The People's Republic of Bangladesh
Ministry of Planning

DATA COLLECTION SURVEY FOR DISASTER RISK REDUCTION AND PREVENTION IN BANGLADESH

FINAL REPORT

SUMMARY

October 2022

JAPAN INTERNATIONAL COOPERATION AGENCY

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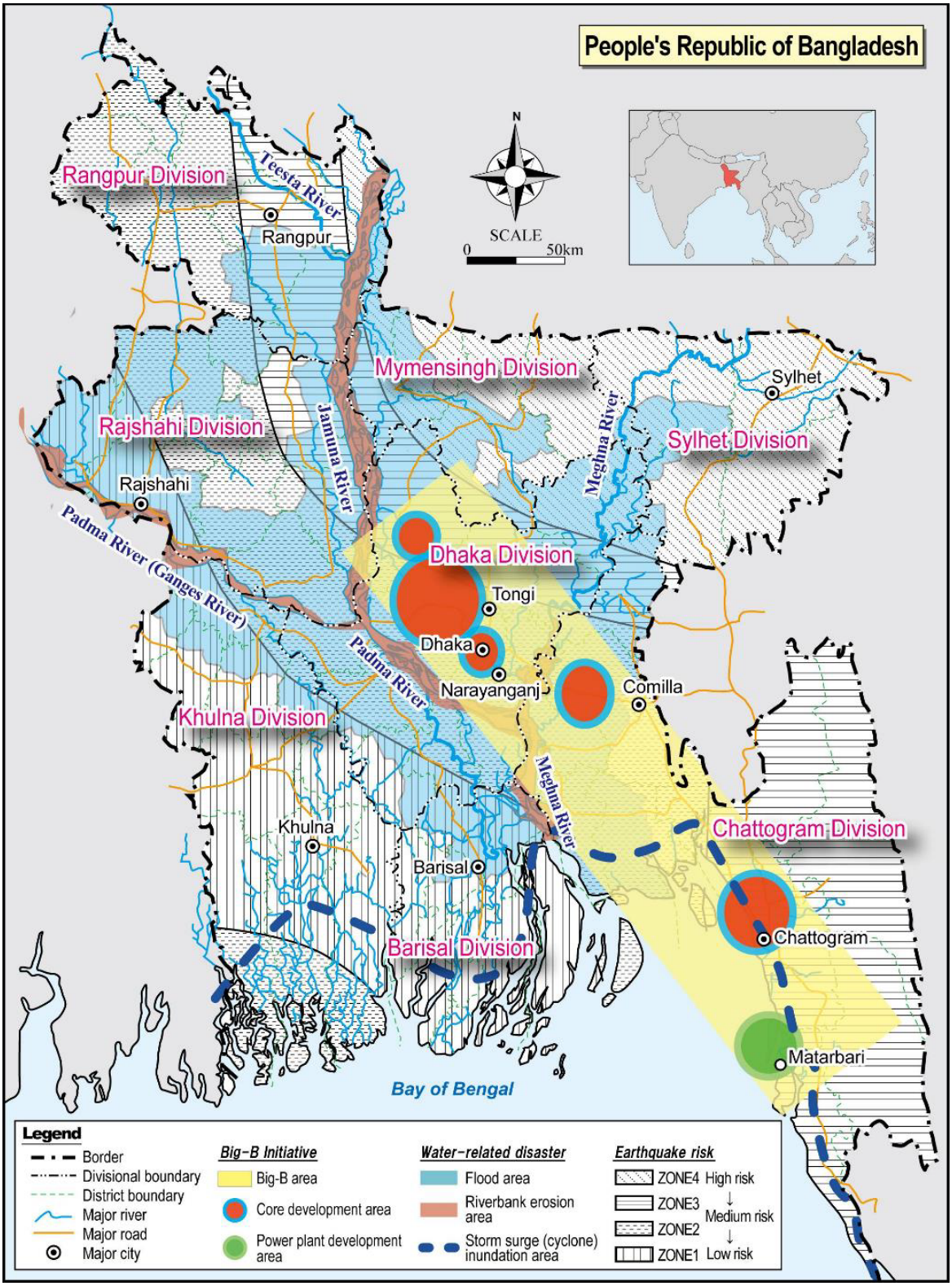

Source

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/): EM-DAT is a globally used international disaster database and is widely used as a tool for understanding past disaster occurrences. It is operated by the Centre for Research on the Epidemiology of Disasters (CRED) in Belgium and manages damage status data on approximately 22,000 major disasters that have occurred worldwide since 1900 (as of August 2022)..

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 Overview 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.

The following contents were investigated and examined according to the work flow shown in Figure 1.2.1;

Organizing and Analyzing Current Situation of the DRR Sector:

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.

Conducting Scientific and Economic Disaster Risk Analysis:

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.

Support for JICA’s Cooperation Policy Review:

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 was studied as short-term cooperation projects to be implemented over the next three to four years.

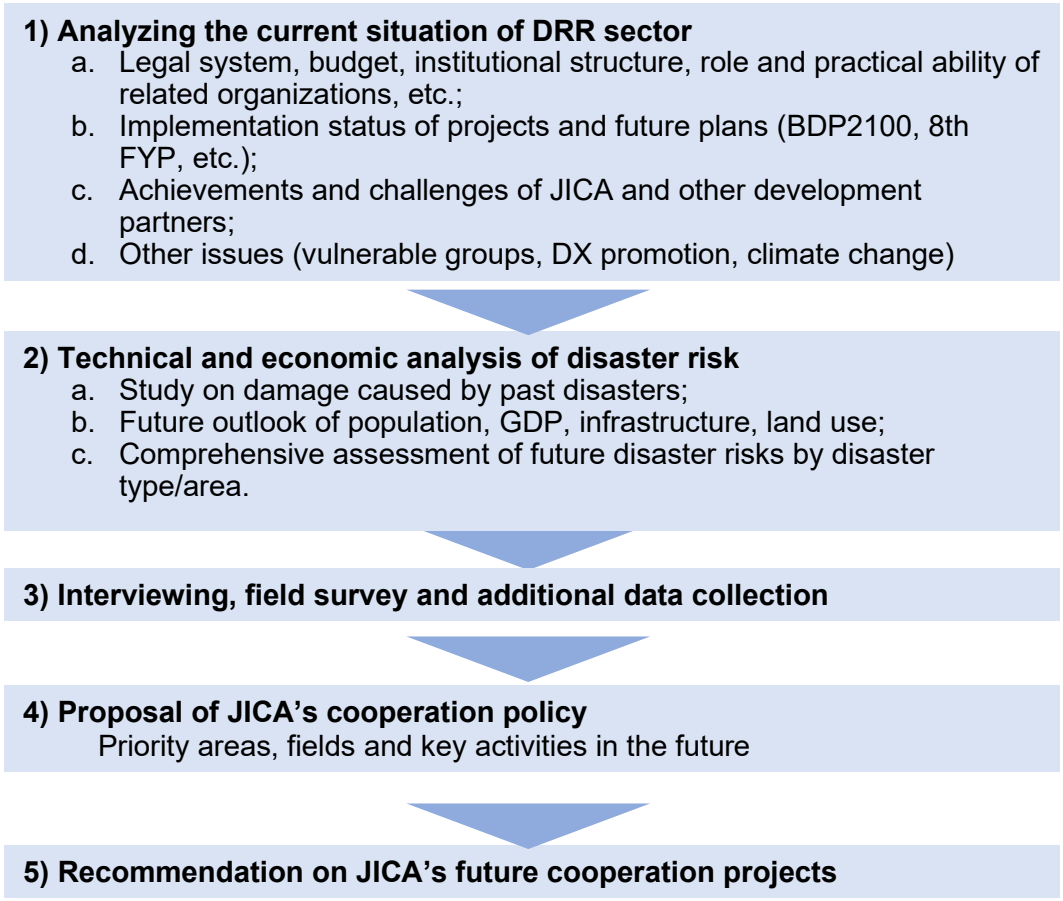


Figure 1.2.1 Work Flow of the Survey

1.2.2 Target Disaster Types

Among various natural disasters, the number of victims, damages, deaths, and outbreaks due to floods, storm surges/storms are extremely large in Bangladesh (see Chapter 3). In addition, although there has been no major damage due to the earthquake in recent years, the risk is still high, and once it occurs, great damage is expected. Regarding riverbank erosion, it is difficult to investigate the damage situation with clear figures, however, it is considered to be an area that requires continuous cooperation 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 and the expected magnitude of damage when it occurs.

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. 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].

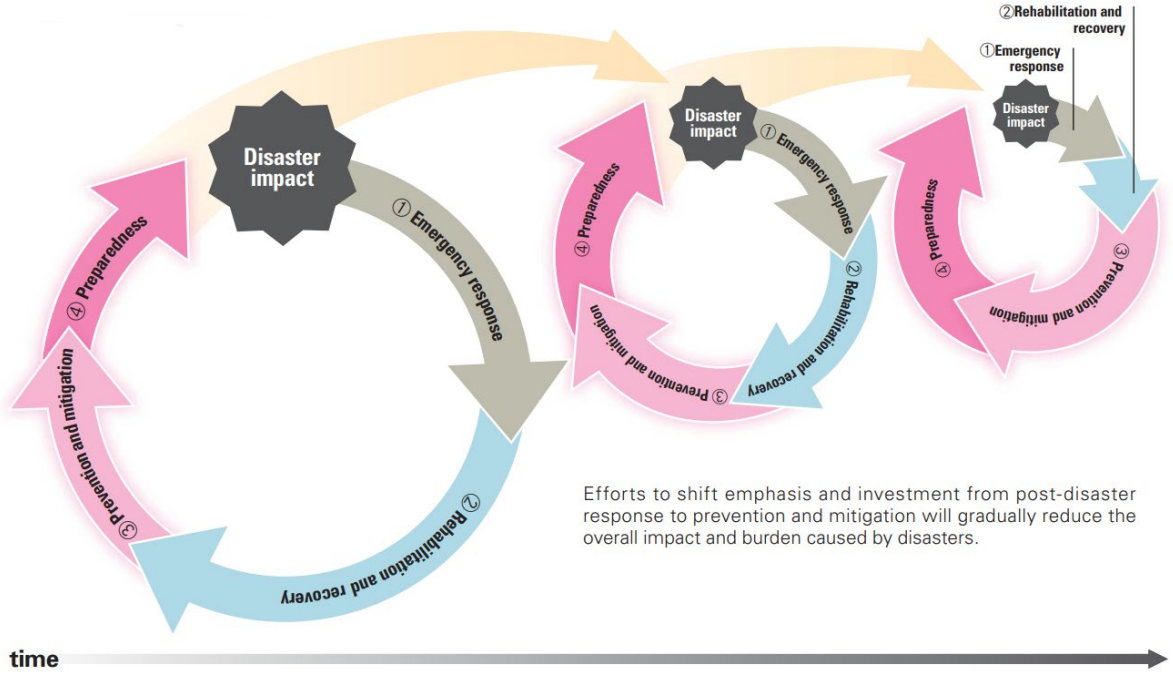
In addition to the above five disaster types, "DRR governance", which is the comprehensive and cross-sectoral management of each disaster type, and "Meteorological forecasting and warning", which is generally involved in reducing water-related disaster risks, were also included in this survey because 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.



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

Figure 1.2.2 Disaster Management Cycle

[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.

CHAPTER 2 APPROAH OF THE SURVEY

2.1 Target Area of the Survey

The survey covers the whole of Bangladesh.

2.2 Relevant Authorities and Stakeholders

Table 2.2.1 shows the relevant authorities and stakeholders where the survey team collected information and exchanged opinions in this survey. A seminar was held for the purpose of the final report for some of the following related ministries and the stakeholders.

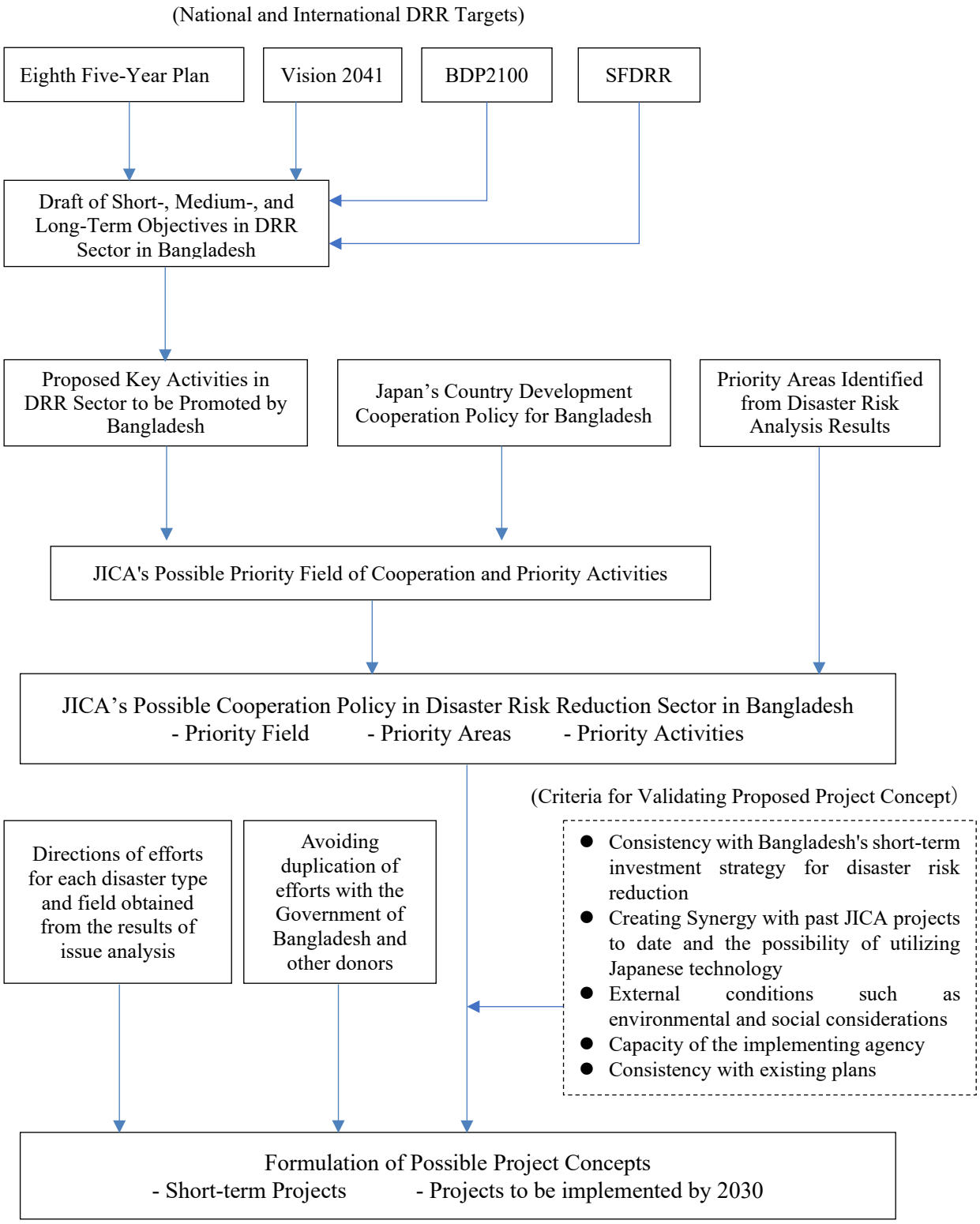
Table 2.2.1 Relevant Government Organizations and Stakeholders Involved in the Survey

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

2.3 Flow of DRR Sector Cooperation Policy Formulation

The formulation of the draft cooperation policy proceeded according to the examination flow shown in Figure 2.3.1.



Source: JICA Survey Team

Figure 2.3.1 Flow of DRR Sector Cooperation Policy Formulation

CHAPTER 3 METHODOLOGY OF DISASTER RISK ANALYSIS

3.1 Implementation Policy of Risk Analysis for Each Disaster

The implementation policy of risk analysis for each disaster type targeted in this survey is shown below.

Table 3.1.1 Implementation Policy of Risk Analysis for Each 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.)

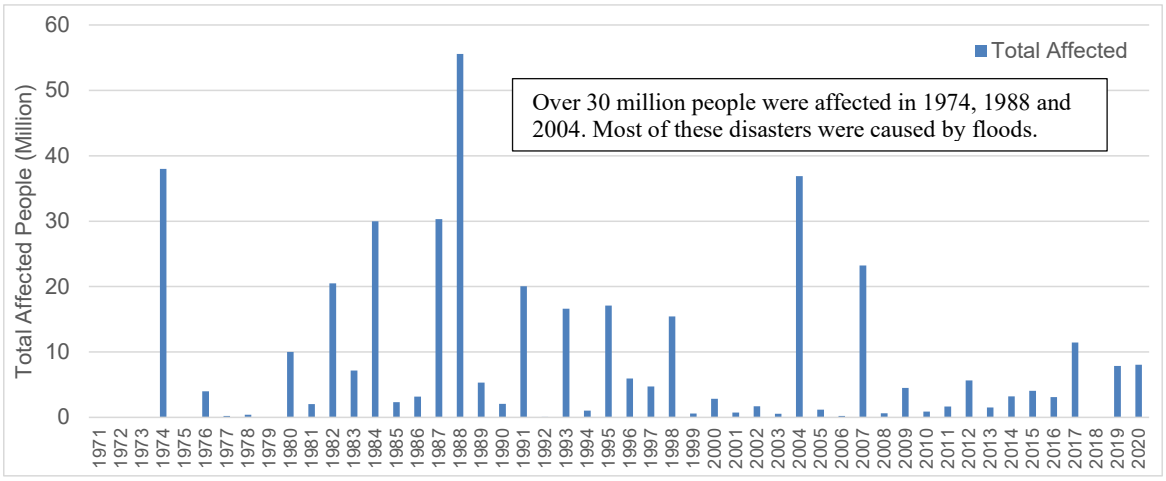
Source: JICA Survey Team

3.2 Analysis of Disaster Occurrence

3.2.1 Yearly Changes in Disaster Situation

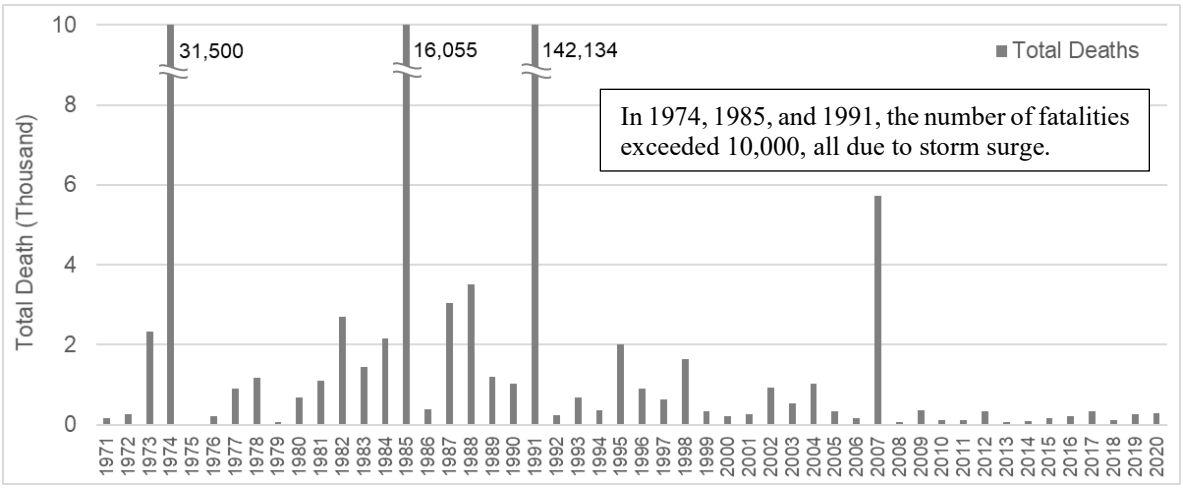
The trend of damage occurrence over time is studied based on EM-DAT. The number of affected people, the number of deaths, and the amount of damage in each year since 1971 are as shown in Figure 3.2.1 to Figure 3.2.3.

- ✓ The number of affected people exceeding 10 million occurred about once every three to four years during the 1980s and 1990s. However, the frequency tends to decrease with the passage of time, with two occurrences in the 2000s and one in the 2010.
- ✓ In 1974, 1985 and 1991, there were enormous casualties of more than 10,000 deaths. All of these were caused by storm surges. Since then, no single disaster which caused 10,000 casualties have occurred, but in 2007, Cyclone Islay reportedly caused about 4,000 casualties. The proportion of fatalities tends to be higher when disaster occurs due to cyclones.
- ✓ Economic damage exceeding USD 500 million occurred twice in the 1980s, three times in the 1990s, three times in the 2000s, and three times in the 2010s. The most recent economic damage of approximately USD 2,000 million occurred in 2020. There is no clear downward trend with the passage of time.



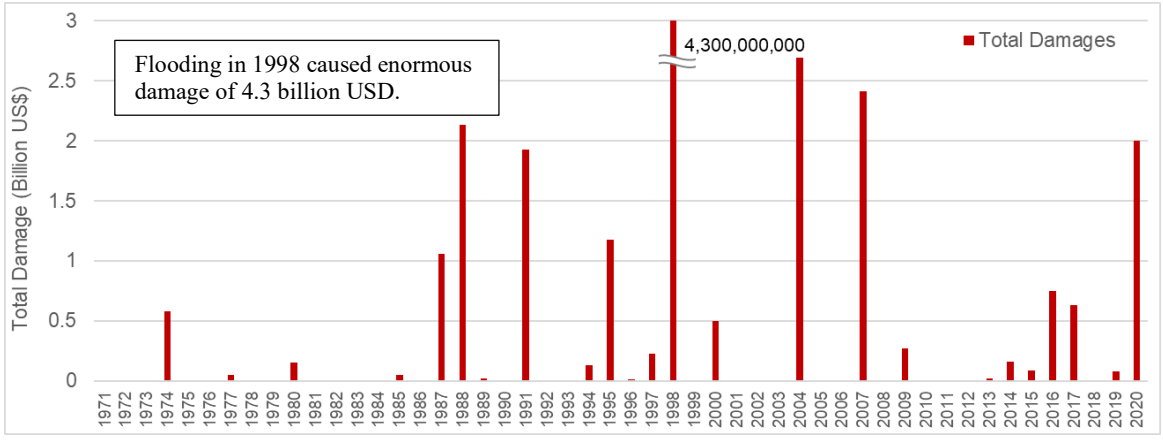
Source: EM-DAT

Figure 3.2.1 Changes in the Number of Affected People over the Years



Source: EM-DAT

Figure 3.2.2 Changes in the Number of Victims over the Years



Source: EM-DAT

Figure 3.2.3 Changes in the Damage Amount over the Years[3]

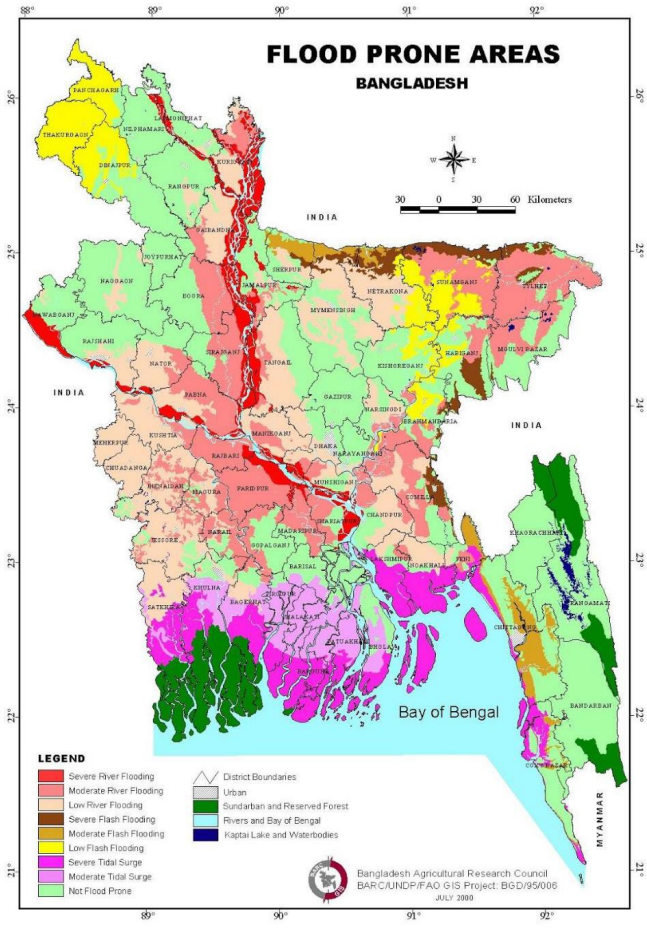
[3] The number of affected people, victims, and the damage amount depend on the situation of the disaster, but each data has the following trends, and each item does not correlate with each other.
Damage amount: The original data is from insurance companies and other sources, and older data is less accurate. In addition, due to economic development, the estimates tend to be larger each year.
Number of affected people and victims: The number of victims is decreasing due to construction of embankment

3.2.2 Analysis Based on Actual Damage Situation or Hazard Maps Prepared by Probability Scale

3.2.2.1 Flood

Due to the high frequency and magnitude of damage by floods, which are the most frequent disasters in Bangladesh, information on the damage history was well organized by BWDB and others. As already organized in the Flood Preparedness Plan (2014), etc., it is recognized that the areas where floods occur are widespread. Figure 3.2.4 shows the flood-prone areas based on past flood occurrences records.

Regarding major river floods, it is said that severe river flooding will occur in the areas along the Padma and Jamuna rivers among the three major rivers. Areas along the Teesta and Dharta rivers, which are branch rivers of the Jamuna river, are also included. Moderate river flooding will occur around the eastern and southern ends of the northwestern region, the northern end of the southwestern region (south and eastern regions of both rivers above), the north side of the southeastern region (Meghna river basin), and the northeastern region (Sylhet Division). On the other hand, with regard to flash floods, it is said that severe flash flooding is likely to occur along the Indian border in the northwest, east and southeastern region.



Source: BARC (2000)

Figure 3.2.4 Map of Flood-Prone Areas in Bangladesh

Since 1980, the major flood disasters have occurred in 1987, 1988, 1998, 2004, 2007, 2017, 2019 and 2022. The damages caused by each flood are as shown in Table 3.2.1. In addition, Figure 3.2.5 shows the change of the total flood-damaged area by year. As shown by these, the size of the flooded area is an indicator in measuring the magnitude of human or economic damage. However, the relationship is not necessarily proportional, and it is better to evaluate by superimposing the distribution characteristics of population and economic activity in the region and the inundation situation including the inundation depth.

Table 3.2.1 shows that in the past major flood events, about one-third to two-thirds of the country was inundated and 2,000 to 3,000 people were killed. These floods are not as deadly as cyclone damage, which

kills tens of thousands of people at a time in some coastal areas. On the other hand, in terms of the number of people affected by the floods, it can be seen that millions of people were affected by these massive floods. These facts indicate that the major river floods in Bangladesh are characterized by damage to economic assets (property and infrastructure facilities) located in the river flood plains rather than direct loss of people's lives, which has had a negative impact on sustainable economic development, such as prolonged stagnation of subsequent economic development. In addition to this, the inundation has also caused sanitation and other problems. Regarding flash flood, there is little statistical information on disasters specific to flash floods, and in particular, there is little available information on inundation areas, making it difficult to determine the extent of their impact in detail. However, based on available information, it is assumed that, as a percentage of the spatial extent of its impact, it tends to cause more damage to human lives than major river floods.

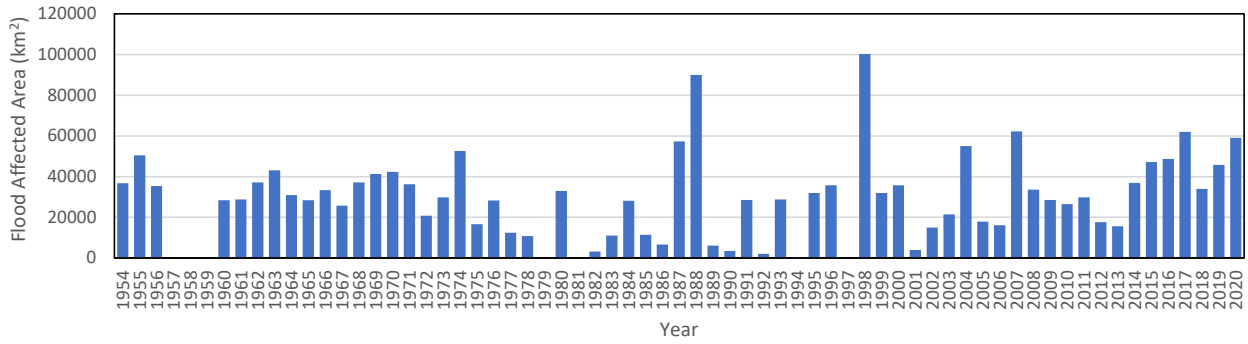
Table 3.2.1 Past Major Floods (Since 1980)

No.	Flood	Outline
1	1987 flood	✓ Inundation area: more than 57,000 km^2 (39% of the country) ✓ Number of deaths: 2,055 ✓ Total Damage Amount: US$ 1.0 billion (The World Bank, 2002)
2	1988 flood	✓ Inundation area: approx. 90,600 km^2 (61% of the country) ✓ **Number of deaths: 2,300** ✓ Affected population: approx. 4,500,000 ✓ Total Damage Amount: US$ 1.2 billion (The World Bank, 2002)
3	1998 flood	✓ **Inundation area: 100,250 km^2 (68% of the country)** ✓ Number of deaths: more than 1,100 ✓ Affected population: approx. 3,100,000 ✓ Damage: houses 500,000, road 23,500 km, embankment 4,500 km, crop land 500,000 ha ✓ Total Damage Amount: US$ 2.8 billion (The World Bank, 2002)
4	2004 flood	✓ Inundation area: approx. 56,000 km^2 (38% of the country) ✓ Number of deaths: 750 ✓ **Affected population: approx. 36,000,000** ✓ Damage: road 58,000 km, embankment 3,100 km, crops 1.3 million ha ✓ Total Damage Amount: US$ 2.2 billion (ADB-World Bank, 2004)
5	2007 flood	✓ Inundation area: approx. 63,900 km^2 (43% of the country) ✓ Number of deaths: 831 ✓ Affected population: approx. 13,300,000 ✓ Damage: completely destroyed houses 81,000, partly destroyed houses 1 million, crops 8.9 million ha, livelihood thousands of deaths, completely destroyed road 3,619 km, partly destroyed road 25,104 km, embankment flowing out 88 km, partly destroyed embankment 1,002 km, bridges/culverts 1,770, education facilities destroyed 557, education facilities partly destroyed 7,592, flood shelter 1,673 ✓ Total Damage Amount: US$ 1.8 billion (DMIC SitRep, 22 September 2007)
6	2017 flood	✓ Inundation area: approx. 62,400 km^2 (42% of the country) ✓ Number of deaths: 144 ✓ Affected population: approx. 8,000,000 ✓ Damage: completely destroyed houses 103,516, partly destroyed houses 618,516, destroyed crops 102,808 ha, partly damaged crops 504,147 ha ✓ **Total Damage Amount: US$ 5.0 billion** (Shelter Cluster, EM-DAT)
7	2019 flood	✓ Inundation area: approx. 46,000 km^2 (31% of the country) ✓ Number of deaths: 114 ✓ Affected population: approx. 7,600,000 ✓ Damage: completely destroyed houses 34,731, partly destroyed houses 548,671, road 6,641 km, embankment 1,515 km, bridges and culvert 1,275, crops 137,798 ha ✓ Total Damage Amount: US$ 0.75 billion (NDRCC, 2019)
8	2022 flood (May - June in Northeast and North)*	✓ Inundation area: more than 5,000 km^2 (60% of Sylhet District and 80% of Sunamganj District) ✓ Number of deaths: 40 ✓ Affected population: approx. 4,300,000 ✓ Damage: agricultural land 266,137 ha, 38 embankments, 600 km of roads, 28 culverts, 600 educational facilities, 11,640 tubewells, 6.5 km of water supply pipes ✓ Total Damage Amount: approx. 1,100 crore BDT (Sylhet District and Sylhet City Corporation, 2022)

Note: Bold indicates the largest ever for each item (excluding damage). No damage details are available for the 1987 and 1988 floods, so they are not included.

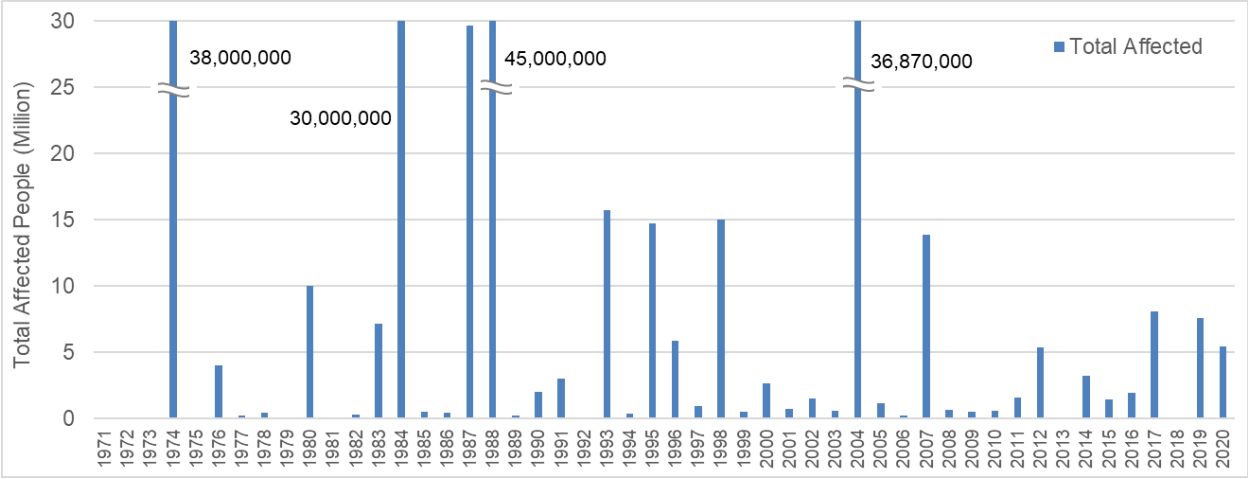
*: The data is organized based on information collected during this survey and may be different from the eventual damage estimation.

Source: Created by JICA Survey Team based on the data from MoDMR, BWDB, RHD, LGED, DPHE, Sylhet District, Sylhet City Corporation, Sylhet Deputy Commissioner's Office, World Bank, WHO, WFP, ADB, Shelter Cluster, EM-DAT and NDRCC



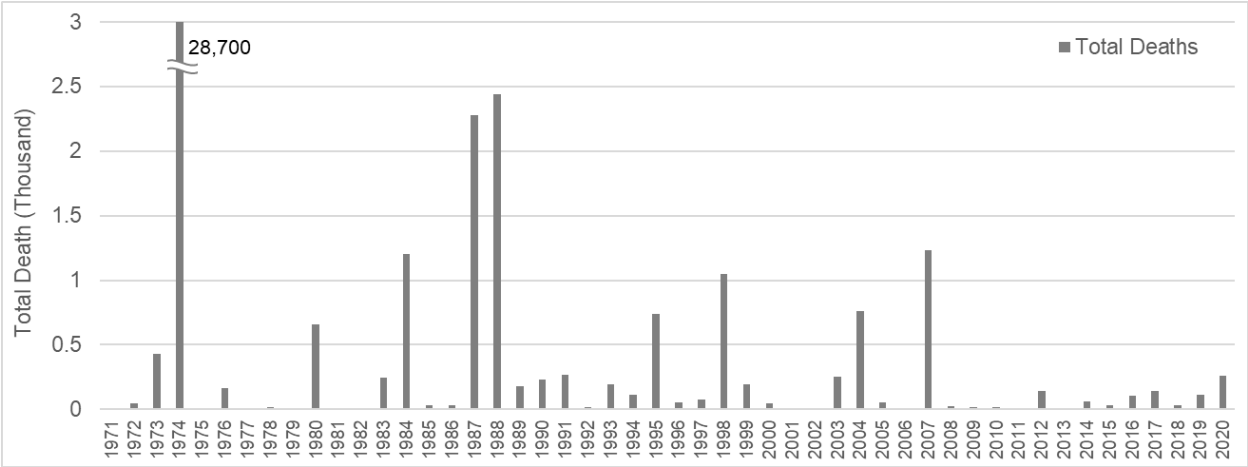
Source: Created by JICA Survey Team based on FFWC data

Figure 3.2.5 Change of Flood-Affected Areas in Bangladesh



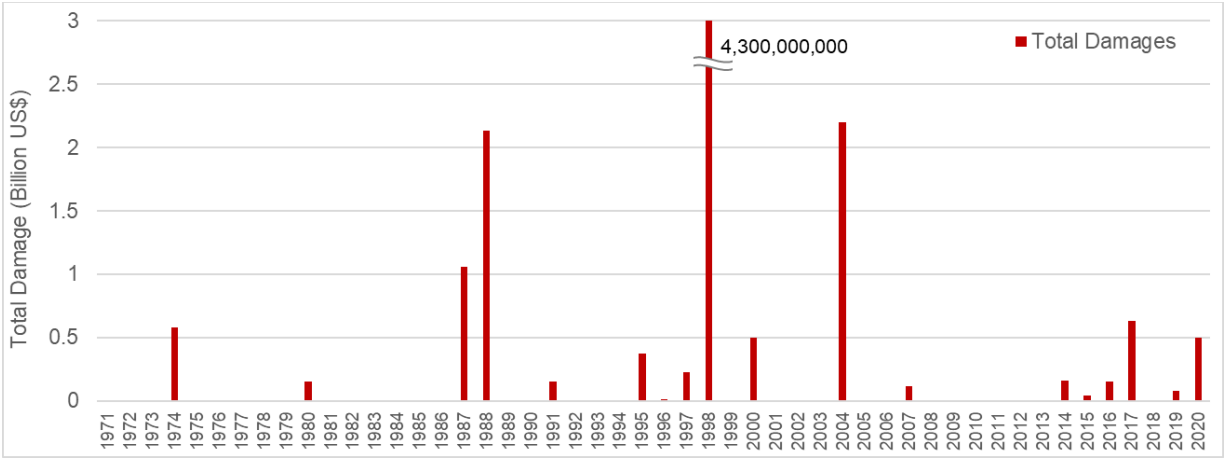
Source: EM-DAT

Figure 3.2.6 Number of victims due to Riverine Flood



Source: EM-DAT

Figure 3.2.7 Number of Deaths Due to Riverine Flood



Source: EM-DAT

Figure 3.2.8 Amount of Damage Caused by Riverine Flood

3.2.2.2 Urban Flood / Inland Flood

The occurrence of inland flood disasters in major cities is organized by city. The Water Supply and Sewage Authority (WASA) or City Corporation of each city is in charge of grasping the occurrence of inland water inundation in the jurisdiction, formulating a drainage countermeasure plan, and implementing countermeasure projects as the drainage management entity of the city (However, although WASA was the main organization at the time of formulating the masterplan, City Corporation is now the main organization in all cities). It is difficult to grasp the detailed inland flood occurrence situation because there is no distinction between inland flood and external flooding, and information is not collected by government agencies. Since the record of inundation depth and/or inundation area could not be hardly obtained, in this survey, potential inundation area for different probability scale was estimated by conducting a simple inundation analysis. Based on the results of simulation, inland flood hazard map in the urban area of each city were determined. Using the statistical analysis results of the rainfall observation records, the inundation area for different probability was calculated.

Table 3.2.2 Urban Flood in Major Cities

City	Population (10^3persons)	Area (km^2)	Population density (person/km^2)	Outline of Inland Water Inundation*	Formulation of Drainage Plan
Dhaka	8,910	316	28,196	It is the capital and has the highest population density. Inland Flood in urban areas is more problematic than river flooding. It occurs mainly in the western part of the city and the DND district. The target area has jurisdiction over multiple institutions.	2015 (DWASA)
Khulna	660	50.61	13,040	Inland Flood occurred during the monsoon period in the lowlands of the western and southern parts of the city. Existing drainage facilities are inadequate and inadequate.	2011 (KCC)
Chattogram	2,590	155.40	16,666	The second largest city in the country. Located at the end of the hills, the impact of Inland Flood is greater than that of river floods, and there is a high need for countermeasures.	2017 (CWASA)
Barisal	340	58.05	5,857	Even with normal rainfall, the drainage function deteriorates to the extent that inland water overflows. The flooding period is longer than before.	-
Sylhet	530	42	12,619	Although the catchment area has a relatively high elevation difference, Inland Flood is likely to occur during the monsoon period when the water level of the Surma River, where drainage flows in, is high.	2017 (SCC)
Rajshahi	450	97.18	4,630	During the monsoon season, when the water level of the Padma River in the south rises, the city's drainage system does not function, causing inland flooding in the lowlands.	-
Rangpur	310	50.69	6,115	Inland flood occurred because the drainage system for canals and rivers does not function.	-

*: indicates the situation at the time of planning for each city.
The characteristics of economic damage in each city are described in Section 4.3.2.
Source: BBS (2011)

Table 3.2.3 shows the possible causes of inland waters inundation in the country. As a factor to consider as a hazard assessment for inland waters flooding, stormwater drainage tends to be hindered by artificial conditions in the city rather than natural conditions, and inland inundation tends to be exacerbated. Although it is unlikely that many lives will be lost, the economic loss will be very large for the inundated area due to the flooding of economic activity centers, urban areas, densely populated areas, roads, etc. Due to their characteristics, these factors need to be properly reflected in the hazard assessment.

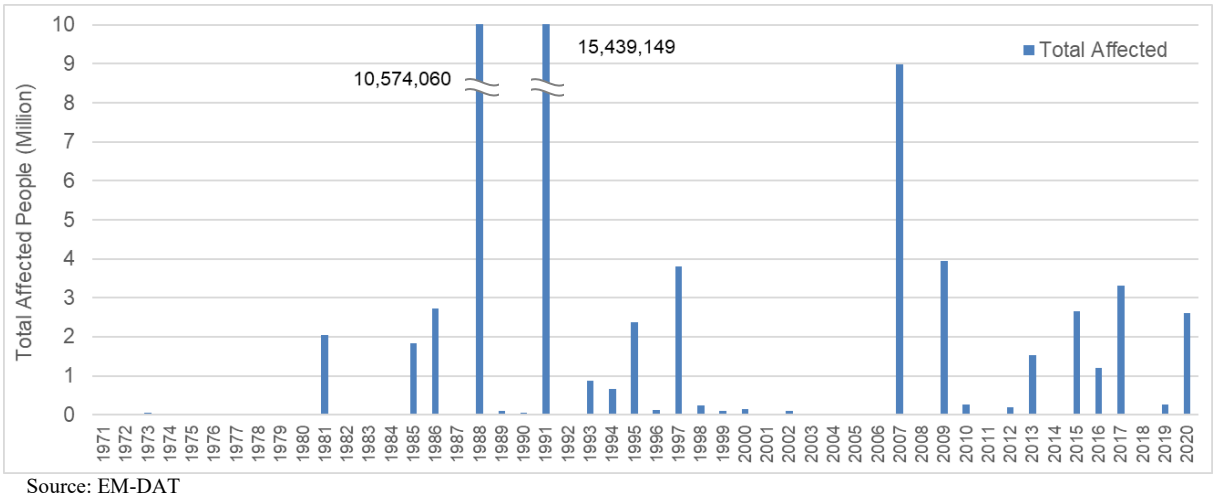
Table 3.2.3 Possible Factors for Urban Inland Flood

Type of Condition	Possible Factors
Natural condition	✓ Heavy rain (continuous rainfall) ✓ Local depression terrain ✓ Rising water level in the drainage destination river (backwater phenomenon, backwater, rising tide level)
Artificial condition	✓ Lack of drainage facilities ➢ Reduction or lack of capacity of drainage pump ➢ Unplanned building construction (construction that does not consider drainage) ➢ There is no room for construction of drainage facilities ➢ Inaccurate rainfall estimation due to inappropriate rainfall observations ➢ Existence of drainage channels that are difficult to access due to inadequate planning (decrease in drainage capacity due to inadequate management) ✓ Decrease in drainage capacity of drainage channels and drainage capacity of facilities ➢ Dumping / blocking of waste into drainage channels ・Many drainage channels are uncovered ・Delay or no dredging of sediments and/or waste removal works ・Lack of public awareness activities (to prevent illegal dumping) ➢ Insufficient management of drainage channels and drainage machines ・Not implemented / insufficient maintenance of drainage channels ・Implementation of inappropriate maintenance due to lack of human resources ・Insufficient monitoring of drainage channel status (by management entity) ✓ Changes in land use ➢ Landfill of retarding basin ➢ Conversion of low-lying areas to residential areas, settlement of the poor ➢ Impermeable surface of the ground due to urban growth and expansion of urbanization ➢ Concentration of inflow rainwater that exceeds the drainage capacity of the drainage channel ✓ Structure characteristics (underpass, basement, etc.)

Source: JICA Survey Team

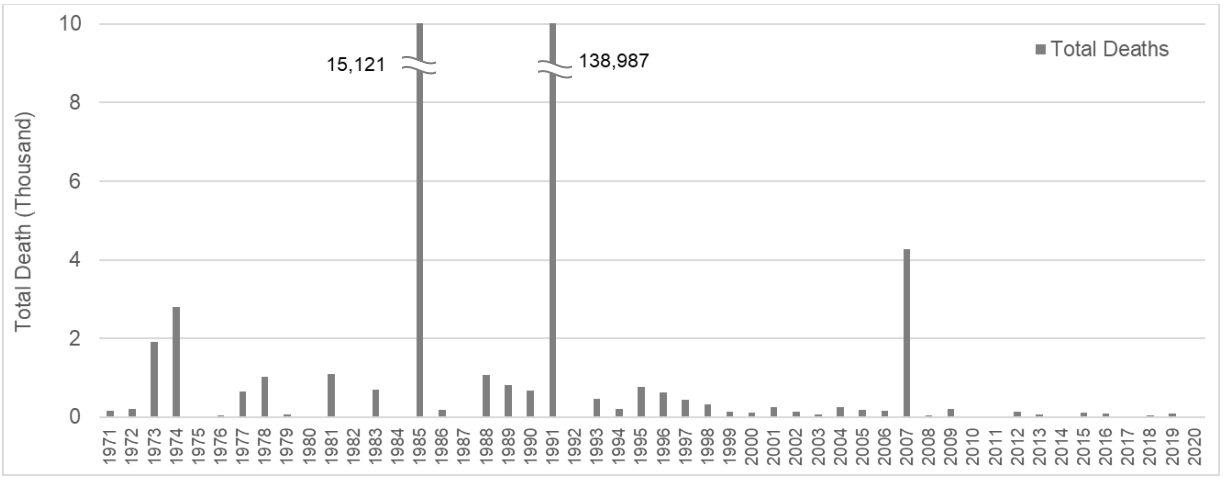
3.2.2.3 Storm Surge

According to EM-DAT, the 1991 cyclone Gorky in the last 30 years has caused the most damage. Since then, Cyclone Sidr in 2007, Cyclone Roanu in 2016, and Cyclone Amphan in 2020 have suffered great damage every few years.



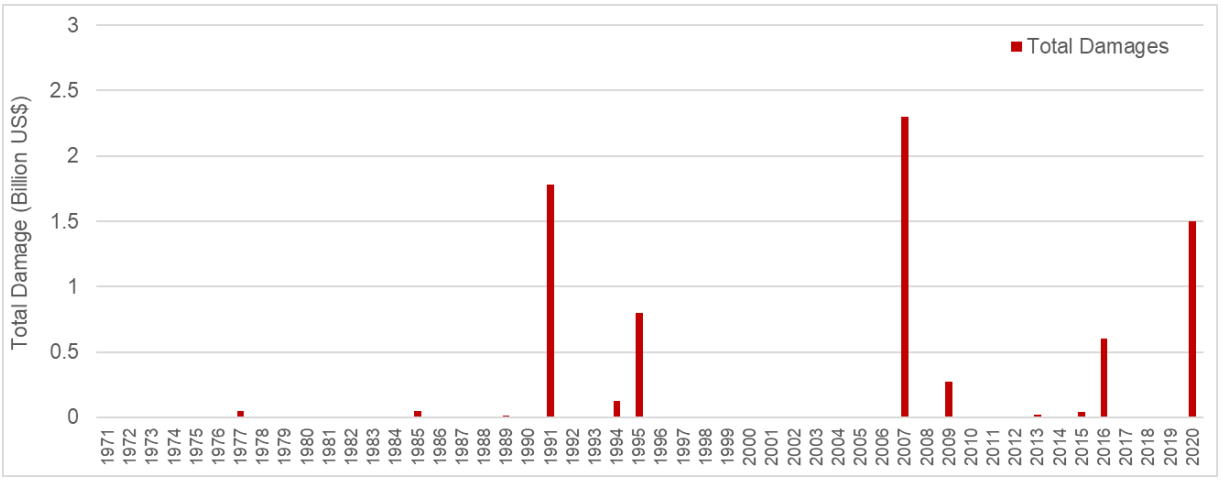
Source: EM-DAT

Figure 3.2.9 Number of victims due to Storm Surge



Source: EM-DAT

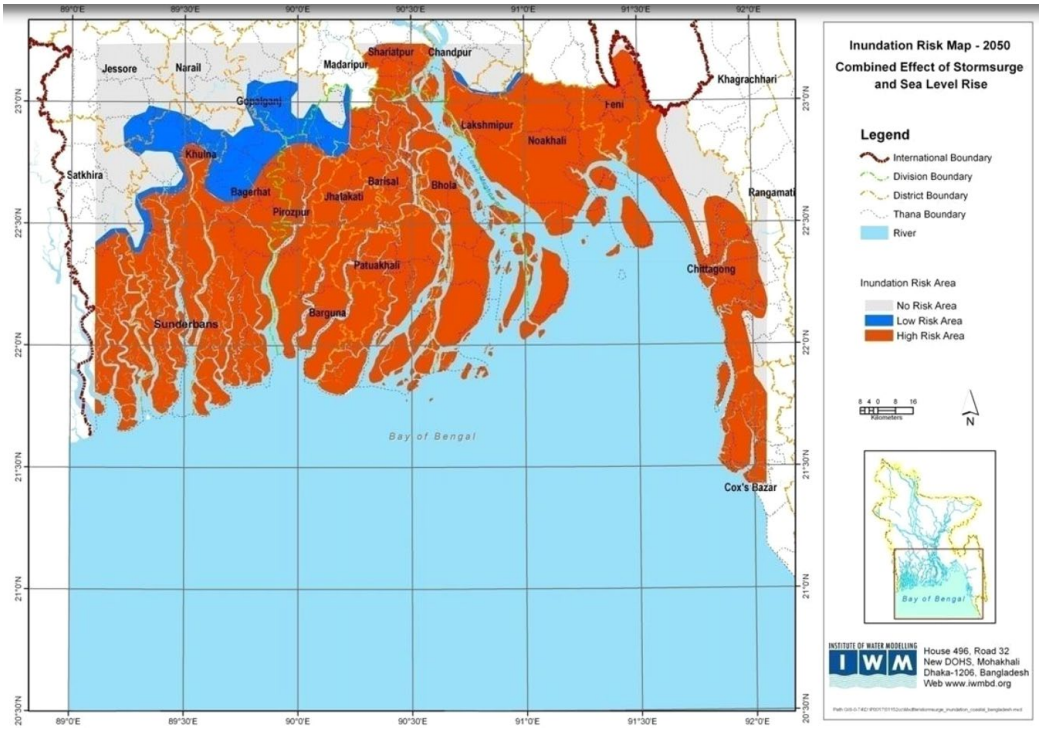
Figure 3.2.10 Number of Deaths Due to Storm Surge



Source: EM-DAT

Figure 3.2.11 Amount of Damage Caused by Storm Surge

Storm surge damage occurs mainly in coastal areas, but no inundation record data could be found. The areas in Bangladesh that are considered to have a high risk of storm surge are shown below. A wide range of coastal areas are exposed to storm surge risk.



Source: World Bank (https://thedocs.worldbank.org/en/doc/937191464117246704-0050022016/original/PolicyResearchTalkSusmitaDasguptaMay2016.pdf)

Figure 3.2.12 Risk Area by Storm Surge

3.2.2.4 Riverbank Erosion

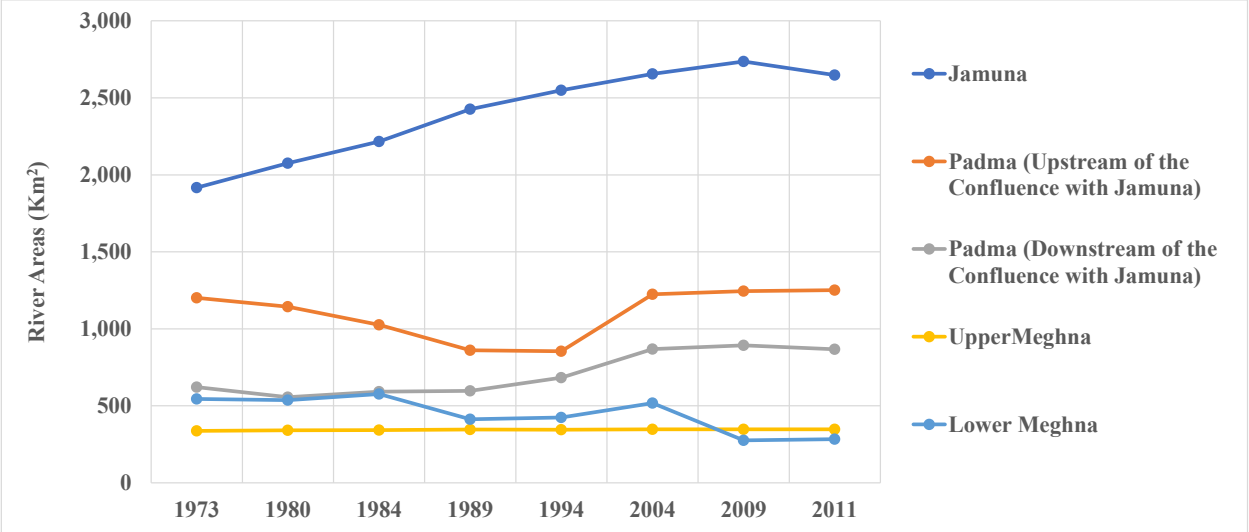
Riverbank erosion depends to various factors such as quantity of rainfall, river morphology, soil properties and bank material, flow regime and water level variations, near bank flow velocities, sediment supply into the river due to large earthquakes or sudden river mergers that cause rapid sediment inflows, stability of reticulated channels, topography of river floodplain, socio-economic condition of riparian communities, large-scale intervention in upstream. The increase in riverine area due to riverbank erosion means a reduction in agricultural land area, especially in Bangladesh, which is an impediment to the country's development.

The riverbank lines for major rivers and two confluences have been collected from the BWDB for year 1973, 1980, 1984, 1989, 1994, 2004, 2009 and 2011. Table 3.2.4 shows bank to bank areas of the major river system for different years. In addition, Figure 3.2.13 shows an intercomparison changes of riverbank areas between 1973 and 2011 for Jamuna, Padma and Meghna rivers. It is upper Meghana river has a relatively fixed areas over the time. However, Jamuna, Padma and the lower Meghan have been observed drastic changes in total river areas.

Table 3.2.4 Changes in Total Rivers Areas from 1973 to 2011

River Area (km^2) from bank to bank using satellite images								
River Name	**1973**	**1980**	**1984**	**1989**	**1994**	**2004**	**2009**	**2011**
Jamuna	1,916.4	2,075.8	2,217.0	2,426.1	2,549.7	2,655.8	2,736.0	2,647.7
Padma (Upstream of the Confluence with Jamuna)	1,201.4	1,143.7	1,025.7	860.7	853.9	1,223.9	1,245.3	1,251.5
Padma (Downstream of the Confluence with Jamuna)	621.2	556.4	592.6	597.2	683.4	869.0	893.3	866.9
Upper Meghna	337.3	341.3	342.0	346.5	345.2	348.0	348.1	347.0
Lower Meghna	544.3	536.6	576.3	413.1	424.2	518.1	275.9	283.1
Padma-Jamuna Confluence	106.4	99.3	99.4	115.8	108.7	121.5	124.1	124.2
Padma-Upper Meghna Confluence	210.4	227.6	237.9	258.5	261.1	279.8	287.7	290.1

Source: Prepared by JICA Survey Team based on BWDB data



Source: Prepared by JICA Survey Team based on BWDB data

Figure 3.2.13 Comparison in Changes of River Areas (km^2) from 1973 to 2011

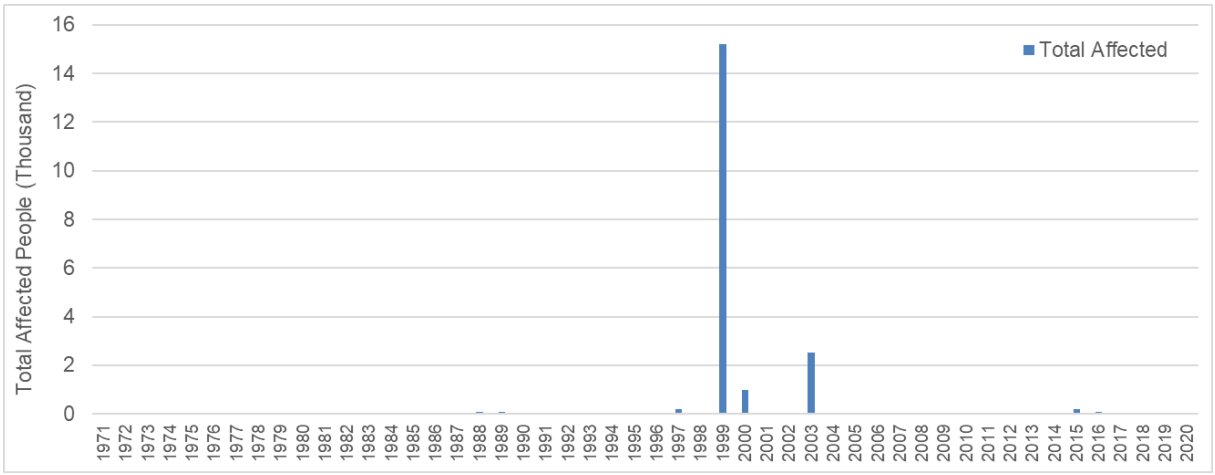
3.2.2.5 Earthquake

Bangladesh is an earthquake-prone area because it is located near plate boundary. However, since the 1897 Assam earthquake (more than 1,500 dead in India), there have been no major earthquakes in recent years. Below is a list of recent earthquakes.

Table 3.2.5 Recent Earthquakes and the Damage

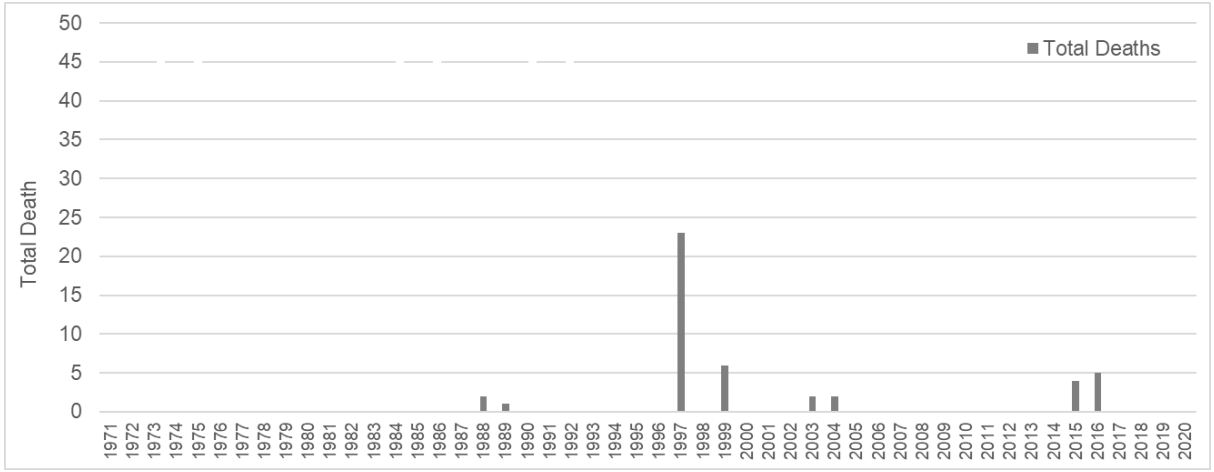
Date	Main Affected Area	Magnitude	Depth (km)	Total Death	No. of Injured	Total Affected
1988/2/6	Sylhet	5.8	33	2	100	100
1989/6/12	Banaripara area	5.1	6	1	100	100
1997/11/22	Chattogram	6.1	54	23	200	200
1999/7/22	Maheshkhali Island	5.2	10	6	200	15,200
2000/1/2	Maheshkhali area	4.6	33	-	-	1,000
2003/7/26	Chattogram, Cox's Bazar	5.6	10	2	25	2,525
2015/4/25	Dhaka, Narayanganj, Gazipur, Gopalganj	7.8	15	4	200	200
2016/1/3	Dhaka, Rajshahi, Lalmonirhat, Panchagarh	6.7	37	5	70	70

Source: EM-DAT



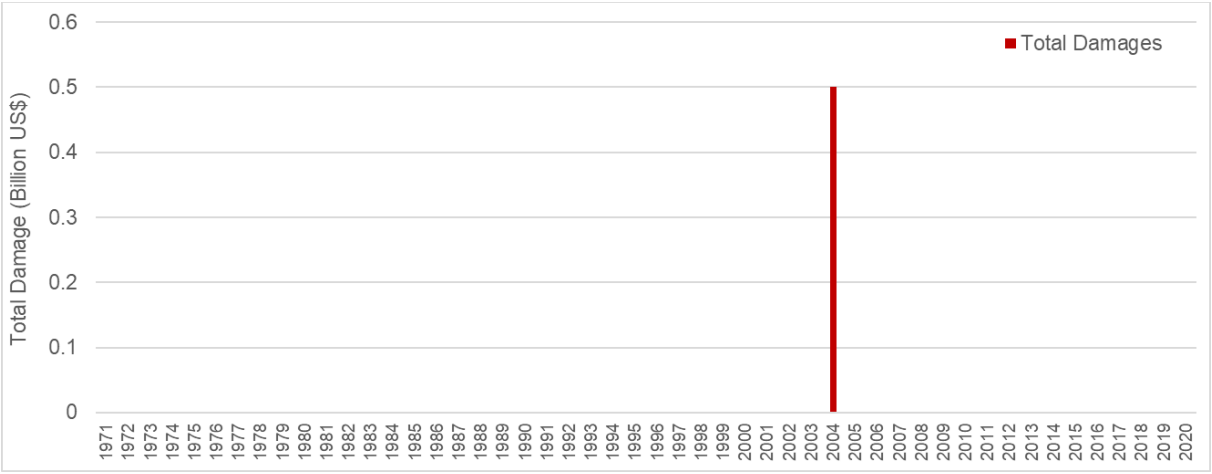
Source: EM-DAT

Figure 3.2.14 Number of victims due to Earthquake



Source: EM-DAT

Figure 3.2.15 Number of Deaths Due to Earthquake



Source: EM-DAT

Figure 3.2.16 Amount of Damage Caused by Earthquake

3.3 Trends in Population, Land Use, Infrastructure Development, and Urban Development

Temporal changes in population and land use, as well as future trends in infrastructure development, are the important factors in understanding high disaster risk areas in the future from the economic point of view. Regarding population and economic activities, future population changes are predicted based on past statistical data, research results, current population published by the Bangladesh Bureau of Statistics, the number of workers by industry and GDP per capita, etc.

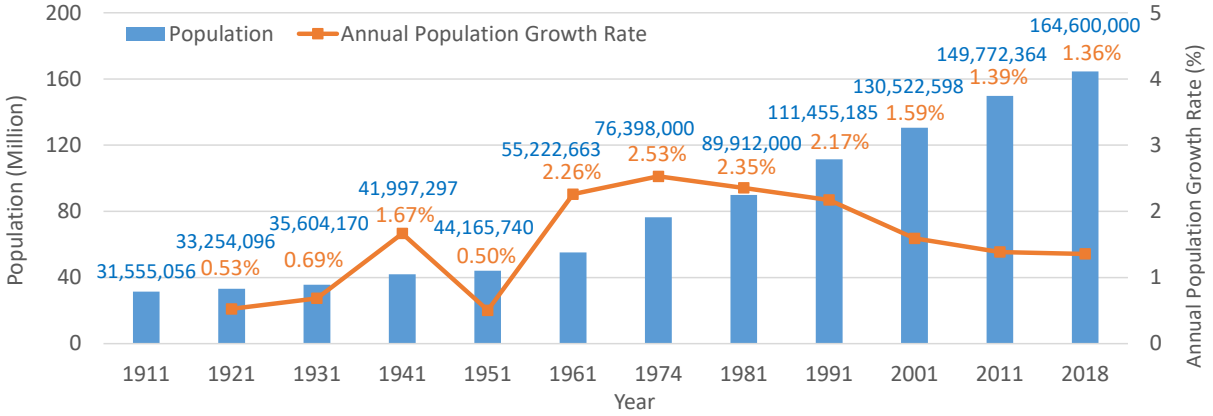
Also, regarding the layout of major infrastructure and the location of industrial areas, the future development status is confirmed based on future development plans in addition to the existing status. The data is handled and processed on GIS to be the input conditions for the disaster risk analysis shown below.

In addition, future land use predictions are made based on time-series analysis of satellite images, targeting five urban city areas. By forecasting the expansion of urban areas in detail, the scope of investment to be made in the future is clarified, which enables to evaluate the effectiveness of investment in a more reasonable manner.

3.3.1 Population

3.3.1.1 Trend in Population

In Bangladesh, the census is conducted every 10 years and the most recent census was carried out in 2011. Since then, although there are some analysis results on the population transition, according to the Bangladesh Sample Vital Statistics 2018 published by the Statistics Bureau, the total population as of 2018 is 164.6 million. The changes in population since 1911 are shown in Figure 3.3.1. In recent years, the population has been increasing at a ratio of about 1.4% per year.



Source: Bangladesh Statistical Yearbook until 2011; for 2018, Bangladesh Sample Vital Statistics 2018.

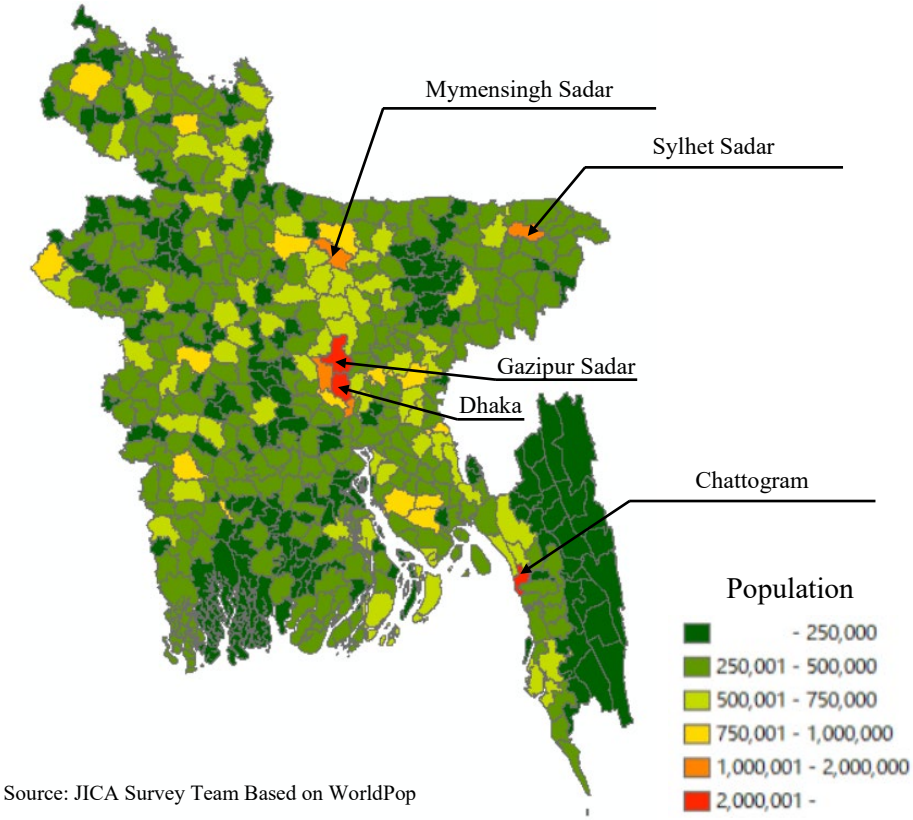
Figure 3.3.1 Population Change (1911-2018)

3.3.1.2 Population Distribution Based on Satellite Image Data

In the disaster risk analysis described later, it is necessary to grasp the spatial distribution of the population with detailed resolution. In the survey, the spatial population distribution in Bangladesh is grasped based on WorldPop data, which maintains a global population distribution data set with 100m resolution. WorldPop estimates the spatial distribution of the residential area from satellite images, as well as by referring to statistical data of each country.

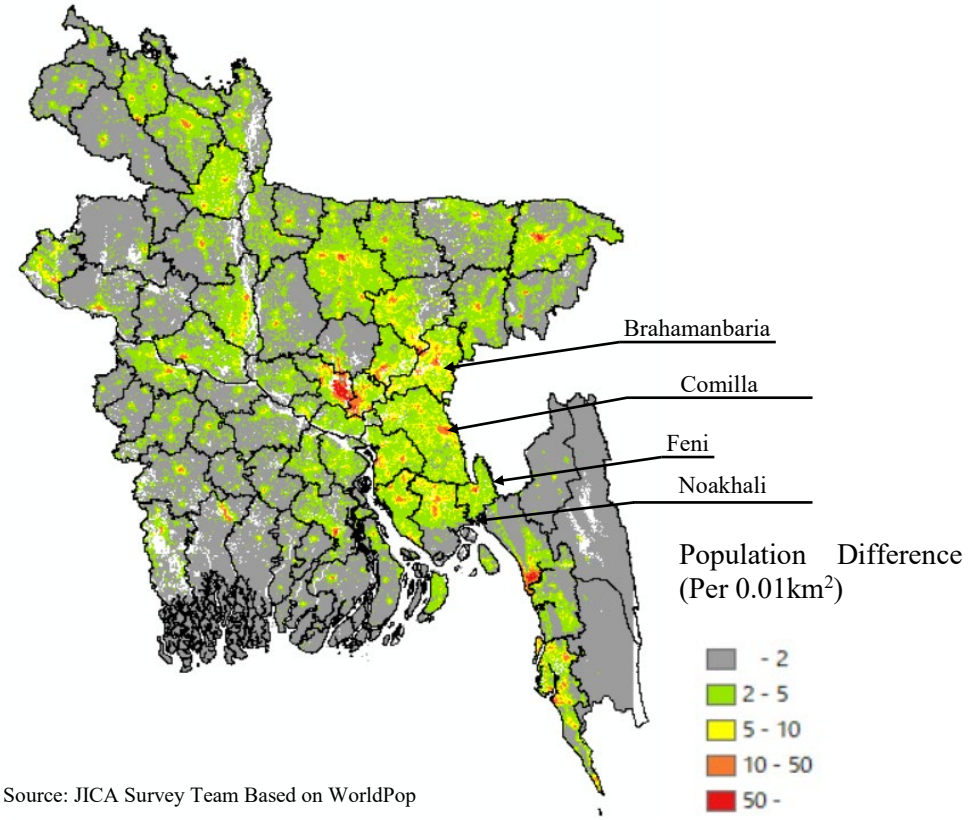
To prepare the future population dataset as of 2030, the values of each grid of WorldPop as of 2011 are corrected so as to match the forecast values for each district in 2030 published by the government.

Figure 3.3.2 shows the projected population in 2030 for each of the Upazila, indicating that the population will still be concentrated in the current major urban areas of Dhaka, Chattogram, Sylhet, Mymensingh, etc. in 2030. Figure 3.3.3 shows the difference between the projected population in 2030 and the population distribution in 2011. In the population projections used in this survey, a trend of population growth centered on each of the regional centers nationwide can be confirmed. In terms of the macro population growth trend for the country as a whole, it can be seen that there are areas of broad population growth, especially in the eastern and southeastern regions, from the Dhaka area to Brahamanbaria, Comilla, Noakhali, Feni, etc.



Source: JICA Survey Team Based on WorldPop

Figure 3.3.2 Predicted Population per Upazila as of 2030



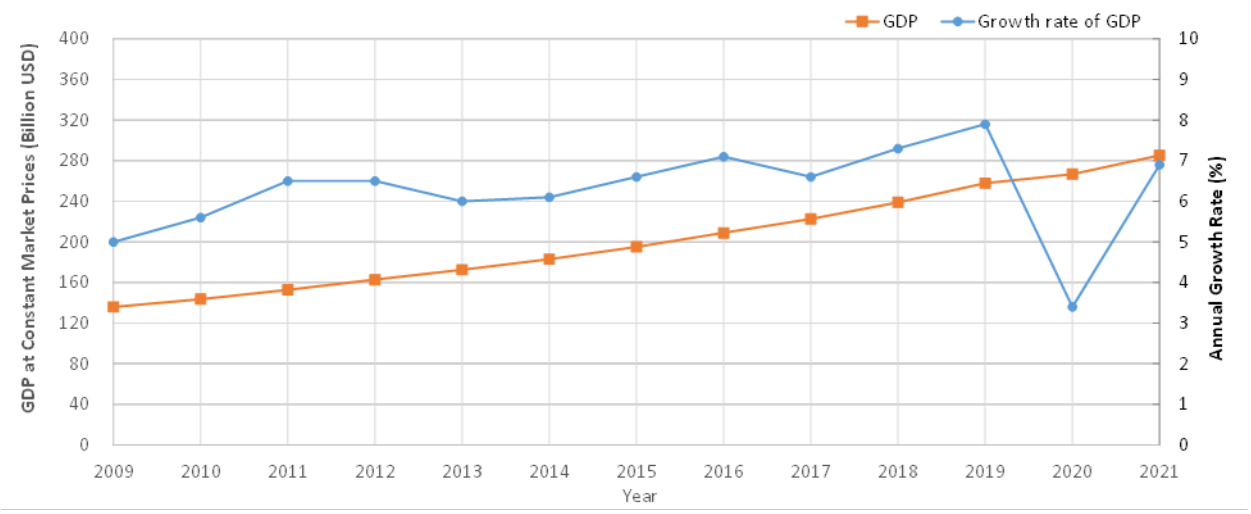
Source: JICA Survey Team Based on WorldPop

Figure 3.3.3 Difference between 2030 Projected Population and 2011 Population

3.3.2 GDP

(1) Temporal Transition of GDP

The transition of GDP since 2009 is as shown in Figure 3.3.4. Over the last decade, Bangladesh's economy has continued to grow steadily. Although it slowed down in 2020 due to the influence of Covid 19, it has grown at a high rate of 6% or more in recent years.



Source: World Bank Open Data (https://data.worldbank.org/)

Figure 3.3.4 Transition of GDP from 2009 to 2021

(2) Prediction of Future Total GDP

In the UK's Center for Economics and Business Research (CEBR), Bangladesh's future GDP projection for 2030 is published. According to the CEBR, Bangladesh's GDP will reach 21,893 billion Taka by 2030, which is expected to increase by more than 90% from 2020.

Table 3.3.1 Future GDP Projection in Bangladesh

Year	2005	2010	2020	2025	2030
GDP, BDT billion (constant prices)	4,523	6,071	11,478	15,979	21,893
GDP, USD billion (constant prices)	86	129	301	420	594
GDP, USD billion (current prices)	69	115	318	488	760
Rank*	57	59	41	34	28

*: Rank is based on the World Bank's Ease of Doing Business Index.
Source: CEBR (https://cebr.com/wp-content/uploads/2020/12/WELT-2021-final-23.12.pdf)

(3) Future GDP Distribution by Region

The number of workers by sector in each Upazila were surveyed in a 2011 census conducted by BBS. Based on the information, the GDP of each sector is distributed into each Upazila, as shown in Figure 3.3.5 to Figure 3.3.8. In addition, by dividing these GDPs by the population of each Upazila as of 2030, the GDP per capita of each Upazila can be estimated. The information is used for disaster risk analysis as described later.

GDP in the agricultural sector is widely distributed in the non-urban areas, but there are some areas with high values, especially from the north to the northwest, such as Thakurgaon Sadar, Mitha Pukur, Sundarganj, and Gobindaganj. Industrial GDP is high in several areas in Sirajganj, as well as in major urban areas such as Dhaka, Chattogram, and Khulna. GDP in the services sector and GDP per capita, as in the industrial sector, are also high in major urban areas such as Dhaka, Khulna, Sylhet, and Barisal.

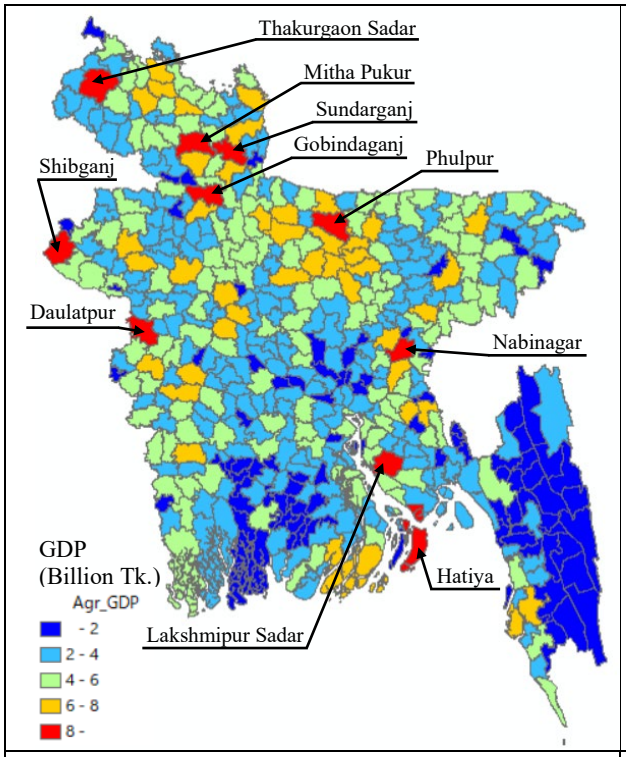


Figure 3.3.5 GDP Distribution by Upazila in 2030 (Agricultural Sector)

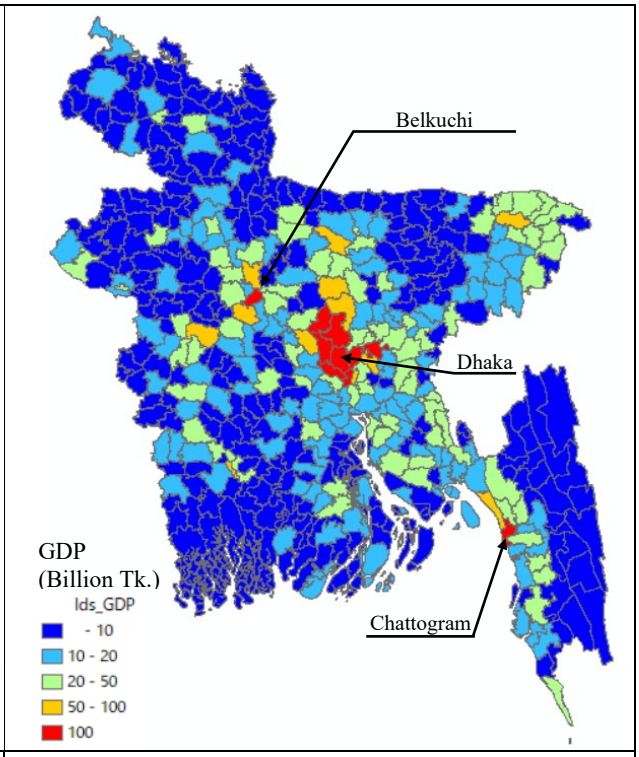


Figure 3.3.6 GDP Distribution by Upazila in 2030 (Industrial Sector)

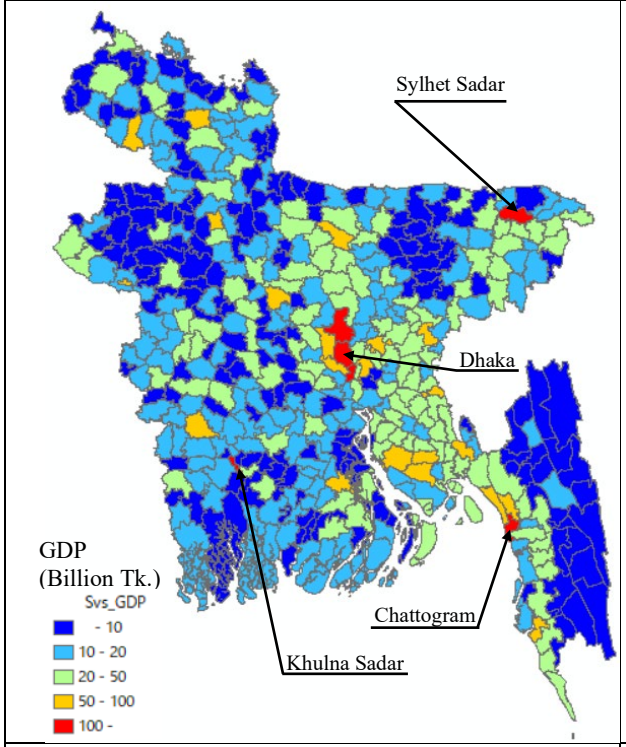


Figure 3.3.7 GDP Distribution by Upazila in 2030 (Service Sector)

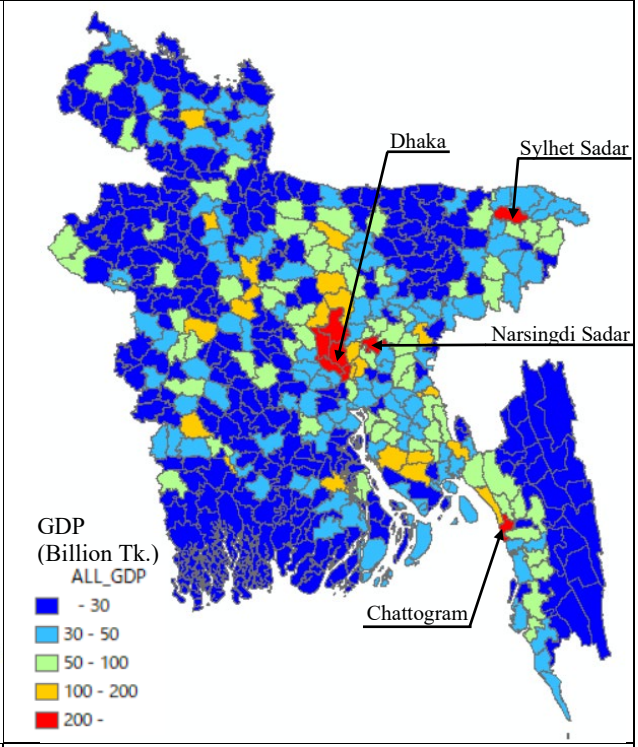


Figure 3.3.8 GDP Distribution by Upazila in 2030 (Total of All Sector)

Source: JICA Survey Team Based on SOB Statistic and WorldPop

3.3.3 Land Use Conditions

(1) Change of Land Use Conditions

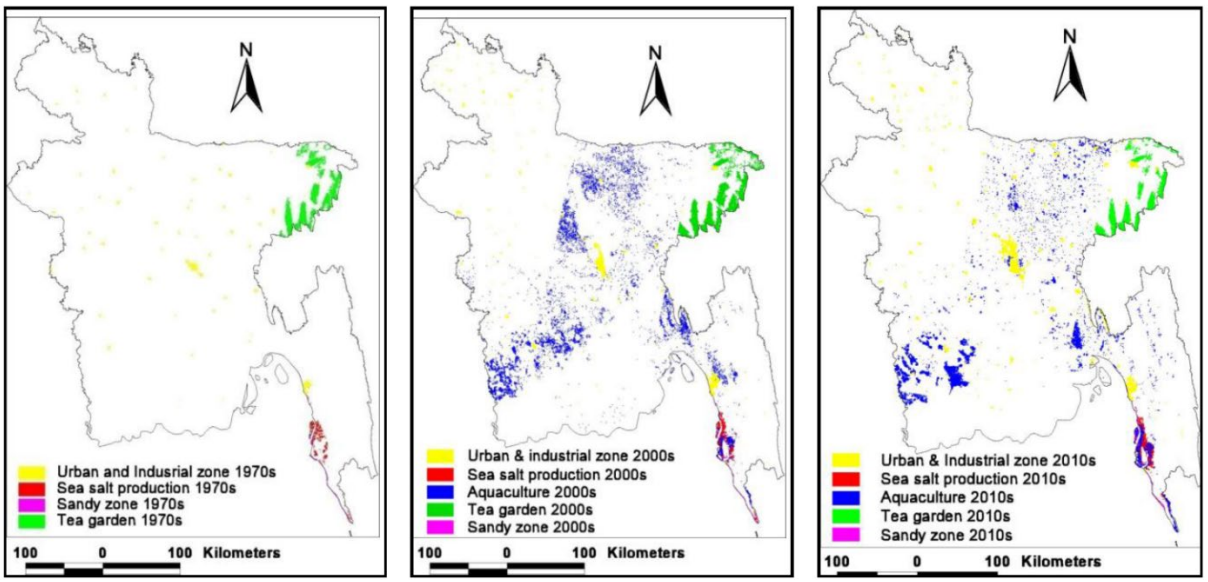
The changes in land use conditions based on the results of past studies that analyzed the changes in land use in 1976, 2000, and 2010 derived from Landsat satellite images are as shown in Table 3.3.2 and Figure 3.3.9. Most of the land area is used as agricultural land, which consistently accounts for more than 60%. However, the ratio is gradually decreasing from 67.4% in 1976 to 60% in 2010.

On the other hand, land use as non-agricultural land continues to expand. Total residential and industrial land use nearly doubled between 1976 (6.3%) and 2010 (12.7%), which corresponds to the aforementioned decline in agricultural land. If the conversion of agricultural land to residential and industrial land continues, the population and assets exposed to hazards will increase in the future, especially in the event of widespread inundation due to major river floods and storm surges.

Table 3.3.2 Changes in Land Use Type

Land Cover	Area (1976)		Area (2000)		Area (2010)	
	ha	%	ha	%	ha	%
Cropland	9,761,450	67.4	9,439,541	65.0	8,751,937	60.0
Forest	1,754,917	12.1	1,311,121	9.0	1,434,136	9.8
Mangrove	452,444	3.1	486,791	3.4	441,455	3.0
River	911,819	6.3	888,441	6.1	939,073	6.4
Lake	50,829	0.4	58,261	0.4	51,739	0.4
Beel and Haor	239977	1.7	251,774	1.7	250,727	1.7
Aquaculture	582	0.01	143,506	1.0	175,663	1.2
Tea	119,847	0.8	138,533	1.0	96,152	0.7
Salt pan	11,789	0.1	24,306	0.2	36,022	0.3
Agriculture	**13,303,654**	**91.8**	**12,742,274**	**87.7**	**12,176,904**	**83.5**
Rural settlement	885,637	6.1	1,458,031	10.0	1,766,123	12.1
Urban & Industrial	26,799	0.2	47,495	0.3	87,616	0.6
Settlement & Industrial	**912,436**	**6.3**	**1,505,526**	**10.3**	**1,853,739**	**12.7**
Accreted Land	**271,169**	**1.9**	**282,781**	**2.0**	**547,128**	**3.8**

Source: Hasan, M. N., M. S.Hossain., M. R. Islam., and M. A. Bari. 2013: Trend in the availability of agricultural land in Bangladesh. Soil Resource Development Institute (SRDI), Farm, gate, Dhaka-1215, with partial modification by JICA Survey Team



Source: Hasan, M. N., M. S.Hossain., M. R. Islam., and M. A. Bari. 2013: Trend in the availability of agricultural land in Bangladesh. Soil Resource Development Institute (SRDI), Farm, gate, Dhaka-1215.

Figure 3.3.9 Transition of Urban Areas Based on Satellite Images

(2) Urban Growth Prediction for Major Cities Based on Satellite Images

In this study, spatial expansion of urban areas in major cities in Bangladesh is predicted based on a model to understand the points to be considered in the formulation and implementation of DRR projects in each urban area. The target cities are Dhaka, Chattogram, Barisal, Khulna and Sylhet among 7 major cities in the country which are hot spots of urban area in BDP 2100 from the viewpoint of flood and earthquake disaster risk management. In these 5 cities, the spatial growth of cities in 2030, 2040 and 2050 is predicted and examined using land use change history every 5 years from 2000 to 2020.

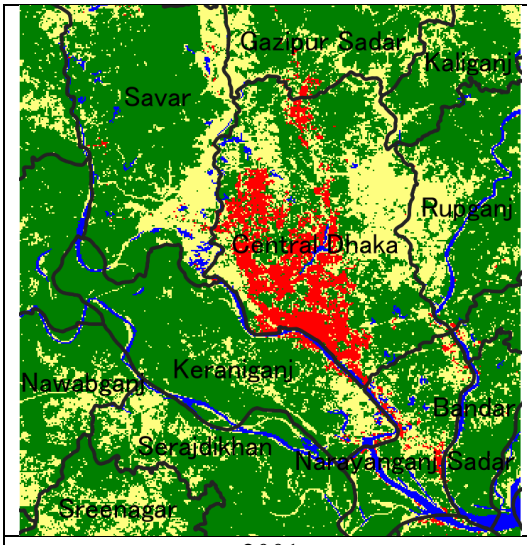
Points of attention in future DRR projects based on the results of the analysis of the urban growth prediction carried out in this study can be arranged as shown in the following table. However, it should be noted that this analysis focuses on predicting urban development preferences, which are actually formed by complex factors, by focusing on road networks and topography, and does not take into account future infrastructure development. Therefore, it should be noted that this does not apply to development trends depending on the state of infrastructure development.

Table 3.3.3 Summary of Results by Urban Growth Prediction Model

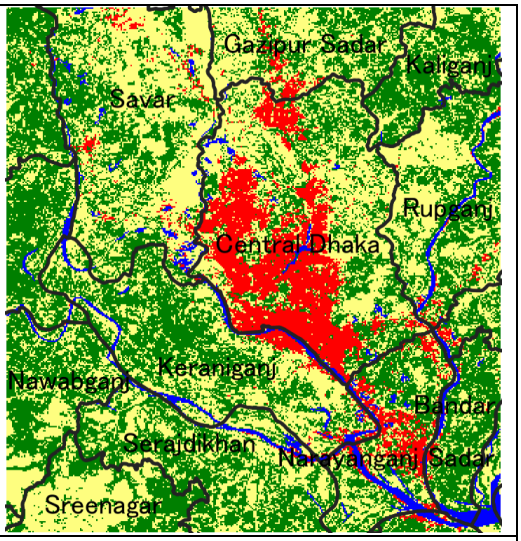
City Name	Direction of Measures to Cope with Changes in Disaster Risks Assumed from the Results of Urban Growth Projections
Dhaka	In view of the current high density of urban areas, it is important to secure rainwater drainage and storage functions in urban areas and to make earthquake-resistant buildings.
Chattogram	Since it has been suggested that further urban development may progress in coastal areas and along rivers, it is assumed that improvement of river channels for river flooding (Dredging, widening, embankment, etc.) and measures against storm surges (embankments, etc.) are necessary.
Khulna	Since it is suggested that future urban growth may proceed mainly along rivers, it is considered important to secure measures against inundation from rivers and rainwater drainage and storage functions. In particular, as the region is susceptible to sea level rise due to climate change, it is important to develop drainage facilities and embankments in consideration of sea level rise.
Barisal	It is considered important to secure rainwater drainage and storage functions in urban areas in the future, as the current higher density of urban areas suggests. In particular, as the region is susceptible to sea level rise due to climate change, it is important to develop drainage facilities and embankments in consideration of sea level rise.
Sylhet	In addition to make earthquake-resistant buildings, securing rainwater drainage and storage functions in urban areas will be important in the future, as further densification of urban areas suggests.

Source: JICA Survey Team

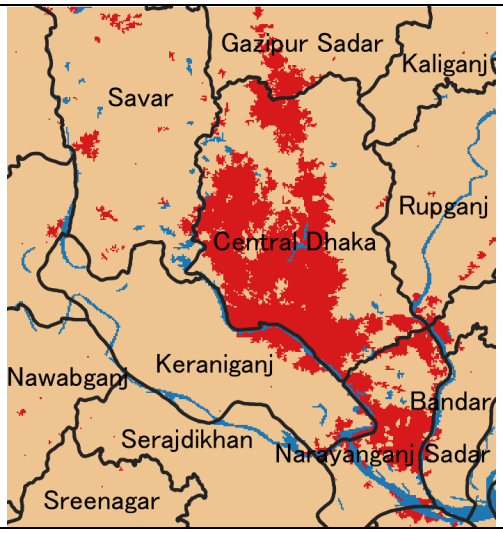
Future trends of urban growth in Dhaka are shown in Figure 3.3.10 as an example of the prediction model.



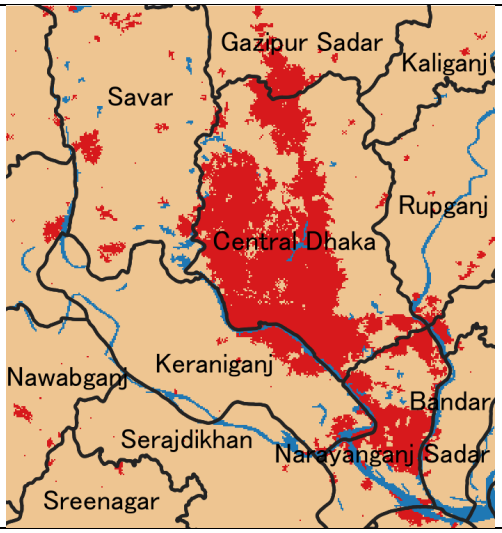
2001



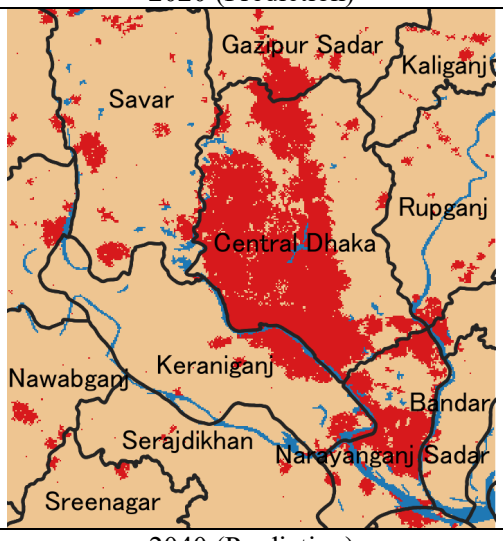
2010



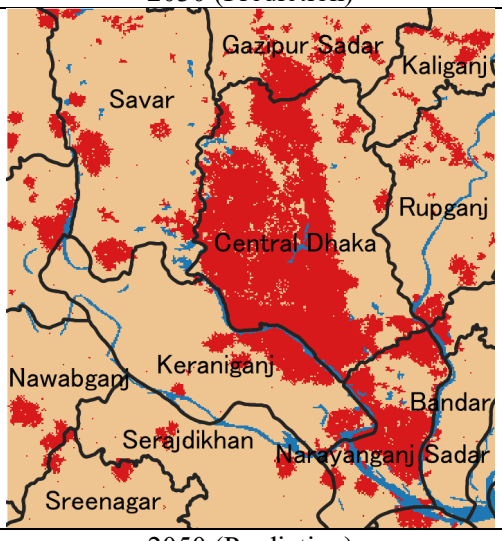
2020 (Prediction)



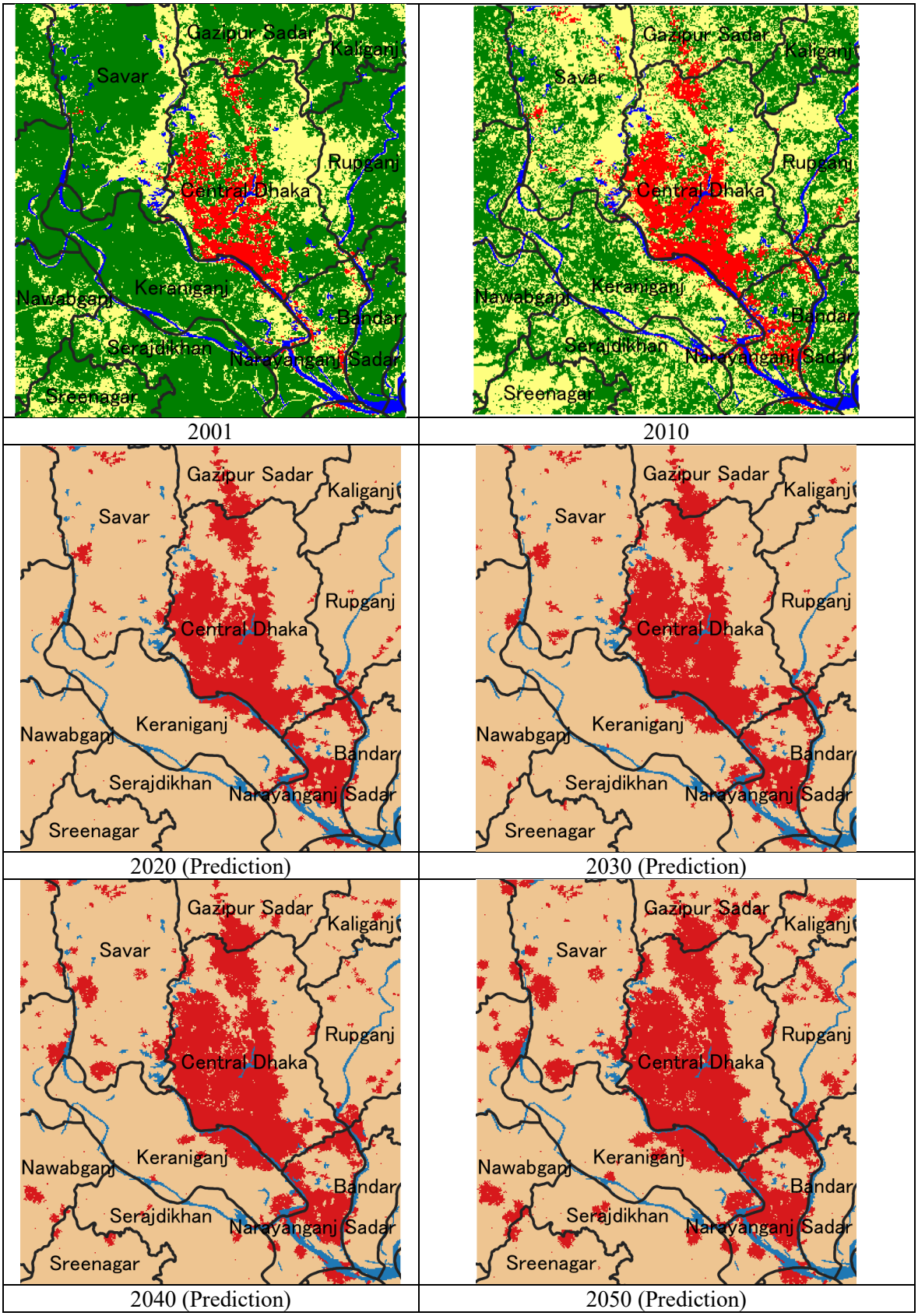
2030 (Prediction)



2040 (Prediction)

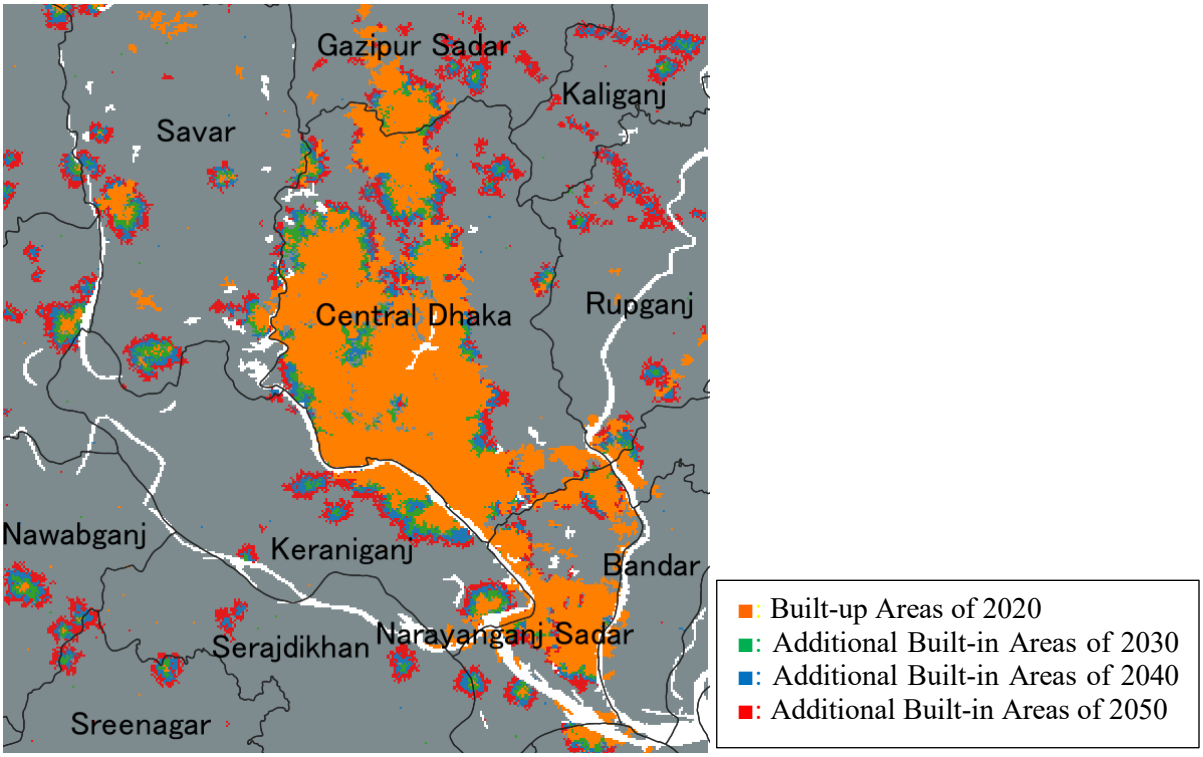


2050 (Prediction)



Source: JICA Survey Team and GLODAL, Inc.

Figure 3.3.10 Urban Growth Model Prediction Results (Dhaka)



Source: JICA Survey Team and GLODAL, Inc.

Figure 3.3.11 Growth Trends by Urban Growth Model (Dhaka)

3.4 Comprehensive Disaster Risk Assessment

For disaster risk analysis, the following information shown in Table 3.4.1 and Table 3.4.2 are used.

The scale of hazard to be employed in this survey is set in consideration of the available data and the largest disasters that have occurred in Bangladesh in the past. However, due to the lack of information on the past situation for some types of disasters, the scale of the hazard is set based on the external force conditions employed in previous related studies, as well as examples of recent major disaster in Japan.

The evaluation index shown in Table 3.4.3 is used to identify the focus areas for future countermeasures based on the disaster risk analysis. Based on this index, each Upazila is given an evaluation score, and the Upazila with the highest overall evaluation score is selected as the focus area.

In view of the fact that there are only a few examples of efforts to create hazard data at the national level in Bangladesh, and that further improvement of the accuracy of topographical data is needed, especially for floods and storm surges, the analysis will not focus excessively on the strict priority of individual Upazilas, but rather on a broad perspective that should be focused on in future disaster reduction investments.

The highest score is given to the Upazila with the highest value in each evaluation item, and the other Upazilas are scored according to the ratio of their value to that of the Upazila.

The hazard information used in this survey is based on multiple assumptions regarding the conditions of occurrence, scale, and intensity of the hazard. Therefore, it should be noted that the quantitative risk assessment, which is conducted using this hazard information, contains a certain amount of uncertainty.

Table 3.4.1 Hazard Data in Disaster Risk Analysis

Disaster Type	Basic Policies for Data Preparation and Use	Scale of the Hazard (Probability of Occurrence)	
Major River Flood	Scanned data of flood map image created by the Institute of Water Modeling (IWM) is used.	50-year probability	It is based on the fact that the discharge in the 1998 flood, which caused the largest damage in the past, is generally evaluated to correspond to 50-year return period[4], and that the largest external force among the available IWM hazard maps is of the 50-year return period.
Flash Flood	Since there is no data available to uniformly assess the hazard in the target areas, the damage potential will be assessed based on distribution of population, GDP, infrastructure, and industrial parks.	-	-
River Erosion	Analysis of river channel evolution based on time series satellite imagery is conducted.	-	-
Inland Flood	Due to the lack of past disaster history information on inland water inundation, simple hydraulic simulations using the RRI model are conducted to roughly estimate the inundation characteristics.	25-year probability	Since there is no information on the scale of past rainfall that can be referred to, it is set by referring to the external force setting conditions adopted in the stormwater drainage M/P study for Dhaka City (2015).
Storm Surge	Scanned data of storm surge inundation hazard map from the Multi-Hazard Risk and Vulnerability Assessment, Modeling and Mapping (MRVAM) is used.	100-year probability	It is set based on the fact that the storm surge hazard caused by the 1991 cyclone is evaluated to have a 100-year probability of occurring[5].
Earthquake	Scanned data of MRVAM's seismic hazard map image is used.	1000-year probability	Since Bangladesh has not experienced any recent major earthquake damage that can be referred to, it is set based on the largest recent case in Japan (Great East Japan Earthquake).

Source: JICA Survey Team

[4] Economics of Adaptation to Climate Change, World Bank, 2010
[5] Disaster Risk Financing in Bangladesh, Mayumi Ozaki, ADB, 2016

Table 3.4.2 Data to be Considered in Disaster Risk Analysis

No.	Items	Conditions for Data Preparation	Evaluation Method
1	Population	The population distribution as of 2030 is obtained by correcting the values of each mesh in WorldPop's 100-meter resolution population dataset to be consistent with the population projections as of 2030 for each District published by the Bureau of Statistics.	Count the population that overlaps with each disaster hazard. In counting the number of people who are affected by the hazards, the damage function described later is taken into account, and the damage rate corresponding to the magnitude of the hazard is multiplied.
2	GDP (Total of All Sector)	Based on national future GDP projections as of 2030, population future projections as of 2030, and the number of workers by sector in each Upazila based on the 2011 census, the GDP of each economic sector is estimated for each Upazila Furthermore, the GDP per capita of each Upazila is estimated by dividing these sectoral GDPs by the population of each Upazila in 2030.	The amount of damage is quantified by multiplying the aforementioned affected population by the GDP per capita calculated for each Upazila.
3	GDP (Agricultural Sector)		
4	GDP (Industrial Sector)		
5	GDP (Service Sector)		
6	Road	Information on the spatial layout of the existing road network is obtained.	Count road lengths that overlap with disaster hazards.
7	Railway	Information on the spatial layout of the existing railway network is obtained.	Count railway lengths that overlap with disaster hazards.
8	Bridge	Location information of major bridges is obtained. In addition, new bridges that are scheduled to be completed in recent years are also included in the dataset.	Count the number of facilities that overlap with disaster hazards.
9	Airport	Location information of existing domestic airports is obtained.	Count the number of facilities that overlap with disaster hazards.
10	Sea Port	The location of existing domestic sea ports is obtained. In addition, new ports scheduled to be completed in recent years are also included in the dataset.	Count the number of facilities that overlap with disaster hazards.
11	Power Plant	The location of existing power plants in the country is obtained. Also new power plants scheduled to be completed in recent years are included in the dataset.	Count the number of facilities that overlap with disaster hazards.
12	Industrial Zone	Location information of existing industrial zones in the country is obtained. In addition, the dataset also includes new Japanese dedicated industrial park that are scheduled to be established in the near future.	Count the number of facilities that overlap with disaster hazards.

Source: JICA Survey Team

Table 3.4.3 Evaluation Indices for Disaster Risk Analysis

No.	Item	Evaluation Index	Reason for Selecting the Index	Point	Point
1	Affected People	Number of Affected Population per Upazila	To reflect the affected population in the identification of candidate areas.	30	30
2	Economic Damage	Damaged GDP per Upazila (Sum of Agriculture, Industry and Service Sectors)	To reflect economic damage in the selection of candidate areas.	30	30
3	Damage to Infrastructure	Affected Road Length per Upazila (km)*	To reflect the impact on road infrastructure in the identification of candidate areas.	5	30
		Affected Rail Length per Upazila (km)*	To reflect the impact on rail infrastructure in the identification of candidate areas.	5	
		Number of Bridges Affected per Upazila*	To reflect the impact on bridge infrastructure in the identification of candidate areas.	5**	
		Number of Affected Airports per Upazila *	To reflect the impact on airport infrastructure in the identification of candidate areas.	5	
		Number of Affected Sea Ports per Upazila *	To reflect the impact on sea port infrastructure in the identification of candidate areas.	5	
		Number of Affected Power Plants per Upazila *	To reflect the impact on power generation infrastructure in the identification of candidate areas.	5	
4	Damage to Industrial Parks	Number of Affected Industrial Parks per Upazila *	To reflect the impact on the industrial parks in the selection of candidate areas.	10	10
Total					100

Source: JICA Survey Team

Note: * In assessing the affected infrastructure facilities and industrial parks, different damage conditions are assumed depending on the scale of the external force. In this case, although the allowable external force for each facility actually depends on the design of each individual facility, the correction factors are multiplied to the evaluation points, taking into account the classification of the scale of external force in the available hazard data.

** As for the evaluation of the impact on bridges, in floods and storm surges, inundation depths are evaluated only in land areas, and it is difficult to evaluate inundation in water areas, so bridges are reflected in the evaluation only in seismic hazards. Therefore, bridges are only included in the evaluation for seismic hazards. If bridges are not included in the evaluation, 6 points are allocated for other infrastructure facilities.

CHAPTER 4 FUTURE DIRECTIONS IN DISASTER RISK REDUCTION SECTOR

4.1 Overview

A disaster risk assessment is conducted for the disaster types targeted in this survey, and areas that should be prioritized in the future are selected based on the results. After considering specific coping policies for them, the direction of future cooperation is examined. The direction of future cooperation is organized for each field shown at the right end of the table below, taking into consideration the relationship with JICA's cooperation fields so far.

Table 4.1.1 Areas for Organizing Future Directions in This Survey

Target disaster type/field in the survey	Areas of risk analysis	Areas to organize future directions (Items in this chapter)
Flood	Major river flood	4.2 River management
	Flash flood	
River erosion	River erosion	
Urban flood (Inland flood)	Urban flood	4.3 Urban flood
Storm surge	Storm surge	4.4 Storm surge and coastal management
Earthquake	Earthquake	4.5 Earthquake
		4.6 Meteorological forecasting and warning
		4.7 Disaster risk governance

Source: JICA Survey Team

The flowchart of project concept formulation is shown below. Project concepts are proposed based on the issues obtained through the survey, lessons learned from past JICA and other donor projects, and the results of disaster risk analysis, taking into consideration the strategy of Bangladesh, synergy with past JICA cooperation, etc.

In the areas of meteorological forecasting and warning and DRR governance, no disaster risk analysis is conducted. The project concepts for these areas are developed based on the issues identified through discussions with relevant agencies and lessons learned from previous JICA projects.

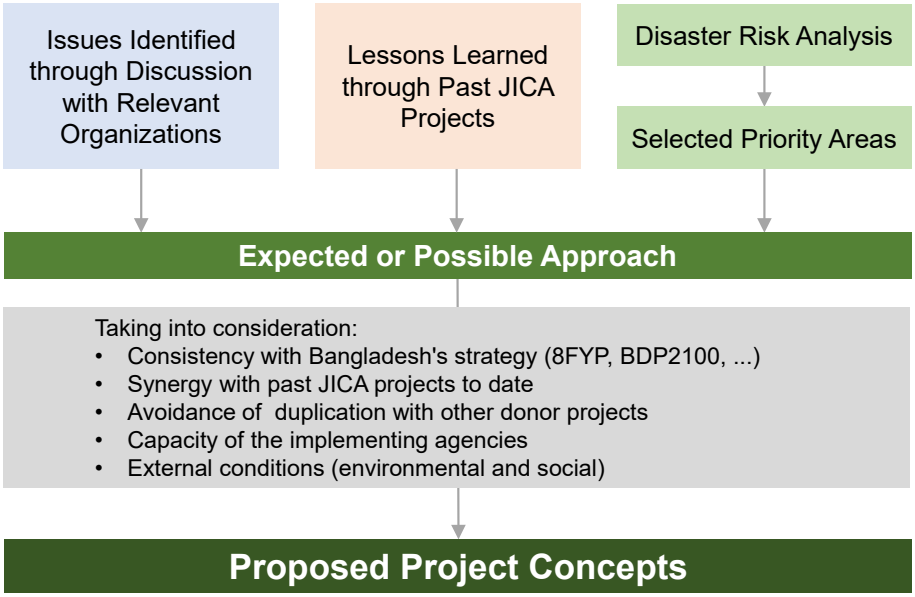


Figure 4.1.1 Examination Flow from Disaster Risk Analysis to Project Concepts Proposal

4.2 River Management

4.2.1 Achievements and Lessons Learned from JICA's Cooperation

(1) JICA's Cooperation in the Past

Table 4.2.1 Major DRR-related Surveys and Projects by JICA (River Management)

Project	Scheme	Implementation Period
Flood Control and Drainage Plan in Northwestern Region	Development research	Jan 1991 – Jan 1993
Operation and Maintenance Study for Action Plan for Flood Control	Development research	Jul 1992 – Aug 1992
Project for Protecting Revetment on the Bank of Meghna River	Grant aid	Jun 1992 – Jan 1994
Action Plan for Flood Control	Research cooperation	Jul 1994 – Jul 1997
Project for Improving Revetment on the Bank of Meghna River	Grant aid	Mar 1997 – Feb 1998
Advisor for Water Resources Development Policy	Technical cooperation	May 1999 – May 2002
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
Advisor for Water Resources Management Planning	Technical cooperation	Apr 2004 – Apr 2006
River Management Advisor	Technical cooperation	Sep 2010 – Sep 2014
Integrated Water Resource Management Advisor	Technical cooperation	Sep 2014 – Sep 2016, Jul 2019 – Mar 2022
Water Resources Management Policy and Technical Advisor	Technical cooperation	Jul 2022 – Jun 2025
The Project for Capacity Development of Management for Sustainable Water Related Infrastructure	Technical cooperation	Jul 2013 – Jun 2016
Research Project on Disaster Prevention/Mitigation Measures against Floods and Storm Surges (SATREPS)	Technical cooperation	Apr 2014 – Mar 2019
Project for Planning Capacity Enhancement and Establishment of a Technology Adaptation Cycle on Comprehensive Nodi (River) Management	Technical cooperation	May 2020/5 – Apr 2024
Haor Flood Management and Livelihood Improvement Project	Loan	Jun 2014 – Apr 2023
Disaster Risk Management Enhancement Project (Maintenance of polders for storm surge)	Loan	Jun 2016 – Jun 2025

Source: JICA Survey Team added to JICA materials

(2) Lessons Learned from the Results of Cooperation

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. 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.

JICA has 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. This is due to the widespread awareness that facility specifications are determined at the discretion of the construction site, the lack of awareness of compliance with the guidelines, and the absence of a mechanism to properly manage the construction process (see 4.2.3 and 4.4.3 for details). It is considered important to explore the establishment and dissemination of strong embankments in cooperation with Bangladesh.

Since more than 90% of the catchment areas of major rivers flowing through Bangladesh are located outside the country, Bangladesh has not been able to develop basin-wide river management plans. 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 for small and medium sized river basins through the implementation of the project.

In the field of river management, lessons learned from the previous cooperation are listed below.

- ✓ Difficulties in river channel management, especially river channel stabilization for major rivers
- ✓ Importance of establishing and promoting resilient embankment construction methods
- ✓ Necessity to promote a comprehensive river management approach that takes into account the catchment area in the small and medium-sized river basins
- ✓ Necessity to address flash floods in small and medium-sized rivers
- ✓ Importance of river management based on the interaction between water and sediment transport

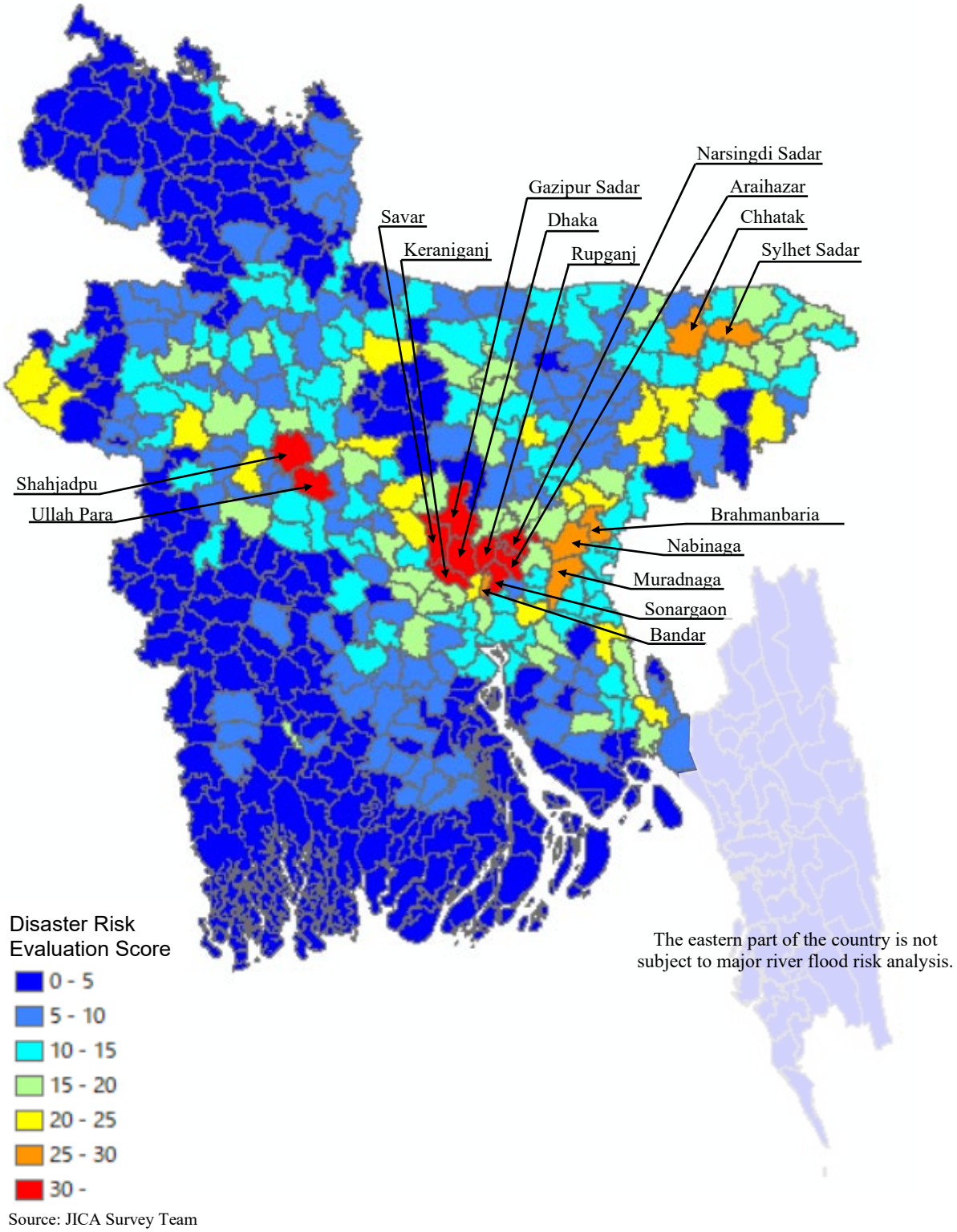
4.2.2 Conduct of Disaster Risk Analysis

(1) Major River Flood

The assessment results from the disaster risk analysis are shown below.

- ✓ As a center of economic activity, the Dhaka metropolitan area and its environs have the highest flood risk, resulting in the highest impact in terms of affected population, industry and service sector economic damage.
- ✓ Similarly, disaster risk is high in the eastern part of Dhaka, especially along the Meghna River. This is due to the high concentration of industrial parks in the eastern part of Dhaka. The main cities are scattered along the Meghna River.
- ✓ Disaster risk is high in the hub cities on the right bank of the Jamuna River. The agricultural sector in particular is considered to be severely affected.
- ✓ In addition, the flood risk is high in and around Sylhet, the industrial hub of the northeast. This area is in the Haor region, which is subject to major flooding almost every year.

The results of the major river flood disaster risk assessment based on the distribution of scores are shown in Figure 4.2.1 below.



Source: JICA Survey Team

Figure 4.2.1 Results of Risk Analysis (Major River Flood)

Figure 4.2.1 represents a comprehensive risk score calculated from the possible life and economic losses, infrastructure damage and industrial zone damage, which clearly shows the relative risks among different areas. Based on the figure, the following areas are identified as priority areas for flood risk management in terms of disaster risk assessment points.

Table 4.2.2 Selection of Priority Areas (Major River Flood)

No	District	Reasons for Selection	Upazila of Particular Interest
1	Dhaka metropolitan area and its suburbs	Severe impact on the affected population and economic activities, especially in the industrial and service sectors.	Central Dhaka Gazipur_Sadar Keraniganj Rupganj Savar
2	Areas alongside of Meghna River in Eastern Dhaka	Severe impact on the affected population and economic activities, especially in the industrial and service sectors.	Narsingdi_Sadar Sonargaon Araihazar Muradnagar Nabinagar Brahmanbaria_Sadar Bandar
3	Right bank of the Jamuna River	Affected population is large, and the impact on the agricultural sector is enormous.	Shahjadpur Ullah_Para
4	Sylhet and surrounding areas	Severe impact on the affected population and economic activities, especially in the agriculture and service sectors.	Sylhet_Sadar Chhatak

Source: JICA Survey Team

(2) Flash Flood

As for flash floods, there is no hazard map for understanding the inundation status during floods and the erosion status of river banks and embankments, and it is difficult to conduct risk analysis by superimposing hazards, population, assets, and infrastructure facility layout as in other disaster types. Therefore, the potential of damage of each Upazila is quantitatively evaluated based on the by aggregating the population, GDP, infrastructure, and the concentration of industrial parks in each Upazila without considering the hazard superposition and the damage rate based on the size of the hazard. The results are shown in the table below.

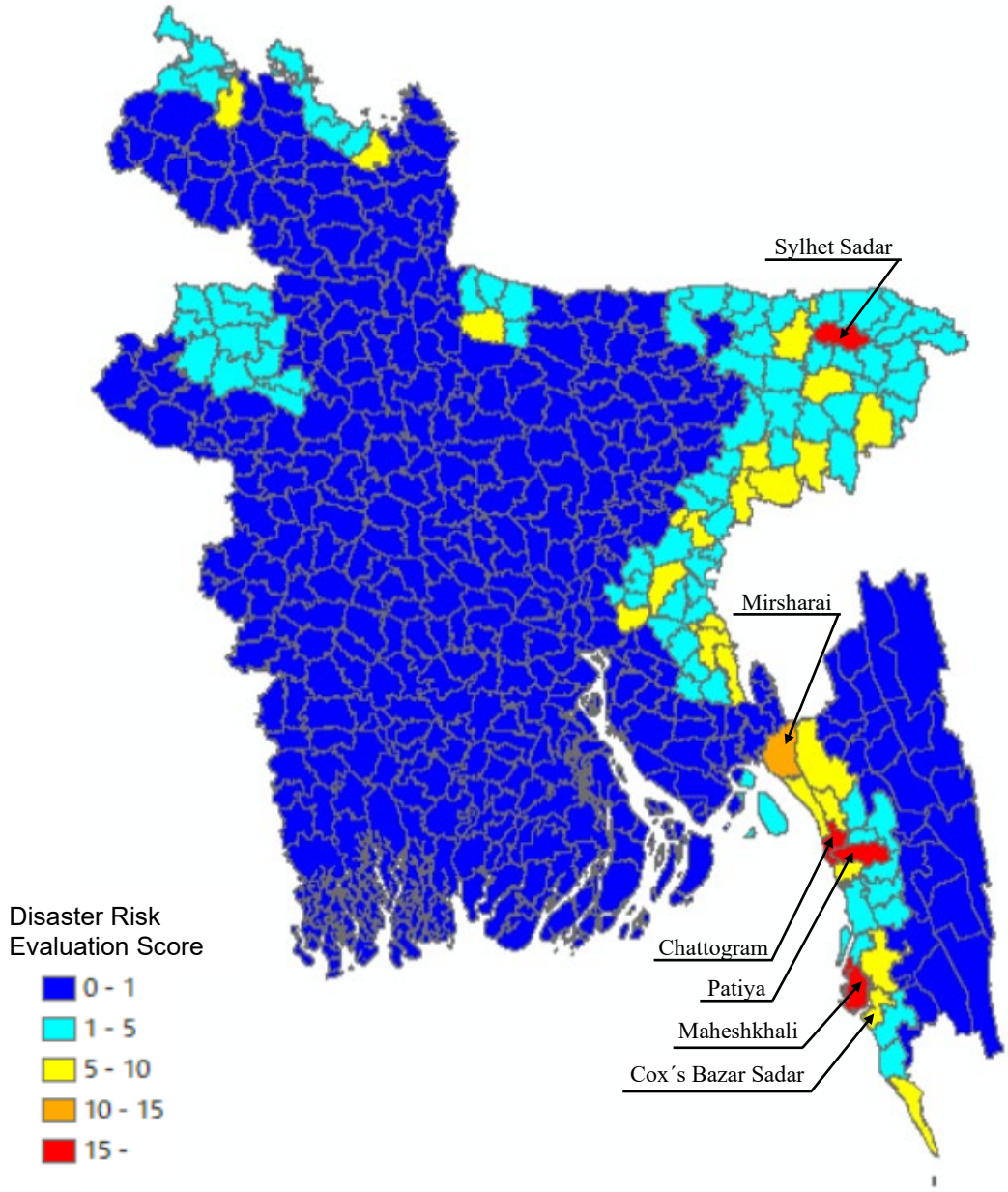
- ✓ The damage potential of the Chattogram urban area and its suburban industrial area as a hub of economic activity is the highest, resulting in a significant impact in terms of economic damage to the affected population, industry, and service sector.
- ✓ Mogheshkhali and Cox's Bazar townships, which have a high concentration of industrial parks, are also assessed to have high damage potential.
- ✓ In addition, Sylhet, the industrial hub of the northeast, has high damage potential.

The following locations are identified as focus areas where flash flood risk management needs to be prioritized.

Table 4.2.3 Selection of Priority Areas (Flash Flood)

No	District	Reasons for Selection	Main Target River Basins	Upazila of Particular Interest
1	Chattogram city center and surrounding areas	Severe impact on industrial activities in and around central Chattogram, one of the nation's most important industrial centers.	Karnaphuli River Basin	Chattogram Mirsharai Sitakunda
			Sangu River Basin	Patiya Anwara
2	Moheshkhali and Cox's Bazar city center	The impact on the industrial park that will be developed and the population damage in the southernmost regional center will be enormous.	Matamufuri River Basin	Maheshkhali
			Bakkhali River Basin	Cox's_Bazar_Sadar
3	Sylhet city center	Severe population damage in regional centers in the northeast and impact on economic activities, especially agriculture and service sectors.	Surma River Basin (Upper Section)	Sylhet_Sadar

Source: JICA Survey Team



Source: JICA Survey Team

Figure 4.2.2 Results of Risk Analysis (Flash Flood)

(3) Riverbank Erosion

Riverbank erosion differs from other disaster types as it requires assessment based on the understanding of trends in change over time, rather than impact assessment at the time of a specific large-scale event, thus a different approach is adopted.

The river extraction method applied as it was developed in the "Project for Strengthening Planning Capacity and Technology Adaptation Cycle for Comprehensive River Management in Bangladesh".

The channel shape polygons and their buffers of 100m, 500m, 1000m, 2000m, and 5000m outside of the channel area (riverbank) were generated from Landsat satellite images archive.

The population for 2030 that are living within maximum extent of river (channel area) and its buffer zones are calculated (Table 4.2.4). In 2021, 160,000 people lived in the buffer zones of 100m from the maximum extent of riverbank in 2021 in area of 166 km^2. Similar study shows area of buffer zone of 5000 m is 7,089

km^2. The number of people living only in buffer zone (not main river channel) ranged from 176,000 (100m) to 9,416,000 (5,000m). It is clear that many people live in the areas near river channels, which are at high risk of loss of assets such as houses and farmland due to riverbank erosion.

The districts (Upazila) that are partly included in the riverine area for 34 years (1988-2021) were extracted (Figure 4.2.3, colored based on the population density of the county). The settlements included in these Upazila can be considered to be at risk of riverbank erosion.

Table 4.2.4 Population Living in Main River Channel and River Buffer Zones

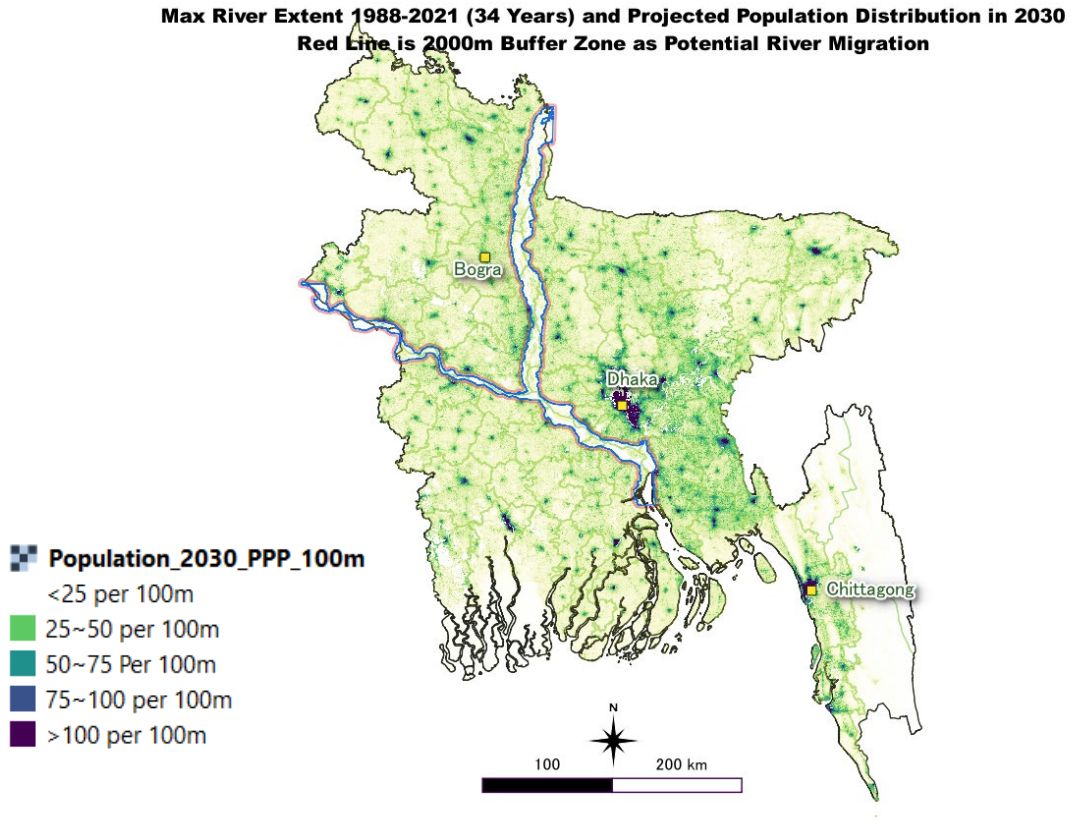
Items	Channel area from 1988 to 2021 (34 Years)		Channel area 2017 to 2021 (5 years)		Channel area in 2021	
	Population	Area (km^2)	Population	Area (km^2)	Population	Area (km^2)
Max. River Extent	2,942,000	3,804	2,037,000	2,735	1,537,000	2,004
Max. River Extent＋100m	3,169,000	3,968	2,227,000	2,893	1,713,000	2,170
Max. River Extent＋500m	4,069,000	4,563	2,970,000	3,451	2,429,000	2,773
Max. River Extent＋1,000m	5,166,000	5,271	3,915,000	4,128	3,353,000	3,504
Max. River Extent＋2,000m	7,250,000	6,642	5,819,000	5,487	5,244,000	4,920
Max. River Extent＋5,000m	13,112,000	10,597	11,598,000	9,539	10,953,000	9,093

Source: JICA Study Team

Table 4.2.5 Selection of Priority Areas (River Bank Erosion)

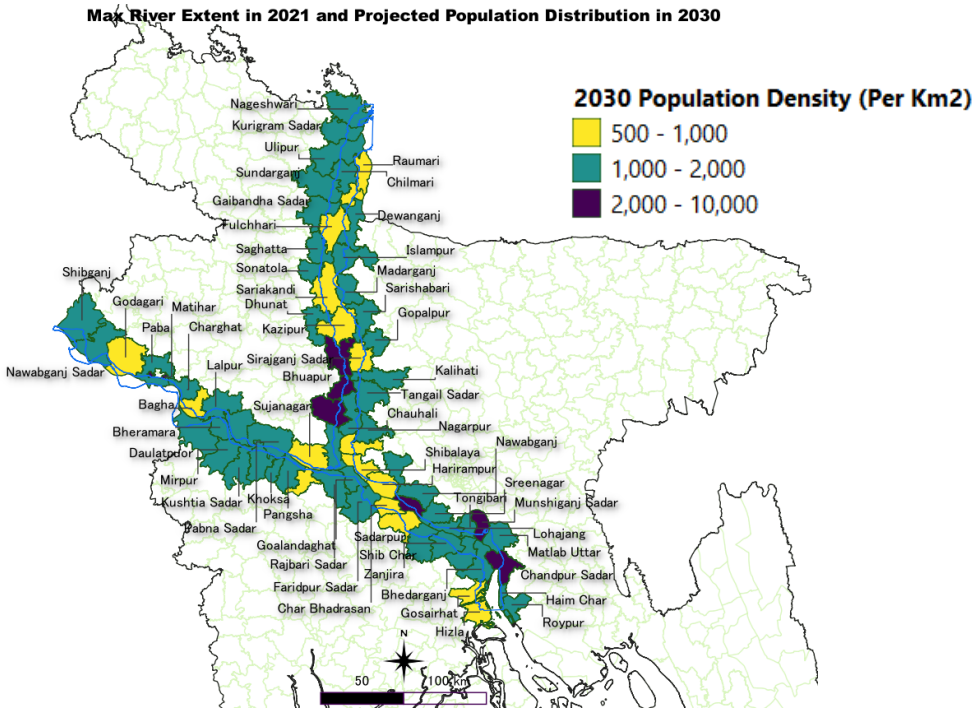
No	District	Reasons for Selection	Upazila of Particular Interest
1	Along Jamuna River	Severe impacts on economic activity due to drastic changes in riverbanks	Sirajganj Sadar Shahjadpur Chauhali Sariakandi
2	Along Downstream of Meghna River	The area is important for economic development. Ongoing development of special economic zones and the improvement of the transportation network will further increase its importance.	Chandpur Shariatpur
3	Along Downstream of Padma River	The banks of the Padma River are particularly unstable and threatened by extreme erosion; the completion of the Padma Bridge will lead to rapid economic development in the surrounding area.	Harirampur Naria

Source: JICA Study Team



Source: JICA Survey Team

Figure 4.2.3 Maximum River Extent (Channel Area) with 2,000m Buffer Zone for 34 years (1988-2021) and Population Distribution in 2030



Note: The figure shows areas focusing on the major rivers that are the subject of this analysis, not the entire country.
Source: JICA Survey Team

Figure 4.2.4 Upazila Partially Included in the Maximum Riverbank Areas from 1988 to 2021 (34 years)

4.2.3 Issues Obtained through the Survey

The following table shows the main issues and challenges in the field of river management obtained through discussions with related organizations, field surveys and literature surveys. The establishment of effective countermeasures for channel stabilization for large rivers, and basin-wide river management in small and medium-sized river basins are considered as major issues to be addressed, respectively. In levee management, the persistent problem is that although a large amount of budget is invested in restoration and repair of levee damage caused by floods, repeated damage cannot be reduced, and efforts to ensure the quality of levees are desired.

Table 4.2.6 Issues and Challenges in River Management

Item	Issues and Challenge
Insufficient Basin-wide Flood Management Approaches in Small and Medium-sized Rivers in the East	The importance of a planned water management approach has been highlighted in the 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. In small and medium-sized rivers in the eastern part of the country, basin-wide river management is applicable, but it is not being practiced sufficiently at present. As a result, there is a possibility that embankment construction and dredging projects conducted at one location may increase the risk of damage at another location, and studies have not been conducted from the perspective of minimizing risk in a comprehensive manner.
Vicious Cycles in the Construction, Rehabilitation and Maintenance of River Structures	One of the major problems in water management is the failure to reduce repeated damage despite investing a large amount of budget in rehabilitation and repair of embankments damaged during floods. River structures with low durability are constructed, damaged by floods, and then inadequately repaired due to 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 a 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. Also, there is 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.
Insufficient Understanding of Future Disaster Risk Areas and Insufficient budgets for Pre-disaster Investment	Flood management measures for new development areas has not yet been fully installed. 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. Also, the concept of pre-disaster investment is still in the process of penetration in the existing water management that lives with floods and allows flooding to occur. In addition, future risk areas have not been identified and investment priorities have not been organized. Although it is necessary to consider project prioritization based on risk and benefit-cost analysis in order to continuously implement DRR projects, the practice of selecting projects based solely on political aspects is still deeply rooted.
Difficulties in Acquiring Land for Implementing Flood Control Projects in Urban Areas	In urban rivers, there are some cases in which the implementation of levee improvement plans along urban areas has not progressed. Although the need for levee construction is recognized, illegal land occupation, purchase of urban land by private developers who expect land price increases, complicated land-rights due to repeated land resales, illegal land reclamation, and other factors have made land acquisition less feasible, and the construction of the embankment has not been realized. In addition, the lack of laws and regulations in Bangladesh that envisage the process of consultation with communities affected by land acquisition and resettlement is another factor causing difficulties in land acquisition. There is a possibility that the problem of land acquisition can be solved through funding and compensation by public organizations for the implementation of the project. However, even in such a case, the burden on local residents due to resettlement associated with project implementation is significant.

Item	Issues and Challenge
Establishment of Effective Methodologies for River Channel Management in Large Rivers	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, 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. While it is widely recognized that riverbank erosion is a major problem, drastic measures have not been established so far due to the technical difficulties in finding a fundamental solution.
Insufficient River Management in Response to Changing External forces due to Climate Change.	It is assumed that extreme rainfall events of unprecedented scale will continue to occur in the future, such as the heavy rains that occurred mainly in the north-eastern districts of Sylhet and Sunamganj in June 2022. In order to reduce flood risks from possible future major floods, it is a prerequisite that existing river structures, including river channels, are properly managed to maximize their capacity. In particular, river channels need to be enhanced in terms of flood risk reduction by widening, dredging, embankment construction, shortcuts, etc. In such cases, effective and sustainable measures should be implemented according to the hydrological and hydraulic characteristics of the target area.
Difficulties in Ensuring the Accuracy of Flood Forecasting Systems	Bangladesh 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 prediction, collection of hydrological information outside Bangladesh is essential. Also, 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. 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. Under the current arrangement with India, water level data is only provided at a limited number of locations, and the frequency of such data is limited to twice a day. Considering the characteristics of flash floods, where water levels and flow rates change over a short period of time, more frequent acquisition of hydrological data is desirable.
Low Accuracy of Inundation Area Forecasts	Since the hydraulic model 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 flood plain and its reproduction are carried out by interpolation. However, the interpolated inundation map is prepared based on a coarse-resolution Digital Elevation Model (DEM) with 300 m resolution model created based on survey results conducted decades ago. The output has not been validated, causing errors in some areas.

Source: JICA Survey Team

4.2.4 Future Directions Considered from Issues and Lessons Learned

In the river management of large rivers, as described in the aforementioned issues and lessons learned from past JICA projects, it is important to strengthen the technical approach to river channel stabilization, and continued cooperation can be considered based on the technical cooperation projects currently being implemented. For small and medium-sized rivers, it is important to establish comprehensive flood risk reduction practices through the development of basin-based project plans and their implementation. Cooperation for project implementation could be considered especially in rivers in the eastern Chattogram hilly areas, which are considered to be at high disaster risk.

Table 4.2.7 Formulation of Possible Project Concepts (River Management)

Issue	Lesson learned	Approach	Proposed project
Insufficient basin-wide flood management approaches in small and medium-sized rivers in the East	● Necessity to promote a comprehensive river management approach considering the basin; ● Difficulty in managing river channels, especially stabilizing river channels; ● Importance of establishing and disseminating strong embankment construction methods; ● Necessity of measures against small and medium-sized river floods (flash floods); ● Importance of river management based on the interaction between water and sediment movement.	● Implementation of projects based on the basin-wide comprehensive river management planning ● To clarify the mechanism of river channel change and enhance approaches for erosion damage prevention ● Introduction of efficient river patrol and surveying system ● River management responding to changes of hazard due to CC ● Introduction of embankment technologies for urban rivers that require less land acquisition ● Further discussions on strengthening the durability of the embankment and confirmation of the effectiveness of existing pilot projects ● Automation and frequency of hydrological observation ● Strengthening cooperation among related orgs. in geospatial information development ● Two-dimensional flood forecasting system	Comprehensive Water Management Project in Southeastern Three Rivers in Chattogram Hills Comprehensive Flood Risk Management Project in Cox's Bazar Capacity Development Project for Comprehensive River Management (Phase II)
Vicious cycles in the construction, rehabilitation and maintenance of river structures			
Lack of understanding of future disaster risk areas and lack of budget for prior investment			
Difficulty in acquiring land for implementing projects in urban areas			
Lack of effective measures for river channel management of large rivers			
Inadequate river management against changing hazards due to climate change			
Flood forecasting system for flash floods with less accuracy and long time calculations			
Low accuracy of inundation area prediction			

Source: JICA Survey Team

Table 4.2.8 provides an overview of the project concepts that are expected to be implemented. With regard to flood risk management projects, the focuses are on the small and medium river basins in Chattogram and Cox's Bazar from the viewpoint of protecting the Big-B areas as well as utilizing Japanese technology and knowledge. Through the cooperation for these small and medium-sized river basins, the process from basin-wide planning to project implementation can be practiced in Bangladesh. The flood management master plans and local DRR Plan in Cox's Bazar will be formulated through ongoing JICA's capacity development projects. The proposed projects will be implemented based on the output from these on-going projects.

With regard to riverbank erosion, JICA and other donors are currently exploring effective measures through projects, and will work to utilize and disseminate the results of these ongoing projects.

Table 4.2.8 Proposed Projects to be Implemented by 2030 (River Management)

Name of Project Concept	Project Scheme	Target Area	Outline	Conformity with the Short-term Plan of Bangladesh	Effects/ Concerns	Imple-mentation Organi-zation	Assumed Project Implementation Period
Comprehensive Water Management Project in Southeastern Three Rivers in Chattogram Hills	Financial Investment	Karnaphuli River basin, Sangu River basin, Matamuhuri River basin.	Japanese-style flood management and water resources management practices (planning construction maintenance)	BDP 2100 (CH 26.2) BWDB Preferred Project List	Flood Control /Land acquisition and resettlement.	BWDB	2026-2030 To be Implemented after completion of NODI Project.
Comprehensive Flood Risk Management Project in Cox's Bazar	Financial Investment	Bakkhali River and Coastal Areas	Comprehensive flood management, including inland flood, storm surge and sediment management	-	Flood Control /Land acquisition and resettlement.	BWDB	2026-2030 To be Implemented after completion of Local DRR Planning Capacity Enhancement Project.
Capacity Development Project for Comprehensive River Management (Phase II)	Technical Cooperation Project	Nationwide	National roll-out of the technology adaptation cycle studied in "Phase 1" Identification of issues and optimal design of submerged levee in northeastern region	BWDB Preferred Project List Sustainable Management of Brahmaputra - Jamuna River including Channelization and Riverbank Stabilization	Improved technology at national level; reduced maintenance costs. / Establishment of the technology adaptation cycle in "Phase 1	BWDB	2026-2030 To be Implemented after completion of NODI Project.

Note) Regarding the project implementation period, it is necessary to conduct F/S and other surveys in the future, so the information is provisional at this stage.
Source: JICA Survey Team

4.3 Urban Flood

4.3.1 Achievements and Lessons Learned from JICA's Cooperation

(1) JICA's Cooperation in the Past

Table 4.3.1 Major DRR-related Surveys and Projects by JICA (Urban Flood)

Project	Scheme	Implementation Period
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	Jan 1991 – Jan 1993
Project for the Improvement of the Storm Water Drainage System in Dhaka City Phase II	Grant aid	Feb 2007 – Aug 2009

Source: JICA Survey Team added to JICA materials

(2) Lessons Learned from the Results of Cooperation

From 1990 to 2000, JICA formulated a rainwater drainage M/P and provided a drainage pump station for Dhaka, and measures against inland flood, mainly on the west side of Dhaka City, are 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 core cities of the region, such as Khulna and Barisal, drainage pump stations and other facilities have not been fully developed. Urgent drainage measures are needed, but little support has been provided for project implementation. In the area of Urban Flood, lessons learned from previous cooperation are shown in below.

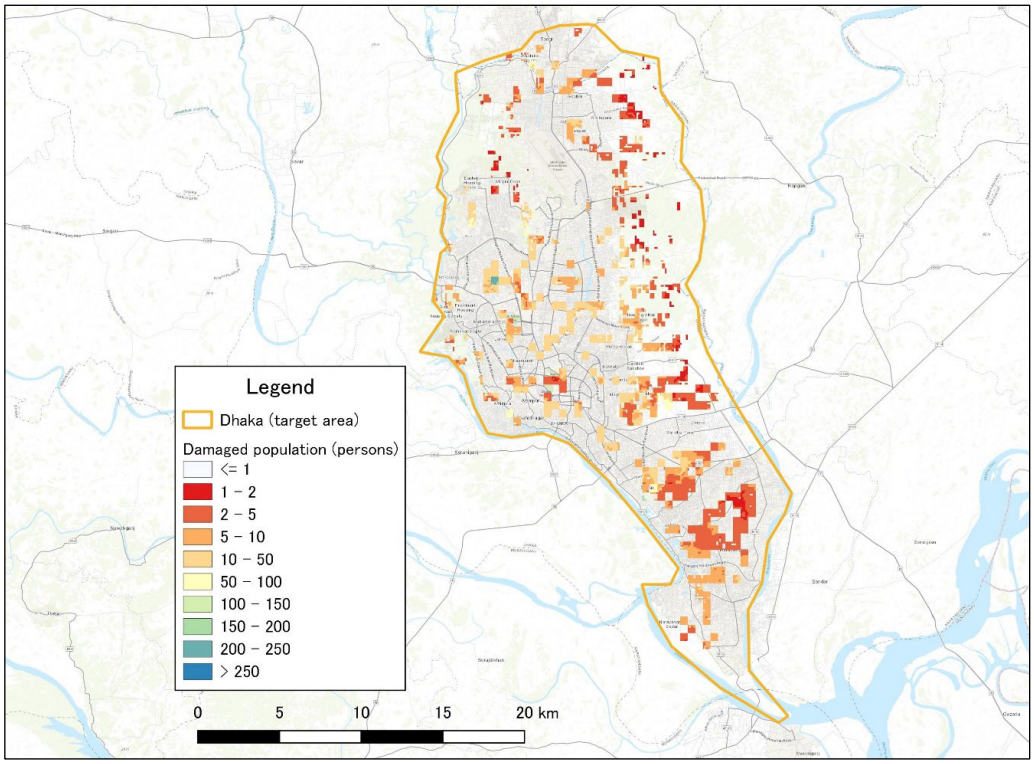
- ✓ Importance of planned drainage projects in harmony with rapid urban development
- ✓ The need for drainage measures in major regional cities
- ✓ Difficulties in the proper maintenance of drainage management facilities
- ✓ Promotion of organic linkages with other projects, especially waste management
- ✓ The need for expanded system of drainage management and mechanism to facilitate planning

4.3.2 Conduct of Disaster Risk Analysis

The inundation depth and inundation distribution were obtained by simple analysis of inland flood due to rainfall on a 25-year return period (duration of 3 days), and the estimated affected population and damage amount were calculated. The distribution of the estimated affected population and the amount of damage (all industries) in the five cities (Dhaka, Chattogram, Khulna, Barisal, Sylhet) are shown in Figure 4.3.1 through Figure 4.3.10 and Table 4.3.2.

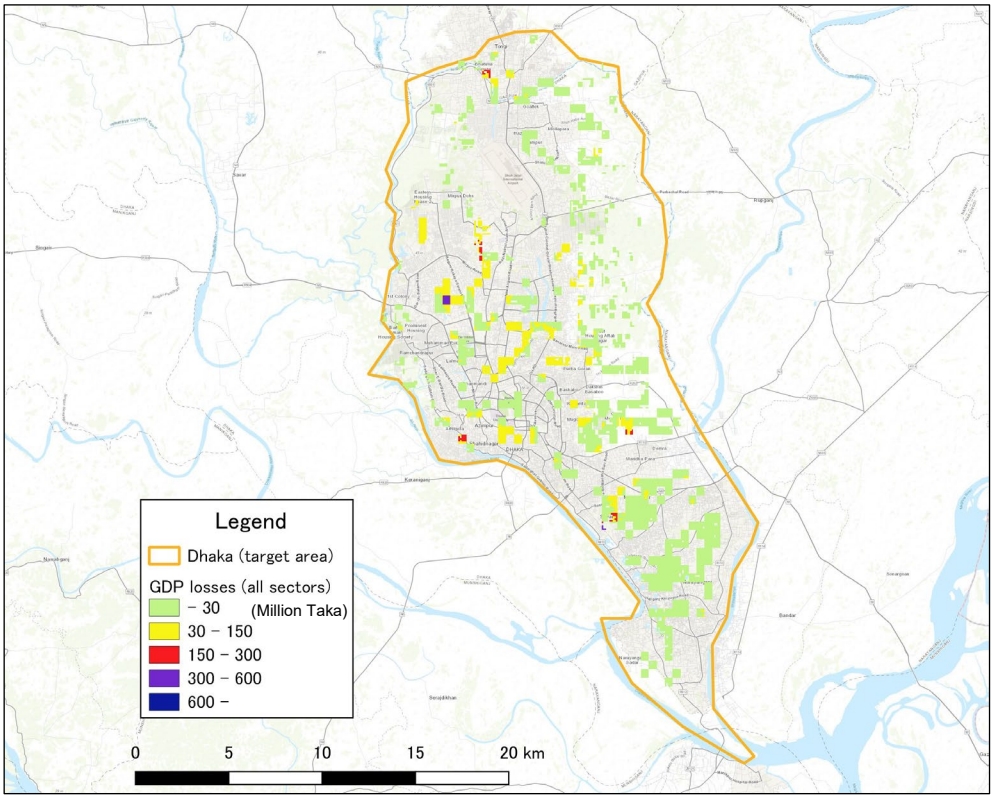
Affected Population: Dhaka has the largest affected population, followed by Chattogram, while Sylhet, Khulna, and Barisal have less than 1/10 of the that of these two largest cities. In Dhaka, the affected population is distributed throughout the entire area, and the areas where affected population is concentrated (more than 50 persons/0.01 km^2) exist locally from the center to the western area. In Chattogram, there are the areas where affected population is concentrated locally, while in the other three cities, the affected population is limited to 50 persons/0.01 km^2 at most. The result indicates that the larger the size of the city is, the more concentrated the residential population is in areas at high risk of inundation.

Damage amount: Dhaka has the highest total damage in all sectors, followed by Chattogram and Sylhet. By sector, the industrial sector has the largest damage except Barisal, and the service sector tends to have the largest damage in Barisal.



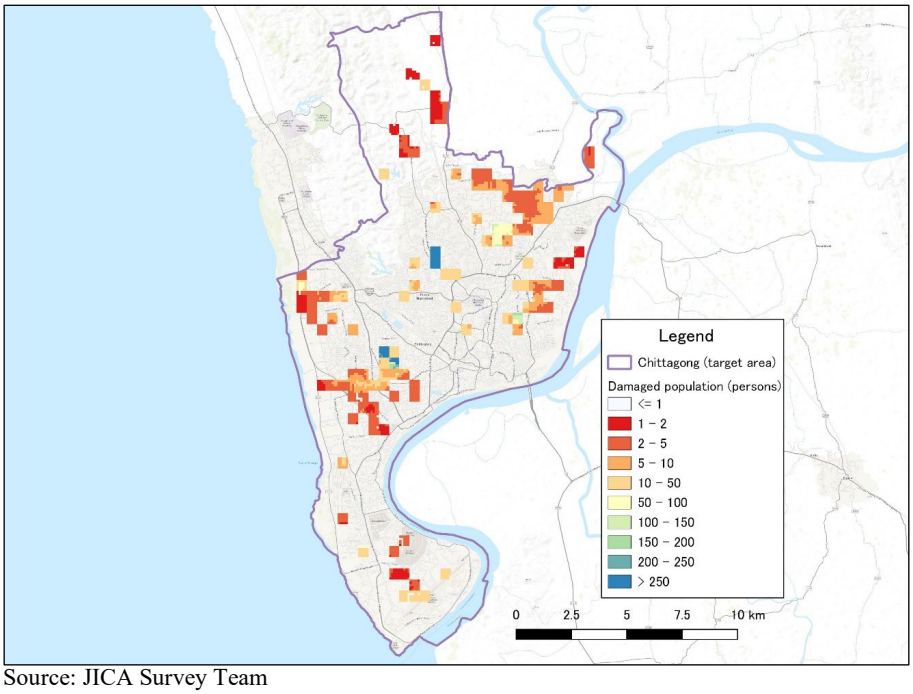
Source: JICA Survey Team

Figure 4.3.1 Distribution of Affected Population (Urban Flood, Dhaka)



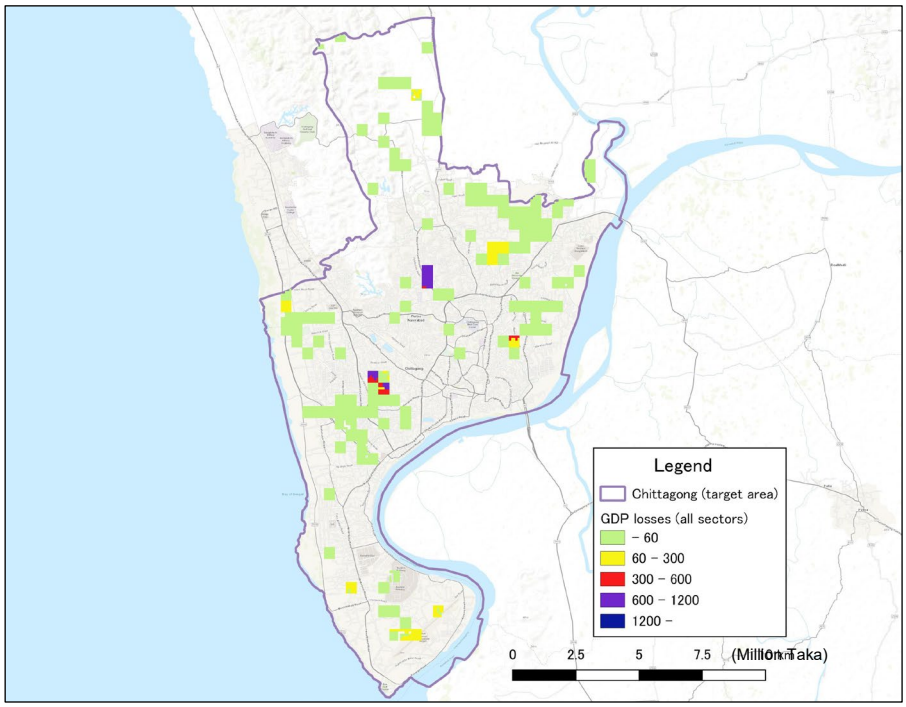
Source: JICA Survey Team

Figure 4.3.2 Distribution of Damage Amount (All Sectors, Urban Flood, Dhaka)



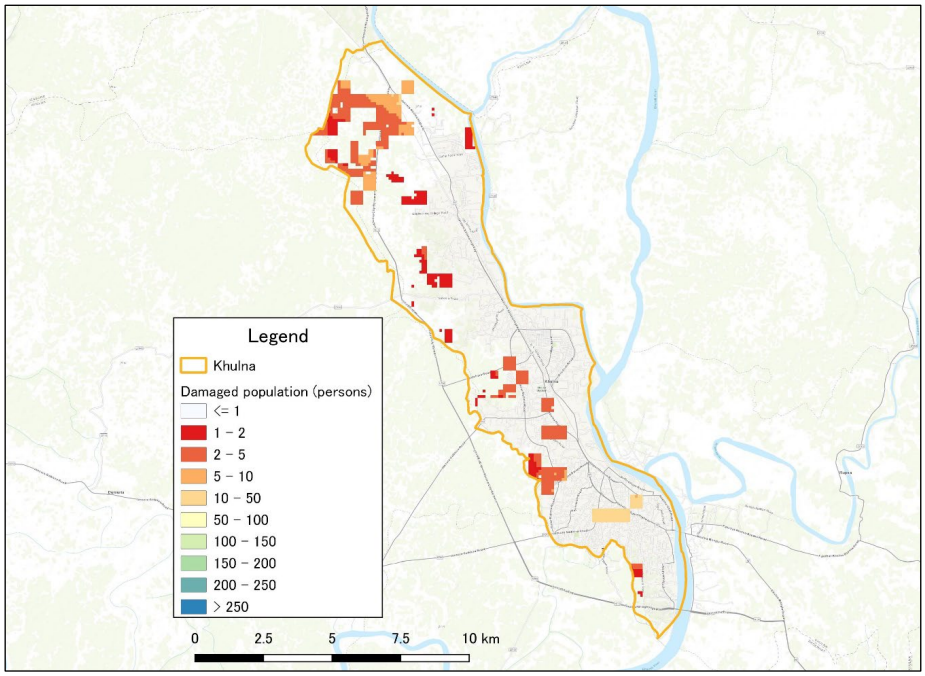
Source: JICA Survey Team

Figure 4.3.3 Distribution of Affected Population (Urban Flood, Chattogram)



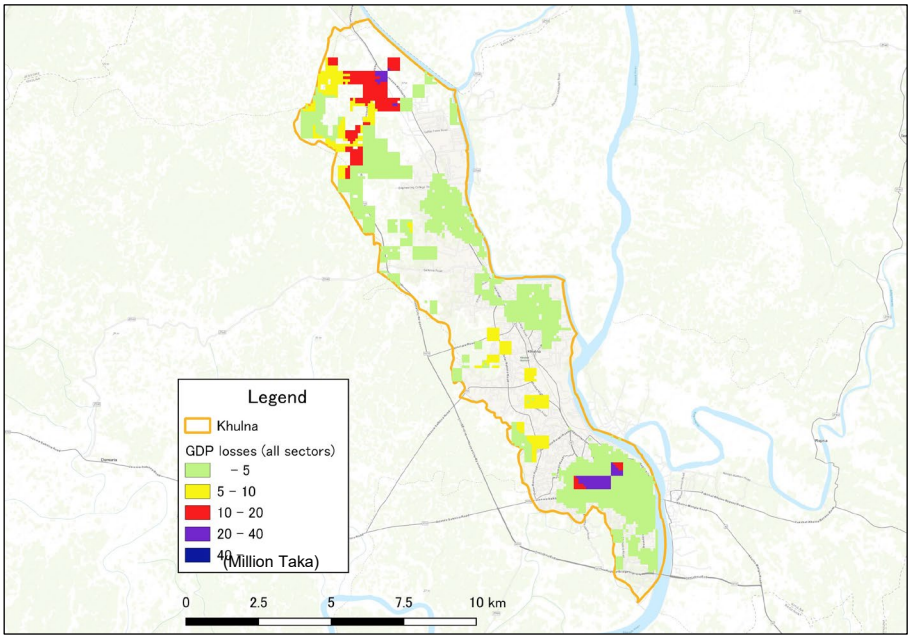
Source: JICA Survey Team

Figure 4.3.4 Distribution of Damage Amount (All Sectors, Urban Flood, Chattogram)



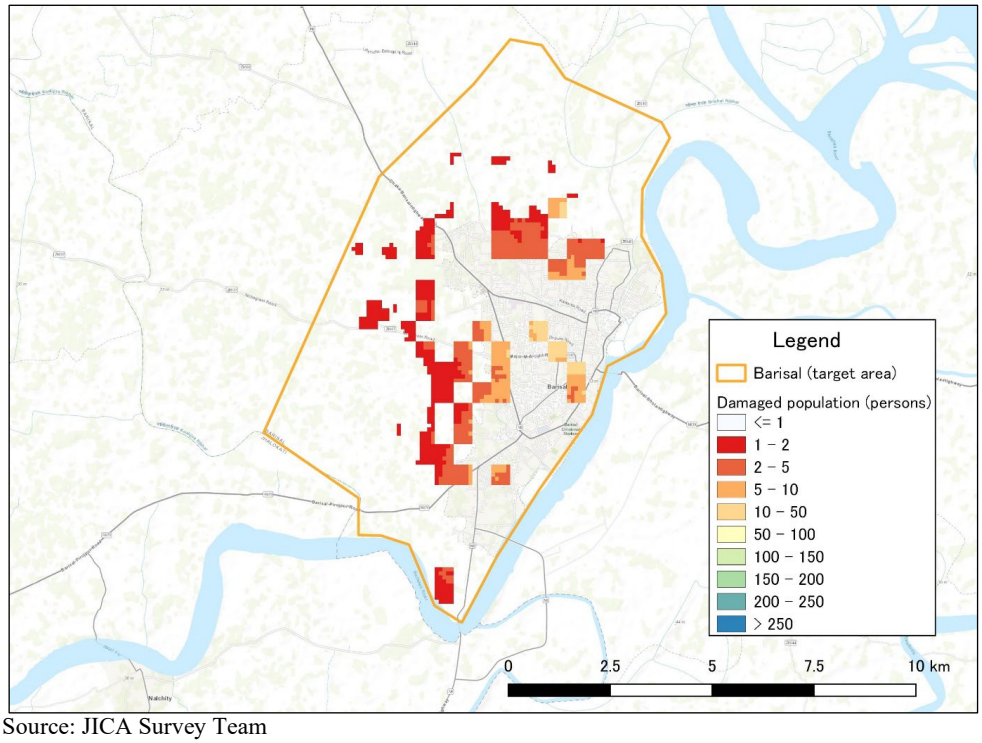
Source: JICA Survey Team

Figure 4.3.5 Distribution of Affected Population (Urban Flood, Khulna)



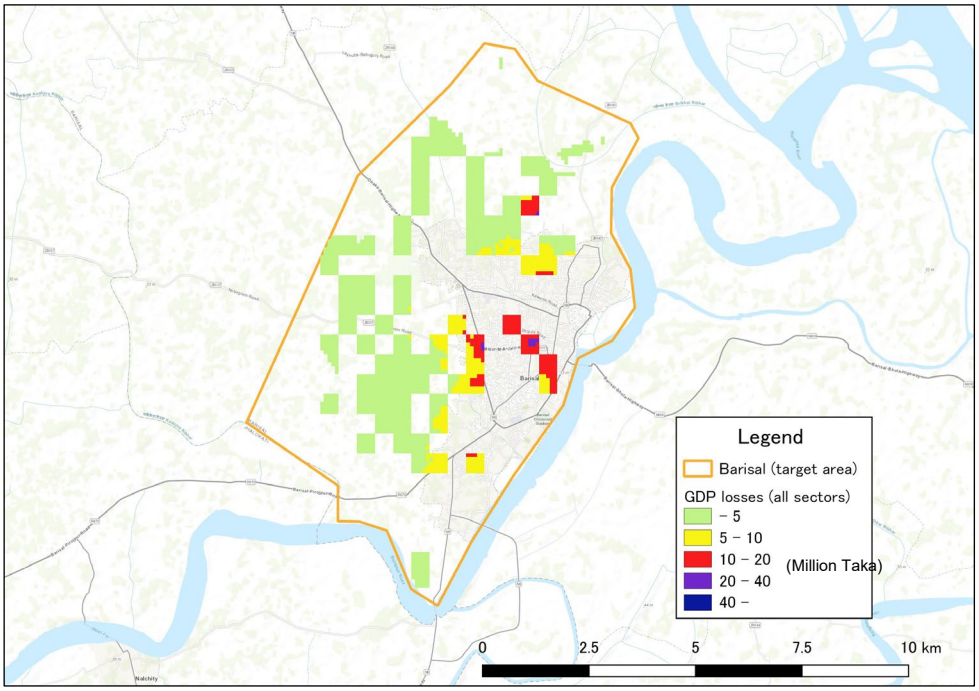
Source: JICA Survey Team

Figure 4.3.6 Distribution of Damage Amount (All Sectors, Urban Flood, Khulna)



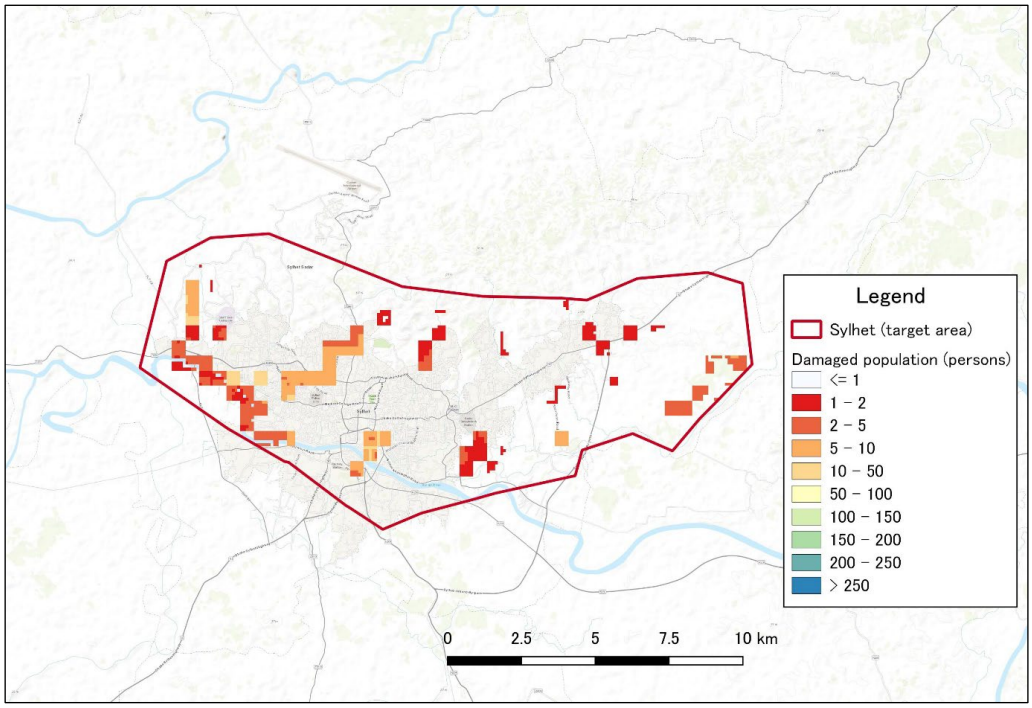
Source: JICA Survey Team

Figure 4.3.7 Distribution of Affected Population (Urban Flood, Barisal)



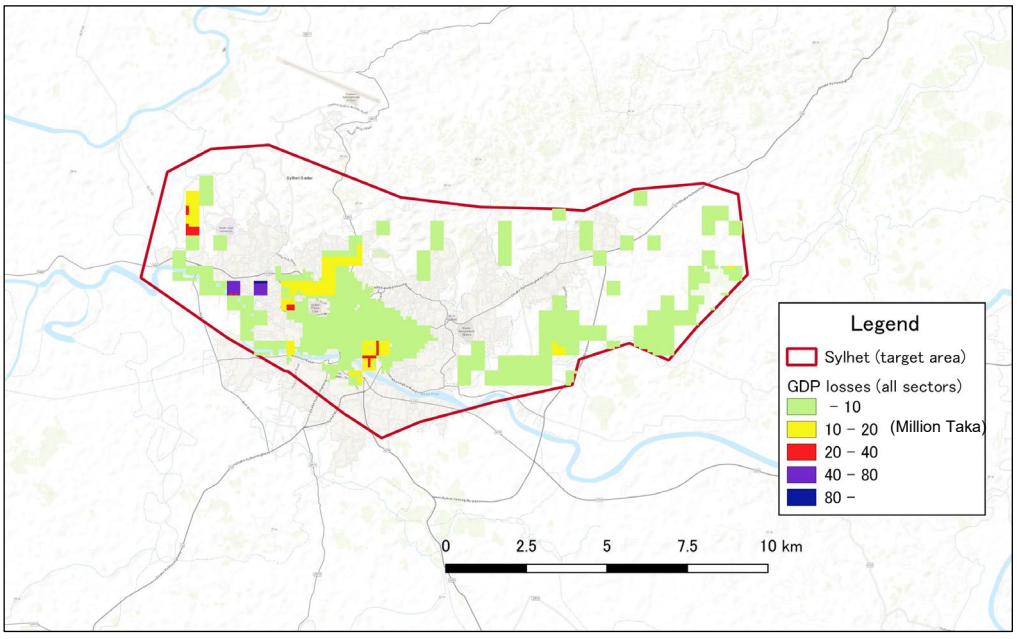
Source: JICA Survey Team

Figure 4.3.8 Distribution of Damage Amount (All Sectors, Urban Flood, Barisal)



Source: JICA Survey Team

Figure 4.3.9 Distribution of Affected Population (Urban Flood, Sylhet)



Source: JICA Survey Team

Figure 4.3.10 Distribution of Damage Amount (All Sectors, Urban Flood, Sylhet)

Table 4.3.2 Estimated Damage Amounts (Urban Floods)

City	Damage Amount (Million Taka)	Areas with Large Amounts of Damage	
		Upazila/Thana	Damage Amount (Thousand Taka)
Dhaka	17,542.8	Kafrul Badda Demra Kadamtali	1,478.6 1,345.9 1,174.1 1,100.5
Chattogram	14,037.0	Halishahar Bayejid Bostami Panchlaish Chandgaon	3,574.1 2,584.4 2,540.6 1,142.0
Khulna	1,172.1	Khan Jahan Ali Khulna Sadar	724.4 227.7
Barisal	802.8	Barisal Sadar	795.7
Sylhet	1,433.5	Sylhet Sadar	1,386.2

Source: JICA Survey Team

Due to the nature of the disaster, the risk analysis of urban floods and inland floods does not cover the entire country, but is limited to the five extracted cities, and the location of damage is very local. The accuracy of the inland waters inundation disaster risk analysis is not so high, and it is better to think that the results indicate the inland waters inundation damage potential based on the elevation distribution. Unlike other disaster types, it was not able to collect inland inundation record information (especially inundation range map) at a comparable level between cities and regions. Therefore, risk analysis results were organized by verifying simple simulation results with the available flooded performance information.

- ✓ Compared between cities, the potential for damage from inland flood in Chattogram and Dhaka, which are the centers of economic activity of Bangladesh, is high. As a base for economic activities, the damage potential of the Chattogram urban area and its suburbs is the highest, and the result is that it has a large impact in terms of the affected population, and the economic damage on industry and service sector.
- ✓ In Dhaka, there are the areas where the damage potential due to inland flood is high over the entire area. However, judging from the inundation record map, Upazila that has areas where the flood frequency is high should be narrowed down as region of particular interest. The central area (Kafrul), which is a densely populated area and an area where industrial and service sector are concentrated, is evaluated as the area with the highest risk of inland inundation. The eastern region (Badda) is also considered as having a high risk of waterlogging due to the high damage potential from riverine flood of the Balu River and inland flood due to ongoing urban development. The western (Mirpur) and southern (Demra and Kadamtali) regions also have widespread areas of high risk of inland flood.
- ✓ In Chattogrram, Upazila in the western (Halishahar) and central regions (Panchlaish and Bayejid Bostami), which is a densely populated area and a concentrated area of industry and services, are evaluated as the area with the highest inland flood risk. Judging from the inundation record map, Upazila in the Karnaphuli riverside area (Chandgaon) is also evaluated as having a high risk.
- ✓ In Sylhet, the inland flood damage potential was high in the western and eastern areas along the Surma River, however judging from the estimated inundation area map, the inland flood risk was evaluated high in the central west and east of the right bank of the Surma River (all in Sylhet Sadar).
- ✓ In Khulna, the inland flood damage potential was higher in the northern region (Khan Jahan Ali), however, judging from the inundation record map, the inland flood risk was evaluated to be higher in multiple Upazila in the western region from the central (Khalishpur) to the southern part (Sonadanga and Khulna Sadar). Areas with high flood potential in the risk analysis results (Khan Jahan Ali) are areas where it is necessary to verify the necessity of preferentially taking measures against inland flood as pre-disaster investment depending on the future urban development plan and progress of

development.

- ✓ In Barisal, the potential for inland flood damage in the northern and southern parts of the inland side was high, however, judging from the actual damage, it was evaluated the city center and slum area along the Kirtankhola River (Barisal Sadar) as a high risk of inland flood.

Based on both the disaster risk evaluation and the analysis of past damage occurrences, the following areas are listed as areas of interest that require prioritized measures against urban floods and inland floods in the future.

Table 4.3.3 Selection of Priority Areas (Urban Floods)

No	District	Reasons for Selection	Upazila of particular interest
1	Chattogram urban area, western, central and the area along Karnaphuli River	Great impact on affected population, economic activity, especially industry and service sector	Halishahar Panchlaish Bayejid Bostami Chandgaon Patenga Khulshi
2	Barisal urban area, along the Kirtankhola River	A representative economic base of the region and a large impact on economic damage.	Barisal Sadar
3	Khulna urban area, from central to southern area	A representative economic base of the region and a large impact on economic damage.	Daulatpur Khalishpur Sonadanga Khulna Sadar
4	Dhaka urban area, central and eastern area	Great impact on affected population, economic activity, especially industry and service sector	Kafrul Badda Demra Kadamtali Mirpur
5	Sylhet urban area, along the Surma River	A representative economic base of the region and a large impact on economic damage.	Sylhet Sadar

Source: JICA Survey Team

4.3.3 Issues Obtained through the Survey

The following table shows the main issues and challenges in the field of Urban Flood obtained through discussions with related organizations, field surveys and literature surveys. The rapid development of urban areas has not kept pace with the drainage system. In the field of urban flooding, there is no centralized information gathering at the national level. City Corporations in each city are mainly responsible for planning, implementation, operation, and maintenance. However, they do not have sufficient knowledge and technology, especially in the fields of planning and maintenance.

Table 4.3.4 Issues in the Field of Urban Flood

Item	Issue and Challenge
Development of drainage facilities that cannot keep up with urban development	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 priority, and laws and ordinances related to development and construction have not been complied with. For these reasons, urban development and land use are not adequately controlled. As a result, flood control and drainage facilities have not kept pace with the pace of urban development. Because of the prevalence of reactive measures as well as inadequate organization and staffing of the related agencies, there are insufficient measures to prevent and mitigate internal flooding proactively.
Project delays due to difficulties in acquiring land	Since land use is already at a certain high level and there is little space for construction of new facilities or maintaining the existing drainage facilities, project implementation requires huge costs for securing land and often involves relocation. The larger the drainage infrastructure, the more the problem of securing fund and land becomes a major impediment to the promotion of the project. In Dhaka, due to delays in the legal process for land expropriation, there are cases where the land for regulating pond at an existing pumping station has been illegally developed and occupied, and the planned area has not yet been secured.
Transfer of Drainage Projects and Lack of Maintenance Capacity of Project Owners	Different cities are at different stages of implementing urban flood and drainage management projects, but none have sufficient capacity to maintain and operate drainage facilities. Most of the City Corporations lack experience in operating and maintaining large or multiple drainage facilities. In DNCC, DSCC and Chattogram City Corporation, where drainage management operations have been transferred, there has been a transfer of drainage pumping stations and personnel, but no effective transfer of capacity has occurred. Strengthening the management capacity of the organizations is an urgent issue for proper maintenance and update/upgrade of facilities. In addition, City Corporation does not have sufficient size of organization and budget as a managing agent. In particular, the construction of large-scale drainage facility requires external financial support and technical cooperation.
Lack of Balance in Drainage Improvement	With the exception of Dhaka and Chattogram, drainage facility development has been limited to the installation and raising of small-scale retaining walls for drainage channels and dredging, re-excavation, and waste removal in the channels, due to the lack of available fund. There have been almost no progress made in the construction of large-scale facilities such as gates and pumping stations between the drainage and destination rivers. In addition, due to inadequate organizational structure and insufficient personnel and funds, soil and waste removal measures are not being implemented at the appropriate frequency and in the appropriate locations. Waste collection systems are not functioning adequately, and measures to control the abandonment and illegal dumping of waste are not sufficient to control drainage obstruction.
Disharmony between Riverine Flood Measure and Urban Flood Measure	Inland flood is not only caused by heavy rains and poor drainage, but also by overflows from drainage channels due to backwater caused by rising river levels during flood or storm surge events. In areas with inadequate urban drainage facilities, measures against river backwater such as the installation of sluice gates are often inadequate due to insufficient funding. In Sylhet, the decrease in flow capacity of the Surma River due to its reduced cross-sectional area of river is a factor in the rise in river levels, and river channel excavation by the BWDB is not progressing due to the risk of riverbank erosion.
Inadequate and inaccurate hazard maps	No hazard maps have been prepared specifically for urban flood (inland flood). Hazard maps need to be made available for future drainage planning and input into urban planning by organizing not only basic information such as the location and depth of inundation due to urban flood, but also information on affected items, amount of damage, public facilities, commercial facilities, etc. It is also necessary to map information on traffic routes that are not affected by flooding and disseminate this information to citizens and businesses.
Inadequate guidelines and manuals for developing urban drainage improvement plans	There are no standards for the planning and design of drainage facilities in urban areas. In addition, there are inadequate organizational structures, personnel and budgets for drainage management. It would be desirable to develop uniform guidelines or manuals that show the know-how in the formulation of urban drainage management plans, such as how to protect or reduce the risk of damage on what scale through urban and inland flood control, the complex coordination between the many agencies involved and how to reflect this in land regulations and higher-level plans (e.g. urban planning).

Source: JICA Survey Team

4.3.4 Future Directions Considered from Issues and Lessons Learned

In the field of urban flooding, it is important to promote flood management projects in major cities and regional cities from the perspective of reducing flood risks in urban areas, which are the centers of economic activity. In doing so, as indicated by the above-mentioned issues and lessons learned in previous cooperation, it is necessary to implement the projects in a planned manner in harmony with the rapidly advancing urban development. There are no specific systems or standards for planning and designing drainage facilities in urban areas. In addition, there are insufficient organizational structures, personnel, and budgets for drainage management. It is desirable to develop a unified guideline or manual that shows the know-how in the development of urban drainage management plans, such as at what scale to protect or reduce the risk of damage, how to coordinate the complexities among the many agencies involved and how to reflect them in land regulations and higher-level plans.

Table 4.3.5 Formulation of Proposed Project Concepts（Urban Flood）

Issue	Lesson learned	Approach	Proposed project
Development of drainage facilities that cannot keep up with urban development Project delays and difficulty in securing land due to land acquisition problems	● Importance of planned drainage projects in harmony with rapid urban development; ● Necessity of drainage measures in regional core cities; ● Difficulty in proper maintenance of drainage management facilities; ● Necessity of a mechanism to promote the expansion and planning of drainage management system; ● Promotion of organic cooperation with other fields, especially solid waste management.	● Promotion of flood and drainage management projects in large cities ● Implementation of measures based on future urban development and land use plans ● Strengthening drainage facility planning and maintenance capacity ● Preparation of the manual for formulating drainage management plan ● Promotion of solid waste management in urban areas	Eastern Dhaka Regional Urban Flood Control and Drainage Management Project
Transfer of drainage projects and lack of maintenance capacity of implementing entity			Drainage Facility Construction Project in Khulna
Lack of balance in drainage facility maintenance Unharmony between measures against river floods and measures against urban floods (inland water floods)			Drainage Management Master Plan Development in Barisal
Underdevelopment and inaccuracy of Hazard maps Undeveloped guidelines and manuals for formulating urban drainage improvement plans			Strengthening Drainage Facility Maintenance, Maintenance System and Capacity

Source: JICA Survey Team

Table 4.3.6 provides an overview of the project concepts that are expected to be implemented. Among the urban areas that are expanding and developing and have a high need for flood and drainage management, particular attention will be given to Chattogram, Khulna and Barisal from the viewpoint of feasibility of project implementation. JICA's Projects for Improvement of Storm Water Drainage System in Dhaka City (Phase I and Phase II) have faced problems in the past in terms of cooperation, such as delays in land acquisition, insufficient waste management, and insufficient continuous facility maintenance. Therefore, capacity enhancement corresponding to these matters will be implemented.

Table 4.3.6 Proposed Projects to be Implemented by 2030 (Urban Flood)

Name of Project Concept	Project Scheme	Target Area	Outline	Conformity with the Short-term Plan of Bangladesh	Effects/ Concerns	Imple-mentation Organi-zation	Assumed Project Implementation Period
Eastern Dhaka Regional Urban Flood Control and Drainage Management Project	Financial Investment	Eastern Dhaka	Urban flood control projects (e.g. construction of embankments, pumping stations and gates) combined with drainage management	BWDB's Priority Project List Dhaka Circular Route, Eastern Bypass Project	Flood Control / Land acquisition and resettlement.	BWDB, DNCC, DSCC	After 2026 Although this project is important from the viewpoint of flood risk reduction, the hurdles for implementation are high, as it requires huge amount of funds, securing of land, and coordination among related agencies.
Drainage Facility Construction Project	Financial Investment and/or Technical Cooperation Project	Khulna	Drainage Pump Station	DPP proposed by Khulna City Corporation BDP2100 (U.A 3.1)	Flood Control /Land acquisition and resettlement.	Khulna City Corporation	2026-2029 Detailed design has been completed; however, it requires more detailed investigation such as the validity of the design.
Drainage Management Master Plan Development	Technical Cooperation Project	Barisal	Developing a master plan for Drainage management in collaboration with waste management.	BDP2100 (U.A 9.3)	Flood Control/ Lack of organizational experience and capacity.	Barisal City Corporation	2024-2026
Strengthening Drainage Facility Maintenance, Maintenance System and Capacity	Technical Cooperation Project	Chattogram, Major cities	Strengthening of project implementation and maintenance capacities related to urban drainage facilities	BDP2100 (U.A 9.3)	Improved capacity to maintain drainage facilities / Lack of organizational experience and capacity	Chattogram City Corporation, Major City Corporation	2024-2026

Note) Regarding the project implementation period, it is necessary to conduct F/S and other surveys in the future, so the information is provisional at this stage.
Source: JICA Survey Team

4.4 Storm Surge and Coastal Management

4.4.1 Achievements and Lessons Learned from JICA's Cooperation

JICA's Cooperation in the Past

Table 4.4.1 Major DRR-related Surveys and Projects by JICA (Storm Surge and Coastal Management)

Project	Scheme	Implementation Period
River management advisor	Technical cooperation (Individual experts)	Sep 2010 – Sep 2014
Research Project on Disaster Prevention/Mitigation Measures against Floods and Storm Surges (SATREPS)	Technical cooperation	Apr 2014 – Mar 2019
Disaster Risk Management Enhancement Project (Partial repair and maintenance of polders for storm surge)	Loan	Jun 2016 – Jun 2025

Source: JICA Survey Team added to JICA materials

(1) Lessons Learned from the Results of Cooperation

As structural measures, JICA has cooperated in the provision of cyclone shelters and maintenance of polders. Previous cooperation has been aimed for vulnerable groups mainly in rural areas, selected with an emphasis on disaster hazard. In view of Bangladesh's remarkable economic development in recent years, cooperation with a view to protecting economic development is considered necessary in the future.

In the area of storm surge, lessons learned from previous cooperation are shown in below.

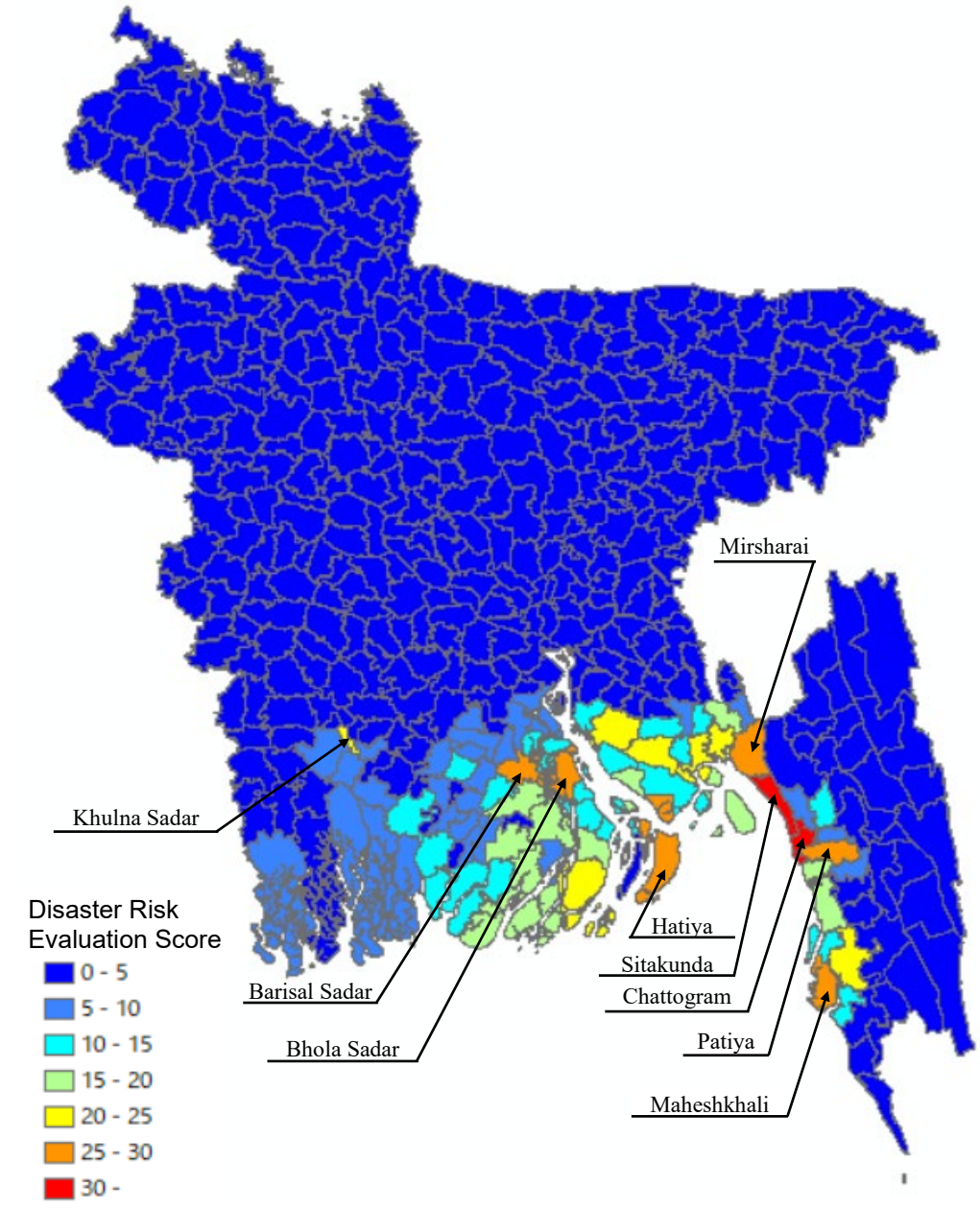
- ✓ Difficulties in securing budgets to promote the necessary pre-disaster investment
- ✓ Need for defense of economic bases in view of remarkable economic development
- ✓ Need for storm surge protection in view of the effects of climate change
- ✓ Difficulties in ensuring the quality and strength of embankments
- ✓ Necessity of setting embankment alignment based on scientific evidence

4.4.2 Conduct of Disaster Risk Analysis

The evaluation results from the disaster risk analysis are shown below.

- ✓ The population centers of Chattogram and the section between Chattogram and Mirsharai are assessed to be the areas with the highest risk of storm surge. This is due to the presence of the urban area of Chattogram, the second largest city in the country in terms of population and economic size, the surrounding industrial estate area and the proposed industrial development area at Mirsharai.
- ✓ The coastal area southwest of Noakhari is assessed to be at high risk of storm surge hazards, as it is one of the most vulnerable areas to storm surge inundation, but also one of the most populous coastal cities.
- ✓ The city center areas of Barisal and Bhola, which are representative of the southern part of the country, are also considered to be high risk areas for storm surge hazards due to the concentration of population and economic activities.
- ✓ In Khulna district as a whole, the risk of storm surge disasters is high in the disaster risk analysis, and indeed there are many disaster records. The storm surge damage in the urban area of Khulna has been limited to partial damage to revetments and other structures. However, in the event of a large-scale storm surge with a 1/100-year probability of occurrence, the urban area is expected to be flooded.
- ✓ The Matarbari-Maheshkhali area is considered to be at high risk of storm surge hazards due to its susceptibility to flooding caused by storm surge, while the area is expected to be developed as an industrial hub with industrial parks, power plants and sea ports.

Figure 4.4.1 represents a comprehensive risk score calculated from the possible life and economic losses, infrastructure damage and industrial zone damage, which clearly shows the relative risks among different areas. Based on the figure, the following areas are identified as priority areas for storm surge countermeasures in terms of disaster risk assessment points.



Source: JICA Survey Team

Figure 4.4.1 Result of Risk Analysis (Storm Surge and Coastal Management)

Table 4.4.2 Selection of Priority Areas (Storm Surge and Coastal Management)

No	District	Reasons for Selection	Upazila of particular interest
1	Matarbari-Maheshkhali development area	The area has a high concentration of power plants and industrial parks, and the impact on economic activities will be enormous.	Maheshkhali
2	Coastal area of Chattogram-Mirsharai	Severe impact on the affected population and economic activities, especially in the industrial and service sectors.	Chattogram Sitakunda Mirsharai Patiya
3	Southern Noakhali area	Highly concentrated population as well as significant economic damage in the agriculture and service sectors.	Hatiya
4	Regional hub of Barisal and Bhola	Being a representative economic center of the region, the impact on economic damage is significant.	Barisal_Sadar Bhola_Sadar

Source: JICA Survey Team

4.4.3 Issues Obtained through the Survey

The following table shows the main issues and challenges in the field of storm surge and coastal management obtained through discussions with related organizations, field surveys and literature surveys. At present, BWDB is systematically implementing the project to some extent. Considering the future development of Bangladesh, it is necessary to aim for further technological development. The quality of construction of embankments becomes a great issue. In particular, embankment compaction greatly affects the strength of the embankment. Due to lack of monitoring during construction, the required compaction rate is not met and dykes with lower strength than expected are often formed.

Table 4.4.3 Issues in the Field of Storm Surge and Coastal Management

Item	Issue and Challenge
Large Discrepancy between the Huge Area to be Protected from Disasters and the Inadequate Budget.	International cooperation by various donors, including Japan, is proceeding with the development of coastal embankment (polders), but the long coastline is still not fully protected. Considering the status of development in Bangladesh, large-scale development, urbanization, and population growth are expected in southeastern part of Bangladesh in future. It is also important to cooperate for the implementation of storm surge countermeasures in the area to be developed in the future. However, the coastline without embankments is so long that it requires huge amounts of money to exceed BWDB's annual budget.
Bias towards Storm Surge Restoration Projects.	Projects to date have tended to be biased towards post-disaster response. This is because disaster recovery has not been able to keep up with the storm surge damage that occurs every year. While post-disaster response is important, future cooperation should also focus on pre-disaster investment. For this purpose, a national storm surge action plan needs to be developed and projects implemented in order of priority. Currently, the concept of pre-disaster investment with planning is not widespread among policymakers in Bangladesh. It is also suggested that climate change impacts should be taken into account in the planning.
Low Awareness of Compliance with New Storm Surge Guidelines.	There are several design manuals in BWDB (Table 4.4.4). Basically, 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.
Quality of Embankments not Satisfied at Construction Stage	The quality of construction is always a problem when constructing storm surge embankments. Especially, the compaction of the embankment is the part which 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.
Insufficient Budget for 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.

Source: JICA Survey Team

Table 4.4.4 Comparison of Manuals/ Guidelines

Contents	BWDB Revetment Design Guidelines 2021	BWDB Revetment Design Guidelines 2010	BWDB Standard Design Manual 1996	BWDB Levee Design, Construction, and Maintenance Manual 2017 (Prepared through JICA T/C)
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)
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

4.4.4 Future Directions Considered from Issues and Lessons Learned

In storm surge countermeasures, it will be important to promote pre-disaster investment in development areas in coastal areas in the future, in light of the past emphasis on post-disaster restoration and reconstruction projects. In addition, it will be important to build stronger levees by improving the quality of planning, design, and construction of levees, leading to a reduction in restoration and repair costs.

Table 4.4.5 Formulation of Possible Project Concepts (Storm Surge and Coastal Management)

<table>
<tr><th>Issue</th><th>Lesson learned</th><th>Approach</th><th>Proposed project</th></tr>
<tr><td>Large gap between vast areas to protect from disasters and limited budgets</td><td rowspan="5">● Difficulty in securing a budget to promote the necessary prior investment;
● Necessity to protect economic bases in consideration of remarkable economic development;
● Necessity of storm surge measures considering the impacts of climate change;
● Difficulty in ensuring the quality and strength of the embankment;
● Necessity of a scientifically-based setting of alignment of the embankment.</td><td rowspan="5">● Prior investment in coastal development areas
● Dissemination of embankment strengthening
● Ensuring embankment construction quality</td><td rowspan="2">Matarbari Urban Planning Area Protection Project</td></tr>
<tr><td>Bias to restoration / reconstruction in storm surge countermeasure projects</td></tr>
<tr><td>Low awareness of observing new guidelines for storm surge countermeasures</td><td rowspan="2">Chattogram Area Industrial Estate Protection Project</td></tr>
<tr><td>Low quality of embankment at the construction stage</td></tr>
<tr><td>Insufficient maintenance budget</td><td>Technical Cooperation for Strengthening Embankment Plan/ Design/ Construction Capacity for Climate Change Adaptation</td></tr>
</table>

Source: JICA Survey Team

Table 4.4.6 shows the outline of the proposed project concepts. In the results of the priority evaluation, the areas around Matarbari and Chattogram in the Big-B area have high priority. It is desirable to make pre-disaster investments focusing on the Big-B region, which will be the center of future economic development. The BWDB suggests Super Dyke in the Chattogram region according to the survey interview. In addition, the BWDB seeks financial assistance for the development of coastal areas in the southwest region.

Table 4.4.6 Proposed Projects to be Implemented by 2030 (Storm Surge and Coastal Management)

Name of Project Concept	Project Scheme	Target Area	Outline	Conformity with the Short-term Plan of Bangladesh	Effects/ Concerns	Imple-mentation Organi-zation	Assumed project implementation period
Matarbari Urban Planning Area Protection Project	Financial Investment	Matarbari Development Area	Construction of Super Dyke	BWDB Project List	Storm Surge defense/ Land acquisition, resettlement and negative impact on nature	BWDB	2026~2030 At the time of project implementation, it is necessary to confirm the progress of the Chittagong-Mirsharai Super Dike project being implemented at the BWDB.
Chottogram ea Industrial tate Protection oject	Financial Investment	Around Candidate Site of Industrial Park in Chattogram ～Mirsharai	Construction of Super Dyke	BWDB Project List	Storm Surge defense/ Land acquisition, resettlement and negative impact on nature	BWDB	2026~2030 At the time of project implementation, it is necessary to confirm the progress of the Chittagong-Mirsharai Super Dike project being implemented at the BWDB.
Technical Cooperation for Strengthening Embankment Plan/ Design/ Construction Capacity for Climate Change Adaptation	Technical Cooperation Project	Nationwide	Technical Cooperation for Embankment Plan/Design /Construction	8FYP 18	Improved technology at national level; reduced maintenance costs. / Establishment of technology and knowledge in the implementing agencies	BWDB	2024~2026

Note) Regarding the project implementation period, it is necessary to conduct F/S and other surveys in the future, so the information is provisional at this stage.
Source: JICA Survey Team

4.5 Earthquake

4.5.1 Achievements and Lessons Learned from JICA's Cooperation

(1) JICA's Cooperation in the Past

Table 4.5.1 Major DRR-related Surveys and Projects by JICA (Earthquake)

Project	Scheme	Implementation Period
Earthquake countermeasure strengthening project (short-term expert dispatch)	Research	2004
Project for Capacity Development on Natural Disaster-Resistant Techniques of Construction and Retrofitting for Public Buildings	Technical cooperation	Mar 2011 – Feb 2015
Urban Building Safety Project	Loan	Dec 2015 – Dec 2023
Building Safety Promotion Project for Disaster Risk Reduction	Technical cooperation	Feb 2016 – Feb 2022
The Project for Technical development to upgrade structural integrity of buildings in densely populated urban areas and its strategic implementation towards resilient cities	Technical cooperation (SATREPS)	Apr 2016 – Jul 2022
Project for improvement of the quality of design and construction of private buildings	Technical cooperation	Aug 2021 – Mar 2026
Project for assistance of capacity enhancement of urban community disaster risk reduction in Bangladesh	Technical cooperation	Apr 2016 – Apr 2019

Source: JICA Survey Team added to JICA materials

(2) Lessons Learned from the Results of Cooperation

In terms of earthquake countermeasures in Bangladesh, the first priority is to establish a system that enables the construction of new buildings in compliance with building standards to proceed. As for existing unsuitable structures, it is necessary to establish a national system for seismic retrofitting of important public buildings from the viewpoint of disaster risk reduction, through the transfer of knowledge and technology to relevant organizations. In particular, it will be necessary to improve the earthquake resistance of bridges, overpasses, and other critical transportation infrastructure related to the BIG-B concept area and the economic hub of the city in the future. For private buildings, it will be necessary to reduce the number of nonconforming buildings through strengthening the building permit application system and regulations.

In the area of earthquake, lessons learned from previous cooperation are shown in below.

- ✓ Difficulties in promoting projects to secure the safety of public buildings (lack of funds and coordination between relevant agencies).
- ✓ Difficulties in quality control and promotion of seismic reinforcement of private buildings
- ✓ Necessity of seismic considerations for important transport infrastructure during emergency response

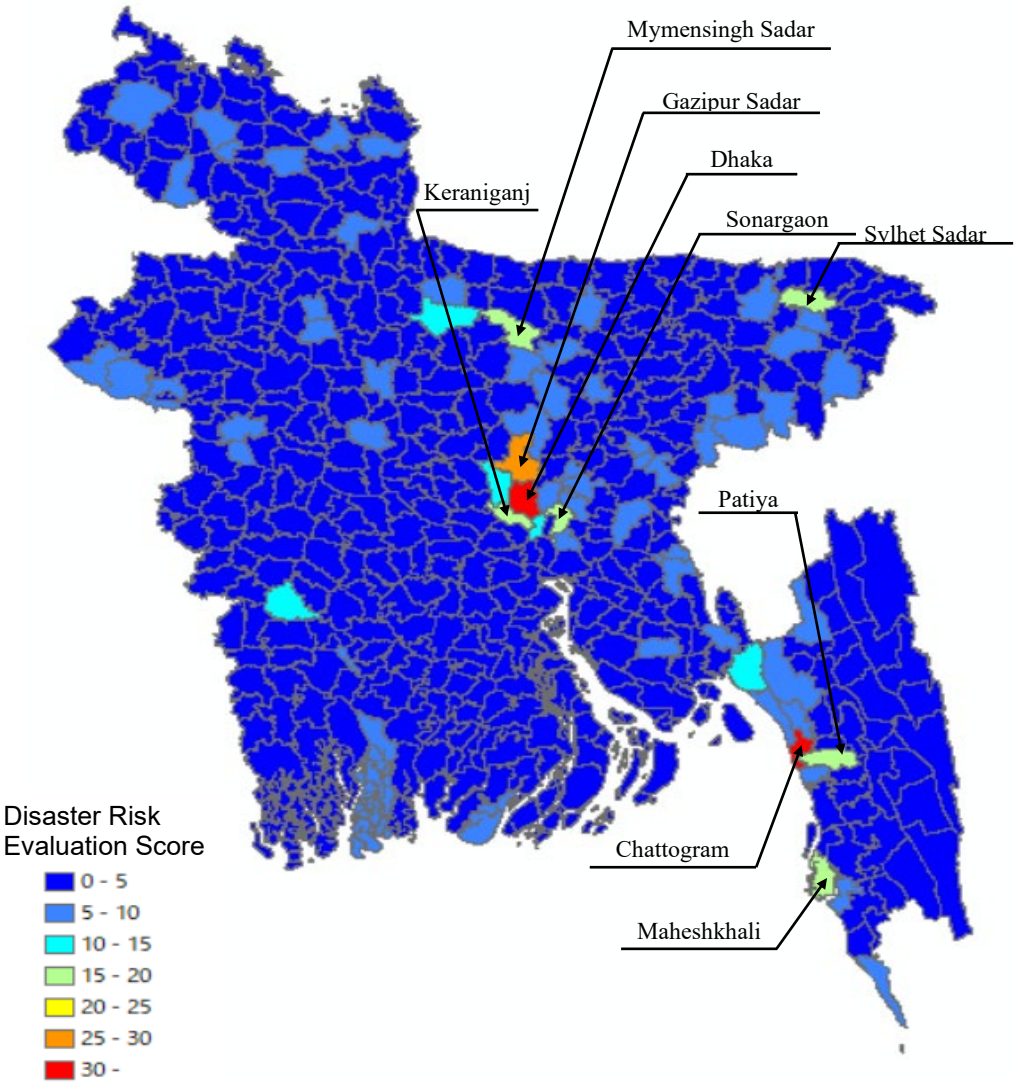
4.5.2 Conduct of Disaster Risk Analysis

The results of the disaster risk analysis are shown in the table below.

- ✓ Dhaka Metropolitan Area and Chattogram have the highest disaster risk as economic hubs. In particular, the seismic hazard of the Dhaka metropolitan area is lower than that of the northeastern and southeastern regions, but the concentration of assets as the nation's economic center is prominent, resulting in higher risk assessment score. The hazard information adopted in this study also considers the seismic hazard to be significant not only in the northeast along the Dauki Fault, which is generally considered to be at high hazard, but also in the southeast. Therefore, Chattogram, the economic center of the southeastern region, also has high risk assessment score.
- ✓ The next highest disaster risk is observed in the northern and northeastern hub cities of Sylhet and Mymensingh. The reason for this is that the region is susceptible to seismic hazard.

- ✓ The southeastern part of the country has the same high seismic hazard as the northern part. Therefore, Maheshkhali, which is expected to have a cluster of industrial parks, also has a high seismic disaster risk.

The results of the earthquake disaster risk assessment based on the distribution of scores are shown in Figure 4.5.1.



Source: JICA Survey Team

Figure 4.5.1 Result of Risk Analysis (Earthquake)

Figure 4.5.1 represents a comprehensive risk score calculated from the possible life and economic losses, infrastructure damage and industrial zone damage, which clearly shows the relative risks among different areas. Based on the figure, the following areas are identified as priority areas for earthquake disaster risk reduction.

Table 4.5.2 Selection of Priority Areas (Earthquake)

No	District	Reasons for Selection	Upazila of Particular Interest
1	Dhaka metropolitan area	Severe impact on the affected population and economic activities, especially in the industrial and service sectors.	Central Dhaka Gazipur Sadar
2	Chattogram metropolitan area	Severe impact on the affected population and economic activities, especially in the industrial and service sectors.	Chattogram
3	Urban areas in Sylhet	The earthquake hazard is large, and the impact on the affected population and economic activities is enormous.	Sylhet Sadar
4	Urban areas in Mymensingh	The earthquake hazard is large, and the impact on the affected population and economic activities is enormous.	Mymensingh Sadar

Source: JICA Survey Team

4.5.3 Issues Obtained through the Survey

The following table shows the main issues and challenges in the field of earthquake obtained through discussions with related organizations, field surveys and literature surveys. The current building permit system carries out examinations mainly focusing on city planning and architectural design. Although structural design is supposed to be checked, but not practically implemented in reality. For improving the building permit system and construction quality control, JICA and WB are supporting through the on-going projects. Through these projects, the building permit system is getting progressively improved in Dhaka. But it remains an urgent issue for the building code compliance nationwide, spatially for the high seismic hazard areas designated in the building code. For the improvement of existing buildings, due to the large number of vulnerable buildings, it is necessary to evaluate the safety of existing buildings and prioritize the implementation of safety enhancements.

Table 4.5.3 Issues in the Field of Earthquake

Item	Issue and Challenge
Insufficient building approval and licensing system to ensure the safety of new buildings	The current building permit system carries out examinations mainly focusing on city planning and architectural design. Although structural design is supposed to be checked, but not practically implemented in reality. Besides, the completion examination is also not functionated. This is thought to be due to the lack of manpower, budget and capacity of the local development agencies in charge of the project as well as insufficient political commitment. For improving the building permit system and construction quality control, JICA and WB are supporting through the on-going projects. Through these projects, the building permit system is getting progressively improved in Dhaka. But it remains an urgent issue for the building code compliance nationwide, spatially for the high seismic hazard areas designated in the building code. As for the safety of new public buildings, such as public office buildings, schools and hospitals, it is ensured by the seismic design with the new BNBC and construction quality control by the respective response organizations of PWD, LGED, EED and HED. However, most schools and hospitals are actually below building standards.
Unclear risk of damage from seismic hazards	Due to the large number of vulnerable buildings, it is necessary to evaluate the safety of existing buildings and prioritize the implementation of safety enhancements. However, the number of targeted buildings is so large that priority has to be given to select buildings that are truly important for disaster risk reduction. While building safety assessments are underway in Dhaka and elsewhere, they are mainly conducted by visual evaluation. There are no detailed seismic diagnosis and actual seismic retrofitting plans to be developed based on these assessments at present. In order to strengthen the system to promote voluntary building safety in Bangladesh, it is important to establish priority buildings based on building safety assessments and to prepare plans for seismic retrofitting of important public buildings.
Inadequate seismic protection of important structures	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. Safety reinforcement of existing private buildings depends on the safety awareness of the owners and their financial situation. With the exception of the safety projects of garment factories that was upgraded under pressure from buyers in Europe and the United States after a collapse accident in 2013, there has been no progress in strengthening the safety of existing buildings, especially private buildings used by a large number of people.
Urban planning and infrastructure development that does not take seismic risks into account	To reduce seismic risk, it is necessary not only to strengthen the seismic performance of buildings themselves, but also to plan cities that incorporate land use regulations that take into account weak ground, liquefaction, and landslides, as well as roads, parks, and other public facility layouts that prevent excessively high density. In addition, maintaining the functionality of transportation infrastructure such as roads, bridges, airports, and ports, as well as lifeline facilities such as water, electricity, and telecommunications, is important for efficient emergency operations and rapid recovery after an earthquake.

Source: JICA Survey Team

4.5.4 Future Directions Considered from Issues and Lessons Learned

Based on the above summary of issues and lessons learned from past cooperation, it is important to ensure the safety of new buildings, and the first priority is to establish a mechanism for this purpose. In addition, it is necessary to promote the seismic upgrading of existing public structures with limited funds. To this end, technical cooperation for safety assessment and prioritization can be considered.

Table 4.5.4 Formulation of Possible Project Concepts (Earthquake)

Issue	Lesson learned	Approach	Proposed project
Undeveloped building permit system to ensure the safety of new buildings	● Difficulty in promoting business related to ensuring the safety of public buildings (insufficient funds and insufficient coordination between related organizations); ● Difficulty in quality control of private buildings and promotion of seismic retrofitting; ● Necessity of consideration for earthquake disasters for important transportation infrastructure during emergency response.	● Building a framework for quality control of new buildings ● Safety assessment and prioritization of existing buildings ● Strengthening the seismic performance of important public infrastructure	Project for the Promotion of Building Code Compliance
Unclear risk by earthquake disasters			Project for Accelerating Promotion of Public Building Retrofitting
Undeveloped seismic resistance system of important structures			
Urban planning and infrastructure development without considering earthquake risk			Urban Building Safety Enhancement Project(Phase II)

Source: JICA Survey Team

Table 4.5.5 provides an overview of the project concepts that are expected to be implemented by 2030. The process for the establishment of BBRA is under consideration now within MoHPW. In a relevant document, it is considered that the BBRA will be a key player for the promotion and implementation of building code compliance. It is then considered that the experience and knowhow on building administration and professional qualification system of Japan could contribute to the establishment of an effective nationwide building code compliance system. Since the exact time of the BBRA establishment is not clear, the time for the commencement of the project could not be specified right now.

With regard to the Urban Building Safety Enhancement Project, there is a large number of vulnerable buildings, especially those critical buildings that need seismic retrofitting. On the other hand, there is no firm plan and budget arrangement for the retrofitting at the moment. For sustainable development and promotion on building safety in the future, the continuous support, both technically and financially, for the implementation of retrofitting work, capacity building and knowledge dissemination is important.

In addition, under JICA's ongoing project for “Capacity Enhancement on Formulation and Implementation of Local Disaster Risk Reduction Plan”, local DRR plans will be developed for three areas (Cox's Bazar, Sunamganj, and Kurigram). Although it depends on the results of this technical cooperation project, all three areas are located in the northern or eastern to southeastern parts of the country where seismic hazard is high, and it is expected that the project will be implemented based on the local DRR plans to be developed in the future.

Table 4.5.5 Proposed Projects to be Implemented by 2030 (Earthquake)

Name of Project Concept	Project Scheme	Target Area	Outline	Conformity with the Short-term Plan of Bangladesh	Effects/ Concerns	Implementation Organization	Assumed Project Implementation Period
Project for the Promotion of Building Code Compliance	Technical Cooperation Project	Whole Country / Public and Private Buildings	Establishment of guidelines and manuals for building code compliance Establishment of licensing system Educational activities for building code compliance Pilot projects, etc.	NPDM 2021-2025 8FYP 2020-2025	Building code compliance strengthens buildings and reduces maintenance costs / Delay in establishment of implementing agency	BBRA (Under the discussion for establishment)	Start date depends on the situation of the establishment of BBRA,
Project for Accelerating Promotion of Public Building Retrofitting	Technical Cooperation Project	Whole country	Technical development, manual development, and pilot projects for seismic assessment and retrofitting of existing buildings	Project Requested by PWD	Building code compliance strengthens buildings and reduces maintenance costs / Establishment of technology and knowledge in the implementing agencies	PWD	2024-2028
Urban Building Safety Enhancement Project (Phase II)	Financing Investment	Dhaka, Chattogram, Sylhet, etc. / Important Government Buildings, Hospitals and Schools, etc.	Capacity building and technology dissemination for building renovation and reconstruction assessment, planning, design, and project implementation	Project for Accelerating Promotion of Public Building Retrofitting (requested by PWD)	Disaster preparedness capacity has been improved by upgrading critical facilities to be more earthquake resistant / Functional replacement during renovation and reconstruction	PWD	2026-2031 To be Implemented after completion of UBSP.

Note) Regarding the project implementation period, it is necessary to conduct F/S and other surveys in the future, so the information is provisional at this stage.
Source: JICA Survey Team

4.6 Meteorological Forecasting and Warning

4.6.1 Achievements and Lessons Learned from JICA's Cooperation

(1) JICA's Cooperation in the Past

Table 4.6.1 Major DRR-related Surveys and Projects by JICA (Meteorological Forecasting and Warning)

Project	Scheme	Implementation Period
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
Development of Human Capacity on Operation of Weather Analysis and Forecasting	Technical cooperation	Sep 2009 – Jan 2014
The Project for Improvement of Meteorological Radar System in Dhaka and Rangpur	Grant aid	Apr 2020 – Nov 2023
Capacity Enhancement Project on Weather and Climate Analysis	Technical cooperation	Mar 2022 – Sep 2025

Source: JICA Survey Team added to JICA materials

(2) Lessons learned from the Results of Cooperation

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.

In the area of meteorological forecasting and warning, lessons learned from previous cooperation are shown in below.

- Necessity to improve the accuracy of forecasts
- Necessity to improve the maintenance and management capacity of equipment
- Difficulties in collecting and securing observation data due to weak communication and power supply infrastructure
- Necessity for better understanding of advanced technologies such as climate models and radar
- Importance of information transmission to the public

4.6.2 Issues Obtained through the Survey

The following table shows the main issues and challenges in the field of meteorological forecasting and warning obtained through discussions with related organizations, field surveys and literature surveys. In terms of ensuring the accuracy of meteorological observations, ground observation data from automatic weather stations (AWS) are not being used, real-time data is not being acquired, and precipitation is not being estimated with sufficient accuracy because inspections and calibrations are not being conducted properly. In terms of operation and maintenance, there is no operational plan or training system in place, especially for the appropriate repair and operation of radar and maintenance of observation equipment.

Table 4.6.2 Issues in the Field of Meteorological Forecasting and Warning

Item	Issue and Challenge
Lack of ground-based weather observations to issue accurate weather forecasts and warnings.	Ground observation data from automatic weather stations (AWS) are not being used and real-time data is not being obtained. Periodic inspections and calibrations are not properly carried out, which prevents the estimation of precipitation with sufficient accuracy for forecasting and warning issuing decisions.
Lack of adequate repair and operation of weather radars and radar analysis technology.	The life of the radar is generally expected to be 15 to 40 years in Japan. However, most radars were out of operation before their lifetime. BMD installed five radars throughout the country, however, they have not shown radar images except Cox's Bazar and Moulvibazar. Automatic Weather Station (AWS) data has not been used at all and real-time data has also not been obtained yet. Therefore, Quantitative Precipitation Estimation (QPE) has not been developed and the accumulated precipitation estimation cannot be obtained accordingly.
Insufficient operational plans and training systems for the O&M of observational equipment	Regular inspections and parts replacement are essential for radar, and it is necessary to formulate an operation plan and budget plan for that purpose. Although a manual exists, regular maintenance and inspections have not been carried out in line with it. In addition, there is no training system for radar engineers, and maintenance and operation techniques are not handed over to the person in charge.
Lack of understanding of risks due to climate change impacts	Even at present, sufficient observation equipment and observation systems for meteorology are not secured, and there is a lack of data and information to understand the possibility of disasters and future climate change risks. In order to understand climate change risks and reflect them in development plans, it is desirable to enhance the data aggregation and management system related to climate change, and to introduce research and tools for further understanding

Source: JICA Survey Team

4.6.3 Future Directions Considered from Issues and Lessons Learned

Based on the aforementioned issue compilation, it is necessary to improve knowledge and technology for the appropriate operation and maintenance of radars in addition to their renewal. Also, in addition to regular weather observation, from the viewpoint of spreading understanding of the risks due to climate change, cooperation is considered for the development of infrastructure for the aggregation, management, and sharing of weather and climate information.

Table 4.6.3 Formulation of Possible Project Concepts (Meteorological Forecasting and Warning)

Issue	Lesson learned	Approach	Proposed project
Lack of ground weather observations to issue accurate weather forecasts and warnings Lack of appropriate repair and analysis technology of radar observation system	● Necessity of improving the accuracy of forecasting and warning; ● Need to improve equipment maintenance capacity; ● Difficulty in collecting and securing observation data due to fragile communication and power supply infrastructure;	● Complementing rainfall observation network by radar rainfall ● Resuming operation of aging radar ● Capacity improvement of staff involved in the maintenance of meteorological observation equipment	Project for the Renewal of Weather Radar
Undeveloped operation plan and training system for maintenance of observation equipment Lack of understanding of risks due to the impacts of climate change	● Need to deepen understanding of advanced technologies such as climate models and radar; ● Importance of ease of information communication to the general public.	● Facilitating understanding of the risks of the impacts of climate change ● Enhancement of climate change-related data aggregation and management system	Project for the Improvement of Meteorological Data Observation, Monitoring, and Sharing Platforms

Source: JICA Survey Team

Table 4.6.4 shows the outline of the proposed project concepts. The development of rainfall observation networks, which are fundamental information for understanding and predicting water-related disaster risks, and technical cooperation and facility development for understanding future climate and weather disaster risks are considered important. For the former, radar upgrades will be promoted as a project that needs to be implemented in the short term. For the latter, the development of a BMD ground observation, monitoring, and data sharing platform is proposed from the perspective of improving the convenience of weather information and disseminating knowledge and understanding of the climate change impacts. This is expected to have a synergistic effect with JICA's upcoming technical cooperation for capacity building of the BMD through the "Capacity Building Project on Meteorology and Climate Analysis in Bangladesh".

Table 4.6.4 Proposed Projects to be Implemented by 2030 (Meteorological Forecasting and Warning)

Name of Project Concept	Project Scheme	Target Area	Outline	Conformity with the Short-term Plan of Bangladesh	Effects/ Concerns	Imple-mentation Organi-zation	Assumed Project Implementation Period
Project for the Renewal of Weather Radar	Financial Investment	Cox's Bazar, Kheppara	Renewal of ageing weather radar.	8FYP 10	Improved weather forecasting capacity / Establishment of technology and knowledge in the implementing agencies	BMD	2024-2029
Project for the Improvement of Meteorological Data Observation, Monitoring, and Sharing Platforms	Financial Investment and/or Technical Cooperation Project	Pilot project for BMD and any of 64 districts	Construct and introduce systems related to the infrastructure for information aggregation, transmission and reception from each observatory, and information publication, with the aim of improving the usability of weather and climate data.	-	Improved weather forecasting capacity / Establishment of technology and knowledge in the implementing agencies	BMD	2026-2030 To be implemented after confirming the results of the Bangladesh Weather and Climate Services Regional Project of WB.

Note) Regarding the project implementation period, it is necessary to conduct F/S and other surveys in the future, so the information is provisional at this stage.
Source: JICA Survey Team

4.7 Disaster Risk Governance

4.7.1 Achievements and Lessons Learned from JICA's Cooperation

(1) JICA's Cooperation in the Past

Table 4.7.1 Major DRR-related Surveys and Projects by JICA (Disaster Risk Governance)

Project	Scheme	Implementation Period
The Capacity Enhancement on Disaster Risk Reduction, Emergency Response and Recovery Project (Disaster recovery fund, communication equipment procurement)	Loan	Jun 2016 – Jun 2025
The Project for Capacity Enhancement on Formulation and Implementation of Local Disaster Risk Reduction Plan	Technical cooperation	Jul 2020 – Jun 2024
Coordination adviser for disaster risk reduction sector	Technical cooperation (Individual experts)	Jun 2015 – Jul 2022
Project for National Geospatial Information Development	Technical cooperation	Aug 2019 – Aug 2021

Source: JICA Survey Team added to JICA materials

(2) Lessons Learned from the Results of Cooperation

In the phase of 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 pre-disaster prevention/mitigation 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 are suited to the actual conditions in Bangladesh, and to focus on strengthening cooperation between the local and central governments, based on lessons learned from on-going yen loan and technical cooperation projects to strengthen disaster risk management capabilities.

In the area of disaster risk governance, lessons learned from previous cooperation are shown in below.

- ✓ Promoting a shift in emphasis from post-disaster response to pre-disaster investment
- ✓ Necessity to further strengthen disaster management coordination agencies
- ✓ Promoting capacity building in disaster risk management at the local level
- ✓ Importance of rapid budget execution mechanisms during the recovery and reconstruction

4.7.2 Issues Obtained through the Survey

The following table shows the main issues and challenges in the field of disaster risk governance obtained through discussions with related organizations, field surveys and literature surveys. As mentioned in 4.2, 4.4, and 4.6, which summarize the issues for each disaster, the available funds are very limited relative to the sections, areas, and number of buildings to be developed, and therefore, sufficient pre-disaster investment has not been made. In addition, the DDM, which has the primary responsibility of disaster management administration, lacks the experience and skills of its staff for its extensive scope of work. In addition, many special economic zones have been developed or are under development in Bangladesh. It is considered necessary to take measures to protect these priority economic activity zones in the future.

Table 4.7.2 Issues in the Field of Disaster Risk Governance

Item	Issue and Challenge
Insufficient budget for disaster risk reduction projects and improving management capabilities of related organizations	Much of the budget is spent on emergency response to repeated disasters and on operation and maintenance, which limits the budget that can be allocated for future investments. In addition, there is a lack of concrete investment plans and priorities for project implementation. These factors make it difficult to secure sufficient funds to proceed with projects to reduce disaster risk. Given the situation, BWDB, the main agency in charge of water infrastructure development, has no prospect of obtaining enough budget to implement projects under BDP2100, a long-term plan in water management. 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 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 the area of earthquake countermeasures as well, the Government of Bangladesh is currently limited in the number of projects it can implement because of the huge amount of money required to upgrade existing structures to be earthquake resistant.
Unclear division of responsibilities and budget allocation for disaster recovery activities	Agencies of the Government of Bangladesh are implementing disaster management operations in accordance with SOD 2019, but the division of responsibilities regarding disaster recovery activities is unclear. In addition, the lack of a method to secure budget for disaster recovery is a major challenge. 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.
Insufficient capacity of DDM staff for the extensive jurisdiction	DDM lacks the capacity of DDM staff to carry out its work in relation to the scope of DDM's work; the Disaster Management Act of 2012 merged the department in charge of policy and legislation with the relief and reconstruction department to form DDM, but this has caused problems within DDM in carrying out work that is different in characteristics. In addition, DDM conducts repair and improvement works and design of roads, bridges, and other small-scale infrastructure related to disaster management, but design standards have not been developed. DDM's capacity in these civil engineering techniques is insufficient compared to its extensive work scope.
Lack of DRR functions at the local government level (Union level)	In many cases, disaster management plans have not been formulated at the Upazila level, and the formulation of disaster management plans at the Union level has not progressed either. In terms of organizational structure, DRRO is assigned at the District level and 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.
Insufficient communication and unshared disaster-related information	Regarding the communication of disaster information, although the use of mobile phones has been started, some disaster information is still being communicated by megaphones and sirens. In addition, water levels and other disaster-related data observed by the BWDB, BMD, and other related organizations have not been consolidated.
Insufficient disaster risk reduction measures in priority economic activity areas	Many special economic zones (EZs) have been developed or are under development in Bangladesh. From the viewpoint of sustainable economic development, measures to protect economic assets by investing in these priority economic activity zones are considered essential. To this end, it is important to develop disaster management plans for EZs at risk and guidelines for developing such plans, in addition to installing necessary structural measures based on the understanding of the risks of each EZ.
Necessity of effective assistance according to local conditions	In accordance with DMA, disaster management committees are established up to the Union level, and at the same time disaster management plans are to be formulated at each level. As a result, understanding of the necessity of participation in DRR activities by local residents has progressed, and concrete activities are being carried out. However, residents' awareness of DRR differs from region to region, and depending on their level of maturity, the details of necessary support and approach methods differ. There is a need for a mechanism to provide appropriate support according to the situation of DRR activities in the region and the degree of maturity of DRR awareness.

Source: JICA Survey Team

4.7.3 Future Directions Considered from Issues and Lessons Learned

As indicated in the aforementioned issue summary, it is important to strengthen a series of capabilities related to the disaster management cycle, including the coordination function of DDM, the main agency of disaster management administration. Partly because the authority of DDM is practically limited to post-disaster response, and because of the insufficient budget and personnel system, it is expected that the capacity of DDM as a coordinating body will be improved, especially in terms of cooperation between the central and local governments. In addition, from the perspective of protecting economic activities, cooperation in the implementation of DRR projects for economic zones can be considered.

Table 4.7.3 Formulation of Possible Project Concepts (Disaster Risk Governance)

Issue	Lesson learned	Approach	Proposed project
Insufficient budget for disaster risk reduction projects and improving management capabilities of related organizations	● Further promotion of shift from post-disaster response to prior-investment; ● Necessity of further strengthening DRM administrative coordinating body ● Promotion of improvement of DRM capacity at local level ● Importance of a rapid budget execution mechanism in the restoration / reconstruction phase	● Strengthening of the capacity of DRR administrative coordinating organizations ● Promotion of participation in DRM planning and DRM activities at the community level ● Modernization of disaster risk information system ● Formulation of DRM plan for economic zones ● Establishing an activity system and securing a budget in the disaster recovery phase	DRR Governance Capacity Enhancement Project
Unclear division of responsibilities and budget allocation for disaster recovery activities			
Insufficient capacity of DDM staff for the extensive jurisdiction			Disaster Information Management Modernization (DX) Project
Absence of DDM Staff at the Local Government Level (Union level)			
Insufficient communication and unshared disaster-related information			
Insufficient disaster risk reduction measures in priority economic activity areas			Comprehensive Disaster Risk Reduction Project in SEZs
Inadequate community DRR activities			

Source: JICA Survey Team

Table 4.7.4 provides an overview of the project concepts that are expected to be implemented by 2030. In addition to capacity enhancement projects aimed at strengthening local-central coordination and disaster information transmission and sharing systems, a possible project concept is the development of disaster risk management plan targeting special economic zones where countermeasures need to be taken on a priority basis.

Table 4.7.4 Proposed Projects to be Implemented by 2030 (Disaster Risk Governance)

Name of Project Concept	Project Scheme	Target Area	Outline	Conformity with the Short-term Plan of Bangladesh	Effects/ Concerns	Imple-mentation Organi-zation	Assumed Project Implementation Period
DRR Governance Capacity Enhancement Project	Technical Cooperation Project	DRR Administrative Agency	Supporting the activities of disaster management committees at the Upazila level and below, strengthening central and local coordination, pilot projects for the establishment of a Disaster Management Information Center at the Union level, and examining the framework for community participation in DRR planning and activities.	8FYP 8	Strengthening the disaster management capacity of the whole government/ Establishment of technology and knowledge in the implementing agencies	DDM	2026-2029 It is assumed to be implemented after completion of Local DRR planning capacity enhancement project.
Disaster Information Management Modernization (DX) Project	Financial Inestment and/or Technical Cooperation Project	DRR Administrative Agency	Installation of equipment and systems, creation of mechanisms, and human resource development with a view to comprehensive digitization of data sharing, disaster information transmission, etc.	8 FYP 18	Enhancement of information communication on disaster management/ Establishment of technology and knowledge in the implementing agencies	DDM, DMC, CPP, (BMD, BWDB)	2026-2029 It is assumed that the project will be launched after the results of the Bangladesh Weather and Climate Services Regional Project by the World Bank are confirmed.
Comprehensive Disaster Risk Reduction Project in SEZs	Technical Cooperation Projetc (Development Survey) and/or Financial Investment	Prioritized Economic Zones	Technical cooperation for the development of disaster management plans for special economic zones that need to be developed on a priority basis, including consideration of establishing Emergency Operation Center (EOC).	-	Strengthening disaster management capacity of SEZs/ Clarification of implementing agencies and role-sharing among other relevant agencies	BEZA, DDM、BWDB、LGED, BMD, etc.	2025-2028

Note) Regarding the project implementation period, it is necessary to conduct F/S and other surveys in the future, so the information is provisional at this stage.
Source: JICA Survey Team

CHAPTER 5 EXAMINATION OF JICA'S POSSIBLE COOPERATION POLICY IN DISASTER RISK REDUCTION SECTOR IN BANGLADESH

5.1 Building a Roadmap for DRR Sector

5.1.1 National Development Plans and International Targets

When considering the roadmap in the DRR, attention to the alignment with the following national development plans and international targets are paid.

Table 5.1.1 National Development Plans and International Targets

National Development Plans and International Targets	Consideration for Building a Roadmap for DRR Sector
BDP2100	BDP 2100 will be implemented by combining the long-term development outcomes of national targets for economic growth and poverty reduction as shown in Vision 2041. Also, it includes targets for reducing long-term vulnerability to water and climate change-related disasters, as well as targets for environmental protection. BDP 2100 proposes three high-level objectives and six specific targets for water resources, ecosystems, and land use that contribute to the said high-level objectives. The roadmap proposal in the draft cooperation policy in this survey will take into account, in particular, the alignment with the high-level objectives of BDP 2100.
Vision 2041	The main vision behind the Perspective Plan 2021-2041 (PP 2041) is to emerge from poverty as incomes rise by 2041. The roadmap proposal in the draft cooperation policy in this survey will take into account consistency with Vision 2041, particularly in setting long-term goals.
Eighth Five Year Plan	The 8th Five Year Plan is the first in a series of Five-Year Plans to complete the agenda for achieving social and economic transformation as visualized in the PP 2041. The concrete activities for strengthening in DRR are shown in the plan. In proposing a roadmap for the draft cooperation policy in this survey, these specific activities are used to set targets in the short term.
SFDRR	The SFDRR has established four priority actions and seven global targets for the year 2030. The short- and mid-term goals of the roadmap proposed in this survey will be set in consideration of the achievement of these global targets. In addition, the key activities proposed in this survey will be consistent with these priority actions.
SDGs	In setting out the key activities in the draft cooperation policy, consideration will be given to the alignment with the SDG targets that are particularly relevant to disaster risk reduction.

Source: JICA Survey Team

5.1.2 Short-Term Objectives (By Year 2025)

For short-term objectives, they are proposed with particular attention to alignment with the Eighth Five-Year Plan and SFDRR. Short-term objectives to be considered by 2025 in the disaster risk reduction sector roadmap are (1) through (8) below.

Global Targets for 2020 in SFDRR	Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020.	→	Short-term Objective (1) Short-term Objective (2)
Specific Activities to Strengthen DRR in the Eighth Five-Year Plan	10. Increased investments in gender sensitive DRR and climate risk reduction to reduce the cost for response and recovery.	→	Short-term Objective (3)
	2. Promote private sector resilience to disasters and climate change risks through improved public private partnerships. 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		Short-term Objective (4)
	1. Institutionalization of DRR and CCA. 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, programs and projects. 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. 20. Increase afforestation through a major program 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.		Short-term Objective (5)
	18. Improve early warning systems through relevant technology adoption.		Short-term Objective (6)
	3. Develop adaptive research on disaster and climatic issues. 4. Adopt proven technologies. 12. Incorporate best practices and technology in Disaster Management of Bangladesh from around the world.		Short-term Objective (7)
	11. Support skill development by giving training to Government officials, NGO officials and volunteers concerned in Disaster Management and develop greater partnership with NGOs to improve “cyclone preparedness” capacity. 19. Increase investments in training emergency responders to cope with extreme events.		Short-term Objective (8)

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Short-Term Objectives in the DRR sector
Strengthen DRR investment and DRR governance by 2025, especially focusing on: (1) Appropriate understanding of disaster risk. (2) Development of disaster risk reduction strategies. (3) Increased investments in DRR and climate risk reduction to reduce the cost for response and recovery. (4) Operational processes of DRR related agencies, cross-agency coordination mechanisms, and enhanced inter-sector coordination. (5) Further development of DRR-related systems, standards, and guidelines. (6) Strengthening of DRR information system. (7) Promotion of R&D on DRR and CCA, and introduction of technologies and lessons learned. (8) Promotion of education, training, and enlightenment related to DRR.

Figure 5.1.1 Short-Term Objectives to be Achieved in the Disaster Risk Reduction Sector

5.1.3 Medium-Term Objectives (By Year 2030)

In addition to the 2030 targets in BDP 2100 and Vision 2041, the medium-term objectives are proposed with particular attention to alignment with the 2030 global targets in SFDRR. Medium-term objectives to be considered by 2030 in the disaster risk reduction sector roadmap are (1) through (3) below.

Targets for 2030 in BDP2100 and Vision2041	Eliminate extreme poverty by 2030. Achieve upper middle-income status by 2030.		
Global Targets for 2030 in SFDRR	Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030.	Substantially reduce global disaster mortality by 2030. Substantially reduce the number of affected people globally by 2030.	Substantially reduce disaster damage to critical infrastructure such as health and educational facilities and disruption of basic services through developing their resilience by 2030.
	Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030.		

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Medium-Term Objectives in the DRR Sector		
(1) Substantial reduction in disaster fatalities, victims, and economic losses by 2030	(2) Achieving resilience of critical infrastructure and basic services by 2030	(3) Improve access to disaster risk information by 2030

Figure 5.1.2 Medium Term Objectives to be Achieved in the Disaster Risk Reduction Sector

5.1.4 Long-Term Objectives (By Year 2040)

For long-term objectives, they are proposed with particular attention to alignment with targets for 2040 in BDP 2100 and Vision 2041. The major targets to consider in the national level development in Bangladesh are "becoming a high-income country by 2041" and "remaining a prosperous country after 2041". Based on these targets, the followings are the proposed long-term objectives to be considered by 2040 in the disaster risk reduction sector roadmap.

Targets for 2040 in BDP2100 and Vision2041	High-income country by 2041 Being a prosperous country beyond 2041

↓

Long-Term objectives in the DRR sector
Continuous and reliable reduction of disaster risks that will hinder sustainable economic development by 2040

Figure 5.1.3 Long-Term Objectives to be Achieved in the Disaster Risk Reduction Sector

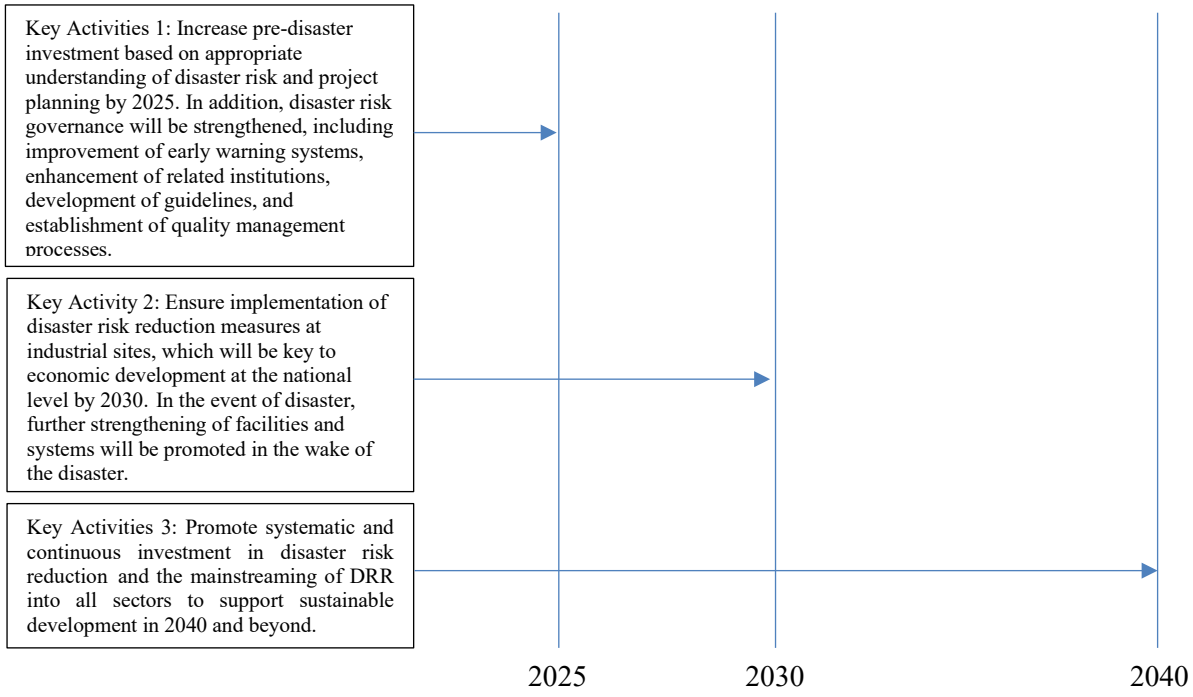
5.1.5 Proposed Activities to be Promoted in Bangladesh

In order to achieve the above short-, medium- and long-term objectives, key activities in the disaster risk reduction sector that Bangladesh should promote in the future are proposed in the table below.

Table 5.1.2 Proposed Activities in the Disaster Risk Reduction Sector to be Promoted in Bangladesh

Short-Term Objectives in the DRR sector	Proposed Short-Term Activities
Strengthen DRR investment and DRR governance by 2025, especially focusing on: (1) Appropriate understanding of disaster risk. (2) Development of disaster risk reduction strategies. (3) Increased investments in DRR and climate risk reduction to reduce the cost for response and recovery. (4) Operational processes of DRR related agencies, cross-agency coordination mechanisms, and enhanced inter-sector coordination. (5) Further development of DRR-related systems, standards, and guidelines. (6) Strengthening of DRR information system. (7) Promotion of R&D on DRR and CCA, and introduction of technologies and lessons learned. (8) Promotion of education, training, and enlightenment related to DRR.	Key Activities 1: The implementation of disaster risk reduction measures requires the formulation of strategies, which is listed as target (e) in the SFDRR. This requires an appropriate understanding of disaster risk and the development of project plans based on the understanding. Investments in disaster risk reduction and climate change risk reduction should be promoted based on the established project plans. In parallel with the pre-disaster investment, it is also necessary to strengthen disaster risk governance, including organizational and institutional enhancement, development of forecasting and warning systems, human resource development, and guidelines. Key Activities 1-1: Promoting understanding of disaster risk. Key Activities 1-2: Development of comprehensive DRR plan. Key Activities 1-3: Increased investment in DRR and climate change risk reduction. Key Activities 1-4: Strengthening DRR organizations and systems. Key Activities 1-5: Further Development of DRR-related standards and guidelines. Key Activities 1-6: Strengthening DRR information systems. Key Activities 1-7: Introduction of technologies that match the natural and social characteristics of the country. Key Activities 1-8: Promotion of DRR education, training, and enlightenment.
Medium-Term Objectives in the DRR sector	Proposed Medium-Term Activities
(1) Substantial reduction in disaster fatalities, victims, and economic losses by 2030. (2) Achieving resilience of critical infrastructure and basic services by 2030. (3) Improve access to disaster risk information by 2030.	Key Activity 2: In order to achieve substantial human loss reduction, GDP loss reduction, and elimination of extreme poverty by 2030, it is critical to implement solid disaster risk reduction measures over the next decade. Continued investment in disaster risk reduction and further strengthening of facilities and systems after disaster strikes are important for this purpose. It is also important to strengthen information dissemination, sharing, and management systems to improve the accessibility of disaster risk information, which should be major activities to be implemented by 2030. Key Activities 2-1: Disaster risk reduction investment. (continuation of 1-3) Key Activities 2-2: Realization of resilient recovery and reconstruction measures. Key Activities 2-3: Strengthening the dissemination, sharing, and management of disaster risk information.
Long-Term Objectives in the DRR sector	Proposed Long-Term Activities
Achieving continuous and reliable reduction of disaster risks that hinder sustainable economic development by 2040.	Key Activity 3: In order to support long-term and continuous economic development to achieve high income and entry into the developed countries by 2040, it is important to continuously and reliably realize disaster risk reduction as a major impediment to economic growth. To this end, in addition to continuous pre-disaster investment, non-structural measures including early warning system should be enhanced, with a view to expanding the all-round DRR promotion system at national level. Also, it is important to incorporate the DRR perspective into all sectors of development and to expand the budget for DRR investment, which should be major activities to be implemented until 2040. Key Activities 3-1: Planned and continuous investment in disaster risk reduction. (continuation of 2-1) Key Activities 3-2: Enhancement of non-structural measures including early warning systems. Key Activities 3-3: Promoting DRR considerations for all sectors.

Source: JICA Survey Team



Source: JICA Survey Team

Figure 5.1.4 Proposed Roadmap in Disaster Risk Reduction Sector

5.2 Examination of JICA's Possible Cooperation Policy

In response to the proposed key activities in the disaster risk reduction sector in Bangladesh shown in 5.1.5, fields of possible priority cooperation and activities by JICA are proposed based on Japan's Country Development Cooperation Policy for Bangladesh.

5.2.1 Japan's Country Development Cooperation Policy for Bangladesh[6]

The following is a summary of Japan's Country Development Cooperation Policy for Bangladesh.

In recent years, Bangladesh's GDP has been growing at an annual rate of more than 6%, attracting attention as a potential production base following China and Vietnam, and as a new market of 160 million people, and Japanese companies are also expanding their operations into the country. However, Bangladesh is still a least developed country with a poverty-stricken population of about 40 million, or about 30% of its population. The country faces challenges such as the need to strengthen governance, underdevelopment of basic infrastructure such as electricity and transportation, and vulnerability to natural disasters such as cyclones and floods, all of which are factors that hamper the country's economic and social development

Under the "Comprehensive Partnership" agreed at the Japan-Bangladesh Summit Meeting in 2014, Japan will support Bangladesh's efforts to revitalize economic activities and overcome social vulnerabilities in a bid to boost the country's growth and poverty eradication through sustainable and equitable growth with equity.

1. Accelerating Economic Growth for the Benefit of All Citizens toward a Middle-income Country
   - ✓ The Government of Japan will support the acceleration of sustainable economic growth through cooperation based on the "Bay of Bengal Industrial Growth Belt (BIG-B)" concept, while giving due consideration to the poor, in order to achieve the a middle-income country, set as a policy goal by the Government of Bangladesh.
   - ✓ The Government of Japan will contribute to the improvement of regional connectivity by promoting the efficient move of people and goods through the development of high quality

[6] https://www.bd.emb-japan.go.jp/files/100136824.pdf

transportation and traffic infrastructure in accordance with international standards, while paying attention to the diversification of transportation systems.

- ✓ In order to solve the serious shortage of electricity and energy, which is the most serious obstacle to economic development, a stable supply of electricity and energy will be ensured through the construction of power plants and transmission and distribution networks.
- ✓ In the pursuit of promoting the activities of the private sector and in a bid to attract and increase private investment, the Government of Japan will support the improvement of the investment environment and engage extensively in human resource development, which is the foundation for the growth of the private sector.

2. Overcoming Social Vulnerabilities

- ✓ The Government of Japan will contribute to the achievement of the SDGs related to poverty, hunger, education, health, gender, and water and sanitation.
- ✓ For education, the Government of Japan will contribute to improving the quality of primary education, improving technical education, and promoting research and development in the field of science and technology.
- ✓ As for healthcare, the Government of Japan will contribute to the achievement of universal health coverage by improving the quality of public health services, especially maternal and child health and non-communicable disease control, and by supporting the strengthening of comprehensive health systems through capacity building of health administration, including the development of human resources for health and the establishment of community-based health support systems.
- ✓ The Government of Japan will also provide support for disaster prevention and measures to tackle climate change, focusing on disaster forecasting and warning, earthquake disaster mitigation, and river management, as well as for improving living conditions and livelihoods in rural areas.

5.2.2 JICA's Possible Priority Fields of Cooperation and Priority Activities in DRR Sector

In light of the development cooperation policy outlined in 5.2.1, the following items are considered most important in the direction of supporting sustainable economic development in Bangladesh.

- ✓ Protection of economic activity centers
- ✓ Promote the resilience of critical infrastructure
- ✓ Strengthening post-disaster recovery and reconstruction measures
- ✓ Promote mainstreaming of disaster risk reduction in all sectors

Based on the above directions, JICA's proposed short, medium, and long-term priority fields of cooperation and priority activities are proposed as shown in Table 5.2.1.

Table 5.2.1 JICA's Possible Priority Fields of Cooperation and Priority Activities in DRR Sector

Proposed Activities in the Disaster Risk Reduction Sector to be Promoted in Bangladesh	JICA's Possible Priority Fields of Cooperation and Priority Activities in DRR Sector Based on Japan's Country Development Cooperation Policy
Proposed Short-Term Activities	JICA's Possible Priority Fields of Cooperation and Priority Activities (Short-Term)
1-1: Promoting understanding of disaster risk. 1-2: Development of comprehensive DRR plan. 1-3: Increased investment in DRR and climate change risk reduction. 1-4: Strengthening DRR organizations and systems. 1-5: Further Development of DRR-related standards and guidelines. 1-6: Strengthening DRR information systems. 1-7: Introduction of technologies that match the natural and social characteristics of the country. 1-8: Promotion of DRR education, training, and enlightenment.	In order to "protect the centers of economic activity" and "promote the resilience of critical infrastructure", the highest priority shall be placed on promoting 1-3, based on the recognition that the most important thing is to realize disaster risk reduction through pre-disaster investment in major cities and critical infrastructure related to transportation, energy, and other sectors. However, the promotion of 1-3 is premised on appropriate understanding of disaster risk and the formulation of comprehensive project plans based on this understanding. In addition, it is important to develop the infrastructure (observation network, organization, and systems) for the promotion of the projects. (1-1, 1-2, 1-4, 1-5) From the viewpoint of economic damage reduction, emphasis should be placed on disaster risk reduction through structural countermeasures, while non-structural countermeasures, including forecasting and warning system, should be positioned as a field for long-term cooperation. Based on the above, the following activities will be selected as JICA's priority cooperation activities. 1-1: Promoting understanding of disaster risk. 1-2: Development of comprehensive DRR plan. 1-3: Increased investment in DRR and climate change risk reduction. 1-4: Strengthening DRR organizations and systems. 1-5: Further Development of DRR-related standards and guidelines.
Proposed Medium-Term Activities	JICA's Possible Priority Fields of Cooperation and Priority Activities (Medium-Term)
2-1: Disaster risk reduction investment. (Continuation of 1-3) 2-2: Realization of resilient recovery and reconstruction measures. 2-3: Strengthening the dissemination, sharing, and management of disaster risk information.	In order to "protect the centers of economic activity" and "promote the resilience of critical infrastructure", the greatest emphasis will continue to be placed on pre-disaster investments, based on the recognition that achieving fundamental disaster risk reduction is extremely important from the perspective of sustainable development. (2-1) In order to promote disaster risk reduction centered on the structural measures mentioned above, it is necessary to enhance the accessibility and usability of disaster risk information. From a medium-term perspective, the sharing and management system of disaster risk information should be enhanced in particular. (2-3) For "strengthening post-disaster recovery and reconstruction measures", from the viewpoint of future disaster risk reduction in the mid-term and beyond, strong post-disaster reconstruction measures will be established and put into practice after disasters that could not be prevented and actually occurred. (2-2) Based on the above, the following activities will be selected as JICA's priority cooperation activities. 2-1: Disaster risk reduction investment. (continuation of 1-3) 2-2: Realization of resilient recovery and reconstruction measures. 2-3: Strengthening the dissemination, sharing, and management of disaster risk information.

Proposed Long-Term Activities	JICA's Possible Priority Fields of Cooperation and Priority Activities (Long-Term)
3-1: Planned and continuous investment in disaster risk reduction. (Continuation of 2-1) 3-2: Enhancement of non-structural measures including early warning systems. 3-3: Promoting DRR considerations for all sectors.	In order to "protect the centers of economic activity" and "promote the resilience of critical infrastructure", the greatest emphasis will continue to be placed on pre-disaster investments, based on the recognition that achieving fundamental disaster risk reduction is extremely important from the perspective of sustainable development. (3-1) From a long-term perspective, in addition to structural countermeasures, non-structural countermeasures including forecasting and warning system should be enhanced, with a view to expanding the national all-round DRR promotion system. (3-2) For long-term economic development, it is important to incorporate the disaster risk reduction perspective in all sectors to "promote mainstreaming of disaster risk reduction". The effort will be based on an accurate understanding of disaster risk. (3-3) Based on the above, the following activities will be selected as JICA's priority cooperation activities. 3-1: Planned and continuous investment in disaster risk reduction. (Continuation of 2-1) 3-2: Enhancement of non-structural measures including early warning systems. 3-3: Promoting DRR considerations for all sectors.

Source: JICA Survey Team

5.2.3 Possible Directions of Efforts by Disaster Type and Field

Based on the issues identified from the survey and discussions with relevant organizations, possible directions of efforts by disaster type and field can be summarized as follows. These are expected to contribute to the proposed key activities mentioned above, especially in terms of "Promoting understanding of disaster risk", "Increased investment in DRR and climate change risk reduction", "Strengthening DRR organizations and systems", and "Strengthening the dissemination, sharing, and management of disaster risk information".

Table 5.2.2 Possible Directions of Efforts by Disaster Type and Field

Theme	Possible Directions of Efforts	Correspondence with Proposed Key Activities
Strengthening Disaster Risk Governance	Capacity enhancement of disaster management administrative coordination organizations	1-4: Strengthening DRR Organizations and Systems
	Securing funds for pre-disaster investment in risk areas	1-3: Increased Investment in DRR and Climate Change Risk Reduction
	Improvement of operational structure and securing budget for disaster recovery phase	2-2: Realization of Resilient Recovery and Reconstrution Measures
	Formulation of DRR plans for special economic zones	1-2: Formulation of Comprehensive DRR Plans
	Promotion of community participation in DRR planning and activities	1-4: Strengthening DRR Organizations and Systems
	Modernization of disaster information systems	2-3: Strengthening the Dissemination, Sharing, and Management of Disaster Risk Information
River Management	Implementation of projects based on basin-wide comprehensive river management plan	1-2: Formulation of Comprehensive DRR Plans
	Introduction of embankment technologies for urban rivers that require less land acquisition	1-3: Increased Investment in DRR and Climate Change Risk Reduction
	Further discussion on strengthening the durability of levees and confirming the effectiveness of past pilot projects	1-3: Increased Investment in DRR and Climate Change Risk Reduction
	To clarify the mechanism of river channel change and enhance approaches to prevent damage from erosion	1-3: Increased Investment in DRR and Climate Change Risk Reduction

	River management responsive to changes in external forces due to climate change	1-3: Increased Investment in DRR and Climate Change Risk Reduction
	Introduction of efficient river monitoring and surveying system	2-3: Strengthening the Dissemination, Sharing, and Management of Disaster Risk Information
Flood Forecasting and Warning	Automation and higher frequency of hydrological observations	2-3: Strengthening the Dissemination, Sharing, and Management of Disaster Risk Information
	Strengthening cooperation among relevant organizations in the development of geospatial information	1-4: Strengthening DRR Organizations and Systems
	Two-dimensionalization of flood prediction systems	1-1: Promoting Understanding of Disaster Risk
Urban Flood	Implementation of flood and drainage countermeasures in large cities	1-3: Increased Investment in DRR and Climate Change Risk Reduction
	Implementation of drainage management measures based on future urban development and land use plans	1-2: Formulation of Comprehensive DRR Plans
	Strengthening maintenance and management capacity for urban drainage	1-4: Strengthening DRR Organizations and Systems
	Strengthening cooperation with the waste management sector	1-4: Strengthening DRR Organizations and Systems
	Development of drainage management planning manual	1-5: Further development of DRR standards and guidelines
Storm Surge Countermeasures	Investment in coastal development areas	1-3: Increased Investment in DRR and Climate Change Risk Reduction
	Promotion and deployment of strengthening dikes	2-2: Realization of Resilient Recovery and Reconstrution Measures
	Improvement of dike construction quality	1-3: Increased Investment in DRR and Climate Change Risk Reduction
Meteorological Forecasting and Warning	Radar observations to supplement rainfall observation network	1-1: Promoting Understanding of Disaster Risk
	Resumption of operation of aging weather radar	1-1: Promoting Understanding of Disaster Risk
	Improving the capacity of officials relevant to the maintenance and management of weather observation equipment	1-4: Strengthening DRR Organizations and Systems
	Development of data and tools to facilitate understanding of climate change risks	2-3: Strengthening the Dissemination, Sharing, and Management of Disaster Risk Information
Earthquake	Establishment of quality control process for new buildings	1-5: Further development of DRR standards and guidelines
	Assess and prioritize the safety of existing buildings	1-2: Formulation of Comprehensive DRR Plans
	Seismic retrofitting of important public buildings	1-3: Increased Investment in DRR and Climate Change Risk Reduction

Source: JICA Survey Team

5.2.4 Possible Cooperation Policy in Disaster Risk Reduction Sector

Based on the above study, possible contents of cooperation in disaster risk reduction sector are proposed in Table 5.2.3. In addition, Table 5.2.4 shows possible key effectiveness indicators to be achieved in Bangladesh by 2030.

Table 5.2.3 Possible Cooperation Policy in Disaster Risk Reduction Sector

Priority Disaster Phases:	It covers all phases of disaster risk management, but focuses are especially on pre-disaster investment based on appropriate understanding of risks, from the perspective of supporting sustainable economic development towards poverty alleviation.	
Priority Cooperation Areas:	Overall	From the perspective of pre-disaster investment, focus is on proactive protection of key industrial zones, especially the Big-B areas.
	River Management	Chattogram Hills Area Northeastern Flash Flood Region Padma and Jamuna Rivers
	Urban Flood and Drainage	BDP 2100 Major Urban Hotspots. Especially Dhaka, Chattogram, Khulna, and Barisal
	Storm Surge	Coastal area of the Big-B zone (Dhaka – Chattagram – Matarbari). (In particular, the Matarbari industrial park area and the Mirsarai industrial park area)
	Earthquake	Dhaka, Chattogram, Sylhet and Mymensingh
Priority Activities:	(Key Activity 1: Implementation by 2025) 1-1: Promoting Understanding of Disaster Risk. 1-2: Formulation of Comprehensive DRR Plans. 1-3: Increased Investment in DRR and Climate Change Risk Reduction. 1-4: Strengthening DRR Organizations and Systems. 1-5: Further Development of DRR-related Standards and Guidelines. (Key Activity 2: Implementation by 2030) 2-1: Continuous DRR Investment in a Planned Manner. (Continuation of 1-3) 2-2: Realization of Resilient Recovery and Reconstruction Measures. 2-3: Strengthening the Dissemination, Sharing, and Management of Disaster Risk Information. (Key Activity 3: Implementation by 2040) 3-1: Continuous DRR Investment in a Planned Manner. (Continuation of 2-1) 3-2: Enhancement of Non-structural Measures Including Early Warning Systems. 3-3: Promoting DRR Considerations for All Sectors.	

Source: JICA Survey Team

Table 5.2.4 Proposed Effectiveness Indicators to be Achieved by 2030

Disaster Type/Field	Effectiveness Indicators	
Common	Number of deaths, affected persons, and amount of damage.	
DRR Governance	Number of local government units with DRR plans. Amount and type of DRR information archived. Communication time from the ministries and agencies in charge of disaster management to the relevant organizations.	
Reduction of Water Disaster Risk	Common	Annual maximum flood inundation area (km^2), Maximum number of units inundated in a year (units), Annual maximum water level at reference point (m).
	River Planning/River Management	Number of basin management plans formulated, Reduction in maintenance and management costs due to the establishment of strong embankments and revetments.
	Urban Flood/Drainage	Number of drainage management plans formulated.
	Storm Surge	Reduction in maintenance and management costs due to the establishment of strong embankments and revetments.
	Flood/Meteorological Forecasting and Warning	Number of hydrological and meteorological instruments installed, their operating rates and forecast period.
Reduction of Earthquake Related Disaster Risk	Number of schools, hospitals, and other critical infrastructure that have benefited fromseismic retrofitting projects.	

Source: JICA Survey Team