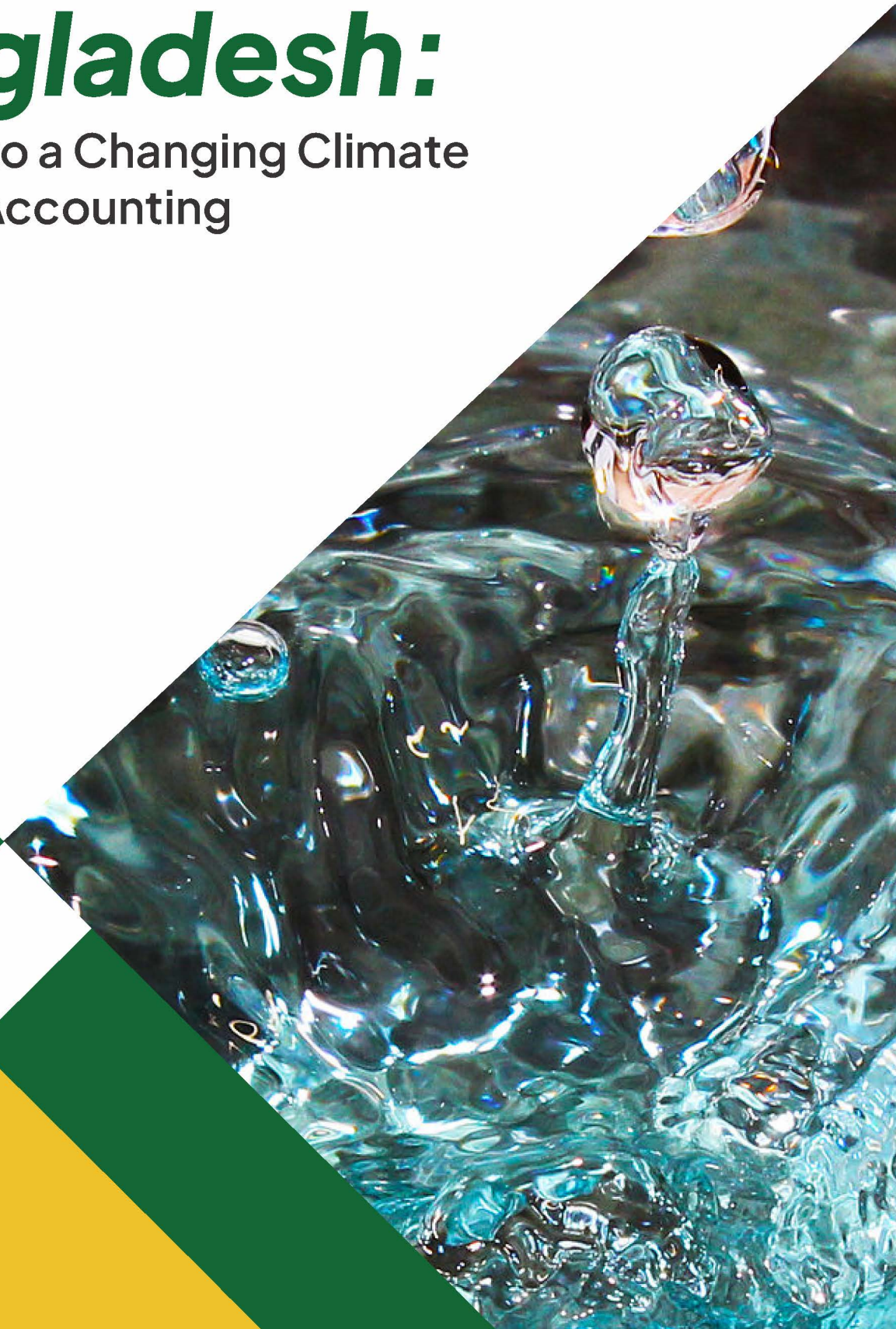
Bangladesh:

Adapting to a Changing Climate by Water Accounting



Climate Adaptation and Resilience (CARE) for South Asia Project

Bangladesh:

Adapting to a Changing Climate by Water Accounting

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

This publication is produced by Asian Disaster Preparedness Center as part of the project titled "Climate Adaptation and Resilience (CARE) for South Asia," funded by the World Bank (WB Reference: P171054). The findings, interpretations, and conclusions expressed in this work do not necessarily reflect the views of Asian Disaster Preparedness Center, its Board members, or the governments they represent. The boundaries, colors, denominations, and other information shown on any map in this work do not imply any judgment on the part of ADPC concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

Citation— Milner, H., Foisal, A., Gupta, N., & Basnayake, S. (2023). Bangladesh: Adapting to a Changing Climate by Water Accounting. Bangkok: ADPC

Layout: Lakkhana Tasaka

Document No: ADPC/CARE/WAT/BD-01

Date of Publication: August 2023

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

Climate change is an undeniable reality that continues to affect nations across the globe, and Bangladesh is no exception. Our nation, with its unique geography and dependence on water resources, is particularly vulnerable to the impacts of changing weather patterns, sea-level rise, and extreme weather events. The importance of accurate and comprehensive water accounting in mitigating these impacts cannot be overstated.

I am pleased to extend my warmest regards to Asian Disaster Preparedness Centre, Thailand along with officials from Water Resources Planning Organization who have contributed to the development and completion of the report titled "Bangladesh: Adapting to a Changing Climate by Water Accounting." This report represents a significant milestone in our ongoing efforts to address the pressing challenges posed by climate change in the realm of water resources management.

This report, which is the result of dedicated research, review, and collaboration, provides a comprehensive overview of the current state of water resources in Bangladesh and offers valuable insights into the necessary adaptations required to confront the challenges of a changing climate. The findings and recommendations contained within this document will undoubtedly serve as a valuable resource for policymakers, water resource managers, and researchers in our country to develop an effective Water accounting System for Bangladesh at hydrological region level.

As we move forward, it is imperative that we translate the insights and recommendations of this report into concrete actions and policies. The Water Resources Planning Organization (WARPO) is fully committed to implementing the strategies outlined herein and working in tandem with all relevant stakeholders to ensure the long-term resilience of our nation's water resources.

In closing, I encourage all readers to study the report thoroughly, engage in discussions, and take proactive steps to implement the suggested measures. Together, we can safeguard Bangladesh's water resources for future generations and create a more resilient and sustainable future.

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

Table Contents

List of Figures

List of Tables

EXECUTIVE SUMMARY

The 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 & planning, and finance sectors. 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, which focuses on promoting evidence-based climate-smart decision-making, and ADPC is implementing the second, which focuses on enhancing policies, standards, and capacities for climate-resilient development in South Asia. More detailed information on the project can be found at: https://www.careforsouthasia.info/

In a deltaic environment, high dependency on water demands more efficient management of water resources, especially for the agriculture sector. The erratic and adverse conditions caused by climate change compound existing challenges. The present review study is part of developing a framework for climate-inclusive water accounting (WA) to manage future water availability for the agriculture sector in Bangladesh. Although part of the Ganges-Brahmaputra-Meghna (GBM) basin, Bangladesh has abundant water resources and suffers from drought stress in the dry season. Additionally, water demand in Bangladesh is increasing with a growing population and economic development. A climate-inclusive WA framework will enhance the country's strategic focus on agricultural water management (AWM) and provide opportunities to enhance water security for various uses, including urban and industrial consumption, by identifying priority areas for regulatory action to conserve water in AWM. The dominance of agricultural water use in Bangladesh's total water consumption justifies applying a WA framework to AWM.

The review used information from the government's publications, international literature, and stakeholder consultation for this study. A number of remotely sensed data-based WA frameworks and tools developed by the International Water Management Institute (IWMI), the Food and Agricultural Organization of the United Nations (FAO), and other international organizations were explored for their potential application in Bangladesh. In addition, demonstrated examples and best practices of WA application by several nations or water-based institutions were documented in this study to understand the impact of WA on water governance across different regions of the world. The review findings proposed an initial selection of the appropriate WA method for AWM. Climate and disaster-related issues are also recommended to be incorporated into the WA framework to make it future-ready and support the Bangladesh Delta Plan 2100.

Analysis of the suitability of alternative water allocation frameworks for application in Bangladesh was based on four criteria:

i. Water accounting procedure provides information on water consumption by location/area and source and use.

ii. Water accounting procedure provides information on the economic values of production and the social and environmental use of water.

iii. Water accounting procedure provides standardization and can be used by agencies and water users, allowing delegation of reporting and comparison between reports.

iv. Water accounting procedure provides results suitable for informing both government and the public.

The status of WA practice in the country was assessed based on the following eleven critical questions (Box 1). The analysis covered the mapping of stakeholder roles for WA, a review of the existing sectoral and national policy frameworks, an initial assessment of gaps and needs, scopes of climate adaptation and resilience, and potential linkage with the sectoral priorities identified in the national Eighth Five Year Plan (8FYP). Furthermore, a SWOT analysis was conducted to understand the implementation and operationalization needs of the WA framework for AWM in Bangladesh.

Box 1: Questions on the status of water accounting in Bangladesh

1. Which government agencies are the major stakeholders in:
    a. The water or IWRM sectors?
    b. The agriculture sector?
    c. The urban water management sector?
    d. The industrial development sector?

2. What are the available legal, institutional, regulatory, and other policy frameworks for the following thematic areas or sectors in Bangladesh which are applicable for water accounting?
    a. Water or IWRM
    b. Agricultural water management, including subsectors of crop, fisheries, and livestock
    c. Climate change
    d. National-level integrated plans and policies

3. What is the status of the existing water accounting system or practice in Bangladesh?

4. What is the status of the existing water accounting system or practice for agricultural water management in Bangladesh?

5. What is the status of existing water accounting practices in the urban water management and industrial sectors?

6. Provide a summary of the recent studies conducted for or relevant to water accounting for the following applications in Bangladesh.
    a. Water resources management
    b. Agricultural water management
    c. Urban water management
    d. Industrial sector development

7. Are the existing water accounting practices climate-informed? What is the status of climate actions in the water accounting framework?

8. What are the major identified gaps or challenges for incorporation, operation, and sustainability of water accounting in water governance?

9. What are the major identified needs for the establishment of water accounting?

10. Based on the initial review of the water resources data of Bangladesh and the standard frameworks of water accounting, which framework or tool can be adopted for the preparation and presentation of water accounting for agricultural water management in Bangladesh?

11. Explore the country's 8FYP (2021-2025) and identify the relevant policies or strategies which can support the implementation of a water accounting system for agricultural water management in Bangladesh.

Various stakeholders from different line ministries provide water governance in Bangladesh. The relevant ministries and their implementing agencies for agricultural, urban, and industrial water use would form WA's core governance network. A summary of the potential stakeholders in developing a WA framework is provided in Figure 1.

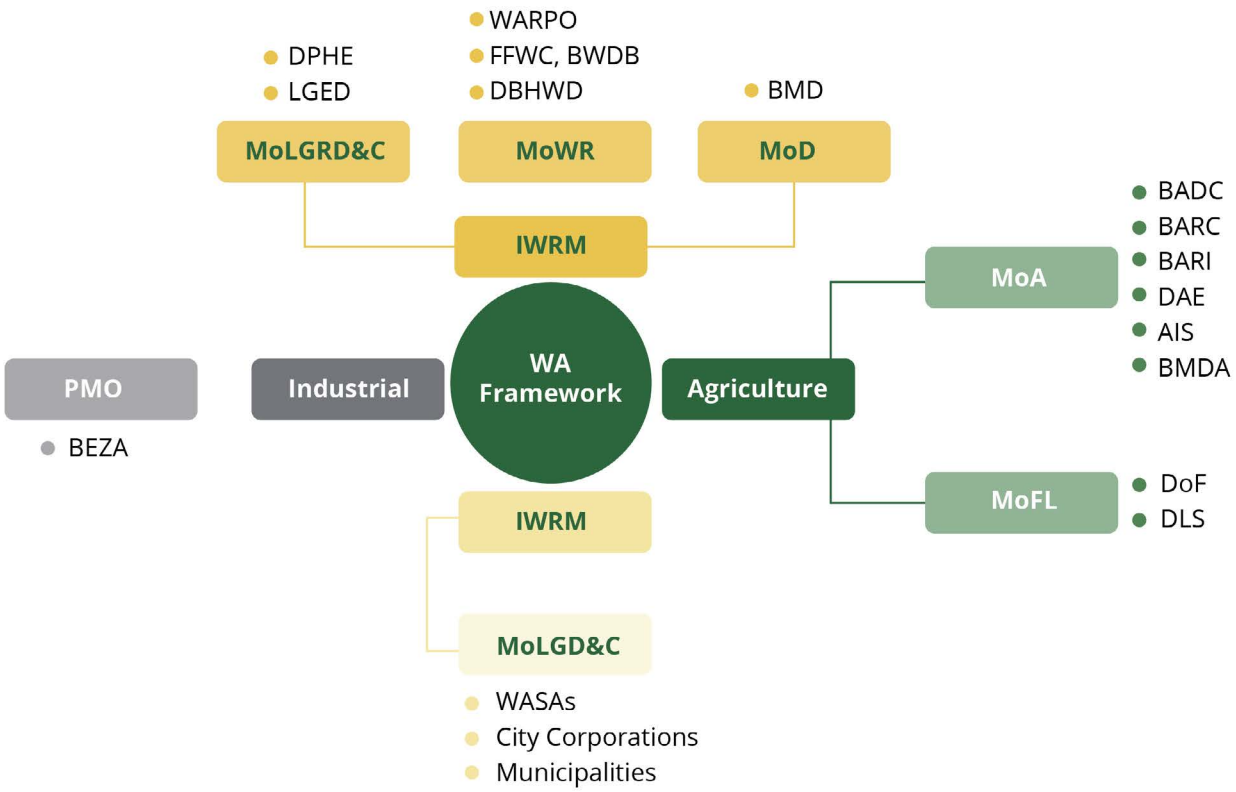


Figure 1: List of Stakeholders for the Development of the Water Accounting Framework

Note: The full name of these institutions can be found in Appendix II of the main report.

There is no water accounting in Bangladesh at present. Water budgeting (using water balance calculations in planning future water use) is performed on a project basis by applying the hydrological or engineering perspectives. Still, there is no operational reporting of water balance for water auditing and governance. Additionally, none of the country's sectoral or national-level policy frameworks have addressed the complete concept of WA in water governance. More than thirty policy documents were reviewed in this study to get supporting information on WA concepts and the government's other instruments on water governance. In addition, relevant major projects and case studies on water resources management, AWM, and urban and industrial applications were also reviewed to get a complete picture of the WA status in the country. Water balance is the best known of the water accounting terms and the one that water sector stakeholders commonly understand.

It is difficult to conclude whether project water balance studies are climate-informed. Some recent studies have considered climate change as including climate actions as climate change impact, and actions are required in every government project or program in the water sector. The impact of actions taken for climate adaptation and resilience are often embedded within and reported together with a project's overall outputs or outcomes. Thus, the specific results of climate-informed actions may appear unavailable or uncertain. While all water sector interventions must be climate-informed, no systematic and sector-specific roadmap has been developed to assist the implementing agencies in complying with this requirement.

The gap assessment identified several critical concerns. Sector-specific SWOT analyses on the water and agriculture sectors of the country supported the assessment findings. The findings of the SWOT analysis are displayed in Figure 2.

Gaps in the policy framework

No water or agriculture policy framework suggests using a structured WA system. These policies focus on the strategic objectives for water resources management and encourage the adoption of useful decision support systems. WA, although not mentioned, is a decision support tool.

Resources gap

A WA framework like the IWMI WA or SEEA-Water is not used. Water resources and agricultural water management studies still follow a conventional water balance approach.

There is a wealth of water resources information, but it is not well organized, stored, used, and shared among the stakeholders. There is no data-sharing protocol or standard. Data duplication is frequent because of the lack of central control. There is no national procedure for data collection, management, and sharing.

Knowledge gap

The principle and benefits of using a standardized WA framework are not conceptualized in water governance, although it is studied in the research and academic arenas.

Collaboration gap

The collaboration gap is one of the most critical and persistent challenges. A more detailed assessment may be required to identify the loopholes and potential consequences in the absence of an active collaboration by the stakeholders and take necessary actions accordingly.

Sustainability challenges

O&M is needed if a standardized WA framework is implemented. Requirements for this O&M include capacity building, infrastructure, seamless flow of geospatial and temporal datasets, information management and sharing, and transboundary and regional aspects.

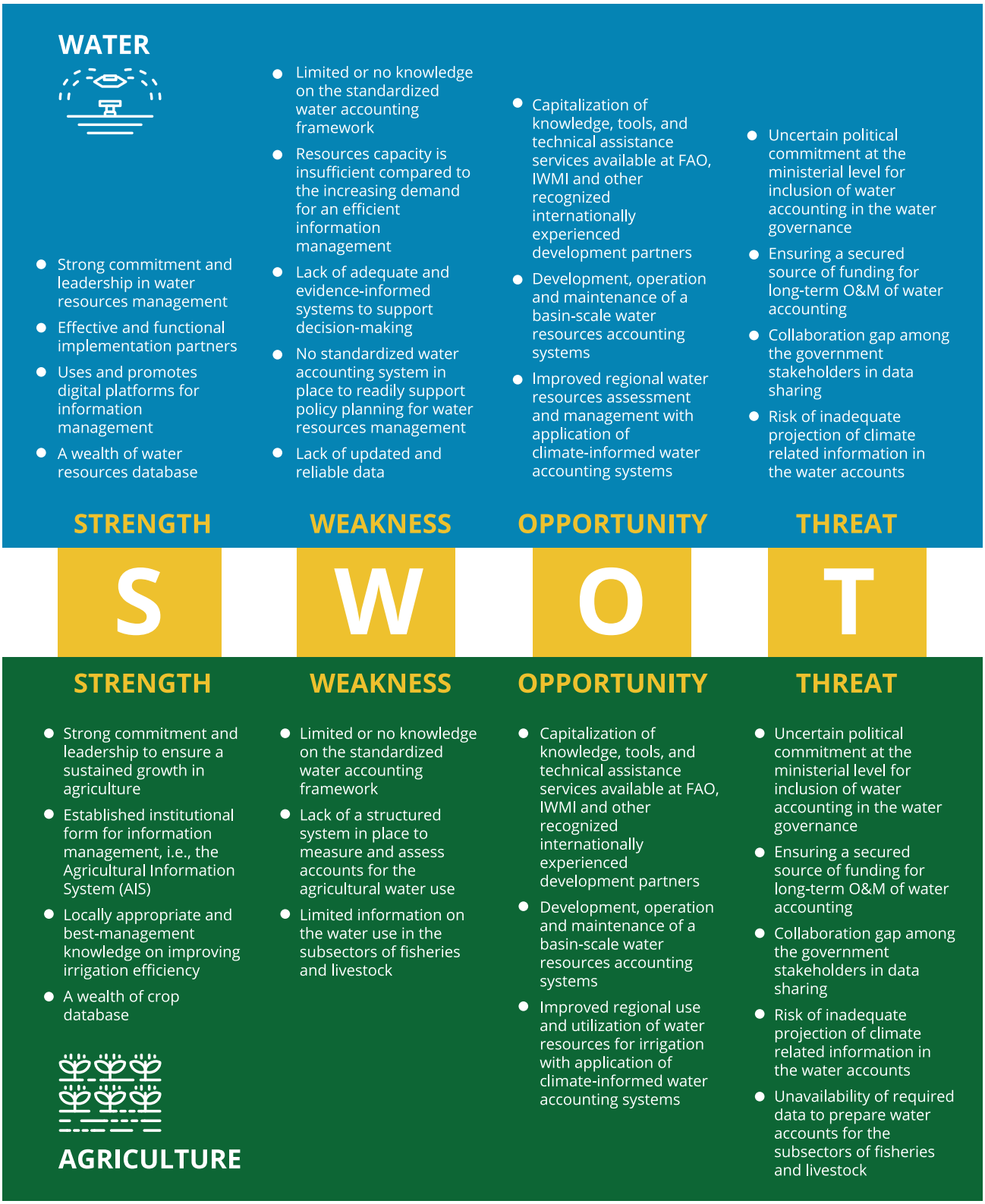


Figure 2: Findings of the SWOT Analysis

Figure 3 summarizes the needs assessment for implementing a standardized WA system for agricultural water management in Bangladesh. The water sector will lead the implementation of the national water accounts. Therefore, a needs assessment was conducted and reported focusing on the water sector only.

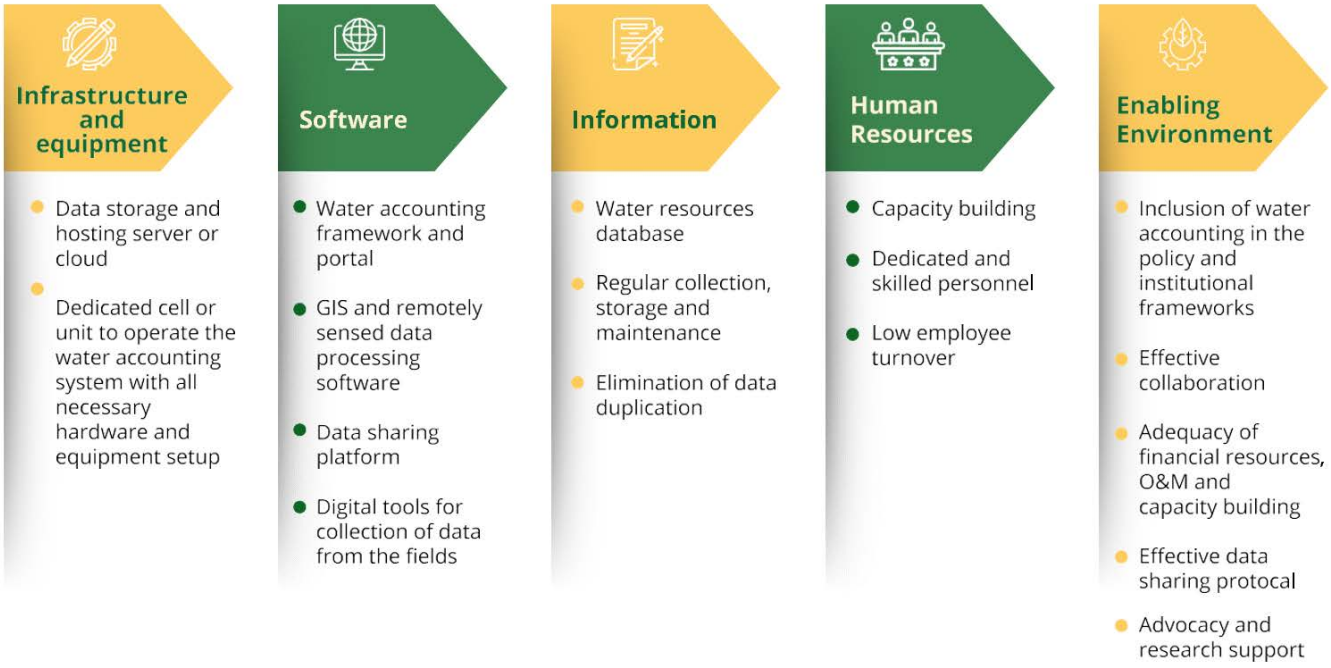


Figure 3: Summary of the Needs Assessment of the Water Sector in Bangladesh for Implementation and Operationalization of Water Accounting System

The IWMI or the WA+ framework is recommended as best suited with customization, as the available databases at basin or country scale can be fed seamlessly to the framework from open-source GIS and remote sensing data platforms on water resources.

A functional WA system is likely to substantially impact the successfully implementing of essential water sector development strategies of the 8FYP. The study identified several critical strategic objectives of the 8FYP where a climate-informed WA system can provide necessary decision support. The framework could help implement a demand-led agricultural extension by providing an IT-enabled decision-support platform on irrigation water demand and geospatial distribution. The 8FYP recommends the adoption of the demand-led agricultural extension to promote small-scale irrigation, conserve and optimize irrigation water supply, and ensure sustainable food production.

The study concludes that the systems for AWM and other purposes need to primarily consider basin-scale models, data sharing protocols, Disaster Risk Reduction (DRR) and climate actions, additional stakeholder consultations, and awareness building to create buy-in toward the development and implementation of the framework. Other important requirements are capacity building, policy and institutional framework updates, and essential resources to sustain the O&M of the implemented framework and the software.

Seven major recommendations arise from the review. These are: i) awareness of climate-informed WA, its applications, and benefits should be increased; ii) further stakeholder consultation is needed before applying the findings and recommendations of this review; iii) WA frameworks should be developed for each of the water sub-sector, each hydrological region and aggregated nationally. WA could guide regulatory action where needed in water-scarce areas; iv) water resources data institutions should be strengthened to support WA; v) inter-agency collaboration should be improved to support WA; vi) water resources data adequacy should be evaluated and improved; and vii) WA should explicitly address and incorporate climate-related considerations.

Six steps are proposed to prepare for the implementation of WA. The time for implementation of these steps is estimated as 18 months. Implementing climate-informed WA for AWM is recommended to follow over two years to capture two full agricultural cycles.

ABBREVIATIONS

8FYP	The Eighth Five Year Plan (2021-2025) of Bangladesh
ABS	Australian Bureau of Statistics
ADB	Asian Development Bank
ADP	Annual Development Plan
ADPC	Asian Disaster Preparedness Center
AgWA	Partnership for Agricultural Water for Africa
AIS	Agricultural Information System
AWAS	Australian Water Accounting Standards
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
BDP 2100	Bangladesh Delta Plan 2100
BEZA	Bangladesh Economic Zones Authority
BMD	Bangladesh Meteorological Department
BMDA	Barind Multipurpose Development Authority
BPC	Bangladesh Planning Commission
BS MSN	Bangabandhu Sheikh Mujib Shilpa Nagar
BWDB	Bangladesh Water Development Board
CARE	Climate Adaptation and Resilience for South Asia
CEGIS	Center for Environmental and Geographic Information Services
CRI	Climate Risk Index
CSIRO	Commonwealth Scientific and Industrial Research Organization, Australia
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
DPHE	Department of Public Health Engineering
DSS	Decision Support System
DWASA	Dhaka Water Supply and Sewerage Authority
ET	Evapotranspiration
FAO	Food and Agricultural Organization of the United Nations
FFWC	Flood Forecasting and Warning Center of the BWDB

GED	General Economics Division
GPWAR	General Purpose Water Accounting Report
ICID	The International Commission on Irrigation and Drainage
IDM-KUET	Institute of Disaster Management, Khulna University of Engineering and Technology
INDC	Intended Nationally Determined Contribution
IT	Information Technology
IWM	Institute of Water Modeling
IWMI	International Water Management Institute, Sri Lanka
IWMI WA	IWMI Water Accounting Framework
IWRM	Integrated Water Resources Management
JRC	Joint River Commission
LGD	Local Government Division
LGEA	London Group on Environmental Accounting
LGED	Local Government Engineering Department
LIRPF	Legal, Institutional, Regulatory, and Policy Framework
LPAD	Legal and Parliamentary Affairs Division
M&E	Monitoring and Evaluation
MoA	Ministry of Agriculture
MoD	Ministry of Defense
MoEFCC	Ministry of Environment, Forest and Climate Change
MoFL	Ministry of Fisheries and Livestock
MoLGRD&C	Ministry of Local Government, Rural Development and Cooperatives
MoWR	Ministry of Water Resources
NAPA	National Adaptation Program of Action
NWMP	National Water Management Plan
NWRD	National Water Resources Database O&M Operation and Maintenance
OBHM	Okanagan Basin Hydrological Model
OBWAM	Okanagan Basin Water Accounting Model, Canada
PMO	Prime Minister's Office
PP 2041	Perspective Plan 2041
RIMES	Regional Integrated Multi-Hazard Early Warning System for Africa and Asia
SEEA-Water	System for Environmental and Economic Accounting for Water
SWOT	Strengths, Weaknesses, Opportunities, Threats
UN	United Nations
UNEP	United Nations Environment Program
UNSD	United Nations Statistics Department
USACE	U.S. Army Corps of Engineers
WA	Water Accounting
WA+	Water Accounting Plus tool of IWMI

WaPOR	FAO's Portal to monitor Water Productivity through Open-access to Remotely-sensed derived data
WARPO	Water Resources Planning Organization
WASA	Water Supply and Sewerage Authority
WASB	Water Accounting Standards Board
WB	World Bank
WBCSD	World Business Council for Sustainable Development
WEAP	Water Evaluation and Planning System
WP	Water Productivity

1. INTRODUCTION

The 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 & planning, and finance sectors. 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, which focuses on promoting evidence-based climate-smart decision-making, and ADPC is implementing the second, which focuses on enhancing policies, standards, and capacities for climate-resilient development in South Asia. More detailed information on the project can be found at: https://www.careforsouthasia.info/

This document summarizes findings from a review study on the water accounting systems in the context of Bangladesh's Integrated Water Resources Management (IWRM). Water accounting is a scientific and systematic procedure for measuring water resources' status, trends, and utilization for any purpose. The development and economy of Bangladesh are heavily dependent on its water sector, which demands a more efficient management of the existing water resources day by day. The country's low-lying delta plain is already experiencing the erratic and adverse impact of climate change, which has compounded the existing social and economic challenges. A data-driven, climate-informed, and well-managed water governance, therefore, has become one of the government's top priorities to achieve its vision for the Delta Plan 2100, Perspective Plan 2041, Mujib Climate Prosperity Plan, and the incremental five-year plans.

In the past, Bangladesh was a water-rich country. Hence it has not developed institutional processes for regularly assessing water availability and permitting and tracking water use, which may be needed to comply with the Water Act 2013. This Act says the needs of priority users must be met, and water should be fairly distributed. Bangladesh is approaching the United Nations' "water stress" level when water generated within the country is compared to water use. Further, Bangladesh must manage the high annual variability in its supplies between wet and dry seasons and the heavy use of groundwater systems.

As water stress levels rise, water resource conflicts occur. These water resource conflicts might be between users or concern the ecological sustainability of water resource systems. Both conflicts between water users and threats to the sustainability of water resource systems are now appearing in Bangladesh.[1]

Because of these conflicts and impacts, Bangladesh needs to commence water accounting to understand more completely where and how water is used and whether this use is efficient in meeting the country's economic, social, and environmental objectives. Such information should be publicly available to explain to all interested parties how water resources are shared and used for the common good.

This report and the results of this review of climate-informed water accounting systems in Bangladesh will be presented to the Ministry of Water Resources, Bangladesh, to consider the benefits of making water accounting part of Bangladesh's institutional water management landscape.

Water accounting is already considered in the National Water Policy (NWPo), 1999, which states, in section 4.3 Water Rights and Allocation: "Rules for water allocation will be developed for in-stream needs (ecological, water quality, salinity control, fisheries, and navigation) during low-flow periods; for off-stream withdrawal (irrigation, municipal and industrial, power), and for groundwater recharge

[1] Milner, H., Foisal, A., Gupta, N., & Basnayake, S. (2023). Assessment of Water Sector Policy Frameworks of Bangladesh: Identifying Gaps and Addressing Needs. Bangkok: ADPC

and abstraction. Allocation for non-consumptive use (e.g., navigation) would imply ensuring minimum levels in water bodies used for that purpose."

The Policy further states at 4.3 a), "The Government will exercise its water allocation power in identified scarcity zones on the basis of specified priorities.", which includes at 4.7, for irrigation water use, with equity and social justice.

It is noted that the Bangladesh Country Investment Plan for Environment, Forestry and Climate Change (2016–2021) includes as a priority investment area under sub-programme 3.2.2, "Adaptation and implementation of integrated water resource management (IWRM) and implementation of the National Water Management Plan through the development of a water allocation plan and hydrological and environmental prediction models to support decision-making, and the monitoring of water quantity."

Defining "water scarcity zones" of Section 4.3 of the NWPo falls to the Water Resources Planning Organization (WARPO). The National Water Management Plan Development Strategy states that the WARPO will define water management zones, including regulatory zones. "Regulatory zones are water scarcity zones, industrial zones, fisheries and wildlife zones, water body zones, and brackish water zones. The Water Resources Act will provide for special powers in regulatory zones to enable the Government to intervene in prescribed circumstances." Studies of water availability and water use are needed to identify these water-scarce areas, and water accounting studies are the key to understanding water use within geographic areas. Once the water-scarce areas are defined, a water accounting study identifies whether water is allocated "with equity and social justice."

1.1 Study Objectives

The study was performed to understand the existing policy and institutional frameworks of water accounting systems and identify the current practices, challenges, and available standard principles and practices for water accounting in Bangladesh, particularly for the agriculture sector.

It had the following specific objectives.

- Review and assess the water accounting systems in place in Bangladesh in terms of legal, institutional, and policy frameworks, organizational practices, water governance, project applications, etc.
- Identify the common practices and techniques for measuring or accounting for water resources.
- Review and assess the status of water accounting processes for the agriculture sector, including crop, fisheries, and livestock subsectors.
- Review and assess the inclusion and extent of climate-informed water accounting processes in different applications.
- Perform a rapid assessment of the status of water accounting in the urban and industrial sectors employed by the relevant implementing agencies of the government and in different development projects.
- To recommend why a structured and climate-informed water accounting system for agricultural water use in Bangladesh is required, why system characteristics must be met, and why actions need to be prepared for its adoption.

The review work additionally included a study of standard principles, guidelines, tools, and application examples for water accounting relevant to Bangladesh. The Food and Agricultural Organization of the United Nations (FAO) and the International Water Management Institute (IWMI) guidelines were extensively reviewed.

Furthermore, the document will provide a technical reference or knowledge base for incorporating a

comprehensive water accounting system in the water governance process and designing a climate-informed water accounting system for the agriculture sector in Bangladesh. Such a system would also provide decision support and benefits to other functional sectors in the country.

Water accounting is needed in Bangladesh because there is competition for water at certain times and places, and this competition is forecast to increase under the influence of climate change.

Water accounting will allow:

1. The government:
    a. to understand
        i. more completely where and how water is used
        ii. whether this use is efficient in meeting the economic, social, and environmental objectives of the country
    b. to compare between water use areas and/or water users and provide information to encourage more efficient and effective water use
2. the public to be informed on where and how water is used, how this contributes to their welfare, and;
3. water users to be informed on the availability of "their water" and to compare this with the history of their water supply.

The mandate to undertake water accounting rests with the Ministry of Water Resources (MoWR), to which this report and its recommendations are addressed. However, implementing water accounting will involve and require the active cooperation of other ministries, including the Ministry of Agriculture (MoA) and the Ministry of Local Government, Rural Development and Cooperatives (MoLGRD&C). It is anticipated that MoWR will delegate responsibility for undertaking water accounting to its agencies. Therefore, it is recommended that MoA, MoLGRD&C, and relevant agencies of MoWR also read this report.

Discussions with the agency stakeholders led to the decision to focus the study and objectives on water use by the agricultural sector. The reasoning can be summarized as follows:

- Water use by the agricultural sector in Bangladesh is estimated to be 88% of the total water withdrawal[2]
- The agricultural sector's Water use and productivity can be estimated using remote sensing methods, which is not the case for water supply and industrial water use.
- Obtaining detailed water use data for water supply and industry is anticipated to be difficult.
- Experience in the application of water accounting to the agricultural sector will be useful in understanding its value to water management in Bangladesh.

The review and assessment conducted in this assignment focused on agricultural water use with sub-sectors of crop, fisheries, and livestock. The agriculture sector accounts for the highest consumption of the country's annual freshwater withdrawal. Therefore, a well-recognized and scientific technique such as water accounting is essential for efficiently managing water resources and ensuring food security against the growing demand and climate vulnerabilities.

[2] FAO AQUASTAT, Bangladesh http://fao.org/aquastat/statistics/query/index.html?lang=en

1.2 Definitions

Key terms relevant to this review are defined in Table 1 below.

Table 1: Definition of Terms

Term	Definition	Comment
Water accounting	Water accounting is a systematic process of identifying, recognizing, quantifying, reporting, and assuring: • information about water • the rights and other claims to that water, and • the obligations against that water.	Water accounting supports adequate measurement, monitoring, and reporting systems. Effective water accounting should: • Improve understanding of how water resources are sourced, managed, shared, and used • improve public confidence in the amount of water consumed or recovered, and manage environmental and other public benefit outcomes • inform users' decisions about the allocation of resources.
Water allocation (process)	Water allocation is the process of distributing water supplies to meet the various requirements of a community.	The process may be informal or formalized in regularly undertaken and reported procedures.
Water allocation (an entitlement)	The specific volume of water allocated to water access entitlements in a given season or accounting period, and if formalized, is defined according to rules established in a water plan.	Water plans may be prepared for a natural (e.g., river basin or groundwater aquifer) or constructed water resource system, such as an irrigation scheme.
Water balance	The flow of water in and out, and changes in, storage of a surface water system, groundwater system, catchment, or specified area over a defined period of time.	It may be expressed mathematically as $P = Q + ET + \Delta S$ Where: P is precipitation Q is streamflow ET is evapotranspiration ΔS is the change in storage (in soil or the bedrock/groundwater, or a constructed storage)
Water budgeting	The use of water balance calculations in planning future water use.	
Water (resource) asset	A water asset is a water, or a water claim, that provides a future benefit.	For example, the stored water behind the dam is a water asset. A water asset is the minimum volume of water that must be supplied from another country.
Water access entitlement	The legal entitlement to exclusive access to a volumetric share of water from a specified consumptive pool as defined in the relevant water plan.	The Bangladesh Water Rules 2018 provides for water access entitlements to be granted, but this provision does not effectively protect and share the available water resources.

1.3 Methodology

The assessment was performed by applying a desk review of the information obtained from the secondary sources and informal consultations with the sector focal points (SFPs) of the CARE for South Asia project. The findings will provide essential input to developing the water accounting framework for agricultural water management. The workflow of the review study performed can be illustrated as depicted in Figure 4.

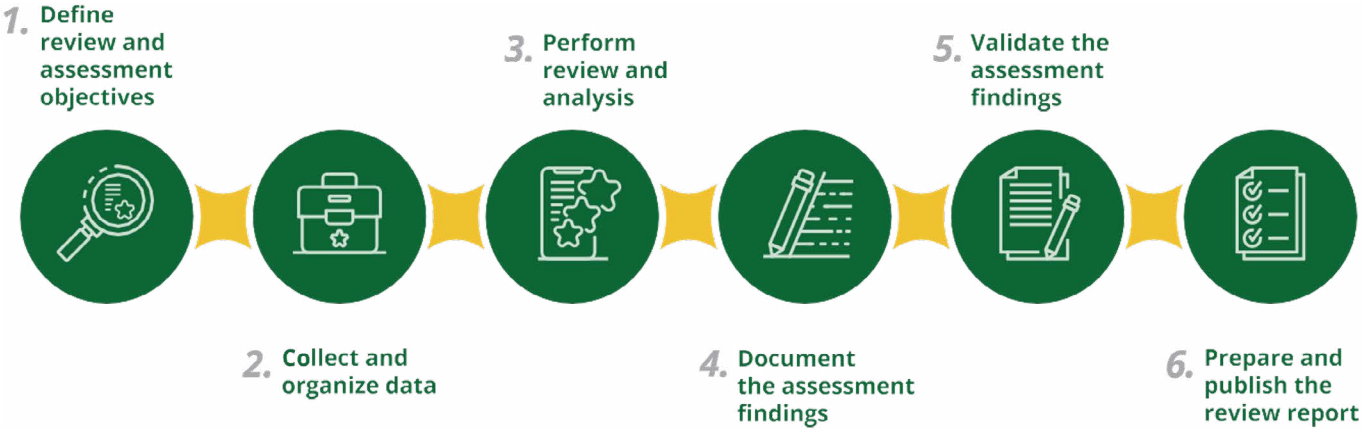


Figure 4: Workflow Diagram for the Study Review

Considering the objectives for commencing water allocation in Bangladesh (Section 1.3), the following criteria are used to consider the current status among water agencies and the appropriateness of water allocation procedures that have been trialed in Bangladesh or used elsewhere.

Institutional

1. Policy framework applicability for water accounting
2. Government agency capability for water accounting
3. Data system capability (surface measurement) for water accounting
4. Data system capability (remote measurement) for water accounting
5. Data sharing arrangement suitability for water accounting

Procedural

1. Water accounting procedure provides information on water consumption by location/area and source and use.
2. Water accounting procedure provides information on the economic values of production and the social and environmental use of water.
3. Water accounting procedure are standardized and can be used by agencies and water users, thereby allowing delegation of reporting and comparison between reports.
4. Water accounting procedure provides results suitable for informing both government and the public.

1.4 Sources of Information

A list of reviewed documents in this study is provided in Annexure-I.

The documents can be categorized at the macro level into the following types.

- Available legal, institutional, regulatory, and policy frameworks in Bangladesh's water, agriculture, and climate adaptation sectors. These policy frameworks also include different national and local level development plans and strategies
- Published project documents and annual reports of relevant government agencies
- Published news articles, research papers, case studies, etc., on water accounting and relevant concepts
- Literature on principles, guidelines, and best practices in water accounting

2. LITERATURE REVIEW

2.1 Concept and Principles of Water Accounting

Water accounting is not new and has been practiced for over two decades (FAO, 2017, 2017a). However, FAO formally introduced the concept in 2012 as an advanced decision-making tool to support and improve water governance. By definition, water accounting is "the systematic study of quantitative assessment of the status and trends in water supply, demand, distribution, accessibility and use in specified domains, producing information that informs water science, management, and governance to support sustainable development outcomes for society and the environment" (FAO, 2016).

Water is the most precious resource for life on earth. At the same time, it is at the center of any development. Over decades, it has become one of the scarcest resources due to uncontrolled and inefficient management of water resources. The availability and accessibility of water are uncertain and are influenced by biophysical and societal factors (FAO, 2012). For this reason, water accounting matters to all stakeholders ranging from the water governance system to the end users. It has always been the highest concern, whether structured or not, to the Integrated Water Resources Management (IWRM) sector.

In its simplest form, water accounting closely follows the structure of financial accounting and provides the status of "balance" and "flow" of water as an asset. Some standard frameworks are available that help develop and maintain the intended accounting system for water. A water accounting model's principal elements include supply, demand, accessibility, use, and trend for a selected location and time. Usually, the space dimension is chosen based on the hydrologic basin boundaries. The system for water accounting connects and integrates three perspectives, namely, hydrology, irrigation or civil engineering, and monitoring and evaluation (M&E) in its application (Perry et al., 2009).

Water accounting supports effective and evidence-informed water governance. FAO (2018) explains that "Water accounting can help identify common and cross-sector water problems. Organizations that work in 'silos' often influence and shape their problems with little regard to how it affects others. Working together enables everyone to address problems collectively, achieve consensus, and establish resource needs and data requirements for more evidence-based solutions."

2.2 Methods and Frameworks for Water Accounting

Since its formal inception, water accounting has gained special attention across different sectors which affect or are affected by water resources. Many standard or sector-specific water accounting frameworks have been developed to support the formulation and management of water accounting in water governance. However, it should be noted that different hydrological, engineering and other scientific methods have been applied to measuring the quantity and quality of water as a resource from the beginning of water management practices. The standard water accounting frameworks facilitate nothing but an alternative and advanced method for water balance computation for a defined purpose.

This review study explored some of the commonly used and widely recognized frameworks of water accounting. A brief overview of these frameworks and other traditional water balance calculation methods is provided in the following sections.

2.2.1 IWMI WA Framework

The International Water Management Institute (IWMI) developed a comprehensive framework for water accounting (WA) at the basin scale in 1997, widely known as the IWMI WA framework. According to Godfrey and Chalmers (2012), "IWMI WA provides information on supply and use of water and relates water use to the economy. It is a multiscale method to account for the water

available and used by various sectors. The value derived from the use to promote understanding of water use and assist with improved water management". The framework focuses on the consumptive use of water as a resource. It applies a quantitative "balanced" approach to measure and allocate water accounts in different parts of an environmental system. The IWMI WA framework can be illustrated at the macro level in the following diagram, as shown in Figure 5.

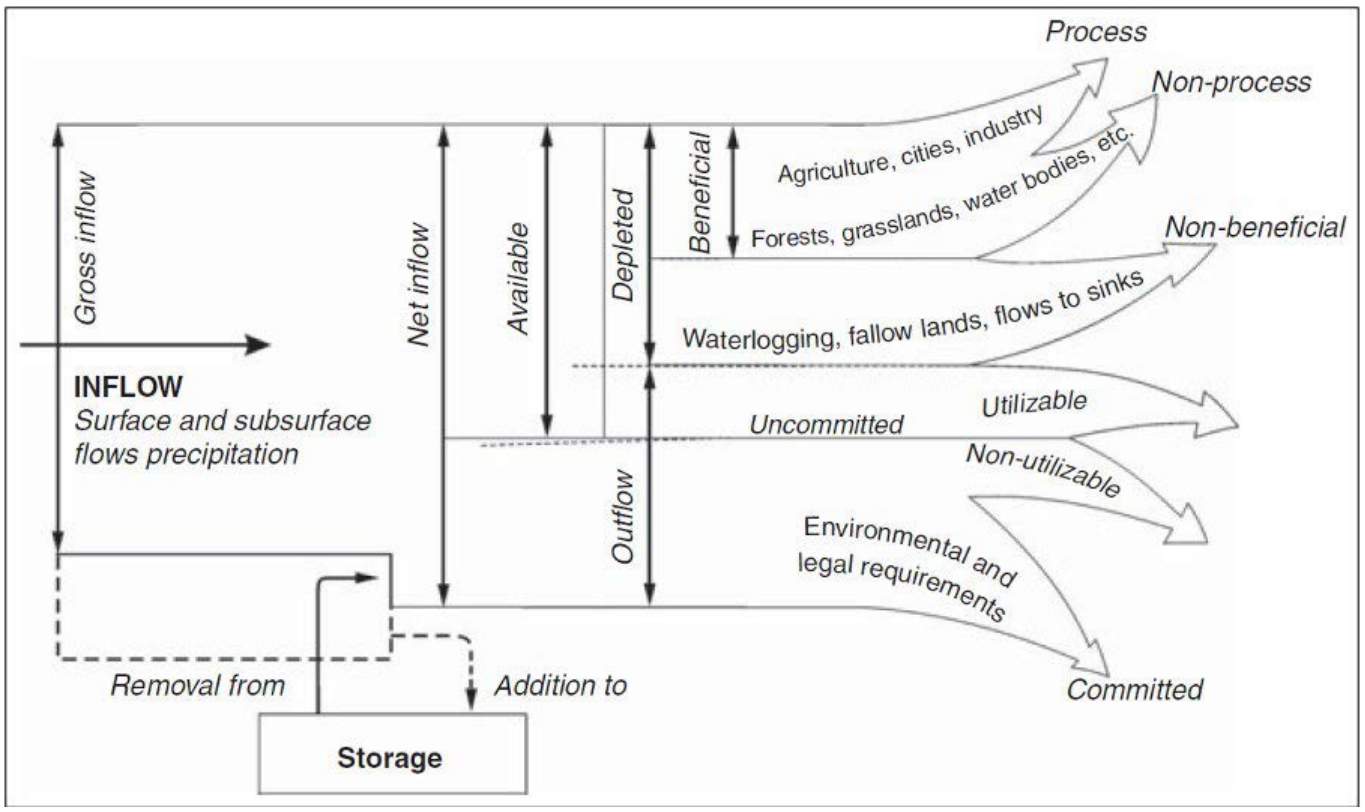


Figure 5: IWMI WA Generalized Diagram (Source: Molden et al., 2003)

The IWMI water accounting framework can be applied at the field, irrigation service, or basin level, with the components of the water balance calculation adjusted to suit. Groundwater and groundwater use is also provided for by adjusting component calculations. For example, if groundwater is used, estimates of contributing recharge are included in "Beneficial, Process, and Non-process."

The IWMI water accounting framework provides information on estimating water productivity. Molden advises, "It is meaningful to compare values of the mass of production per unit of water diverted or depleted when comparing like crops. But the output mass is not as meaningful when different crops are compared." (Molden, 1997). The author further recommends converting crop mass values into crop value and, comparing across different agricultural settings, using Standardized Gross Value of Production.

The IWMI WA framework meets procedural criteria 1, 3, and 4 and partly meets criteria 2 since it does not attempt to provide information on social and environmental values.

2.2.2 SEEA-Water Framework

The System for Environmental-Economic Accounting for Water (SEEA-Water) was developed by the United Nations Statistics Division (UNSD) in collaboration with the London Group on Environmental Accounting (LGEA) in 2012. The SEEA-Water provides a standardized system for preparing and managing water accounts. It provides a conceptual framework for organizing economic and hydrological information, enabling a consistent analysis of the contribution of water to the economy and of the impact of the economy on water resources (UNSD, 2012a). The SEEA-Water follows the structure of a financial accounting model for data recording, presentation, and analysis. The

framework also has additional potential for preparing time series accounts of water. The conceptual diagram of the SEEA-Water is presented in Figure 6.

SEEA Water Framework meets all 4 procedural criteria but needs to be redesigned and reformulated to provide information to the public.

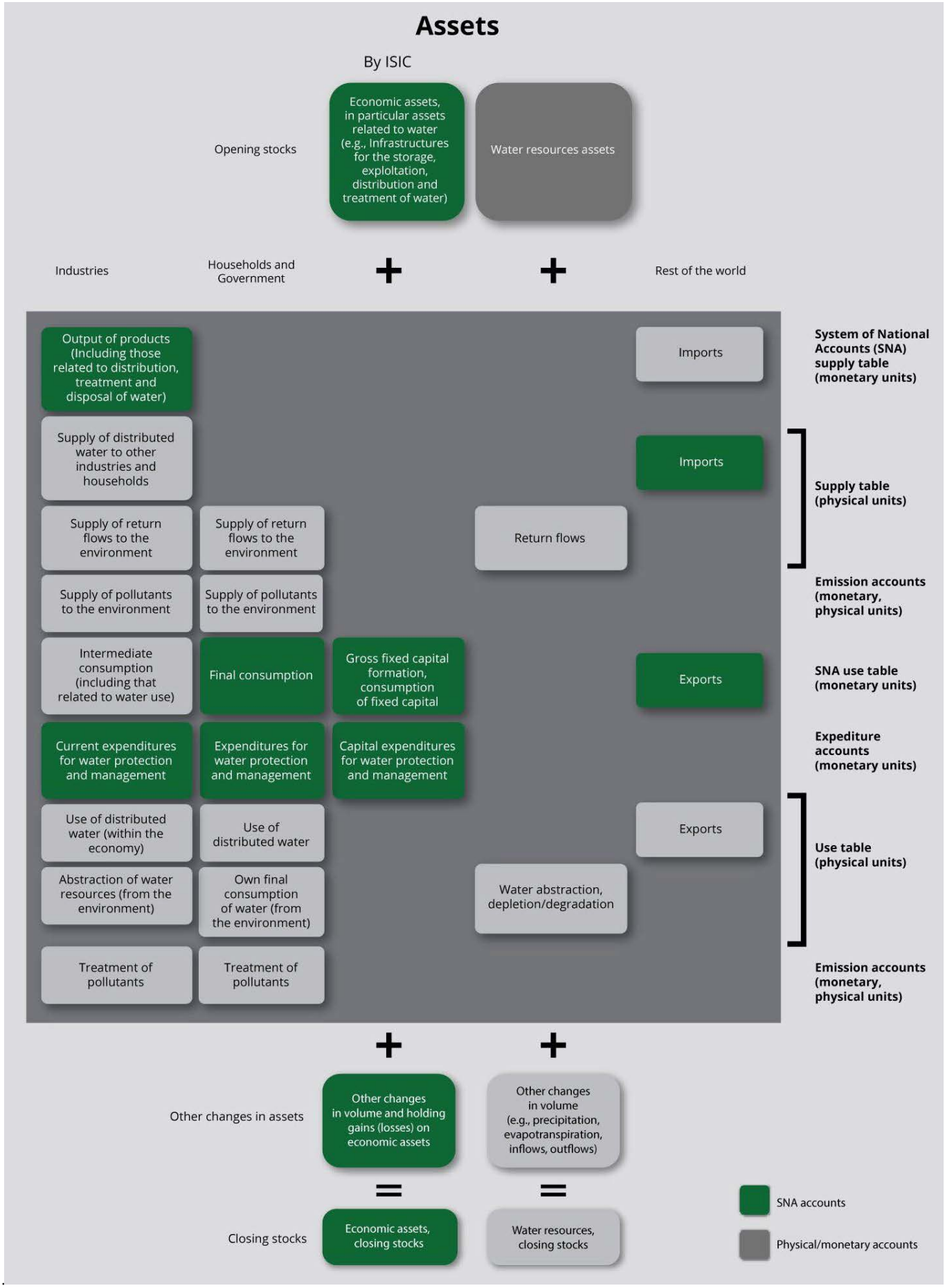


Figure 6: SEEA-Water Framework (Source: UNSD, 2012)

2.2.3 AQUASTAT

AQUASTAT is a global information system on water resources and agricultural water management developed by FAO. The system collects, analyzes, and provides free access to information and water status at the country level. AQUASTAT offers a comprehensive knowledge platform on standardized data and information, tools, and capacity building for measuring and monitoring water accounts. To support country-level water management and decision-making, the platform generates long-term average statistics on water resources.

AQUASTAT only provides information at the country and international river basin levels. Therefore, it only partly meets procedural criteria 1. AQUASTAT relies on government-level information and occasional estimates by FAO consultants. Therefore, it does not fully meet criteria 3.

2.2.4 Australian Water Accounting Standard

The Australian Water Accounting Standard (AWAS) was developed by the Water Accounting Standards Board (WASB) of Australia in 2010. AWAS formulates the basis for preparing and presenting a general-purpose water accounting report (GPWAR) and describes the requirements for recognition, quantification, presentation, and disclosure of those items in the report (Karimi, 2014). GPWAR provides essential information on water resources and uses for different purposes by following a structured accounting template that the WASB prescribes. It complements SEEA-Water accounting and supports preparing reports for a wider audience than statisticians and economists.

The Australian Water Accounting Standard meets all 4 procedural criteria. It has been designed to involve and inform water users and the public.

2.2.5 ICID Framework for Water Accounting

The International Commission on Irrigation and Drainage (ICID) uses a water accounting framework (Perry, 2007; Haie, 2008) similar to the IWMI WA framework. The framework keeps accounts of the consumed water in two primary categories: beneficial consumption and non-beneficial consumption. Basin-wide water balance estimates can be comprehensively developed by applying this framework to support agricultural water management.

The ICID Framework for Water Accounting meets procedural criteria 1, 3, and 4 and partly meets criteria 2 since it does not attempt to provide information on social and environmental values.

2.2.6 Water Footprint Accounting

Water footprint was introduced in 2002 to quantify the amount of freshwater used or consumed throughout the production supply chain for a commodity or business. By definition, the water footprint of a product is the volume of freshwater used to produce that product, measured over the complete supply chain (Godfrey and Chalmers, 2012). It is a multidimensional indicator with the potential for the quantitative reporting of both volume and quality and geospatial and temporal extents. The water footprint accounting system has gained substantial attention in the industrial and business processes, particularly in the supply chain of the consumer industry. The concept has helped measure the quantity of water used and reduce wastage and pollution by introducing better solutions. There could be a wide variety of forms for water footprints, such as:

- The water footprint of a product is the volume of water used to produce a unit quantity of a product in its full supply chain.
- The water footprint of a consumer measures the total volume of water used by a consumer, including their direct consumption and the water footprints of the goods and services they consume.
- National water footprint accounting measures the total freshwater withdrawal volume at the national or country level.

- The water footprint of a business is the volume of total water used to run and support that business.

Water Footprint Accounting does not fully meet criterion 1 as it does not consider the water source. It does not meet criterion 2 since it does not directly report on social and environmental values. It has value in public reporting on the efficiency of water use. Table 2 lists the global average water footprint for some selected commodities.

Table 2: Global Average Water Footprint for Some Selected Commodities (Source: Godfrey and Chalmers, 2012)

Commodity	Unit	Water Footprint (Liters)
Apple or pear	1 kg	700
Banana	1 kg	860
Beef	1 kg	15,500
Beer (from barley)	1 glass of 250 ml	75
Biodiesel from soybean	1 liter	14,000
Bio-ethanol from maize	1 liter	2,600
Bio-ethanol from sugar beet	1 liter	1,400
Bio-ethanol from sugar cane	1 liter	2,500
Bread (from wheat)	1 kg	1,300
Cabbage	1 kg	200
Cheese	1 kg	5,000
Chicken	1 kg	3,900
Chocolate	1 kg	24,000
Coffee	1 cup of 125 ml	140
Cotton	1 shirt of 250 gm	2,700
Cucumber or pumpkin	1 kg	240
Dates	1 kg	3,000
Eggs	1 60-gm egg	200
Goat meat	1 kg	4,000
Groundnuts (in shell)	1 kg	3,100
Leather (bovine)	1 kg	17,000
Lettuce	1 kg	130
Maize	1 kg	900
Mango	1 kg	1,600
Milk	1 glass of 250 ml	250
Milk powder	1 kg	4,600
Olives	1 kg	4,400
Orange	1 kg	460
Paper	1 A4 (80 gm/m2)	10
Pasta (dry)	1 kg	1,900
Peach or nectarine	1 kg	1,200
Pizza Margherita	0.725 kg	1,200
Pork	1 kg	4,800
Potato	1 kg	250
Rice	1 kg	3,400
Sheep meat	1 kg	6,000

Commodity	Unit	Water Footprint (Liters)
Sugar (from sugar cane)	1 kg	1,500
Sugar (from sugar beet)	1 kg	935
Tea	1 cup of 250 ml	30
Tomato	1 kg	180
Wine	1 glass of 125 ml	120

Sources: Hoekstra and Chapagain (2008); Water Footprint Network (2010)

2.2.7 Virtual Water Trade

The concept of virtual water was introduced by Tony Allan in 1993, similar to the concept of water footprint. Virtual water is an interesting theme considering the volume of water used to produce a commodity is actually "embodied" in that particular product. Now, if the product is traded between two countries, then it can be said that a certain volume of water is exported or imported in the virtual sense. The growing concern for freshwater scarcity across the globe captured the attention of this concept in recent years. The concept of virtual water trade has both environmental and economic perspectives. It can be an effective and important instrument for the utilization of water use and ensuring water security at the regional scale (Hoekstra, 2003). Figure 7 displays the virtual water trade balance from 1995-1999.

Note: The negative values with green colors demonstrate net water export.

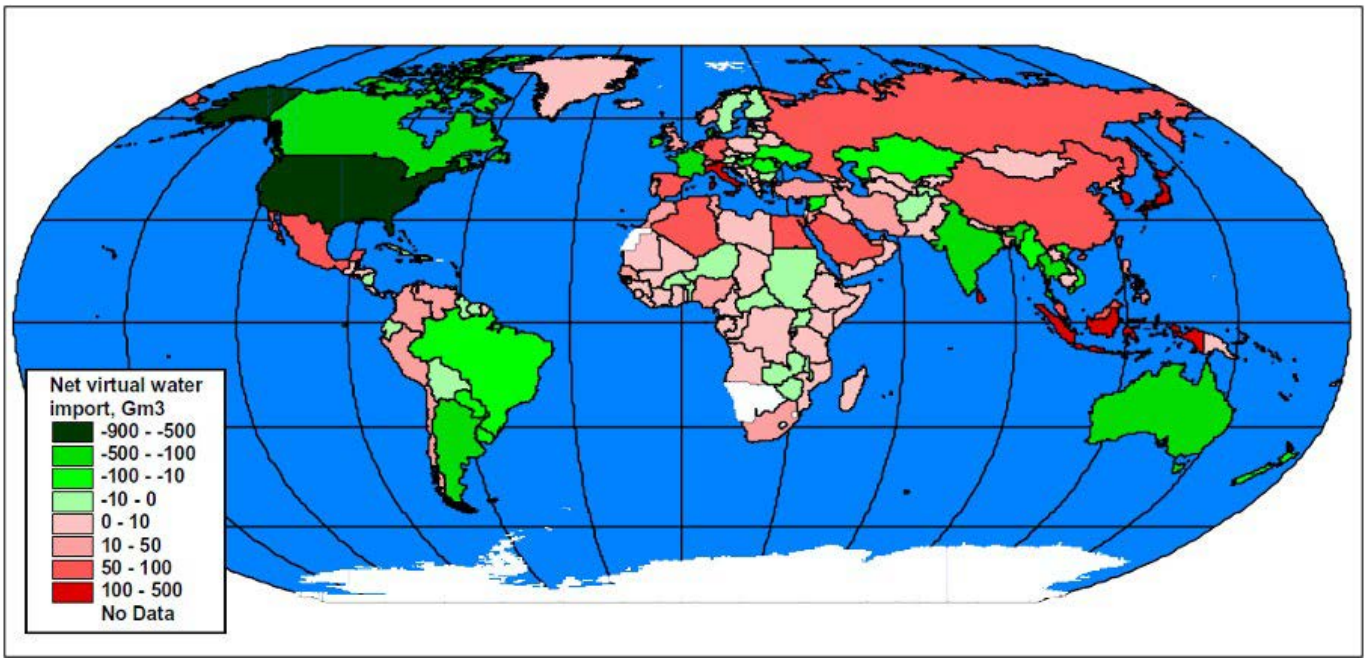


Figure 7: National Virtual Water Trade Balance for 1995-1999 (Source: Hoekstra, 2003)

Virtual Water Accounting does not fully meet criterion 1 as it does not consider the water source. It is usually restricted to the national level. It does not meet criterion 2 since it does not report on social values (Graham et al., 2020).

Measuring and analyzing the quantity and quality of water have always been a fundamental requirement in water resources management and related applications. The science of quantifying water in the environment is described in hydrology. Water resources professionals and engineers conduct hydrological studies to understand and estimate water volume, flow, and balance through different hydrologic cycle elements. The commonly applied scientific techniques for accounting and forecasting water are listed in the following points.

- Hydrological modeling – several hydrological models are extensively used in different irrigation, IWRM, flood control, and drainage studies. This is, perhaps, the most common engineering technique applied to water accounting. It has substantial potential to be embedded in any water accounting framework (Esen and Hein, 2020).
- Flow monitoring – to support the assessment of water resources, the installation, and use of flow monitoring gauges are very common in almost every basin under the control of water management. Water authorities collect flow data at regular intervals from these gauging stations, which provide essential information on water availability, water level, flow rate, quality indicators, etc. Data obtained at these stations are also used to validate information obtained from computer models (http://www.bom.gov.au/water/standards/niGuidelinesHyd.shtml).
- User-, project-or sector-specific assessment – The intended use of water may vary across different users, projects, and sectors. Therefore, each user may have its method for assessment of water resources. For example, a national-level irrigation scheme may use and apply FAO's AQUASTAT framework to determine the water accounts. On the other hand, a flood-control project may apply a suitable hydrological model or an established empirical formula to estimate the flow and inundation extent of flood water. It is important to note that each functional sector may have a different technique for measuring water despite having a single national or governance accounting framework.

2.3 Water Accounting Tools

There are several tools available for performing water accounting nowadays. These tools use principles of a standard water accounting framework or other scientifically accurate methods for water balance calculation. The IWMI WA framework can be a good instrument for supporting water auditing. The framework can potentially accommodate the requirements of datasets with the available information on the country's water resources.

The following sections describe some recognized water accounting tools. Note that this list does not include commonly applied engineering applications such as hydrological modeling platforms.

In addition to these tools, the reader is directed toward the ICID Webinar on water accounting: https://www.icid.org/icid_webinar_2.html

2.3.1 Water Accounting Plus (WA+)

The Water Accounting Plus (WA+) tool is developed by the IWMI, which follows the IWMI WA framework. This spreadsheet-based comprehensive tool applies the water balance concept and helps users measure water consumption for different purposes. The FAO supports the tool, focusing on I WRM and agricultural water use. It estimates the average state of water balance at the basin scale. However, it also has the potential to capture water accounts for other user-defined geographic boundaries.

WA+ applies GIS-based and remote sensing methods to capture and estimate the amount of precipitation and evapotranspiration (ET). The net balance is then distributed appropriately in the environmental subsystems. The tool uses standard indicators such as crop water productivity (CWP) or land productivity to process and present the crop water accounts for agricultural water use. Recently, the IWMI has facilitated an online version of the tool, accessed at the link: www.wateraccounting.org. This platform enables water account calculation for agriculture and other purposes using online sheets. Figure 8 provides a resource use sheet of WA+ designed for agriculture.

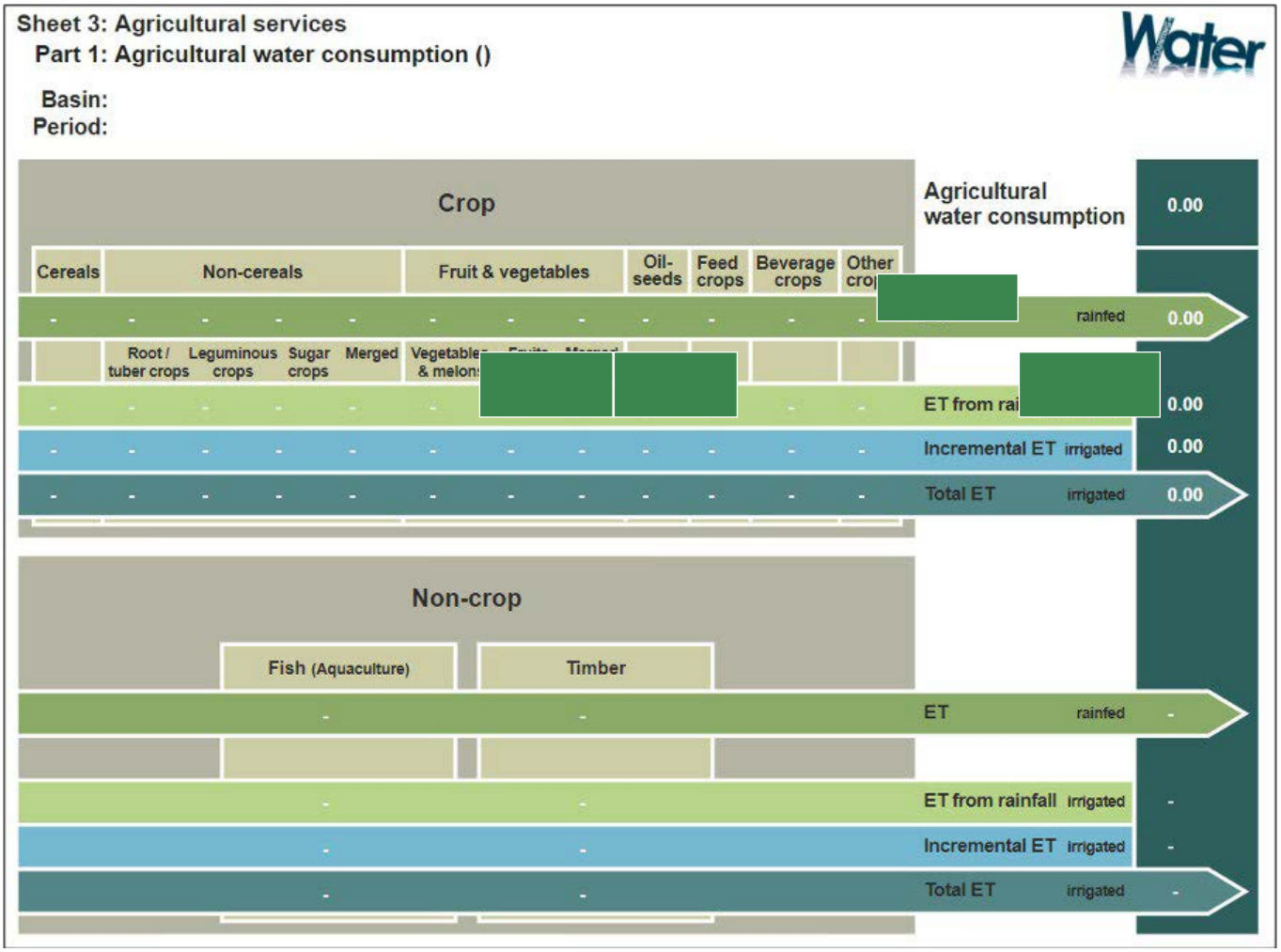


Figure 8: Water Accounting Sheet of WA+ Tool used for Agricultural Water Consumption (Source: www.wateraccounting.org)

2.3.2 WaPOR

FAO developed the online portal to monitor Water Productivity through Open-access to Remotely-sensed derived data or the WaPOR portal. WaPOR enables countries to manage and monitor their water productivity data for various purposes, including agriculture and IWRM, and efficiently prepare and maintain water accounts. The WaPOR development project commenced in 2015, and version 2.1 of the portal is currently available. With technical assistance from the IHE Delft Institute for Water Education, FAO developed many basin-scale water accounting reports such as for the Nile River Basin (FAO and IHE Delft, 2020), Awash River Basin (FAO and IHE Delft, 2020a), Jordan River basin (FAO and IHE Delft, 2020b) and Niger River Basin (FAO and IHE Delft, 2020c). WaPOR can be accessed at the link: https://wapor.apps.fao.org/home/WAPOR_2/1. The present interface of the WaPOR portal is displayed in Figure 9.

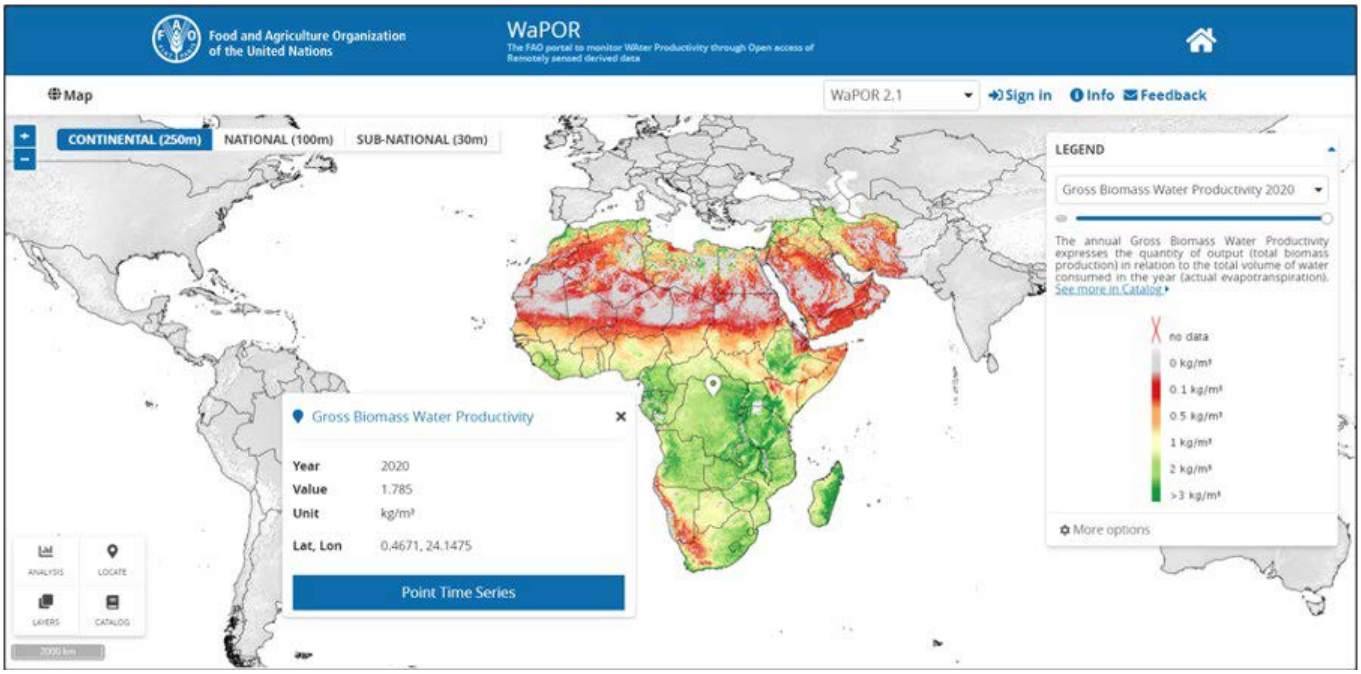


Figure 9: WaPOR Portal (Source: FAO)

2.3.3 SEEA-Water

The SEEA-Water framework uses a set of standard tables to support the preparation and management of water accounts (UNSD, 2012). Water accounts are one of many accounts covered by the SEEA Central Framework. The SEEA-Water is an internationally agreed methodological document for water accounts in support of the SEEA Central Framework. The standard water tables enable users to quantify water supply, demand, and use for different purposes and present the accounts in a comprehensive structure. For instance, the asset (water) account table prescribed in the SEEA-Water is shown in Table 3. The framework provides necessary technical details with computational methods for each table parameter. Reference to the SEEA Framework is provided in Section 2.8.

Table 3: Asset Account Table in the SEEA-Water Framework (Source: UNSD, 2012)

	EA.131 Surface water				EA.132 Ground-water	EA.132 Ground-water	Total
	EA.1311 Artificial reservoirs	EA.1312 lakes	EA.1313 Rivers	EA.1314 Snow, ice, and glaciers			
1. Opening stocks							
Increases in stocks							
2. Returns							
3. Precipitation							
4. Flows							
4.a. From upstream territories							
4.b. Drom other resource in the territory							

	EA.131 Surface water				EA.132 Ground-water	EA.132 Ground-water	Total
	EA.1311 Artificial reservoirs	EA.1312 lakes	EA.1313 Rivers	EA.1314 Snow, ice, and glaciers			
Decreases in stocks							
5. Abstraction							
6. Evaporation/actual evapotranspiration							
7. Outflows							
7.a. To downstream territories							
7.b. To the sea							
7.c. To other resources in the territory							
8. Other changes in volume							
9. Closing stocks							

2.3.4 Water Evaluation and Planning System (WEAP)

The Water Evaluation and Planning System (WEAP) is a desktop application to support integrated water resources planning and policy analysis. The Stockholm Environment Institute develops the application with additional support from the U.S. Army Corps of Engineers (USACE). WEAP applies a "balanced" approach to quantify water resources and use and supports various computational schemes, including hydrology and hydraulics, water quality, risk and vulnerability assessment, reservoir operation, demand and financial assessment, policy analysis, etc. The tool can be applied to both municipal and agricultural water systems. WEAP provides a comprehensive instrument for preparing water accounts for agricultural water management (https://www.weap21.org/).

2.4 Water Accounting for Agriculture

This review study focuses on the water accounting for the agriculture sector in Bangladesh. Agriculture accounts for more than 87% of total freshwater withdrawal in the country (World Bank, 2017). Additionally, it governs the overall context of IWRM with national-level policies and strategy formulation because of the dominance of its water use. The Eighth Five Year Plan or 8FYP (GED, 2020) suggests several strategies to improve agricultural water use efficiency throughout 2021-2025. Necessary interventions are proposed to increase crop water productivity and mitigate climate change's impact in the 8FYP. Thus, the agriculture sector needs a well-formulated water accounting system to enable efficient water resources management and provide decision-support for water conservation and security.

The agriculture sector consists of three major subsectors, i.e., crop, fisheries, and livestock. Unfortunately, little information is available at the governance level on water consumption in the fisheries and livestock subsectors. The available statistics for the fisheries and livestock subsectors cannot adequately describe water consumption and are not favorable for decision-making to improve water use efficiency. Nonetheless, because of the high proportion of water used for agriculture, undertaking water accounting for this subsector alone will provide information to guide action to improve water use efficiency.

2.5 Climate-informed Water Accounting

Bangladesh ranks at the 7th position in the list of Climate Risk Index (CRI) list and is considered one of the most climate-vulnerable countries (Germanwatch, 2019). If the likely impact of climate change is not taken accurately into account, the country's development and sustainability will be severely affected. The water and IWRM sector is one of the most critically affected by the adverse impact of climate change. Ensuring water security for all and development will be the most challenging task if appropriate adaptation and mitigation measures are not taken in advance.[3]

The World Bank's 2021 Bangladesh Climate Risk Country Profile[4] summarized the projected impacts of climate change:

- Bangladesh's projected average temperature rises are broadly in line 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.

However, the country has demonstrated its commitment to building a climate-resilient nation in the last decade. Bangladesh has been known as the pioneer in formulating climate adaptation measures in the South Asian region and the world (Ban Ki-moon, Former UN Secretary-General, 2018). The government has formulated the Delta Plan 2100 with a vision to establish a poverty-free, prosperous, and resilient delta against the adverse impact of climate change. Additionally, the country has adopted and implemented different national- and local-level policies and strategies for adaptation and resilience. Almost all line- and cross-cutting sectors take climate action into project implementation to a certain extent, demonstrating the country's awareness and contribution toward building climate resilience.

---

[3] Milner, H., Foisal, A., Gupta, N., & Basnayake, S. (2023). Assessment of Water Sector PolicyFrameworks of Bangladesh: Identifying Gaps and Addressing Needs. Bangkok: ADPC Section 2.6

[4] 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

Water accounting is needed in the context of climate change and the country's efforts to address the coming crisis. It will provide another mechanism for tracking adaptation progress.

Climate-informed water accounting refers to incorporating or considering climate-related issues, projections, and actions into the water accounting framework. Several of the components in a water accounting calculation will need to be adjusted from their historical values. Referring back to Figure 5: IWMI WA Generalized Diagram, 'Inflows,' 'Beneficial process' (water demands), and 'Non-process' (catchment evapotranspiration) flows are expected to change under future climatic conditions. In addition, government decisions may change the Outflows of 'Environmental and legal requirements,' and water resource development work such as the conversion of paddy to alternate wetting and drying practice may also require consideration in determining the values of components.

To ensure an accurate accounting of measures and evaluate the effectiveness of the actions taken, it is necessary to consider these climate change effects explicitly and to report these considerations separately in the documentation of the water accounting study. Such a strategy helps the water governance accurately measure its performance, conduct climate-informed policy analysis, and make evidence-informed planning, budgeting, and resource allocation decisions.

Therefore, a well-designed water accounting framework should primarily include the following information related to climate change and have an exclusive reporting system.

- The types and characteristics of climate risks, hazards, and vulnerabilities for IWRM
- The likely or evident impact of climate change on the elements of the water accounting framework, measured individually or as whole
- Identified and listed climate actions (e.g., adaptation and mitigation) with their outcomes, measured quantitatively
- Pre- and post-action accounts clearly demonstrate differences obtained from the applied climate resilience measures.

2.6 Data Commonly Used in Water Accounting

Water accounting includes a set of monitoring methods to regularly monitor water supply and usage to create performance measures such as productivity, efficiency, and equity (FAO, 2018). Built on the common principle of water balance, sector-specific data requirements or presentation in an organized water accounting system may exist. Table 4 provides a list of datasets commonly used to develop and operate water accounting systems and manage water-related information of the respective sector.

Table 4: Water Accounting Information Used for Managing Infrastructure (Source: FAO, 2018)

What system data is gathered?	What management indicators can water accounting provide?	How is this information used in water management?
Agrometeorological data (rainfall, evaporation).	Productivity (kg/ha or kg/cubic meter of water or $/ha or $/m3).	Compares production to benchmarks and identifies which inputs constrain production.
Hydrometric data (stream flows, canal flows, drain flows, quality).	Efficiency (volumetric % water target) or timing efficiency (e.g., hours of delay)	Reveals how losses might affect timeliness or explain poor uniformity of water supply.

What system data is gathered?	What management indicators can water accounting provide?	How is this information used in water management?
Inputs data (area, energy, soil, labor, agrochemicals, materials).	Equity and uniformity (Many measures examine uniformity, e.g., the coefficient of variation).	Determines how the variability of supply and demand is spread between users or geographic regions. Higher uniformity benefits efficiency and productivity.
Production data (crop types, yields, planting schedules, prices.)	Adequacy (% flows or % area, or % households above a given threshold).	Measures of coverage can be used to compare with previous years or between peers.
Economic data (prices, costs).	Associated input ratios (e.g., energy per ha or per farm).	Helps to determine costs for different inputs in relation to each other.
Rainwater harvesting creates additional water and "greens" semi-arid catchments.	Quality (e.g., salinity, agro-chemicals, pathogens, biological oxygen demand).	Determines treatments and/or dilution ratios needed to bring water quality to satisfactory levels.

Bangladesh's agricultural water management system has some primary inputs, such as information on rainfall, runoff, evaporation and transpiration, water yields, water productivity, and land productivity. Availability, extent, and quality of data for water use and water productivity vary among the crop, fisheries, and livestock subsectors, with neither the annual Fisheries Year Books, livestock database, nor FAO AQUASTAT containing data on water use for fisheries and livestock. Nonetheless, because of the high proportion of water used for agriculture, undertaking water accounting for this subsector alone will provide information to guide actions to improve water use efficiency.

2.7 Approaches to Improving Data Systems for Water Accounting

Reliable and comprehensive data is essential to water accounting. The prepared accounts cannot be more accurate or reliable than the data on which the accounts are based. Water accounting also requires data that may be collected by different agencies to be brought together and used to prepare the accounts. Thus, four aspects of data systems must be assessed and improved if necessary: data coverage in terms of both area and type of data, timeliness of data, accuracy, and reliability, and data sharing. The last of these aspects is a matter of concern for implementing water accounting in Bangladesh.

Countries have taken different approaches to strengthening water resources data systems. Some examples of the varying approaches taken, specifically for water accounting, are given below.

2.7.1 Australia

Under Australia's Constitution, water and other natural resources are a matter for each of the seven States and Territories to manage. However, given the history of conflict between the States over the management of transboundary water resources, specifically in the Murray Darling Basin, the Commonwealth Government intervened, claiming its powers to manage international obligations required its action to ensure obligations arising from international treaties and conventions were met. This led to the enactment of the national Water Act 2007.[5]

The Water Act gave functions to the Commonwealth Bureau of Meteorology (BOM) and its existing responsibilities for weather and climate. These additional functions include:

[5] Connell, D. 2011. Water Reform and the Federal System in the Murray-Darling Basin. https://link.springer.com/article/10.1007/s11269-011-9897-8

- Collecting, holding, managing, interpreting, and disseminating Australia's water information
- Providing regular reports on the status of Australia's water resources and patterns of usage of those resources
- Providing regular forecasts on the future availability of Australia's water resources
- Compiling and maintaining water accounts for Australia, including a National Water Account.

"In 2007, Australia's water information base was in poor shape and deteriorating because of a lack of investment and inefficiencies in managing it across more than 200 different data collecting agencies nationwide. Under the Australian Government's *Improving Water Information* Program, the Bureau of Meteorology was provided with ten-year funding to develop a national water information service that would accurately monitor, assess and forecast our water resources' availability, condition, and use."[6]

The Water Regulations, 2008, interalia specified obligations and requirements on all persons (comprising individuals, trusts, companies, and corporations as well as agencies of State, Territory, or Australian governments[7]) to provide data[8] to the BOM and specified the reporting requirements (format, data delivery, metadata and contextual information, and recommended data be provided under a Creative Commons Licence). The data is organized under categories of person and information. A 'person' is required to provide data only if it is collected. There is no obligation to start collecting any new data, but if new data collection activity is started, then the 'person' is obliged to provide the data.[9]

The BOM and water industry representatives have developed water data collection standards and guidelines to be followed voluntarily.[10]

2.7.2 Viet Nam

In November 2002, the Government assigned the responsibilities of state management of natural resources and other natural resources and environment to the Ministry of Natural Resources and Environment (MONRE). The Decree separates the responsibility for state water management from public water services delivery. The Ministry of Agriculture and Rural Development and other ministries with water-related responsibilities carry out water service delivery. The Prime Minister's Decree specifically assigns MONRE functions to:

- survey and allocate water resources
- inventory, assess water resources, and establish data bases
- protect water resources
- support the National Water Resources Council.

A Decree on coordinated information management in the water resources sector was prepared for MONRE and NWRC. This Decree specifies the role of MONRE as the overall coordinator of water resources data and information. At the same time, many ministries and agencies are defined as "custodians" of specific databases.

Decree No. 73/2017/ND-CP[11] applies to regulatory authorities, organizations, and individuals performing activities of collecting, managing, and using natural resources and environment data. The Decree deals with the collection, management and use of 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,

[6] http://www.bom.gov.au/water/regulations/background.shtml
[7] The BOM maintains a list of 'persons' which is updated regularly.
[8] Data means any raw data or value added information product related to the availability, distribution, quantity, quality, use, trading or cost of water, but only if it is held in digital alphanumeric form (scanned documents are not classified as "data").
[9] http://www.bom.gov.au/water/regulations/regsData.shtml, http://www.bom.gov.au/water/regulations/faqAuxNav.shtml
[10] http://www.bom.gov.au/water/standards/aboutStds.shtml
[11] https://kenfoxlaw.com/wp-content/uploads/2019/01/73_2017_ND-CP_357624.pdf

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.

2.7.3 European Union

The Water Framework Directive (WFD, 2000/60/EC)[12] requires EU Member States to achieve good status in all surface water and groundwater bodies by 2027. Good status is comprised of four assessments:

- Ecological status of surface waters
- Chemical status of surface waters
- Chemical status of groundwaters
- Quantitative status of groundwaters

Article 8 of the WFD specifies the requirements for monitoring surface, groundwater, and protected areas.

i. for surface waters such programmes shall cover:
   a. the volume and level or rate of flow to the extent relevant for ecological and chemical status and ecological potential, and
   b. the ecological and chemical status and ecological potential;
ii. for groundwaters such programmes shall cover monitoring of the chemical and quantitative status,
iii. for protected areas the above programmes shall be supplemented by those specifications contained in Community legislation under which the individual protected areas have been established.

Articles 8 and 13[13] of the WFD specify that data will be provided on the condition of waterbodies (including groundwater bodies) within each river basin. The detailed requirements for monitoring and providing data are specified in Appendix V of the WFD. The WFD Reporting Guidance supports Appendix V[14].

The WISE Water Framework Directive database contains data from the 1st and 2nd River Basin Management Plans reported by EU Members States, Norway, and the United Kingdom.[15]

2.7.4 Remotely sensed data for water accounting

In countries where comprehensive water data is not yet acquired and may not be available for the water accounting study area, remotely sensed data has been used. The methods and applications of remotely sensed data to water accounting by FAO are described below in Sections 2.8.1 and 2.8.2, using the IWMI WA+ tool in Sections 2.7.7, 2.7.8, and 2.7.9.

2.8 Examples of Water Accounting Applications

This section summarizes some previous works and studies on water accounting by various organizations and governments. Since the inception of its concept, a wealth of studies and research works have been performed on water accounting. Many governments have adopted the system in their institutional form to improve water governance. This report does not intend to cover all the work done on water accounting but to provide an idea of how this tool has been supporting

[12] https://eur-lex.europa.eu/eli/dir/2000/60/oj
[13] Article 13 requires the preparation and 6-yearly updating of river basin management plans for the protection, improvement and sustainable management of the water environment.
[14] https://cdr.eionet.europa.eu/help/WFD/WFD_521_2016/Guidance/WFD_ReportingGuidance.pdf
[15] https://www.eea.europa.eu/data-and-maps/data/wise-wfd-4

governments and other organizations in making evidence-informed decisions on water conservation, water security, and water resources management across the globe and how these experiences might inform decisions relevant to the criteria set for a proposed water accounting system in Bangladesh in Section 1.1

2.8.1 Basin-scale Water Accounting Studies Conducted by FAO and IHE-Delft

In association with the IHE-Delft Institute for Water Education, FAO conducted basin-scale water accounting studies for five large river basins between 2019 and 2020. These river basins are:

- Nile River Basin on the African Continent
- Jordan River Basin in the Middle-East
- Niger River Basin on the African Continent
- Awash River Basin in Ethiopia
- Litani River Basin in Lebanon

These studies aimed to apply remote sensing technology and open access data to prepare water accounts focusing on the agriculture sector and identify and measure water productivity gaps. The available data provide decadal information on water consumption and biomass production. By following the principles of the IWMI WA framework, these studies used FAO's WaPOR tool to prepare and present the water accounts and determine water productivity. For instance, some of the analysis outcomes from the Nile River study are provided in Figure 10. This basin was studied from 2009 to 2018 (FAO, 2020).

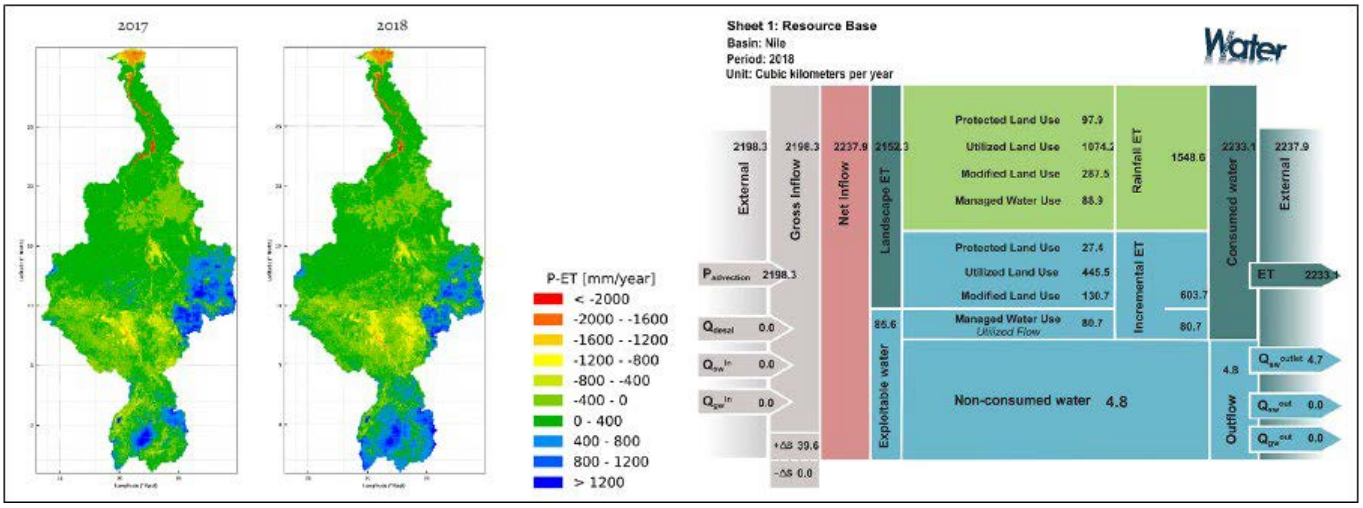


Figure 10: Water Accounting Results for the Nile River Basin (Source: FAO, 2020)

Figure 10 shows the difference between rainfall and evapotranspiration and the completed resources base sheet for water balance obtained from the study.

2.8.2 FAO Study on Application of Water Accounting for Water Governance

FAO (2018) explored case studies on how water accounting has supported water governance with its capabilities for evidence-informed decision-making. According to the FAO, several critical lessons are learned from these case studies, including the following ones.

- Water accounting quantifies unsustainable or inequitable practices and trends
- It defines target levels of sustainable withdrawal and consumption of water
- Water accounting combined with water auditing helps to unpack the political economy of water, which in turn affects how water governance is designed

- The tool supports water management, which feeds into water auditing and governance.

Table 5 provides the list of cases explored by the FAO on how water accounting has been supporting water governance.

Table 5: Success Stories on Water Accounting for Water Governance (Source: FAO, 2018)

Case	What was the water governance problem?	What information did water accounting provide?	What governance advice was generated, or how adid water policy change?	Further information
USA, Nebraska	Excessive and unsustainable water use from aquifers to support irrigation.	Correct analysis of sustainable yield of the aquifer and annual consumption by irrigation.	Introduced water meters, Regulated withdrawals, created water user groups, and self- monitoring.	Bleed and Hoffman Babbitt, 2015; Scanlon et al., 2012.
China, North China Plain	Excessive and unsustainable water use from aquifers.	Analysis of aquifer yield and annual consumption by irrigation.	Regulation of land use under irrigation, changes to irrigation technology, and shortening the irrigating season length.	Kendy et al., 2003; IWMI, 2006.
USA, Arizona aquifer	Excessive and unsustainable water use from aquifers.	Correct analysis of sustainable yield of the aquifer and annual consumption by irrigation.	Water banking via managed Aquifer recharge. Investment in this approach by one public entity–the Arizona Water Banking Authority–has exceeded US $350 million.	Megdal et al., 2014.
Thailand	Uncertainty over water consumption for different sectors in different basins.	Revealed the water consumption of different future economic scenarios to aid ministerial planning.	No policy change as yet; for information only.	Sriwongsitanon et al., Unpublished (with IWMI)
Ghana, Volta River	Uncertainty over water consumption for different sectors in the Volta River.	The quantification of green and blue water linked to land use to identify potential sources of water saving.	No policy change as yet; for information only.	Leh and Rebelo, 2018.
Italy	Excessive and uneven consumption by irrigators.	Volumetric assessment of water withdrawn and consumed by farmers.	Application of user-pay principles to volumetric water to curtail unwarranted withdrawals for agricultural water.	Zucaro, et al., 2015/16

Case	What was the water governance problem?	What information did water accounting provide?	What governance advice was generated, or how adid water policy change?	Further information
Australia	Allocation of water in the Murray-Darling basin.	Revealed a more accurate picture of withdrawals And consumption by different sectors to support market-based allocation.	The water utility uses information from the accounts to help explain water allocation and use in various sectors along the Murrumbidgee River and inform the ongoing debate.	BOM, 2017.
Indonesia	Regulation and management of the Brantas River Basin.	Volumes of water withdrawals and allocations.	Application of pricing incentives in water markets to regulate water demand.	Rodgers and Hellegers, 2005.
Russia (all major basins)	Lack of knowledge about water volumes for use.	Identifying basins that: a) were prepared for climate-induced variability and b) had spare water for further development.	Advice on demand and supply-side reforms, including instruments such as inter-basin transfers.	Danilov- Danilyan et al., 2014; Georgievsky, 2016.
Turkey	Performance of Irrigation systems transferred to farmers from the government.	Performance indicators of irrigation systems; cost recovery for operation and maintenance; area irrigated.	No policy change as yet; for information only. No substantial increase in performance was seen to result from the irrigation management transfer; the authors concluded that Ongoing support to farmers is needed.	Burak, 2013.

2.8.3 Initiatives Taken by the Partnership for Agricultural Water for Africa (AgWA)

With the Swiss Agency for Development and Cooperation funding, the AgWA implemented the project: Strengthening Agricultural Water Efficiency and Productivity on the African and Global Level in 2014 in three African countries, namely, Burkina Faso, Morocco, and Uganda (FAO, 2016). The project aimed at improving agricultural water management (AWM) practices and mainstreaming AWM in the national frameworks on the African and global levels. Water accounting was applied in this project to support water auditing and, thereby, future policies for water management. The summary of outcomes from the water accounting study is presented in Table 6.

Table 6: Water Accounting Comparative Analysis Summary for Burkina Faso, Morocco, and Uganda (Source: FAO, 2014)

Burkina Faso	Morocco	Uganda
• Water supply and demand		
• Predominantly rain-fed; • The percentage of renewable water resources withdrawn is 10.6%; • Agriculture accounts for 51% of total water withdrawals; and • Agricultural water demand is primarily met by surface water.	• Predominantly irrigated; • The percentage of renewable water resources withdrawn is estimated at 50%; • Agriculture accounts for 87.3% of total water withdrawals; and • Agricultural water is primarily supplied through storage infrastructures (85%).	• Predominantly rain-fed; • The percentage of renewable water resources withdrawn is 0.5%; • Agriculture accounts for 40% of total water withdrawals; and • Water demand is met with rainfall.
Small-scale irrigation		
• The total extent of small and medium-scale irrigation schemes is estimated at 13 700 ha and 3 237 ha, respectively (7.2% of total irrigation potential); and • The total irrigation potential is estimated at 233 500 ha (MAHRH estimate).	• Small and medium scale irrigation systems (PMH) cover approximately 0.3 million ha with 2 927 systems; and • Groundwater use is increasing, particularly in private irrigation.	• The total land under small-scale irrigation is 300 ha (less than 1% of total irrigation potential); and • The total irrigation potential is estimated at 90 000 ha (study in 2003). Other studies varied from 200 000 to 400 000 ha.
Water accounting-related issues		
• Conflicts for surface water around reservoirs and rivers and in densely populated areas (peri-urban) arise; and • Identifying alternative sources of water for different uses could help address these conflicts.	• Groundwater use needs to be monitored to avoid overexploitation; and • Morocco is characterized by severe water stress, with a large diversity of small-scale systems. • The impacts of climate variability on these systems need to be better understood.	• Agriculture largely relies on rainfall, but the scope for developing irrigation exists; • The country has a low water resources monitoring capacity; and • Wetlands development externalities need to be understood.

2.8.4 Pilot Studies Conducted by the European Commission

The European Commission conducted rigorous water accounting work in fifteen European countries on a pilot basis and published the findings on the European Statistics or Eurostat in 2002. The study applied Eurostat's water accounts framework for preparing and presenting the water accounts at the country level. The water accounts presently focus on the monetary and physical description of water-related economic activities and the economy's direct impacts on water abstraction and emissions to water (European Commission, 2002).

2.8.5 Water Accounting for the Ca River Basin in Viet Nam

Winrock International conducted a case study on water accounting for the Ca river basin in Viet Nam in 2015. The study used the WA+ tool of IWMI to prepare and present the water accounts for the basin. The study outcomes demonstrated the capabilities of WA+ tools to support improved water governance for the Ca River basin.

2.8.6 Case Study Conducted in the Five European River Basins

Hunnick et al. (2019) performed extensive water accounting to assess climate change's impact on agricultural water use in the five European river basins, as shown in Figure 11. The study applied a

simplified IWMI WA framework and used the WA+ tool to prepare the water accounts. The study's objective was to create and demonstrate a common water accounting framework for different European river basins, which the respective water management bodies could easily understand and translate into water policy actions. The applied framework utilized the basin-level information on climate change impacts which can support policymaking on climate adaptation, water resources, and agriculture (Hunnick et al., 2019).

The results demonstrate the application of a simplified water accounting framework combining multiple studies of climate change impacts on water resources. Using indicators that aggregate data from various basins into a single figure or table allows trends to be compared and the consistency among different studies or similar basins to be assessed. Indicators of future water availability, water use, and water stress allow hotspot regions to be identified. Future water accounts based on projected climate scenarios have the potential to synthesize a wide range of data, allowing for the regular production of information and indicators that can contribute to decision-making processes in the five river basins.

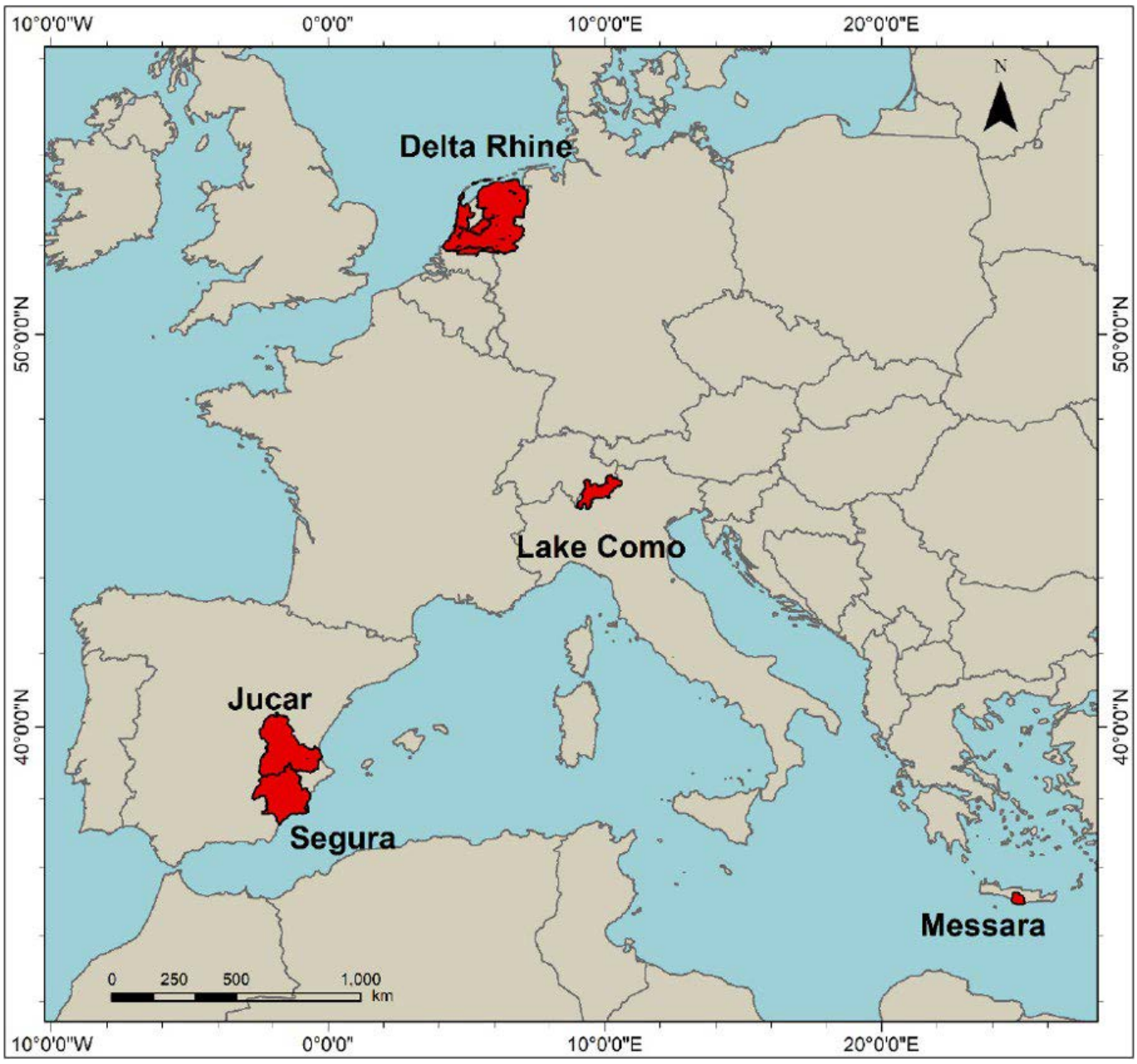


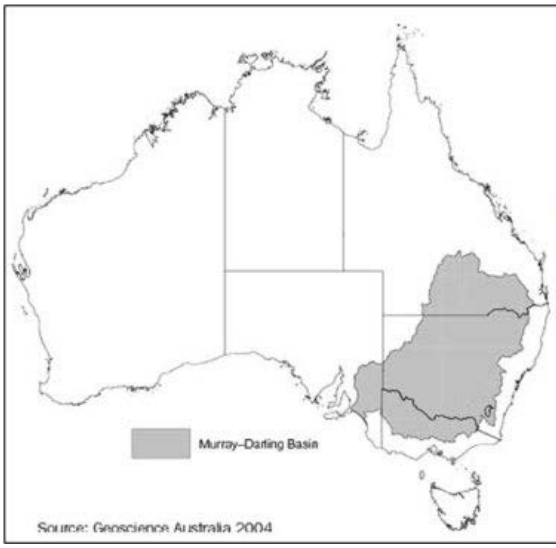
Figure 11: Location of the Selected River Basins in the Study Performed by Hunnick et al. (2019)

2.8.7 Basin-wide water accounting for the Indus Basin

The WA+ tool was applied to the Indus River basin in Pakistan to produce information on the depletion of water resources, storage change, and land and water productivity. Satellite-derived estimates of land use, rainfall, evaporation (E), transpiration (T), interception (I) and biomass production were used with measured basin outflow for water accounting using the WA+ tool. "For one selected year (2007), the total annual water depletion in the basin (501 km^3) plus outflows (21 km^3) exceeded total precipitation (482 km^3). The water storage systems that were effected are groundwater storage (30 km^3), surface water storage (9 km^3), and glaciers and snow storage (2 km^3). Evapotranspiration of rainfall or "landscape ET" was 344 km^3 (69 % of total depletion). "Incremental ET" due to utilized flow was 157 km^3 (31% of total depletion). Agriculture depleted 297 km^3, or 59% of the total depletion, of which 85% (254 km^3) was through irrigated agriculture and the remaining 15% (44 km^3) through rainfed systems. Due to excessive soil evaporation in agricultural areas, half of all water depletion in the basin was non-beneficial. Based on the results of this accounting exercise, loss of storage, low beneficial depletion, and low land and water productivity were identified as the main water resources management issues. (Karimi et al., 2013)"

2.8.8 Managing Water Accounting for the Murray-Darling Basin in Australia

The Australian Bureau of Statistics (ABS) published a comprehensive environmental accounting status for the Murray-Darling Basin in Australia in 2012, including the water accounts to support water resources management. ABS applied the standard SEEA-Water framework to prepare and present the water accounts. The framework provided the essential platform for water information management, monitoring of the water resources, and evidence-informed decision-making. An illustration of the water accounts developed for the basin is shown in Figure 12.



	Volume of water	Percent of total	Value of water(a)(b)	Percent of total	Water rate
	GL	%	$m	%	$/kL
	2009–10				
Supply					
Water supply industry(c)	3 120	99	867	100	0.28
Use					
Intermediate consumption by industries					
Agriculture, forestry, fishing	2 823	90	280	32	0.10
Mining	14	1	14	2	1.01
Manufacturing	22	1	34	4	1.55
Electricity and Gas Supply	12	—	12	1	1.01
Other industries	95	3	185	21	1.95
Final consumption					
Households	173	6	343	40	1.98
Total use	**3 138**	**100**	**867**	**100**	**0.28**

Figure 12: Water Accounts for the Murray-Darling Basin in Australia (Source: ABS, 2012)

2.8.9 Okanagan Basin Water Accounting Model, Canada (2010)

The DHI Water and Environment Canada developed the Okanagan Basin Water Accounting Model (OBWAM) under the Okanagan Basin Water Supply and Demand project. The project included developing distributed hydrological and water accounting models. The purpose of developing and calibrating the OBWAM was to understand and evaluate the status of the basin's water resources and hydrology, the impact of climate change, water use efficiency, and agricultural water use (DHI Canada, 2010).

The OBWAM builds on the Okanagan Basin Hydrological Model (OBHM) developed in the same project using the MIKE SHE software. The accounting model incorporated gauged records of water use and operational data. The OBWAM is a data-intensive and high-resolution model that demonstrated satisfactory performance in providing evidence-informed results on the system hydrology and water management measures. Figure 13 shows the spatial distribution of some analysis variables used in the OBHM and OBWAM.

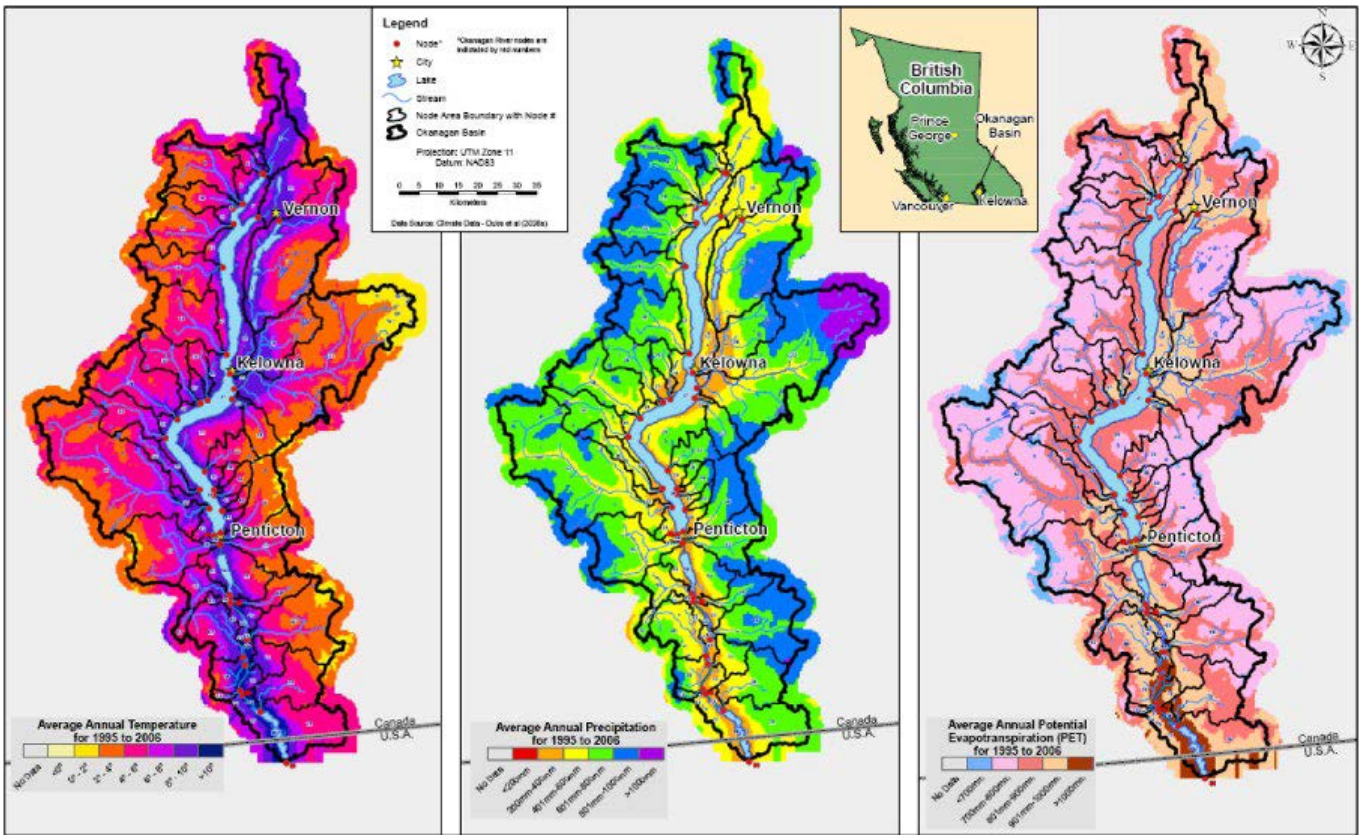


Figure 13: Temperature, Precipitation, and Potential Evapotranspiration in the Okanagan Basin Model (Source: DHI Canada, 2010)

In addition to the studies mentioned above on water accounting, a wealth of information related to the nation-wide current practices and development potentials for water accounting was documented by Australia's Water Accounting Standards Board (WASB) in 2011.

3. REVIEW OF THE WATER ACCOUNTING SYSTEM IN BANGLADESH

Widely known as the land of rivers, Bangladesh has abundant natural water courses. Additionally, the country is recognized as the largest delta in the world. Life, development, and economy grow here by keeping water systems at the center. However, despite having this immense resource potential, the country is severely threatened by the adverse impact of climate change and natural disasters. Water is one of the most critically affected sectors facing climate change challenges, increasing demands for freshwater and water security, and agricultural water management. Thus, water governance is crucial in managing the country's water resources and ensuring water and food security under natural, climate-induced, and human-induced hazards.

Bangladesh has a long experience in successfully managing the IWRM and adapting to the impacts of climate change. However, there has always been a need for accurate, data-driven, and evidence-informed decision-making for the water and IWRM sector at the governance level. Impressively, the country has a wealth of datasets and information related to water resources which are prepared, owned, and managed by different government agencies. On the contrary, managing this immense amount of information often appears challenging for consolidation, validation, updating, and maintenance. The Water Resources Planning Organization (WARPO) under the Ministry of Water Resources (MoWR) develops national-level plans and guidelines on IWRM and maintains the National Water Resources Database (NWRD). WARPO faces many challenges associated with water resources planning due to the lack of coordination among the sectoral implementation agencies, inadequate organizational capacity regarding human resources, tools and technologies, infrastructure and funding, unregulated data generation, policy gaps, etc. The government's vision, as reflected in the Perspective Plan 2021-2041 (PP 2041) and the Bangladesh Delta Plan 2100 (BDP 2100), needs efficient and evidence-informed water governance to resolve those challenges and be successful. The government has demonstrated a strong commitment to building a sustainable and resilient delta and is making tremendous efforts for it in every national or local action.

Water balance and planning for an estimated long-term water budget (water budgeting) have been in practice in the IWRM sector of the country for a long time. However, the terminology may appear quite new to some of the policymakers. This is probably because many of the water policies were developed before the scientific frameworks of water accounting and definitions of water accounting terms were developed. Therefore, none of Bangladesh's policy frameworks have directly addressed this concept in water governance. In this context, water balance is the best known of the water accounting terms and the one that water sector stakeholders commonly understand. As a result, water governance in Bangladesh is yet to be sensitized to the concept and principles of a standard water accounting framework. The CARE for South Asia project has the opportunity to bring the water sector actors led by the MoWR together and develop necessary guidelines for establishing a comprehensive water accounting system at the governance level.

As mentioned in Section 1, the status of water resources development and use in Bangladesh and the expectations for the future under the influence of climate change make it timely to introduce a formal water accounting process. In fact, should Bangladesh continue planning water-using developments using a water balance process based on historical records of climate and water resources, the sustainability of both projects and water resource systems will be put at risk.

This section summarizes the review and assessment of the existing water budgeting system in Bangladesh. Additionally, the study outcomes provide a list of identified major gaps and sectoral needs for water accounting, the status of water accounting for the agriculture sector, and a review of the relevant works performed earlier by various agencies. The specific objectives and methodology of the review work are outlined in Section 1.

3.1 Assessment Questions and Criteria

This assignment took an attempt to address and explore answers to the following eleven questions or review criteria. These questions were developed in alignment with the assessment objectives (Section 1.1) and the requirements of the CARE for South Asia project. The assessment questions were discussed, and views were obtained at a hybrid workshop. Attendance at the workshop is given in Annexure IV. The Care South Asia sector focal points in the MoWR, WARPO BWDB, and GED were consulted individually to understand the government's views on each assessment question. The consolidated views and information in response to each question are given in Section 3.2, Stakeholder Mapping. The assessment description, including its considerations, findings, and other narratives, is constructed by following the sequence of these questions in this report.

1. Which government agencies are the major stakeholders in:
    a. Water or IWRM sector?
    b. Agriculture sector?
    c. Urban water management sector?
    d. Industrial development sector?
2. What are the available legal, institutional, regulatory, and other policy frameworks for the following thematic areas or sectors in Bangladesh which are applicable for water accounting?
    e. Water or IWRM
    f. Agricultural water management, including subsectors of crop, fisheries, and livestock
    g. Climate change
    h. National-level integrated plans and policies
3. What is the status of the existing water accounting system or practice in Bangladesh?
4. What is the status of the existing water accounting system or practice for agricultural water management in Bangladesh?
5. What is the status of existing water accounting practices in the urban water management and industrial sectors?
6. Provide a summary of the recent studies conducted for or relevant to water accounting for the following applications in Bangladesh.
    i. Water resources management
    j. Agricultural water management
    k. Urban water management
    l. Industrial sector development
7. Are the existing water accounting practices climate-informed? What is the status of climate actions in the water accounting framework?
8. What are the major identified gaps or challenges for incorporation, operation, and sustainability of water accounting in water governance?
9. What are the major identified needs for the establishment of water accounting?
10. Based on the initial review of the water resources data of Bangladesh and the standard frameworks of water accounting, which framework or tool can be adopted for the preparation and presentation of water accounting for agricultural water management in Bangladesh?
11. Explore the country's 8FYP (2021-2025) and identify the relevant policies or strategies which can support the implementation of a water accounting system for agricultural water management in Bangladesh.

3.2 Stakeholder Mapping

[Assessment Question 1]

Accurate mapping of the government stakeholders is essential to understand how water governance operates and collaborate with other connected sectors. Since the study focuses on both the water and agriculture sectors and the cross-cutting issue of climate change, any intervention on the policy level shall require an active engagement and effective collaboration by all concerned agencies of the government. Table 7 provides a list of identified stakeholders for this assignment and the water sector activities planned in the CARE for South Asia project.

Table 7: List of Identified Stakeholders for the Review Study on Water Accounting

Sector	Theme/ Subject	Ministry/ Authority	Dept./ Agency	Notes
Water/ IWRM	IWRM	MoWR	WARPO, FFWC and BWDB, DBHWD	WARPO develops and maintains national water sector policies
Water/ IWRM	Groundwater resources	MoLGRD&C	DPHE	Groundwater resources are the major supply source for irrigation
Water/ IWRM	IWRM	MoLGRD&C	LGED	LGED implements small-scale water resources
Water/ IWRM	Meteorological Data	MoD	BMD	
Agriculture	Crop water management	MoA	BADC, BARC, BARI, DAE, AIS, BMDA	DAE is the nominated focal agency for the agriculture sector in the CARE for South Asia project
Agriculture	Fisheries water use	MoFL	DoF	
Agriculture	Livestock water use	MoFL	DLS	
Urban Sector	Water and wastewater management	MoLGRD&C	WASA, City Corporation, Urban Municipality (Pourashava)	
Industrial Sector	Economic Zone	PMO	BEZA	BEZA develops economic zones in different districts

NB: Full names of the organizations are provided in Annex II.

It is important to note that the MoWR, BWDB, and WARPO are the key stakeholders in the water sector in the CARE for South Asia project. Information about the functions of other stakeholders is required to obtain the complete picture of water accounting practice in the agriculture, urban, and industrial sectors.

3.3 Legal, Institutional, Regulatory, and Policy Framework

[Assessment Question 2]

Annex III provides the results of the detailed assessment conducted on water accounting in the available legal, institutional, regulatory, and Policy frameworks (LIRPF) in Bangladesh. Only the following sectoral LIRPFs were considered for review in alignment with the specific study objectives.

- Water and IWRM
- Agricultural water management, including the subsectors of crop, fisheries, and livestock
- Climate change
- National-level integrated plans and policies

Some major policies of the urban and industrial sectors were also reviewed to a certain extent.

Reviewing the LIRPFs was to identify if any provisions were made explicitly for a structured water accounting system in those policy frameworks. Realizing that a different form of water accounting may exist, such as assessing water balance conditions in these LIRPFs, the review study expedited the presence of the following parameters or elements related to water resources in the policy actions.

- Supply
- Demand
- Accessibility
- Use

The assessment yields the following major outcomes.

The water sector policies are designed by two ministries, namely, MoWR and the Local Government Division (LGD) under the MoLGRD&C. WARPO is the national-level government agency responsible for the development of essential LIRPFs for water resources management. The governing water resources policy frameworks are the Water Act 2013 and the National Water Management Plan 2001 (NWMP 2001). To support water governance, WARPO designed IWRM guidelines for the district, upazila (sub-district), and union (sub-upazila) administrations in 2020.

None of the reviewed LIRPF (Annex III) suggests or incorporates any standard water accounting framework to support water governance. However, an accurate assessment of water balance conditions has been recommended in almost every policy framework, wherever it applies. It is to be noted that many of the policy frameworks were designed before the inception of the standardized water accounting frameworks. Again, the most common technical approach for water accounting is the hydrological perspective practiced by Bangladesh's water institutions and industry experts. Therefore, the conventional water balance approach is the most common method in any policy framework or project implementation.

The essential elements of water accounting, such as supply, demand, accessibility, and use, are exclusively addressed in many LIRPFs at national- and local-level plans to ensure water security. The LIRPFs of the agricultural sector emphasize ensuring irrigation water availability and management. The country's irrigation supply depends on groundwater resources. Therefore, these policies suggest efficient management and safe abstraction of groundwater resources. The LIRPFs of the fisheries and livestock sectors do not appear to contain adequate information on the use of water resources in these sectors. There is likely to be a considerable amount of information gap and a lack of updated data on water accounts.

The recommended technical methods for preparing and reporting water data are mathematical modeling, GIS, and remote sensing, as found in the existing policy frameworks.

WARPO manages and maintains the national water resources database (NWRD). Additionally, several government departments prepare and own a wealth of spatial and temporal data on the quantity and quality of water resources. Although these datasets help design water sector policies, there is substantial scope for the utilization of these datasets for evidence-informed decision-making.

The government has recently formulated the Eighth Five Year Plan or 8FYP from 2021 to 2025 (GED, 2020). The plan describes the government's priorities and strategies for IWRM during this five-year implementation period. Though not explicitly addressed, the provisions made in the 8FYP can be utilized to develop a standard water accounting framework for the agriculture sector and enhance capabilities for efficient and resilient water governance. Section 3.9 discusses the provisions made in the 8FYP in the context of IWRM and agricultural water use.

Many of the LIRPFs are not climate-informed, i.e., the policies do not address the impact of climate change or the necessary adaptation and resilience measures. However, the recent national plans and strategies, such as the BDP 2100, 8FYP, etc., exclusively recommend including climate information in every action and across all development sectors. The climate action-related policies are designed by the MoEFCC in the country. The governing policy frameworks are the National Adaptation Program of Action 2009 (NAPA 2009), Intended Nationally Determined Contribution 2015 (INDC 2015), and the Bangladesh Climate Change Strategy and Action Plan 2009 (BCCSAP 2009).

3.4 Existing Water Accounting Practices in Bangladesh

[Assessment Question 3]

Water accounting mostly follows the hydrological perspective in Bangladesh. As mentioned in the introduction of Section 3, the conventional water balance approach is employed to quantify the status, availability, demand, and use of water resources for various purposes. Water resources assessments are generally conducted in engineering applications, water resources development projects, irrigation planning schemes, water supply programs, and feasibility studies. Most of these applications employ the following methods to determine the water balance condition for the intended use.

- Mathematical modeling (e.g., hydrological modeling, watershed analysis, and simulation, geospatial modeling, remote sensing, etc.)
- Standard empirical and statistical methods (e.g., as applied in flood mapping and forecasting studies)
- Flow monitoring (at gages) and trend analysis

There is no standard framework established for water accounting at the governance level. The existing water resources database is used for water balance assessment, but no system has been developed to prepare and present water accounts to support policy formulation. The essential calculations for policy planning are made manually or by using some customized decision support systems (DSSs). However, these DSSs have other purposes than accounting for water resources and limited access since they are designed and maintained by separate organizations. For instance, the CEGIS and IWM under the MoWR have a wealth of databases and DSSs related to water resources which require a collaborative arrangement to develop and promote a standard water accounting framework.

3.4.1 Water Accounting for the Agriculture Sector

[Assessment Question 4]

The agriculture sector accounts for the lion's share of the total freshwater use in the country. Specific to the regional geographies, extreme and flash flooding and droughts are major challenges in irrigation water management. At present, the irrigation system of Bangladesh depends on the groundwater supply. BADC reported that about 73% of the total irrigation area is covered by the groundwater supply (The Daily Star, January 18, 2021).

BADC, BARI, and BMDA are the primary agencies of the MoA which deal with irrigation planning and management for the subsector of crops. These interventions include planning for irrigation schemes, developing strategies for irrigation efficiency, facilitating essential infrastructure and equipment for irrigation, conducting necessary research on improved irrigation processes, etc. Though this sector is the bulk user of water resources, it does not manage or maintain a structured accounting system for water. The sector reports the volume of irrigation water use, projected demands, and spatial coverage on an annual or other required interval.

The subsectors of fisheries and livestock have little information published on their status of water consumption or planning for water resources. No comprehensive statistics are found during this assessment on the proportion of domestic or total water consumption used by either of these sectors. To some extent, the fisheries sector exercises the development or enhancement of small-scale surface water reservoirs for fish cultivation.

Overall, groundwater resources are integral to the sustainability of the agriculture sector. However, the government is actively trying to develop and facilitate more surface water resources to limit groundwater's excessive abstraction. The nationwide supply and groundwater use is mainly managed by the DPHE, which operates under the MoLGRD&C.

3.4.2 Water Accounting for the Urban and Industrial Sectors

[Assessment Question 5]

The urban and industrial sectors are predominating consumers of freshwater after agriculture in Bangladesh. This study made a limited effort to explore and understand the status of water accounting practices in these sectors. Rapid urbanization and accelerated growth in industrial development, such as establishing and expanding economic zones, have resulted in a substantial increase in water demand in recent years in Bangladesh.

The urban sector focuses on the supply, demand, use, and accessibility of water as one of the basic human needs or an essential commodity. Water accounts are estimated by performing demand-supply assessments under various water supply sector development projects or programs. This sector has no separate, structured, and living form of water accounting. Urban water management in the country is distributed and managed by urban water supply authorities, city corporations, and small-scale urban municipalities (locally known as Pourashavas). For instance, the Dhaka Water Supply and Sewerage Authority (DWASA) has implemented many groundwater resource assessments and demand-supply assessment studies for the megacity of Dhaka. This information is used to develop essential strategies for water supply, allocation, and distribution within the service boundary of DWASA.

A similar context applies to the industrial sector as well. BEZA, the country's economic zone authority, has implemented several feasibility studies. They have conducted a rigorous demand-supply assessment and forecasting to support the installation and operation of those economic zones. This kind of feasibility study is essential for any economic development project in the country. Generally, the industrial establishments construct facilities for their own supply system and wastewater treatment with essential environmental clearance and permission from the relevant authorities such as DoE, city corporations, or WASAs. These supply systems use groundwater production tube wells or extract water from nearby surface water sources, although groundwater sources are predominant.

Available statistics from secondary sources infer that there is some information related to industrial water consumption. Still, these records do not provide a complete picture of the water accounts for the industrial sector. No structured water accounting system exists to support this sector's water resources management and allocation strategies. The available data are insufficient, disorganized, and not updated. There is no common platform available to get easy access to this information. At the governance level, it is also unclear which organization is mandated to manage sector-specific detailed information on water accounts. Extensive stakeholder consultations are required with the

MoWR and its partner organizations to understand and clarify the sector-specific water accounting context.

3.5 Relevant Projects and Case Studies in Bangladesh

[Assessment Question 6]

This section overviews some relevant projects and case studies conducted in Bangladesh. Generally, almost all water sector development projects include a water balance assessment, which can be easily linked with the elements of a standard water accounting system. The selected case studies show how water balance assessment is being carried out in different projects in the country. However, it is not intended to cover all implementation programs or research works performed on any form of water accounting under this review work.

3.5.1 Regional Water Balance Study Conducted by CSIRO (2014)

The Commonwealth Scientific and Industrial Research Organization (CSIRO) of Australia and the IWM performed an extensive water resources assessment at the regional scale in Bangladesh. The study involved the preparation of water balance for the regional basins and included both surface water and groundwater resources in the estimation. The water balance condition was modeled and analyzed from 1985 to 2010. Additionally, the analysis considered agricultural land use and climate change projections in the estimation. The water balance status was calculated for the three components: land-based surface water balance, groundwater balance, and in-stream water balance within the regional boundaries. It did not consider the major rivers, such as the Padma, Meghna, and Brahmaputra systems, in the analysis. The study applied simplified models, equations, and remotely sensed geospatial datasets to assess the water balance condition. The analysis outcomes are presented separately for each region. Figure 14 illustrates the status of annual average water balance conditions for the selected five regions.

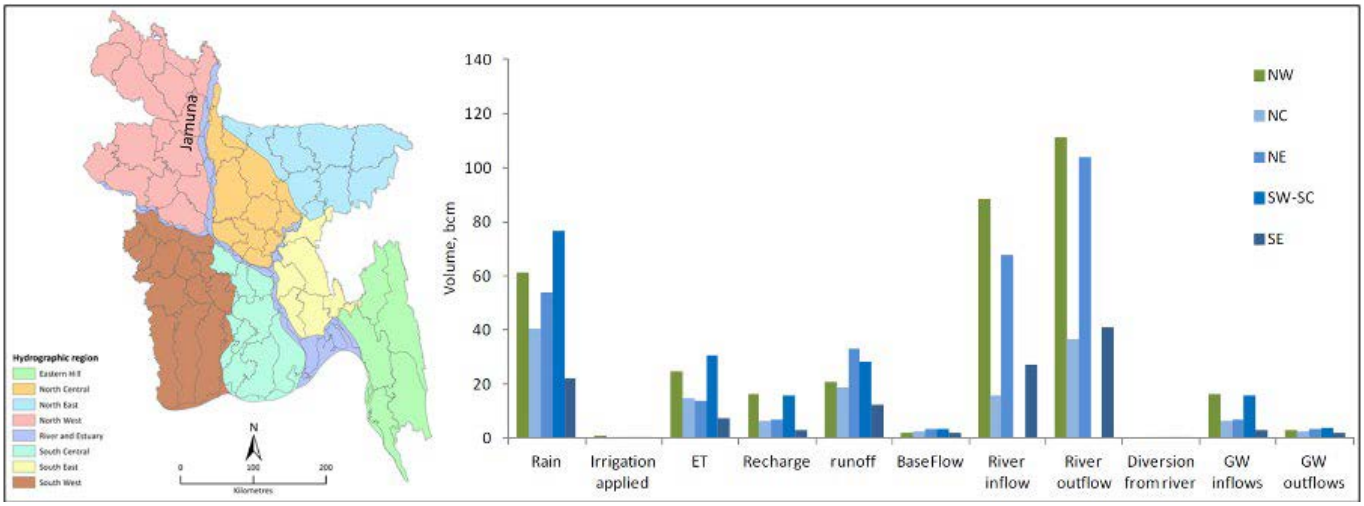


Figure 14: Annual Average Water Balance Condition in Different Regions for 1985-2010 (Source: CSIRO, 2014)

The CSIRO study demonstrates a good example of a water accounting exercise at the regional basin scale in Bangladesh. Such attempts should be taken by following a structured water accounting framework regularly.

3.5.2 Recent Projects Implemented in the Selected Sectors

[Assessment Question 6]

This section provides some examples of recently implemented projects, including water balance studies. These examples are relevant in water accounting since water balance studies are the country's only form of water accounting practice.

3.5.2.1 Water Resources Management

Table 8 provides a list of a few projects implemented in the water sector, including a water balance study to a certain extent. However, these assessments were performed to achieve the project objectives, but not to exercise or present the status of water resource accounts. Almost all of these projects applied hydrological methods or simple spreadsheet-based water balance calculations to measure the supply potential of water resources.

Table 8: Relevant Recent Projects Implemented by Various Agencies of the Water Sector

Sl. No.	Project Name	Implementing Agency	Description of the Project
1	Operationalizing Integrated Water Resources Management (IWRM) in Compliance with the Bangladesh Water Rules, 2018 (2020-2023)	WARPO	This feasibility study project, funded by the Swiss Agency for Development and Cooperation, is being implemented in three districts, namely, Rajshahi, Naogaon, and Chapai Nababganj. The project aims to identify surface water and groundwater resources with supply potential, assess demand, determine safe yield from the groundwater resources, protect reservoirs, and assess the availability, adequacy, and quality of water resources. The study will apply hydrological modeling and the participatory rural appraisal (PRA) approach.
2	Research on Water Security Assessment in the South-West Coastal Region of Bangladesh	WARPO and IDM-KUET	This is a research project on assessing water security for the coastal region of Bangladesh, considering the impact of climate change and other hazards induced by climate change, such as sea-level rise and salinity intrusion.
3	Study for Investigation of Groundwater and Surface Water Irrigation in Habiganj, Moulovibazar, Sylhet, Sunamganj, Netrokona, and Kishoreganj Districts (2015-2019)	DBHWD	The project assessed the status and supply potential of surface water and groundwater resources for irrigation in the selected areas. The study was conducted with the application of mathematical models.
4	37-Town Water Supply Project (2010-2021)	DPHE	The project performed an extensive demand-supply assessment to construct and expand the necessary water supply infrastructure in the project area.
5	Feasibility Study for Water Supply and Sanitation in the Cox's Bazar District (2017-2019)	DPHE	The project performed a water resources assessment and demand-supply analysis for the selected area.

3.5.2.2 Agricultural Water Management

This review study could not find relevant projects for water accounting except for a long list of irrigation schemes. The irrigation development projects mainly included interventions required for improving irrigation efficiency, constructing small-scale surface water sources (e.g., canals), and introducing advanced equipment and technologies.

3.5.2.3 Urban Water Management

The groundwater sources in Bangladesh predominate the urban water supply. Local government agencies such as the WASAs, DPHE, and city corporations implement urban water management programs. These agencies implement numerous projects on water supply and sanitation. As mentioned, these projects focus on installing and expanding groundwater-based supply facilities and networks. Demand-supply projection or water balance assessment is an essential requirement in these projects. For instance, the DWASA has recently implemented the ADB-funded Dhaka Water Supply Sector Development Project (DWSSDP, 2007-2020). The project included an extensive assessment and projection for the water demand and supply for the study area. The water balance status was used to determine the adequacy of interventions designed and implemented under the project.

Many of the water resources development or urban water supply projects across the nation are designed and implemented by the DPHE, some of which are already listed in Table 8. Additionally, DPHE provides technical assistance and implementation support to the local urban authorities, such as the Pourashavas.

3.5.2.4 Industrial Sector Development

During 2014-2021, the BEZA implemented several study projects for the proposed economic zones in the country, as listed below.

- Pre-feasibility studies for the economic zones of Tangail, Sylhet, Sitakundo, Panchagarh, Nilphamari, Nawabganj, Manikganj, Jamalpur, Gopalganj, Chandpur, Bhola, Moheshkhali, Bogura, Natore, Araihazar, etc.
- Feasibility studies for the economic zones of Mirsharai, Gopalganj, Feni, Narayanganj, Jajira, Shreehatta, Netrokona, Mongla, etc.
- Master plan studies for the Bangabandhu Sheikh Mujib Shilpa Nagar (BSMSN), Sabrang Tourism Park, Naf Tourism Park, etc.
- A detailed study on total water demand and water availability for the BSMSN, Sabrang, and Naf Tourism Parks, etc.

These studies include an extensive assessment of water balance conditions and projections for the demand-supply for the selected economic zones. The economic zones consider surface water and groundwater resources for supply, as found in the study reports. However, these study reports generally recommend more surface water and a safe abstraction from the groundwater.

3.6 Water Accounting and Climate Change

[Assessment Question 7]

The water balance assessment study conducted by the CSIRO (Kirby et al., 2014) is a good example of how the climate change impact is addressed in water sector projects. However, it is difficult to draw a concrete conclusion that all interventions in the context of water accounting are climate-informed. Rather, this kind of investigation varies case by case. The inclusion of climate actions has captured the attention of policymakers, financing organizations, and project implementing agencies in the last decade in Bangladesh. Nowadays, considerations for climate

change impact and climate actions are often presented as an essential requirement in every government project or program in the water sector. However, it was not a common scenario in the past. The 8FYP formulates implementation of the programs under the BDP 2100 from 2021, and the policy adequately addresses the inclusion of climate-informed actions in all activities the water sector will implement.

Nevertheless, there is still a significant challenge to quantifying climate-informed actions. The impact of or actions taken for climate adaptation and resilience is generally embedded within and reported with a project's overall outputs or outcomes. Thus, the specific results of climate-informed actions often appear unavailable or uncertain. The climate policy framework in the country generally requires that all interventions be climate-informed. Still, no systematic and sector-specific roadmap has been developed to support the implementing agencies in complying with this criterion.

3.7 Gaps and Needs Assessment

[Assessment Questions 8 and 9]

The assessment exercise identified some critical gaps (or challenges) as well as sector-specific and organizational needs for formulating a structured water accounting system in Bangladesh. However, these findings require a rigorous consultation with the relevant government stakeholders to validate the next step under the direction of MoWR. The gaps and needs assessment primarily used qualitative information obtained from the publications and reports of the sectoral implementing agencies.

Table 9 lists major gaps or challenges identified in the context of water accounting and its implementation for agriculture water management.

Table 9: Major Gaps Identified in the Review Study

Gap Perspective	Description
Gaps in the policy framework	None of the existing water and agriculture sector policy frameworks suggests adopting a structured water accounting system. However, these policies focus mainly on the strategic objectives for water resources management and encourage the adoption of useful decision support systems like water accounting, although not addressed explicitly. The water resources and agricultural water management exercises still follow the conventional water balance approach.
Institutional and Sectoral Challenges	The description is provided in Section 3.7.1.
Resources gap	The existing practice does not follow a standardized water accounting framework like the IWMI WA or SEEA-Water. Information on water resources needs to be organized, stored, used, and shared among the stakeholders. Operating standards and data-sharing protocols should be defined. Controls are required to avoid data duplication. For example, rainfall data are collected simultaneously and separately by more than one agency, e.g., BMD and DAE in Bangladesh, and there is a need to maintain an established procedure for the same data collection, management, and sharing. Since the system is not established yet, the existing resources are not utilized for that purpose, nor are they managed from the perspective of water accounting.

Gap Perspective	Description
Knowledge gap	The existing water balance approach is an ancillary form for water accounting. The principle of standardized water accounting framework is not conceptualized at the governance level yet though there are possibilities of its existence in the research or academic arena.
Collaboration gap	The collaboration gap is one of the most critical and persistent challenges across all sectors in Bangladesh. A more detailed assessment may be required to identify the loopholes and potential consequences in the absence of an active collaboration by the stakeholders and take necessary actions accordingly.
Sustainability challenges	Several other important issues are associated with the sustainability of the water accounting framework if implemented for agricultural water management. For instance, implementing a standardized water accounting framework needs to address the requirements for O&M, capacity building, infrastructure, seamless geospatial and temporal datasets flow, information management and sharing, transboundary and regional aspects, etc.

3.7.1 Institutional and Sectoral Challenges

The challenges can be precisely identified at the institutional level by applying useful tools like the SWOT (S-Strength, W-Weakness, O-Opportunities, T-Threats) analysis. Each organization will have its status in the SWOT framework.

However, this assessment did not perform the SWOT analysis at the individual institution level for two major reasons.

- It requires extensive stakeholder consultation with the individual stakeholder to get reliable and updated information.
- This kind of analysis should not rely on only the secondary data.

Therefore, the exercise was performed on a coarse level only for the subject sectors of water and agriculture. The assessment findings may be common at the institutional level and applicable to other sectors. The major findings from the SWOT analysis are listed in Figure 15. The assessment considers only the aspect of the water accounting system, including its implementation and operationalization for agricultural water management in Bangladesh.

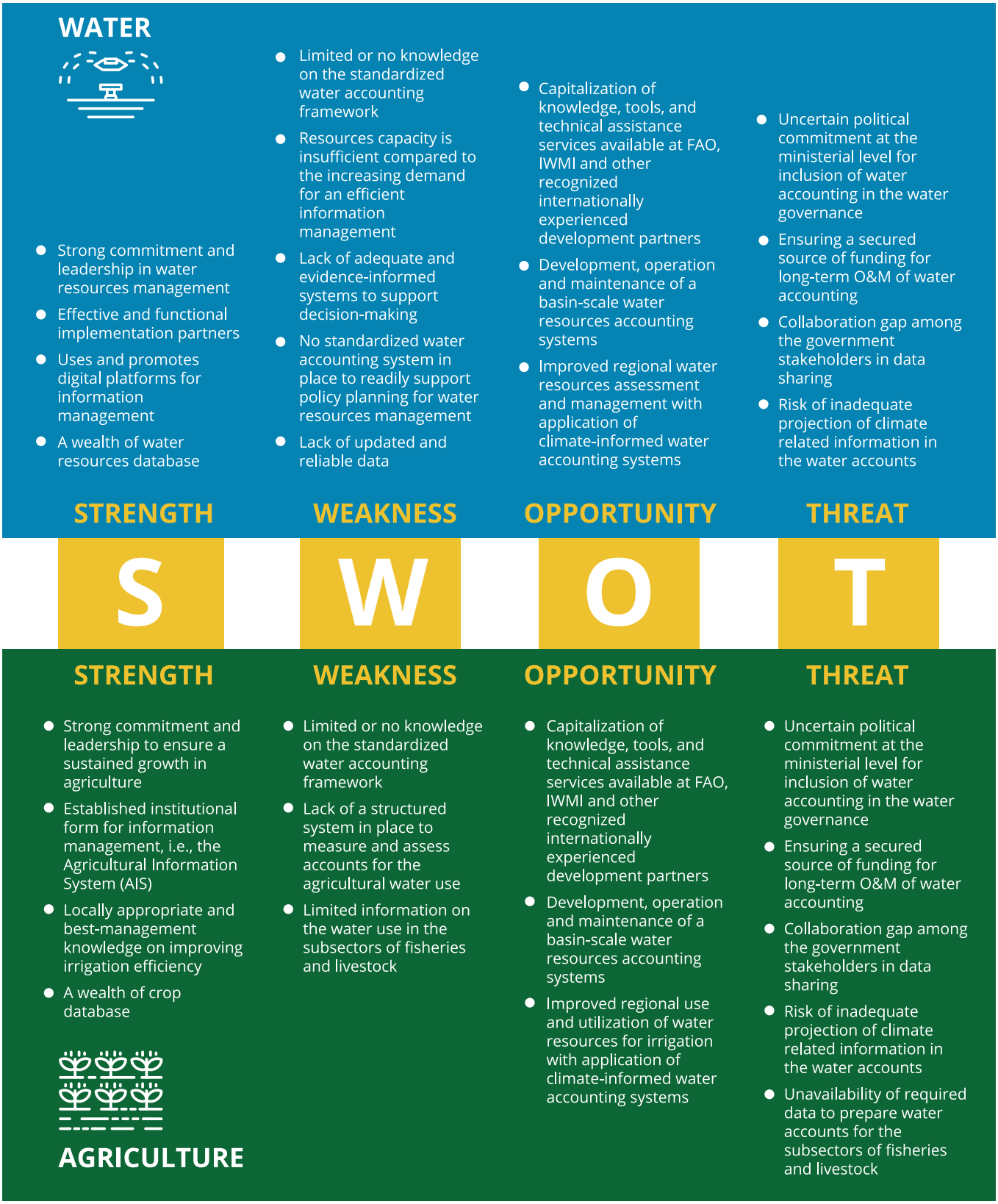


Figure 15: Summary of the findings of the SWOT Analysis

3.7.2 Summary of the Needs Assessment

Table 10 summarizes the needs assessment for implementing a standardized water accounting system for agricultural water management in Bangladesh. The findings are subjected to review and validation by the water sector stakeholders during the next steps to be taken under the guidance of MoWR. Though there may be sector-specific separate water accounting platforms, the water sector

will play the lead role in managing the nation's overall water accounts. Therefore, the needs assessment was conducted and reported with a focus on the water sector of Bangladesh only.

Table 10: Summary of the Needs Assessment of the Water Sector in Bangladesh for Implementation and Operationalization of Water Accounting System

Item	Description of Needs
Infrastructure and Equipment	• Data storage and hosting server or cloud • Dedicated cell or unit to operate the water accounting system with all necessary hardware and equipment setup
Software and Tools	• Developed standardized water accounting framework and portal • GIS and remotely sensed data processing software • A common and easily accessible platform for data use and sharing by the stakeholders • Digital tools for the collection of data from the fields
Database/ Information	• Consolidated water resources database and operational data for the agricultural water use • Data collection, updating, and validation at a regular interval • Elimination of data duplication
Human resources	• Capacity building to support knowledge gain, and O&M of the implemented water accounting systems and tools • Designated officials for managing the water accounting system and applying it for evidence-informed decision-making • A low employee turnover in the cell which maintains the water accounting framework
Major elements of the enabling environment	• *Policy framework* – Inclusion of a standardized water accounting system in the available policy frameworks on water resources management or agricultural water management • *Institution* – Strengthening governance structure to support the incorporation of a dedicated cell for managing the water accounting system, whichever appears feasible • *Institutional collaboration* – Facilitation and improvement of collaboration among all contributing stakeholders on water accounting • *Financing* – A seamless flow of funds to cover all costs incurred for operating the water accounting system • *O&M* – Adequate human resources and other infrastructure to support the O&M • *Data sharing protocol* – An effective and functional data sharing protocol in place to ensure a seamless flow of required data among the stakeholders • *Capacity building* – Training, workshops, demonstrations, etc., on water accounting principles and practice on a regular interval • *Advocacy and research* – Capturing best practices and lessons learned and conducting regular research and studies on water accounting in collaboration with experts in this field, such as FAO, IWMI, etc.

3.8 Selection of an Appropriate Water Accounting Framework

[Assessment Question 10]

Several standardized water accounting frameworks, such as the IWMI WA, SEEA-Water, AWAS, and water footprint accounting, are available in practice. Built on the same principle, these frameworks generally vary in the form of the datasets they use and the collection, processing, and presentation method of those datasets.

Thus, selecting an appropriate water accounting framework for agricultural water management in Bangladesh should consider characteristics, availability, spatial and temporal resolutions, frequency, volume, and methods for collecting both framework-specific and sector-specific datasets. The BDP 2100 references datasets used in Bangladesh's water and IWRM sector (GED, 2018). This list is shown in Table 11.

Additionally, datasets of the agriculture sector, including crop, fisheries, and livestock subsectors, will be required to prepare and present the water accounts for agriculture. The two major outputs presented in the standardized water accounting frameworks for agriculture are water productivity and land productivity. With the advancement of GIS-based and remote sensing technologies, several open-source platforms now provide access to the basin- or country-specific datasets that feed directly into the framework and are used to calculate the abovementioned outputs. For instance, FAO provides access to a wealth of resources on its AQUASTAT platform.

Table 11: Water Resources Data with Sources in Bangladesh (Source: BDP 2100)

Data Types	Authority/ Source
• Surface Water Level • Discharge • Sediment • Rainfall • Evaporation • Surface water quality • Groundwater level and quality • River Morphology • Lithology • Aquifer testing	BWDB
• Irrigation equipment, • Irrigation water quality, • Groundwater levels • Irrigation costs • Crop production cost • Water Quality	BADC
• Groundwater table • Water quality	DPHE

Data Types	Authority/ Source
• Temperature • Sunshine • Relative humidity • Rainfall • Soil moisture • Pan evaporation	BMD
• Census data • Agricultural products	BBS
• Water level (Tidal & Nontidal) • Discharge (Tidal & non-tidal) • Velocity profile • River cross-section • Bathymetric data • Bed sample • Groundwater Level • Evaporation • Rainfall	WARPO and BWDB
• Water Quality • Land Topography • Suspended sediment • River water level • River flow discharge • Groundwater level • Groundwater quality • Temperature • Humidity • Wind speed • Sunshine hour	WARPO and BWDB
• Fish production • Fish biodiversity	DoF

Findings from the literature review and existing best practices on water accounting for IWRM or agricultural water management show that the IWMI WA framework is probably the most recognized and widely applied water accounting method nowadays by the FAO and other international organizations on water. The method can also be applied to developing the water accounting system for Bangladesh because the available databases on water resources can feed into the framework with minimal processing effort. The WA+ or WaPOR tool, built on the IWMI WA framework, can be used in this context to prepare, present and maintain the climate-informed water accounts for the agriculture sector. A similar system can also be designed for the urban and industrial sectors.

However, while this review has identified the IWMI WA Framework and the tools based on this framework as being suitable for application in Bangladesh, the final selection of the water accounting method and tool will be made in consultation with the water sector stakeholders.

3.9 Eighth Five Year Plan and Implementation Prospects for Water Accounting

[Assessment Question 11]

The Eighth Five Year Plan, or 8FYP, is the prevailing national policy framework for development for 2021-2025. The plan additionally feeds into the overarching objectives of the PP 2041 and the BDP 2100. The 8FYP has provided special attention to the resilience and sustainable growth of the water and IWRM sector. Exclusively, the implementation of a standardized water accounting system can adequately address the following essential strategies of the 8FYP, as listed in Table 12.

Notably, in the ADP allocation of the 8FYP, the water sector, i.e., the MoWR, has received 65%-80% of the total budget to implement the agriculture sector projects. This allocation will be utilized over the next five years up to 2025.

Table 12: Selected Strategies of the 8FYP Which Have Potential for Application of Water Accounting (extracted from the 8FYP)

Page Reference	Strategy Mentioned in the 8FYP	Prospective Application of Water Accounting
p. 297	Ensure sustained agricultural growth through more efficient and balanced utilization of land, water, and other resources, and encourage more use of surface water for irrigation and reduction of pressure on ground water while expanding irrigation facilities through improving existing irrigation systems and related infrastructures.	Water accounting will be able to provide the status of the volume of both surface water and groundwater resources, the balance between those resources, the trend in the patterns of supply, availability, and use, the status of resources accounts under climate change and after climate actions, etc. This information will help make informed and improved decisions on irrigation planning and maximization of surface water use.
p. 297	Promote gradual shifting of high water-consuming crops to low water-consuming high-value crops.	The water accounting framework will be able to identify, categorize, and list crop and non-crop water productivity and present land productivity in its outputs, ultimately assisting in decision-making for this gradual transition.
p. 297	Ensure proper use of water resources through active participation in the formulation of strategies and their proper implementation through inter-ministerial/ inter-agency coordination.	A standardized water accounting framework, established at the governance level, will help policymakers, non-technical authorities, and water management institutions obtain and quantify necessary information on the status of resources across different sectors and for other development and economic objectives.

Page Reference	Strategy Mentioned in the 8FYP	Prospective Application of Water Accounting
p. 301	Ensuring optimal use of water resources: Crop diversification is an effective tool for ensuring optimal use of water, given that the water requirement for paddy is much higher than for other crops. For ensuring irrigation efficiency, technologies that enhance conveyance efficiency (e.g., buried pipe, PVC/plastic/polythene pipe, etc.) and on-farm water use efficiency (e.g., drip irrigation, fertigation through drip irrigation system for the non-cereal crops, etc.) need to be promoted. As in BMDA areas, volumetric water pricing that offers incentives to the farmers to rationalize water use will be promoted in areas under deep-tube wells. Tiered pricing – setting the lowest price at that threshold level of water use – will further encourage farmers in the Barind areas to rationalize water use.	Water accounting provides evidence-informed values of water resources both from the hydrological and economic perspectives. Thus, the framework will potentially address the gaps in the current practice and indicate the need for optimization.
p. 304-305	Demand-led agricultural extension • Expansion of small-scale irrigation technology and surface water for irrigation • Strengthening MIS and ICT-based knowledge management system and e-agriculture.	The surface water balance can be measured, monitored, and managed with the information provided by the water accounting framework. The framework, implemented as a web-based decision support system, will equip water governance with an advanced digital technology and knowledge management platform.
p. 318	Open-water capture fisheries • Inland unused water resources will be conserved and developed for fish production. Pollution control of rivers and lakes will be a major focus for government agencies.	The balance of water resources obtained from the water accounting framework will help formulate necessary conservation, development, and treatment strategies.
p. 325	Increasing water use efficiency in crop production and enhancing the utilization of surface water irrigation.	The essential output variables, such as crop water productivity or land productivity, will help make informed decisions on irrigation practices and requirements.
p. 325	Ensuring conjunctive use of surface and groundwater for sustainable irrigation, securing groundwater conservation	The resource accounts regarding volume, availability, accessibility, and use will provide the necessary evidence for planning the conjunctive use.

Page Reference	Strategy Mentioned in the 8FYP	Prospective Application of Water Accounting
p. 325	Strengthening regional and international cooperation for basin-wide water resources development and management of transboundary rivers	Frameworks such as IWMI WA support preparing and presenting basin-scale water accounts. These accounts provide the necessary evidence for policy planning and formulation on regional water management, water security issues, resource conservation, and transboundary water access and sharing.
p. 325	Strengthening capacities of the institution in the water resource management	Implementing a standardized water accounting framework will substantially contribute to the capacity building of MoWR and its partner organizations, such as WARPO, BWDB, and the Joint River Commission (JRC). The application of this tool will enhance good water governance with increased management efficiency.
p. 328-331	Basin-wide Water Resources Development Initiatives	Water accounting will provide access to essential information on the status of basin-scale resources. The measured accounts will automatically feed into the planning of resource development activities and help measure those initiatives' effectiveness regularly.

4. CONCLUSION AND RECOMMENDATIONS

This review study explored the evaluation of existing systems in place for water accounting and evidence-informed water governance, despite having limited available information on the secondary sources. The CARE for South Asia sector focal point within WARPO, MoWR reviewed the draft report and provided detailed comments. These comments and suggestions have been incorporated into this final report.

The review study concluded that a climate-informed water accounting system is needed in Bangladesh because of the decreasing water security under the pressure of growing population and economic growth and the compounding effects expected from projected climate change. A water accounting system is needed to correctly identify water-scarce areas (National Water Policy, Section 4.3) and the actions needed to address water scarcity within these areas. Water accounting can be used to monitor whether water is allocated "with equity and social justice."

The next step, under the guidance of the MoWR, is for the outcomes of this assessment to be presented to all other relevant agencies for their information, comments, and guidance in designing an appropriate water accounting system for the agricultural water subsector in Bangladesh. This report and the knowledge sources referenced will provide technical support for the design.

The recommendations, as listed in Table 13, are expected to show the way forward and provide necessary directions for:

- Developing a comprehensive guideline with a roadmap for the establishment of a climate-informed water accounting system for agricultural water management in Bangladesh
- Implementing and operationalizing the water accounting system at the governance level

Table 13: List of Major Recommendations

Subject	Relevant Policy	Recommendations
Awareness building	NWPo: "4.16 The Government has to be at the core of the effort to help build the local institutions and to impart a precise awareness of the issues and an unambiguous understanding of their role in water management."	• Standardized water accounting is relatively new and unknown to Bangladesh's water and agriculture management institutions. This concept must be understood, recognized, and shared among the active stakeholders. • The difference between the traditional water balance method and a structured water accounting system must be demonstrated to the water sector agencies.
Stakeholder consultation	NWPo: "The policy of the Government is … that all stakeholders actively and fruitfully participate in water resources management decision making at all stages."	• The findings of this assessment need to be validated with inputs from the MoWR, WARPO, and BWDB. • The selection of the water accounting framework needs to be consulted with the MoWR, BWDB, and WARPO.

Subject	Relevant Policy	Recommendations
		• Climate-informed water accounting should be implemented in a participatory manner that encourages individual and representative water user stakeholder engagement, activities, and inputs. This is important as water accounting may lead to water auditing and regulatory action.
Sector-specific framework development	Bangladesh Country Investment Plan for Environment, Forestry, and Climate Change (2016 – 2021): 3.2.3 Support the development of irrigation schemes (drought-prone areas), Priority investment areas under sub-programme 3.2.3, Water accounting and water productivity.	• It is recommended to design and develop sector-specific water accounting frameworks and an aggregated overall system for the national water resources system. • The proposed water accounting framework may provide essential technical reference to other functional and cross-cutting sectors. • The WARPO should define water scarcity zones as a matter of priority, and climate-informed water accounting should be used where necessary to effectively implement special regulatory powers to strengthen the protection of water security for equity, social justice, and/or environmental protection. These water scarcity areas should be sub-areas of the already defined hydrological regions for water resources planning and management. WARPO, while making assessments to define water scarcity zones, should make its evaluation considering the study area in the context of its hydrological region and the water inflows and outflows (both surface and subsurface) between the study area and the region, and the instream and environmental requirements of that region.
Basin-scale development	NWMP Vol 2: 3.2 Analytical framework, Extended hydrological regions	• The water resources management and studies generally follow a basin-wide approach in analysis which is also required for the hydrological investigations. Therefore, a basin-scale (or hydrological region) water accounting framework may be designed to maintain consistency in managing water resource information and accounts.
Data sharing protocol and standard	NWMP, Vol 2, Table 10.1, Establishment of reliable and available data	• The challenges associated with data sharing among different stakeholder agencies need to be resolved, and an effective data-sharing protocol and standard need to be developed to ensure the operation of the water accounting framework.

Subject	Relevant Policy	Recommendations
Collaboration system and requirements	NWMP Vol 2, 8.1.4 Assumptions "comprehensive collaboration between BWDB and other water sector stakeholders is assumed"	• The collaboration among the water sector stakeholders needs to be substantially enhanced to ensure a seamless sharing of data and information and to support the operation of the water accounting system.
Data analysis and assessment	NWMP, Vol 2, Table 10.1,	• An adequacy analysis of the available data and required data (for the framework) are required from the hydrological, operational, and economic perspectives before deciding on the water accounting framework beginning development.
Climate actions	NWMP, Vol 2, 3.8 Knowledge gaps, 3.8.1 Climate change	• The proposed water accounting framework must explicitly address and incorporate climate-related considerations, indicators, and outputs. The implemented system should be able to translate climate actions into evidentiary accounts of water resources.
Other sustainability issues		• Responsibility and Accountability – One or more designated water management institutions must be mandated with responsibility and accountability for establishing and operating water accounting systems in water governance. There may also be a designated cell or unit within the existing institutions. • O&M – Necessary resources, including data flow, funding, and capacity building, must be arranged and maintained to support continuous O&M of water accounting practices. Additionally, an effective and functional system should be in place to execute the O&M of the water accounting portal. • Resources – The system should facilitate and assure the availability of all technical and management resources to support the water accounting system's functioning. • Capacity building – Relevant capacity building programs such as training on data collection and processing, use of water accounting portal, data updating and maintenance, reporting of accounts, interpretation of results for decision making, data sharing procedures and protocols, water resources auditing, evaluation of climate actions, etc., need to be conducted on a regular interval.

Subject	Relevant Policy	Recommendations
		• Financing – Financing to support the operating cost of the water accounting system and reporting portals is an essential requirement. At the management level, there should be an adequate and consistent flow of funds to bear all costs for O&M and system upgradation.

The steps which should be taken and the suggested duration for implementation of each step in preparation for climate-informed water accounting are:

i. Awareness building and stakeholder agency consultation, 6 months.

ii. Sector-specific framework development for climate-informed water accounting and potential extension to regulatory action for strengthened water security, 12 months.

iii. Improved and collaborative data and information management among the water sector and water development and use agencies, 18 months.

iv. Review and strengthening of the sector-specific framework to incorporate climate-related considerations, indicators, and outputs, 6 months.

v. Government decisions on the linkages to be developed between climate-informed water accounting, national statistics, SDG reporting, and the UN's Global Assessment of Environmental-Economic Accounting and Supporting Statistics, 3 months.

vi. Government decisions and actions to assign responsibility and provide human and financial capacity to implement climate-informed water accounting, 6 months.

Many of these steps can be taken in parallel, so the preparation period for climate-informed water accounting could be between 18 months and 2 years.

Implementing climate-informed water accounting is recommended to extend over a 2-year period to capture 2 full agricultural cycles.

Based on the recommendations provided in this section of the report, ADPC proposes to consult with the Ministry of Water Resources (MoWR), the Government of Bangladesh as well as with the Water Resources and Planning Organization (WARPO), and relevant government agency stakeholders identified by MoWR and WARPO on the implementation of climate-informed water accounting, and on awareness building on the topic which may be necessary. ADPC will also explore options to propose a project to develop a comprehensive framework and implement climate-informed water accounting with relevant donor agencies.

REFERENCES

ADB. (2020). Asian Water Development Outlook 2020: Advancing Water Security Across Asia and the Pacific. ADB. Metro Manila. Philippines

ADB. (2019). Project Data Sheet. Dhaka Water Supply Sector Development Program. ADB. Metro Manila. Philippines

Australian Bureau of Statistics. (2012). Completing the Picture-Environmental Accounting in Practice. ABS. Australia

BADC. (2020). Minor Irrigation Survey Report 2018-19. Digitalization of Survey and Monitoring for Development of Minor Irrigation Project. BADC. MoA. Dhaka. Bangladesh

BWDB. (2020). Environmental Management Framework. Climate Smart Agriculture and Water Management Project (CSAWMP). BWDB. MoWR. Dhaka. Bangladesh

Comprehensive Assessment of Water Management in Agriculture. (2007). Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture. London: Earthscan, and Colombo: International Water Management Institute. Sri Lanka

Cook, S. E., Andersson, M. S., and Fisher, M. J. (2009). Assessing the Importance of Livestock Water Use in Basins. The Rangeland Journal. CSIRO Publishing. Australia

DHI Water and Environment, Canada. (2010). Okanagan Basin Water Accounting Model: Final Report. Okanagan Basin Water Board. Canada

Dieter, C.A., Maupin, M.A., Caldwell, R.R., Harris, M.A., Ivahnenko, T.I., Lovelace, J.K., Barber, N.L., and Linsey, K.S., (2018). Estimated Use of Water in The United States in 2015: U.S. Geological Survey Circular 1441, 65 p. USGS. U.S.A.

DoE. (2019). Good Practices and Innovations in Implementing Rio Conventions in Bangladesh. DoE. MoEFCC. Dhaka. Bangladesh

DWASA. (2014). Water Supply Master Plan for Dhaka City. JV of IWM and DevCon. DWASA. Dhaka. Bangladesh

Elmahdi, A. (2020). Guided Paper: Water Accounting Reporting System-WARS Framework from Concept to Implementation for Sustainable Water Management. International Journal of Environmental Sciences and Natural Resources. Juniper Publishers

European Union. (2015). Guidance Document on the Application of Water Balances for Supporting the Implementation of the WFD. European Union. Luxembourg

Eurostat. (2002). Water Accounts-Results of Pilot Studies. Eurostat. European Commission. Belgium

FAO and IHE Delft. (2020). Water accounting in the Nile River Basin. FAO WaPOR water accounting reports. FAO. Rome. Italy

FAO and IHE Delft. (2020a). Water accounting in the Awash River Basin. FAO WaPOR water accounting reports. FAO. Rome. Italy

FAO and IHE Delft. (2020b). Water accounting in the Jordan River Basin. FAO WaPOR water accounting reports. FAO. Rome. Italy

FAO and IHE Delft. (2020c). Water accounting in the Niger River Basin. FAO WaPOR water accounting reports. FAO. Rome. Italy

FAO and IWMI. (2020). Stakeholder Mapping and Needs Assessment – Lebanon. Remote Sensing for Water Productivity. WaPOR Capacity Development Series. FAO. Rome. Italy

FAO and IHE Delft. (2019). Water accounting in the Litani River Basin. FAO WaPOR water accounting reports. FAO. Rome. Italy

FAO. (2019). WaPOR Database Methodology: Level 3 Data – Using Remote Sensing in Support of Solutions to Reduce Agricultural Water Productivity Gaps. FAO. Rome. Italy

FAO. (2019). Water Use in Livestock Production Systems and Supply Chains – Guidelines for Assessment (Version 1). Livestock Environmental Assessment and Performance (LEAP) Partnership. FAO. Rome. Italy

FAO and World Water Council. (2018). Water Accounting for Water Governance and Sustainable Development: White Paper. FAO and World Water Council. Rome. Italy

FAO. (2017). Water Accounting and Auditing: A Source Book. FAO Water Reports: 43. FAO. Rome. Italy

FAO. (2017a). Water for Sustainable Food and Agriculture: A Report Produced for the G20 Presidency of Germany. FAO. Rome. Italy

FAO. (2016). Strengthening Agricultural Water Efficiency and Productivity on the African and Global Level: Status, Performance and Scope Assessment of Water Harvesting in Uganda, Burkina Faso and Morocco. FAO. Rome. Italy

FAO. (2014). Towards Sustainable Agriculture and Improved Food Security and Nutrition. Bangladesh Country Program Framework 2014-2018. FAO. Rome. Italy

FAO. (2012). Building Resilience for Adaptation to Climate Change in the Agriculture Sector: Proceedings of a Joint FAO/OECD Workshop held on 23-24 April 2012. FAO. Rome. Italy

GED. (2018). Bangladesh Delta Plan 2100. Vol 1: Strategy. GED. Dhaka. Bangladesh Germanwatch. (2020). Global Climate Risk Index 2020. Germanwatch. Berlin. Germany

Godfrey, J. M., and Chalmers, K. (2012). Water Accounting: International Approaches to Policy and Decision-making. Edward Elgar Publishing, Inc. Massachusetts. U.S.A.

Graham, N.T., Hejazi, M.I., Kim, S.H. et al. Future changes in the trading of virtual water. Nat Commun 11, 3632 (2020). https://doi.org/10.1038/s41467-020-17400-4

Groom, B. (2012). Climate Change Adaptation: The Bangladesh Experience. World Wide Fund for Nature – Pakistan

GWP South Asia. (2018). Annual Report 2018. GWP South Asia

GWP. (2009). Water Management, Water Security and Climate Change Adaptation: Early Impacts and Essential Responses. GWP

Haie, N., Comment: Efficient Irrigation; Inefficient Communication; Flawed Recommendations. Irrigation and Drainage 57: 245- 247. Available: https://core.ac.uk/download/pdf/55619126.pdf

Esen, S.E. and Hein, L. (2020). Development of SEEA water accounts with a hydrological model. Science of The Total Environment. 737: 140168. Doi: 10.1016/j.scitotenv.2020.140168

Hoekstra, A.Y. (2003). Virtual Water Trade: Proceedings of the International Expert Meeting on Virtual Water Trade. IHE Delft. Netherlands

Hossain, L., and Khan, M. S. (2020). Water Footprint Management for Sustainable Growth in the Bangladesh Apparel Sector. MDPI Water

Hunink, J., Simons, G., Alminana, S. S., Solera, A., Andreu, J., Giuliani, M., Zamberletti, P., Grillakis, M., Koutroulis, A., Tsanis, I., Schasfoort, F., Contreras, S., Ercin, E., and Bastiaanssen, W. (2019). A Simplified Water Accounting Procedure to Assess Climate Change Impact on Water Resources for Agriculture across Different European River Basins. MDPI Water

ICID. (2019). Position Paper on Water Accounting as a Sustainable Agricultural Water Management Framework. ICID. New Delhi. India

IWMI. (2014). Presentation on Water Accounting: Water Productivity Workshop, World Bank. IWMI. Sri Lanka

Kam, S.P., Cai, X., Sood, A., Hoanh, C.T., Yen, B.T., Nagoli, J., and Chijere, A. (2013). Decision Support for Water Management for Integrating Aquaculture in Small-Scale Irrigation Systems: A Case for The Chingale Catchment in Malawi. WorldFish. Penang. Malaysia

Karimi, P. (2014). Water Accounting Plus for Water Resources Reporting and River Basin Planning. PhD Thesis. IWMI. Sri Lanka

Karimi, P., Bastiaanssen, W. G. M., Molden, D., and Cheema, M. J. M. (2013). Basin-wide water accounting based on remote sensing data: an application for the Indus Basin, Hydrol. Earth Syst. Sci., 17, 2473–2486, https://doi.org/10.5194/hess-17-2473-2013, 2013.

Kirby, M., Ahmad, M., Mainuddin, M., Palash, W., Qadir, E., and Shahnewaz, A. M. (2014). Bangladesh Integrated Water Resources Assessment, Supplementary Report: Approximate Regional Water Balances. CSIRO. Australia

Lovelace, J. K. (2009). Method for Estimating Water Withdrawals for Livestock in The United States, 2005:

U.S. Geological Survey Scientific Investigations Report 2009–5041, 7 p. USGS. U.S.A.

Ministry of Foreign Affairs of the Government of Netherlands. (2018). Climate Change Profile: Bangladesh. The Government of the Netherlands. Netherlands

Molden, D. (1997). Accounting for Water Use and Productivity. SWIM Paper 1. IWMI. Colombo, Sri Lanka

Morrison, J., Schulte, P., and Schenck, R. (2010). Corporate Water Accounting: An Analysis of Methods and Tools for Measuring Water Use and Its Impacts. The CEO Water Mandate. UNEP. Pacific Institute. California. U.S.A.

Nicholls, R. J., Adger, W. N., Hutton, C. W., and Hanson, S. E. (2020). Deltas in the Anthropocene. Pages: 22-26. Springer. Switzerland

OECD. (2014). Climate Change. Water and Agriculture: Towards Resilient Systems, OECD Studies on Water. OECD Publishing

Perry, C. 2007. Efficient Irrigation; Inefficient Communication; Flawed Recommendations. Irrigation and Drainage 56: 367- 378. Available: https://onlinelibrary.wiley.com/doi/epdf/10.1002/ird.323

Perry, CJ., 2018. The IIMI Water Balance Framework: A Model for Project Level Analysis. https://www.iwmi.cgiar.org/Publications/IWMI_Research_Reports/PDF/pub005/REPORT05.PDF Molden, D., Accounting for Water Use and Productivity. System wide Initiative for Water Management, Paper 1. https://www.iwmi.cgiar.org/Publications/SWIM_Papers/PDFs/SWIM01.PDF

Pound, B., Lamboll, R., Croxton, S., Gupta, N., and Bahadur, A. V. (2018). Climate-Resilient Agriculture in South Asia: An Analytical Framework and Insights from Practice. Learning Paper. Oxford Policy Management. The U.K.

PWC. (2015). Consolidation and Analysis of Information on Water Resources Management in Bangladesh. 2030 Water Resources Group. India

Rahman, M. M., Nicholls, R. J., Hanson, S. E., Salehin, M., and Alam, S. (2019). Integrated Assessment for the Bangladesh Delta Plan 2100: Analysis of Selected Interventions. BUET, Southampton University, and GED. Dhaka. Bangladesh

Schuenemann, F., and Hess, S. (2019). The Impact of Livestock Support Measures on Groundwater Depletion in Turkey. 22nd Annual Conference on Global Economic Analysis. Warsaw. Poland

Stats NZ. (2019). Environmental-Economic Accounts: Sources and Methods. Second Edition. Stats NZ Tatauranga Aotearoa. Wellington. New Zealand

Stockholm Environment Institute. (2016). WEAP Tutorial. Stockholm Environment Institute. Stockholm. Sweden

The CEO Water Mandate. (2011). Water Footprint and Corporate Water Accounting for Resource Efficiency. UNEP.

UN FAO, AQUASTAT - FAO's Global Information System on Water and Agriculture. https://www.fao.org/aquastat/en/

United Nations. (2021) The United Nations World Water Development Report 2021: Valuing Water. UNESCO. Paris. France

UNSD. (2012). International Recommendations for Water Statistics. United Nations. U.S.A.

UNSD. (2012a). System for Environmental and Economic Accounting for Water. United Nations. U.S.A.

United Nations. (2014). System of Environmental-Economic Accounting 2012—Central Framework. https://unstats.un.org/unsd/envaccounting/seeaRev/SEEA_CF_Final_en.pdf

UN-Water. (2020). United Nations World Water Development Report 2020: Water and Climate Change. UNESCO. Paris. France

UN-Water. (2019). Climate Change and Water: UN-Water Policy Brief. UN-Water. UNESCO. Paris. France

WASB. (2012). Australian Water Accounting Standard 1: Preparation and Presentation of General Purpose Water Accounting Reports. WASB. Bureau of Meteorology. Australian Government. Australia

WASB. (2011). International Water Accounting: Current Practice and Potential Development. WASB. Bureau of Meteorology. Australian Government. Australia

WASB. (2009). Water Accounting Conceptual Framework for the Preparation and Presentation of General Purpose Water Accounting Reports. WASB. Bureau of Meteorology. Australian Government. Australia

Winrock International. (2015). Water Accounting Plus (WA+) for reporting Water Resources Conditions and Management: A Case Study in the Ca River Basin, Vietnam. Winrock International

The Water Footprint Network (2010) Available: https://www.waterfootprint.org/

World Bank. (2016). High and Dry: Climate Change, Water, and the Economy. World Bank. Washington, DC. U.S.A.

WWF. (2015). Water Governance in Bangladesh: Challenges and Opportunities around Policy, Institutional Function and Implementation for a Sustainable Water Future. WWF. Switzerland

ANNEXURE I: LIST OF GOVERNMENT PUBLICATIONS AND RESOURCES REVIEWED TO PERFORM THE ASSESSMENT

List of Reviewed Legal, Institutional, Regulatory, and Policy Frameworks

Sl	Sector	Name of Policy Framework	Abbreviated Form of the Policy Framework	Type of Policy Framework	Policy Level	Publication Year	Issued by
1	Water	National Water Management Plan 2001	NWMP 2001	Plan	National	2004	WARPO
2	Water	Bangladesh Water Act 2013	Water Act 2013	Act	National	2013	LPAD
3	Water	National Water Policy 1999	NWPo 1999	Policy	National	1999	MoWR
4	Water	Bangladesh Water Rules 2018	Water Rules 2018	Rules	National	2018	MoWR
5	Water	Coastal Zone Policy 2005	CZPo 2005	Policy	Regional	2005	MoWR
6	Water	District Integrated Water Resources Management Guideline 2020	District IWRM Guideline 2020	Guideline	National	2020	WARPO
7	Water	Upazila Integrated Water Resources Management Guideline 2020	Upazila IWRM Guideline 2020	Guideline	National	2020	WARPO
8	Water	Union Integrated Water Resources Management Guideline 2020	Union IWRM Guideline 2020	Guideline	National	2020	WARPO
9	Water	Guidelines for Participatory Water Management 2000	GPWM 2000	Guideline	National	2000	WARPO
10	Water	Haor Master Plan 2012	Haor Master Plan 2012	Plan	Regional	2012	DBHWD
11	Water	National Policy for Safe Water Supply and Sanitation 1998	NPSWSS 1998	Policy	National	1998	LGD
12	Water	National Strategy for Water Supply and Sanitation for Hard-to-Reach Areas of Bangladesh 2012	NSWSS HtR 2012	Strategy	National	2012	LGD
13	Water	Sector Development Plan for Water Supply and Sanitation Sector of Bangladesh (FY 2011-2025)	SDP 2011-2025	Plan	National	2011	LGD

Sl	Sector	Name of Policy Framework	Abbreviated Form of the Policy Framework	Type of Policy Framework	Policy Level	Publication Year	Issued by
14	Water	Water Supply Master Plan for Dhaka City 2014	Water Supply Master Plan 2014	Plan	Local	2014	DWASA
15	Agriculture	National Agriculture Policy 2018	NAP 2018	Policy	National	2018	MoA
16	Agriculture	National Agriculture Extension Policy 2020	NAEP 2020	Policy	National	2020	MoA
17	Agriculture	Groundwater Management Act 2018 for Agriculture Use	Groundwater Management Act 2018	Act	National	2018	MoA
18	Agriculture	Medium-Term Strategy and Business Plan 2012-2016	MTSBP 2012-2016	Strategy	National	2012	MoA
19	Agriculture	National Agricultural Mechanization Policy 2020	NAMP 2020	Policy	National	2020	MoA
20	Agriculture	Bangladesh Agricultural Research Council Act 2012	BARC Act 2012	Act	National	2012	MoA
21	Agriculture	National Organic Agriculture Policy 2016	NOAP 2016	Policy	National	2016	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	Master Plan for Agricultural Development in the Southern Region 2011	MPADSR 2011	Plan	Regional	2011	MoA
25	Climate Change	National Adaptation Program of Action 2009	NAPA 2009	Plan	National	2009	MoEFCC
26	Climate Change	Bangladesh Climate Change Strategy and Action Plan 2009	BCCSAP 2009	Strategy	National	2009	MoEFCC
27	Climate Change	Intended Nationally Determined Contribution 2015	INDC 2015	Strategy	National	2015	MoEFCC
28	National Policy	National Sustainable Development Strategy 2010-2021	NSDS 2010-2021	Strategy	National	2013	GED

Sl	Sector	Name of Policy Framework	Abbreviated Form of the Policy Framework	Type of Policy Framework	Policy Level	Publication Year	Issued by
29	National Policy	Bangladesh Delta Plan 2100	BDP 2100	Plan	National	2018	GED
30	National Policy	Perspective Plan 2021-2041	PP 2041	Plan	National	2020	GED
31	National Policy	8th Five Year Plan 2021-2025	8FYP 2021-2025	Plan	National	2020	GED
32	Fisheries	Fisheries Research Institute Act 2018	FRI Act 2018	Act	National	2018	LPAD
33	Fisheries	Bangladesh Fisheries Development Corporation Act 1973	BFDC Act 1973	Act	National	1973	LPAD
34	Fisheries	Pond Development Act 1939	PD Act 1939	Act	National	1939	LPAD
35	Fisheries	Policy for Establishment of Fish Hatchery in the Vabadaha Area 2019	Vabadaha Fish Hatchery Policy 2019	Policy	Regional	2019	MoFL
36	Fisheries	National Aquaculture Development Strategy and Action Plan 2013-2020	Aquaculture Strategy 2013-2020	Strategy	National	2014	MoFL and FAO
37	Livestock	National Livestock Development Policy 2007	LDP 2007	Policy	National	2007	MoFL

Other Publications and Resources

- AIS, Annual Report 2019-2020
- BADC, Annual Report 2019-2020
- BARC, Annual Report 2019-2020
- BARI, Annual Report 2019-2020
- BEZA, Annual Report 2020 (Draft)
- BEZA Different Study Reports:
  - » Detail study on total water demand and water availability for Sabrang and Naf Tourism Park
  - » Feasibility Report of Mongla EZ
  - » Feasibility Study for Mirershorai Economic Zone
  - » Feasibility Study of Anowara-2 and Sabrang Tourism Park
  - » Feasibility Study of Anwara Economic Zone
  - » Feasibility Study of Feni Economic Zone
  - » Feasibility Study of Gopalgonj EZ
  - » Feasibility Study of Jajira Economic Zone
  - » Feasibility Study of Jaliardip, Narayanganj Economic Zone
  - » Feasibility Study of Mirersarai 2 EZ
  - » Feasibility Study of Mirsarai Economic Zone
  - » Feasibility Study of Netrokona EZ
  - » Feasibility Study of Sabrang Tourism Park
  - » Feasibility Study of Shreehatta Economic Zone
  - » Feasibility Study Report for Jamalpur Economic Zone
  - » Feasibility Study Report of Sreehatta Economic Zone
  - » Master Plan of BSMSN
  - » Master Plan of Naf Tourism Park
  - » Master Plan of Sabrang Tourism Park
  - » Master Plan of Sonadia Eco Tourism Park
  - » Pre- Feasibility Study Report of Araihazar EZ
  - » Pre- Feasibility Study Report of Bhola EZ
  - » Pre- Feasibility Study Report of Chandpur EZ
  - » Pre- Feasibility Study Report of Gopalganj EZ

» Pre- Feasibility Study Report of Jamalpur EZ
» Pre- Feasibility Study Report of Manikgonj EZ
» Pre- Feasibility Study Report of Nawabganj EZ
» Pre- Feasibility Study Report of Nilfamari EZ
» Pre- Feasibility Study Report of Panchagarh
» Pre- Feasibility Study Report of Sitakundo EZ
» Pre- Feasibility Study Report of Sylhet EZ
» Pre-Feasibility Study Report of Tangail EZ
» Pre-feasibility Report of Mirsarai (2) EZ
» Prefeasibility Study of Dhaka SEZ
» Prefeasibility Study of Moheshkhali EZ
» Pre-feasibility Study Report for Bogura Economic Zone
» Pre-feasibility Study Report for Natore Economic Zone
» Prefeasibility Study Report Jaliar Dwip Economic Zone (Naf Tourism Park)
» Water demand and water availability assessment for Bangladesh Sheikh Mujib Shilpanagar

- DBHWD, Annual Report 2018-2019
- DBHWD, Haor Master Plan 2012
- DoF, Annual Report 2018
- DPHE, Annual Report 2019-2020
- DPHE, Water Resources Status and Coverage Report, June 2019
- DWASA, Annual Report 2019-2020
- GED, SDG: Bangladesh Progress Report 2020
- LGED, Annual Progress Report 2019-2020
- MoFL and FAO, National Aquaculture Development Strategy and Action Plan of Bangladesh 2013- 2020
- MoWR, Annual Report 2019-2020
- MoWR, APA Report for the First Quarter of 2021
- WARPO, Annual Report 2019-2020
- The Daily Star, Press Release on the Event of BADC on January 18, 2021

ANNEXURE II: LIST OF IDENTIFIED STAKEHOLDERS

AIS	Agricultural Information System
BADC	Bangladesh Agricultural Development Corporation
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BEZA	Bangladesh Economic Zones Authority
BMD	Bangladesh Meteorological Department
BMDA	Barind Multipurpose Development Authority
BWDB	Bangladesh Water Development Board
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
DPHE	Department of Public Health Engineering
FFWC	Flood Forecasting and Warning Center of the BWDB
LGD	Local Government Division
LGED	Local Government Engineering Department
MoA	Ministry of Agriculture
MoD	Ministry of Defense
MoEFCC	Ministry of Environment, Forest and Climate Change
MoFL	Ministry of Fisheries and Livestock
MoLGRD&C	Ministry of Local Government, Rural Development and Cooperatives
MoWR	Ministry of Water Resources
PMO	Prime Minister's Office
WARPO	Water Resources Planning Organization
WASA	Water Supply and Sewerage Authority

ANNEXURE III: DETAILED ASSESSMENT TABLE OF THE AVAILABLE LEGAL, INSTITUTIONAL, REGULATORY, AND POLICY FRAMEWORKS ON THE WATER ACCOUNTING (WA) SYSTEM OF BANGLADESH

COLOR LEGEND:

YES

NO

Name of Policy Framework	Issued by	Overview of the Policy Framework	Explicitly includes provision or system for WA?	Includes Element(s) of WA?	Elements of WA Addressed				Policy Summary on WA	Incorporates Climate Actions?	Suggested Climate Action		Policy Summary on Climate Action	Notes
					Supply	Demand	Accessibility	Use			Adaptation	Mitigation		
National Water Management Plan 2001	WARPO	This is the principal policy framework for water resources management in the country.							The plan does not explicitly address or recommend a WA system. But it provides essential assessment and planning for the demands, supply, distribution, and use of water resources for the selected hydrological and socio-economic zones				The plan provides a summary of potential climate change impact on the water and relevant sectors, but provides no guidelines or directions for climate adaptation or mitigation measures.	
Bangladesh Water Act 2013	LPAD								The Act provides the necessary legal foundation for the management and conservation of water in the country. Though it does not explicitly address the requirement for a decision support system like WA, the provisions made are adequate for an enabling environment for WA and water governance. Some useful clauses are: > Clause 15 (Ch IV) states that the national water resources plan shall contain, among others, the following matters: c. Scientific analysis of all data and information on water resources d. Development of overall planning, infrastructure for abstraction, distribution, use, protection, and conservation of water resources and formulation of instructions thereof for short, medium, and long terms.					

Name of Policy Framework	Issued by	Overview of the Policy Framework	Explicitly includes provision or system for WA?	Includes Element(s) of WA?	Elements of WA Addressed				Policy Summary on WA	Incorporates Climate Actions?	Suggested Climate Action		Policy Summary on Climate Action	Notes
					Supply	Demand	Accessibility	Use			Adaptation	Mitigation		
									f. Present and future use of water resources. j. Basin-wise development plan. > Clause 18 (Ch V) states use of water in agriculture at the third order of national interest in the category of preferential use of water in the water-stressed area. > Clause 23 (Ch V) explicitly addresses the requirement for the demarcation of agricultural water zones to support the management of agricultural water use. > Clause 38 (Ch VII) allows provisions for the utilization of information and communication technology to support management activities for water resources for any purpose.					
National Water Policy 1999	MoWR	This is the active and guiding policy document that provides direction to all agencies working with the water sector, and institutions that relate to the country's development, management, and utilization of water resources.							The policy document gives an emphasis on the development and utilization of safe groundwater and surface water resources to meet the country's water demand, and ensure water security across different socio-economic levels. The document does not explicitly address any system or requirement for WA but includes policies for supply, accessibility, and use. The guidance provided in this framework is integral to the design of a structured WA system for the country.				No provisions for climate actions are made in this policy document.	

Name of Policy Framework	Issued by	Overview of the Policy Framework	Explicitly includes provision or system for WA?	Includes Element(s) of WA?	Elements of WA Addressed				Policy Summary on WA	Incorporates Climate Actions?	Suggested Climate Action		Policy Summary on Climate Action	Notes
					Supply	Demand	Accessibility	Use			Adaptation	Mitigation		
Bangladesh Water Rules 2018	MoWR	The Water Rules 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 partner organizations.							The framework provides only the management and operational procedures for the water sector agencies of the government. It does not deal with the concept or elements of WA.				No provisions for climate actions are made in this policy document.	
Coastal Zone Policy 2005	MoWR	This policy provides essential guidance for developing and managing the coastal zone with water as the focus.							The policy document does not explicitly address provisions for WA, but it includes development and management plans for water supply sources and their distribution and accessibility. Additionally, it emphasizes the application of mathematical modeling, remote sensing, and GIS for managing the resources information and supporting planned interventions.				The policy encourages the application of appropriate adaptation and mitigation measures in response to the experienced and predicted climate change impacts (Section 4.8.3, p.8).	Section 5.5.3, p.11 suggests the application of mathematical modeling, remote sensing, and GIS for coastal development and management of information.
Upazila Integrated Water Resources Management Guideline 2020	WARPO	This guideline document builds on the Water Rules 2018 and provides direction for water governance to the Upazila-level management committee.							The guideline deals with the administrative procedures for water management, and does not explicitly address features of WA.				The guideline or any prescribed form under the guideline does not explicitly address any action for climate change.	
Union Integrated Water Resources Management Guideline 2020	WARPO	This guideline document builds on the Water Rules 2018 and provides direction for water governance to the Union-level management committee.							The guideline deals with the administrative procedures for water management, and does not explicitly address features of WA.				The guideline or any prescribed form under the guideline does not explicitly address any action for climate change.	

Name of Policy Framework	Issued by	Overview of the Policy Framework	Explicitly includes provision or system for WA?	Includes Element(s) of WA?	Elements of WA Addressed				Policy Summary on WA	Incorporates Climate Actions?	Suggested Climate Action		Policy Summary on Climate Action	Notes
					Supply	Demand	Accessibility	Use			Adaptation	Mitigation		
Guidelines for Participatory Water Management 2000	WARPO	This guideline provides the definition and participatory role of different implementing water organizations in the country.							The guideline deals with the administrative procedures for water management, and does not explicitly address features of WA.				The guideline or any prescribed form under the guideline does not explicitly address any action for climate change.	The guideline explicitly addresses the agricultural-aspect of participatory water management at different local levels.
Haor Master Plan 2012	DBHWD	This is a 20-year master plan for developing and managing the haor areas in Bangladesh, focusing on the water sector.							Though the plan deals with management of water resources, it does not explicitly address the system or features of WA.				The plan provides requirements for climate adaptation and mitigation measures at the strategy level, but no specific direction or methodology has been listed.	This policy framework focuses on domestic or community water supply. It does not describe provisions for sectoral water use, such as agriculture.
National Policy for Safe Water Supply and Sanitation 1998	LGD	This policy was formulated to support the government's goal of ensuring safe water and sanitation access.							This policy focuses on the domestic water supply and utilization of surface water and groundwater sources. It does not provide any strategy or system for developing WA.				No provisions for climate actions are made in this policy document.	This policy framework focuses on domestic or community water supply. It does not describe provisions for sectoral water use, such as agriculture.
National Strategy for Water Supply and Sanitation for Hard-to-Reach Areas of Bangladesh 2012	LGD	This policy document helps the government formulate water supply and sanitation strategies for specially defined communities that are difficult to reach and deprived of the national level of citizen services.							This policy focuses on the domestic water supply and utilization of surface water and groundwater sources. It does not provide any strategy or system for developing WA.				No provisions for climate actions are made in this policy document.	This policy framework focuses on domestic or community water supply. It does not describe provisions for sectoral water use, such as agriculture.

Name of Policy Framework	Issued by	Overview of the Policy Framework	Explicitly includes provision or system for WA?	Includes Element(s) of WA?	Elements of WA Addressed				Policy Summary on WA	Incorporates Climate Actions?	Suggested Climate Action		Policy Summary on Climate Action	Notes
					Supply	Demand	Accessibility	Use			Adaptation	Mitigation		
Sector Development Plan for Water Supply and Sanitation Sector of Bangladesh (FY 2011-2025)	LGD	This is the guiding and most comprehensive national plan for water supply and sanitation. It focuses on the domestic or community water supply.							This policy focuses on the domestic water supply and utilization of surface water and groundwater sources. It does not provide any strategy or system for developing WA.				Although no climate actions are included, the plan recognizes the lack of climate actions and relevant policies in other policy frameworks and development plans. It also indicates climate change's potential impact on the water supply sector.	This policy framework focuses on domestic or community water supply. It does not describe provisions for sectoral water use, such as agriculture.
Water Supply Master Plan for Dhaka City 2014	DWASA	This is a 50-year master plan for the water supply services of Dhaka WASA. The plan provides direction and strategies for the water supply and distribution in the Dhaka megacity.							The plan provides detailed information on existing and future water supply, demand, sources, and distribution mechanisms. However, it does not discuss any system or proposal for a structured WA.				Rainwater harvesting has been suggested as an alternative source of supply and an adaptation measure in response to climate change (Section 8.4, p.93).	This policy framework focuses on domestic or community water supply. It does not describe provisions for sectoral water use, such as agriculture.
National Agriculture Policy 2018	MoA	This is the guiding document for the agriculture sector in Bangladesh. The policy statements target sustained development of the sector and food security under the changing climate.							The policy document does not explicitly address provisions for or features of WA. The policies are focused on infrastructure and hardware components in the sector. Additionally, it promotes research and development of resilient and more- productive crops.				The policy encourages the application of appropriate adaptation measures and promotes research and development of climate resilient species (Section 3.3.6, p.7).	The policy objectives, among many, include requirements for effective coordination and active participation in water resources management.
Agriculture Extension Policy 2020	MoA	This policy document aims at ensuring food security and managing and expanding a sustained development of the agriculture sector.							The policy document provides emphasis on the establishment of a digital or electronic database system to support information management of crops, productions, technologies, markets, etc. (Section 4.9, p.11 and Section 5.9, p.13). However, it does not explicitly address the features or requirements of WA.				The policy encourages the application of appropriate adaptation and mitigation measures to maintain and enhance food security (Section 5.10, p.14).	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 (Section 5.23, p.16).

Name of Policy Framework	Issued by	Overview of the Policy Framework	Explicitly includes provision or system for WA?	Includes Element(s) of WA?	Elements of WA Addressed				Policy Summary on WA	Incorporates Climate Actions?	Suggested Climate Action		Policy Summary on Climate Action	Notes
					Supply	Demand	Accessibility	Use			Adaptation	Mitigation		
Groundwater Management Act 2018 for Agriculture Use	MoA	The Act provides a legal framework for groundwater use in agriculture.							The document does not explicitly address the features of WA. It provides legal requirements for groundwater use in agriculture.				No provisions for climate actions are made in this policy document.	
Medium Term Strategy and Business Plan 2012-2016	MoA	This strategy document provides investments and programs to sustain the development of the agriculture sector for the period of 2012-2016. Additionally, it states the policies and plans adopted to mitigate the existing and potential challenges.							The document does not explicitly address the features of WA. It provides strategies for irrigation and utilization of surface water resources.				The suggested programs include climate actions and appropriate adaptationbor mitigation measures.	
National Agricultural Mechanization Policy 2020	MoA	This is the government's policy toward building and enhancing agricultural mechanization for crop production management.							The policy promotes using and expanding machinery for crop production and eliminates manual intervention as much as possible.				No provisions for climate actions are made in this policy document. However, the policy recognizes the need for mechanization to cope with the growing demand and tackle the impact of climate change.	
Bangladesh Agricultural Research Council Act 2012	MoA	This is the legal framework under which the BARC was established with a mission to institutionalize the nation's agricultural research system.							Not applicable. However, the development and practice of WA may be a living subject of research under the Act.				No provisions for climate actions are made in this policy document.	

Name of Policy Framework	Issued by	Overview of the Policy Framework	Explicitly includes provision or system for WA?	Includes Element(s) of WA?	Elements of WA Addressed				Policy Summary on WA	Incorporates Climate Actions?	Suggested Climate Action		Policy Summary on Climate Action	Notes
					Supply	Demand	Accessibility	Use			Adaptation	Mitigation		
National Organic Agriculture Policy 2016	MoA	The policy was developed to sustain and promote organic agriculture practices and thereby reduce the adverse impact of excessive use of agrochemicals.							The policy does not include WA contexts but emphasizes the optimum utilization of water resources.				No provisions for climate actions are made in this policy document.	
Bangladesh Agricultural Development Corporation Act 2018	MoA	This is the legal framework under which the BADC was established with a mission to institutionalize the nation's agricultural management system and ensure food security.							Though the Act does not contain the context of WA, it includes essential elements of WA for irrigation and overall agricultural water use.				No provisions for climate actions are made in this policy document.	
Bangladesh Agricultural Research Institute Act 2017	MoA	This is the legal framework under which the BARI was established with a mission to institutionalize the nation's agricultural research work and develop essential solutions and knowledge base.							The policy includes provisions for research work on irrigation and agricultural water use.				The policy suggests research work on climate change impact (Clause 5(h), p.3).	
Master Plan for Agricultural Development in the Southern Region 2011	MoA	This is a regional development plan for the southern and coastal parts of the country.							Though the plan does not contain the context of WA, it includes essential elements of WA for water resources management.				The policy suggests research work on climate change impact (Clause 5(h), p.3).	
Master Plan for Agricultural Development in the Southern Region 2011		This is a regional development plan for the southern and coastal parts of the country.							Though the plan does not contain the context of WA, it includes essential elements of WA for water resources management.				The policy discusses the likely impact of climate change and suggests the adoption of necessary adaptation and mitigation measures.	

Name of Policy Framework	Issued by	Overview of the Policy Framework	Explicitly includes provision or system for WA?	Includes Element(s) of WA?	Elements of WA Addressed				Policy Summary on WA	Incorporates Climate Actions?	Suggested Climate Action		Policy Summary on Climate Action	Notes
					Supply	Demand	Accessibility	Use			Adaptation	Mitigation		
National Adaptation Program of Action 2009	MoEFCC								The policy does not explicitly address the elements of WA, but it includes adaptation strategies for water resources use and utilization.				The policy designs adaptation strategies across different sectors in response to climate change.	
Bangladesh Climate Change Strategy and Action Plan 2009	MoEFCC	This is the principal strategy for responding to climate change for the period of 2009- 2018.							The policy does not explicitly address the elements of WA, but it includes adaptation strategies for improving water use efficiency.				The policy builds on NAPA 2009 and includes extensive measures for adaptation and mitigation.	
Intended Nationally Determined Contribution 2015	MoEFCC	This is the guiding mitigation policy of the government in response to climate change. It builds on BCCSAP 2009 and sets national targets on carbon emission limits.							The policy does not explicitly address WA's elements but suggests rainwater harvesting adoption.				The policy builds on BCCSAP 2009 and includes extensive measures for mitigation.	
National Sustainable Development Strategy 2010-2021	GED	The strategy focuses on development priorities for some selected sectors for a period of 2010-2021. This is the guiding reference for the nation's sustainable development.							The policy does not explicitly address WA, but it suggests strategies for the management of all elements of WA (Section 7.1, p.116-118).				The policy addresses climate change as a cross-cutting issue and sets strategies for adaptation and mitigation across different sectors (Section 7.5, p.125-128).	
Bangaladesh Delta Plan 2100	GED	This is the century-wide vision for national development. The policy is designed to keep the water sector at the center of development.							The policy does not explicitly address WA, but it adequately covers all elements of WA.				The policy addresses climate change as a cross-cutting issue and sets strategies for adaptation and mitigation across different sectors.	
Perspective Plan 2021- 2041	GED	The policy describes the vision for national development up to 2041.							The policy does not explicitly address WA, but it adequately covers all elements of WA.				The policy addresses climate change as a cross-cutting issue and sets strategies for adaptation and mitigation across different sectors.	

Name of Policy Framework	Issued by	Overview of the Policy Framework	Explicitly includes provision or system for WA?	Includes Element(s) of WA?	Elements of WA Addressed				Policy Summary on WA	Incorporates Climate Actions?	Suggested Climate Action		Policy Summary on Climate Action	Notes
					Supply	Demand	Accessibility	Use			Adaptation	Mitigation		
8th Five Year Plan 2021- 2025	GED	This is the latest five-year development plan of the government.							The policy does not explicitly address WA, but it adequately covers all elements of WA (Part II, Section 4.6.3, p.325-332).				The policy addresses climate change as a cross-cutting issue and sets strategies for adaptation and mitigation across different sectors.	
Fisheries Research Institute Act 2018	LPAD	This is the legal framework under which the Fisheries Research Institute was established.							The Act does not provide any information related to WA.				No provisions for climate actions are made in this policy document.	
Bangladesh Fisheries Development Corporation Act 1973	LPAD	This Act provides the legal framework for the development of the fisheries sector in Bangladesh.							The Act does not provide any information related to WA.				No provisions for climate actions are made in this policy document.	
Pond Development Act 1939	LPAD	This Act provides the legal framework for the development of the ponds for the purpose of fish cultivation.							The Act does not provide any information related to WA, but includes guidelines for pond development as a water reservoir to support fish cultivation.				No provisions for climate actions are made in this policy document.	
Policy for Establishment of Fish Hatchery in the Vabadaha Area 2019	MoFL	This is the policy framework for developing fish hatcheries in the Vabadaha area of Jessore district.							The policy framework suggests the conservation and use of water resources in the area, but it does not explicitly address the features of WA.				No provisions for climate actions are made in this policy document.	
National Aquaculture Development Strategy and Action Plan 2013-2020	MoFL and FAO	This is the guiding policy document for the development of the aquaculture sector in Bangladesh for the period of 2013- 2020							The policy framework suggests necessary strategies for the utilization of water resources to support aquaculture development, but it does not explicitly address the features of WA.				The policy recognizes risks and hazards from the impact of climate change but does not specifically address any adaptation or mitigation strategy.	
National Livestock Development Policy 2007	MoFL	This is the guiding policy document for the development of the livestock sector in Bangladesh.							The policy document does not address any elements of WA.				No provisions for climate actions are made in this policy document.	

ANNEXURE IV: LIST OF STAKEHOLDERS CONSULTED

Mr. Md. Delwar Hossain, Director General, WARPO, Bangladesh

Mr. Md. Alamgir Hossain, Director of Planning, WARPO, Bangladesh

Mr. Md. Mashuk Miah, Director General, DBHWD, Bangladesh

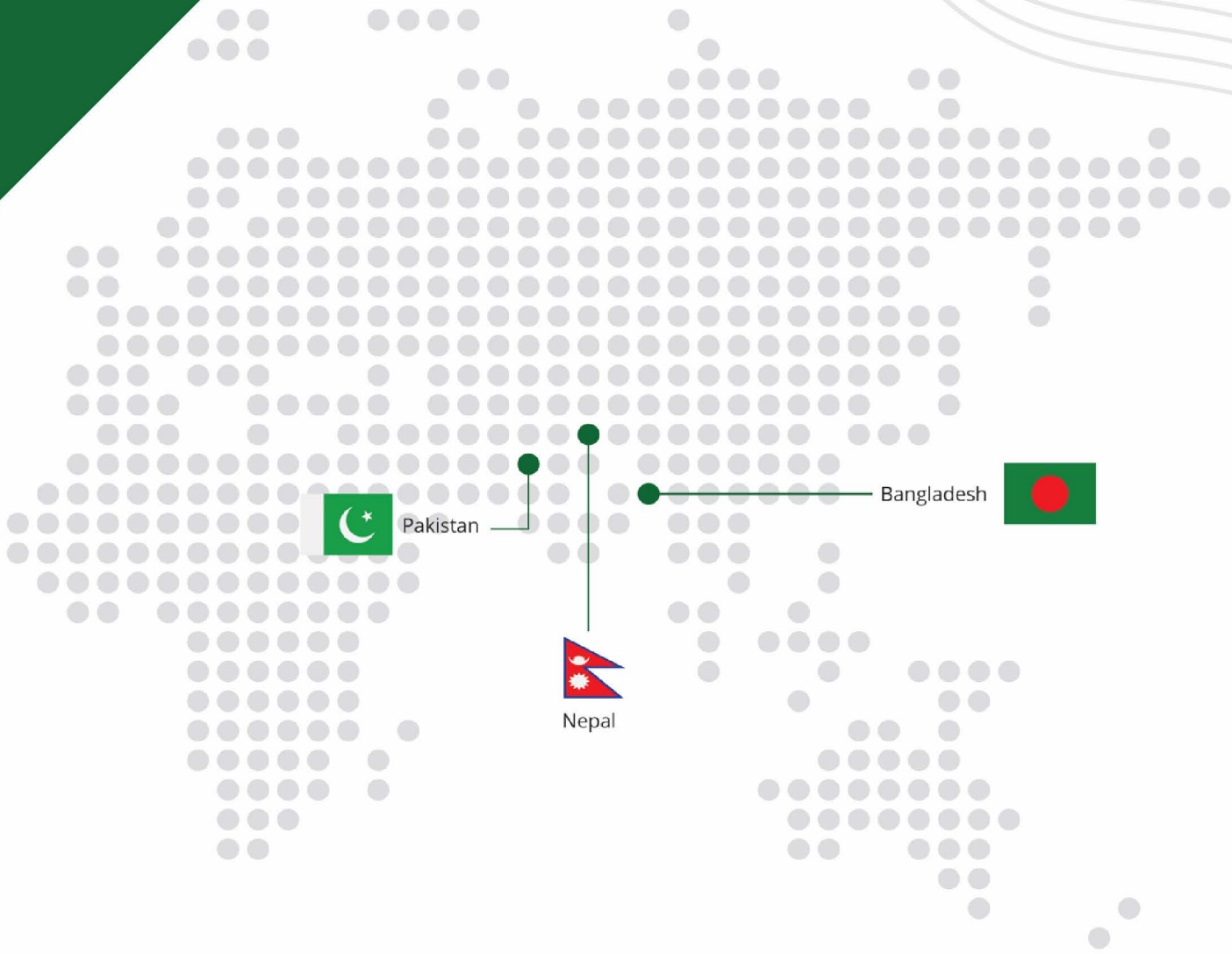
Mr. Md. Rafiqul Islam, Deputy Director, DoE, Bangladesh

Mr. Md. Ziaul Haque, Member Director (Irrigation), BADC, Bangladesh (online)

Sector Focal Points for the Water Sector of Bangladesh in CARE for South Asia Project

Mr. Md. Mahmud Hasan, Deputy Secretary, MoWR, Bangladesh

Mr. Md. Hasan Shahariar, Senior Scientific Officer (Environment), WARPO, Bangladesh



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)