type presented in the previous sections (Sections 4.1 to 4.7) can be summarized into the directions shown in Table 4.8.1 below. In Chapter 6, further analysis will be made regarding the appropriateness and feasibility of the direction of issue solving.

The results of the organization in this section, together with the results of the risk analysis in Chapter 5, will be reflected in the draft cooperation policy and the basic ideas for the proposed short-term project concepts.

Table 4.8.1 Summary of Direction of Issue Resolution

Field or Disaster Type	Issue		Direction of Issue Solving
Strengthening DRR Governance	Secure Budget for DRR Projects and Capacity Enhancement of Relevant Organizations Unclear Segregation of Duties of Disaster Recovery Activities and Method of Securing Budget for Disaster Recovery Capacity Enhancement of the DRR Administrative Agencies Lack of DRR Functions at the Local Level Lack of Disaster Countermeasures in the Bangladesh Economic Zones		• Capacity enhancement of disaster management administrative coordination organizations • Securing funds for advance investment in risk areas • Improvement of operational structure and securing budget for the disaster recovery phase • Formulation of DRR plans for economic zones • Promotion of community participation in DRR planning and activities • Modernization of disaster information systems
River Planning, River Management, Flood Forecasting and Warning	Lack of a Basin-wide Flood Management Approach Vicious Circle in Construction, Rehabilitation, and Repair of River Structures Lack of Understanding of Future Risk Areas and Prior Investment Difficulty of Implementation of River Management Projects in Urban Areas Establishment of Effective Methodologies for River Channel Management in Large Rivers Inadequate River Management to Cope with Increasing External Forces Caused by Climate Change Difficlty of Improving Flood Forecasting System in Accuracy and Lead Time Low Accuracy of Inundation Area Prediction		• Implementation of projects based on a basin-wide comprehensive river management plan • Introduction of embankment technologies for urban rivers that require less land acquisition • Further discussion on strengthening the durability of levees and confirming the effectiveness of past pilot projects • To clarify the mechanism of river channel change and enhance approaches to prevent damage from erosion • River management responsive to changes in external forces due to climate change • Introduction of efficient river monitoring and surveying system • Automation and higher frequency of hydrological observations • Strengthening cooperation among relevant organizations in the development of geospatial information • Two-depersonalization of flood prediction systems
Urban Flooding and Inland Water Inundation	Development of Drainage Facilities that cannot Keep up with Urban Development Delays in Project Implementation and Difficulty in Securing Land Due to Land Acquisition Problems Jurisdictional Transfer of Drainage Management and Lack of Maintenance Capacity of Implementation Agency Lack of Balance in Drainage Facility Development Disharmony between Riverine Flood Control and Urban Flooding and Inland Water Inundation Countermeasures Enhancement of Dissemination and Public Awareness of Inundation Information Absence of Guidelines and Manuals for Formulating Urban Drainage Management Plans		• Implementation of flood and drainage countermeasures in large cities • Implementation of drainage management measures based on future urban development and land use plans • Strengthening maintenance and management capacity for urban drainage • Strengthening cooperation with the waste management sector • Development of drainage management planning manual
Storm Surge	Large Gaps between the Vast Areas to Be Protected from Disasters and the Insufficient Budget		• Investment in coastal development areas • Promotion and deployment of strengthening dikes

Field or Disaster Type	Issue	Direction of Issue Solving
	Bias toward Restoration and Reconstruction Projects in Storm Surge Countermeasure Projects Low Awareness of Compliance with New Storm Surge Protection Related Guidelines	● Improvement of dike construction quality
Meteorologocal Forecasting and Warning	Insufficient Ground-based Weather Observations to Issue Accurate Weather Forecasts and Warnings Insufficient Appropriate Repair and Upgrading of Weather Radars and Radar Observation Analysis Techniques Insufficient Weather Forecasting Skills	● Radar observations to supplement rainfall observation network ● Resumption of operation of aging weather radar ● Improving the capacity of officials relevant to the maintenance and management of weather observation equipment ● Promoting Understanding of Risks from Climate Change Impact ● Development of data and tools to facilitate understanding of climate change risks
Earthquake	Enhancement of Building Permit System for Securing Building Safety Understanding of Seismic Disaster Risk Improvement of Seismic Safety of Critical Structures Risk-informed Urban Planning and Infrastructure Development	● Establishment of a quality control process for new buildings ● Assess and prioritize the safety of existing buildings ● Seismic retrofitting of important public buildings

Field or Disaster Type		Issue
Cross Sectional Field	Climate Change	● Lack of Data and Information to Understand Disaster and Climate Change Risks ● Project Implementation Plans without Consideration for Disaster and Climate Change Risks
	Communication and Awareness	● Existence of the Area with Lower DRR Literacy ● Lack of Understanding of DRR Infrastructures ● Insufficiency of Information and Communication System by Government Organizations
	Vulnerable groups	● Maintenance of Shelters with Consideration for Gender and Vulnerable Groups ● Women's Participation in DRR Activities in the Community ● Establishing Implementation System to Promote DRR from a Gender Perspective ● Violence against Women and Children ● Vulnerabilities Based on Strongly Fixed Gender Roles
	DX	● Reliability of Communications Infrastructure ● Lack of Technicians at Relevant Institutions to Ensure State-of-the-art Technology and Knowledge ● Restricted Access to Data and Monitoring ● Inadequate Systems for Incorporating New Technologies and Innovations into Disaster Management Administration
	Advanced Case Studies	● Strong Promotion of DRR Investment ● Budgetary Measures in Local Governments ● Collaboration with Private Sector
	Japanese Company to Enter Bangladesh	● Underdeveloped Logistics Infrastructure and Serious Traffic Congestion ● Anxiety about Natural Disaster Risk ● Lack of Information on Disaster Risk Assessment and DRR Plan for Economic Zones ● Insufficient Earthquake Disaster Countermeasures ● Inadequate Drainage System in Urban Areas

Source: JICA Survey Team