Assessment of Water Sector Policy Frameworks of Bangladesh:

Identifying Gaps and Addressing Needs

Climate Adaptation and Resilience (CARE) for South Asia Project

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adpc

SM Tower 24th Floor No. 979/66-70 Phahonyothin Road,
Phaya Thai Sub-District Phaya Thai District, Bangkok 10400
Telephone: +66 2 298 0681-92
Website: www.adpc.net

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WARPO
পানি সম্পদ পরিকল্পনা সংস্থা

Water Resources Planning Organization
Ministry of Water Resources
Government of the People's Republic of Bangladesh
WARPO Bhaban
72 Green Road, Dhaka-1215, Bangladesh
Tel: 44819015, 44819006, Fax: 44819002
E-mail: dg@warpo.gov.bd
Website: www.warpo.gov.bd

Foreword

Water is the essence of life, and its responsible management is a cornerstone of sustainable development. Bangladesh, a country endowed with an intricate network of rivers and an abundant monsoon climate, is both blessed and challenged by water. The dynamic interaction between water and the people of Bangladesh has shaped the nation's history, culture, and identity. In a land where the rhythm of life is inseparable from the ebb and flow of its rivers, the water sector plays a pivotal role in shaping the nation's future.

It is with great pleasure that I introduce this comprehensive report, "Assessment of Water Sector Policy Frameworks of Bangladesh: Identifying Gaps and Addressing Needs." This document represents a significant milestone in our collective efforts to better understand and enhance the management of water resources in Bangladesh. It is a testament to the dedication, expertise, and commitment to contribute knowledge and insights to the discourse on water policy in Bangladesh.

As the world grapples with the ever-increasing challenges of climate change, population growth, urbanization, and the need for sustainable development, the importance of sound water policies cannot be overstated. Bangladesh, with its unique geographical and environmental characteristics, is particularly susceptible to the impacts of water-related challenges. Hence, a robust and adaptable policy framework is imperative to ensure the equitable and efficient use of water resources while safeguarding the environment and the well-being of its people.

This report meticulously examines the existing water sector policy frameworks of Bangladesh, shedding light on their strengths, weaknesses, and areas requiring improvement. It provides a comprehensive overview of the current state of water governance, highlighting the successes achieved thus far and the challenges that lie ahead. By identifying gaps and proposing concrete solutions, it serves as a valuable resource for policymakers, researchers, and stakeholders alike.

Furthermore, this report underscores the need for integrated and inclusive approaches to water resource management. In a rapidly changing world, where water-related issues transcend boundaries and sectors, collaboration among diverse stakeholders becomes essential. The insights and recommendations presented here are not only timely but also align with the global agenda of achieving Sustainable Development Goal 6 (SDG 6) ensuring availability and sustainable management of water and sanitation for all.

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Website: www.warpo.gov.bd

I would like to extend my heartfelt gratitude to the authors, and contributors for their collective efforts which have resulted in a valuable tool that can guide our endeavors to build a resilient and water-secure future for Bangladesh. I encourage all readers to engage with the findings and recommendations presented herein, to foster dialogue, and to act where necessary.

Together, we can transform challenges into opportunities and ensure that water continues to be a source of life and prosperity for the people of Bangladesh.

Md. Rezaul Maksud Jahedi
Director General
Water Resources Planning Organization (WARPO)

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EXECUTIVE SUMMARY

Asian Disaster Preparedness Center (ADPC) and the Regional Integrated Multi-Hazard Early Warning System (RIMES) are jointly implementing a five-year (2020-2025) regional project called 'Climate Adaptation and Resilience (CARE) for South Asia,' with support from the World Bank. The project's overall objective is to contribute to an enabling environment for climate resilience policies and investments in South Asia's agriculture, transport, water, policy and planning, and finance sectors. Initially, national-level activities are being implemented in Bangladesh, Nepal, and Pakistan. The project has two parallel but distinct components. RIMES is implementing the first component, which focuses on promoting evidence-based climate-smart decision-making; ADPC is implementing the second component, which focuses on enhancing policies, standards, and capacities for climate-resilient development in South Asia.

Bangladesh is the only downstream riparian country in the Ganges-Brahmaputra-Meghna river basins (GED, 2020). These three rivers, including their catchment areas, are commonly known as the GBM basin system. The country's surface water resources have developed at the lower end of this GBM basin system. Only about 7 percent of the total basin area of 1.72 sq. km falls within the country boundary (GED, 2020). More than 700 rivers flow in the country, including 57 transboundary rivers. These rivers constitute the surface water system of the country and are fed by the runoff from upstream and hydrological regions within the national boundary.

On the other hand, groundwater is a renewable and dynamic natural resource in Bangladesh (Mojid et al., 2019). It provides an essential supply for domestic, irrigation, and industrial use in the country. Despite having a fairly abundant surface water resources system, the country's water usage pattern heavily depends on groundwater supply. An average volume of 32.0 cubic kilometers is withdrawn annually to meet the nation's water demand for agriculture, industry, and household needs (Shamsudduha et al., 2019). This amount equals approximately 4 percent of global groundwater withdrawal (Hanasaki et al., 2018).

In terms of consumption, agriculture is the primary user of groundwater. According to World Bank statistics (2017), irrigation accounts for more than 87 percent of total groundwater withdrawal in the country. Estimated present (2011) and future (2030) water demands in the country are listed in Table 1. The government has been trying to increase the share of surface water supply for irrigation to limit excessive groundwater abstraction through deep tube wells. Besides the natural systems, the country has limited water resource development options, such as rainwater harvesting (RWH), installing surface reservoirs, and wastewater reclamation. The governing water consumer in the country is the agriculture sector.

Table 1: Estimates of Water Demands in Different Sectors (Source: World Bank, 2015)

Sector/ Use	Demand (withdrawal, bcm)	
	Year 2011	Year 2030
Agriculture (irrigation, fisheries, and livestock)	32.3	46.3
Only irrigation	23.6	34.5
Domestic	2.4	4.2
Industry	0.1	0.2
Instream Demand or Environmental Flows	106.2	106.2

Water resources are at the center of the economy and development in Bangladesh. They are linked with the sustainability of other governing sectors such as food and agriculture, industry, and infrastructure. Water policies play a crucial role in managing the extraction, treatment, supply, demand, distribution, and allocation of water for various purposes. With the growing concern for climate change and its impact on water security, the government has to closely monitor and update these policy

instruments to ensure the country's water needs are met and maintain a sustained balance on the basin- or regional scale.

This report summarizes the findings of a review of Bangladesh's water sector policy framework. The study was performed under Component 2 of the CARE for South Asia project, which aims to develop or enhance climate-resilient standards for the subject sector at national- and South Asian Regional (SAR) levels.

Several legal, institutional, policy, and regulatory instruments at national and regional scales support water resources management and conservation in the country. Bangladesh, one of the world's largest deltas, has a long history of managing water resources that required the formulation of different policy frameworks over time. In addition to sector-specific policy frameworks, the country has prepared several short-, medium- and long-term national plans, including strategies for integrated water resources management (IWRM). All these policy instruments, along with the institutional structure of the government, facilitate the required environment for water governance.

The assignment also explored the country's water governance history and the government's institutional form in different periods. It is anticipated that the form of water management in Bangladesh has evolved from a flood control approach to the concept of water governance over time. The Ministry of Water Resources (MoWR) is the government's mandated institution for Bangladesh's water resources development. It is supported by many implementation partners, including the Water Resources Planning Organization (WARPO), Bangladesh Water Development Board (BWDB), and the Department of Bangladesh Haor and Wetlands Development (DBHWD). In addition, water-related service sectors such as water supply and wastewater drainage, as well as water, sanitation, and hygiene (WASH), are managed by the Local Government Division (LGD) and its implementation partners, e.g., Water Supply and Sewerage Authorities (WASAs), Department of Public Health Engineering (DPHE), City Corporations, Local Government Engineering Department (DPHE), and other local water management bodies.

There are several other water institutions, technical and development partners, and organizations from other sectors, such as the Ministry of Agriculture (MoA), Ministry of Shipping (MoS), Ministry of Environment, Forest and Climate Change (MoEFCC), etc., which contribute to the nation's water governance system.

Several policy instruments are used by different ministries and their implementation partners connected with the water sector of Bangladesh. More than 40 prevailing policy instruments from different sectors were reviewed in this study. Among them, a total of 33 instruments were summarized in this document. The policy instruments include Acts, rules, policies, strategies, plans, guidelines, treaties, etc. Among the reviewed documents, there were 14 and 8 policies from the water and agriculture sectors. In addition, three national-level policies for climate adaptation and mitigation and three national plans, i.e., the Bangladesh Delta Plan 2100, Perspective Plan 2041, and the Eighth Five Year Plan (2021-2025), were reviewed in this assignment. The reviewed climate policies were the National Adaptation Program of Action 2009 (NAPA 2009), the Bangladesh Climate Change Strategy and Action Plan 2009 (BCCSAP 2009), and the Intended Nationally Determined Contributions 2015 (INDC 2015). Some local adaptation plans and measures were also explored with information on relevant projects and case studies.

A review of Bangladesh's water sector policy framework yielded the following findings from this assignment.

Status of Water Resources

- Despite having a fairly abundant surface water resources system, water consumers are heavily dependent on the groundwater supply in Bangladesh. The largest consumer is the agriculture sector.
- Executing agencies not only from MoWR but other ministries such as MoLGRD&C and MoA are engaged in water resources development.

- The government has been trying to shift the water balance toward surface water.
- The transboundary inflow occupies almost 75% of the total water volume, indicating the country's dependency on regional availability and cooperation with WRM.
- The main issue associated with the availability of water resources is its abundance in the wet season and shortage in the dry season. Water storage potential remains unharvested. The government has promoted rainwater harvesting as a renewable and alternative supply source through its different policy instruments.
- The coastal zone is the most critically affected hydrologic region regarding access to safe water due to arsenic (As) contamination, climate vulnerabilities, and salinity intrusion.
- A water reclamation option could be a viable source for industrial and agricultural applications and a solution for reducing stress on the excessive abstraction of groundwater. However, this study did not find reliable information on the status of water reuse in the country. No policy instrument is found that promotes adopting resource recovery and reuse for water applications.

Status of Water Governance

- Water governance in Bangladesh demonstrates a complex and participatory arrangement with a network of water institutions, both at the central government and local government levels.
- Although MoWR is the focal ministry for water governance, the groundwater supply infrastructure and operations are managed by the DPHE under the MoLGRD&C. Therefore, agricultural water use is linked with the operations of both MoWR and MoLGRD&C.
- The water organizations follow the policy instruments designed by the MoEFCC to address climate actions in their development programs.
- Though the policy instruments suggest a basin-scale practice of WRM, the existing institutional setups, such as water management committees, include administrative boundaries for IWRM.
- The country has adequate information on the technical, hydrological, and operational aspects of water management. Yet, the practice of evidence-based decision-making and access to supporting tools for information management are not present to a satisfactory level.

Review of the existing policy frameworks

- The governing policy instruments on water resources are the National Water Policy 1999, National Water Management Plan 2001, Water Act 2013, Water Rules 2018, and the IWRM Guidelines 2020. The Water Policy 1999 and the Water Management Plan 2001 shape the country's development of water resources and flood control infrastructure. Yet, these instruments have not been updated since their first publication.
- In the context of transboundary river management, Bangladesh has only one bilateral treaty with India. The government has been trying to formulate another treaty for the Teesta River with India. However, no policy instrument was found to address transboundary aquifer management.
- The LGD generally adopts sector development policies focusing on water supply and sanitation.
- The water sector policies are supported and enhanced with input from the national level plans and strategies such as the Delta Plan 2100, Eighth Five Year Plan 2021-2025 (8FYP), etc.
- Many water sector policies address the impact of climate change, but only a few provide directions toward formulating specific adaptation and resilience measures.
- Relevant policies in the agriculture sector focus on enhancing irrigation efficiency and technologies, but there is a gap in the linkage with the information on water resources.

- The subsectors of fisheries and livestock have no specific policy instruments to provide directions on the use of water resources. Currently, these sectors use instruments supplied by MoWR and MoA.
- There is a lack of adequate and well-formulated legal capacities for monitoring and regulations identified in the existing policy instruments of the water sector. It is essential to address the deficiency in policy compliance and protect natural water resources.
- Recent policy instruments like the 8FYP encourage establishing a decentralized water management practice. If it could be implemented successfully, water governance in the country would experience a noticeable shift in the near future.

As listed below, the review findings and information on water sector stakeholders were further analyzed to identify noticeable gaps and sectoral needs in the policy framework.

- Water governance in Bangladesh strictly follows a top-down approach. It leaves the lower-level and community-based water organizations with a knowledge gap on policy implementation to a certain extent. Coupled with this challenge, the locally adopted best management practices are frequently absent in these policy instruments.
- There is evidence of data duplication and a lack of appropriate data management and sharing protocols among the stakeholders. Therefore, acquiring the right data at the right time from the right authorities may be challenging. Many agencies use IT-enabled platforms to store and manage their data, but the systems are unfavorable for instant and easy access. Also, the quality of metadata is unsatisfactory. The implementation programs produce a wealth of daily information, but those are not properly stored and archived to support data analytics and decision-making.
- There is a lack of advanced and IT-enabled M&E systems to support water governance. Many implementation projects still adopt traditional and manual M&E processes, leading to limited governance compared to expectations. Fortunately, the 8FYP formulated a development plan for a digital and result-based M&E system to support the implementation of the BDP 2100. This example must be demonstrated as much as possible in every sector and program.
- Many of the requirements of the policy instruments appear ambitious compared to the current status of implementation and resource capacity of the executing institutions. For example, the SDGs targets are incorporated in many policy instruments, but the local institutions are not yet ready to deliver the intended results. There is a significant need for capacity building, particularly for local-level (rural and municipal) water institutions. There is further scope for conducting an extensive capacity needs assessment for the water sector agencies.
- No decision-support framework is currently institutionalized to support water accounting and auditing at the governance level.
- The National Water Policy 1999 and the National Water Management Plan 2001 could not be updated due to various challenges, including resource limitations at WARPO. The same scenario applies to many other policy instruments. For instance, the last policy framework in the livestock sector was developed in 2007. It reveals that some government institutions cannot regularly update the policy instruments and implementation status.
- IWRM requires a participatory approach, yet only one policy instrument is available to provide proper directions and ensure an enabling environment for all stakeholders. There is a lack of understanding, clarity, and accountability regarding the roles and responsibilities of the individual institution in the existing setup.
- MoWR has no dedicated policy instrument to support protecting and enhancing water quality in the existing water resources.

- The sub-sectors of fisheries and livestock are very important in the context of IWRM. Still, no well-designed policy instruments were found in these sectors to support the efficient use of water resources.
- Considerations for an integrated balance of surface water and groundwater resources are essential in the operating policy frameworks and among the participating water institutions from different ministries. A coordination gap is sensed between the policy frameworks adopted by the MoWR and the LGD.
- A well-designed policy instrument on IT-enabled platforms, geospatial technologies, remote sensing, simulation, and analytics tools needs to be formulated considering sector-specific water applications and climate actions.

The assessment findings also helped establish the following linkages with the planned activities of the CARE for South Asia project.

- The CARE for South Asia project plan to develop a climate-informed water accounting framework for agricultural water management. The framework will provide evidence-based decisions on water use for agricultural production and support water accounting and auditing by MoWR and its partner organizations.
- The 8FYP recommends developing a Result-Based M&E (RBM&E) system following the principles outlined in the BDP 2100. Developing necessary guidelines for this M&E framework and an online portal to access the framework in consultation with GED and MoWR are being explored.
- An extensive capacity needs assessment will be performed for the selected water institutions, and the project will arrange appropriate training for the staff of those agencies.
- Essential technical assistance will be provided on enhancing water sector policy instruments used by MoWR, WARPO, and BWDB. The policy instrument will be selected in consultation with the sector focal points from MoWR, WARPO, and BWDB.
- Adequate training will be provided on the frameworks and decision support systems designed through the project to ensure the sustainability of the use of project outputs and improved capabilities for water governance.

The policy support interventions in the CARE for South Asia project will assist the stakeholders with managing water resources better and incorporate essential adaptation and resilience measures on climate change, both at national and regional scales.

Abbreviations

8FYP	The Eighth Five Year Plan (2021-2025) of Bangladesh
ADB	Asian Development Bank
ADP	Annual Development Plan
ADPC	Asian Disaster Preparedness Center
AIS	Agricultural Information System
As	Arsenic
AWM	Agricultural Water Management
BADC	Bangladesh Agricultural Development Corporation
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BCCT	Bangladesh Climate Change Trust
bcm	Billion cubic meters
BDP 2100	Bangladesh Delta Plan 2100
BEZA	Bangladesh Economic Zones Authority
BIWTA	Bangladesh Inland Water Transport Authority
BIWTC	Bangladesh Inland Water Transport Corporation
BMD	Bangladesh Meteorological Department
BMDA	Barind Multipurpose Development Authority
BPC	Bangladesh Planning Commission
BRRI	Bangladesh Rice Research Institute
BUET	Bangladesh University of Engineering and Technology
BWDB	Bangladesh Water Development Board
CARE	Climate Adaptation and Resilience for South Asia
CEGIS	Center for Environmental and Geographic Information Services
City Corp.	City Corporation
CRI	Climate Risk Index
CSIRO	Commonwealth Scientific and Industrial Research Organization, Australia
cusecs	Cubic feet per second
CWP	Crop Water Productivity
DAE	Department of Agricultural Extension
DBHWD	Department of Bangladesh Haor and Wetlands Development
DLS	Department of Livestock Services
DoE	Department of Environment
DoF	Department of Fisheries
DoS	Department of Shipping
DPHE	Department of Public Health Engineering

DSS	Decision Support System
DWASA	Dhaka Water Supply and Sewerage Authority
EbA	Ecosystem-based Adaptation
ECNWRC	Executive Committee of the National Water Resources Council
EIA	Environmental Impact Assessment
ET	Evapotranspiration
EU	European Union
FAO	Food and Agricultural Organization of the United Nations
FAP	Flood Action Plan
FFWC	Flood Forecasting and Warning Center
FY	Fiscal Year
GBM	Ganges-Brahmaputra-Meghna basin system
GCF	Green Climate Fund
GED	General Economics Division
GEF	Global Environment Facility
GHG	Greenhouse Gases
GIZ	German Development Agency
GPP	Guidelines for People's Participation
ICCCAD	International Center for Climate Change and Development
IIED	International Institute for Environment and Development
INDC	Intended Nationally Determined Contribution
INGO	International Non-Government Organization
IsDB	Islamic Development Bank
IT	Information Technology
IUCN	International Union for Conservation of Nature
IWFM	Institute of Water and Flood Management
IWM	Institute of Water Modelling
IWRM	Integrated Water Resources Management
JRC	Joint River Commission
LAPA	Local Adaptation Plans for Action
LGD	Local Government Division
LGED	Local Government Engineering Department
LIPRF	Legal, Institutional, Policy, and Regulatory Framework
LoGIC	Local Government Initiatives on Climate Change
LPAD	Legal and Parliamentary Affairs Division
M&E	Monitoring and Evaluation
MoA	Ministry of Agriculture
MoD	Ministry of Defense
MoDMR	Ministry of Disaster Management and Relief
MoEFCC	Ministry of Environment, Forest and Climate Change

MoFL	Ministry of Fisheries and Livestock
MoLGRD&C	Ministry of Local Government, Rural Development and Cooperatives
MoP	Ministry of Planning
MoS	Ministry of Shipping
MoWR	Ministry of Water Resources
NAP	National Adaptation Plan
NAPA	National Adaptation Program of Action
NbS	Nature-based Solution
NGO	Non-Government Organization
NRCC	National River Conservation Council
NWMP	National Water Management Plan
NWRC	National Water Resources Council
O&M	Operation and Maintenance
PP 2041	Perspective Plan 2041
PSB	Policy Support Branch
RBM&E	Result Based Monitoring and Evaluation
RIMES	Regional Integrated Multi-Hazard Early Warning System for Africa and Asia
RRI	River Research Institute
RWH	Rainwater Harvesting
SDG	Sustainable Development Goal
SDP	Sector Development Plan
SIDA	Swedish International Development Cooperation Agency
SoB	Survey of Bangladesh
SPARRSO	Bangladesh Space Research and Remote Sensing Organization
SREDA	Sustainable and Renewable Energy Development Authority
UN	United Nations
UNCDF	United Nations Capital Development Fund
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
USACE	U.S. Army Corps of Engineers
USAID	United States Agency for International Development
WA	Water Accounting
WARPO	Water Resources Planning Organization
WASA	Water Supply and Sewerage Authority
WASH	Water, Sanitation, and Hygiene
WB	World Bank
WHO	World Health Organization
WMP	Water Master Plan
WRM	Water Resources Management
WSS	Water Supply and Sanitation

1. INTRODUCTION

Asian Disaster Preparedness Center (ADPC) and the Regional Integrated Multi-Hazard Early Warning System (RIMES) are jointly implementing a five-year (2020-2025) regional project called 'Climate Adaptation and Resilience (CARE) for South Asia' with support from the World Bank. The overall objective of the project is to contribute to an enabling environment for climate resilience policies and investments in agriculture, transport, water, policy and planning, and finance sectors in South Asia.

The national-level activities are being implemented in Bangladesh, Nepal, and Pakistan. The project has two parallel but distinct components: RIMES is implementing the first component, which focuses on promoting evidence-based climate-smart decision-making; ADPC is implementing the second component, which focuses on enhancing policies, standards, and capacities for climate-resilient development in South Asia.

This report summarizes findings after reviewing Bangladesh's water sector policy framework. Several legal, institutional, policy, and regulatory instruments at national and regional scales support water resources management and conservation in the country. Bangladesh, one of the world's largest deltas, has a long history of managing water resources that require formulating different policy frameworks over time. In addition to the sector-specific policy frameworks, the country has prepared several short-, medium- and long-term national plans, including the strategies for integrated water resources management (IWRM).

Water resources are at the center of the economy and development in Bangladesh. They are linked with the sustainability of other governing sectors such as food and agriculture, industry, and infrastructure. Water policies play a crucial role in managing the extraction, treatment, supply, demand, distribution, and allocation of water for various purposes. With the growing concern for climate change and its impact on water security, the government has to closely monitor and update these policy instruments to ensure the country's water needs and maintain a sustained balance on the basin- or regional scale.

Despite significant progress in Bangladesh in increasing access to clean water, increasing agricultural production by irrigation, and managing floods, many challenges must be addressed by the country's water policy, particularly as climate change impacts grow. A comprehensive analysis of water policy in Bangladesh is needed to understand the effectiveness of existing policies and identify potential areas for improvement to ensure that all citizens benefit from the many aspects of water security.

This assignment explored the status of the governing water sector policy framework and the country's fundamental water governance structure. Relevant policy instruments of other important thematic areas, such as agriculture and industry, were investigated to assess their relation and linkage with the water sector policy framework. However, the review focused on only the recent and governing policies to accurately predict the existing institutional and operational forms of water governance. There are many ancient and ancillary instruments left unassessed in this assignment. These should be reviewed by Government and assessed for their continued relevance.

The country's water sector acts and rules, policies, strategies, plans, and guidelines, and the structure of water resources governance through the Government's agencies were evaluated against the requirements for agencies to adopt IWRM. These requirements are summarized for each of the agencies in Table 12.

1.1 Study Objectives

The objectives of this report are to:

- Review and assess the country's existing WRM practice, and identify critical policy and institutional resource gaps for climate-resilient water governance.

- Identify the government's priority areas for the water sector's institutional development and check the adequacy of climate adaptation and resilience in those priority themes.

This review and its recommendations have been presented to the Ministry of Water Resources. Its findings will be used later in the work with the Government of Bangladesh to develop improved policies, standards, and capacities for climate-resilient development.

The review is one of three undertaken for the pilot countries in the CARE for South Asia project, Bangladesh, Nepal, and Pakistan. These reviews will be synthesized into a policy brief for South Asia, which is to be a resource document for later interventions under CARE for South Asia project.

1.2 Technical Approach

This study was performed by a desk review of the available documents related to the country's water institutions, WRM policy and legislation framework, various WRM projects implemented by government and international organizations, published research materials on the web, etc. In addition, the reflections obtained from informal and formal consultations, project workshops, and stakeholder meetings were also used. Thus, there are three types of information used to prepare and document the findings in this report as follows:

i. The WRM gaps and challenges addressed in the active policy and legislation frameworks;

ii. The WRM needs to be assessed in various publications, including academic research, project documents, or recent case studies;

iii. The priority needs and gaps addressed by the government stakeholders in different consultations held within the scope of the CARE for South Asia project

Two types of active policy instruments were reviewed in this assignment such as 1) the key policy and legislations used by MoWR and 2) national development plans. The water sector in Bangladesh has a fairly large number of plans, policies, and guidelines. However, the key references include the National Water Policy 1999, National Water Management Plan 2001, Water Act 2013, Water Rules 2018, etc. The Acts and Rules do not explicitly provide information on gaps or needs. Rather, they describe legal actions and procedures for water resources management.

The National Water Policy is the government's current guiding document for water sector development. The National Water Management Plan and the supporting Integrated Water Resources Management (IWRM) Guidelines build on the National Water Policy. This study also reviewed some regional water management policies and plans, such as the Coastal Zone Policy 2005 and the Haor Master Plan 2012.

Other than sectoral policies, the concurrent national development plans were reviewed in this assignment. These plans include the Delta Plan 2100, Perspective Plan 2021-2041, and the Eighth Five Year Plan 2021-2025. Among these, the Delta Plan 2100 and the Eighth Five Year Plan 2021-2025 are the most important national documents required to understand the government's strategies for climate adaptation in water sector interventions.

The gaps and needs for WRM were identified by performing stakeholder consultations with the Ministry of Water Resources (MoWR) and the Water Resources Planning Organization (WARPO). The consultation took place through phone calls, informal interviews, and project meetings. In addition, a national workshop was arranged on 31 August 2021, in which water sector gaps, needs, and implementation priorities were addressed by the participants. Senior officials from the MoWR, WARPO, Department of Bangladesh Haor and Wetlands Development (DBHWD), Bangladesh Agricultural Development Corporation (BADC), Department of Environment (DoE), and Institute of Water Modeling (IWM) attended the workshop.

The analysis performed in this assignment primarily focused on the following.

- Identifying and understanding the prevailing policy and legislative framework for the water sector, including both IWRM and the water service sector (e.g., water utility service sectors)
- Opportunities for the inclusion of climate adaptation and resilience

It is important to note that some important cross-cutting themes of the CARE for South Asia project, such as gender inclusion, institutional capacity needs assessment (CNA), etc., were not thoroughly evaluated in this assignment. These activities will be implemented separately by subject matter experts in the project's work plan for 2023 and beyond.

1.3 Geography, Population, and Climate

Bangladesh is a sovereign country that lies across the delta formed by the confluence of the Ganges and Brahmaputra River systems. It is part of South Asia, bordering the Bay of Bengal, between Burma and India. Bangladesh has an area of 148,460 km^2, of which 130,170 km^2 is land and 18,290 km^2 is water. It has a coastline of 580 km. The terrain is mostly flat alluvial plain, although the land is hilly in the southeast. The highest point is Mowdok Taung at 1,060 m, while the average elevation is 85 m. The Brahmaputra River, which rises in China and has part of its basin in Bhutan, has a length of 3,969 km. The Ganges River originates in India and has tributary flow from Nepal and China, with a length of 2,704 km. Three transboundary rivers also flow into Bangladesh from Myanmar, and numerous transboundary rivers flow into Bangladesh from India.

The population of Bangladesh is estimated at 165,650,475 (2022). The largest group is Bengali (98% or more), with other ethnic groups comprising only 1.1%. The median age is 28 years, and the population grows annually at 0.93% (2022). 39.7% of the population lives in urban centers, growing at 2.88% annually. The major urban centers are Dhaka (the capital, 22.478 million), Chittagong (5.253 million), Khulna (950,000), Rajshahi (942,000), Sylhet (928,000), and Bogura (864,000[1])[2].

The poverty headcount ratio at US $2.15 per day - 2017 purchasing power parity (percentage of the population) is 13.5% which has reduced rapidly from 33.3% in 2000.[3] Life expectancy at birth is 74.7 years, rising from 65 years in 2000. Bangladesh's gross domestic product (GDP) was 416.26 million in 2021, an average of $2,503 per person. 11.6% of the GDP is from agriculture, forestry, and fisheries. Ninety-eight percent of the population has access to at least a basic water supply (2020), with 58.4% having basic facilities for handwashing, including soap and water (2020). Only 4.9% of the marine territorial waters are protected.

The monsoon drives the climate of Bangladesh. The country has a tropical climate: a hot, humid summer (March to June), a humid, warm rainy monsoon (June to October), and a mild winter (October to March). The majority of Bangladesh's rainfall occurs from May to October. Only 10% of the annual rainfall occurs from November to April. Rainfall is high across the whole country. Most regions receive at least 1,500 mm; the largest annual falls of up to 5000 mm are in the northeast border region. Humidity remains high throughout the year, peaking during the monsoon season (June to October). Typically, a tropical cyclone (of strength classification Tropical Storm or above) will land in Bangladesh every two to three years, bringing heavy rainfall, high wind speeds, and storm surges. Variations in temperature, precipitation, and tropical storms between years are related to the El Niño cycle and the Indian Dipole.[4]

[1] https://www.macrotrends.net/cities/20112/bogra/population
[2] CIA. The World Factbook. https://www.cia.gov/the-world-factbook/countries/bangladesh/
[3] World Bank, 2017 is the latest data available https://data.worldbank.org/indicator/SI.POV.DDAY?locations=bd
[4] https://climateknowledgeportal.worldbank.org/country/bangladesh/climate-data-historical

2. WATER RESOURCES IN BANGLADESH

The long-term average precipitation is 2666 mm/year or a volume of 393.42 $10^9 m^3$/yr. Bangladesh is highly reliant on inflow from its upstream neighbor, India. Its internally sourced water is 83.91 km^3/yr or an average of just under 634 m^3 per person per year. Adding 1122 km^3/yr of water, which inflows from India, increases the per capita water available to 7407 m^3 per person per year, which lifts the country well above the UN's "water stress" level of 1000 m^3 per person per year. The details are given in Table 2[5] and Table 3.

Table 2: Share of the Flow (cusecs) of the Ganges (Padma) River between Bangladesh and India (Source: Ganges Water Sharing Treaty 1996)

Flow at Farakka (R. Padma)	India's share	Bangladesh's share
70,000 cusec* or less	50%	50%
70,000-75,000 cusec	Balance of flow	35,000 cusec (991 m3/s)
75,000 cusec or more	40,000 cusec (1133 m3/s)	Balance of flow

Table 3: Bangladesh's Population and Annual Renewable Resources

Item	Population (2022)	Water Resource km^3/yr
	165,650,475	
Internally sourced surface water		83.91
Internally sourced groundwater[6]		21.09
Overlap between surface water and groundwater		0
Total internal renewable water resource[7]		105.0
Average internal renewable water available per person (m^3/yr)		634
	Average surface water resources subject to treaties (km3/yr)	**Average surface water resources available (km3/yr)**
Total surface water inflow from India[8]	0.0	1122[9]
Inflow secured by treaty		0[10]
Inflow not secured by treaty		1122
Total external renewable water resources		1122
Total available water resource[11]		1227.032
Average total available water available per person		7407 (m^3/yr)
Surface water leaving Bangladesh to another country		0
Groundwater entering or leaving Bangladesh		0

[5] FAO AQUASTAT, Bangladesh http://fao.org/aquastat/statistics/query/index.html?lang=en
[6] Estimate. Not all of the groundwater (GW) recharge becomes surface water, some GW flows directly into the sea.
[7] Long-term average annual flow of rivers and recharge of aquifers generated from endogenous precipitation.
[8] Long-term average quantity of water annually entering the country through transboundary flow in rivers.
[9] The long-term average flow in the Ganges is about 424 km^3/yr and that of the Brahmaputra is about 555 km^3/yr.
[10] The Ganges Treaty, 1996, between Bangladesh and India requires India to share the flow in the Ganges at Farakka according to the table below. The treaty followed the decision and action by India to India to construct a barrage at Farkka, West Bengal, which was completed in 1975. The treaty is widely considered inadequate in its failure to consider aspects such as environmental requirements and climate change. https://internationalaffairsbd.com/sharing-ganges-bangladesh-perspective-environmental-impacts-political-implications/
[11] This is the sum of the Total internal renewable water resource and the Total external renewable water resource.

Agricultural land comprises 59.6% of the country. 53.9% of the country is arable land.[12] Permanent crops are planted on 5.0% of the land.[13] The forested area is 11.1%[14] (2018 estimate). The land equipped for irrigation is 50,500 km^{2,} and there is potential for a further 18,830 km^2.[15] However, this would require significant improvement in irrigation efficiency as water in the dry season is a limiting factor.

2.1 Surface Water

Bangladesh is the downstream riparian country in the Ganges-Brahmaputra-Meghna river basins (GED, 2020). These three rivers, including their catchment areas, are commonly known as the GBM basin system (Figure 1). The country's surface water resources have developed at the lower end of this GBM basin system. Only about 7 percent of the total basin area of 1.72 sq. km falls within the country boundary (GED, 2020). More than 700 rivers flow in the country, including 57 transboundary rivers. These rivers constitute the surface water system of the country and are fed by the runoff from upstream and hydrological regions within the national boundary. Most transboundary rivers, 54 among 57, are shared with India (Joint River Commission of Bangladesh, 2019). The Ganges-Brahmaputra-Meghna river basins are shown in Figure 1, and the hydrological regions of Bangladesh are depicted in Figure 2.

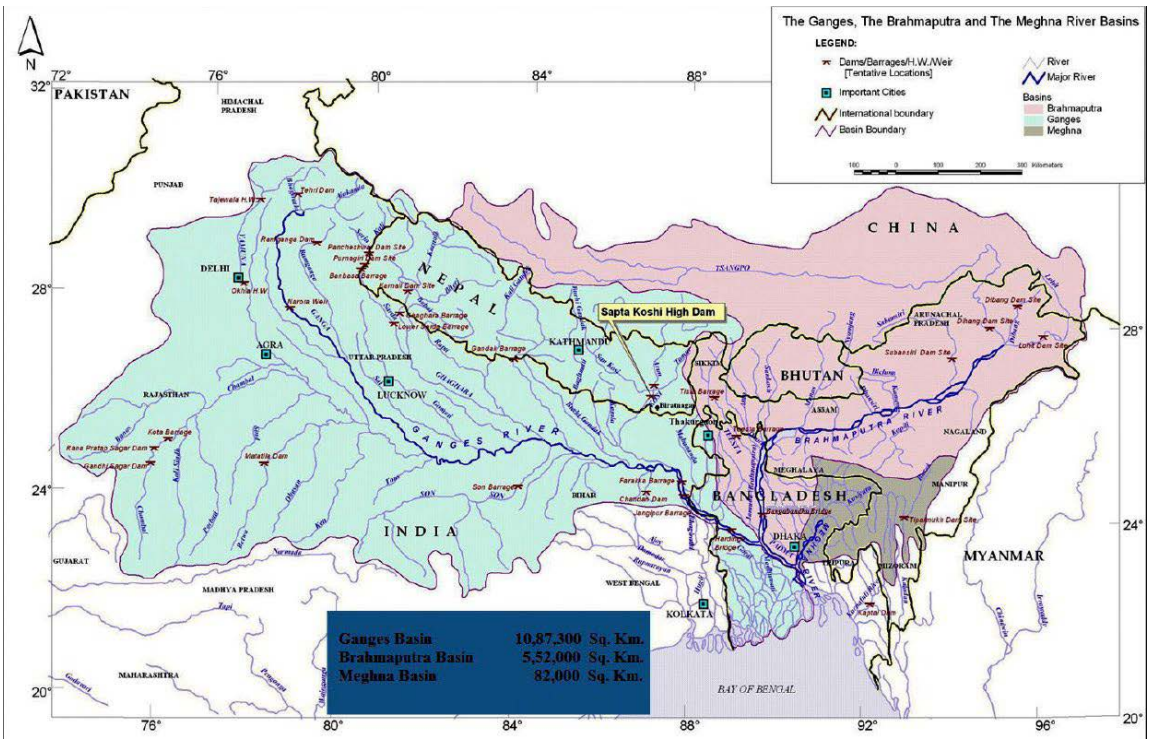

Figure 1: Ganges-Brahmaputra-Meghna (GBM) Basins (Source: Joint River Commission of Bangladesh, 2019)

Annually, the cross-border river flows entering into the country's surface water system are estimated to be 1,200 billion cubic meters (bcm), 78% of which is contributed by the three main rivers: Padma or Ganges, Brahmaputra or Jamuna and Meghna (GED, 2020). The contribution of inflow from the major rivers is 31%, 54%, and 14%, respectively. About 85% of the river flow occurs during the monsoon and post-monsoon periods of June-October. While flow is abundant during this period, the country receives only 15% of the total transboundary river flow (about 148 bcm) during the dry season.

[12] FAO AQUASTAT, Arable land is Land under temporary crops (double-cropped areas are counted only once), temporary meadows for mowing or pasture, land under market and kitchen gardens and land temporarily fallow (less than five years).
[13] FAO AQUASTAT
[14] Ibid. World Factbook
[15] FAO AQUASTAT

The total water withdrawal for use estimated by FAO is 35.87 km³/yr (not allowing for water reuse, which is 34% of the total internal renewable water resource). However, because of the large seasonality of river flow and water use, an annual comparison does not indicate the level of water stress. In the lean season, January to April, internally generated river flow is very small, and reliance is placed on water inflow from India. Most water is used for agriculture (31.5 km³/yr, 88% of total water withdrawal), of which irrigation accounts for 24.6 km³/yr, water supply use is 3.6 km³/yr, and industrial water is 0.8 km³/yr. The total annual water use per capita is 220.0 m³/yr, the lowest in South Asia (excluding the Maldives). The total dam capacity is 6.48 km³ (18% of annual use). The environmental flow requirements are 600.3 km³/yr (48.9% of the total available water resources, as estimated by IWMI). The reported groundwater withdrawal is 28.48 km³/yr, supplying more than 79% of Bangladesh's irrigation. Groundwater is being over-extracted by 7.36 km³/yr. FAO does not give an estimate of the reuse of water withdrawn.

2.2 Groundwater

Groundwater is Bangladesh's renewable and dynamic natural resource (Mojid et al., 2019). It is generally found at shallow depths throughout Bangladesh through the three major rivers' sedimentary alluvial and deltaic deposits (Ahmed and Roy, 2007). It provides an essential supply for domestic, irrigation, and industrial use in the country. Despite having a fairly abundant surface water resources system, the country's water usage pattern heavily depends on groundwater supply. An average volume of 32.0 cubic kilometers is withdrawn annually to meet the nation's water demand for agriculture, industry, and households (Shamsudduha et al., 2019). This amount equals approximately 4% of global groundwater withdrawal (Hanasaki et al., 2018). Figure 3 illustrates the region-wide status of groundwater withdrawal in Bangladesh.

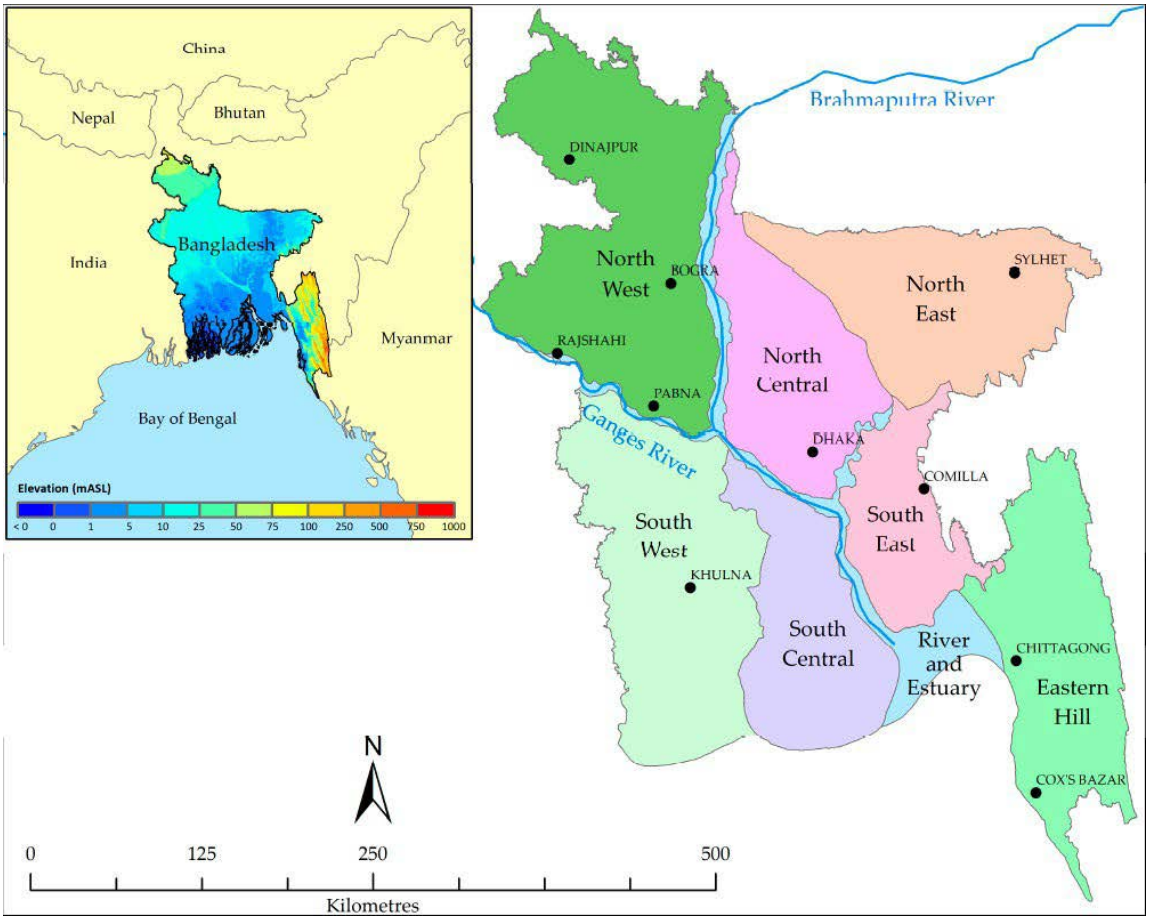

Figure 2: Hydrological Regions in Bangladesh (Source: Mojid et al., 2019)

Groundwater is commonly found in sand deposits (such as in the higher terraces of the Barind and Madhupur tracts, the Pleistocene Dupi Tila, and the Pliocene Tipam sands in the hilly areas). The groundwater table over most of Bangladesh lies very close to the surface and fluctuates with the annual recharge discharge conditions, falling to a maximum depth during April and May. Recharge to aquifers in Bangladesh is mainly from vertical percolation of rainwater and floodwater. Rivers and other standing water bodies provide local recharge to the nearby aquifers. Groundwater withdrawal is normally by tubewell.

Presently about 80% of the people in rural Bangladesh depend on groundwater for drinking. Urban water supply is also largely dependent on groundwater. Constraints on groundwater use result from large-scale arsenic contamination and fecal coliform pollution of shallow groundwater. Other water quality issues include high concentrations of iron, manganese, and boron and high salinity in coastal areas, which will be an increasing problem with rising sea levels.[16] Hand tube wells commonly cannot pump water if the level goes below 6m in the dry season. Ground subsidence has been seen in some areas. Indiscriminate disposal of industrial and municipal wastes in large cities is causing groundwater quality degradation.[17] "The groundwater table is going down by 2 to 5 meters yearly in some parts of the country."[18]

In organizational responsibilities, groundwater is addressed as a separate source even though it is fed by the recharge from surface water (primarily from transboundary flows) on the inundated floodplains during the wet or monsoon season (June-September) or the rainfall-induced surface runoff in the country's hydrological territory.

About 98% of drinking and 80% of dry-period irrigation supplies come from groundwater at shallow depths less than 150 m below the ground level (Shamsudduha, 2018). However, the availability of groundwater sources is gradually dwindling, threatened by some critical hydrological and socioeconomic factors: e.g., excessive abstraction, climate change, and chemical contamination. Water governance also has the scope for substantial improvement to ensure the conservation and sustainability of safe groundwater resources. About 26% of tube wells are estimated to be affected by arsenic (As) contamination of shallow aquifers (Shamsudduha et al., 2019).

Nevertheless, the availability of groundwater resources across all hydrological regions in the country has always blessed access to the water supply. About 1.6 million and 17 million tube wells are installed by the Department of Public Health Engineering (DPHE) by the government and owned by private entities, respectively (Shamsudduha et al., 2019).

[16] https://link.springer.com/chapter/10.1007/978-981-10-3889-1_13
[17] https://en.banglapedia.org/index.php?title=Groundwater
[18] https://2030wrg.org/improving-water-security-in-bangladesh-through-new-partnerships/

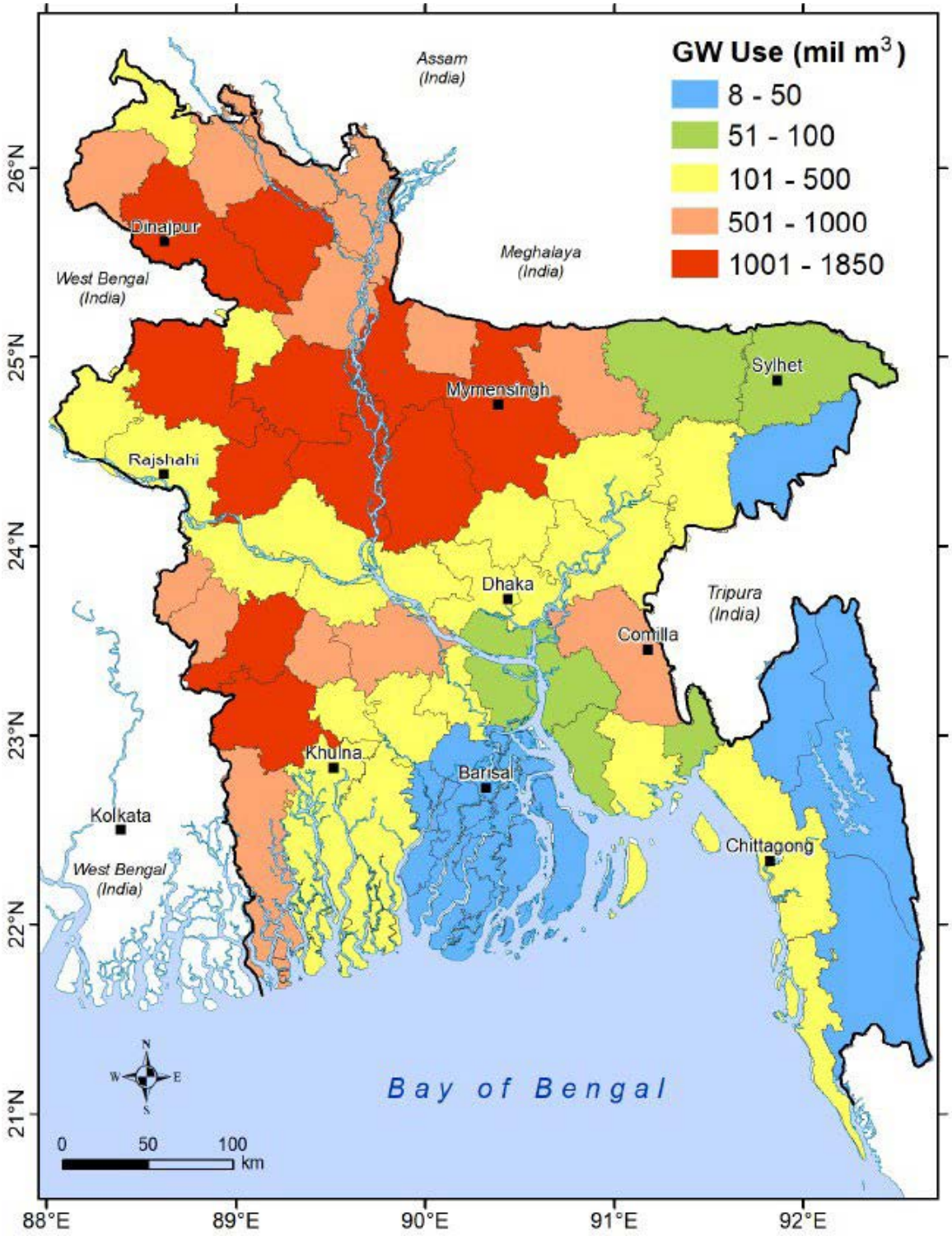

Figure 3: Estimates of Groundwater Withdrawal for Domestic Use and Irrigation (Source: Shamsudduha et al., 2019)

Figure 3 shows the groundwater used for domestic and irrigation in the country's regions in a million m^3. In terms of consumption, agriculture is the primary user of groundwater. Irrigation accounts for more than 87% of total groundwater withdrawal in the country according to the World Bank statistics of 2017 (available at the following web link: https://data.worldbank.org/indicator/ER.H2O.FWAG.ZS?locations=BDhttps://data.worldbank.org/indicator/ER.H2O.FWAG.ZS?locations=BD).

The government has been trying to increase the share of surface water supply for irrigation to limit of groundwater excessive abstraction through deep tube wells. Currently, 73 percent of total irrigated land is served by groundwater; which the government aims to reduce to 70 percent by 2030 (The Daily Star, March 18, 2021). As pointed out in World Bank's Bangladesh Water Sector Diagnostic: Priorities for the New Decade, transferring irrigation water use from groundwater sources to

surface water by supplementing the supply from surface water sources will require complementary demand side management.[19] A reference level of water use must be set as a first step in such management action. The water accounting activity proposed by ADPC could be part of developing this demand management process.

2.3 Status Summary on Water Resources

Ahmed and Roy (2007) reported a distribution of 74 percent, 24 percent, and 2 percent for transboundary inflow, rainfall-induced runoff, and groundwater, respectively. One of the main issues associated with surface water resources in Bangladesh is disproportionate availability in wet and dry seasons. A study by the Bangladesh University of Engineering and Technology (BUET, 2004) reported acute problems of abundance (or flooding) in the wet season and scarcity in the dry season.

Groundwater, on the other hand, is fairly available to a varying extent in every hydrological region in the country. However, the main issue with groundwater is chemical contamination, such as arsenic (As) and salinity. Additionally, a long history of groundwater abstraction, with growing water demand, has threatened aquifer sustainability.

2.4 Resources Development Potential

Providing surface storage by constructing reservoirs or harvesting rainwater could increase supply during the dry season. In addition to water shortage in the dry period, the southern and coastal regions of the country are facing an extreme challenge for a safe water supply due to increasing arsenic and salinity problems in the groundwater – noted in several investigations of groundwater by DPHE and other water organizations.

Rainwater harvesting (RWH) is an ancient technology that provides water supply for various uses (WaterAid, 2019). However, there is inadequate infrastructure, and the full potential of harvesting technology is not supported by institutional setups in Bangladesh. Numerous research works have been performed over the last decade to identify and estimate the RWH potential at various locations in the country. The estimates of harvesting potential vary depending on the characteristics of the catchment area and the type of instruments used for collection and use.

In recent years, RWH has gained significant attention, particularly in densely populated urban areas like Dhaka and other divisional cities, to address the growing water demand, stress on groundwater abstraction, and water logging problems during the rainy season. For domestic use, it is estimated that RWH can reduce the stress on the groundwater supply by more than 50% (Choudhury and Sultana, 2010). To promote the use of rainwater and conserve the sustainability of groundwater aquifers, the government has also incorporated requirements for installing RWH facilities in the national building code (BNBC, 2020).

Besides the option for household RWH facilities in the coastal areas, the government is actively looking to install surface water reservoirs to capture rainwater and utilize it during the dry period. The Ministry of Water Resources (MoWR) has already initiated work on this matter.

Managed aquifer recharge can be a solution to increase the safe yield of aquifers. MAR is commonly used to address supply and demand imbalances by recharging during wet seasons and recovering during dry seasons. The International Association of Hydrologists has recently published a 90-page guidebook, "Managed Aquifer Recharge: Overview and Governance[20], which has three sections written by different teams give (1) an overview of purposes, types, source waters, advantages, challenges, and essential requirements of MAR; (2) an international synthesis of policy innovations to harness and encourage MAR in water resources management for sustainability in both developing and advanced jurisdictions; and (3) an overview of water quality management strategies for health and environmental protection in MAR from a variety of starting positions and capabilities.

[19] World Bank, 2020. Bangladesh Water Sector Diagnostic: Priorities for the New Decade. Where do we go. Priority 4.
[20] https://www.researchgate.net/publication/361408175_Managed_Aquifer_Recharge_Overview_and_Governance

In industrial use, stress on water requirements can be reduced by applying the principles of wastewater reclamation. Although there is a national policy framework for the 3R strategy (reduce, reuse, and recycle), it is not formulated to the full potential of addressing wastewater reuse in the industrial sector. Sharmin (2016) depicted that a decentralized wastewater management system (such as the reuse of treated effluent in agricultural fields) can help reduce stress on groundwater abstraction to a certain extent. Unfortunately, the potential of wastewater reclamation is yet uncertain and unknown, and only a few investigations have been made so far. During this assignment, no reliable statistics were found to predict the amount of resource recovery and reuse.

2.5 Current and Projected Water Demands

It is stated in Section 2.2 that agriculture is the primary consumer of freshwater in Bangladesh. Annually, the sector accounts for the withdrawal of about 32.0 bcm of water, including sub-sectors of fisheries and livestock (World Bank, 2015). However, water is the largest requirement to meet instream environmental requirements (106.2 bcm). The estimated water demands for the different sectors are listed in Table 4.

Table 4: Estimates of Water Demands in Different Sectors (Source: World Bank, 2015)

Sector/ Use	Demand (withdrawal, bcm)	
	Year 2011	Year 2030
Agriculture (irrigation, fisheries, and livestock)	32.3	46.3
Only irrigation	23.6	34.5
Domestic	2.4	4.2
Industry	0.1	0.2
Instream Demand or Environmental Flows	106.2	106.2

The environmental flows consider water requirements for navigation and natural fisheries, salinity control, pollution control, and other needs to maintain the instream environment (NWMP, 2001). There is a wide range of estimates for this requirement. The International Water Management Institute (IWMI) estimated the requirement at 600.3 bcm. FAO quotes this figure in AQUASTAT, 2019. The differences may relate to the consideration of salinity exclusion flows.

2.6 Impact of Climate Change on the Water Resources

Climate variability and climate change affect any country's basin hydrology, water security, and water governance, and Bangladesh is no exception. The country is one of the most vulnerable countries to climate change and ranked 7th on the Global Climate Risk Index (CRI) list by Germanwatch (www.germanwatch.org) in 2019. Climate change affects temperature and rainfall, evapotranspiration, crop-water demand, runoff, and recharge (World Bank, 2015). The status of water resource balance in the hydrological environment is altered accordingly.

Climate change also affects the flow of regional air masses and, thus, the timing of seasonal events. The onset and withdrawal of the rainy season in Bangladesh have advanced by 12 days in all regions of the country from 1983 to 2017. The interannual variability of rainfall has also increased spatially and temporarily. These changes are important to farmers and are expected to continue.[21] Kirby et al. (2014) investigated the impact of climate change in the hydrological regions of Bangladesh to a certain extent. The analysis was conducted for the wet and dry seasons and the horizons of 2030 and 2050. The following key findings were obtained from the study.

- Surface water availability is expected to increase by 11% in 2030 and 2050 from the base scenarios during the wet season. On the other hand, it will reduce by 2% in 2030 during the dry

[21] https://www.researchgate.net/profile/Syed-Rahman-22/publication/352838718_Estimation_of_Arrival_and_Withdrawal_Date_of_Rainy_Season_in_Bangladesh/links/60dc6769a6fdccb745f80d5d/Estimation-of-Arrival-and-Withdrawal-Date-of-Rainy-Season-in-Bangladesh.pdf

period.

- In the wet season, the irrigation water demand will likely reduce by 9% and 1% in 2030 and 2050, respectively. On the contrary, it will increase by 4% during the dry season 2030.
- Analysis with a set of climate variability scenarios concluded that it has a more dominant impact on the country's water resources than the effect of climate change scenarios. However, many uncertainties, data limitations, and knowledge gaps exist on climate change and the water balance condition. The study recommended conducting rigorous investigations and studies on climate change at regular interval.

The World Bank's 2021 Bangladesh Climate Risk Country Profile[22] summarized the projected impacts of climate change:

- Bangladesh's projected average temperature rises to align with the global average. The highest emissions pathway (RCP8.5) projects a rise of 3.6°C by the end of the century, above the 1986–2005 baseline, compared to a rise of 1.0°C on the lowest emissions pathway (RCP2.6).
- Rises in minimum and maximum temperatures are considerably higher than the change in average temperature and are concentrated in December–March.
- Increased frequency of periods of prolonged high heat is a major threat to human health and living standards in Bangladesh, particularly in urban environments and for outdoor laborers.
- Livelihoods in Bangladesh's coastal zone, including many of the poorest communities, are threatened by saline intrusion and degrading natural resources linked to climate change.
- Flash, river, and coastal flooding are likely exacerbated by intensified extreme rainfall, tropical cyclones, and associated storm surges, putting lives, infrastructure, and the economy at risk.
- Without adaptation, the number of people exposed to an extreme river flood is expected to grow by 6–12 million by the 2040s, and the number of people facing coastal inundation could grow by 2–7 million by the 2070s.
- Food production and the agricultural sector could face reduced yields driven by temperature rises in the growing season, saline intrusion, increased drought frequency, flooding, and waterlogging.
- Climate impacts are not restricted to the coastal zone, and vulnerability hotspots can be found nationwide. Global modeling and local evidence suggest that poor and marginalized groups and women are likely to suffer disproportionately in a changing climate. Unless rapid global decarbonization can be achieved, inequalities are likely to widen.
- Despite recent progress in disaster risk management, adaptation, and disaster risk reduction are still urgent priorities in Bangladesh as the livelihoods and well-being of millions of people are threatened.

The World Bank stated that the modeling used in their study did not indicate an increased risk from cyclones. However, later studies suggest otherwise. A study by Tim Willem Bart Leijnse et al.[23] published in June 2022 gives estimates of storm surge and significant wave heights. These are shown in Table 5. The data has been based on a projection of the future climate for 2100 under RCP 4.5, a lower concentration pathway of greenhouse gasses than the RCP 8.5 recommended by the World Bank in the Climate Risk Country Profile for planning studies.[24] The quoted data shows an increase by 2100

[22] Climate Risk Country Profile: Bangladesh (2021): The World Bank Group https://climateknowledgeportal.worldbank.org/sites/default/files/country-profiles/15502-WB_Bangladesh%20Country%20Profile-WEB.pdf

[23] T. W. B. Leijnse et al.: Generating reliable estimates of tropical-cyclone-induced hazards. Nat. Hazards Earth Syst. Sci., 22, 1863–1891, 2022 https://doi.org/10.5194/nhess-22-1863-2022

[24] A Precautionary Approach: Studies published since the last iteration of the IPCC's report (AR5), such as Gasser et al. (2018), have presented evidence which suggests a greater probability that earth will experience medium and high-end warming scenarios than previously estimated. Climate change projections associated with the highest emissions pathway (RCP8.5) are presented here to facilitate decision making which is robust to these risks." Gasser, T., Kechiar, M., Ciais, P., Burke, E. J., Kleinen, T., Zhu, D., . . . Obersteiner, M. (2018). Path-dependent reductions in CO2 emission budgets caused by permafrost carbon release. Nature Geoscience, 11, 830–835. https://www.nature.com/articles/s41561-018-0227-0?WT.feed_name=subjects_carbon-cycle

for 10 and 100-year return periods for average storm surge (11%, 5%) and for wave height (8%, 5%) in Bangladesh compared to the average over the Bay of Bengal of storm surge (6%, 7%) and wave height (10%, 7%).

Table 5: Storm Surge and Wave Height (in meters) in Tropical Cyclone Hazards Under Climate Change

Variable		Bangladesh		
		BA-KB	BA-CH	Averaged over Bay of Bengal
Storm surge 10-year return period	STCC	1.26	1.1	0.67
	CI	[1.23, 1.29]	[1.07, 1.13]	[0.65, 0.69]
	HTCs	**0.96**	**1.03**	**0.46**
	CI	**[0.71, 1.26]**	**[0.79, 1.29]**	**[0.34, 0.62]**
	STCF	*1.35*	*1.26*	*0.71*
	CI	*[1.32, 1.39]*	*[1.22, 1.30]*	*[0.69, 0.74]*
Storm surge 100-year return period	STCC	2.57	2.38	1.19
	CI	[2.32, 2.82]	[2.17, 2.61]	[1.06, 1.33]
	HTCs	**2.09**	**2.25**	**1.04**
	CI	**[1.30, 3.04]**	**[1.51, 3.07]**	**[0.62, 1.56]**
	STCF	*2.72*	*2.49*	*1.28*
	CI	*[2.49, 2.97]*	*[2.28, 2.70]*	*[1.14, 1.42]*
Wave height 10-year return period	STCC	6.98	7.14	5.45
	CI	[6.86, 7.10]	[7.01, 7.27]	[5.35, 5.56]
	HTCs	**6.6**	**6.83**	**5.36**
	CI	**[5.30, 8.24]**	**[5.44, 8.42]**	**[4.38, 6.51]**
	STCF	*7.52*	*7.67*	*5.97*
	CI	*[7.36, 7.70]*	*[7.50, 7.85]*	*[5.83, 6.12]*
Wave height 100-year return period	STCC	11.97	11.99	9.47
	CI	[11.09, 12.89]	[11.17, 12.85]	[8.75, 10.23]
	HTCs	**12.07**	**12.73**	**10.04**
	CI	**[8.58, 16.48]**	**[8.97, 17.03]**	**[6.97, 13.68]**
	STCF	*12.64*	*12.48*	*10.1*
	CI	*[11.78, 13.59]*	*[11.71, 13.35]*	*[9.38, 10.88]*

Bangladesh (KB, Khulna and Barisal; CH, Chittagong) STCC (synthetic tropical cyclone current climate) (regular typeface), HTC (historical tropical cyclone) (in bold), and STCF (synthetic tropical cyclone future climate) (in italic) including CI (confidence interval) (2.5th, 97.5th), for return periods of 10 and 100 years, averaged over the entire Bay of Bengal and per region. (Source: Leijnse et al., 2022)

The impact of climate change on water resources and their use will be significant and require adaptation both in plans for water use and protection of water resources and in the governance of water resources. The key changes will be:

- Surface water resource availability will increase in the wet season and decrease in the dry season.
- Groundwater resources will increase due to the greater wet season surface water resource. Still, they will be impacted and possibly salinized in coastal regions due to increased seawater levels and cyclone activity.
- Agricultural water demand will increase as a result of higher temperatures and evaporation.
- Coastal dykes will require strengthening and raising to combat more intense and frequent cyclones, and river embankments and revetments will be at increased risk of erosion from flash and river flooding.
- Rural water supply and sanitation activity will require substantial adaptation to changes in water resources in coastal areas.
- The greater agricultural water demand in the dry season and its reliance on groundwater resources will intensify competition for access to groundwater and require strong action to ensure water is allocated to domestic supplies in the priority given in the Water Act.
- Spatial and temporal variability in rainfall will increase, creating issues for farm plans.

3. CHALLENGES FOR WATER RESOURCES MANAGEMENT

The Eighth Five Year Plan (2021-2025), or the 8FYP, published by the Government of Bangladesh, reported the following major challenges for water resources management in the country.

- *Flood risk management* – The northwest, north-central, and southwest regions experience river flooding, whereas the northeast and eastern-hilly regions are vulnerable to flash floods during the wet season. Flooding is a regular phenomenon in Bangladesh, and it causes extensive damage to life, livelihood, and development (GED, 2020).
- *Water availability in the dry season* – Though water flow is abundant in the wet season, the country faces water scarcity, particularly in drought-prone areas during the dry season. The most critically affected sectors are agriculture and food production.
- *River water management* – The main challenge associated with river water management is the severe water shortage in the instream flow during dry periods due to various reasons. Reduced stream flow during this period causes increases in salinity intrusion, excessive stress on groundwater sources, environmental degradation, and reduction in crop yield.
- *Coastal zone protection and management* – The governing challenges are inundation by high tides, salinity intrusion, and storm surges.
- *Wetlands conservation* – The total wetlands area is approximately 7 million hectares, which is important for ecological balance. The main challenge is to protect these wetlands from human-induced development and water pollution.
- *Climate change* – The 8FYP depicts the coastal zone to be most severely affected by the adverse impact of climate change. The unanticipated change in temperature and rainfall induced by climate change has been disturbing the balance of water resources and affecting food production and water security.
- *Population growth* – The Bangladesh Delta Plan 2100 (BDP 2100) forecasts an estimated increase in domestic water demand by 50% by 2030. An increase in population will, additionally, create stress on agricultural water requirements and food production. Also, a considerable portion of water use is linked to the country's sanitation system, which is likely to increase along with the population.
- *Upstream development* – Since the country is located downstream of the GBM basin, the availability and hydrological response of water resources are affected by development activities upstream of the basins. The reduction in the flow from the Ganges River has detrimentally affected the freshwater supply and the ecology of the Sundarbans. Transboundary river management issues have always been a major challenge on the regional scale.
- *Institutional capacities* – Inadequate resource capacity at water governance is one of the major challenges for implementation and management activities in the water sector. Despite the large number of water organizations in the government, limitations in the policy framework, technology, finance, skilled human resources, and infrastructure are the major barriers to efficient water resources management.

The government acknowledges in the 8FYP that effective water governance equipped with a well-designed policy framework, advanced information technology, and human and legal capacities are essential to address and resolve the current challenges and operationalize the country's integrated water resources management (IWRM) system.

The **Bangladesh Delta Plan 2100** (BDP 2100) provides a consolidated description of the country's issues, challenges, and required interventions for IWRM. In addition to the problems and challenges identified in the Eighth Five-year Plan, the BDP-2100 Delta Plan describes the unique characteristics

of the individual hydrological regions. It addresses its WRM gaps and challenges in Volume 1 (Strategy, Chapter 4). The BDP 2100 classifies issues and challenges for WRM into the following three categories:

i. Specific water-related problems (flood, drought, water quality, etc.) vary in priority and intensity by region while also being projected to be exacerbated by climate change
ii. Institutional capacity and management – largely as described above in the Five-year Plan
iii. Knowledge management and sharing:
    - Inadequate and inaccessible information on actual development upstream, e.g., the information gap within transboundary flows and trends.
    - Uncontrolled and unregulated encroachment of the river banks and other water bodies.
    - Limited research on water management issues and an integrated approach to water management.
    - Lack of research work on the institutional arrangement mechanism for water resources management and water-based development programs in collaboration with other sectoral agencies.

3.1 Water Security

The two most pressing water security issues are removing the reliance on arsenic-contaminated shallow groundwater, providing suitable water for domestic consumption, and ensuring environmental flow requirements. The first might be countered by the extension of rural water supply networks, implementation of managed aquifer recharge, and transfer of irrigation water demand from groundwater to surface water. The latter issue could likely be supported by increased efficiency and productivity of agricultural water use and better management and regulation of riparian land use.

The discussion and data above may appear to focus on water security during droughts, but there is at least equally a risk in water security during floods. This risk arises not only from the physical threat of flooding but from the damage to water-related service infrastructure for urban, industrial, and irrigation water supply, to wastewater treatment plants; to transport systems and to the health risks arising from unsanitary conditions related to flooding, exacerbated by a very low level of wastewater treatment and a lack of septage management.[25] The low-lying coastal land in Bangladesh is highly vulnerable to storm surges, which will increase with climate change and sea level rise.

25 https://www.adb.org/sites/default/files/linked-documents/LD-E-WUS-Operations-Assessment.pdf

Box 1: Water Security in Bangladesh

A global assessment of water security "*Measuring global water security towards sustainable development goals*" considering multiple indicators showed Bangladesh to be highly insecure in water.

"The performance of selected indicators and their aggregated notions for China, India, USA, Australia, Brazil and Bangladesh is shown in the figure 4 below. Flood risk, impaired water quality, governance and transboundary management [Legal]) are major problems in Bangladesh, India, Brazil and China. Therefore, the performance for quality and safety as well as management is very low in these countries. Due to high flood risks (Gain et al 2013) and high arsenic concentration in the groundwater (Burgess et al 2010), along with transboundary complexities (Gain and Schwab 2012, Gain and Giupponi 2014, Rouillard et al 2014), water resources is highly insecure in countries like Bangladesh, even physical water availability is not a major problem there."

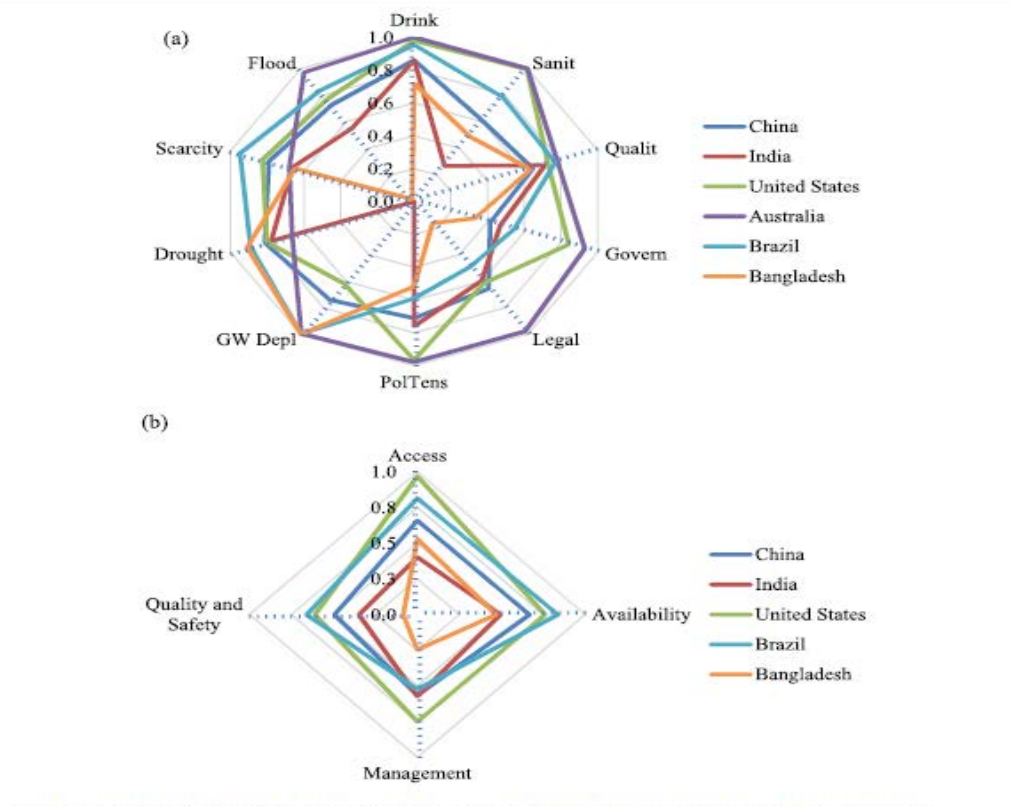

Figure 4: Performance of Designated Indicators and their Aggregated Notions for Selected Countries

Performance of designated indicators (a) and their aggregated notions (b) for some selected countries. The value '0' represents worst performance, whereas '1' represents best performance. The average value of water scarcity index (Scarcity), drought index (Drought) and groundwater depletion (GW Depl); access to sanitation (Sanit) and access to drinking water (Drink); water quality index (Qualit), and flood frequency index (Flood); world governance index (Govern), Transboundary legal framework (Legal) and transboundary political tension (PolTens) is shown in (a), whereas their aggregated notion, 'availability', accessibility (Access), qualit and safety, and management is shown in (b).

Animesh K Gain et al., 2016. Measuring global water security towards sustainable development goals. Environmental Research Letters. 11, 124015. https://iopscience.iop.org/article/10.1088/1748-9326/11/12/124015

4. WATER GOVERNANCE IN BANGLADESH

4.1 History of Water Governance in Bangladesh

Water governance in Bangladesh originated in the sixth decade of the last century after the country experienced two consecutive devastating floods in 1954 and 1955 (Gain et al., 2017). Realizing the need for an effective flood control mechanism and intending to protect agriculture, the authorities designed a 20-year master plan after the two devastating floods. Thus, water management at the governance level in Bangladesh evolved out of a need for flood control. Later, the government recognized the need for an institutional setup and essential reforms, with a policy framework to create an enabling environment for IWRM. Gain et al. (2017) summarized the evolution of water governance in Bangladesh in four distinguished phases as follows:

- During the 1960s, a master plan and structural engineering measures were formulated for flood control.
- During the 1970s and 1980s, governance moved towards building water management through the installation of institutions and policy tools.
- During the 1990s and 2000s, the focus gradually shifted toward implementing IWRM. In the country context of Bangladesh, the IWRM consists of seven strategic dimensions such as: integrated management of water resources, river basin-wide development schemes, functional legal and policy framework to support water governance, application of a multi-stakeholder and participatory approach to water sector development, economic development, gender, equity and social inclusiveness, and conservation of ecology and environment.
- After the 2000s, the transition gradually considers linkage with livelihood, water economy, climate change, and delta development and aims at establishing an effective water governance system.

Several policy tools were designed to support water governance after the independence in 1971. The evolution of the water sector policies can be divided into four eras, with some distinguishing characteristics as listed in Table 6 (Chan et al., 2016). However, the findings from the study of Chan et al. (2016) do not include some recent policy tools, such as the Bangladesh Delta Plan 2100 (BDP 2100), National Perspective Plan 2041 (PP 2041), etc., which were prepared later. However, given the major hydrologic and economic changes occurring in Bangladesh, and the failure of the WARPO to review and update the National Water Policy and the National Water Management Plan, the findings of Chan et al. may need reconsideration to recommend further institutional development.

Table 6: Evolution of Water Policies in Bangladesh (Source: Chan et al., 2016)

Era	Laying the Foundation of Water Institution (1947–1988)	Establishing the Flood Action Plan (1989–1994)	Restructuring the Water Sector (1995–1998)	Evolution of Water Governance (1999 to Date)
Main Concerns/ Goals	Establishment of key institutions (e.g., BWDB) for water management	Strategy formulation for controlling and managing floods	Overhaul the water management systems, particularly decision- making process	Developing calibrated policy instruments to face water challenges
Main Issues	Increasing agricultural production	Controlling floods, particularly saving crop cultivation	Integrated planning and management and preserving water resources	Managing water demand and crisis by leveraging science and technology
Main Instruments	A 20-year Water Master Plan (WMP)	The Flood Action Plan (FAP)	The Guidelines for People's Participation (GPP) for water development projects	The National Water Policy and National Water Management Plan (NWMP)
Key Features	Preparing WMP was the initial step of water planning. It overemphasized surface water interventions and overlooked groundwater management. In this era, water management was mainly followed by "sectoral approaches" and "structural engineering solutions, " which raised much criticism. Broadly, water management was based on flood control, drainage, and irrigation management, and decision-making was BWDB-centric.	Due to the devastating floods in 1987 and 1988, flood control received international attention and donors' support. However, NGOs and civil societies criticized FAP since it discouraged decentralized decision-making. Minor irrigation (e.g., shallow tube wells) flourished at this time owing to the privatization of the irrigation technology business and a substantial reduction of government taxes.	Water management was based on flood control and drainage, albeit water crises in the dry season and droughts were becoming increasingly concerning. Enacting Upazila (Sub-district) Parishad Act 1998, formulating LGED guidelines on involving local people in water projects, strengthening local government institutions and provisioning impact assessment, and applying EIA practice in approving projects were the main issues of this era.	Several strategic initiatives were taken, such as facilitating partnerships and devolutions of power. The government had approved a 25-year NWMP and developed other instruments, namely BWDB Strategic Plan 2009–2014, National Water Act 2013, and Haor (flooded tectonic depressions) Master Plan 2012–2032. However, the challenges lie in implementing these instruments as the country has a shortage of resources and political will.

4.2 Current Structure of Water Governance

The Bangladesh Water Act 2013 (BWA) is a framework law for consolidating and coordinating water resource management in the country. The Water Act establishes a new integrated approach to the protection, improvement, and sustainable use of national rivers, lakes, estuaries, coastal waters, and groundwater. BWA entails a coordinated and comprehensive water system for the country's development, management, extraction, distribution, use, protection, and conservation of water resources. The BWA aims at the effective use of water resources, integration of actions of different organizations, legitimate water rights for the poor and disadvantaged, controlling uncontrolled/ unexplained abstraction, appropriation, and pollution, and an optimal, efficient way of using scarce

water resources. The BWA adopts a National Water Policy and a National Water Resources Plan (NWRMP), provides water resource protection/pollution control and water quality standards, and allows the Government to fix a water price that can vary by sector.

Water is at the center of the national economy and development in Bangladesh, making it a cross-cutting theme across various sectors. This has created quite a complex form of water institutions within the government. More than 35 central government organizations are affiliated with around 13 ministries/ divisions, somehow linked with water sector activities and development (GED, 2020).

The National Water Resources Council (NWRC) is the highest body of the government on water governance in Bangladesh which the Prime Minister heads. The MoWR is mandated at the sectoral level. In context to the IWRM, there are two connected ministries: the Ministry of Agriculture (MoA) and the Ministry of Local Government, Rural Development and Cooperatives (MoLGRD&C).

At the execution level, the Water Resources Planning Organization (WARPO – which acts as the Secretariat of the Executive Committee of the NWRC) – and the Bangladesh Water Development Board (BWDB) under the MoWR are the core institutions for policy formulation and implementation, respectively. However, the BWDB deals mainly with developing surface water resources for irrigation and actions to protect against water-related risks. On the other hand, the Department of Public Health Engineering (DPHE) under the MoLGRD&C develops and manages groundwater resources for domestic and agricultural use across the country. The Local Government Engineering Department (LGED) under the MoLGRD&C and the Barind Multipurpose Development Authority under the MoA implement many small-scale water resources development projects to support irrigation and drainage. Other important institutions that support IWRM, navigation, information management, conservation of water resources, climate actions, etc., include, but are not limited to, the Ministry of Shipping, Ministry of Environment, Forest and Climate Change (MoEFCC), Ministry of Planning (MoP), and the Ministry of Defense (MoD).

An important component in water governance is the connection with technical and development partners. Although the government's agencies are responsible for decision-making and the implementation of any water project, many of their decisions are shaped through input from these external partners that may also support their implementation. Academic institutions and NGOs are crucial in technical assistance and knowledge acquisition on IWRM. Bilateral or multilateral development organizations provide essential assistance on financing, implementation, and supervision, as well as technical assistance.

The World Bank, in its recent Water Sector Diagnostic – Priorities for the New Decade, commented on the organizations and their capacity:

> *"The Government of Bangladesh has long recognized that governance has been a limiting factor for achieving development goals across sectors, including water. The weakness of institutions is also reflected in the low sustainability of projects as well as the low absorptive capacity. Moreover, the feedback and accountability mechanisms between the lower and higher levels of government lack the necessary incentives to function adequately. Timely data to inform decisions are a major gap area. For instance, data on the functionality of flood control infrastructure or extraction levels of groundwater would contribute towards effective government interventions. The systematic collection and analysis of administrative output and outcome data are key to begin identifying gaps in state capability across the sector."*

The country's overall structure on water governance is provided in Figure 5.

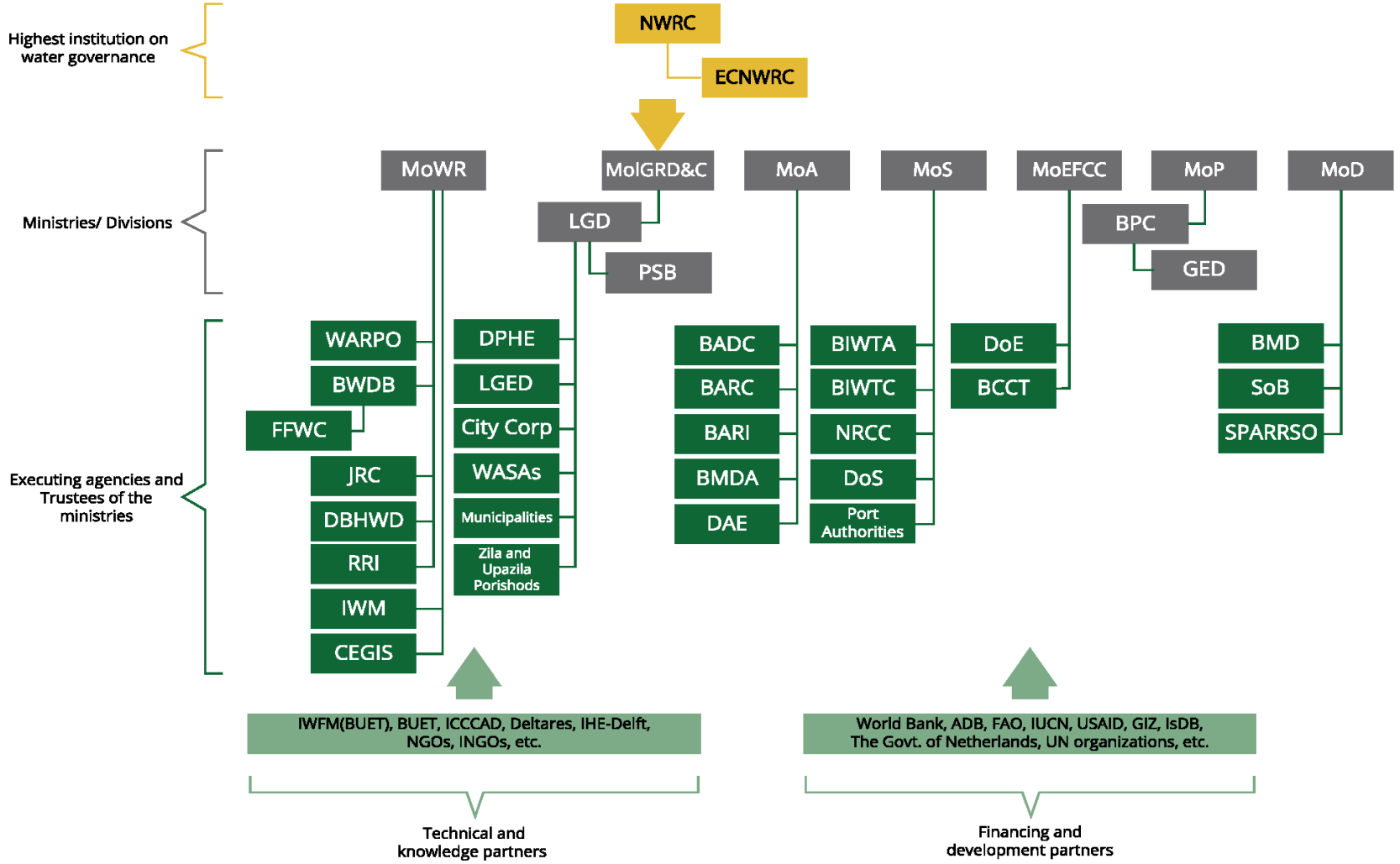

Figure 5: Current Structure of Water Governance in Bangladesh

The above diagram (Figure 5) is derived from the BDP 2100 and the government's organogram for different ministries and departments. Full names of individual institutions are provided on the following list. An analysis of the roles of the key water sector agencies in this diagram compared to the requirements to implement IWRM is given in Section 6.

5. LEGAL, INSTITUTIONAL, POLICY, AND REGULATORY FRAMEWORKS

This section summarizes the review findings on the existing legal, institutional, policy, and regulatory frameworks (LIPRFs) for water governance in Bangladesh. Numerous policy instruments are available to support sector-specific responsibilities in the context of IWRM and overall water governance. Many of these instruments have evolved over the last four decades to address the needs for water resources management, water sector development, and water security for various use. It was not intended in this assignment to cover every single LIPRF. Rather, the focus was on identifying and reviewing only the government's contemporary or prevailing policy instruments. Additionally, considerations for climate adaption and resilience, IWRM, and delta development plans were made for screening and analyzing the policy documents. The list of reviewed frameworks is provided in Appendix-I.

Bangladesh's weight and level of policy instruments vary following the diagram shown in Figure 6.

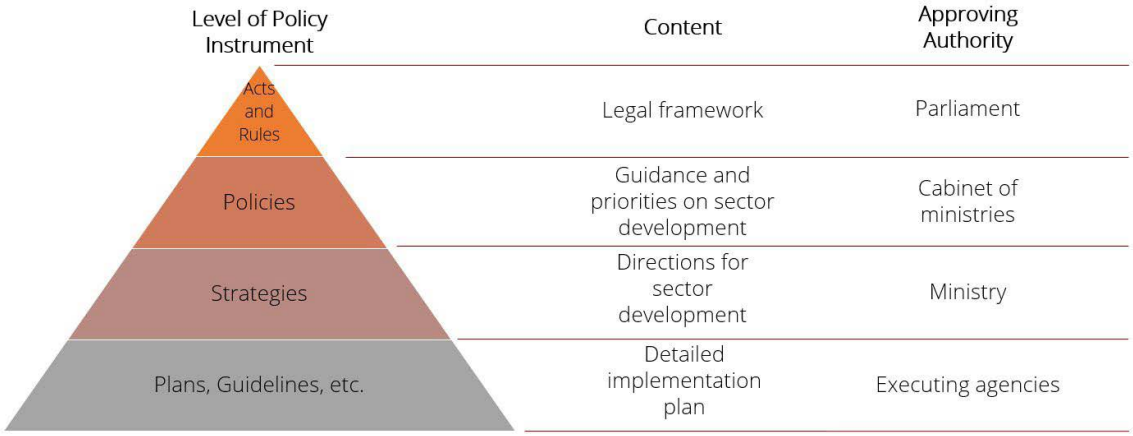

Figure 6: Levels of Different Policy Instruments in Bangladesh (Source: LGD, 2014)

Acts and rules are legal requirements, while policies are statements of government intent. Strategies are the means to implement policies through plans and guidelines. Thus, plans and guidelines are instructions to agencies that should be followed, monitored, and progress reported. The number of documents and reports reviewed in each category is given in Table 7.

Table 7: Number of Legal, Institutional, Policy, and Regulatory Frameworks Reviewed

Type of document (see Figure 6)	Number of documents
Acts and Rules	10 Acts, 1 Treaty, 2 Rules
Policy documents	13 Policy documents
Strategy documents	7 Strategy documents
Plans and Guidelines	10 Plans, 5 Guidelines

On the coarse level, the existing LIRPFs can be classified into two categories: those for the water sector and those for other linked areas, e.g., agriculture, climate change, environment, industries, etc. The water sector policies can be grouped into two types such as:

- The policies used by the MoWR and its executing agencies
- The policies used by the LGD and its executing agencies

The main difference between the above two groups is that the policies used by the MoWR focus on water resources development, management, and conservation. In contrast, the policies used by

the LGD concentrate on water supply and sanitation, WASH, water utility and infrastructure, etc. The DPHE manages the groundwater resources under the LGD with necessary policy instruments. The MoWR deals chiefly with surface water resources.

5.1 Policy Frameworks Used by the Ministry of Water Resources

5.1.1 Bangladesh Water Act 2013

The Bangladesh Water Act 2013 (BWA) is a framework law for consolidating and coordinating water resource management in the country. The Water Act establishes a new integrated approach to the protection, improvement, and sustainable use of national rivers, lakes, estuaries, coastal waters, and groundwater. It provides a necessary legal foundation for managing and conserving water in the country and is the prevailing instrument to support water governance. The Act provides essential provisions for integrated development, management, abstraction, distribution, use, protection, and conservation of water resources in the country (BWA 2013). It covers every potential water resource, including surface, groundwater, marine, rainwater, and atmospheric water.

BWA 2013 provides the legal basis for establishing the NWRC and its executive committee and defines its power and responsibility, including functions for international and regional cooperation on water management. This responsibility includes the authority to adopt water policies at the national level to meet the needs of IWRM and water governance.

The BWA aims at the effective use of water resources, integration of actions of different organizations, legitimate water rights for the poor and disadvantaged, controlling uncontrolled/ unexplained abstraction, appropriation, and pollution, and an optimal, efficient way of using scarce water resources. The BWA adopts a National Water Policy and a National Water Resources Plan (NWRMP), provides water resource protection/pollution control and water quality standards, and allows the government to fix a water price that can vary by sector.

5.1.2 Bangladesh Water Rules 2018

The Bangladesh Water Rules 2018 (i.e., BWR 2018) builds on the Water Act 2013 and provides the necessary administrative framework for water resources management by the designated organizations of the government, particularly by MoWR and its executing partners. The administrative framework includes procedural requirements for implementing water resources activities and infrastructure development along with the list and role of responsible authorities from the government. The Water Rules 2018 require many standard templates for water administration for various purposes and to support monitoring and auditing after task implementation.

5.1.3 The Ganges Water Sharing Treaty 1996

The Ganges Water Sharing Treaty between the governments of Bangladesh and India was formulated in 1996, and it is the only regulatory framework available in the country for transboundary flow management. The Joint River Commission (JRC) under the MoWR deals with the transboundary river flow issues with the participating nations and arranges essential bi- or multi-lateral dialogues. According to the Ganges Water Sharing Treaty 1996, the flow of the Ganges River is shared between the two nations at the Farakka dam following the amounts mentioned in Table 8.

Table 8: Share of the Flow (cusecs) of the Ganges River between Bangladesh and India (Source: Ganges Water Sharing Treaty 1996)

Flow at Farakka (R. Padma)	Share of Bangladesh	Share of India
70,000.0 cusecs or less	50%	50%
70,000.0 – 75,000.0 cusecs	35,000.0 cusecs	Balance of flow
75,000.0 cusecs or more	Balance of flow	40,000.0 cusecs

Notes: Subject to the condition that India and Bangladesh each shall receive guaranteed 35,000.0 cusecs of water in alternate three 10-day periods from March 11 to May 10.

5.1.4 National Water Policy 1999

The National Water Policy 1999 (NWP) addresses issues related to developing all forms of surface and groundwater, the efficient and equitable management of these resources, and ensuring that all elements of society, especially the poor, women, and children, have access to water. It aims to provide direction to all agencies and institutions related to the water sector in Bangladesh to achieve the goals of the sector. It is the active and guiding policy document that provides direction to all agencies working with the water sector and institutions that relate to the development, management, and utilization of water resources in the country. The policy document emphasizes developing and utilizing safe groundwater and surface water resources to meet the country's water demand and ensure water security across different socio-economic levels. Additionally, the NWP 1999 aimed at bringing institutional changes to support decentralized water management and gender inclusion.

The Policy proposes to accelerate the development of sustainable public and private water systems with appropriate legal and financial measures and incentives, including depictions of water rights and water prices; bring about institutional changes to decentralized water management, manage resources and strengthen the role of women in water management; establish a legal and regulatory environment that supports the process of decentralization, sound environmental management, and improve the investment climate for the private sector in water development and management.

5.1.5 Coastal Zone Policy 2005

The Coastal Zone Policy 2005 (i.e., CZPo 2005) provides essential guidance for developing and managing the coastal zone, with water at its focus. It includes development and management plans for water supply sources and their distribution and accessibility. Additionally, it emphasizes the importance of applying mathematical modeling, remote sensing, and GIS for managing resources, information, and planned interventions. The coastal region in the country is much more vulnerable to climate change, arsenic (As), and salinity contaminations in the water sources than inland areas. Thus, CZP has set instructions and instruments to support the conservation and development of safe water resources.

5.1.6 National Water Management Plan 2001

The National Water Management Plan 2001 (i.e., NWMP 2001) is the country's principal water resource management framework plan. The Plan was formulated in alignment with the National Water Policy 1999 (i.e., NWPo 1999) with the following objectives:

- Rational use and management of water resources
- Ensuring equitable, safe, and reliable access to water for production, health, and hygiene
- Ensuring adequacy of clean water for various purposes and conservation of aquatic and water-dependent ecosystems

The NWMP 2001 was designed with three distinguished phases of WRM, e.g., for short-term (2000-2005), medium-term (2006-2010), and long-term (2011-2025). A total of 84 programs were designed

over the period running from 2000-2025 under the Plan to accomplish the intended objectives and national goals for water management. It provided essential assessment and planning for water resource demands, supply, distribution, and use for selected hydrological and socio-economic zones. The NWMP 2001 recommended regular monitoring, with updates every five years. Unfortunately, the Plan has not been updated since its formulation and is needed in the light of new information and conditions. Yet, the document provides the key policy instrument for the activities of MoWR and its executing agencies.

5.1.7 Haor Master Plan 2012-2032

This is a 20-year master plan prepared for developing and managing the haor areas in Bangladesh, focusing on the water sector. Haor is the local name for a large, depressed, flat floodplain in the country's seven districts of Sylhet and Mymensingh divisions. The master plan identified 373 haors in the above-mentioned districts, comprising an area of about 859,000 hectares (DBHWD, 2012). The Haor Master Plan was formulated using IWRM principles, and it included implementation plans in the three phases such as short-term (2013-2017), medium-term (2018-2022), and long-term (2023-2032). The Plan aimed at developing the haor areas with appropriate utilization of natural and human resources.

5.1.8 IWRM Guidelines 2020

The WARPO formulated the IWRM Guidelines 2020 for the District, Upazila-, and Union-level administrations. It is built upon the Water Rules 2018 and provides water governance direction to the assigned management committee. This policy instrument leaves the operational jurisdiction for water governance to the administrative boundaries at three levels, as mentioned above.

5.1.9 Guidelines for Participatory Water Management 2000

The Guidelines for Participatory Water Management 2000 (i.e., GPWM 2000) was prepared within the framework of NWPo 1999. This guideline provides a definition and participatory roles of different implementing water organizations in the country towards project implementation and water sector development. The instrument was recommended for application in all public sector water resources development projects, including flood control, drainage, irrigation, etc. It provided a detailed operational framework for establishing and increasing stakeholder participation in water management.

5.2 Policy Frameworks Used by the Local Government Division

5.2.1 Water Safety Framework in Bangladesh 2011

The Water Safety Framework 2011 (i.e., WSF 2011) was prepared by employing the water safety framework approach of the World Health Organization (WHO) and in consultation with the sector representatives to ensure the safety of drinking water (LGD, 2011). The framework has three components: health-based targets, a water safety plan, and surveillance. The instrument accommodated a risk-management approach in the value chain of the water supply system from the source to the end user. The WSF 2011 provided essential guidelines for piped and non-piped water supply systems. The architecture of the WSF 2011 is illustrated in the diagram shown in Figure 7.

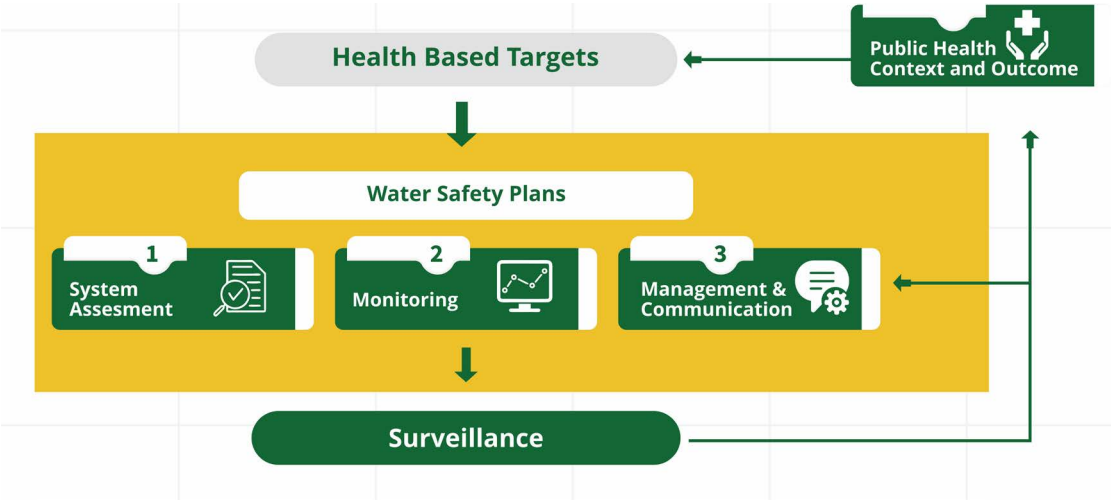

Figure 7: System Architecture of the WSF 2011 (Source: LGD, 2011)

5.2.2 National Policy for Safe Water Supply and Sanitation 1998

The National Policy for Safe Water Supply and Sanitation 1998 (i.e., NPSWSS 1998) was formulated to support the government's goal to ensure access to safe water and sanitation at an affordable cost. It focused on the domestic water supply and utilization of surface water and groundwater sources. The NPSWSS 1998 aimed at making the water supply and sanitation (WSS) sector equitable and sustainable by implementing its policy actions.

5.2.3 National Strategy for Water Supply and Sanitation 2014

The National Strategy for Water Supply and Sanitation 2014 (i.e., NSWSS 2014) was prepared by following the frameworks of the SDP 2011-2025 and the National Policy for Arsenic Mitigation 2004 to set essential directions for developing the WSS sector. Furthermore, the strategy incorporated required actions to support the accomplishment of the sustainable development goals (SDGs) of the United Nations. This National Strategy for Water Supply and Sanitation translated these goals and directions into action, including further developing different guidelines to suit the sector's specific needs (LGD, 2014). The instrument included 17 strategies under three themes, as illustrated in Figure 8.

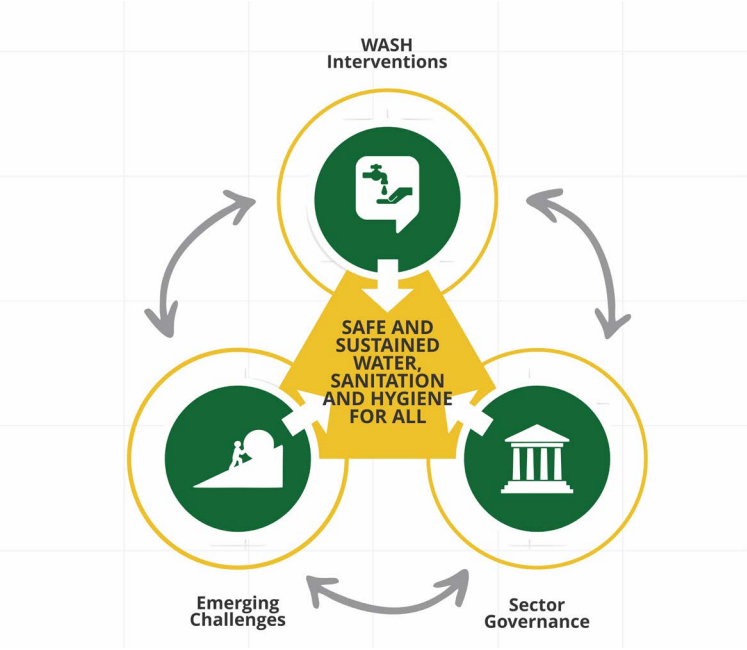

Figure 8: Three themes of the NSWSS 2014 (Source: LGD, 2014)

5.2.4 Sector Development Plan for the Water Supply and Sanitation Sector of Bangladesh (2011-2025)

The Sector Development Plan (SDP 2011-2025) is WSS's guiding and most comprehensive national plan. It focuses on the domestic or community water supply. The objectives of the SDP were to provide a framework for planning, implementing, coordinating, and monitoring all activities in the WSS sector. The Plan was developed for 15 years in three phases. The implementation outlines of these phases are illustrated in Figure 9.

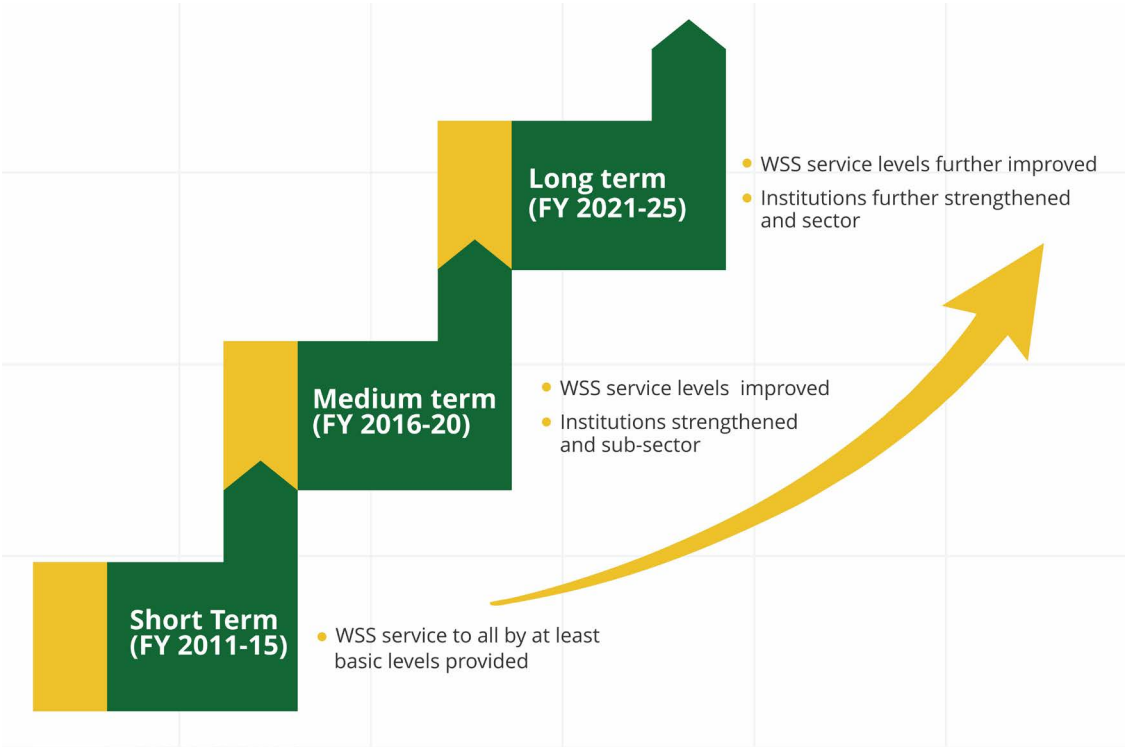

Figure 9: Implementation Roadmap of the SDP 2011-2025 (Source: LGD, 2011)

5.2.5 Water Supply Master Plan for Dhaka City 2014

This is a 50-year master plan up to the year 2060 prepared for the water supply services of Dhaka WASA. The plan provides direction and strategies for the water supply and distribution in the Dhaka megacity. It provides detailed information on existing and future water supply, demand, sources, and distribution mechanisms. The Plan was formulated to support the attainment of the SDGs in the water supply sector and the establishment of essential institutional and financial frameworks for a sustainable O&M. It additionally prepared a priority list of investment projects from 2010 to 2020.

5.3 Relevant Policy Frameworks Used in the Agriculture Sector

5.3.1 Groundwater Management Act 2018 For Agricultural Use

The Groundwater Management Act provides the legal framework for the use of groundwater in the agriculture sector. It includes essential provisions for a safe abstraction of groundwater, impact on nearby other sources, and environmental sustainability. The Act formulated an Upazila-level management committee for execution, monitoring, and regulating groundwater use for agriculture and procedural requirements for installing and operating tube wells. However, some provisions of this Act necessary to regulate groundwater use and protect its quality are not effectively implemented. They may require lower-level, more specific legislation and capacity building to support implementation.

5.3.2 National Agriculture Policy 2018

This is the guiding document for the agriculture sector in Bangladesh. The policy statements target a sustained development of the sector and food security under the changing climate. The instrument focused on infrastructure and hardware components in the sector. Additionally, it promoted research and development of resilient and more-productive crops. The policy objectives, among many, include requirements for effective coordination and active participation in water resources management and efficient utilization of all natural resources used in agriculture.

5.3.3 National Agriculture Extension Policy 2020

The National Agriculture Extension Policy 2020 (i.e., NAEP 2020) aims to ensure food security and manage and expand a sustained development of the agriculture sector. The policy emphasizes the use of surface water for irrigation. Additionally, it promotes using GIS, remote sensing, and geospatial databases for agricultural information management and planning. NAEP 2020 also encourages the application of appropriate adaptation and mitigation measures to maintain and enhance food security.

5.3.4 Integrated Micro-Irrigation Policy 2017

The Integrated Micro-Irrigation Policy 2017 aims to reduce irrigation costs by modernizing the existing irrigation systems and capacity building, ensuring food security and alleviating poverty. Specific objectives of the policy, among others, included reasonable use of water resources for irrigation, expansion of sustainable technologies to assure efficient use of water, discouraging excessive use of deep tube wells and introduction of water-saving irrigation means, utilization of rainwater, etc.

5.3.5 Medium-Term Strategy and Business Plan 2012-2016

This strategy document provided directions for investments and programs to sustain the agriculture sector's development for 2012-2016. Additionally, it stated the policies and plans to mitigate the existing and potential challenges for agricultural development. The instrument included strategies for irrigation and more utilization of surface water resources.

5.3.6 Master Plan for Agricultural Development in The Southern Region 2013-2021

The Master Plan for Agricultural Development in the Southern Region 2013-2021 was prepared by the MoA in collaboration with the Ministry of Fisheries and Livestock (MoFL), MoWR, and with technical assistance from the Food and Agriculture Organization of the United Nations (FAO). It is a regional-level policy instrument that includes three hydrological regions: south-central, southwest, and southeast of the coastal zone in the country. The objective of the Plan was to provide a roadmap for an integrated development of agriculture in the selected areas and thereby ensure food security, poverty reduction, and livelihood development. It included essential plans for improving water management, increasing surface water irrigation facilities, and developing climate-resilient infrastructure for 2013-2021.

5.3.7 National Aquaculture Development Strategy and Action Plan 2013-2020

The MoFL developed the National Aquaculture Development Strategy and Action Plan with technical assistance from the FAO. It is the guiding policy document for the development of the aquaculture sector in Bangladesh for the period of 2013-2020. The policy framework included 16 outputs under four distinguished objectives to improve the welfare of the resource-poor people depending on the aquatic resources, reduce poverty, conserve natural resources, and promote sustainable development. The instrument suggested necessary strategies for using water resources to support aquaculture development.

5.3.8 Pond Development Act 1939

This Act provided the legal framework for developing the ponds for fish cultivation and irrigation. It included necessary provisions for the development and restoration of ponds, the right to use pond water, legal and operational capacities of the pond owners and communities, etc.

5.4 Supporting Other Policy Frameworks

5.4.1 Environmental Conservation Act 1995 and Environmental Conservation Rules 1997

The Environmental Conservation Act 1995 (ECA 1995) and the Environmental Conservation Rules 1997 (ECR 1997) provide the legal framework for conservation measures and pollution control for all human interventions on the natural systems in Bangladesh. The ECA 1997 provides criteria for environmental clearance for any development program and standards for water quality indicators of the existing resources and water consumption.

5.4.2 Bangladesh National Building Code 2020

The Bangladesh National Building Code 2020 (i.e., BNBC 2020) was enacted in 2021 to provide a legal obligation for complying with structural design standards in construction. The code incorporates design criteria, methodologies, and standards for installing household rainwater harvesting facilities. Additionally, the code provides structural design requirements for the household water supply, sanitation, and drainage equipment.

5.4.3 National Environment Policy 2018

The MoEFCC formulated the National Environment Policy 2018 with a vision to ensure sustainable development for the nation through environmental conservation, pollution control, conservation of biodiversity, and climate actions. Specific objectives of this policy instrument, among others, included expansion of climate adaptation measures, reduction in emissions, and sustainable management of natural resources, including water. It suggested policy actions for rainwater harvesting, flood control measures, pollution control in the water resources, limiting groundwater abstraction, maintaining a functional IWRM, adopting participatory water management, and economic valuation of all water resources.

5.4.4 National Industry Policy 2016

The National Industry Policy 2016 adopted the Water Act 2013 and the Environmental Conservation Rules 1997 to protect water resources from industrial contamination. Additionally, the framework recommended reduced emissions from various industries for environmental conservation and climate mitigation as part of the nationally determined contribution.

5.4.5 National Renewable Energy Policy 2008 and the Power System Master Plan 2016

These policy documents were reviewed to explore the provisions for hydropower potential made in the country's energy sector. The National Renewable Energy Policy 2008 set renewable energy share targets to 5% and 10% of the total installed capacity by 2015 and 2020, respectively. Unfortunately, the hydropower potential is very low in Bangladesh. The Power System Master Plan 2016 concluded that the targets could not be achieved with limited renewable sources, and the government may extend the period to 2041 to accomplish the 10% share of renewable energy. The Sustainable and Renewable Energy Development Authority (SREDA) under the Ministry of Power, Energy and Mineral Resources (MoPEMR) reported a target of only 4 MW from hydropower by 2021.

Solar-powered pumping of groundwater is becoming popular as a reliable irrigation water source. While this benefits individual farmers, it presents a challenge for equitable water sharing and the sustainability of groundwater systems. These pumping systems' power is mostly a few kilowatts and will be difficult to identify, register and regulate. Since the operation cost is very low, water use may increase compared to previous diesel-powered pump sets.

5.5 Policy Frameworks on the Climate Actions

5.5.1 National Adaptation Plan

The National Adaptation Plan (NAP) is the key strategic process undertaken by the government of Bangladesh, which will identify adaptation needs and facilitate the incorporation and integration of climate change adaptation into relevant national policies and development programs. NAP is currently under execution with support from the United Nations Development Program (UNDP) and the Green Climate Fund (GCF) and is expected to be completed by the end of 2022 (GED, 2020). NAP focuses on the Nature-based Solution (NbS) and Ecosystem-based Adaptation (EbA) measures for sustained and effective adaptation.

Water resources have been listed at the top among the priority sectors of the NAP process. Therefore, the Ministry of Water Resources and its partner organizations are assigned major responsibilities and are the key beneficiaries of NAP.

NAP is built upon the National Adaptation Program of Action (NAPA, 2009) and Bangladesh Climate Change Strategy and Action Plan (BCCSAP, 2009), with necessary improvements to establish a systematic adaptation process in all levels of national planning. The NAP formulation project has the following two key objectives (UNDP):

- Formulate the NAP with a focus on medium-to-long-term adaptation investment, and
- Enhance national capacity to integrate climate change adaptation in planning, budgeting, and financial tracking processes.

It is expected that NAP will have the following four outcomes.

a Outcome 1: Strengthened institutional coordination and climate change information and knowledge management capacities to support medium-to-long-term planning

b Outcome 2: Adaptation options appraised and prioritized, and the NAP formulated

c Outcome 3: Developed and piloted climate risk-informed decision-making tools at national and sectoral levels

d Outcome 4: Established appropriate mechanism for adaptation investment tracking and financial plan for mid-, and long-term adaptation measures

The national governing plans, such as the 8FYP (2020-2025), PP 2041, and BDP 2100, reflect NAP's key objectives and adaptation priorities. Strong institutional coordination, cooperation, and collaboration are integral to the success of NAP formulation.

As of April 2021, NAPA (2009) and BCCSAP (2009) are two important milestones achieved during the NAP formulation process. These two documents provide information and strategies for adaptation at the national level. A general overview of these two documents focusing on the water sector is provided in the following.

5.5.2 National Adaptation Program of Action 2009

The National Adaptation Program of Action (NAPA) was originally developed by the MoEFCC in 2005 with support from the Global Environment Facility (GEF). Later, the document was updated in 2009 as a part of the NAP formulation process. The objectives of NAPA were to identify the adaptation needs across different sectors in response to climate change and formulate appropriate projects.

Water resources and agriculture (including subsectors: crop, fisheries, and livestock) were identified as the critically affected sectors due to the adverse impact of climate change. Extreme flooding, droughts, and increased salinity intrusion are the governing events resulting from climate change that threaten water and food security if appropriate adaptation measures are not implemented

on time. The degree of adaptation requirement depends on the nature and magnitude of adverse effects imposed by climate change.

Examples of successful adaptation measures are provided in NAPA, which demonstrated effectiveness recently. These actions are:

- Construction of cyclone shelters and coastal embankments
- Green belt project (a reforestation program in the coastal region)
- Rainwater harvesting
- Floating agriculture
- Development of salinity tolerant crop (paddy) species by BRRI and BARI

Additionally, to cope with the uncertain and dynamic nature of climate change, NAPA (2009) provides an outline of potential adaptation measures, which include the following:

- Modeling the likely hydrological impacts of climate change on the GBM basin system to assess likely future system discharges and river levels to derive design criteria for flood-protection embankments
- Filling the climate change knowledge gap for water resources planning, designing, and implementation of the project
- Reviewing and revising, where appropriate, all government policies (sector by sector) to ensure that they fully account for climate change and its impacts
- Mainstreaming climate change in national, sectoral, and spatial development planning (in government ministries and agencies, local government, the private sector, civil society, and communities) and ensuring that impacts on vulnerable groups and women are prioritized in plans
- Building the capacity of key government ministries and agencies to take forward climate change adaptation
- Executing capacity development for water sector managers for designing structural adaptation
- Formulating land and water zones for climate change adaptation in Bangladesh

Finally, NAPA suggested necessary criteria and indicators for prioritizing adaptation measures for implementation.

There are some important barriers to implementing the NAPA, such as:

- ***Deficiency in awareness building*** **–** despite implementing many awareness-building initiatives, these attempts have failed to trigger large-scale implementation. Climate change and its results are often uncertain and unrecognized at the mass level. There is much space for learning in this field for connecting people with adaptation activities.
- ***Lack of incorporation of climate change impact in the national development policies*** **–** Many climate-sensitive sectors such as water, agriculture, and disaster management lack inclusion of climate-informed decisions in their development activities. However, this scenario is improving over time as the government has placed a praiseworthy commitment to climate actions.
- ***Inadequate resources to support climate actions*** **–** There are limited resources available to people and governance on climate actions, such as tools, knowledge bases, and methodologies. These resources are essential to equip governance with adequate capabilities for adaptation measures. At the same time, these resources should be comprehensive enough for the policymakers to be easily understood and shared across the critically impacted sectors.

An evaluation of the process of formulating and advancing the National Adaptation Plan undertaken for UNDP confirmed the relevance, interest, and support for the Plan both within Government and among donors but also identified difficulties faced by the project team, including limited capacity within the Government, its limited appreciation of local engagement, and a lack of understanding of the process and importance of monitoring and evaluation.[26]

Nevertheless, these are being overcome. The Government states, concerning the current progress in implementing NAPA:

> *"The Government of Bangladesh presently spends approximately 6-7 percent of its annual budget on enhancing climate resilience through adaptation initiatives, among which seventy-five percent of cost comes from domestic resources. The Bangladesh Climate Change Trust Fund has undertaken over 800 projects with a sole focus on effective climate adaptation and mitigation. Advances in agricultural research have made possible the development of stress-tolerant crop varieties, and practices of floating agriculture and effective irrigation methods, are contributing widely to year-round vegetable farming and multiple crop cultivation to ensure food & nutrition security. Innovations in climate-smart fisheries, aquaculture & livestock development and improved post-harvest facilities, including silos for food storage, are contributing to making the resilient food production system and reinforcing food security. Integrated and participatory water management with strengthened early warning systems, and irrigation, flood, and erosion protection schemes have enabled an intricate blending of both structural and nature-based interventions to bolster disaster preparedness in increasing climate resilience. Coastal afforestation programmes have been undertaken to stabilize the coastline and create green belts by engaging community people. Transformation in developing climate resilient infrastructures, improved public health and enhanced urban resilience is underway."*[27]

An updated NAPA (2023-2050) is now available[28], which notes that climate change and the geography of Bangladesh are exerting considerable stress on its economy and attainment of the SDGs. However, it notes that the needed 113 interventions are aligned with its plans to attain the SDGs and to implement the Bangladesh Delta Plan 2100, and does not propose any change in government agency arrangements beyond the existing Interministerial Committee on Climate Change and a National Technical Advisory Committee (to be established).

5.5.3 Bangladesh Climate Change Strategy and Action Plan 2009

The Bangladesh Climate Change Strategy and Action Plan 2009 (BCCSAP 2009) was developed by the Ministry of Environment, Forest and Climate Change (formerly named as Ministry of Environment and Forest) to support the implementation of the immediate and urgent adaptation needs which were outlined in NAPA (2005). It is a living document of the government incorporating necessary changes and the experience gained from climate actions and climate-informed decision-making.

The climate change strategy of BCCSAP follows the Bali Action Plan (2007), which included four building blocks for sustainable development as listed below:

- Adaptation to climate change
- Mitigation
- Technology transfer, and
- Adequate and timely flow of funds for investment

A food, energy, water, and livelihood securities framework provided the above building blocks.

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[26] https://erc.undp.org/evaluation/documents/download/21630
[27] https://www.undp.org/sites/g/files/zskgke326/files/2022-11/National%20Adaptation%20Plan%20of%20Bangladesh%20%282023-2050%29.pdf
[28] https://www.undp.org/bangladesh/publications/national-adaptation-plan-bangladesh-2023-2050

The climate change action plan of BCCSAP is a 10-year program (2009-2018) that supported the country's capacity building for adaptation and resilience through implementing the projects identified in NAPA (2005). The action plan included considerations for the poor and vulnerable people, including women and children (BCCSAP 2009).

There are six pillars in the action plan of BCCSAP in its first five-year period (2009-2013), as listed below. All programs and sub-programs for implementation are grouped under these six pillars.

i. Food security, social protection, and health
ii. Comprehensive disaster management
iii. Infrastructure
iv. Research and knowledge management
v. Mitigation and low carbon development
vi. Capacity building and institutional strengthening

Actions for water sector adaptation directly or indirectly link five of the six pillars mentioned above. Appendix II provides the complete list of programs designed under the six pillars.

To support the implementation of the action plan, the government established a National Steering Committee on Climate Change under the National Environmental Committee. The institutional structure that will implement the BCCSAP action plan is illustrated in Figure 10 below. The government established the National Climate Change Fund to finance the action plan. The fund is open to all development partners and donor agencies. Financing for the projects listed under the action plan was separate from other annual development programs.

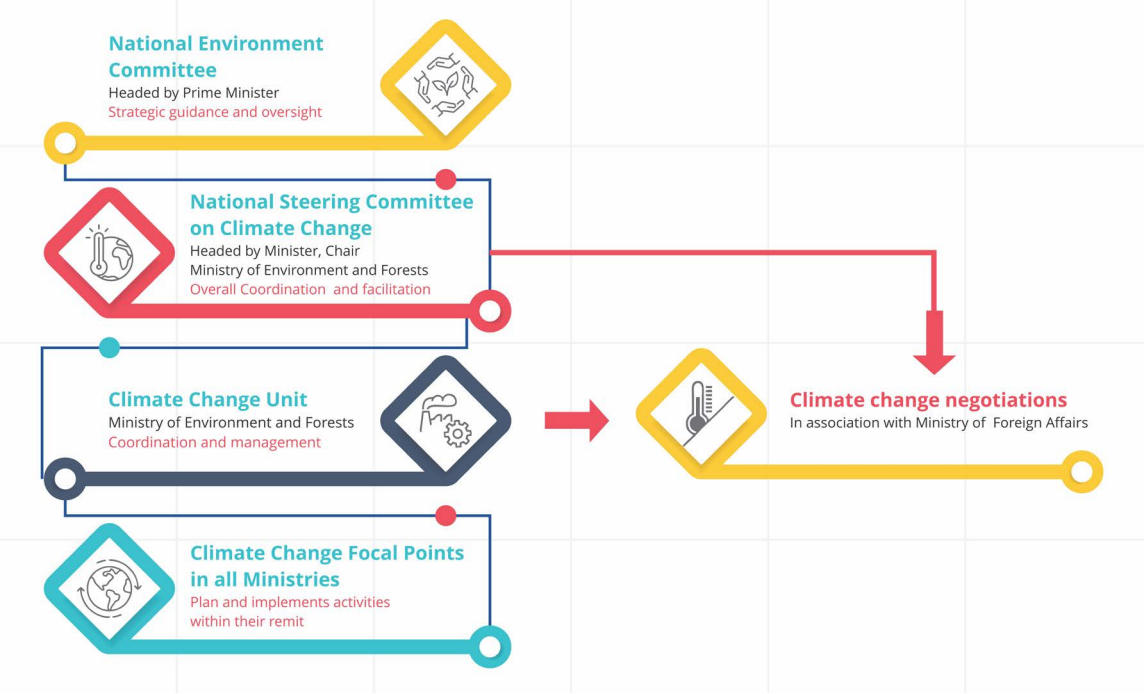

Figure 10: Institutional Structure for the BCCSAP Action Plan (Source: BCCSAP, 2009)

5.5.4 Local Actions for Adaptation

Bangladesh has a long history of successfully adapting to natural disasters and the adverse impact of climate change with local or community-based actions. Cyclones, floods, and heavy storms are frequent phenomena that severely affect the country's northern, southern, and coastal regions. Additionally, the northeastern region (e.g., the haor area in Sylhet Division which has a unique hydrological setting and a diverse ecosystem) is critically affected by flash-flood. Complementing the

national level policies and strategies, these community-based action plans have always helped people recover from the disaster and adapt their way of living and dealing with disasters. The government supports or administers local actions through several Local Government Initiatives (LGIs) and applying a multi-stakeholder approach.

Local adaption strategy differs from the national strategy in following a bottom-up approach. However, it helps connect the on-ground or local strategies, practices, and lessons learned to the national-level planning and eliminate the information gap. In recent years, local adaptation in Bangladesh has been greatly inspired by the national framework of Local Adaptation Plans for Action (LAPA) designed and developed by the Government of Nepal. LAPA is |defined as a participatory, contextual, and inclusive bottom-up planning process developed to operationalize the policy objectives outlined in NAPA and BCCSAP (Islamic Relief Bangladesh, 2017).

The LAPA Consortium in Bangladesh defines the specific objectives of LAPA in the country as follows:

- To strengthen the capacity of local government Institutions and government authorities on LAPA
- To initiate an all-inclusive, participatory, bottom-up planning process for scaling out and scaling up
- Leverage international funding from climate funds

LAPA was first designed and piloted in ten districts of Bangladesh in 2010 with support from the International Institute for Environment and Development (IIED) and local NGOs. Over seventy LAPAs have been prepared since 2014 to address local adaptation measures (Islamic Relief Bangladesh, 2017). Several INGOs and NGOs formed the LAPA Consortium to help the government implement several LAPA initiatives and integrate its application with the national development plans.

Steps involved in the LAPA process adopted by several implementing partners, such as Islamic Relief Bangladesh, are illustrated in Figure 11. The process is derived from the LAPA framework of Nepal with necessary adjustments to suit the local context of Bangladesh.

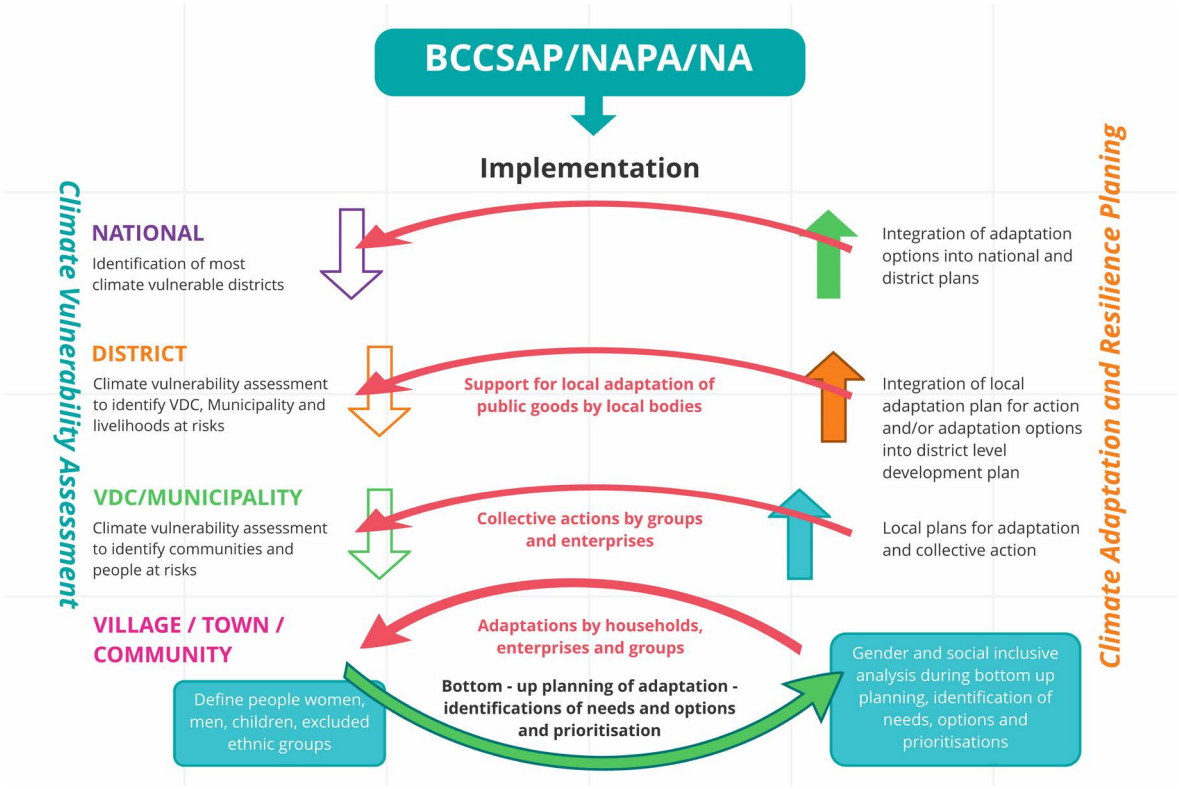

Figure 11: LAPA Implementation Process (Source: Islamic Relief Bangladesh, 2017)

Among several ongoing local adaptation programs, it is worth mentioning that the Local Government Initiatives on Climate Change (LoGIC), a four-year duration (2016-2020) project financed jointly by UNDP, UNCDF, EU, and SIDA, has been implemented by the Local Government Division (LGD). This project is a classic example of how the local government is supporting the communities in building effective adaptation and resilience against the impact of climate change. The project was designed to support local and most vulnerable communities from 72 unions in 7 districts (UNDP, 2016). The objective of LoGIC was to facilitate improved and inclusive local-level planning and a strengthened financing mechanism for community-based climate change adaptation solutions through local government (UNDP, 2016). More information about the LoGIC project can be found at: https://www.undp.org/bangladesh/projects/local-government-initiatives-climate-change-logic.

The project's midterm evaluation raised serious questions about its broader impact and sustainability. Approval processes within the government delayed the project's commencement by two years. While there is evidence of increased climate impact resilience at the local implementation level, the project is not engaging with the relevant national agencies and influencing national policies for climate change adaptation. Further, the evaluation found that project processes may be too complex for unaided implementation by the local government agencies and that project assets are at risk of post-project capture by local elites.[29]

5.5.5 Nationally Determined Contribution

The Intended Nationally Determined Contribution (INDC, 2015) is a living policy document that addresses the commitment or contribution of the government of Bangladesh to global efforts for climate actions with a particular focus on mitigation measures. These mitigation actions are expected to help reduce the country's GHG emissions. The INDC 2015 sets the core mitigation actions for the power, transport, and industry sectors. Although there is a separate component for adaptation, the governing actions and roadmap in this policy were developed to address the mitigation.

The INDC 2015 was prepared under the frameworks of BCCSAP 2009 and other relevant national-level policies of the energy and industry sectors. The targeted contributions were categorized into two types: unconditional and conditional. Targets outlined in these contributions are reduction in greenhouse gas (GHG) emissions by 5% and 15%, respectively, concerning the base scenario by 2030. The conditional contributions required additional support from the international bodies on climate actions.

Since the core contribution areas included power, transport, and industry sectors, this INDC does not explicitly address actions or targets for the water sector. However, rainwater harvesting was recommended as a conditional contribution for the housing sector (commercial) to adopt and promote water conservation.

A document titled "Nationally Determined Contributions (NDCs) 2021, Bangladesh (updated)" was submitted to UN Framework Convention on Climate Change (UNFCCC) in August 2021. This document confirms the intentions in the earlier submission and provides some information on actions taken.30

5.6 Governing National Development Plans and Policy Instruments

5.6.1 Bangladesh Delta Plan 2100

Bangladesh Delta Plan 2100 (i.e., BDP 2100) is a long-term comprehensive vision document for managing the country's water resources and land assets. It is expected to reference overall development targets until 2100 (GED, 2018). BDP 2100 is built upon the core vision for sustainable and climate-resilient water resources management, which is integral to natural resource management and the ecosystem-based livelihood of the people. With three high-level and six specific national goals, BDP 2100 adopted a flexible and adaptive strategy to manage uncertainties, link short-term,

[29] https://info.undp.org/docs/pdc/Documents/BGD/LoGIC%20Mid-Term%20Evaluation%20Report%20(Print%20Version).pdf
[30] https://unfccc.int/sites/default/files/NDC/2022-06/NDC_submission_20210826revised.pdf

medium-term, and long-term expected outcomes, and cope with future water dynamics, climate change, and other environmental issues.

The plan is developed with support from the Government of the Netherlands and using the extensive experience of the Netherlands' delta management. The General Economics Division (GED) under the Bangladesh Planning Commission (BPC) is the responsible authority for coordination, facilitation, and M&E for implementing the plan. The investment plan of BDP 2100 initially has eighty (80) projects in the pipeline, which will be implemented by different ministries by 2030. The estimated total investment cost for the initial phase is approximately 37.0 billion USD (GED, 2018). The Ministry of Water Resources (MoWR) and its partner organizations will implement many of the listed projects. GED will work in coordination with these ministries, perform M&E, and evaluate the outcomes of the projects against the targets of the BDP 2100.

The BDP 2100 proposes significant institutional developments to support the coordination necessary for implementation. A Delta Commission will be created, with a steering committee and implementing agency appointed for each hotspot program or subprogram. The steering committee and implementing agency for each program and sub-program will provide the institutional framework to coordinate implementation.[31]

ADPC has reviewed the monitoring and evaluation framework BDP 2100.[32] The review report noted that the monitoring and evaluation (M&E) framework of the BDP 2100 is "goal-based," whereas the existing M&E is project-based. Therefore, a bridge is required to connect the two systems. Further, the indicators in the BDP 2100 Development Result Framework (DRF) may need to be disaggregated for monitoring of the work by each sector, and there is limited or no information on the technical definition of the indicators. Data provision for the M&E framework may also need attention since with the distributed with the authority of various agencies, and there is no established single or centralized data platform. Additionally, some data may need to be climate adjusted to allow for variability in the climate.

5.6.2 Perspective Plan 2021-2041

The Perspective Plan 2021-2041 (i.e., PP 2041) is the key policy instrument to support the accomplishment of the government's vision for 2041 and transform Bangladesh into a middle-income country. The Plan focused on controlling air and water (surface water) pollution, applying geospatial data analysis, and conserving and enhancing biodiversity. Additionally, realizing the impact of climate change, the instrument recommended adopting essential adaptation and mitigation measures in different sectors. The Plan sets strategies in alignment with the BDP 2100 to achieve the national goals and ensure sustained growth.

5.6.3 Eighth Five Year Plan 2021-2025

The Eighth Five Year Plan 2021-2025 (i.e., 8FYP) was published in December 2020 to provide strategic directions for development for 2021-2025. The 8FYP provides essential guidance on initiating implementation of the BDP 2100 from 2021 onward. The government's vision toward building a climate-resilient delta is well-reflected in this 8FYP. To support IWRM, the 8FYP allocates an investment of US $21.7 billion in 2021 prices for 47 new projects. The line ministries or sectors implementing these projects are MoWR, LGD, MoA, BIWTA, MoFL, MoEFCC, and the Ministry of Disaster Management and Relief (MoDMR). More than 50% of the total investment plan of the 8FYP is allocated to MoWR since it is the focal ministry to deal with water resources. The 8FYP recommended a basin-wide water resources development approach and suggested a decentralized water governance structure. Additionally, to support implementing the projects listed under the BDP 2100, the Plan suggested developing a Result-Based Monitoring and Evaluation (RBM&E) system in 2021. To address the strategies for climate action, the 8FYP encourages incorporating appropriate climate adaptation and resilience measures at all levels of national and sectoral development.

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[31] World Bank, 2020. Bangladesh Water Sector Diagnostic: Priorities for the New Decade. Executive Summary, Challenge 6, footnote 15
[32] Hugh et al. 2023. Towards a Sustainable Delta: An in-depth analysis for a Climate-inclusive M&E Framework for Bangladesh Delta Plan 2100

6. CHARACTERISTICS OF GOOD WATER RESOURCES MANAGEMENT

As noted in the Introduction and Section 3.7, Bangladesh aims through its policies and plans to adopt and implement IWRM. However, as noted in various sections, there are shortcomings in implementation and difficulties in adopting the internationally recognized characteristics of IWRM within the context of existing institutions of Bangladesh, particularly the organizational structure of government agencies.

6.1 Characteristics of IWRM

As the Global Water Partnership puts it: "IWRM is a challenge to conventional practices, attitudes and professional certainties. It confronts entrenched sectoral interests and requires that the water resource is managed holistically for the benefits of all. No one pretends that meeting the IWRM challenge will be easy but it is vital that a start is made now, to avert the burgeoning crisis."

Principles and Practices: Since good IWRM is analogous to good river basin management, it is useful to explore contemporary trends in IWRM and to assess what impacts the state and basin manager can have on influencing the scope, nature, and quality of water management and of major water infrastructure projects.33

In recent years the key principles of good integrated water resource management have become a matter of international consensus. These principles are based on the often poorly appreciated fact that water is a finite resource, vulnerable to degradation, and essential for life. From the 1992 Rio Summit on Sustainable Development, one of the clearest management principles was developed and agreed upon. Agenda 21 describes them as follows.

"Integrated water resources management is based on the perception of water as an integral part of the ecosystem, a natural resource and a social and economic good, whose quantity and quality determine the nature of its utilisation. To this end, water resources have to be protected, taking into account the functioning of aquatic ecosystems and the perennial nature of the resource, in order to satisfy and reconcile needs for water in human activities. In developing and using water resources, priority has to be given to the satisfaction of basic needs and the safeguarding of ecosystems. Beyond these requirements, however, water users should be charged appropriately.

Integrated water resources management, including the integration of land- and water-related aspects, should be carried out at the level of the catchment basin or sub-basin.

Four principal objectives should be pursued, as follows:

a *To promote a dynamic, interactive, iterative and multi-sectoral approach to water resources management, including the identification and protection of potential sources of freshwater supply, that integrates technological, socio-economic, environmental and human health considerations;*

b *To plan for the sustainable and rational utilisation, protection, conservation and management of water resources based on community needs and priorities within the framework of national economic development policy;*

c *To design, implement and evaluate projects and programs that are both economically efficient and socially appropriate within clearly defined strategies, based on an approach of full public participation, including that of women, youth, indigenous people and local communities in water management policy-making and decision-making;*

33 UNSECO (2009) IWRM Guidelines at River Basin Level – Part 1: Principles. https://unesdoc.unesco.org/ark:/48223/pf0000186417

d *To identify and strengthen or develop, as required, in particular in developing countries, the appropriate institutional, legal and financial mechanisms to ensure that water policy and its implementation are a catalyst for sustainable social progress and economic growth."*

Stated simplistically, this is all about:

- Water sharing amongst competing uses and users;
- Water protection to ensure access for present and future generations to acceptable quality water;
- Water supply to all citizens fairly and equitably.

How these three water management components have been achieved varies greatly from country to country and must consider all the social and cultural factors that dictate government and community values and aspirations. What can be said, however, is that in both developing and developed countries where good integrated water resources management is practiced, four common features constitute best practice.

They can be stated as follows.

i. An institutional framework that is robust and flexible is developed, including modern legislation and an integrated policy framework.
ii. Planning and management are knowledge-driven. Strategic assessment of water and related resources receives high priority and does not stop at mere data management but actively pursues the generation of strategically focused information and knowledge.
iii. Integration is built into institutions, resource management, and policy. There is a recognition of the holistic nature of ecosystems, and all policies, decisions, and projects are evaluated against this background.
iv. Community participation is built into all processes. It is the normal way of doing business in the public sector. It also recognizes that the natural resources of a country or a State belong to its people, and they have a right to participate in its management. And not only do people have a right to participate, but community participation leads to government efficiency, ownership of policies and actions by the community, and readily accepted principles of cost sharing.

Perhaps the integration aspect of water-related policies and strategies is the most difficult to achieve. It goes against the most traditional way of thinking that seeks to solve a particular problem from within one's resources and not involve others until the problem is solved. Yet this approach of relying on one's own resources can cause river basin management and water resource development to be viewed from a narrow or single-issue perspective.

So, what constitutes "integration" in water resources planning and management issues, and why is it difficult to achieve?

Part of the problem in achieving 'integration' is that people from different professional backgrounds view water resources management differently.

To the ecologist, water resources management is often connected with reversing the effects of the deterioration of ecosystems, land degradation, pollution, and destruction of wetlands. To the water engineer, water resources management is about dams, reservoirs, flood protection, diversions, river training, water treatment, and reclamation. To the lawyer, the main issues in water resources management are the ownership of water, systems of water usufruct rights, the priority of use, water markets, water legislation, and international water law. To the economist, water resources management is connected with economic efficiency, cost recovery, and attaining national objectives. To the sociologist, water resources management is often viewed as an attempt by the state to reduce further the autonomy that local communities feel they should enjoy.

Accordingly, sociologists must work with local communities to ensure they do not lose in the process and to understand that it provides an opportunity to define their rights and influence future development.

Not only do the views and attitudes of the key 'players' create some confusion and uncertainty as to what constitutes an integrated approach, but this integration also must embrace many other "dimensions," for example:

- Sectoral (and sub-sectoral) integration refers to the planning and managing water resources considering the competition and conflicts for water among irrigated agriculture, hydropower, domestic water supply and sanitation, industry, and so on. In this sense, integrated planning leads to such things as multi-purpose storage reservoirs and other projects, water allocation and licensing systems, and river operations, specifically for navigation and other non-consumptive uses.
- Economic, social, and environmental integration means considering the financial and economic costs and benefits of water management decisions and the social and environmental costs and benefits. In most countries, this integration is facilitated by legal requirements for environmental and social impact assessments for new projects and often also for major changes to the prevailing water management regime.
- Administrative integration refers to the coordination of the water management responsibilities and activities at all levels of government, including national, state/provincial, and local/community, and between those levels. A well-formulated and enunciated legal and organizational framework for water resource management is essential. This dimension of IWRM appears to be often overlooked. Yet, a lack of integration of this type can lead to serious inefficiencies and reduced effectiveness in managing any country's water and other natural resources.
- Geographical integration means using hydrologic boundaries (catchments and river basins) rather than administrative boundaries as the basic units for water resource management. It also means considering the catchments themselves and the interactions between land use and the water in rivers, streams, and lakes, when making decisions about developing and managing all natural resources.
- In developing countries, donor integration - that is, effective coordination among the many external support agencies in the development and implementation of projects and the provision of other assistance - also needs to be achieved if water resources are to be managed effectively and with the greatest efficiency in the investment of the limited available funds.

All of these elements can largely be represented in good integrated water resources management if there is no overlap or confusion of roles and functions between the components of:

- Regulator, standard setter, auditor;
- Resource manager;
- Operator and provider of technical services

There is broad agreement on the merit and need for separate roles, but there is some debate as to what functions comprise the regulator and the manager.

For example, some consider it is a function of the regulator to issue water abstraction licenses and pollution permits. Others see all aspects of water quantity. Quality management should be functionally integrated and prefer the 'resource manager' to be the body responsible for quantity and quality measurement and monitoring, allocation of water shares, managing a water licensing and pollution permitting system, and generally managing within the policies and to the standards set by the regulator.

This latter approach reflects that water is a holistic, finite resource, and all aspects of its management should be considered together. Therefore, on this basis, the various roles can be defined as follows:

Regulator/standard setter:

i. Develops and implements a financial/economic or pricing regulatory regime.
ii. Develops water quality and other natural resource objectives, standards or guidelines.
iii. Audits the performance of the water sector as to compliance with standards.

Resource manager:

i. Undertakes strategic water assessments.
ii. Develops policies and strategies to comply with national objectives and with standards set by the regulator. Also develops and oversights a strategic water research program.
iii. Develops legislation to support regulatory standards and policies.
iv. Plans and allocates water.
v. Manages quantity and quality for surface water and groundwater.
vi. Supports inter-agency and community driven basin coordination.
vii. Develops water sector capacity building programs.
viii. Promotes public participation and water awareness.

Operator/service provider –

i. Builds and operates water supply, sewerage, drainage, and irrigation systems.
ii. Maintains infrastructure.
iii. Provides technical advice and assistance to others.
iv. Charges others for services provided.
v. Operates under some form of contract(s), usually to the regulator for operating rights and to the resource manager for water resource utilization.

In some circumstances, the 'policy development' function is separated from the 'resource manager' so that there is clear accountability between those who develop policy and those that manage it. In other cases, these functions remain in the one organization, but the policy is distinctly 'ring-fenced' as a separate division or unit within the organization to provide clarity of purpose.

The key to removing role confusion is clearly defining the boundary conditions between these levels or components. Where do the functions of one finish and the other start? Are there clear mandates or legal agreements, acts, or decrees that specify what each 'player' in resource management should do? Are there appropriate levels of direction and oversight by the government and reporting to the government and community?

The following Table 9 has been assembled to detail what constitutes 'best practice' in integrated water resources management. It is stressed that this is a listing of principles that must be assessed for any particular circumstance and developed into the appropriate institutional response suitable for that circumstance. Nonetheless, these principles are a useful basis for the assessment of the water sector policy frameworks in Bangladesh.

Table 9: Institutional Principles for implementing Integrated Water Resource Management

Institutional Principle needed for IWRM	Rationale
Clear accountability Single accountability for sustainable planning and allocation of water resources and for overall water cycle management (quantity and quality) to achieve maximum social and economic benefits while meeting national environmental goals.	Water is a resource owned by the people and managed by the government. The water cycle is indivisible. Therefore, a single institution is more efficient and effective and removes the confusion of roles.
Clarity of roles - 1 Separation of regulator/resource manager from operator/resource user should be strongly pursued.	Removal of conflicts of objectives. Clarity of accountability. Service provider focuses on customers.
Clarity of roles - 2 Separation of regulator/standard-setter/auditor roles from the resource manager should be a goal, but limited by common sense and guided by efficiency.	This separation achieves a high level of transparency and should be pursued.
Clarity of roles - 3 Defined resource utilization rights, which acknowledge customary use and the environment	This is at the heart of IWRM – water development and use should be under procedures that protect the environment and people's basic rights to water for their daily lives.
Efficiency and effectiveness - 1 The commercialization of operator or service provider functions. (Being more business-like, not necessarily corporatization, etc.)	Value for money. Minimizes demands on Government finances – although some services will always be publicly funded. (Government as the 'customer'). Drives good customer service.
Efficiency and effectiveness - 2 Freedom to manage efficiently through removal of unnecessary constraints and restrictions on services managers. This requires strong delegation.	Value for money. Efficiency and effectiveness. Unlocks creativity and energy of management and staff.
Efficiency and effectiveness - 3 Accountable, cost-effective service delivery based on buyer/seller relationships	In some ways, a restatement of the previous point but emphasized because of the importance of a service ethic in water management.
Being knowledge-driven A focus on knowledge generation (including data acquisition and management).	Absolutely required to underpin good water resource management.

Institutional Principle needed for IWRM	Rationale
Integration Provision for integration across other natural resources and national/regional economic planning.	No resource exists in isolation. Use by one sector can be a cost to another sector (including the natural environment).
Community participation Community participation, built-in to policy development and ongoing operations, provides feedback and advice directly to Ministerial levels.	Resources are 'owned' by the people. Participation creates efficiency, trust, and commitment. Minimises Government costs.
Regionalization Water management devolved to regional and district levels meaningfully, accompanied by necessary resources.	A very effective way to achieve combined efficiency and effectiveness with genuine community participation.

To provide an overall perspective of policy implementation shortcomings and to address them within the framework of IWRM, after reviewing various documents, the available literature, and in the light of the consultant's experience, a list of key issues is presented here:

Organizational structures

- There is no agency dedicated to water resources management providing properly functioning regulatory services to share resources equitably and to protect the common property environmental and social uses;
- Existing agency structures, which do not adequately separate functions, create potential conflicts of interest between resource management and service provision;
- Duplication of institutional effort arises from overlapping mandates and lack of an effective coordinating agency;
- Little or no transparency and poor accountability arise from ill-defined institutional structures (overlaps, gaps, conflicts of interest); few mechanisms for stakeholder involvement and public participation, which are related in part to the limited focus on building awareness on water issues;
- A blurring of the boundaries between the private sector and public sector in resource management, resource protection, service provision, and resource use needs to be addressed;

Legislative and procedural issues

- Land management and land use change controls are yet to include processes to evaluate and manage water impacts;
- A unified plan and operation for data collection and information generation and data and information sharing, which is necessary to support integrated water management, is yet to be developed;
- Cost recovery mechanisms lack defined processes for setting charge levels concerning service levels and are subject to political interference;
- Poor value of money for the quality of service provided results from inadequate maintenance funds (which is related to the cost recovery issue);

- Insufficient care in strengthening and building the capacity of irrigation and water supply user groups as they are formed and in confirming capability, authority, and capacity before management functions are handed over to them in conformity with provisions in the Irrigation and other Acts;
- Need to standardize and strengthen dispute-resolution mechanisms.

Human resource management

- A weak institutional capacity arising in part from an inability to develop specialist skills because of staff mobility;
- Inefficient water service and weak sanitation service providers at the district level resulting from delegation with inadequate capacity building and support;
- Insufficient attention to matching human resources to changing responsibilities;
- Need to strengthen enforcement capacity in line with developing regulatory processes.

Without good regulation, maximizing the economic and social benefits resulting from water use in an equal manner is impossible without compromising the sustainability of vital ecosystems. Good water resource regulation requires an enabling environment that ensures the rights and assets of all stakeholders (individuals and public and private sector organizations and companies, women and men, the poor and the better off) and protects public assets such as intrinsic environmental values.

6.2 Organizations in the Bangladesh Water Sector

Table 10: Agencies Involved in Water Resources Activities at National and Local Levels

	Activities								
Agency	Coordination institution (Policy and Work Plan)	Irrigation and Agriculture	Domestic	Fishery	Flood Alleviation	Industry	Navigation	Water Quality	Implementation: L= large, M= medium, S= small
National									
National Water Resources Council	D(P)								
Ministry of Water Resources	D(P)	D(P)			D(P), D(C), X				
Water Resources Planning Organization	D(P), X	D(P), X			D(P), X				
Bangladesh Water Development Board		D, R, O			D(P), D(C), R, O		X		L, M
Flood Forecasting and Warning Center					X				
Joint River Commission	D(P)				D(P)				
Department of Bangladesh Haor and Wetlands Development	D(P), D(C), O, X	D(P)		D(P), X	D(P), X			D(P), X	

Agency	Activities								
	Coordination institution (Policy and Work Plan)	Irrigation and Agriculture	Domestic	Fishery	Flood Alleviation	Industry	Navigation	Water Quality	Implementation: L= large, M= medium, S= small
River Research Institute	D(P), R	D(P), R	D(P), R				D(P),R		
Institute of Water Modelling			D(P), D(C), R, O, X						L, M
Center for Environmental and Geographic Information Services	D(P), D(C), R	D(P), D(C), R, X			D(P), D(C), R, X		D(P), D(C), R, X		M S
Ministry of Local Government, Rural Development and Cooperatives	D(P)	D(P), R							
Department of Public Health Engineering		D(P), X							S
Local Government Engineering Department		D(P), X							
Water Supply and Sewerage Authority		D(P), D(C), R		D(P), D(C), R	D(P), D(C), R				
City Corporation		D(P), O, X		D(P), O, X	D(P), O, X				
Ministry of Agriculture	D(P)								
Bangladesh Agricultural Development Corporation	D(P)						D(C), O		L
Bangladesh Agricultural Research Council									L
Bangladesh Agricultural Research Institute	D(P), X							O, X	L
Barind Multipurpose Development Authority							D(P)		L
Department of Agricultural Extension	D(P)	D(P)	D(P)	D(P)	D(P)	D(P)	D(P)	D(P)	
Ministry of Shipping	D(P)	D(P)	D(P)	D(P)	D(P)	D(P)	D(P)	D(P)	L, M
Bangladesh Inland Water Transport Authority	D(P)	D(P)	D(P)	D(P)	D(P)	D(P)	D(P)	D(P)	L, M

Agency	Activities								
	Coordination institution (Policy and Work Plan)	Irrigation and Agriculture	Domestic	Fishery	Flood Alleviation	Industry	Navigation	Water Quality	Implementation: L= large, M= medium, S= small
Bangladesh Inland Water Transport Corporation	D(P), R								
National River Conservation Council	X	X	X	X	X	X	X		L, M
Department of Shipping	X	X	X	X	X	X	X		L, M
Port Authorities	D(P)								
Ministry of Environment, Forest and Climate Change	D(P)	D(P)			D(P), D(C), X				
Department of Environment	D(P), X	D(P), X			D(P), X				
Bangladesh Climate Change Trust		D, R, O			D(P), D(C), R, O		X		L, M
Ministry of Planning					X				
Bangladesh Planning Commission	D(P)				D(P)				
General Economics Division	D(P), D(C), O, X	D(P)		D(P), X	D(P), X			D(P), X	
Ministry of Defense	D(P), R	D(P), R	D(P), R				D(P),R		
Bangladesh Meteorological Department			D(P), D(C), R, O, X						L, M
Survey of Bangladesh	D(P), D(C), R	D(P), D(C), R, X			D(P), D(C), R, X		D(P), D(C), R, X		M S
Bangladesh Space Research and Remote Sensing Organization	D(P)	D(P), R							

Explanatory Notes:
D - Resources development, D(P) - Development planning, D(C) - Development construction,
R - Resource management, O - Scheme operation,
X - Data collection, Implementation scale: S - small, M - medium, L – large
Dark-shaded cell indicates no involvement.

Table 11 below indicates the range of departments related to water issues and the relative strength of their role concerning their overall mandate (S=strong, M= minor) within the various aspects of water development and management.

Table 11: Agency Involvement in Water Issues

Agency	Water Sharing	Water Protection	Water Supply
Water Resources Planning Organization	S, Surface and groundwater	S, Surface and groundwater	S, Groundwater
Bangladesh Water Development Board	S, Surface water	S, Surface water	
Department of Bangladesh Haor and Wetlands Development	M, Surface water in Haor and wetlands	S, Surface water	
Department of Public Health Engineering	S, Groundwater	S, Groundwater	S, Groundwater
Local Government Engineering Department	M, Surface and Groundwater	M, Surface and Groundwater	M, Groundwater
Department of Environment		S, Surface and groundwater	

6.3 Water Related Agencies and IWRM

Section 6.1 identified four features of good IWRM institutions. Against this backdrop, the most basic IWRM principle of planning and managing hydrologic boundaries and other principles necessary for IWRM plans, the water-related institutions, are assessed in Table 12.

Table 12: Analytical Framework to Adopt IWRM by Water Sector Agencies

IWRM Principle	Agency	Does the Agency adopt this principle in its work?	What changes are needed for the adoption of this principle?
Clear accountability Single agency that is accountable for sustainable planning and allocation of water resources and for the overall management of the water cycle (quantity and quality) to achieve maximum social and economic benefits while meeting national environmental goals.	Ministry of Water Resources and its Departments	The MWR aims for coordinated planning through the WRPO and NWRC, but plans are not revised frequently, and other agencies undertake their own planning. The planning focuses primarily on structural solutions, with less effort on regulatory and non-structural solutions.	Organizations in each of the 8 hydrologic regions comprising multistakeholder groups (multistakeholder water management organizations, MSWMO) to have an advisory function supporting the MoWR's statutory functions in water resources planning and management that advocate IWRM and are technically and administratively supported by MoWR, and linked to the State apex body. Irrigation functions should be licensed and separated from water management responsibilities. Other needs: strengthened performance monitoring, an increase of skilled human resources, and advanced IT technologies enabled.

IWRM Principle	Agency	Does the Agency adopt this principle in its work?	What changes are needed for the adoption of this principle?
Clarity of roles - 1 Separation of regulator/ resource manager from operator/resource user should be strongly pursued.	MoWR and its Departments	No. The BWDB determines and implements resource management rules and undertakes and operates resource developments.	Comprehensive institutional review; drafting and implementation of water law, restructuring of responsibilities, particularly to establish a State water resource manager to support and coordinate IWRM implementation; creation of water usufruct rights which recognize (i) environmental needs, (ii) customary rights, (iii) the economic value of water – trading; and development of an annual water allocation system supported by water storage operations and groundwater use rules. Assurance of implementation of the rights should be at the field or local level.
Clarity of roles - 2 Separation of regulator/ standard-setter/auditor roles from the resource manager should be a goal, but limited by common sense and guided by efficiency.		No. The MOWR undertakes all 3 roles. The existing legislation contains some overlaps and significant gaps.	
Clarity of roles - 3 Defined resource utilization rights, which acknowledge customary use and the environment		There is a lack of defined water usufruct rights and an annual water allocation system. Water allocation is needed to protect the environment and equitably share the available resource among users.	
Efficiency and effectiveness - 1 The commercialization of the operator or service provider functions. (Being more business-like, not necessarily corporatization, etc.)	Water Supply and Sewerage Authority (and other agencies providing water services)	Unknown	Organizational business plans Customer contracts Comprehensive asset management plans Water use and wastewater discharge permits
Efficiency and effectiveness - 2 Freedom to manage efficiently through the removal of unnecessary constraints and restrictions on services managers. This requires strong delegation.	MoWR	Low	Clearly defined roles and responsibilities throughout the organization down to the individual level. Enhancing and adopting compliance requirements.
Efficiency and effectiveness - 3 Accountable, cost-effective service delivery based on buyer/seller relationships	Water Supply and Sewerage Authority (and other agencies providing water services)	Unknown	Establish an independent water regulatory tribunal to evaluate the service delivery and cost implications of regulatory controls.

IWRM Principle	Agency	Does the Agency adopt this principle in its work?	What changes are needed for the adoption of this principle?
Being knowledge-driven A strong "knowledge" base derived from a good, uniform, and comprehensive data network, data systems, and models is used to prepare and implement "knowledgeable" natural resources/water management policies and strategies.	All agencies	No. Generally, agencies assess individual developments separately. These may not be consistent, so multiple development assessments cannot be made. Effects of developments on other water users may not be estimated.	Significant quantities of data are available, but much is retained within each agency and unavailable to others; improvements to the hydro-met network are underway; water use and demand data are poor; river basin modeling needs development; impact and benefit assessment models are needed. Further, the development of the Bangladesh Delta Portal[34] could be considered.
Being knowledge-driven A focus on knowledge generation (including data acquisition and management).	Bangladesh Meteorological Department, Survey of Bangladesh, Bangladesh Space Research and Remote Sensing Organization, Water Resources Planning Organization	Adopted to some extent.	Prepare and pass a water resources data law to define the rights and responsibilities of all concerning water resources data. Strengthen a single agency to undertake data analysis needed for water resources management and planning.
Integration Planning and management of natural resources that are integrated, with development impacts and improvements assessed for all natural resources.	All agencies	While there is a water master plan, each agency undertakes its own planning and makes separate resource management decisions.	Procedures for integrated river basin planning
A strong community awareness and participation program exists, allowing planning and management to be effectively devolved.	All agencies	WARPO, DPHE, and LGED engage the community in planning to some extent. BWDB has commenced implementing participatory irrigation management (PIM).	The creation of MSWMOs would strengthen community engagement. PIM is not yet linked to wider basin management. The current PIM management delegation could be strengthened with further institutional, legal, and financial support, and linking them to wider basin planning and management is needed.

[34] https://bdp2100kp.gov.bd/

IWRM Principle	Agency	Does the Agency adopt this principle in its work?	What changes are needed for the adoption of this principle?
Regionalization Water management devolved to regional and district levels meaningfully, accompanied by necessary resources.	Bangladesh Water Development Board, Barind Multipurpose Development Authority, Department of Bangladesh Haor and Wetlands Development, Water Supply, and Sewerage Authority	Adopted to varying extents.	Delegate responsibilities to district agencies. Strengthen these agencies financially and institutionally. Encourage inter-agency working at the district level. Provide policy and planning support through the RBOs (to be formed).

7. SUMMARY OF REVIEW FINDINGS

The assignment tried to capture a holistic view of the water sector LIPRFs in Bangladesh, including the elements of climate actions, the status of water resources, and the institutional setup for water governance. The water sector has contributed significantly to the development of Bangladesh, and the country, despite being one of the most critically affected by climate change, has been able to successfully deal with WRM and meet the consistently growing need for water in different sectors. The current assignment identified a wealth of policy instruments that support MoWR and other agencies performance in the water sector. However, only the active and governing LIPRFs were documented in this report to understand the country's operating water governance. The key findings from the review work are listed in the following points.

7.1 Status of Water Resources

- Despite having a fairly abundant surface water resources system, water consumers heavily depend on the largest consumer, the agriculture sector.
- Executing agencies from MoWR and other ministries such as MoLGRD&C and MoA are engaged in water resources development. The policies, plans, and guidelines of these agencies are generally specific only to the needs and interests of that agency, even where other relevant agencies are under the one Ministry.
- Apart from the now outdated National Water Resources Plan, no program or action consistently evaluates the use and commitment of water resources and implements demand-side management or directs water-sharing actions.
- The growing water demand is threatening the sustainability of the existing subsurface aquifers. The government states that it is trying to shift the water balance toward the surface water. However, it is unclear whether the planned activities are correctly focused on the threatened groundwater areas and limit groundwater use, resulting in the transfer of water use from the groundwater reserves.
- The transboundary inflow occupies almost 75% of the total water volume, indicating the country's dependency on regional availability and cooperation with WRM.
- The main issue associated with the availability of water resources is its abundance in the wet season and shortage in the dry season. Water storage potential remains unharvested to the full scale. The government has promoted rainwater harvesting as a renewable and alternative supply source through its different policy instruments.
- The coastal zone is the most critically affected hydrologic region regarding access to safe water due to arsenic (As) contamination, climate vulnerabilities, and salinity intrusion.
- Pollution of surface and groundwater sources by industrial and domestic wastes is a growing problem and is yet to be effectively addressed, although policy instruments recognize the need. Further devolution of regulatory and technical functions will be needed to address this need, which is not only impacting the water environment but also limiting the water available for consumptive uses such as agriculture and domestic use.[35]
- Water reclamation options could be a viable source for industrial and agricultural applications and a solution for reducing stress on the excessive abstraction of groundwater. However, this study did not find reliable information on the status of water reuse in the country. No policy instrument is found that promotes adopting resource recovery and reuse for water applications.

[35] https://www.adb.org/sites/default/files/linked-documents/LD-F-ANR-Operations-Assessment.pdf

7.2 Status of Water Governance

- Water governance in Bangladesh demonstrates a complex and participatory arrangement of water institutions at the central and local government levels. This institutional complexity is a significant factor in limiting the effective implementation of IWRM. A further limiting factor is incomplete delegation and insufficient funding at the local level, which prevents the effective capacity building needed at that level to implement IWRM.
- Although MoWR is the focal ministry for water governance, the groundwater supply infrastructure and operations are managed by the DPHE under the MoLGRD&C. Therefore, agricultural water use is linked with the operations of both MoWR and MoLGRD&C.
- The water organizations follow the policy instruments designed by the MoEFCC to address climate actions in their development programs. While these do not reference the water sector policy instruments, the water sector plans generally support actions required to adapt to climate change.
- Though the policy instruments suggest a basin-scale practice of WRM, the existing institutional setups, such as water management committees, include administrative boundaries for IWRM. Efforts to define where critical water management areas span administrative boundaries and to establish effective coordination mechanisms for these committees should be a priority.
- Efforts in knowledge management are uneven and uncoordinated. The country has adequate information on the technical, hydrological, and operational aspects of water management. Yet, the practice of evidence-based decision-making and access to supporting tools for information management is not satisfactory. The required devolution of management responsibility to local levels (such as controlling water pollution) presents an additional challenge in providing technical skills and support.

7.3 Review of the existing LIPRFs

- The governing policy instruments on water resources are the National Water Policy 1999, National Water Management Plan 2001, Water Act 2013, Water Rules 2018, and the IWRM Guidelines 2020. The Water Policy 1999 and the Water Management Plan 2001 shape the country's water resources and flood control infrastructure development. Yet, these instruments have not been updated since their first publication. It should be urgent to formulate a National IWRM Strategy, integrate climate adaptation actions into the strategy, and commence the significant institutional reforms needed to simplify water governance and provide more effective and transparent participatory processes.
- In the context of transboundary river management, Bangladesh has only one bilateral treaty with India. The government has been trying to formulate another treaty for the Teesta River with India. However, no policy instrument was found to address transboundary aquifer management. Negotiations to reach an understanding and agreement with India on aquifer management should be commenced since, as shown in this review, groundwater management is a priority issue for Bangladesh.
- The LGD generally adopts sector development policies with a focus on WSS. However, opportunities should be sought for greater social, economic, and environmental benefits through integrated and coordinated policies and plans for water supply and sanitation services that consider the objectives of other water-using and water-reliant sectors, such as agriculture, environment, and disaster management.
- The water sector policies have been enhanced through national-level plans such as the BDP 2100, the 8FYP, etc.

- Many of the water sector plans address the impact of climate change, but only a few provide directions toward formulating specific adaptation and resilience measures.
- Relevant policies in the agriculture sector focus on enhancing on-farm irrigation water use efficiency and technologies. Still, there is a gap in linking this activity with managing water resources and understanding its impact.
- The subsectors of fisheries and livestock have no specific policy instruments to provide directions on the use of water resources. Currently, these sectors use instruments supplied by MoWR and MoA. Both fisheries and livestock industries can cause serious water pollution. Instream fisheries are reliant on suitable environmental conditions in the river.
- There is a lack of adequate and well-formulated legal capacities for monitoring and regulations identified in the existing policy instruments of the water sector. It is essential to address deficiencies in policy compliance and protect natural water resources.
- Recent policy instruments like the 8FYP encourage establishing a decentralized water management practice. If the necessary capacity building and financial support are provided, water governance in the country will experience a noticeable shift in the near future.
- The water sector is generally yet to take up the challenge created by climate change and funding opportunities through NAPA and LAPA. The current climate action plans seem not to be integrated with water sector plans like the Bangladesh Delta Plan 2100, notwithstanding that such plans have considered and responded to projected climate change impacts.

7.4 Summary of Major Gaps and Needs in the Policy Framework

See Appendix I: Gaps and Needs in Bangladesh Water Resources Management.

The review findings and information on the water sector stakeholders were further analyzed to identify noticeable gaps and sectoral needs in the policy framework in this assignment. Specific findings from this analysis are documented in the following points.

- The National Water Policy 1999 and the National Water Management Plan 2001 could not be updated due to various challenges, including resource limitations at WARPO. The same scenario applies to many other policy instruments. For instance, the last policy framework in the livestock sector was developed in 2007. It reveals that some government institutions cannot regularly update the policy instruments and implementation status.
- IWRM requires a participatory approach, yet only one policy instrument is available to provide proper directions and ensure an enabling environment for all stakeholders. There is a lack of understanding, clarity, and accountability regarding the roles and responsibilities of the individual institution in the existing setup.
- MoWR has no dedicated policy instrument to support protecting and enhancing water quality in the existing water resources. Water quality management is a major component of IWRM and essential for maintaining the water environment.
- Many of the requirements of the policy instruments appear ambitious compared to the current status of implementation and resource capacity of the executing institutions. For example, the SDGs targets are incorporated in many policy instruments, but the local institutions are not yet ready to deliver the intended results. There is a significant need for capacity building, particularly for the local level (rural and municipal) water institutions. There is further scope for conducting an extensive capacity needs assessment for the water sector agencies.
- Water governance in Bangladesh strictly follows a top-down approach. It leaves the lower-level and community-based water organizations with a knowledge gap on policy implementation. Coupled with this challenge, the locally adopted best management practices are frequently absent in these policy instruments.

- There is evidence of data duplication and a lack of appropriate data management and sharing protocols among the stakeholders. Therefore, acquiring the right data at the right time from the right authorities may be challenging. Many agencies use IT-enabled platforms to store and manage their data, but the systems are unfavorable for instant and easy access. Also, the quality of metadata is unsatisfactory. The implementation programs produce a wealth of daily information, but those are not properly stored and archived to support data analytics and decision-making.
- Considering sector-specific water applications and climate actions, a well-designed policy instrument on IT-enabled platforms, geospatial technologies, remote sensing, simulation, and analytics tools must be formulated.
- There is a lack of advanced and IT-enabled M&E systems to support water governance. Many implementation projects still go through traditional and manual M&E processes, leaving with low-performing governance compared to the expectation. Fortunately, the 8FYP formulated a development plan for a digital and result-based M&E system to support the implementation of the BDP 2100. This example must be demonstrated as much as possible in every sector and program.
- At present, no decision-support framework is institutionalized to support water accounting and water auditing at the governance level.
- The subsectors of fisheries and livestock are very important in the context of IWRM. Still, no well-designed policy instruments were found in these sectors to support the efficient use of water resources.
- Considerations for an integrated balance of surface water and groundwater resources are essential in the operating policy frameworks and among the participating water institutions from different ministries. A coordination gap is sensed between the policy frameworks adopted by the MoWR and the LGD at present.

8. KEY ISSUES AND RECOMMENDED ACTIONS FOR BANGLADESH WATER POLICY

1. Planning and management of water as a single resource

The current separation of water resources assessment, development, allocation, and management into surface and groundwater hinders good management. The two forms of resources are physically interconnected. Assigning regulatory management responsibility to a single agency would be a step towards greater sustainability of water resources.

2. Complexity in institutions

Reduce the number of policies, laws, and regulations relevant to water resources development and management and many agencies with mandates for various aspects of water resources development and management. Clarify rights and responsibilities within agencies for water users and the public. Water is a public good: no liberty should be related to water beyond that needed for personal, private use. All citizens have a duty to protect water resources. Build the required capacity to monitor rights and respond to failure in responsibilities.

3. Delegation of water management responsibility

Climate change adaptation requires primacy for environmental needs: stewardship of water and related resources, maintenance of biodiversity, and responses to local and often unpredictable problems. Effective engagement with the local community in planning and implementing responses is essential and is best accomplished through planning and regulatory action implemented by local offices.

4. Trust in urban water pricing and water regulations generally

Establish an independent regulatory oversight body to control the operations in monopolistic enterprises such as WASA. This body should also review and advise on applying water regulations generally. A simplified version of the approach adopted by the Independent Pricing and Regulatory Tribunal, New South Wales, Australia, might be considered.[36]

5. Water resources data and information

A law on water resources data (it might extend to natural resources) is desirable. It could be modeled on the Vietnam decree No. 73/2017/ND-CP[37], which applies to regulatory authorities, organizations, and individuals collecting, managing, and using natural resources and environmental data. The Decree deals with collecting, managing, and using data on land, water resources, geology and minerals, environment, hydro-meteorology, climate change, topographic and cartographic activities, remote sensing, resources, and environment. It specifies mechanisms for cooperation, connection, and sharing of natural resources and environmental data; responsibility and rights of authorities, organizations, and individuals in collecting, managing, developing, and using natural resources and environmental data.

Strengthen a single agency, such as the IWM, or CEGIS, to undertake computer simulation studies to support scenario, management action, and development planning studies on behalf of water resource management, planning, development, and economic use agencies in both the public and private sectors. The capability should include that needed for evaluating local climate change effects. This agency could operate on a contract basis but with funding guaranteed by Government to ensure its quality and sustainability. It should be well linked to, possibly combined with, the WARPO.

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[36] Water regulation Handbook, April 2023 https://www.ipart.nsw.gov.au/sites/default/files/cm9_documents/Handbook-Water-regulation-April-2023.PDF

[37] https://kenfoxlaw.com/wp-content/uploads/2019/01/73_2017_ND-CP_357624.pdf

The agency assigned these tasks could also usefully undertake annual water accounting, initially for agricultural and later extending to domestic and industrial water uses. The agency should develop clear procedures that, over time, would allow water accounting tasks to be devolved to large individual water users and groups of smaller water users (such as in an irrigation scheme). The water accounting report should be a public document.

6. National IWRM Strategy

WARPO should develop and publish a national IWRM strategy to guide the country toward IWRM implementation. IWRM guidelines (2020) focus on the district, Upazila, and Union administration levels, without guiding national-level agencies. Such a strategy is thought to be more important than updating the National Water Management Plan or the National Water Policy. The proposed national IWRM strategy should focus on regulatory actions and capacity and dovetail with the Bangladesh Climate Change Strategy and Action Plan 2009 and its subsequent related documents, such as The Mujib Climate Prosperity Plan[38], and with other water management strategies for water supply, agriculture, and aquaculture.

The National IWRM Strategy should be a concise living document updated as needed but at least every 5 years. The Strategy is intended to move away from Master plans and infrastructure development proposals to establish strategic water resources management arrangements that can respond flexibly to changing circumstances and needs in social, economic, and environmental conditions. The work of this review has identified that due to climate change and geopolitics, society, the economy, and the environment are rapidly and unpredictably changing and that these changes are poorly predicted at local scales. This speed of change and needs requires a strategic, not planning, approach. It is recommended not to update the National Water Resources Plan or the National Water Policy but to prepare an IWRM strategy. The concept is illustrated in Figure 12.

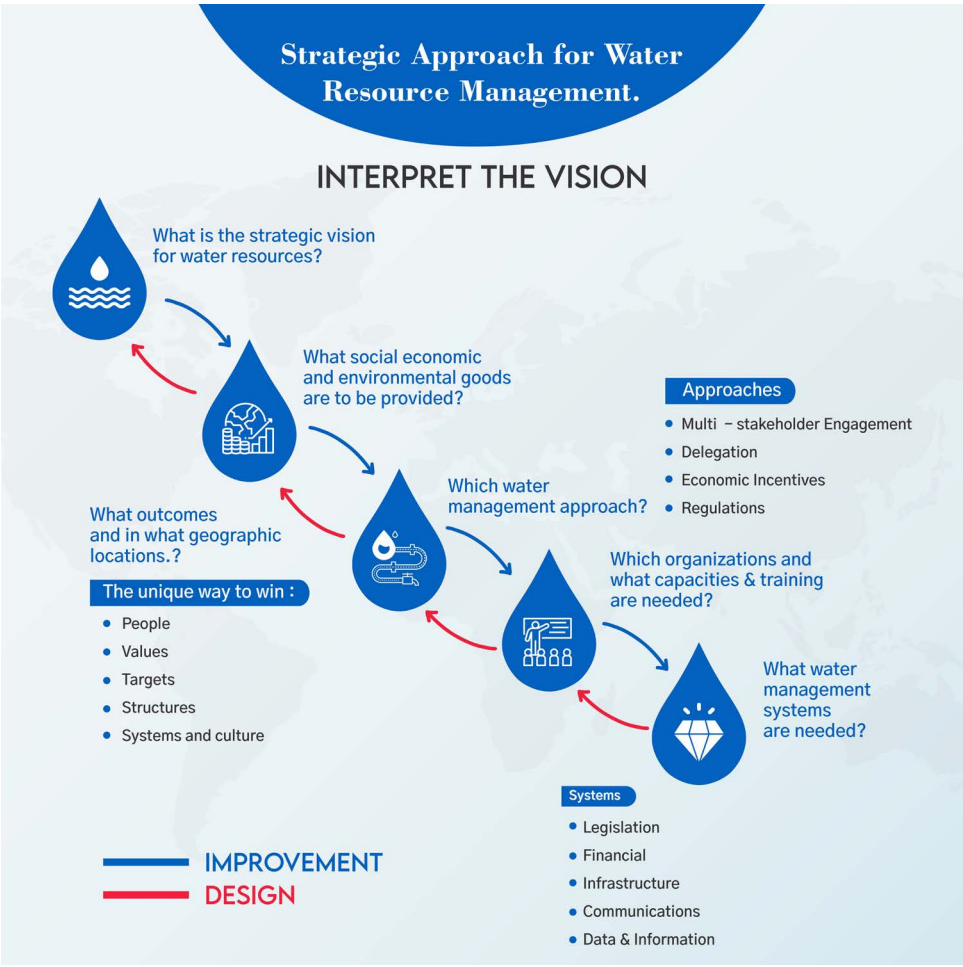

Figure 12: Strategic Approach for Water Resources Management

[38] https://mujibplan.com/

9. CONCLUSION

The assignment produced consolidated information on existing policy frameworks in the water sector and other thematic areas connected with the water governance of Bangladesh. In addition, the history and evolution of water governance in the country, the current institutional setup of the water sector and IWRM in the government, and some contemporary climate adaptation programs, were all reviewed to obtain a comprehensive understanding of the country's status on water management and sectoral development.

Bangladesh demonstrates an impressive commitment to sustainable water sector development and climate adaptation by formulating the Delta Plan 2100. The country's development plans and policy instruments are aligned, or gradually being aligned, to the overarching goals of this ambitious Delta Plan for each thematic area; agriculture, industry and infrastructure, transport, etc. This study reviewed more than forty policy instruments, including the Delta Plan 2100, from various sectors focusing on water and agriculture. A review of the relevant agriculture sector (including the subsectors of crop, fisheries, and livestock) policies was considered as this sector is the primary consumer of freshwater in the country.

Bangladesh's history of water management has evolved from a flood control approach to water governance. The MoWR and the LGRD&C are managing the country's water resources and water-related services, respectively, through several policy instruments. These instruments range from legal frameworks such as Acts and Rules to policy documents such as plans, guidelines, and strategies.

The review notes the water management approach in Bangladesh will be shaped by the interventions in the Eighth Five Year Plan and upcoming five-year plans, the Delta Plan 2100, and the proposed new edition of the National Water Policy (NWPo). Additionally, contemporary policies on the climate actions, such as the updated NAPA or INDC, will set targets for climate adaptation in the water sector.

The review recommends the Government of Bangladesh:

- Strengthen management actions to equitably and sustainably share and protect water resources
- Manage surface and groundwater resources as interconnected and inter-dependent resources
- Simplify the institutions for managing water resources and eliminates the institutional and policy gaps as much as possible
- Clarify rights and responsibilities within agencies for water users and the public with regard to water resources
- Builds the capacity and better monitors water resources, water use, and water pollution
- Establishes an independent regulatory oversight body to control the operations of monopolistic water enterprises and to review and advise on the application of water regulations generally
- Creates a law that deals with the collection, management, and use of water resources data
- Strengthen a single agency to undertake computer simulation studies to support scenario, management action, and development planning studies
- Develops and publishes a national IWRM strategy to guide the country on the path toward IWRM implementation.

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APPENDIX I: GAPS AND NEEDS IN BANGLADESH WATER RESOURCES MANAGEMENT

SUMMARY

This summarizes the gaps and needs assessment performed for water resources management in Bangladesh. The study was performed on a "rapid assessment" basis, using the resources of existing national and regional policy instruments, recent research works and studies, and outputs of the stakeholder consultation through many project meetings, informal interviews, and a national workshop.

Active international frameworks and national plans were reviewed, and the findings from four case studies implemented in the last decade were used to understand the water sector and its current context. Additionally, information was obtained from informal interviews with senior officials of the Ministry of Water Resources (MoWR), Water Resources Planning Organization (WARPO), and General Economics Division (GED) of the Planning Commission; and from a national workshop which was organized on 31 August 2021.

The assessment findings demonstrate two categories of gaps and needs, with some immediate priorities.

1. Water resources management or development needs

- Wetlands conservation and development
- Nature-based solutions
- Increasing surface water-based irrigation
- Sustainable use of groundwater
- Sediment control and management

2. Needs for policy and institutional strengthening

- Upgrading and reforming the National Water Policy or development of IWRM strategy for the country
- Establishment of an effective and IT-enabled M&E system
- Development of a climate-informed drought forecasting system
- Enhancement of the cyclone forecasting system
- Establishment of an effective collaboration mechanism among the water institutions
- Establishment of a standardized and unified data collection, management, and sharing system
- Knowledge and skill development programs on water resources management and climate adaptation and resilience measures
- Incorporation of IT-enable decision support systems in water management activities
- Gender inclusion and responsiveness in all aspects of the water management
- Ensuring community engagement and private sector participation in water management
- Establish an effective and efficient decentralized institutional arrangement for water management and water-related service delivery functions

The first category includes gaps or needs identified by the government (e.g., the Ministry of Water Resources and its various implementing partners). The identified immediate priorities address climate adaptation. The second category addresses the issues and challenges related to the country's

water sector policy framework, institutional arrangement, capacities of the human and technological resources, the status of information management, decision support systems, etc.

Apart from the above-mentioned gaps and needs for water resources management, the assessment notes that water institutions are complex and diversified and may cause inefficiencies. Continuous monitoring and collaboration among many organizations are necessary. The complexity arises in updating information, collaboration gap, and unclear mandates.

SUMMARY OF THE GAPS AND NEEDS IN WATER RESOURCE MANAGEMENT

Findings from the Existing Legislation and Policy Frameworks

Numerous policy instruments are available to support sector-specific responsibilities in the context of IWRM and overall water governance in the country. Many of these instruments have evolved over the last four decades to address the needs for water resources management, water sector development, and water security for various uses. The list of reviewed frameworks is provided in Appendix-I. Specific gaps and needs identified in the country's governing policy documents for WRM are mentioned below.

Eighth Five Year Plan 2021-2025

The country's Eighth Five Year Plan 2021-2025 (also known as 8FYP), published by the government of Bangladesh, reported the following major challenges for water resources management in the country.

- *Flood risk management* – The northwest, north-central and southwest regions experience river flooding, whereas the northeast and eastern-hilly regions are vulnerable to flash floods during the wet season. Flooding is a regular phenomenon in Bangladesh, and it causes extensive damage to life, livelihood, and development (GED, 2020).
- *Water availability in the dry season* – Though water flow is abundant in the wet season, the country faces water scarcity, particularly in drought-prone areas during the dry season. The most critically affected sectors are agriculture and food production.
- *River water management* – The main challenge associated with river water management is the severe water shortage in the instream flow during dry periods due to various reasons. Reduced stream flow during this period causes an increase in salinity intrusion, excessive stress on groundwater sources, environmental degradation, and reduction in crop yield.
- *Coastal zone protection and management* – The governing challenges are inundation by high tides, salinity intrusion, and storm surges.
- *Wetlands conservation* – The total wetlands area is approximately 7 million hectares, which is important for ecological balance. The main challenge is to protect these wetlands from human-induced development and water pollution.
- *Climate change* – The 8FYP depicts the coastal zone as most severely affected by the adverse impact of climate change. The unanticipated change in temperature and increased rainfall induced by climate change have been disturbing the balance of water resources and affecting food production and water security.
- *Population growth* – The Bangladesh Delta Plan 2100 (BDP 2100) forecasts an estimated increase in domestic water demand by 50% by 2030. An increase in population will, additionally, stress the agricultural water requirement and food production. Also, a considerable portion of water use is linked to the country's sanitation system, which is likely to increase along with the population.
- *Upstream development* – Since the country is located downstream from the GBM basin, the availability and hydrological response of water resources are affected by development activities upstream of the basins. The reduction in the flow from the Ganges River has

detrimentally affected the freshwater supply and the Sundarbans' ecology. Transboundary river management issues have always been a major challenge at a regional scale.

- ***Institutional capacities*** **–** Inadequate resource capacity at water governance is one of the major challenges for implementation and management activities in the water sector.
- Despite having a large number of water organizations in the government, limitations in policy framework, technology, finance, skilled human resources, and infrastructure are major barriers to efficient water resources management.

Bangladesh Delta Plan 2100

The Bangladesh Delta Plan 2100 (BDP 2100) provides a consolidated description of the country's issues, challenges, and required interventions for IWRM. At the national level, the problems and challenges mentioned in BDP 2100 are already picked by the Eighth Five Year Plan 2021-2025 and listed in Section 5.1.1. However, the Delta Plan additionally describes the unique characteristics of the individual hydrological regions and addresses its WRM gaps and challenges in Volume 1 (Strategy, Chapter 4). For example, the country's coastal region was identified as having challenges of salinity control, improved polder management, sediment management, land reclamation, ensuring fresh water supply, community, and local stakeholder involvement, etc.

At the macro level, the BDP 2100 classifies issues and challenges for WRM into the following three categories:

i. Specific water-related problems (flood, drought, water quality, etc.)
ii. Institutional capacity and management
iii. Knowledge management and sharing

While addressing region-specific issues, the Delta Plan mentioned the following key gaps and challenges related to water management.

- ***Insufficient Institutional Capacity and Coordination*** **–** The existing water institutions of the government lack skilled human resources, technical knowledge, and financial resources. As a result, these organizations cannot assure efficient performance in operation and maintenance (O&M). Moreover, collaboration among different agencies is limited and not structured. The Delta Plan recognizes that, despite having many water organizations, the prevailing institutional arrangement for water sector interventions is inadequate (GED, 2018).
- ***Knowledge Gaps*** **–** The Delta Plan acknowledges the following knowledge gaps in water resources management in Bangladesh.
  - » Inadequate and inaccessible information on actual development upstream, e.g., the information gap within transboundary flows and trends
  - » Uncontrolled and unregulated encroachment of the river banks and other water bodies
  - » Limited research on water management issues and an integrated approach for water management
  - » Lack of research work on the institutional arrangement mechanism for water resources management and water-based development programs in collaboration with other sectoral agencies
- ***Future Challenges*** **–** The BDP 2100 addresses the following critical challenges for water resources management in the country:
  - » Impact of climate change (e.g., water availability and seasonal distribution, salinity, flooding, etc.)
  - » Challenges for O&M of flood control, irrigation, and drainage infrastructure with current human resources and facilities

- Challenges to meeting the requirements of resource mobilization for water management-related activities on time and with adequate capacity, and establishing an effective and functioning collaboration among acting agencies.
- Challenges to meeting the requirements of freshwater quality and quantity concerning the increasing population

- *Transboundary Flow Issues* – The country has to improve regional cooperation and dialogs to secure and promote a fair sharing of transboundary flow because the governing portion of surface water (about 74 percent, according to Ahmed and Roy, 2007) is fed by the transboundary inflow.

Perspective Plan 2021-2041

With a focus on the necessity for climate actions, the Perspective Plan 2021-2041 (PP 2041) provides a macro-level direction toward ensuring sustainable management of all-natural resources, including water. The plan prioritizes the sustainability of groundwater use, prevention of water pollution, freshwater access, and flood control in urban areas. The suggested key performance indicators (KPIs) include the following targets for 2041, as shown in Table 13.

Table 13: Targets Related to the Water Sector Set in PP 2041 (GED, 2020)

KPI Name	Target for 2041
Urban households with tap water connectivity	100%
Rural households with tap water connectivity	50%
Urban centers with wastewater treatment facilities	100%
Urban water bodies compliance with water quality standards	100%
Flood-free cities with proper drainage	100%

National Water Policy 1999

The MoWR formulated the National Water Policy 1999 (NWPo 1999). It is the prevailing policy instrument for the water resources management of Bangladesh. Despite being more than twenty years old, the guideline is well-adopted by all government water institutions in practice. In NWPo 1999, the following critical challenges regarding water management in the country are explicitly addressed.

- Alternating flood and water scarcity during the wet and the dry seasons
- Expanding water needs of a growing economy and population
- An extensive amount of river sedimentation and bank erosion

The exclusive needs for water quantity and quality management are listed in NWPo 1999 as follows.

- Control and management of salinity, arsenic contamination, and other quality indicators
- Preservation and maintenance of the eco-system which depends on water
- Management of multi-sectoral water needs, promotion of efficient and socially responsible water use, definition and delegation of roles and responsibilities for water management among the public and private sectors
- Decentralization of water management activities
- Management of river basin management and transboundary water resources

To address and resolve the governing water management issues in the country, the policy instrument provided a set of macro-level directives concerning a wide range of critical perspectives. Among these, the governance and institutional level perspectives are as follows.

- Public and private involvement in water resources management
- Economic and financial management
- Research and information management
- Stakeholder participation
- Institutional policy arrangement
- Legislative framework

In the institutional arrangement, WARPO was recommended as the exclusive government organization with water resource planning mandates. Additionally, the legislative framework suggested enacting a national water code to support the implementation and regulation of all water resource management interventions.

Interestingly, the NWPo 1999 does not explicitly address climate change or required measures for climate adaptation and resilience. However, the instrument adequately addresses the requirements for protecting the ecosystem and environment.

National Water Management Plan 2001

The National Water Management Plan 2001 (NWMP 2001) builds on the National Water Policy 1999 (NWPo 1999), and it is the guiding national plan for the country's water resources planning and investment for 2001-2025. The plan was approved by the government in 2004. The plan reflects the water resources management needs in alignment with the NWPo 1999 and explicitly addresses the following challenges.

- Socio-economic challenges
  - Population growth
  - Rapid urbanization
  - Poverty alleviation
  - Economic growth and development
  - Democratization and development
  - Education and public health
  - Food security
  - Availability of agricultural lands
- Environmental challenges
  - Maintaining and improving surface water and groundwater quality
  - Fisheries management
  - Watershed management
  - Environmental conservation and protection

The NWMP 2001 acknowledged the following issues as the key technical challenges in water resource management interventions.

- Maintenance of major and minor rivers, especially for siltation control
- Erosion control

- Land accretion
- Coastal zone management

The climate change issue is addressed as one of the critical knowledge gaps in the country's successful implementation of water resources management. The other exclusive issues and gaps, according to the plan, are:

- Arsenic mitigation
- Groundwater utility
- Determination and management of natural environmental water flow
- Decentralization of the water management activities
- Promotion of private sector participation in water management
- Transboundary water management and cooperation

Coastal Zone Policy 2005

The Coastal Zone Policy 2005 (CZPo 2005) was formulated for integrated socio-economic development of the coastal zones in Bangladesh. The policy included directives for natural resources management, including water, among many thematic areas. The policy documents emphasized interventions for the following issues with water.

- Protection of the coastal zone from sea level rise and salinity intrusion in the groundwater and surface water
- Options for increasing freshwater storage to enhance minor irrigation and safe water supply
- Rainwater harvesting
- Sustainable use and management of groundwater

Haor Master Plan 2012-2032

The Haor Master Plan 2012-2032 is a regional development plan focusing on an integrated socio-economic development of the haor areas in the northeast and north-central part of the country. Haor refers to a special geographic setting that acts as an enormous shaped water reservoir during the monsoon and post-monsoon periods and remains dry in other seasons. The plan exclusively addressed the following issues and challenges for water resources-related management.

- Flash flood
- Siltation and sedimentation of the major rivers
- River bank erosion and wave actions
- Reduction of navigation capacity
- Scarcity of drinking water

FINDINGS FROM THE LITERATURE REVIEW

A wealth of publications and research works are available in the context of WRM of Bangladesh. During this assignment, some notable studies carried out in the last decade were explored to obtain prevailing issues on the country's WRM. The findings are discussed in brief in the following sections.

Bangladesh Water Sector Diagnostic Published by the World Bank (2021)

[Issues: IWRM, water stress, water quality, WASH, water governance, priorities for WRM, and institutional roles for the next decade]

The World Bank published a comprehensive diagnostic of the water sector of Bangladesh in 2021 with a focus on the governing challenges and immediate priorities for the next decade. The study identified the weakness in water governance and institutional capacity as one of the major challenges for integrated water resources management. Specific institutional gaps are addressed as follows.

- Highly centralized decision-making continues to undermine the local government.
- People's participation/citizen engagement needs reorganization, despite Public Participation Guidelines (2000) and Participatory Water Management Regulation (2014).
- Project selection processes are not rigorous or transparent.
- Independent institutions for determining water prices are missing (a prerequisite for effective PPPs).
- Low accountability and transparency: corruption is reported in government internal audit reports, but action is rarely taken.
- Data and information architecture need improved functional capacity, balance, accountability, and regulatory mechanisms.
- Monitoring and evaluation of projects are not transparent.
- Lack of technical backstopping by administrative agencies to LGIs.
- Insufficient human resources and skill gaps; lack of knowledge of LGIs regarding service delivery sustainable operation, contract management capacities to procure and supervise private operators, tariff setting, and overall capacity (WSS accounting system, audit, IT systems, etc.)

The water sector development priorities for the next decade are listed as follows.

- Integrated land and water resource management for the economy and climate resilience
- Providing higher-quality services through comprehensive and inclusive WASH systems
- Addressing institutional binding constraints
- Managing water demand and conjunctive use of surface water and groundwater in water-scarce areas
- Improving water quality management infrastructure, monitoring, and regulatory capacity
- Promoting regional water and economic cooperation

It is important to note that the government's priority may be adjusted anytime based on the ground reality and political considerations.

Study Conducted by the PwC and BCAS (2015)

[Issues: sustainable water management, resources and demand assessment, institutional capacity, business status and strategy with water]

A team of experts from the PwC and the Bangladesh Center for Advanced Studies (BCAS) supported the 2030 Water Resources Group of the World Bank in consolidating and analyzing information on water resources management in Bangladesh. The study was performed with two objectives. The first was identifying the critical issues and challenges for WRM in the country for the existing (2015) and future (2030) scenarios.

The analysis identified some critical technical and institutional challenges for WRM, as listed in the following points.

- Excess water during the wet period and scarcity in the dry period
- Deteriorating surface water quality (due to industrial contamination) and groundwater quality (arsenic and saline contamination)

- Reduction in groundwater recharge and surface water storage
- Limited availability of data with knowledge gap on WRM
- Unclear institutional responsibilities and lack of intra-sectoral and inter-sectoral coordination and collaboration
- Lack of effective enforcement measures and regulations around the protection of water resources
- Lack of organizational capacity for WRM in terms of infrastructure, skilled human resources, etc.

Bangladesh Integrated Water Resources Assessment Study Conducted by CSIRO (2014)

[Issues: IWRM, climate change and climate variability, resources assessment, regional water balance, food security and water, water and economy, livelihood and vulnerabilities, research and knowledge management]

The Commonwealth Scientific and Industrial Research Organization (CSIRO) of Australia, in association with the Water Resources Planning Organization (WARPO), Bangladesh Water Development Board (BWDB), Institute of Water Modeling (IWM), Bangladesh Institute of Development Studies (BIDS) and Center for Environmental and Geographic Information Services (CEGIS) performed a comprehensive assessment on the water resources of Bangladesh in 2014. The study included an extensive analysis of the impact of climate change on water resources and their balance under a set of projected scenarios.

The assessment identified the following critical issues and challenges related to WRM.

- Sustainable use and management of groundwater
- Flood and salinity control under the changing climate
- Managing water quality in urban areas like Dhaka

Review on Gender and Water Management Organizations in Bangladesh Performed by IWMI (2012)

[Issues: gender inclusion and responsiveness in the WRM, women in water organizations, women's well-being in Bangladesh, women and water management in the floodplains]

The International Water Management Institute (IWMI) performed an excellent study on gender issues in the water governance of Bangladesh. The assessment identified the status of women's engagement and provisions in water management services, both at the service provider and service receiver ends. The review identified considerable gaps in gender inclusion and gender responsiveness in the following areas.

- Participation in water management and delivery services
- Effectiveness of participation in the management roles
- Water access and availability for women in various use
- The power distribution within the community and gender relationships within the household related to access and control over domestic and productive water management.

FINDINGS FROM THE STAKEHOLDER CONSULTATION

The study incorporated reflections on water resources management by a list of officials from various organizations in Bangladesh. These reflections were obtained through project meetings, informal discussions on the phone, and one national workshop (organized on 31 August 2021). The summary of discussion findings is provided in the following points.

Major Gaps and Challenges at the Institutional Level

- ***Lack of effective coordination and collaboration among the implementing agencies –*** Many organizations are connected with resource development, conservation, and consumption in the water sector from different ministries. It has long been observed that there is a considerable gap in institutional collaboration among the implementing agencies in sectoral interventions. This causes inefficient utilization of water as a resource, information gaps, overlapping or duplication of data and outputs, and wastage of money.
- ***Lack of authentic data related to WRM and evidence of data duplication –*** Unfortunately, authentic data on water resources are limited due to a lack of standardization, monitoring, and regulation processes in data collection. At the same time, data duplication is often the collection of data on a single or more param, often observed with repetition in multiple projects and by different agencies. These could be avoided with an appropriate coordination and data-sharing mechanism in place.
- ***Lack of institutional capacity for WRM data acquisition, management, and sharing –*** The government's organizations in the water sector, such as WARPO, BWDB, Haor Board, and others, have limited technical capacity for data acquisition, processing, sharing, and O&M. These databases are generally developed by consultants or procured from third parties under the projects. Many data platforms are developed and used by the government's water institutions. Still, many are outdated or dysfunctional due to a lack of O&M. Again, the technically capable institutions observe certain reservations in data sharing. No standardized data-sharing framework has been successfully operationalized at the national level yet.
- ***Unclear and overlapped mandates of responsibilities among various institutions from different or the same ministry –*** Water resources development projects are undertaken and implemented by several departments, including BWDB, BADC, LGED, and BMDA. These organizations come from different ministries and have common areas of institutional mandates. To a certain extent, there is a lack of clarity in these organizations' performed roles and responsibilities due to having the grey area in the mandates.
- ***Lack of an effective monitoring and evaluation (M&E) system in place –*** Despite having a central unit of the government for project M&E (i.e., the project Implementation, Monitoring and Evaluation Division [IMED] under the Bangladesh Planning Commission), the sectoral interventions require an effective M&E system in place. The water institutions have a mechanism for M&E that is not well-structured and ineffective for addressing cross-cutting themes like climate change. Meanwhile, a transition is observed in the applied M&E systems. The government has adopted the result-based M&E (RBM&E) framework for all sectoral projects since its seventh five-year plan (2015-2020) though it is not formalized in all sectors yet.
- ***Knowledge gap on the impact of policy implementation on the ecosystem, livelihood, and environment –*** Bangladesh's water sector has a large number of plans and policy instruments, but this policy framework lacks evaluation. A quantitative and science-based assessment is required to evaluate the impact of policy implementation and identify the critical drivers for success and failure.
- ***Lack of a structured prioritization process for the water sector interventions –*** Project prioritization follows an informal approach, and the interest of the dominating stakeholders often leads it. The implementation priority should be selected by applying an objective and well-structured prioritization methodology.
- ***Management of sediment control or river dredging programs –*** The existing management capacity of the water institutions for sediment control or river dredging is inadequate compared to the demand and the government's target. Organizations need to provide appropriate knowledge, skills, resources, and training to become capable of implementing river dredging projects.

Sectoral Development Needs and Priorities

- ***Wetlands development and conservation –*** The government has provided special attention to the conservation and development of the wetlands across the country, particularly in the southern region. MoWR is actively looking for innovative and resilient solutions to increase these wetlands' water retention capacity, protect the area from unauthorized human interventions, and improve the connectivity of the rivers, canals, and other surface water bodies. Additionally, it was pointed out that the development approach should consider the sustainability of local livelihoods, biodiversity, and ecosystem.
- ***Nature-based Solutions for WRM –*** The MoWR looks forward to applying innovative and locally adopted nature-based solutions (NbS) to combat the adverse impact of climate change on all aspects of water resources management.
- ***Protection of livelihood and ecosystem in the floodplain*** - The livelihood and ecosystem are more vulnerable in the river floodplains and the char lands. The government has planned to intervene in these areas and ensure the protection of the residing population.
- ***Increasing use of surface water for irrigation –*** The agriculture sector focuses on more utilization of surface water to ensure a safe groundwater abstraction.
- ***Sustainable use of groundwater resources –*** The government intends to apply innovative technologies to ensure minimum wastage of used groundwater for irrigation and other purposes.
- ***Land reclamation with proper utilization of the sediments*** - MoWR and WARPO are actively working with other technical partners, like IWM, CEGIS, etc., for land reclamation. WARPO has drafted a comprehensive sediment management plan (SMP). However, critical challenges exist, such as a lack of adequate and authentic data.
- ***Excavation and dredging of rivers and canals*** - The government has implemented an extensive river/canal excavation project in all districts. The overall program is divided into two phases, and the government needs support for technology and financing to accelerate the implementation performance.
- ***Upgradation of the existing water sector policies, particularly the National Water Policy –*** Many water sector policies, including the National Water Policy and National Water Management Plan, need to be updated with strategies for sustainable development and climate adaptation in the water sector.
- ***Application of information technology and geographic information system (GIS) based platforms for water management –*** The government organizations in the water sector need to learn, use and apply more IT-enabled services and GIS-based technologies for water resources planning and management. The public water institutions have a limited capacity for GIS and other supporting IT-enabled platforms – which needs to be resolved by implementing capacity-building programs.
- ***Development of a climate-informed drought forecasting system for water management in drought-***prone areas – Similar to catastrophic and frequent floods, extreme drought is increasingly becoming a concern under the changing climate in Bangladesh. Water management organizations in drought-prone areas need a climate-informed drought information system for evidence-based decision-making on required interventions.

SUMMARY OF THE STUDY FINDINGS

Overview

The assignment used information from the MoWR and its implementing agencies because these institutions are primarily responsible for WRM in the country. Hence, the gaps and needs assessment

for the water utility and WASH service sectors, which the MoLGRD&C administers, are not performed in this assignment. In addition, the study focused on identifying specific WRM needs of the MoWR, WARPO, and BWDB in the context of climate adaptation and resilience.

It is observed that the water sector development priorities are addressed in contemporary national plans such as the Eighth Fiver Year Plan 2021-2025. The MoWR and its partner organizations are expected to respond in alignment with this planning document over the next five years for sector development. In addition, WARPO and BWDB have their mandates and immediate implementation priorities, which were reflected during the stakeholder consultation.

List of Identified Major Gaps and Needs from the Assignment

As discussed in Section 1.2, this assignment compiled information already available in different sources, including the country's plans and policy instruments, published recent research studies and technical papers, and obtained during a stakeholder consultation in different formats. The analogy of the findings from different sources shows many common gaps and needs. These common gaps and needs are grouped into some indicative perspectives to support the planning and design of the required interventions. This categorization was performed at the macro level and by the water sector experts of ADPC in light of the broader objectives of the CARE for South Asia project. Based on this categorization, the identified major gaps and needs from different sources are compiled in Table 14 below. The selection is based on the understanding of the reviewed documents and reflections made by the stakeholders during consultation.

Table 14: List of Identified Major Gaps and Needs for WRM

Category	Explanation	List of gaps or needs
Sectoral management or development	Indicates the gaps or needs for water resources management or sectoral development interventions	• Design and implementation of the nature-based solution (NbS); • Increase share of surface water supply for irrigation • Sediment control and management • Protection of livelihood and ecosystem in the flood plains and char lands • Effective management of transboundary water resources (both surface water and groundwater)
Policy framework	Addresses lack of adequacy, maintenance, and clarity in the relevant policy instruments	• Need for upgrading the prevailing policy on a regular interval, such as the National Water Policy, which was formulated more than twenty years ago.
Institutional Capacity (human resources)	Addresses the need for skill development and adequacy of organizational staff at different operating levels to support WRM activities	• Limited or inadequate knowledge, skills, and training on the impact of climate change on flood management interventions; • Absence of a designated climate cell in the performing department • Limited knowledge of how to adopt climate adaptation measures in WRM

Category	Explanation	List of gaps or needs
Organizational Resources	Describes organizational capacity in terms of infrastructure and information technologies to support WRM activities	• Lack of adequate tools, IT-enabled platforms, and reporting structure to support informed decision-making on water governance and adaptation measures • Limited capacity for application of GIS
Knowledge gap	Indicates knowledge gap related to the critical environmental and climate change-related issues	• Limited knowledge of climate change and future scenarios due to the extremely unpredictable and complex characteristics of climatic events • Limited knowledge of sediment management systems (SMS), Nature-based Solutions (NbS), and drought management
Information Management	Describes the status of data management, M&E, reporting, and data sharing capacity	• Lack of an IT-enabled and functional M&E system in place for the implemented interventions; • Inconvenient or inefficient data access and sharing mechanisms among the government stakeholders • Lack of standardization in data acquisition, processing, and sharing processes
Technology	Indicates the capacity to adapt and apply technologies to advance WRM performance, resources development, and water governance	• Need for implementation of a climate-informed drought forecasting system; • Need for enhancement of the existing cyclone forecasting system • A quantitative and dynamic reporting system for water accounts
Social inclusion and equity	Indicates needs based on critical social and economic aspects such as gender, minorities, and geographically and financially vulnerable groups	• Gaps in gender inclusiveness in some of the policy frameworks • Lack of gender responsiveness in many interventions
Stakeholder Engagement	Indicates the status of coordination and collaboration among the relevant stakeholders along with their functional mandates to support WRM and gaps in private sector participation	• Needs for community and private sector participation in water management; • Insufficient decentralization in water management practices; • Lack of structured coordination and collaboration among the acting stakeholders
Financing	Indicates financial capacity building needs to support the implementation of the WRM activities and adaptation measures	• Needs for adequate financing to support river excavation projects • Lack of a uniform framework for climate-informed budgeting or financing in the water sector interventions

CONCLUSIONS

This assignment was performed in conjunction with the review work on Bangladesh's water sector policy framework in the CARE for South Asia project. The gaps and needs identified are based on a rapid assessment of the country's policy instruments, recent research, and consultation with the government's sector focal points and relevant stakeholders. The primary respondents of the consultation were the staff from the MoWR and WARPO.

The study identified various needs for sectoral development and institutional strengthening. In Bangladesh, the overarching management of the water sector lies upon two ministries, namely, the MoWR and the MoLGRD&C. The assessment findings provide the status of gaps and needs of the WRM interventions, which the MoWR and its partner organizations administer. In light of the water resources planning, the needs of WARPO are exclusively highlighted in the study findings.

Many gaps and needs are common across the different sources used in this assignment. They are laid down in the Eighth Five Year Plan 2021-2025. However, the immediate priorities were addressed by the MoWR in a national workshop held in August 2021.

The consolidated findings from the assessment show that the WRM sector in Bangladesh is trying to adopt ecosystem- and nature-based solutions to cope with natural disasters, growing water demand, and climate change. At the same time, the development initiatives are now focusing more on surface water resources to sustain groundwater's safe abstraction. Apart from these, an effective decentralization of water management and region-specific water management interventions appear inevitable to ensure sustained growth across the country.

From the institutional perspective, although the country has sufficient policy instruments and organizational setup, a significant capacity is needed for proper maintenance, implementation, and collaboration. Lack of adequate capacity for information management and sharing, and knowledge gap on the disrupting issues like climate change, are other critical constraints for efficiently managing water resources.

Additionally, the rapid assessment provided the impression that the complex arrangement of water institutions may sometimes appear overwhelming, especially when it requires continuous monitoring and collaboration among its actors. This often leads to a large backlog of outdated information, a collaboration gap, unclear mandates without sound regulation, etc.

In the future, it is recommended that the list of priorities for WRM is further enhanced by engaging all influential stakeholders. This may be done exclusively using the application of an extensive and organization-wide capacity needs assessment.

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APPENDIX II: LIST OF REVIEWED LEGAL, INSTITUTIONAL, POLICY, AND REGULATORY FRAMEWORKS

Sl	Sector/ Theme	Name of Policy Framework	Abbreviated Form of the Policy Framework	Type of Policy Framework	Policy Level	Publication Year	Issued by
1	Water	District Integrated Water Resources Management Guideline 2020	District IWRM Guideline 2020	Guideline	National	2020	WARPO
2	Water	Upazila Integrated Water Resources Management Guideline 2020	Upazila IWRM Guideline 2020	Guideline	National	2020	WARPO
3	Water	Union Integrated Water Resources Management Guideline 2020	Union IWRM Guideline 2020	Guideline	National	2020	WARPO
4	Water	Bangladesh Water Rules 2018	Water Rules 2018	Rules	National	2018	MoWR
5	Water	Water Supply Master Plan for Dhaka City 2014	Water Supply Master Plan 2014	Plan	Local	2014	DWASA
6	Water	National Strategy for Water Supply and Sanitation 2014	NSWSS 2014	Strategy	National	2014	LGD
7	Water	Bangladesh Water Act 2013	Water Act 2013	Act	National	2013	LPAD
8	Water	Haor Master Plan 2012-2032	Haor Master Plan 2012-2032	Plan	Regional	2012	DBHWD
9	Water	National Strategy for Water Supply and Sanitation for Hard-to-Reach Areas of Bangladesh 2012	NSWSS HtR 2012	Strategy	National	2012	LGD
10	Water	Sector Development Plan for the Water Supply and Sanitation Sector of Bangladesh (FY 2011-2025)	SDP 2011-2025	Plan	National	2011	LGD
11	Water	Water Safety Framework in Bangladesh 2011	WSF 2011	Guideline	National	2011	LGD
12	Water	Coastal Zone Policy 2005	CZPo 2005	Policy	Regional	2005	MoWR
13	Water	National Water Management Plan 2001	NWMP 2001	Plan	National	2004	WARPO
14	Water	Guidelines for Participatory Water Management 2000	GPWM 2000	Guideline	National	2000	WARPO
15	Water	National Water Policy 1999	NWPo 1999	Policy	National	1999	MoWR

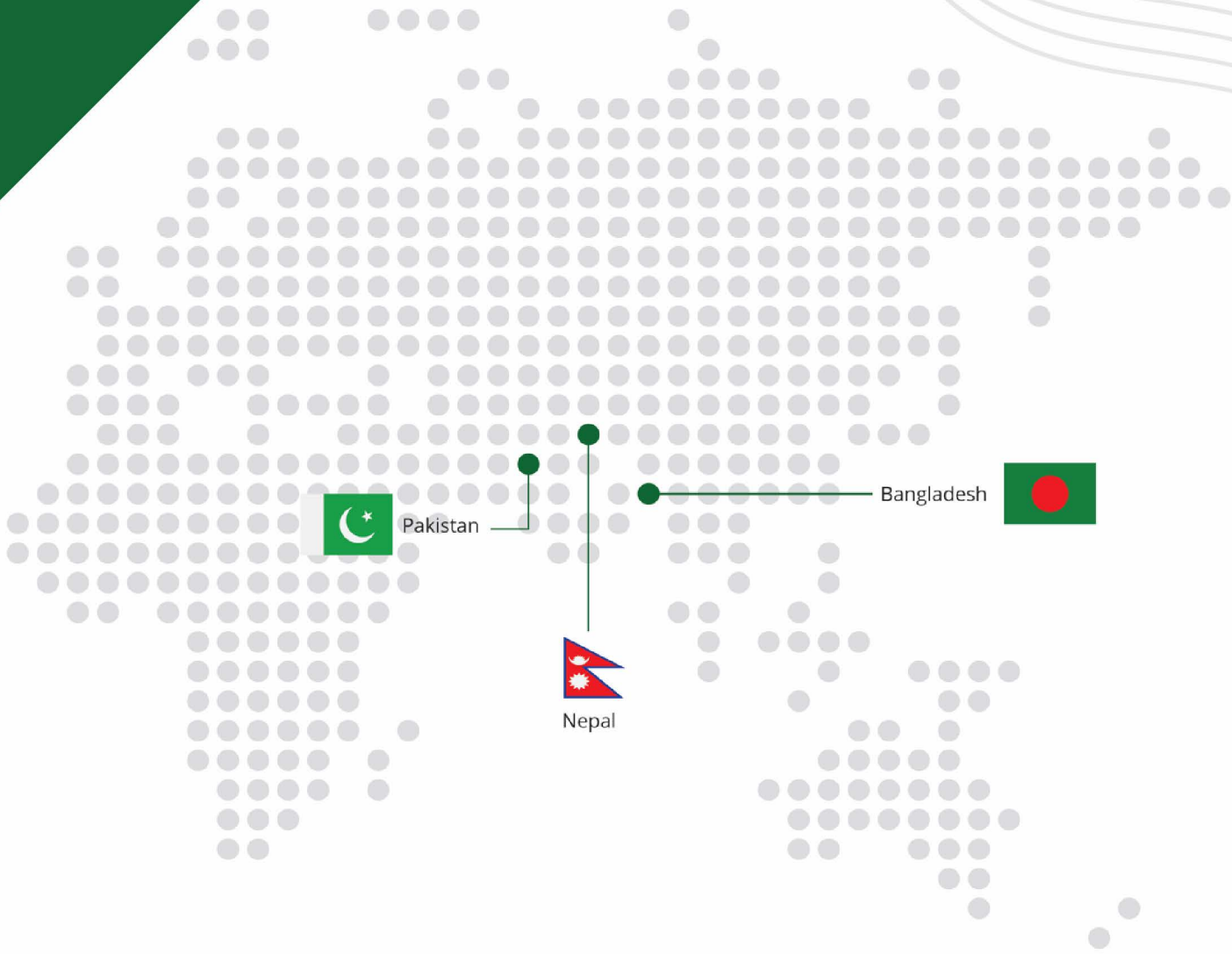
SI	Sector/ Theme	Name of Policy Framework	Abbreviated Form of the Policy Framework	Type of Policy Framework	Policy Level	Publication Year	Issued by
16	Water	National Policy for Safe Water Supply and Sanitation 1998	NPSWSS 1998	Policy	National	1998	LGD
17	Water	Ganges Water Sharing Treaty 1996	Ganges Treaty 1996	Treaty	Transboundary	1996	JRC
18	Agriculture	National Agriculture Extension Policy 2020	NAEP 2020	Policy	National	2020	MoA
19	Agriculture	National Agricultural Mechanization Policy 2020	NAMP 2020	Policy	National	2020	MoA
20	Agriculture	National Agriculture Policy 2018	NAP 2018	Policy	National	2018	MoA
21	Agriculture	Groundwater Management Act 2018 for Agriculture Use	Groundwater Management Act 2018	Act	National	2018	MoA
22	Agriculture	Bangladesh Agricultural Development Corporation Act 2018	BADC Act 2018	Act	National	2018	MoA
23	Agriculture	Bangladesh Agricultural Research Institute Act 2017	BARI Act 2017	Act	National	2017	MoA
24	Agriculture	Integrated Micro-Irrigation Policy 2017	Micro-Irrigation Policy 2017	Policy	National	2017	MoA
25	Agriculture	National Organic Agriculture Policy 2016	NOAP 2016	Policy	National	2016	MoA
26	Agriculture	Medium-Term Strategy and Business Plan 2012-2016	MTSBP 2012-2016	Strategy	National	2012	MoA
27	Agriculture	Bangladesh Agricultural Research Council Act 2012	BARC Act 2012	Act	National	2012	MoA
28	Agriculture	Master Plan for Agricultural Development in the Southern Region 2011	MPADSR 2011	Plan	Regional	2011	MoA
29	Fisheries	Policy for Establishment of Fish Hatchery in the Vabadaha Area 2019	Vabadaha Fish Hatchery Policy 2019	Policy	Regional	2019	MoFL
30	Fisheries	Fisheries Research Institute Act 2018	FRI Act 2018	Act	National	2018	LPAD
31	Fisheries	National Aquaculture Development Strategy and Action Plan 2013-2020	Aquaculture Strategy 2013-2020	Strategy	National	2014	MoFL and FAO
32	Fisheries	Bangladesh Fisheries Development Corporation Act 1973	BFDC Act 1973	Act	National	1973	LPAD
33	Fisheries	Pond Development Act 1939	PD Act 1939	Act	National	1939	LPAD

SI	Sector/ Theme	Name of Policy Framework	Abbreviated Form of the Policy Framework	Type of Policy Framework	Policy Level	Publication Year	Issued by
34	Livestock	National Livestock Development Policy 2007	LDP 2007	Policy	National	2007	MoFL
35	Climate Change	Intended Nationally Determined Contribution 2015	INDC 2015	Strategy	National	2015	MoEFCC
36	Climate Change	National Adaptation Program of Action 2009	NAPA 2009	Plan	National	2009	MoEFCC
37	Climate Change	Bangladesh Climate Change Strategy and Action Plan 2009	BCCSAP 2009	Strategy	National	2009	MoEFCC
38	Environment	National Environment Policy 2018	Environment Policy 2018	Policy	National	2018	MoEFCC
39	Environment	Environmental Conservation Rules 1997	ECR 1997	Rules	National	1997	DoE
40	Environment	Environmental Conservation Act 1995	ECA 1995	Act	National	1995	DoE
41	Energy	Power System Master Plan 2016	PSMP 2016	Plan	National	2016	MoPEMR
42	Energy	National Renewable Energy Policy 2008	Renewable Energy Policy 2008	Policy	National	2008	MoPEMR
43	Industry	National Industry Policy 2016	Industry Policy 2016	Policy	National	2016	MoI
44	Housing	Bangladesh National Building Code 2020	BNBC 2020	Act	National	2021	MoHPW
45	National Develop. Plan	Perspective Plan 2021-2041	PP 2041	Plan	National	2020	GED
46	National Develop. Plan	Eighth Five Year Plan 2021-2025	8FYP 2021-2025	Plan	National	2020	GED
47	National Develop. Plan	Bangladesh Delta Plan 2100	BDP 2100	Plan	National	2018	GED
48	National Develop. Strategy	National Sustainable Development Strategy 2010-2021	NSDS 2010-2021	Strategy	National	2013	GED

Notes: The main report did not describe all the reviewed policy instruments.

APPENDIX III: PROGRAMS OF THE BCCSAP 2009

Theme	**T1: Food Security, Social Protection and Health**
Programme	P1. Institutional capacity for research towards climate resilient cultivars and their dissemination P2. Development of climate resilient cropping systems P3. Adaptation against drought P4. Adaptation in fisheries sector P5. Adaptation in livestock sector P6. Adaptation in health sector P7. Water and sanitation programme in climate vulnerable areas P8. Livelihood protection in ecologically fragile areas P9. Livelihood protection of vulnerable socio-economic groups (including women)
Theme	**T2: Comprehensive Disaster Management**
Programme	P1. Improvement of flood forecasting and early warning P2. Improvement of cyclone and storm surge warning P3. Awareness raising and public education towards climate resilience P4. Risk management against loss on income and property
Theme	**T3: Infrastructure**
Programme	P1. Repair and maintenance of existing flood embankments P2. Repair and maintenance of cyclone shelters P3. Repair and maintenance of existing coastal polders P4. Improvement of urban drainage P5. Adaptation against Floods P6. Adaptation against tropical cyclones and storm surges P7. Planning and design of river training works P8. Planning, design and implementation of resuscitation of river and khals through dredging and de-siltation work
Theme	T4: Research and Knowledge Management
Programme	P1. Establishment of a centre for knowledge management and training on climate change P2. Climate change modelling at national and sub-national levels P3. Preparatory studies for adaptation against sea level rise P4. Monitoring of ecosystem and biodiversity changes and their impacts P5. Macroeconomic and sectoral economic impact of climate change P6. Monitoring of internal and external migration of adversely impacted population and providing support to them through capacity building for their rehabilitation in new environment P7. Monitoring of impact on various issues related to management of tourism in Bangladesh and implementation in priority action plan
Theme	**T5: Mitigation and Low Carbon Development**
Programme	P1. Improved energy efficiency in production and consumption of energy P2. Gas exploration and reservoir management P3. Development of coal mines and coal fired power stations P4. Renewable energy development P5. Lower emission from agricultural land P6. Management of urban waste P7. Afforestation and reforestation programme P8. Rapid expansion of energy saving devices e.g. Compact Florescent Lamps (CFL) P9. Energy and Water Efficiency in Built Environment P10. Improvement in energy consumption pattern in transport sector and options for mitigation
Theme	**T6: Capacity Building and Institutional Strengthening**
Programme	P1. Revision of sectoral policies for climate resilience P2. Main-streaming climate change in national, sectoral and spatial development programmes P3. Strengthening human resource capacity P4. Strengthening gender consideration in climate change management P5. Strengthening institutional capacity for climate change management P6. Main-streaming climate change in the Media



Asian Disaster Preparedness Center
SM Tower, 24th Floor, 979/66-70 Paholyothin Road,
Phayathai, Bangkok 10400 Thailand
Tel: +66 2 298 0681-92
Fax: +66 2 298 0012
Email: adpc@adpc.net

www.adpc.net
@ADPCnet
Asian Disaster Preparedness Center - ADPC
Asian Disaster Preparedness Center (ADPC)