Netherlands Enterprise Agency

Establish a Shared Agenda for Addressing the "Build, Neglect, and Rebuild" Cycle in the Water Sector in Bangladesh

PARTNERS FOR WATER
CO-CREATING IMPACT

TABLE OF CONTENTS

Abbreviations and Acronyms

ADB	Asian Development Bank
AMP	Asset Management Policy
AMS	Asset Management System
BCCSAP	Bangladesh Climate Change Strategic and Action Plan
BDP2100	Bangladesh Delta Plan 2100
BIWTA	Bangladesh Inland Water Transport Authority
BNR	Build Neglect Rebuild
BWDB	Bangladesh Water Development Board
CMG	Canal Maintenance Group
DMA	District Metering Area
DRR	Disaster Risk Reduction
DWASA	Dhaka Water Supply and Sewerage Authority
DWSSDP	Dhaka Water Supply Sector Development Project
EAMS	Embankment Asset Management System
EMG	Embankment Maintenance Group
FCD	Flood Control and Drainage
FCDI	Flood Control Drainage and Irrigation
FFW	Food For Works
FGD	Focus Group Discussion
GBM	Ganges-Brahmaputra-Meghna
GDP	Gross Domestic Product
GIS	Geographic Information System
GoB	Government of Bangladesh
GoN	Government of the Netherlands
GPWM	Guidelines for Participatory Water Management
ICWFM	International Conference on Water and Flood Management
IOB	Policy and Operations Evaluation Department of the Ministry of Foreign Affairs of the Netherlands
IWFM-BUET	Institute of Water and Flood Management Bangladesh University of Engineering and Technology
IWRM	Integrated Water Resources Management
JICA	Japan International Cooperation Agency
KII	Key Informant Interview
KWASA	Khulna Water Supply and Sewage Authority
LGED	Local Government Engineering Department

LGI	Local Government Institute
MFI	Multilateral Finance Institution
MoF	Ministry of Finance
MTBP	Medium-Term Budget Framework
NBS	Nature-Based Solution
NGO	Non-Governmental Organization
O&M	Operation and Maintenance
PC	Planning Commission
PC	Planning Commission
PPR	Public Procurement Regulations
PWM	Participatory Water Management
RB	Revenue Budget
RCA	Root Causes Analysis
RHD	Roads and Highways Department
RVO	Netherlands Enterprise Agency
SC	Southcentral
SDG	Sustainable Development Goal
SRP	System Rehabilitation Project
SW	Southwest
UP	Union Parishad
WMA	Water Management Association
WMG	Water Management Group
WMO	Water Management Organisation
WUA	Water Users Association
WUO	Water Users Organization

Public Paper / Summary[1]

OPERATION AND MAINTENANCE: SETTING AN AGENDA FOR THE WATER SECTOR IN BANGLADESH

1 The need for preserving assets in Bangladesh's water sector.

In Bangladesh's water resources sector, operation and maintenance (O&M) is not always prioritized, and an adequate system for asset management is not in place or is ineffective. This leads to what some describe as a repeating cycle of rebuilding, whereby the lack of adequate asset management leads to premature deterioration of assets and below-optimal operation. This cycle has significant implications for cost-effectiveness in asset management, with the lack of timely minor repairs leading to costly premature rehabilitation in the future. It also manifests itself in inadequate sustainable services from the water system. Four root causes have been identified jointly with the key stakeholders, worked out in more detail in Figure 1:

1. Insecure and insufficient funding for O&M
2. Delayed emergency responses
3. Lack of an asset management system
4. Inadequate management of river sedimentation

This repeating cycle is, for example, illustrated by embankments that were able to give protection in the short term, but then became debilitated over time because of a lack of regular maintenance, with recurrent floods and moderate storm surges weakening or causing breaches in the embankments. Other examples are the reportedly large number of drainage *khals* (canals) silted up, irrigation systems that underachieve, and gated structures that are not in operation. The same applies to equipment, such as dredgers, not being kept operable. Whereas the asset base in the water sector significantly increases, its upkeep is not keeping a similar pace. This has significant implications for realising and sustaining SDGs.

Amongst stakeholders from the water and agriculture sector, including government organizations, financiers and NGOs, there is an acknowledgement of the need to put O&M higher on the agenda. This is, for example, reflected in the Bangladesh Delta Plan 2100 (BDP2100), which mentions that – to make the BDP2100 a reality - the total O&M budget of water infrastructure would need to be raised to 0.5% of GDP, which would equal 2.3 Billion USD (World Bank, 2022), whereas the actual current amount hardly touches 0.1% of GDP.

The neglect of O&M is not only a matter of unavailability of financial resources, but also a matter of organisation. Going beyond the common explanation of "lack of funds" is important: there is a need for better stock-taking, better prioritisation, better planning, clearer roles and responsibilities and more efficient and timely procedures.

With the goal of establishing a shared agenda to address this repeating cycle in the water sector in Bangladesh, the Institute of Water and Flood Management Bangladesh University of Engineering and Technology (IWFM BUET), and MetaMeta – supported by the Partners for Water Program of the Netherlands Enterprise Agency (RVO) – conducted a literature review (on root causes), held stakeholder

1 This summary also serves as the public report (final draft version, to be approved by key stakeholders)

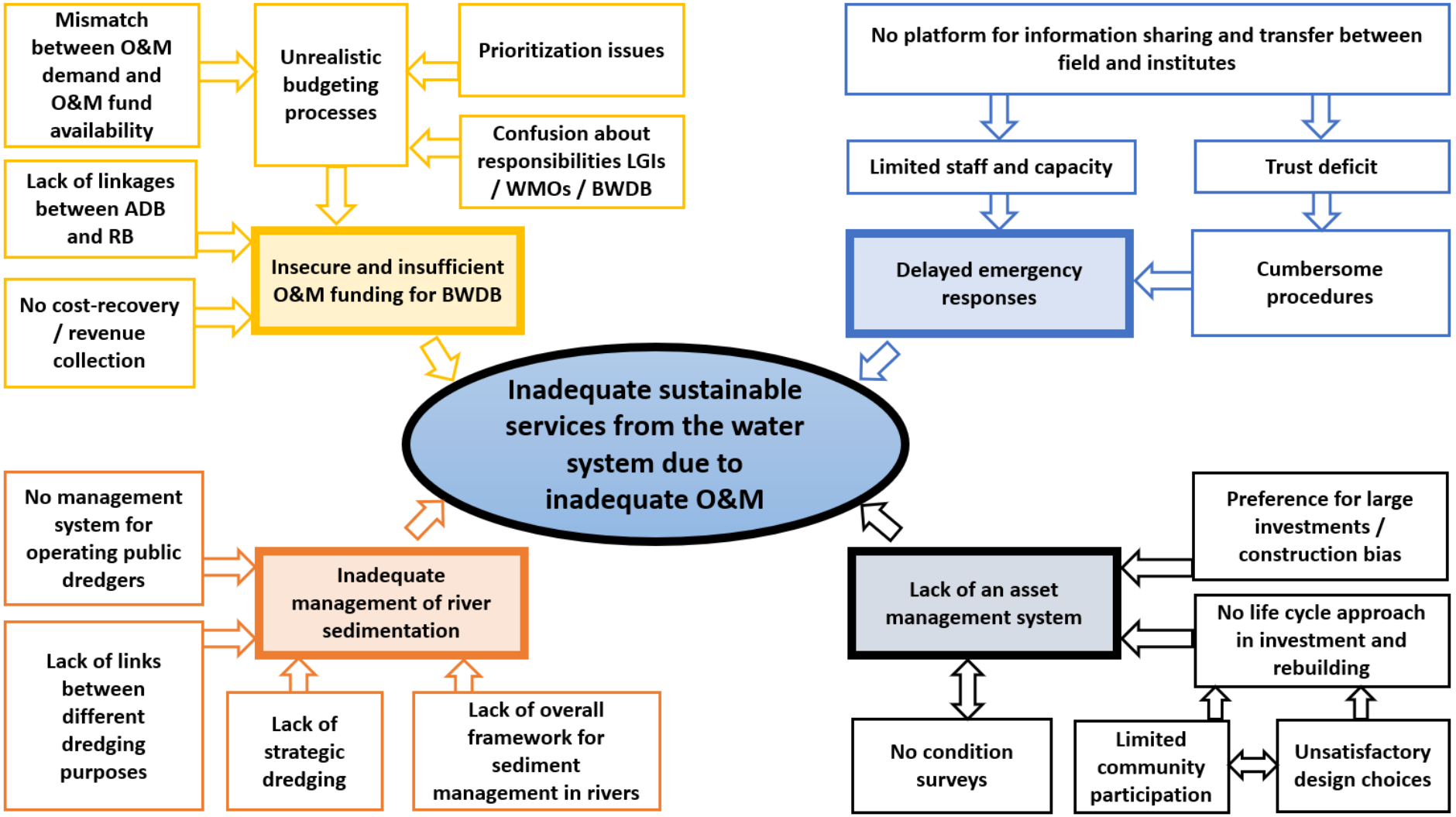

Figure 1 *The root causes of inadequate sustainable services from the water system due to inadequate O&M*

consultations and guided the co-creation of a shared agenda (for O&M) and ways forward. The stakeholder consultations included interviews with key stakeholders, a special session on “Reactive O&M to Asset Management of Water Infrastructure in Bangladesh” at the 9th International Conference on Water and Flood Management 2023 (ICWFM-2023) in October 2023, and a workshop, co-organised by the Bangladesh Water Development Board (BWDB), in November 2023, to confirm interest in, reach consensus on the analysis and finetune the shared agenda and action plan for the coming years (2024-2027).

The starting point of the shared agenda and way(s) forward, is a sound analysis of the root causes of the inadequate sustainable services from the water system. Four root causes have been identified jointly with the key stakeholders, worked out in more detail in Figure 1.

2 Agenda

The identified root causes lead to the following shared agenda:
Asset management should be a central consideration.

- A coherent strategy should be observed to link water infrastructural asset planning, budgeting, (performance) delivery, operation, and monitoring with broader planning objectives – see Figure 2.
- As examples from Bangladesh show, automation and innovation can be helpful, for instance, in the operation of sluice gates.
- Medium-term rolling maintenance plans should be prepared based on updated system inventories per existing guidelines.
- The realistic roles and responsibilities of Water Management Organisations (WMOs) in O&M should be clearly defined and collectively agreed on.
- WMOs should be part of and deeply engaged in the overall operation of the water system, including in in-polder water management.
- Design and construction need to align with the long-term importance of the water infrastructure in a changing climate. Designs and construction standards need to increasingly be based on a ‘life cycle’ approach, whereby long-term reliability of the infrastructure is served, and overall maintenance costs are reduced, albeit at maybe higher initial investment costs.
- To increase accountability, three-yearly engineering and maintenance audits should be done.

Figure 2 *A framework for asset management, showing its different aspects (https://www.assetmanagementbc.ca/framework/)*

Asset management should align with the needs for the functionality of the water system: funding should be certain and sufficient.

- Repairs should not only be done in response to emergencies but also based on the identified priority lists for routine and periodic maintenance.
- O&M should be adequately financed based on well-documented priority submissions by the Bangladesh Water Development Board (BWDB) to the Planning Commission.
- The capacity – both human resources and funds – in BWDB - should be adjusted to the increasing need for O&M.
- Asset management should be given financial importance as defined in the BDP2100 – the Government of Bangladesh (GoB) Annual Development Budget (ADB) and Revenue Budget should be aligned in this regard.
- Development partners should not focus only on new investments, but should factor in adaptative measures, O&M, and consider system and governance improvement programmes.
- Opportunities for user fees and other revenue generation from water systems should be explored.

Emergency responses need to align with the urgency of the emergencies.

- If emergency response is delayed, lives/livelihoods are jeopardised, and recovery and rehabilitation costs increase significantly.
- Addressing emergency response is vital – emergency systems should ensure that response is done almost immediately and prepared for in advance.
- There is a need for a dedicated plan for future emergency repairs based on an overview of the system, learning from BWDB and Local Government Engineering Department (LGED) local offices and data analysis – predicting priority lists of expected emergencies.
- The emergency response procedures and related preparedness and funding arrangements should be reviewed and modified.
- Delegated funds and standby arrangements with contractors should be explored.
- The overall budget for emergency work needs to increase – from the current very low levels – covering less than 20% of emergency needs.

River management needs to be effective and align with the sedimentation challenge.

- An overall framework for sediment management in the river system, defining what should be done, where and how, should be developed and agreed upon with all main stakeholders under the leadership of the Planning Commission.
- Given the large interest, the knowledge basis for sediment management, including bathymetrical surveys, should be strengthened within BWDB and the Bangladesh Inland Water Transport Authority (BIWTA).
- There needs to be systematic coordination between the different sediment operations in the river system – for river management, for sand mining and new land development.
- The financial benefit generated by land development and sand mining should fund part of the river management activities.
- A system for maintaining and sustainable deploying publicly owned dredgers needs to be in place.

3 Immediate next steps

Promising immediate activities that can set in motion medium-term change, addressing the different root causes, include the following:

- **Streamlining procurement processes for emergencies** – There is an urgent need to reconsider procurement processes and make them more flexible and responsive. This includes assessing whether the emergency procurement methods of the Public Procurement Rules (PPR) cover all aspects of emergency procurement, and whether a separate budget can be earmarked for emergency procurement, with a short notice call off option. It may be explored whether a direct procurement method can be deployed in an emergency, with BWDB having a list of local sources of goods and services that might be needed in an emergency and information on rates and charges established and agreed upon in advance. This element is strongly connected to the comparative analysis of emergency repair mechanisms.
- **Moving towards life cycle management** - Reviewing designs (embankments, canals, gates) to come to low maintenance and reasonable cost options, doing full costing analysis (with BWDB and Monetary Financial Institutions (MFIs) - starting with composite gates. This would help to come to low maintenance systems; assessing cost and benefits of asset management with the Planning Board and Ministry of Finance to come to developing pathways from a 'structure inventory system' to an asset management system, building it up in steps.
- **Developing cooperative frameworks** - Between BWDB, WMO, DoA, DAE, and LGIs, to also address the full potential of in-polder water management.

The different activities should be ground-truthed in Polder 31, which is designated to lead in shaping the **Polder of the Future**. However, given the status of Polder 31 and the relatively long time needed to assess the benefits of the activities in this polder, it would also be worthwhile to start activities in comparable polders. An adaptive set-up will help to reach most benefits.

Finally, and importantly, the process should be anchored in a **high-level panel** supported by a number of activities – identified above - that pursue the discussion and dialogue on the different parts of the root cause analysis. This working group is to include key stakeholders and (emerging) champions in Bangladesh and is foreseen to closely link to the BWDB governing board with invitees. Important stakeholders are the Planning Commission, the Ministry of Finance, the Department of Agricultural Extension, the Local Government Engineering Department, representatives of Water Management Federations and other Water Management Organizations, as well as independent experts from universities and technical institutes.

1

Scope of the Report

SCOPE OF THE REPORT

This report is part of the assignment “Literature Review and Stakeholder Consultation to Establish a Shared Agenda for Addressing the “Build, Neglect, and Rebuild” (BNR) Cycle in the Water Sector, with a Collaborative Approach in Bangladesh” funded through the Partners for Water Program by the Netherlands Enterprise Agency (RVO). This assignment has been carried out by MetaMeta Research and the Institute of Water and Flood Management (IWFM) Bangladesh University of Engineering and Technology (BUET). It involves conducting a literature review, stakeholder consultations, comparative analysis, and proposing practical recommendations to break the cycle, which are all reflected upon in this report.

The basic premise of this assignment is that the water resources sector in Bangladesh is characterized by a repeating cycle of BNR (build, neglect and rebuild), whereby operation and maintenance are not prioritized, and an adequate system for asset management is in not place. From this premise, the purpose of this assignment was to set the agenda for a discussion for change in the vital field, by documenting the key issues in BNR and jointly come to an understanding of the why and what and prepare for the process whereby solutions are jointly agreed and addressed.

The report focuses on three important areas: 1) the root causes analysis (RCA), 2) the shared agenda setting, and 3) the action plan 2024-2025. The first one (covered in Chapter 4) addresses the main root causes of the BNR cycle, which have been identified and supported with data and insights based on a review of literature and stakeholder consultations, including interviews. The latter two (covered in Chapter 5) build on the RCA, and on ways to address the agreed upon root causes. They use the RCA as the basis to come to a shared agenda between GoB and GoN for addressing operation and maintenance, defining agenda topics and the fora where it can be discussed, and, more specifically, contribute to an action plan (2024-2025) for assessments, studies, pilots, working groups, events, and media outputs, as well as a central steering of the debate.

2

Introduction

INTRODUCTION

Globally, a lack of operation and maintenance and the absence of asset management[2] has been seen as a major obstacle to infrastructure projects generating economic growth. This can be conceptualized as the "**build, neglect, and rebuild**" (BNR) cycle, which refers to a recurring pattern observed in the water sector globally as well as in Bangladesh, where infrastructure (but also development) projects are implemented but not adequately operated and maintained, leading to their deterioration and subsequent reconstruction. This cycle in the water sector[3] has significant implications for the sustainable development (and SDGs) of the sector, both globally and specifically in Bangladesh.

The problem of BNR is also explicitly discussed in the IOB (Policy and Operations Evaluation Department of the Ministry of Foreign Affairs of the Netherlands) evaluation "Tackling major water challenges" (IOB, 2017). It was found that the BNR cycle was, in fact, widespread and affected Dutch-funded support for water management infrastructure in numerous countries. The issue concerns both institutional upkeep (e.g., WUAs) as well as technical maintenance (e.g., sluice gates). The underlying causes are, according to this evaluation study, related to the inability of the responsible government and community institutions to operate and maintain infrastructure adequately due to, among others, insufficient funding, inadequate staff and local capacity, a dysfunctional user fee collection system, and sometimes a lack of expertise and willing to prioritize maintenance. Too often, the response to poor institutional or technical maintenance has been to finance a new project phase, or a new project, that rehabilitated infrastructure that was built with earlier development assistance.

De Sitter (1984) has put it in his *"Law of Fives"* that every dollar of routine maintenance that is not spent ends up costing $5 in repairs and up to $25 in complete rehabilitation or replacement. Short-term resource constraints are often mentioned as core reasons for this lack of upkeep of water infrastructure, yet prioritizing maintenance makes ample sense from an economic point of view. There are many (intertwined) factors that keep this vicious BNR cycle alive and keep the economy grounded at a low level. In this report, these factors have been mapped, and suggestions to address them are provided.

The importance of going beyond the common explanation of "lack of funds" is increasingly acknowledged. The maintenance issue is perceived as a multi-faceted incentive problem concerning most of the actors involved in maintenance provision (Huppert et al., 2003). Resource constraints can result from institutional arrangements that fail to allocate adequate funding for asset management, even when such resources are may be available. Besides, capacity constraints within infrastructure service providers, poor forward planning of maintenance, unclear roles and responsibilities and an associated lack of accountability are factors in poor asset management.

Also, in several instances user fees and collection efficiencies are not sufficient to cover service provision costs, resulting in poor service provision, further undermining the capacity to generate revenue for operation and maintenance (PIAC, 2003). User fees are often arbitrarily set, not linked to a specific objective such as the maintenance of the infrastructure. Moreover, the assessment and

2 Operation and maintenance is the umbrella for all activities that look after the proper operation of the infrastructure and the timely and adequate repairs. Maintenance should be based ideally on a system of asset management, whereby the assets are registered and inspected, and their upkeep and servicing are systematically planned. Asset management requires proper design decisions, planning, and financial governance at a higher level.

3 The sector managing water, including flood and drought management, as well as providing water services, including irrigation and drainage and water supply.

collection systems for user fees are often complicated and impractical, leading to low collection performance (van Steenbergen et al., 2006). Whereas in many countries, water user fees are in place, even though often ineffective, in Bangladesh no such arrangement exists.

Asset management is also interlinked with motivation and a sense of ownership on the part of the communities. (PIAC, 2003; Huppert et al., 2003). The communities not getting involved in the planning and design of water infrastructure is a typical reason for the failure of service delivery. It is thus important to put forward essential institutional requirements and basic strategies that may lead the way to incentive creation for local operation and maintenance. Poverty may also be a factor with 'there always being some other priority': at the same time, there is often considerable local investment.

In the face of considerable environmental hazards and climate disasters, Bangladesh has made remarkable progress in reducing physical and socio-economic vulnerability and moving towards economic development through different water management interventions guided by important policies and plans, e.g., Bangladesh Delta Plan (BDP2100), National Water Policy, National Water Management Plan, the Coastal Zone Policy, and the Bangladesh Climate Change Strategic and Action Plan (BCCSAP). However, challenges are still aplenty and growing with changing demands, changing climate, intensified and more frequent climatic hazards and enhanced environmental degradation due to human interventions, which are posing considerable challenges to sustainable environmental management and development. The obstacles to the reliability or long-term functionality of the water infrastructure have been of great concern, which is slowing down progress in terms of benefits for the people and overall economic development (Rahman and Salehin, 2013). Vulnerabilities differ, but particularly weak spots are the 'clay' embankments constructed in areas without access to sand and the highly corrodible metal gate in saline or brackish water areas. In coastal Bangladesh, the impact of cyclones and the impact of salt water in particular has meant that rehabilitation of infrastructure is on an 8-12 year cycle. Elsewhere in Bangladesh, similarly, the demanding environment, exacerbated by climate change impacts, results in similar short periods of full-fledged functioning in the absence of proper asset management.

This is illustrated by the following example: while the embankments (e.g., Brahmaputra Right Embankment, coastal polder embankments) were able to give protection in the short term, they became debilitated with time because of a lack of regular maintenance, with recurrent floods and storm surges weakening or causing breaches in the embankments. As a result, embankments have not been able to give protection even against moderate flood or storm surge events in the middle to longer-term (Fig. 1). Flood or storm surge damage has gradually been proportionately more compared to the area of inundation as a sense of security or protection typically led to more development activities, including huge infrastructure development. As a result, more assets and property are now exposed to disasters (Fig. 1) (Salehin et al., 2023; Rahman and Salehin, 2013). Damage to infrastructure is now manyfold greater than damage to agriculture and rural homesteads in terms of monetary units. GDP loss has also been found proportional to the area of inundation, with a 10% loss accruing in the flood event involving inundation of two-thirds of the country (Fig. 1).

The premature deterioration of infrastructure also affects life and livelihood. For example, deterioration of embankments (and hence reliability) enhances flooding (fluvio-tidal, storm surge induced), causing immediate damage (e.g., damage to crops, fisheries, shrimps, households, and infrastructure) as well as prolonged impact (e.g., people's sufferings over long periods due to persistent waterlogging and saltwater inundation of farmlands) due to slow rehabilitation of embankments and livelihoods (Fig. 2).

In addition to the long-term maintenance needs, the immediate problem is to deal with the very high levels of maintenance requirements in the short term. These high levels of maintenance are a result of current levels of several factors below requirements so that a backlog of deferred maintenance has developed.

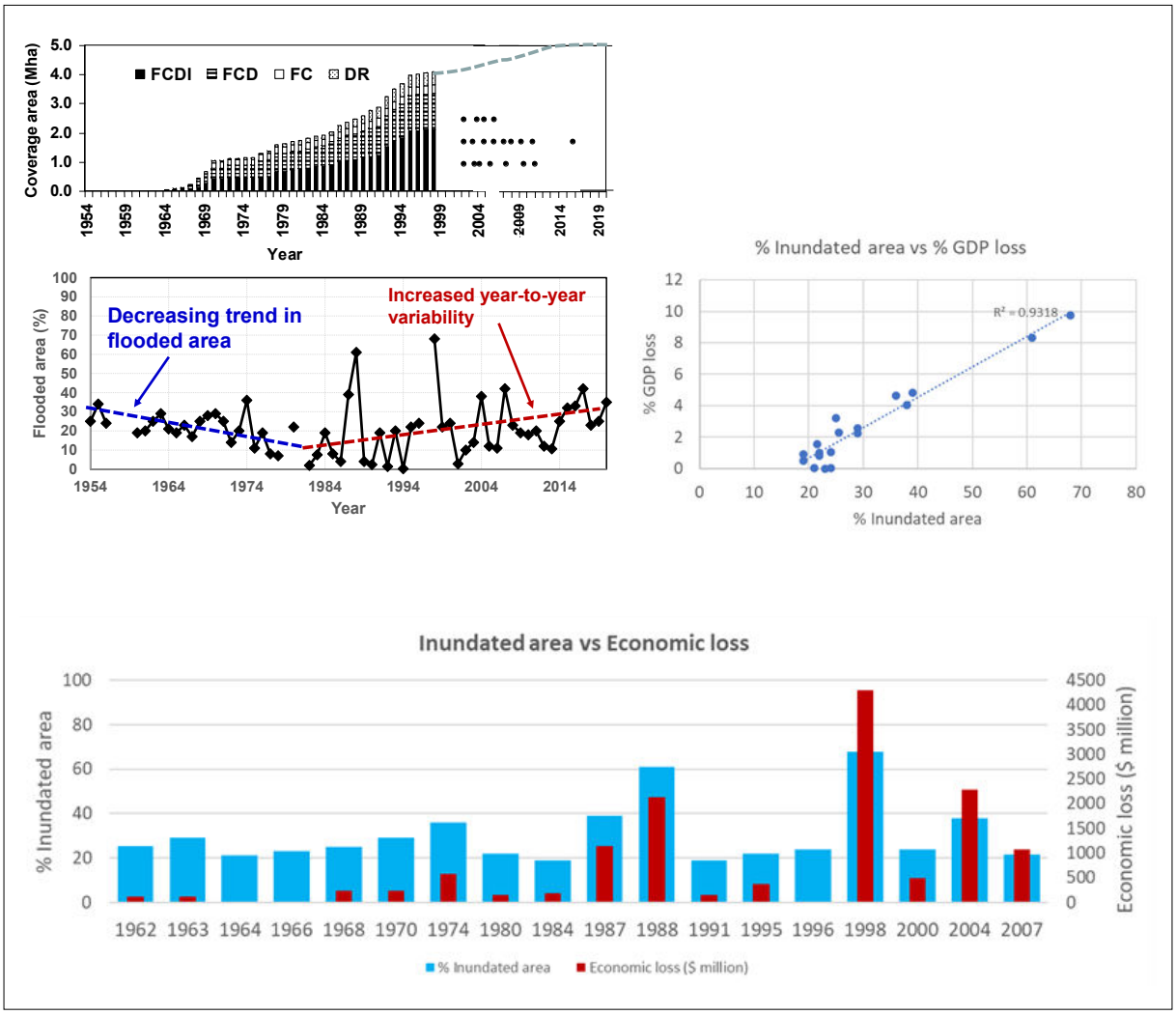

Figure 1 *Performance of embankments in giving protection from short term to long term (Source: Salehin et al., 2023)*

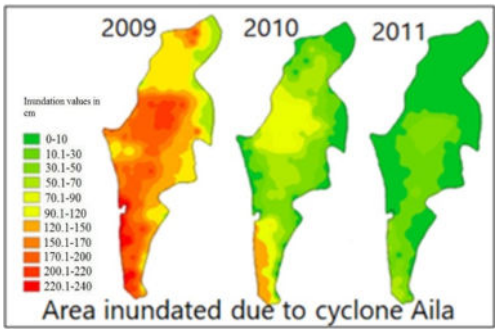

Figure 2 *Persistent inundation in Polder 32 following cyclone Aila due to delay in rehabilitation (Kabir et al., 2015). A considerable area remained inundated even after two years. Persistent inundation has been reported for longer durations following cyclone Aila in several other places.*

The importance of maintaining infrastructures has increasingly received attention in water-related policies and plans since the introduction of the National Water Policy 1999. The Bangladesh Climate Change Strategy and Action Plan (BCCSAP) duly put emphasis on maintenance under Thematic Area: T3, with specific mention of maintenance of flood embankments and polders, to ensure that existing assets are well maintained (MoEF 2009). The BDP 2100 also acknowledged that the "flood control and drainage (FCD) schemes are in urgent need of maintenance and, in selected areas, remodelling to equip them for the future", and "the practice of not maintaining delta-related investment has led to rapid deterioration in the efficiency of water infrastructure and leading to complete rebuilding of the same at much higher costs" (GED 2018). Moreover, the BDP2100 acknowledges the neglect of O&M. It mentions that to make the BDP2100 a reality, the total maintenance of water infrastructure would need to be 0.5% of GDP, which would equal 2.3 Billion USD (World Bank, 2022), whereas the actual current amount does not even touch 0.1% of GDP.

In the discussion above the main emphasis was on maintenance and asset management. There is similarly a lot to gain in better operation. Again, there is a gap here, with relatively little attention to management of the infrastructure, in particular the operation of gates and the use of local storage facilities such as *khals* to improve local water management in service of higher crop productivity and more diversified production. The gains are particularly at the local level, requiring functional local organizations, such as WMGs. Examples of the possible gains are given in table 1. These gains add up to considerable economic benefits.

Table 1 *The water management challenges WMOs in Bangladesh have the potential to deal with, beyond maintenance (van Steenbergen & Mornout). Some of them are possibly better addressed at, or in consultation with, higher spatial level institutions, but can still be brought up by WMOs.*

Water management challenges to deal with – beyond maintenance	Description and activities – in the context of WMOs in Bangladesh
Synchronization of uses	Coordinating water use for agriculture and fisheries, mitigating conflict and creating synergies in water uses for different users.
Address water scarcity	Creating additional storage through ponds, deepened canals, ponds in canals, and small storages in the fields, and finding scopes for reduced demand.
Address water logging	Installing and maintaining culvert and drainage pipes (including gauges), excavating canals, and managing land rise in low-lying areas.
Address flood risks	Elevating roads in low-lying areas, creating of flood shelters, compartmentalization, and creating storage to retain internal flooding.
Address salinity	Adjusting cropping patterns, managing fresh and saline water, or switching from agriculture to aquaculture, requiring specific water management.
Optimise agricultural productivity	Managing field water levels and drainage for hybrid varieties using gated culverts and adequate drainage. Controlling pests by draining land. Synchronising cropping within the polder and adjusting the cropping calendar.
Optimise fishery productivity	Maintaining adequate depth of fishing grounds. Ensuring adequate inflow and outflow.
Address sustainability, climate change and biodiversity	Planting trees and shrubs on the embankments to reduce erosion, boost biodiversity, increase agricultural livelihoods. Finding scope for climate-smart and nature-positive water uses.
Optimise water use efficiency	Managing the water inflow and channels in a way that water is used more efficiently.
Address conflicts	Facilitate conflict-solving between different water users.

3

Methodology

METHODOLOGY

As part of the RCA establishment, the main issues concerning the BNR cycle have been identified and supported with data and insights based on reviews of literature and interviews. An initial version of the root cause analysis was established by the team, which was further validated, populated, and enriched with by stakeholder consultations and comparable international experience. Also, the initial version helped dig deeper, in finding the real root causes, which went much further than the deepest routes as identified in the first version of the RCA.

The reviews included global literature as well as national literature in particular and the previous work of MetaMeta and BUET IWFM. The BNR root cause analysis is the major input for discussion with key stakeholders, the aim being to come to a joint understanding. The interviewees and stakeholders (Annex 1) included key stakeholders of the water sector at the policy/planning level who make the main decisions affecting the BNR cycle, e.g., those from BWDB, as well as LGED, Dhaka Water Supply and Sewerage Authority (DWASA), Roads and Highways Department (RHD), and the Planning Commission.

The interviewees also included those at the 'receiving end' of operation and maintenance, e.g., district engineers, section officers, contractors, water management groups (WMGs) and water management associations (WMAs). Fieldwork was undertaken to get insights on O&M, BNR, in-polder water management and other relevant topics from in-polder stakeholders (Fig 3). Specifically, input was foreseen to come from WMAs, their O&M committees, WMGs, the Bangladesh Water Development Board (BWDB), Local Government Institutes (LGIs), the Local Government Engineering Department (LGED) and contractors. Visits were made to several polders (Polders 30, 31 and 31-part) around Khulna, where Blue Gold was active, with interviews and focus group discussions conducted with the stakeholders.

Figure 3 *Fieldwork undertaken in Polders 30, 31 and 31-part, in Khulna (photos taken by authors in October 2023). The photos illustrate some of the challenges in in-polder water management.*

With the priorities and perceptions related to BNR being at the core, the discussion points with the interviewees broadly included budgeting and finance planning, national policies and visions on BNR, understanding of the financing of O&M, budgeting of O&M and constraints, links between planning and budgeting, links between (annual) development budgets (ADB) and revenue budgets (RB), understanding of priorities between investment versus management and operation, actual constraints and solutions, understanding of emergency repairs, priorities in maintenance and current solutions, local politics and understanding of local priorities in BNR, and understanding of WMO roles and their cooperation with UPs and BWDB. A force field analysis was carried out to understand the dynamics around operation and maintenance in the water sector and to better understand who to engage on what critical topics in particular.

Besides, a special session was organized on “Reactive O&M to Asset Management of Water Infrastructure in Bangladesh Challenges, Root Causes and Way Forward” jointly by the Dutch Embassy, BUET, MetaMeta, and the Netherlands Enterprise Agency (RVO), in the 9th International Conference on Water and Flood Management 2023 (ICWFM-2023) on 16 October 2023 (Fig 4). The session was attended by approximately 40 participants.

The main objective of this session, in line with the larger process of stakeholder consultations, was to create a common and shared understanding of O&M and asset management and to particularly discuss how to go away from the current pattern of reactive and under-resourced O&M, and to move to planned and pro-active asset management in the water system in Bangladesh. In the session – as also in the course of the past months - different stakeholders were engaged in this important topic, and it was aimed to explore partnerships to work on better asset management. Early in the session, the preliminary outcomes of the RCA were presented, after which more inputs were gathered in an interactive setting, capturing insights and interest from the participants.

The session offered an opportunity to engage with different stakeholders, buy in the importance of the topic, and build partnerships to work towards better asset management in the water sector.

Following this special session, interviews and literature review continued, culminating in draft final outputs and the organisation of a workshop on the 23rd of November in Dhaka, at BWDB, to confirm interest in, reach consensus on and finetune the shared agenda and action plan (incl. concrete steps and ideas for immediate action), all meant to unpack and identify ways to reduce the BNR cycle in the water system in Bangladesh, based on a short- and medium-term vision for water management/water infrastructure that moves away from the current reactive and under-resourced O&M, to planned and pro-active and O&M.

Further establishment of the RCA helped in finding out what causes can be tackled, how, and by whom; it helped in finding the low-hanging fruit, in selecting where the Partners for Water program can focus on and invest in and identifying the scope for other actors to act. From the route cause analysis

Figure 4 *Special session on “Reactive O&M to Asset Management of Water Infrastructure in Bangladesh Challenges, Root Causes and Way Forward”, 16 October 2023*

and the shared agenda setting, in an iterative manner, a road map has been developed, outlining the change that needs to happen. This includes short-term and medium-term actions required to break the BNR cycle, promote sustainable water infrastructure development, and establish a shared agenda for collective action in Bangladesh.

The road map will translate into activities for 2024 and 2025 – for which the Partners for Water Program has reserved budget and staff time. As much as possible, these will relate the action plan to ongoing initiatives, such as the follow-up to the Bangladesh Delta Plan and other activities planned by the Bangladesh water sector. In Chapter 5, those are reflected upon.

4

Root causes of the ‘Build-Neglect-Rebuild’ (BNR) cycle

ROOT CAUSES OF THE 'BUILD-NEGLECT-REBUILD' (BNR) CYCLE

As mentioned earlier, in the root causes analysis, the main issues concerning the BNR cycle have been identified and supported with data and insights based on reviews of literature and interviews. This root cause analysis is a major input for the discussion and agenda setting to develop a shared frame of mind and common narrative. Fig. 5 shows the root causes analysis, which integrates inputs from the stakeholder consultations and literature review.

The main problem identified in this RCA, positioned in the middle of Fig. 5, is not the inadequate O&M, but the inadequate sustainable services from the water system due to inadequate O&M. This means, for example, that a sluice gate is not closed and opened when and how required (operation) and that it leaks or is in operational (maintenance). Four main root causes have been identified: 1) insecure and insufficient funding for O&M, 2) delayed emergency responses, 3) the lack of an asset management system, and 4) inadequate management of river sedimentation.

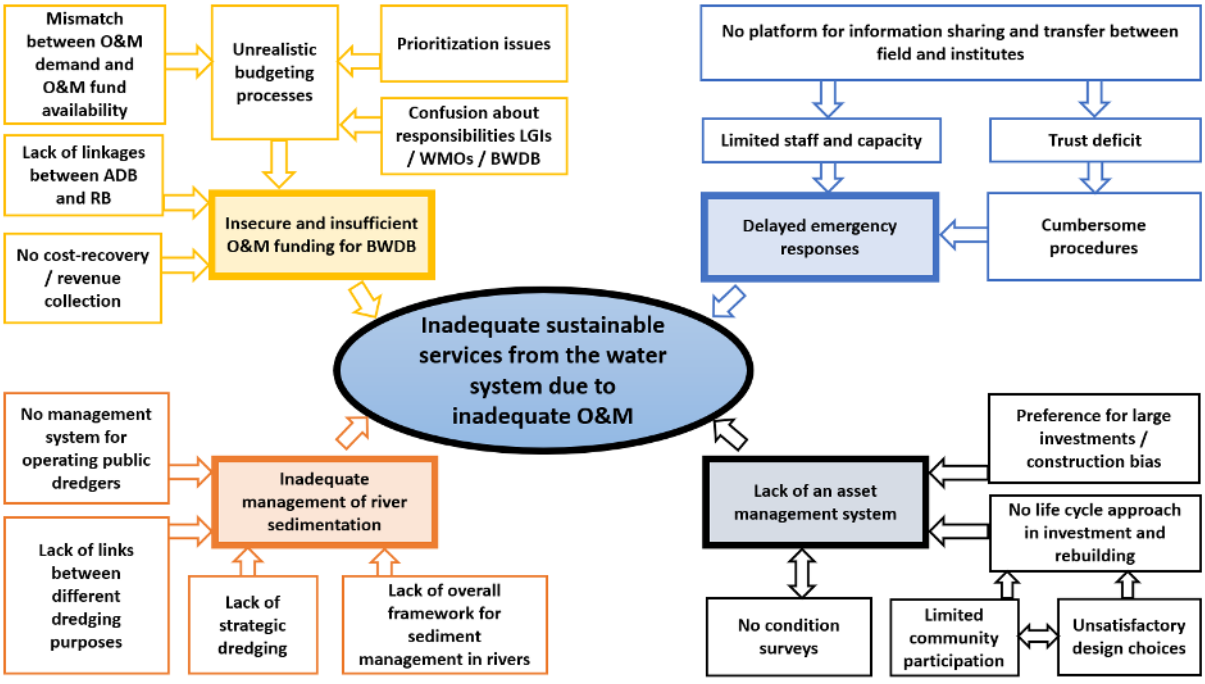

Figure 5 *Root causes for the BNR cycle. Four main causes and threats are identified: 1) insecure and insufficient funding for O&M, 2) delayed emergency responses, 3) the lack of an asset management system, and 4) inadequate management of river sedimentation.*

4.1 Insecure and insufficient O&M funding for BWDB

The first root cause being discussed and dismantled is the insecure and insufficient O&M funding for BWDB (Fig. 6). In the layer below this root cause, one can find the lack of cost recovery/revenue collection, the lack of linkages between the Annual Development Budgets and the Revenue Budget, the unrealistic budgeting processes, and the confusion about responsibilities. Those and their subsequent causes are discussed below.

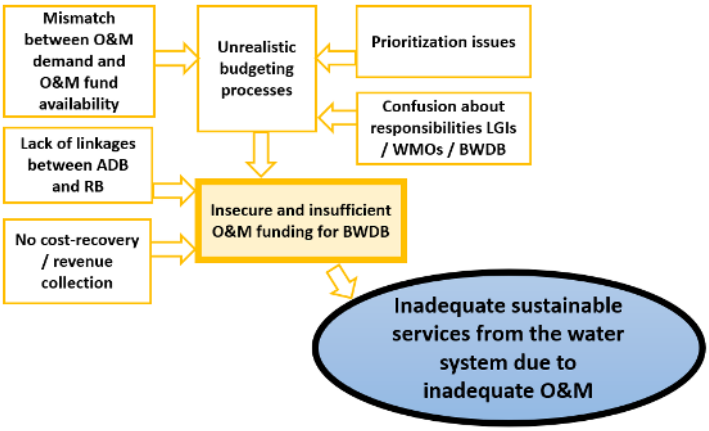

Figure 6 *One of the root causes for the BNR cycle: Insecure and insufficient O&M funding for BWDB*

No cost-recovery / revenue collection

The lack of cost-recovery / revenue collection is considered one of the causes of the insecure and insufficient O&M funding. This is also addressed in the BDP2100, which mentions that international best practices in delta management show the strong role of the application of "the beneficiary pays principle" in financing water-related investments, and their O&M, which is currently far from a reality in Bangladesh – even though there is ample scope for application of this principle in Bangladesh. The BDP refers to the Dutch Delta, in which much of the funding of flood control, irrigation, water supply, sanitation and waste management investments is financed by applying the beneficiary pays principle.

In Bangladesh, user payment is in practice in urban water and sanitation, though it is negligible in other sectors, such as waste management. The BDP proposed to cover operation and maintenance costs through user charges and, in case of a shortfall, recurrent government revenues from taxes and other sources. BDP also gives importance to private financing through public-private partnerships.

Not all water sectors are equally attractive, though, for private financing. Bangladesh has a vibrant, privately financed, and operated groundwater-based irrigation sector with more than 500,000 farmer-owned shallow wells with full cost-recovery. For large-scale flood control and surface water irrigation schemes (FCD and FCDI), on the other hand, there is no cost recovery of either capital cost or O&M. In several coastal zone programs, water management organizations were encouraged to set aside funds for O&M internally. However, the collected and deposited amounts have been relatively negligible (van Steenbergen et al., 2023).

Lack of linkages between Annual Development Budget and the Revenue Budget

Another cause of the insecure and insufficient O&M funding is the lack of linkages between the Annual Development Budget (ADB) and the Revenue Budget (RB). The infrastructural cost of any new project is funded by the ADB. The cost for O&M is allocated from the Revenue Budget (RB), which is very small and mismatches with the requirement by a wide margin. Absence of any link between the implementation budget and O&M needs hence pays a high price of neglected O&M under the newly developed projects under the ADB.

The limited linkages between planning and budgeting challenge the uptake of plans, including the BDP2100. To make BDP2100 a reality, the total investment needed for new projects and maintenance of new and old projects is about 2.5% of GDP per year. Of this, only 0.5% of GDP would need to be spent

on O&M activities, while 1.5% is allocated to the implemenation plan. The BDP2100 mention that O&M is very much neglected, and the actual amount at present (2020) may not even be more than 0.1% of GDP (GED, 2020). Investments in O&M thus need to increase massively – to reach this 0.5% of the GDP needed for the critical O&M.

Bangladesh has adopted the Medium-Term Budget Framework (MTBF) approach in national budgeting since the financial year 2005-06, leaving the traditional line-item method behind, a clear effort to improve the Public Financial Management (PFM) institutional framework. This approach reflects a medium-term perspective establishing a clear link between the government's plans, policies, priorities, and resource allocation in budget formulation. Issuing of a budget circular (Budget Circular-1) is the first step in the strategic phase of the budget formulation process under the MTBF, in response to which the ministries prepare their Budget Framework and project their income and expenditure for three years.

At present, O&M of the BDP projects/programs is minimal in amount which needs to be taken care of. For this, allocation in the MTBF of the respective ministry/division needs to be increased if BDP 2100 projects/programs are to be implemented in full scale.

Unrealistic budgeting processes

Next to the lack of cost-recovery/revenue collection and the lack of linkages between the ADB and RB, the unrealistic budget processes also aggravate the insecure and insufficient O&M funding. For instance, the Planning Commission sees substantial gaps in that prepared budgets are not evidence-based, and the submitted O&M proposals do not contain adequate information. This is linked to BWDB not having a good inventory of the conditions of their infrastructure. Information is available as per the classification of infrastructure. However, complete information is needed regarding location, specification (used), construction year, construction period, damage record, maintenance record, and so on, which are essential for determining O&M needs. The Planning Commission would like convincing information about O&M needs in alignment with progressive requirements since the implementation of the project. The Finance Division sees BWDB as only a water project implementation agency; they are not sensitized enough about the need for O&M of water infrastructure. The lack of detailed information provided by BWDB also does not help change this mindset and keeps the status quo alive.

Also, the Planning Commission's observation is that BWDB should take more projects on the rehabilitation of irrigation projects. Several irrigation schemes are underperforming because of non-functioning irrigation pumps, and other related appurtenance. Instead of rehabilitating sluice gates, there is a tendency to focus on infrastructure-driven projects, which are easier for BWDB to implement.

Mismatch between O&M demand and O&M fund availability

The mismatch in demand and availability of the O&M funding further boosts the unrealistic budgeting processes. Fund insufficiency has been a major reason for BWDB's failure to carry out periodic and adequate maintenance of the water infrastructures. There has always been a mismatch between the demand for O&M funds and funds allocated for O&M. This mismatch has grown exponentially from 1995 to date due to increasing investment in new projects (a 10-fold increase in implementation projects) but with very little increase in O&M budget allocation. Fund availability for O&M has always been an issue. In the late 1990s, the total investment budget was low, and the fund availability for O&M was about two-thirds of demand. However, it declined to only 10% of the demand in 2021 (Fig. 7).

The lack of maintenance did not make itself fully apparent for some time. But, over the decades, more damage has been done, and far more significant amounts of money are now being required to rectify the situation than if preventive maintenance had been carried out in the first instance. The disconnect between budget availability and requirements has also upset the planning system. The request for maintenance budgets has become speculative, with sometimes high amounts requested, not reflecting

genuine needs but driven by the hope that a doable amount will still become available. In the last two years, more funding has become available from the Union Parishads, often accessed by WMOs to maintain the smaller infrastructure. These Union Parishad resources do not cover repair of sluice gates and embankments or river management.

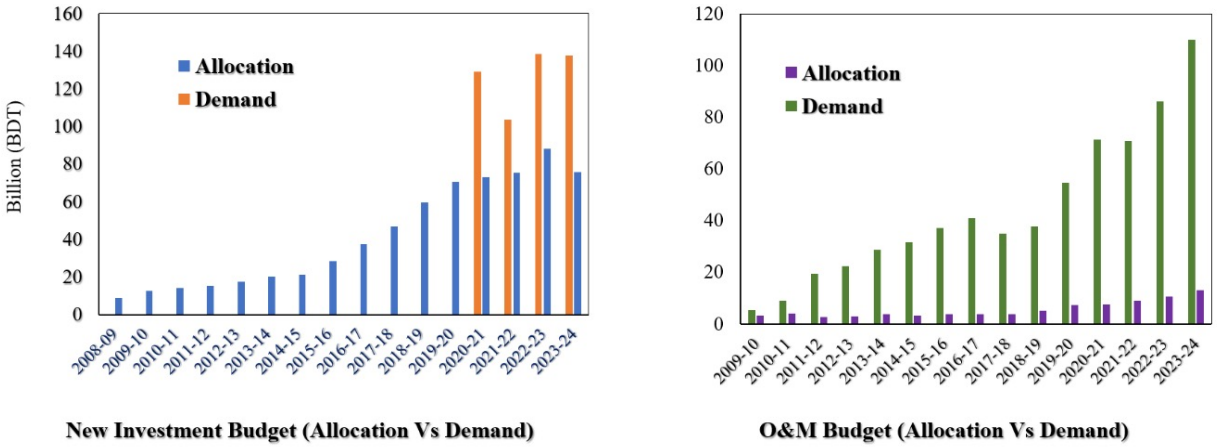

Figure 7 *Fund insufficiency in maintaining water infrastructure (Source: BWDB)*

Prioritisation issues

As might have already become apparent from the above, the lack of prioritising O&M manifests itself in the whole sector and among various stakeholders. This logically reflects the root cause of the unrealistic budgeting process. Below, the prioritisation issues are described for some of the key stakeholders.

Prioritisation issue: Government

BWDB officials opine that there may be more priority given by the government to the water sector. For example, increasing budget allocation for O&M from the current rate of about 10% to 20% would make a massive difference in contributing to water control structure reliability.

Water professionals feel that there has traditionally been less priority on the water sector compared to a few other sectors, for example, transport, health, and education. The funds allocated to the environment, climate change and water in the 2023-2024 budget is about 3.4% of the total development budget[4] (Fig. 8), which has increased from previous years, a clear commitment to giving more importance to climate change related issues; however, the share of the budget for 'water resources' is still comparatively low. There also seems to be comparatively less social hue and cry for this sector, as indicated by several stakeholders, which is apparently only to a limited extent successful in securing its required resources. However, given the substantial GDP loss accrued during moderate to big flood or cyclone/storm surge events resulting from damaged and non-performing structures and that water management sits at the core of the Delta Plan, the water sector clearly warrants more attention.

4 Some caution needs to be taken in interpreting this figure, as it could be that this report's interpretation overlooks water considerations in other sectors, such as possibly overlooking dredging in the (river) transport sector.

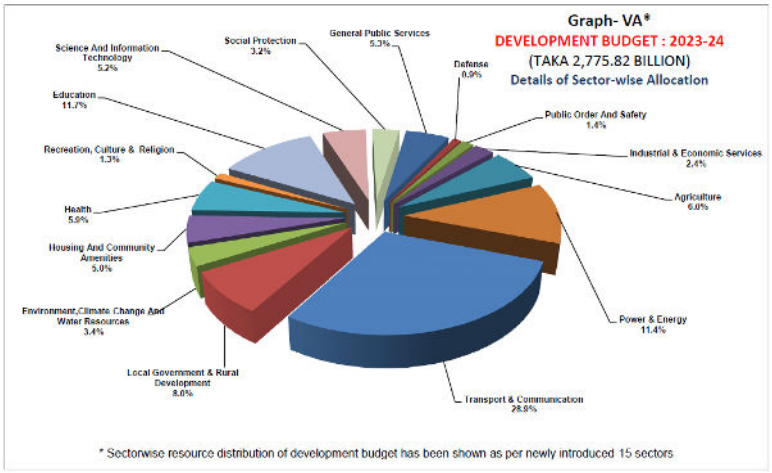

Figure 8 *Sector wise resource distribution of Development Budget for year 2023-24 (Ministry of Finance)*

Moreover, whatever budget is allocated to water and the environment, government focus has been more biased towards construction, i.e., less intention to O&M than development. The government has been approving big infrastructure-focused projects not in alignment with the fiscal capacity and without doing a proper fiscal gap analysis. There is often less freedom for the departments or organizations in prioritizing projects, with political interference or desire of certain groups getting preference in selecting and approving projects. There are sometimes compromises made in the priority list prepared by BWDB at the influence or interference of influential groups at ministries with specific areas of interest.

Prioritisation issue: Local Government Institutes -
Local governments also have several roles in the O&M landscape. Representatives from LGIs are the advisors to WMGs, WMAs and WMFs. While there is no clear definition of what being an advisor entails, this also gives flexibility for the WMOs and LGIs to develop a mutually beneficial relationship based on their own insights. LGIs have ample opportunities to contribute to efficient water resources management within their areas. Instead of some unwanted roles of some of the LGI members in getting involved in unlawful control of water structures with local elites, they can play a big role in minimizing water-related conflicts and improving in-polder water management. The LGIs can, in the coastal area, help the WMOs in getting control over all sluices. The LGIs, being the legal authority, can help the WMGs in getting the cleaning or *khal* re-excavation activities done via taking care of the issues with *khal* or canal encroachment (Hassan, 2022; Hassan et al., 2023).

Similar observations were also made in an evaluation by the Blue Gold project itself earlier (Blue Gold, 2021; 2019). In their 22 surveyed polders, WMGs have been responsible for Khal cleaning (about 61%) and sluice operation (66%) in the surveyed coastal polders. Where WMGs are good at articulating the aspirations of communities concerning water management, the UPs were able to help resolve conflicts in the case of obstructed drainage flows and provide authority to WMG action such as canal cleaning. As the *khals* are leased out by the Upazila administration, there may be better coordination between them and the WMGs to stop problematic leases and help the WMGs clean the *khals* (www.bluegoldwiki.com).

Prioritization issues: Donors
Over the past decades, major infrastructural donors have approached the government with big infrastructural projects. However, while all Development Project Proformas (DPPs) for such projects give importance to O&M, the donors view the O&M as something beyond their purview, with the ownership of the O&M to be taken up by the government. For very big-spending projects, the O&M budgetary needs become large, implying a considerable burden on the government, as the O&M funds are to be borne from the revenue budget. In practice, this burden is too heavy to carry, manifesting in unrealistic budgeting processes.

Prioritization issues: BWDB

BWDB's preference has long been for large infrastructural investments. While these were necessary in the early days for developing disaster protection and water management systems, there has not been any significant shift from an 'implementation' focus to an 'O&M' focus.

Like the Planning Commission, BWDB officials also increasingly feel that more focus is needed on the rehabilitation of the irrigation projects (e.g., Teesta irrigation project, Feni irrigation project, G-K project, Muhuri irrigation project, etc.), instead of new infrastructural projects. Though this note is somewhat outside the focus of this report, it illustrates a paradigm shift in BWDB.

Prioritization issues: Emphasis on improving embankment reliability.

Prioritisation issues are present among stakeholders, but also thematically, with a strong emphasis on improving embankment reliability, which has received priority over O&M in the past decades for sure. Increasing the height of embankments has increasingly been considered for major infrastructural investment for the protection of southwest coastal areas from cyclonic storm surges. It remains a major policy question if raising embankments is necessary at all places or if investments should be prioritized more towards maintaining them at design condition via regular operation and maintenance. Studies have shown that storm surge-induced damage to embankments and subsequent inundation inside polders are predominantly linked to structural weakness and degraded height of embankments below their design heights due to lack of maintenance and faulty repair and recurrent cyclone events with less time for structural recovery (Haque et al., 2019; Salehin et al., 2023).

This allowed embankment overtopping and breaching in several districts in southwest (SW) and southcentral (SC) regions during Amphan, and even during a low-intensity cyclone event Yaas (Fig. 9). The polder embankments are in such dilapidated condition in many places that a slight amplification of surge height (such as 3-6 ft in the case of Amphan and Yaas) and moderate thrust force led to widespread damage.

Studies have also shown that the coastal embankments, if kept at design heights and properly maintained, would protect tidal floodplains against moderate as well as most of the big cyclonic storm surges (Haque et al., 2019; Salehin et al., 2023). This suggests greater investment needs in strengthening of embankments and regular maintenance to keep them at least at design heights, supported by efficient and stronger structural recovery.

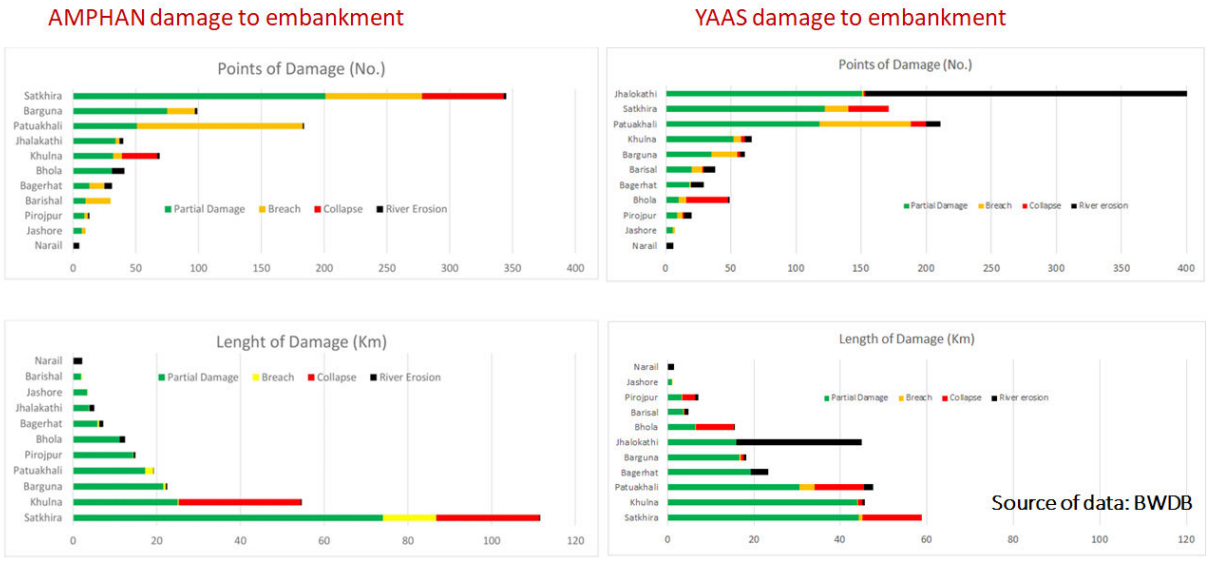

Figure 9 *Comparison of damages by cyclone AMPHAN (left) and cyclone YAAS (right) (Source: Salehin et al., 2023; Data source: BWDB)*

Embankment reliability is challenged by several factors, including regular wear and tear, rain-cut, salinity, soil subsidence, quality of construction, land use (e.g., shrimp ponds involving pipes through embankments to bring in saline water – as observed in the fieldwork of this study), use as transportation routes (while not designed as such), refuge for people, cattle sheds, river erosion, floods, tidal surge, storm surge (DHI and Deltares, 2022). Roads and embankments gradually get lower due to the subsidence of the soil. River erosion is a common feature through which embankments frequently collapse. Embankments are further weakened by soil erosion, e.g., through overgrazing of cattle and goats.

It was previously observed that embankments are vulnerable to a greater extent due to construction rather than faulty design (JICA, 2017). In the southwest coastal area, embankment materials are mainly clay. On the one hand clay can lower the permeability, but on the other hand, it poses an obstacle to increasing shear strength through compaction unless a certain amount of coarse soil (i.e., sand) is not contained. This becomes an issue as materials are often taken from nearby areas, with borrow pits in the set-back area and nearby farmland (JICA, 2017). Previous studies by BUET found that inadequate compaction has been a major factor in embankments becoming weak over a shorter period (Hossain, 2022; Hossain et al., 2018). The repair works of existing damaged river embankments done by BWDB via contractors are mostly done manually, without using heavy machinery, because of limited and insufficient repairing budget.

Confusion about responsibilities LGIs / WMOs / BWDB

When diving further into the unrealistic budgeting processes, one sees that the confusion and unclarity of the responsibilities that the involved parties have, slows down action and sets O&M often on hold, contributing further to the unrealistic budgeting processes. It may be noted here that the roles and responsibilities of and coordination among BWDB, LGIs and WMOs, have not been adequately made clear in the guidelines for participatory water management. These may possibly be brought into the guidelines as a part of modification.

The landscape and relations between different actors in the O&M landscape is complex. In a recent policy evaluation study, it was for isntance found that WMOs' relation to BWDB is positively correlated with its relation to LGIs. On the other hand, there is no clear relation between the recognition by BWDB and LGIs, as a reflection of the dimension of legitimacy, and active engagement in water management including the preparation of polder water management plans. This appears to be more of an internally driven activity (van Steenbergen et al., 2023). The WMGs may have a relation with the DoA, especially the DAE, but this depends on earlier relations and is not systematic. The reason is that the DAE works together with a large range of local farmer organizations, including farmer clubs and extension groups, and does not have an exclusive relation with WMGs, where these exist.

Besides, partnership of WMGs and WMAs with LGIs at Upazila and Union Parishad levels should be strengthened or established (in case of absence of partnership), specifically in the formulation of Village Action Plans and Polder Development Plan (e.g., in the budget/planning processes). Coordination can be further strengthened to enable WMGs to take active participation in disaster risk reduction and sustainable environment management. In the case of embankment being threatened by severe erosion problems, the UP Chairmen are instrumental in mobilizing resources and local action, and together with WMGs the UP jointly prevent the breaching of embankments (Hassan, 2022; Hassan et al., 2023; www.bluegoldwiki.com). The collaboration between Unions and WMGs in the Union Disaster Management Committees has been a clear example of investing in a constructive relationship during good times, so that cooperation is easier during crises. This was also echoed in earlier Blue Gold assessment (Blue Gold, 2014a). Besides, LGIs can also help mobilize resources for investment in small-scale infrastructure.

In-polder water management

In-polder water management is a terrain that has not been systematically stimulated but one that has enormous potential. There is a multitude of water management challenges within polders for water management organizations and other actors to deal with that yet go unaddressed, amongst others, due to the confusion about roles and responsibilities.

Studies have shown that water infrastructure interventions often produce an unequal distribution of water risks and adaptation benefits. While rehabilitating embankments generates benefits in terms of improving agricultural production and hence income, the impacts of flood protection investments may not result in equitable distribution of agricultural incomes across diverse income groups unless in-polder water management strategies are taken up as well (Barbour et al., 2022). Increasing waterlogging and salinity negate the benefits of embankment rehabilitation, with risks of crop loss being most significant for the poor. Improved drainage, one method of in-polder water management, can alleviate these impacts.

Waterlogging within the polders has emerged due to several reasons. There were conflicting land use practices in the 1990s, with large-scale brackish shrimp farming dominating over agriculture. Even after the exodus of large-scale shrimp farming, this type of conflict is still prevalent between crop farmers and small-scale saltwater shrimp cultivators. Blocked canals by ghers and cross dams have hampered irrigation and have disrupted hydrological connectivity, resulting in the silting up of drainage canals, water congestion, loss of fish biodiversity, and reinforcement of pre-existing conflicts between upstream versus downstream communities (Hassan, 2022; Hassan et al., 2023). Marginal and landless people have been most affected by brackish shrimp farming.

In many freshwater environments, big farmers control the sluice gates according to their crop needs, while the gates remain closed when they need to be kept open for fish migration (Sultana and Thompson, 2017). Water allocation via gate operation of the sluice gates is often controlled by politically powerful people who tend to serve their own interests (Hassan, 2022; Hassan et al., 2023; Dewan et al., 2014; Sultana, 2009; Nowreen et al., 2009; Murshed and Khan; 2009; Rahman and Salehin, 2009).

Timing and release often depend on local elites (and may require payments); diverting water for their interests can reduce local water availability in the dry season at the cost of crops or fisheries in other parts of the system. This is more often seen in the coastal environment, with local politically powerful and influential people, either from the UP office or part of the informal *beel*/ catchment committee, controlling the operation of the gates to maximize benefits, for example by allowing water (saline for brackish shrimp) when needed by them, or by actions which prevents or slows down drainage of water from within polders during monsoon (Hassan, 2022; Hassan et al., 2023; Bernier et al., 2016).

Roles and responsibilities of WMOs

This section aims to shine a light on the (possible) roles and responsibilities of WMOs. The 'Blue Gold Wiki' report (www.bluegoldwiki.com) presents the generic structure of WMOs in a polder (Fig. 10 and Fig. 11), with roles and responsibilities of WMOs at different levels of scale in the context of in-polder water management. Also, outside Blue Gold, in other coastal programs, a similar set-up has been employed.

The WMGs are expected to manage gated culverts and/or minor sluices and the secondary khals inside the polder. They would also maintain a register of WMG members, arrange meetings, document activities, and inform WMA about water management issues (source: KII with Blue Gold officials). The responsibilities of WMAs in terms of in-polder water management are at the polder level (i.e., peripheral embankment), and they would ensure major sluice operations and manage primary khal systems through O&M sub-committees formed around each of the drainage sluices or regulators of the polder sub-catchments.

For the operation and maintenance of water infrastructures, the Catchment O&M sub-committees have been formed by the Blue Gold officials comprising representatives of several WMGs in a single sub-catchment for operating sluice gates and water allocation through canals between agriculture and fisheries. The WMAs are expected to coordinate with the O&M committee to effectively manage the catchment.

The responsibility of routine O&M is given to the WMOs. The routine O&M includes routine checks and small repairs on the flood embankments, routine/annual desilting of field channels, clearing weeds and obstacles from secondary and tertiary canals, and greasing and painting of gates. All water management infrastructures (sluice, embankment, and canal) should be well-functioning, and controlled and operated by WMGs and WMAs for good water resources management with reduced conflicts.

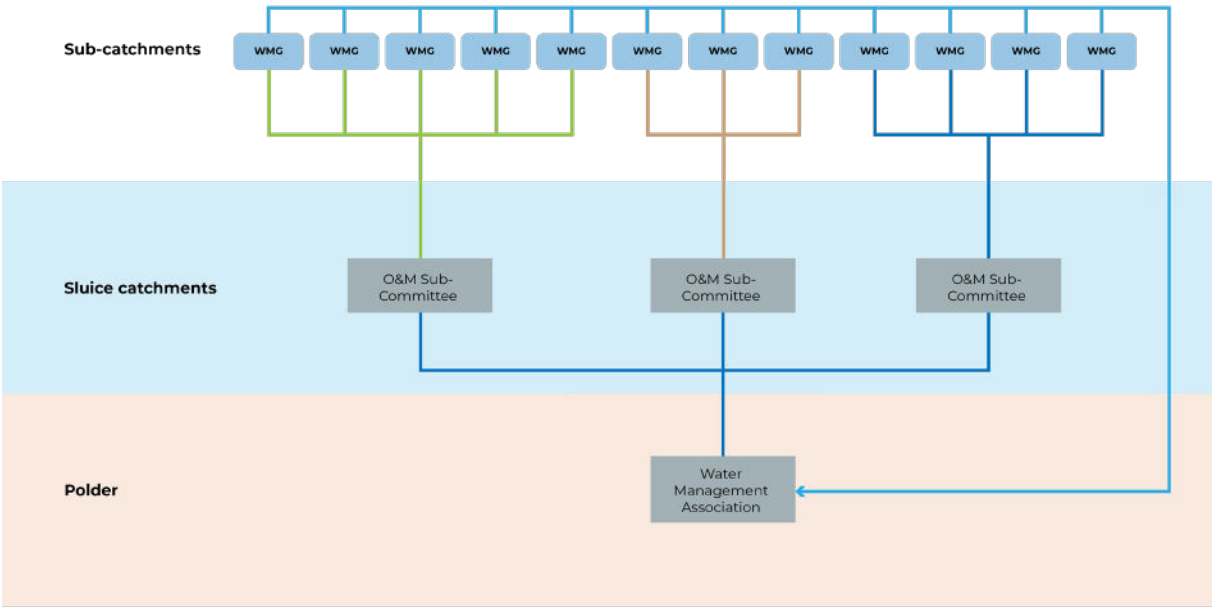

Figure 10 *Structure of water management organizations in a polder (Source: www.bluegoldwiki.com)*

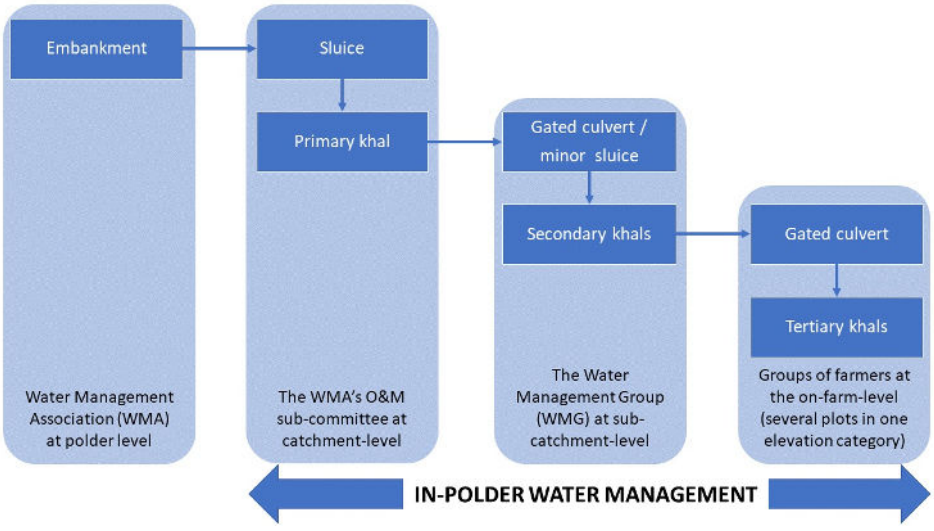

Figure 11 *In-polder water management – interventions at different levels of scale (Source: www.bluegoldwiki.com)*

With the Blue Gold intervention, the WMGs engaged in khal cleaning and better sluice operation. The Blue Gold program funded repairs of sluice gates, re-sectioning and repairs of embankments and re-excavation of drainage khals within 22 polders, to drain excess water, prevent flooding, while improving access to water for irrigation (www.bluegoldwiki.com). Most of these works and tasks were undertaken by BWDB (under the Blue Gold program) with WMG support, with the WMGs themselves mainly being responsible for khal cleaning and better sluice operation. Khal re-excavation (including de-silting), the pivot for irrigation, drainage and sometimes transport (Mornout et al., 2022), was largely done using Blue Gold resources, with support from the WMG in most cases. Khal cleaning (removal of weeds, cross-dams, etc.) and improved operation of sluices were mostly done by the WMGs with their own resources (i.e., voluntary labour) and/or by groups of farmers. This is considered as an achievement of the Blue Gold program in establishing and strengthening the WMGs (www.bluegoldwiki.com). The construction and repair of culverts was, however, primarily done by Local Government Institutions (i.e., Union Parishads), as culverts usually crossroads, which are a government responsibility.

The operation of the sluice gates is arguably pivotal in water management in low-lying areas. The sluice gates' opening and closing determines water inflow and outflow and, hence, the polders' water levels. The inflow of fresh water serves as a source of supplementary water and controls the salinity of the water. This function is often contested, particularly in areas with divergent interests of crop farmers and shrimp/fish cultivators. The local operation – with accountability to a large number of farmers – is essential to capitalize on the benefits that infrastructure improvement brought, in particular in the case of the replacement of non-functional sluice gates and the deepening of local drains (khal). The sluice operation is usually taken care of by WMGs – either by the WMG in which the sluice is located or by a group of WMGs dependent on the sluice (van Steenbergen et al., 2023). As observed by several BWDB officials with long experience working in the field, the size of the sluices becomes an important determinant if the WMGs can do their operation, and their experiences suggest that it becomes very difficult for the WMGs if the sluice has more than three vents. Also, vertical lifting of gates is a cumbersome process, added by an additional problem of the rubber seals of the gates getting impaired too soon. Innovations may be introduced in the form of gates with horizontal/circular rotation mechanisms.

In introducing new crops and facilitating fish cultivation, the mediating role of local water management organizations is essential. The WMGs and the farmer field schools played a critical role in the spectacular gains in food security. Had there not been formal WMGs, it would have been difficult to reach all farmers, difficult to access women and improve their standing in the farming community, difficult to engage landless and marginal farmers, and impossible to have targeted programs.

In many cases, WMOs made these processes easier by agreeing on sluice operations and removing obstacles in the khals. This made it possible to have more flexibility in what was being cultivated. Beyond resolving conflicts between different groups of producers, the WMGs also served as the conduit for agricultural extension programs (van Steenbergen et al., 2023). According to Blue Gold surveys, WMG members are more involved in agriculture than non-members, and more likely to join other community institutions and attend non-BG training (Blue Gold, 2021).

It should be noted that not in all polders, WMOs have been established, under Blue Gold, CDSP, Southwest, or any other program. A field survey in 2023 found that, as WMOs and their counterfactual reported, agricultural production grew (much) more when WMOs were set up compared to when they were not set up (Fig. 12). Interestingly, this study also found that the impact of infrastructural rehabilitation goes hand in hand with the impact of the establishment of WMOs, as reported by WMGs (Fig. 13).

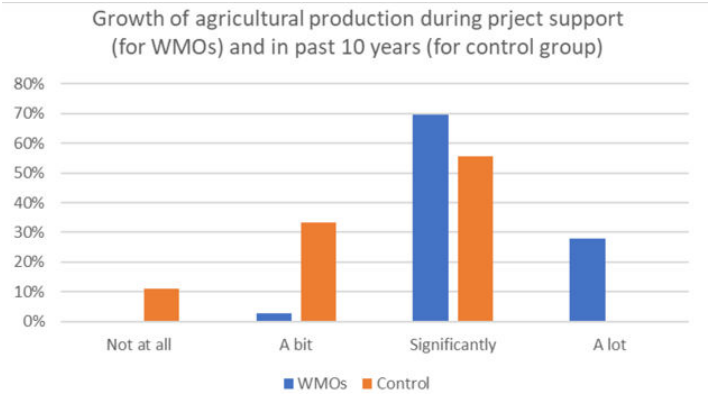

Figure 12 *Changes in agricultural production during project support (for WMOs) and in the past 10 years (for control group) (van Steenbergen et al., 2023)*

	Blue Gold		Southwest		CDSP	
	Impact of infrastructural rehabilitation	Impact of establishment of WMOs	Impact of infrastructural rehabilitation	Impact of establishment of WMOs	Impact of infrastructural rehabilitation	Impact of establishment of WMOs
Not at all	0	0	0	0	0	0
A bit	2	1	1	0	0	1
Significantly	8	8	5	9	6	9
A lot	2	3	6	3	6	2

Figure 13 *Frequency of reporting on the impact of infrastructural rehabilitation and the establishment of WMOs on the increases in agricultural production per unit area during and after project support, as reported by WMOs in 2023 (van Steenbergen et al., 2023)*

As illustrated above, solely coping with O&M already proves to be challenging for WMOs. However, this might be thought around. Maintenance has an intermittent and passive character, meaning that maintenance is only needed occasionally, and members of the organisation only need to become active when an urgent maintenance problem arises, such as the complete sedimentation of a canal. When a local water management organisation solely focuses on maintenance, its sustainability and continuity are under pressure.

However, when truly considering local water management as a key factor in shaping agricultural outputs and livelihoods, water management organisations can tap the full potential of local water management. Hereby, we do not want to neglect the importance of (urgent) maintenance but do want to draw attention to the often-unfulfilled potential of local water management organisations in other aspects of water management and the potential of farmer organisations to be more active in water management.

In the context of Bangladesh, WMOs, both under the umbrella of BWDB and LGED, in collaboration and connection to other actors, have the potential to address many more water management challenges – beyond maintenance (Table 1). Addressing those will not only alleviate the pressure from those challenges but also contribute to the sustainability and continuity of the organisations themselves.

Barriers to WMO functions, including O&M

There are significant barriers to the WMO functions, including O&M, that form barriers to the optimal and sustainable functioning of WMOs, which are discussed in this paragraph. For instance, the Blue Gold project aimed to ensure WMOs would have control over the operation of sluices and significant improvement was seen from 2019 to 2021 in terms of taking control of the sluices by the WMGs (Blue Gold, 2019; Blue Gold, 2021). However, still, many of the sluices and/or primary drainage khals are not

under the control of WMGs, with khals leased out to influential individuals, usually for fish production, as found in the field and literature (Hassan, 2022; Hassan et al., 2023; Blue Gold, 2021).

Still, in many places, the gates are controlled by the informal 'Beel committee'. There had been such an informal management body, known as 'Beel committee', formed by BWDB even before the GPWM was introduced and implemented, with the prime mandate of water management in the catchment defined with respect to drainage sluice or regulator, including the operation and maintenance of the water infrastructure (e.g., operation of sluice gate or regulator), with the help of a gate operator, locally known as "*Khalashi*". Although this informal body has disappeared in many places, it still exists in some places in the coastal area. However, the composition of the committees is not the same; they are typically comprised of some local interest groups and, in some cases, the UP members, especially around the sluice gates, which are illegally leased out to them (Hassan, 2022; Hassan et al., 2023). These informal organizations serve only a narrowly usually problem-defined water management function; outside parties do not recognize them, and the internal organisation depends on individual leaders' ability and availability (van Steenbergen et al., 2023).

Legally, the khals are leased out by the Upazila administration, not by the BWDB, and there is a lack of coordination between the Upazila administration and BWDB. In some cases, WMGs solved the problem (not leasing out the khal anymore) by applying to the Upazila administration to undo the leasing out. However, some WMGs expressed their fear that WMGs may lose control of water management infrastructure in the future (www.bluegoldwiki.com).

Besides, *khas* land (abandoned public property) and khas water bodies are grabbed or leased by local elites. The rules of leasing are that no obstruction to water flow will be created, and the government will take back the land by cancelling the lease in case of any breach of the agreement. But in most places, such conditions are frequently broken by the illegal use of canals, creating barriers to catching fish (e.g., Pata, Kumor), but the concerned authorities have taken no corrective measures.

Key issues around O&M performance and funding by the WMOs

The final part of this section dives further into some of the key issues around O&M performance by the WMOs. In the Blue Gold program, and in many other similar coastal development programs, it was envisaged that strong WMGs form the basis for effective and sustainable water management and, ultimately, overall polder development. Based on the experiences from IPSWAM, it was – in Blue Gold - inferred that a village is the best organizational unit for a WMG, as it is usually a relatively homogeneous group of households or families that have some cohesion among the different stakeholder groups, which brings with its elements of "social control" and "confidence and trust", that are the cornerstones of a successful social organization process. The spontaneous development of saving and micro-credit groups as part of the WMG development is the result and evidence of this conducive environment. In sum, it was generally expected that strong WMGs, strengthened by abilities to generate funds via micro-credit as well as income-generating activities, would contribute to effective and sustainable water management and overall polder development (Blue Gold, 2014).

The committee of WMG charges a monthly payable amount to each general member of WMG to offer loans to local farmers with the fund thus created, irrespective of their membership in the WMG, with a fixed interest rate (fund collection has sometimes been difficult, though even from the local people benefited by the sluices). However, because of the disconnect with water management, water management has not received the desired attention, with many WMGs locally known as only a micro-credit business institute (Samiti) to many villagers. Consequently, they do not know why they are in the WMG and what their roles and responsibilities are regarding water management.

Most of the WMGs do not have dedicated O&M funds and are not willing to provide fund sto WMA and/or O&M committee, making it very challenging for the WMA or O&M committees to manage water management activities. There have been many instances of unwillingness to pay for O&M by the WMGs

as they were not interested in spending their money for water management purposes. From their perspective, funds required for water management should come from the government.

The WMGs need to raise an O&M-related fund from their own incomes. This will require a certain level of motivation, which may be brought forth through more effective and greater engagement and ownership developed thereby. Earthen works, such as khal excavation and repair of embankment, sluice, regulator, and bridge/culvert, should be implemented by WMGs and WMAs through LCS (Labor Contracting Society) projects carried out by BWDB. WMOs should get the top priority in the allocation of LCS funds, which has not been the case in several cases. This will enhance the financial ability of the WMOs. Financial sustainability of WMOs needs to be ensured through utilizing public water resources and other income-generating activities.

The O&M sub-committee needs to be more operationally considered as the base unit of water management instead of WMG. This committee is not a formal body but rather works as a sub-committee under the WMA, comprising representatives of several WMGs in a single sub-catchment, given the role of operating sluice gates and water allocation through canals between agriculture and fisheries. The WMAs need to continually coordinate with the O&M sub-committee for effective management of the catchment. Also, they need to be supported with funds without interruption as they do not have their own funds (dependent on WMGs for funds) to utilize in O&M activities.

Strengthening the financial ability of WMOs may be enhanced through income-generating activities (e.g., microcredit program focusing on water management), utilization of khas land by WMOs instead of elite capture, government projects (e.g., earthen work), and subscription from beneficiaries including farmers and fishermen. The WMGs should assign specific groups of people from general members to participate in different stages of the project cycle, e.g., in preparing annual crop plan and O&M plans, helping the concerned authority and the O&M committee by providing staff, collecting beneficiary contributions towards scheme investment and O&M cost, keeping books of account for record and auditing, identifying local issues and solving them as soon as possible with the help of WMA and LGIs.

4.2 Delayed emergency responses

The second root cause being discussed and dismantled are the delayed emergency (Fig. 14). In the layer below this root cause, one can find, amongst others cumbersome procedures and limited staff and capacity.

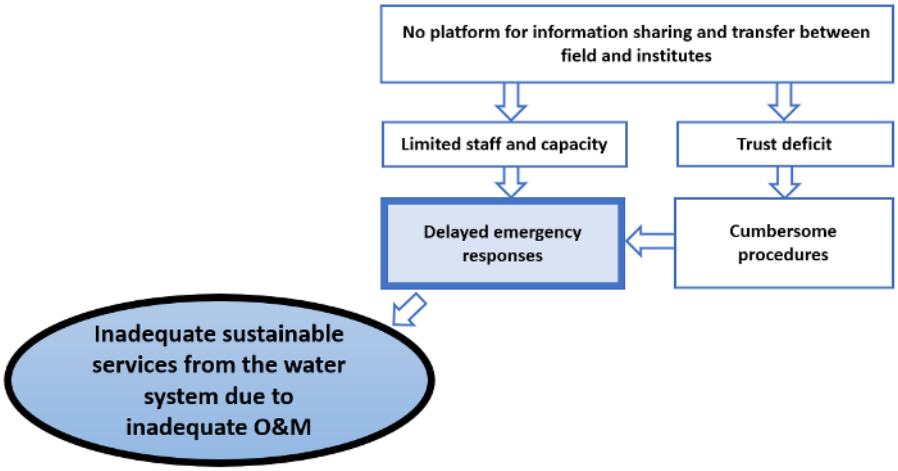

Figure 14 *One of the root causes for the BNR cycle: Delayed emergency responses*

Delayed emergency responses are a root cause of the inadequate sustainable services from the water system due to inadequate O&M. To understand this better, it is helpful to first distinguish the three types of maintenance: (1) preventive or routine maintenance; (2) periodic maintenance; and (3) emergency work.

1. **Preventive or routine maintenance**, carried out around the year, almost continuously or as and when required, refers to regular upkeep and maintenance of the polder system, including all its elements, to ensure good functional order, thereby reducing the need for periodic maintenance, eventually avoiding high rehabilitation costs. Routine maintenance includes small ongoing repairs and replacements, e.g., activities related to vegetative covers on the embankment; small earthworks on the embankment; repairing loose bricks/blocks on the embankment slope; cleaning, greasing, and painting of structures; cleaning canals (khals) and outfall drains from aquatic weeds and floating debris and removing of silt in wet conditions.
2. **Periodic maintenance** intends to bring the components of the hydraulic infrastructure back to their design standard. The work is more expensive than preventive maintenance. Periodic maintenance is characteristic of repair works and is identified during field assessment at (more or less) regular intervals.
3. **Emergency works** cover unforeseen interventions that require immediate actions, e.g., to protect the polder as a whole or a part thereof from the adverse effects of flooding, associated with damage of lives and properties, or effects hampering one or more economic productions sectors, e.g., uncontrolled saline intrusion, negatively affecting agricultural production. The type of work that requires immediate attention includes the closure of an embankment breach, the repair and replacement of sluice gates, or the construction of cross dams over canals if a structure fails.

It is observed that BWDB field engineers identify the areas where water control structures need attention for repair and rehabilitation (routine and periodic maintenance), and they make a priority list and duly send them to the BWDB O&M division in Dhaka. However, funds are not released in most cases until emergencies arise. In other words, the emergency budget for repair is triggered only by damage to the embankment (e.g., breaching). Periodic maintenance would be better, easier, and less costly if it would be done before an emergency occurred (based on observation of vulnerable locations and the need for type and extent of repairs), e.g., by using geo-bags, dumping blocks, etc. Here, we refer again to the "Law of Fives", cited in the introduction of this report (de Sitter, 1984). It can be inferred that the O&M of the water infrastructure of BWDB is at most in between 'reactive (i.e., fixing after the damage or failure) and 'preventive and planned' (i.e., scheduled maintenance and regular check-ups) (Fig. 15), as was also presented by BWDB at the special session at ICWFM 2023.

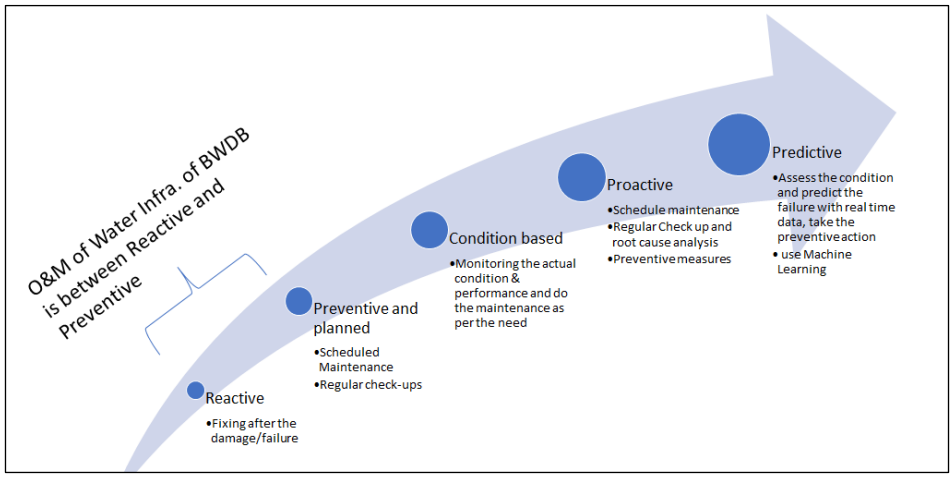

Figure 15 *O&M of the water infrastructure of BWDB, as presented by Shamal Chandra Bas at the special session of the ICWFM 2023 (Source of data: BWDB)*

Cumbersome procedures

One of the major barriers to emergency responses, as generally voiced by the BWDB professionals, and other stakeholders, and described by Saha (2015) (Fig. 16), is the delay in fund disbursement for emergency repair due to complex, bureaucratic procurement rules for relatively small expenses. This delay also leads to increased costs for the repair work. It is further constrained by the often inadequacy of emergency funds received.

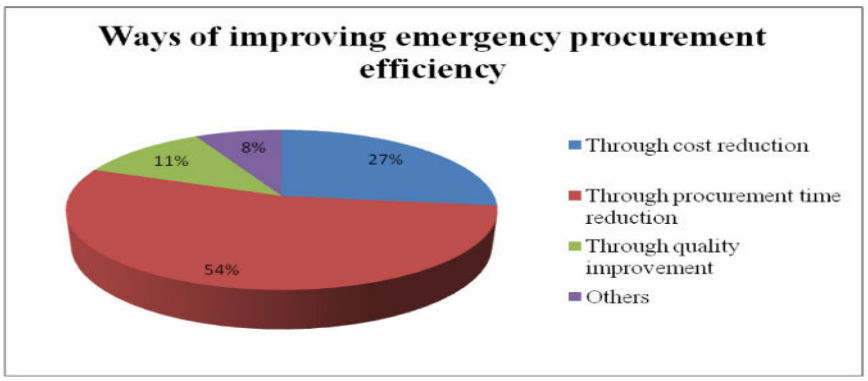

Figure 16 *Division of answers to the question – asked to 52 BWDB officials – on "How can you improve the efficiency of emergency procurement?" (Saha, 2015)*

This has several implications for the quality and longevity of the repair work. The contractors are engaged to do emergency work subject to pending payment, which is a very ad-hoc approach frequently employed by the local BWDB offices. On the one hand, the fund disbursement is delayed for a particular year; on the other hand, contractor's completed bill cannot be paid off before the fund disbursement in the following year. This is a demotivating factor which compromises the quality of work, as indicated also by several stakeholders, including a contractor during the fieldwork.

It is imperative to take a closer look to find out how the procurement process can be made easier, if the emergency procurement methods of PPR (public procurement regulations) cover all aspects of emergency procurement, if a separate budget can be earmarked for emergency procurement, with a short notice call off option if a direct procurement method can be employed emergency procurement, with BWDB having a list of local sources of goods and services that might be needed in an emergency and information on rates and charges established and agreed upon in advance (Saha, 2015). In the case of competitive bidding, the bidders could be briefed during Pre-Bid meetings so that sourcing can be planned well in time, and the bidder's proposals can be solicited and facilitated to resolve potential sourcing issues (ADB, 2023).

Streamlining procurement processes like electronic procurement can be a step forward to reduce unnecessary delays (ADB, 2023). Currently, there is the centralized national electronic government procurement system (e-GP), managed by the Central Procurement Technical Unit (CPTU). The e-GP system covers the entire cycle of procurement, starting from procurement planning to payment processing, including online bid document preparation and submission, electronic bid security, bid evaluation and approval process. It has recently introduced a contract management module. The CPTU has recently developed and launched a citizen's portal to disseminate procurement and contract management data following the Open Contracting Data Standard (OCDS) (https://www.cptu.gov.bd). By engaging in e-GP, the government catalyses the supplier community to participate in e-business.
In summary, budget constraints in emergency projects are significant hurdles to overcome. Funds should be disbursed in due time for the project's timely completion. Again, real-time efficient monitoring should be implemented to eradicate exaggerated requirements, curb misuse of government funds and enhance the quality of work.

BWDB has a proven track record of completing large projects, and officials are well versed with Public Procurement Act and Rules, which are harmonized with ADB procurement policies and regulations with few exceptions (ADB, 2013). BWDB has a dedicated and well-functioning Procurement Wing comprising of experienced procurement professionals (headed by a Superintending Engineer supported by two Executive Engineers and several junior engineers). However, procurement units are overburdened, and hierarchal organization structure sometimes leads to time-consuming decision-making and approval processes. Besides, frequent internal rotation of staff, including those well-trained and experienced in procurement, and an insufficient number of staff dedicated to the project's procurement transactions becomes an issue.

Many of the findings above can be validated with primary data from 2015, in which 52 BWDB officials filled out a survey as part of a study on factors affecting the efficiency and effectiveness of emergency procurement in the BWDB (Saha, 2015) (Fig. 17). From the results, it can be learnt that the statements agreed with widely include notions on time being the vital factor in emergency responses, and budget constraints causing delay to project implementation. Also, the average answer to the last statement, on whether the present procedures are efficient, considering all the factors above, is with 2.60 between "disagree" and "neutral". Interestingly, this last question of the survey gives a very different picture than the first question of the survey, which indicates an average score of 2.94 for the present emergency procurement procedures followed by BWDB to be highly efficient. This is thought-provoking – one could interpret this as BWDB officials initially not being fully aware of the scope for improvement in procedures and gaining more awareness on this while filling out the survey.

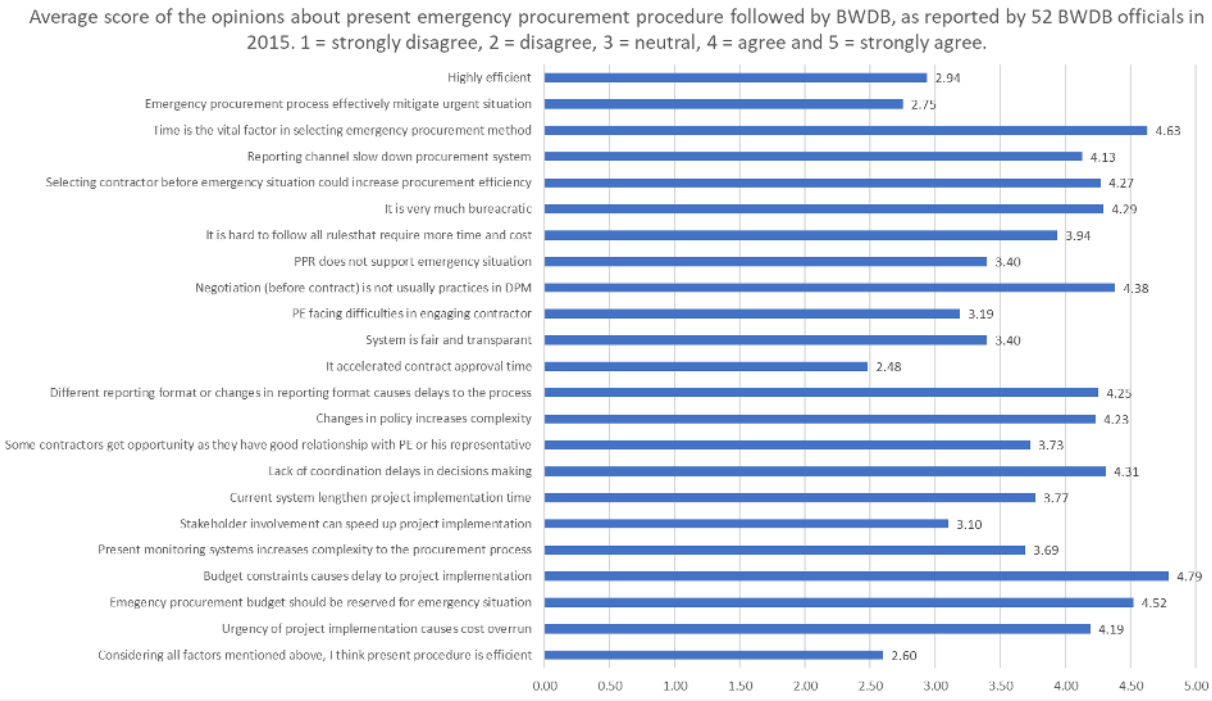

Figure 17 *Average score of the opinions about the present emergency procurement procedure followed by BWDB, as reported by 52 BWDB officials in 2015. 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree (Adapted from Saha, 2015)*

Challenges in carrying out emergency work.
In the actual execution of the emergency works, several challenges are found, which are not the root causes of the delayed emergency responses. Still, they are essential to understand to address the root causes. Those challenges can be different for the two broad categories of emergencies: sudden on-set emergencies, such as typhoons and floods, and slow on-set emergencies, such as river erosion, where the emergency develops over time and can, in many cases, put to a halt. In these cases, extra costs in terms of damage and loss will be incurred if time is wasted during the initial stages.

Emergency works (e.g., closing embankment breaches) become very challenging in tidal environments, for several reasons. Funds for "emergency works" are allocated only after a breach has occurred. At this stage, costs for repair are significantly higher, as large borrow pits with soils suitable for use in embankments are generally not available close to the site of a breach (meaning an additional cost for delivering materials to the site of the breach), it is difficult to get machinery, equipment and materials to the site of a breach (meaning more labourers and boats used to deliver equipment and materials), access by land to the site of a breach is restricted, and soil is often saturated, and achieving an acceptable level of soil compaction at high moisture content become extremely difficult and often impossible.

Closing of the breach becomes technically very challenging as the effective working time is limited to 4 hours in two sessions on either side of high or low tide (depending on the tidal regime during daylight hours), and the velocities on either side of high tide can be considerable. In these conditions, the final closure of breaches often requires driving *bandals* to contain earth filled geotextile bags – so that they are not swept away by the high velocity flows. Unforeseeable risks associated with post-disaster rehabilitation works could slow down implementation due to variations of scope, harsh working conditions, and additional safeguards requirements. Emergency works are spread over a geographically dispersed area, which could lead to comparatively higher costs.

Besides, there are other significant challenges faced by the local (executive) engineers of BWDB regarding the selection of the right approach for the emergency work: whether they should go for embankment retirement, if there is agreement from the community to provide land for the retired embankment, if there will be many houses and land would be outside the proposed embankment and be at risk, if the community will accept an alignment of the embankment sufficient to ensure embankment integrity for a period of (say) ten years if the community had already lost a massive amount of land during previous last decades because of erosion as well as retirement.

O&M needs during the project construction/implementation phase
Another important aspect of the bigger picture on addressing emergencies is related to the lack of budget allocated to O&M during the project construction/implementation phase, which becomes apparent in great challenges emerging in ensuring timely completion of the project and maintaining the quality of construction. Very often, maintenance needs (already) arise during the construction phase with the occurrence of a flood or cyclonic storm surge, with the embankment being built or rehabilitated damaged again. Until a few years ago, some O&M was included in the budget (under ADB) for attending such emergencies. Now, this is contingent upon the availability and use of the emergency funds. There was a suggestion from a senior BWDB interviewee to examine if it would be possible to include O&M in the DPP, meaning making provision for the O&M budget along with the implementation budget, and if some budget can be earmarked for O&M during construction and some for periodic maintenance after the implementation phase. This may also be informed by the steps to be taken to ensure uplifting the allocation and use of O&M funds while ensuring the BDP 2100.

Trust deficit
An extensive trust deficit fuels the cumbersome procedures discussed above. The trust deficit manifests itself between organisations and groups of stakeholders but can also be found between layers of single entities. Currently, cumbersome procedures are in place to replace trust, but this slows emergency responses.

Limited staff and capacity

The limited staff and capacity at several fronts are one of the root causes of delayed emergency responses. This is, amongst others, illustrated by the difficulty and challenges in appropriate assessment of emergency requirements, e.g., via conducting a river bathymetry survey, which is constrained by a shortage of survey equipment and a lack of trained staff. Quick deployment of staff at urgent locations is not always possible.

There has been a significant cut in staff in the late 90s from around 18,000 to around 8,500 in early 2020s. This included the exclusion of essential staff in relation to O&M, notably the Sluice Gate Operators (*Khalashis*) and Section Officers in the field offices, which affected O&M work significantly. The cut in staff particularly affected the O&M of sluice gates and the resulting non-functionality of sluice gates at many places. The non-functioning sluice gates brought a lot of criticism from the government (including the Prime Minister herself) and the media on several occasions.

The staff shortage also affected hydrological data collection as the salaries of gage readers had to be reduced considerably, which gradually compromised the quality of hydrological data in many places. BWDB once had its own agricultural officers in the field offices, who had helped coordinate with the farmers and other government agencies.

Although the approved number of staff has been increased to around 13,000 a few years ago, all BWDB officials are of the opinion that there is not enough human capacity available at the field level. The shortage of staff means that there is a weakness in monitoring of the water (control) infrastructure on a regular basis.

Also, the field staff are not trained enough to connect to the needs of the local people, to understand the social dynamics, and to connect to the functions of different structures with social needs. In line with the confusion about roles and responsibilities, social dynamics are also very contextual and complex. This understanding is essential to facilitate the resolution of conflicts among different water users. It is well documented that conflicts often arise from implementation of different water management projects (Murshed and Khan, 2009; Rahman and Salehin, 2009; Sultana et al., 1995), often associated with non-functionality and/or inappropriate design and operation (often driven by local power dynamics) of water control systems (e.g., drainage canals or sluices) (Murshed and Khan, 2009; Faruque, 2009; Rahman and Salehin, 2009; Mozahedy, 2009).

Besides, there is a need for enhancing capacity building of BWDB staff not working in the field offices, as they do not have enough field orientation and often have a siloed understanding of water resources management needs. Programmes need to be in place to orient them with several projects of different natures in different geographical settings.

No platform for information sharing and transfer between field and institutes.

Connecting to the next root cause being discussed, the lack of an asset management system, is the lack of a platform for information sharing and transfer between field and institutes. This manifests itself in both a trust and knowledge deficit, and in the capability of accelerating emergency responses.

4.3 Lack of an asset management system

The third root cause being discussed and dismantled is the lack of an asset management system (Fig. 18). In the layer below this root cause, one can find, amongst others, the lack of condition surveys, the preference for large investments/construction bias, and the lack of a life cycle approach in investment and rebuilding.

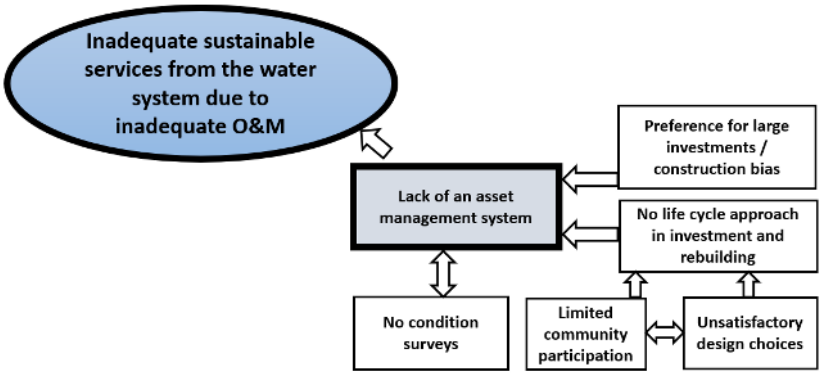

Figure 18 *One of the root causes for the BNR cycle: The lack of an asset management system*

Before diving into the root causes of the lack of an asset management system, it is important first to articulate and showcase the importance of asset management systems, as overcoming the BNR paradigm will require an efficient asset management system, producing wide-reaching benefits. Efforts to improve the time-consuming conventional practice for planning and maintaining water infrastructures embankments and often not being able to cope with the frequent damages to which these structures will benefit from proper asset management in place. Investments in monitoring and evaluation of assets and their performances are a priori in specific biophysical and socio-economic settings, which will underpin the continuous process of updating both strategy and operation delivery and will ensure in the process that flood risks are well-managed, and plans are adapted in a timely manner.

Well-aligned asset management is dependent on having a coherent strategy in place to link water infrastructural asset planning, budgeting, (performance) delivery, operation, and monitoring with broader planning objectives. A shared understanding of the assets to be managed is vital, including basic information on what and where the assets are, how they are likely to perform now and in future, given their current condition, the impacts of natural and anthropogenic pressures, and the present and anticipated future risks. This will entail developing strategies that are flexible and assets that can be modified. Policies and associated appraisal processes should support development strategies that proactively plan for an uncertain future. And as new evidence and insights emerge, these strategies will need to be modified accordingly. It should be noted that asset management entails more components than the narrow focus often attributed to it (Fig. 19). Annex 5.2, on the global recognition of effective asset management and Annex 5.3, on the currently being employed asset management systems by different actors in the Bangladesh water sector, provide further insights and background.

No condition surveys.

One of the root causes for the lack of an asset management system is the lack of condition surveys. Condition surveys would provide input and data for the asset management system, based on which decisions are to be made. As no systematic asset management system has been developed in BWDB, there is often no solid foundation of information based on which decisions are made, leading to suboptimal decision-making and investing.

Figure 19 *A framework for asset management, showing its different aspects (https://www.assetmanagementbc.ca/framework)*

The earliest attempt to make such an asset management system was made in the 90s under the 'Food For Works' (FFW) programme, wherein a 'scheme information management system was developed in 'dbase', which included an inventory of some of the important projects. It made use of the GIS for the first time, which was just introduced in Bangladesh.

Recently, BWDB has made a campaign for producing a 'structure inventory system', for the sluice gates across the country. A variety of information has been collected and stored in the database, such as location, current condition, adverse impacts (if any), sill level, recent photographs, local people's perception about the structure, opinions of the local BWDB officials (in video format), if the structure is functioning or not, need for repair, if the structure is beyond repair and needs to be replaced, or if the structure needs dismantling, etc.

The suggestion would be to extend this to a more comprehensive database of assets, with a history of the performance of the structures, including embankments and other structures (e.g., drainage canals), and update the system with data via the development and employment of an effective monitoring system. Periodic condition surveys would keep the database of assets up-to-date and help prioritise investments and decision-making.

Preference for large investments/construction bias

The preference for large investments/construction bias results in the lack of an asset management system, as asset management is particularly important for existing infrastructure and, to a lesser extent, for large investments in new infrastructure. For the latter, it is, of course, also pivotal, but its importance is not yet demonstrated in the construction phase.

As is also illustrated in the lack of O&M funding and the lack of prioritising O&M, a preference for large investments and construction over maintaining the currently present water infrastructure can be observed. This is in line with the emphasis in the past decades on constructing or rebuilding infrastructure without commensurate attention to systematic operation and maintenance. Resources tend to address themes presumed as more pressing, such as making new water infrastructure, rather than the O&M of existing water infrastructure. However, to boost the long-term functionality of water infrastructure, investments in water infrastructure should be made more effective and efficient to speed up progress and render the desired outcomes of sustainable development over the long term.

No life cycle approach in investment and rebuilding

The lack of a life cycle approach is typical for investments in water infrastructure in Bangladesh, whether it is for new infrastructure or for rebuilding/rehabilitation. This is in line with the lack of an asset management system; the lack of (thinking in) life cycle approaches keep the status quo regarding the lack of an asset management system alive.

The effort on asset management is also related to the type of investments that are made. In the BNR cycle, the almost implicit assumption is that rebuilding will happen every 8-10 years. This is also very much related to the type and quality of investment made. Designs and specifications can be made so that infrastructure is less vulnerable to wear and tear and requires less maintenance or early replacement. A life cycle approach is taken whereby the costs of the investment or rebuilding may be higher. Still, over a longer period the infrastructure lasts longer and is more reliable in delivering the goods. There are several immediate opportunities of this principle that must be explored, besides other examples:

- Replacement of steel sluice gates with composite gates. This is now being introduced by LGED but should be part of BWDB designs as well. Composite gates are not subject to corrosion and wear and tear – and can last almost indefinitely. The cost if locally produced may still be higher technique is now being introduced in Bangladesh.
- Using nature-based solutions to provide additional protection to earthen embankments, especially the use of mangroves and other protective vegetation, which are likely to substantially reduce the cyclonic/storm surge thrust force onto the embankment and reduce surge heights as well. These may have additional benefits of generation of ecosystem services for forest product-based livelihoods as well such as fish spawning.
- In pilots, implemented by Solidaridad under its SaFaL (for IWRM) program, mangrove trees have been planted on the embankments of khals in micro-watersheds. They improve the embankment stability, reduce erosion, and improve the water quality of the canals and the ponds, also via the leaves that fall in the water. When fully grown, the mangrove trees provide several ecosystem services for forest product-based livelihoods. In pond systems, however, some farmers, expressed concerns about mangrove roots creating holes between the ponds and the canal (Mornout et al, 2022).
- Observe material choices in embankment construction – in particular, correct mixtures of sand and clay. This does not always happen as materials need to be transported from larger distances.
- Using tidal river management in the coastal zone to harness the tides of rivers by controlling the deposit of sediment. This could be considered as an approach with initially high costs, depending on how it is implemented, but leading to more sustainable and resilient landscapes and livelihoods.

Limited community participation

The lack of a life cycle approach is kept alive amongst others due to limited community participation. Interviewees and stakeholders consulted expressed that a more mainstreamed participation of communities in decisions on water infrastructure, operation, and maintenance, would enhance the designs chosen, the approach employed for investment and rebuilding, and eventually pave the path for a well-functioning asset management system.

Unsatisfactory design choices

Unsatisfactory design choices are clearly linked to the lack of a life cycle approach. With unsatisfactory design choices, we, on the one hand, refer to the use of outdated design manuals that are not adapted to changes in societal needs and changes to the climate, and on the other hand, to designs that do not consider a lifecycle approach, which is often the case. There is, furthermore, a connection between the unsatisfactory design choices and the limited community participation, as increased community participation is foreseen to lead to more satisfactory and less damage-prone design choices.

4.4 Inadequate management of river sedimentation

The fourth root cause being discussed and dismantled is the lack of an asset management system (Fig. 20). River sedimentation management is a major activity in the water sector, undertaken primarily by the Bangladesh Inland Water Transport Authority (BIWTA) and the Bangladesh Water Development Board. Funding comes from the Government of Bangladesh and, to a lesser degree, from MFIs. It is a major expenditure item; in particular, the cost of dredging, which is around USD 3 per cubic meter, is largely a function of fuel costs.

Currently, river sedimentation is managed in an inadequate manner, contributing to inadequate sustainable services from the water system due to inadequate O&M. In the layer below this root cause, one can find the lack of an overall framework for sediment management in rivers, the lack of strategic dredging, the lack of links between different dredging purposes, and the lack of a management system for operating public dredgers.

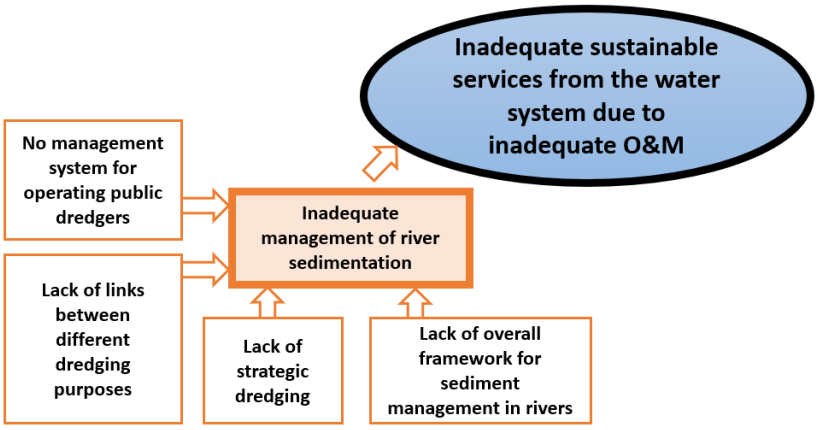

Figure 20 *One of the root causes for the BNR cycle: Inadequate management of river sedimentation*

Lack of overall framework for sediment management in rivers

The lack of an overall framework, using a systems-level understanding, for river sediment management, makes the current management inadequate. With 10 billion cubic meters of sand passing through the river system of Bangladesh, challenges in this regard are huge, and there is a constant threat of rivers silting up and sand shoals (chars) forming. With high population pressure, these chars are often converted into residential and agricultural land, contributing to further changes in the river morphology. Several interventions are undertaken to manage the rivers – sand traps, tidal river management (the forced sedimentation of coastal depressions) and dredging. The latter is a main cost item in the operation and maintenance of the water sector and deserves special attention. In addition, the river morphology is also affected by legal and illegal sand mining (Bari et al, 2022), new land development and the gradual raising of land by the use of silt-laden water. The observation is that there is no overall framework guiding the interventions at the national level. This is also highlighted in the BDP2100, which mentions the need to develop a strategy for sediment management, including a strong capital dredging and maintenance programme, as a strategy for the river systems and estuaries hotspots. BDP2100 recognises the need for effective policy guidelines and rules for sediment management (as a strategy for the cross-cutting issue of sustainable land use and spatial planning). In the suggested strategies for the inland waterway sector, the following is mentioned: “Ensure efficient and equitable use of sand through the regular shifting of the ‘Balu-mahal’ (sand quarry). The local administration should take the necessary steps accordingly. Specific guidelines should be developed for the management of soil/sediment resultant from dredging.”. While the BDP2100 raises several issues and highlights its

importance, the proposed river sediment management framework has not materialised as of yet. Maximising the functions of water infrastructures requires a system-level understanding of bio-physical, socio-economic, governance, and/or institutional processes, which interact in a complex way with feedback. The hydro-morphology of the coastal river systems, including channel shifting (erosion/accretion) and riverbed sedimentation, are largely influenced by the amount of flow and sediments feeding into the coastal system from the upstream freshwater zone. While erosion exceeds accretion in the freshwater zone, accretion is more in the coastal zone (Rahman et al., 2020). There has been a declining trend in the incoming flux. However, the long-term persistence of this phenomenon will depend upon the trend in sediment influx and the change in hydro-morphological processes due to interventions and sea level rise and subsidence.

Importantly, sedimentation in the greater south-west region is part of an integrated process of flow and sediment transport from the inland river systems, erosion-deposition in the inland rivers and floodplain, transportation of these sediments in the estuaries and coastal floodplains, discharge of sediments to the ocean, deposition of sediment in marine environment, transport of sediment with the oceanic processes, and re-entry of part of these sediments into the estuarine systems. Any sediment management practice implemented in this system becomes an integral part of this complex system, requiring a system-level understanding to develop and apply an overall framework for sediment management. This points to the need to study the effectiveness and impacts of any specific sediment management practice or combination of different techniques in any region of the Ganges-Brahmaputra-Meghna (GBM) delta.

System-level research shows that impacts of interventions, for example, dredging and/or cross-dams, at one location, are not limited to that location but may propagate over a wider area through the river systems, thus generating unintended – both positive and negative - outcomes. Key questions are then: whether sediment deposition on the surface of the delta is sufficient to maintain the delta surface above sea level, and that too given that the fluvial sediment influx to the GBM delta system is understood to be decreasing; if any local and regional level interventions (e.g., combinations of tidal river management, dredging) will be able to promote the potential of sediment deposition on the delta surface, plausibly evenly across the coast.

Lack of strategic dredging

In the absence of an overall framework, the lack of strategic dredging is problematic. Strategic dredging is defined as the dredging in the active channel where the natural state of channel development is in an active phase, not in a dying phase (Rahman et al., 2019). The pre-condition of strategic dredging is to identify the active channel reaches by monitoring and modelling where dredging needs to be performed. The advantage of strategic dredging is – as the channel is already in the active phase of natural development, the sedimentation rate after the dredging is performed will be less compared to the condition when dredging is performed in a dying channel section. As the main cause of the sustainability of dredging is a high rate of sedimentation in the dredged section due to increased channel conveyance, while the sediment supply remains the same, strategic dredging will ensure a sustainable dredged section. After the dredged section is selected in this fashion, strategic dredging should ensure minimum negative impact on the system. A recent study showed that the impact of dredging in reach of the Ganges and Brahmaputra rivers can reach up to the coastal ocean and can affect the flooding and floodplain sedimentation patterns on the entire delta (WARPO and BUET, 2022). So, the selection of a strategic dredging section needs a system understanding of the short-term and long-term impacts. This is particularly important in a system where hydraulic connectivity is strong due to relatively flat topography, a situation that prevails in the GBM delta.

Even at a more basic level, some of the dredging operations are questioned on the grounds of limited usefulness: sometimes, short sections of rivers are dredged, only to be refilled quickly. In other

instances, spoil heaps were deposited in the flood plains, which were then washed in soon after. In other wide river sections, there are many river channels, and the choice of whether and where to dredge is not always obvious. In general, there is a need for an overall framework for sediment management that prioritises strategic dredging, combines different possible interventions, and targets cost-intensive operations (read dredging) where it has the best and most long-lasting impact.

Lack of links between different dredging purposes

The lack of links between different dredging purposes causes that many possible synergies in dredging are currently unemployed, contributing to the inadequate management of river sedimentation. Dredging operations can serve several purposes – avoiding drainage congestion, developing or preserving the navigability of rivers and accessibility of jetties, mining sand for construction and pumping up sand for the construction or rebuilding of embankments. These functions are not systematically combined and regulated. The operations where dredging removes a problem (river sedimentation) and where it creates a resource (sand mining, land development) may be more systematically combined to reduce the overall cost of operations. There have been ideas of exporting sand at a profit to Maldives and Singapore. Also, there is a case for regulating illegal sand mining sites, which are widespread in some sub-basins and are a cause of conflict and elite capture but would be better aligned with the requirements of river management (Bari et al., 2022). A related issue arguing for combined approaches concerns the rebuilding of coastal embankments with dredging. As the dredged material may have high clay contents in the coastal areas, it should be mixed with sandy material available further upstream to create relatively reliable coastal earthen embankments. This is not always factored in, resulting in cracking and subsidence of some coastal embankments.

No management system for operating public dredgers

The actual operation and maintenance of the equipment, particularly the dredgers deployed in river management, is problematic, with no management system for operating public dredgers. The track record of dredgers owned by BWDB is not encouraging, with 23 dredgers out of operation. This low functionality occurred after a period when the dredgers were leased out to private operators without necessary oversight on the use and upkeep. With many dredgers non-functional, the Planning Commissioning has refused the procurement of new dredgers for the BWDB, with the argument that the existing dredgers should be refurbished. This indeed is possible but would require an investment and, subsequently also, a better system of asset management for the dredgers. There is also a case to be made for more cooperation with the BIWTA.

5

Shared agenda-setting and action plan

SHARED AGENDA-SETTING AND ACTION PLAN

This section covers two important aspects of this study, namely the shared agenda-setting and the action plan 2024-2025. It builds on the established RCA and analyses provided in Chapter 4 and elaborates on ways to address the agreed-upon root causes. It gives direction for a shared agenda between GoB and GoN that addresses and aims to break the BNR cycle. It also defines agenda topics and the fora where they can be discussed, and more specifically, contribute to establishing an action plan (2024-2025) for assessments, studies, pilots, working groups, events, and media outputs, as well as a central steering of the debate.

To give impulse to the shared agenda, a number of immediate steps need to be undertaken to explore the needed changes in O&M and asset management, overseen by a panel of local and national stakeholders. It is recommended that the process is anchored in a high-level panel and supported by a number of activities – identified in this section - that pursue the discussion and dialogue on the different parts of the root causes identified.

The in-depth activities also would need to be implemented in a co-creation mode, with stimulating coalitions around specific themes, creating contact, shared understanding, and learning between different stakeholders. The activities identified as part of the action agenda are arranged in this fashion.

Action activities should be undertaken directly by the main stakeholders concerned as teams, with expert fact-finding support. The results would be discussed and presented to the high-level panel. Promising immediate activities, considered low-hanging fruit, identified as part of the stakeholder consultations and the meetings, are presented below.

- **Co-design pathways from the current "structure inventory system" to a comprehensive database** - Co-designing pathways to extend the current 'structure inventory system' to a more comprehensive database of assets, with a history of performance of the structures, including embankments and other structures (e.g., drainage canals), and updating the system with data via development and employment of an effective monitoring system.
- **Costs and benefits of asset management** - Comparing the costs of maintenance with the costs of reduced damage (with MoF, Planning Commission, BWDB, LGED) and reviewing current financing mechanisms. Comparing with other asset management strategies (LGED / WASA).
- **Dialogues on river sediment management** - Focusing on integrated river management and linking scales in water management towards better (coordinated) river management, (selected) dredging, and land development. It includes mapping private and public dredging and sand mining, understanding its regulations, challenges and needs and coming to a joint framework.
- **Comparative analysis on emergency repair mechanisms** - Documenting experiences in countries with similar/different problematics/responses, i.e. Indonesia and Vietnam (see blog), including visits by core teams of BUET/BWDB. Preparing a discussion note on improved emergency repair (and preparedness) procedures in Bangladesh – also comparing the approach with other GoB sectors. This also includes the neglected topic of emergency repairs during construction.
- **Case study on the actual needs, requests and allocations** – Conducting a case study on the real needs, requests and actual allocations in some selected districts or in a polder for emergency works. It would be interesting to also add in the element of time – in requests and funding – as time is one of the most critical factors in maintenance. This would help improve the budgeting system and develop cooperative frameworks around asset management and in-polder water management between BWDB, LGED, local governments, WMOs, and others, clarifying roles and responsibilities.

These immediate activities should set in motion medium-term change, addressing the different root causes:

- **Streamlining procurement processes for emergencies** – There is an urgent need to reconsider procurement processes and make them more flexible and responsive. This includes assessing whether the emergency procurement methods of the Public Procurement Rules (PPR) cover all aspects of emergency procurement, and whether a separate budget can be earmarked for emergency procurement, with a short notice call off option. It may be explored whether a direct procurement method can be deployed in an emergency, with BWDB having a list of local sources of goods and services that might be needed in an emergency and information on rates and charges established and agreed upon in advance. This element is strongly connected to the comparative analysis of emergency repair mechanisms.
- **Moving towards life cycle management** - Reviewing designs (embankments, canals, gates) to come to low maintenance and reasonable cost options, doing full costing analysis (with BWDB and Monetary Financial Institutions (MFIs) - starting with composite gates. This would help to come to low maintenance systems; assessing cost and benefits of asset management with the Planning Board and Ministry of Finance to come to developing pathways from a 'structure inventory system' to an asset management system, building it up in steps.
- **Developing cooperative frameworks** - Between BWDB, WMO, DoA, DAE, and LGIs, to also address the full potential of in-polder water management.

The different activities should be ground-truthed in Polder 31, which is designated to lead in shaping the **Polder of the Future**. However, given the status of Polder 31 and the relatively long time needed to assess the benefits of the activities in this polder, it would also be worthwhile to start activities in comparable polders. An adaptive set-up will help to reach most benefits.

Finally, and importantly, the process should be anchored in a **high-level panel** supported by a number of activities – identified above - that pursue the discussion and dialogue on the different parts of the root cause analysis. This working group is to include key stakeholders and (emerging) champions in Bangladesh and is foreseen to closely link to the BWDB governing board with invitees. Important stakeholders are the Planning Commission, the Ministry of Finance, the Department of Agricultural Extension, the Local Government Engineering Department, representatives of Water Management Federations and other Water Management Organizations, as well as independent experts from universities and technical institutes.

REFERENCES

ADB (2023). Strategic Procurement Planning. Bangladesh: Flood Reconstruction Emergency Assistance Project (RRP BAN 56339-001), Asian Development Bank.

Bari, E and Haque, SE. 2022. Legal and Illicit Sand Mining Practice in Bangladesh: Exploring Supply Chain and its Value. Journal of Illicit Economies and Development, 4(1), pp. 44–57. DOI: https:// doi.org/10.31389/jied.149

Barbour, E.J., Adnan, S.G., Borgomeo, E., Paprocki, K., Khan, M.S.A., Salehin, M., and Hall, J.W. (2022). The unequal distribution of water risks and adaptation benefits in coastal Bangladesh. The unequal distribution of water risks and adaptation benefits in coastal Bangladesh. Nature Sustainability, 5 (4). 294 – 302. ISSN 2398-9629.

Blue Gold. (2021). Blue Gold Lessons Learnt Wiki.

https://www.bluegoldwiki.com/index.php?title=Blue_Gold_Lessons_Learnt_Wiki

Blue Gold. (2019). *Technical report 26*. Inproving the productivity of land in coastal Bangladesh: Outcomes of Blue Gold interventions, WMG survey 2019.

Blue Gold. (2015). *Technical Report 13*. Engaging Local Government Institutions In Water Management. Ministry of Water Resources, Government of the People's Republic of Bangladesh.

Blue Gold. (2014a). *Blue Gold Program Technical Report No. 10*. Outcome of Functionality Assessment for Water Management Organizations. Ministry of Water Resources, Government of the People's Republic of Bangladesh.

Blue Gold. (2014b). *Technical Report 09*. Water Management Organizations – Comparative Analysis. Ministry of Water Resources, Government of the People's Republic of Bangladesh.

de Sitter, W. R. (1984). Costs of service life optimization "The Law of Fives". In CEB-RILEM Workshop on Durability of Concrete Structures (Copenhagen, Denmark, May 18-20, 1983) (pp. 131-134). (CEB Bulletin d'Information; Vol. 152). Comité Euro-International du Béton.

Dewan, C., Buisson, M.-C., & Mukherji, A. (2014). The Imposition of Participation? The Case of Participatory Water Management in Coastal Bangladesh. *Water Alternatives*, *7*(2), 342–366.

DHI and Deltares (2022). 6.2+6.3: Polder Management Plan and Performance Monitoring. Component study of Long-Term Monitoring, Research and Analysis of Bangladesh Coastal Zone, Coastal Embankment Improvement Project, Phase I (CEIP-I).

EU (2017). A perspective on the future of asset management for flood protection. A Policy Brief from the Interreg North Sea Region, FAIR project, European Union.

Faruque, S. B. (2009). *Multipurpose use of Hazir khal by making provision for community proposed flow control gate at a culvert*.

GED (2018). Bangladesh Delta Plan 2100 (Bangladesh in the 21st Century). Volume 1: Strategy, General Economics Division, Bangladesh Planning Commission, Ministry of Planning, Government of the People's Republic of Bangladesh.

GED. (2018). Bangladesh Delta Plan 2100. General Economics Division (GED) Bangladesh Planning Commission Government of the People's Republic of Bangladesh. http://oldweb.lged.gov.bd/uploadeddocument/unitpublication/1/757/BDP%202100%20Abridged%20Version%20English.pdf

GoB (2015). Bihar Kosi Flood Recovery Project: Final Report. Flood Management Improvement Support Centre, Water Resources Department, Government of Bihar, India.

Haque, A., Hossain, D., Azad, A.A., Mita, S., Lázár, A.N., Hanson, S.E., Salehin, M., and Rahman, M.M (2019). Inundation due to future climate and proposed interventions. Chapter 3, Rahman et al. edited "Integrated assessment for the Bangladesh Delta Plan: Analysis of selected interventions". Published by BUET-Southampton University-GED, Planning Commission, People's Republic of Bangladesh.
Hasan, M.H. (2022). Study of Changing Water Conflicts and Their Implications for Water Security in Polder-29. MSc in Water Resources Development, Institute of Water and Flood Management, Bangladesh University of Engineering and Technology.

Hasan, M.H., Salehin, M., Hossain, J., and Lima, M.H. (2023). Changing Water Conflicts and Their Implications for Water Security in Southwest Coastal Bangladesh. In Preparation.

Huppert, W., Svendsen, M., and Vermillion, D.L. (2003). Maintenance in irrigation: Multiple actors, multiple contexts, multiple strategies. Irrigation and Drainage Systems 17: 5–22.

Hossain, M.S. (2022). Geotechnical Assessment of Coastal Polders Against Cyclones in Bangladesh. Unpublished MSc dissertation in Civil Engineering (Geotechnical), Department of Civil Engineering, Bangladesh University of Engineering and Technology.

Hossain, M.S., Ansary, M.A., Akter, M., Haque, A., and Rahman, M.M. (2018). Geotechnical Stability of Coastal Polderof Bhola District in Bangladesh Coast against Cyclonic Storm Surges using PLAXIS. 2nd International Conference on Sustainable Development (2nd UIU-ICSD 2018), 15-17 February 2018, United International University (UIU), Dhaka

IOB (Policy and Operations Evaluation Department of the Ministry of Foreign Affairs of the Netherlands). (2017). Tackling major water challenges Policy review of Dutch development aid policy for improved water management, 2006-2016.

IWMI (2004). Pro-poor intervention strategies in irrigated agriculture in Asia: Poverty in irrigated agriculture – Issues and Options, Bangladesh. Country report Bangladesh. International Water Management Institute, Colombo, Sri Lanka.

JICA (2017). The Project for Capacity Development of Management for Sustainable Water Related Infrastructure in the People's Republic of Bangladesh: Final Report. Japan International Cooperation Agency.

Kabir, T., Salehin, M., & Kibria, G. (2015, March). Delineation of physical factors of cyclone aila and their implications for different vulnerable groups. In Proceedings of the 5th International Conference on Water & Flood Management (ICWFM-2015), organized by IWFM, BUET, Dhaka.

Kabir, T. (2016). Assessment of biophysical vulnerability of storm surge hazard and its implications for water and food security. MSc in Water Resources Development, Institute of Water and Flood Management, Bangladesh University of Engineering and Technology.

Kabir, T., Salehin, M. and Kibria, M.G. (2016). "Impacts of Post-Disaster Slow Rehabilitation of a Coastal Polder on Coastal Livelihoods: A Case Study on Aila". Proceedings of the 3rd International Conference on Civil Engineering for Sustainable Development (ICCESD 2016), 12~14 February 2016, KUET, Khulna, Bangladesh (ISBN: 978-984-34-0265-3), pp 506-512.

LGED (2019a). Asset Management Policy (An Organizational Policy of LGED). July 2019.

LGED (2019b). Strategic Asset Management Plan (SAMP) Draft. October 2019.

LGED (2020). Strategic Asset Management Plan (SAMP). July 2020

MoEF (2009). Bangladesh Climate Change Strategy and Action Plan 2009. Ministry of Environment and Forests, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh. xviii+76pp.

Mornout, D., A. Maruf, C. Terwisscha van Scheltinga, 2022. Water management for food systems – case study Bangladesh. Wageningen, Wageningen Environmental Research, Report 3215.

Mozahedy, A. B. M. K. (2011). *Social perceptions and technical evaluation of performance of selected water control structures in Narail district*. MSc in Water Resources Development, Institute of Water and Flood Management, Bangladesh University of Engineering and Technology.

MoWR (2010) Guidelines for O&M of permanent structures of BWDB, Ministry of Water Resources, October 2010.

Murshed, S. B & Khan, M. S. A. (2009). Water Use Conflict between Agriculture and Fisheries in a Selected Water Resources Development Project in Bangladesh. *South Asia Water Journal*, *1*(2), 159–183.

Nobel Systems (2023). Enhancing Water Supply Asset Management System in KWASA. Available at: https://nobelsystemsblog.com/2023/10/19/adb-kwasa/

Nowreen, S., Khan, M.S.A., and Huq, H., (2009). Development of an Operational IWRM Framework in a Selected Small Scale Water Resources Development Sector Project In Bangladesh. South Asian Water Studies (SAWAS) journal, Volume 2, Issue 2.

PIAC (2013). Infrastructure Maintenance in the Pacific: Challenging the Build-Meglect-Rebuild Paradigm. Pacific Infrastructure Advisory Centre, Sydney, Australia. Available at: https://prdrse4all.spc.int/system/files/149856004-infrastructure-maintenance-in-the-pacific-challenging-the-build-neglect-rebuild-paradigm.pdf

Rahman, M., Shampa, Anisul Haque, Quamrul Ahsan (2019). Concept note on Managing Brahmaputra-Jamuna River System. Final Report, BWDB and BUET, September 2019.

Rahman, R., and Salehin, M. (2013). Flood Risk and Reduction Approaches in Bangladesh. In R. Shaw et al. (eds.) Disaster Risk Reduction Approaches in Bangladesh, Disaster Risk reduction, Doi: 10.1007/978-4-431-54252-0_4, Springer Japan.

Rahman, M.S., Salehin, M. (2009). Water management of integrated rice-fish farming in inundated floodplains: A case study. *Journal of Agricultural Engineering*, The Institution of Engineers, Bangladesh, Vol. 37/AE, December 2009.

Saha, P.P. (2015). Factors Affecting the Efficiency and Effectiveness of Emergency Procurement in Bangladesh Water Development Board (BWDB). Master's dissertation in Procurement and Supply Management, BRAC Institute of Governance and Development, BRAC University.

Salehin, M., Haque, A., and Khan, M.S.A. (2023). Development Dilemma with Coastal Protection: Experiences from Recent Cyclones in Coastal Bangladesh. In preparation.

Soussan, J., & Datta, A. (1998). Community partnership for sustainable water management: Experiences of the BWDB Systems Rehabilitation Project. Vol 1, summary report. Dhaka, Bangladesh: University Press.

Van Steenbergen, F., G. Cornish and C. Perry (2006) Charging for Irrigation Services: Guidelines for Practioners. Lonfon: IWA.

Van Steenbergen, F., Mornout, D., Chowdury, A., and Marandy, J. (2023) Food Security and Sustainability of Institutional Interventions in Coastal Zone in Bangladesh: Contribution to IOB Coherence Study Commissioned by the Policy and Operations Evaluation Department of the Ministry of Foreign Affairs of the Netherlands (IOB).

Sultana, P., & Thompson, P. M. (2017). Adaptation or conflict? Responses to climate change in water management in Bangladesh. *Environmental Science & Policy*, *78*, 149-156.

WARPO and BUET (2022). Research on Sediment Distribution and Management in South-West Region of Bangladesh. Final Report, IWFM, BUET, April 2022.

Annexes

ANNEX 1
STAKEHOLDER CONSULTATIONS

Stakeholder consultations took place via one-on-one interviews, interviews and FGDs in the Khulna region, and via organised sessions, being the special session at ICWFM on October 16th and the workshop co-organised by BWDB on 23rd of November. Find below overviews of the stakeholder consultations for each of those categories.

List of interviewees

Name	Designation	Organization
Mr. Mahfuzur Rahman	Ex-Director General (DG)	BWDB
Mr. Fazlur Rashid	Ex-Director General (DG)	BWDB
Mr. Amirul Hossain	Ex- Additional Chief Engineer Ex-PD, Blue Gold Project	BWDB
Mr. A.K.M. Tahmidul Islam	ADG Planning	BWDB
Mr. Muhammad Amirul Haq Bhuiya,	Chief Engineer (Civil), (Western Region)	BWDB
Dr. Shamal Chandra Das,	Chief-Planning	BWDB
Mr. Md. Mukhlesur Rahman	Chief Engineer (Civil), O&M	BWDB
Mr. Md. Asaduzzaman	Addl. Chief Engineer (Civil), Central Zone (Dhaka)	BWDB
	O&M	BWDB
Mr. Mir Sajjad Hossain	Ex-Chief Engineer (Ex-Member, JRC; currently External Member, JRC)	BWDB
Md. Moniruzzaman	Chief Engineer (Civil)	BWDB
Dr. Robin Kumar Biswas,	Superintending Engineer	BWDB
Dr. Saif Uddin	Superintending Engineer	BWDB
Mr. Mohd Enamul Haque	Joint Secretary, Agriculture, Water Resources and Rural Institutions Division	Planning Commission
Mr. Saiful Islam	Joint Secretary, IMED (M&E Sector-4)	Planning Commission
Mr. Gopal Krishna Debnath	Additional Chief Engineer	LGED
Mr. Sheikh Mohd. Nurul Islam	IWRM Division	LGED
Dr. Mizanur Rahman	Deputy Managing Director (DMD) (Ex- ADG, BWDB)	DWASA
Mr. Kamrul Islam	Chief Engineer	DWASA
Mr. Aman Ullah (RHD)	Additional Chief Engineer	RHD
Dr. Rezaur Rahman	Professor	IWFM, BUET
Mr Mohammed Sayeed Momin	Private sector	XXW

List of Interviewee in Khulna region (fieldwork October 2023)

Location	Interviewees
Polder 34/2:	Local Contractor WMG Secretary for Talbunia, Badadlbunia, Jalipara UP Member BWDB Section Officer: Mr. Saidur BWDB Gate Operator: Mr. Humayun
Polder 30 (near Soilmari):	WMG President WMG Secretary WMG Treasurer Local influential person (not direct part of WMG)
Polder 31: Raipur, Rishipara	UP Chairman WMA President of Nandankhali Sluice Gate WMA WMG Secretary
Polder 31P: Bhagabatipur area/ Kechorabad khal	WMG President
Polder 30: Katianangla Bazar	WMG Vice President (and also WMA General Secretary) WMG Ex-President (Andharia-Khejurtola) WMG Committee Member

Other intensively involved stakeholders.

Name	Designation	Organization
Michiel Slotema	Partners for Water Bangladesh Advisor	RVO
Neeltje Kielen	Delegated Representative for Water (DR)	EKN
Shibly Sadik	Senior Policy Advisor (IWRM)	EKN
Catharien Terwisscha van Scheltinga	Sr. Researcher	WUR
Kees Blok	Lecturer	WUR
Several	Several	MoWR / LGED
A. T. M. Khaleduzzaman		World Bank
Md Taufiqul Islam	Joint Secretary	Cabinet Decisions Implementation Coordination Branch
Harry Lammeretz		Rijkswaterstaat

ANNEX 2
BLOGS

Blog 1:
Preserving the assets – Operation and Maintenance in the Delta's

Authors: Dr. Dung Duc Tran (Centre of Water Management and Climate Change, Vietnam), Prof. Mashfiqus Salehin (Institute of Water and Flood Management (IWFM) Bangladesh University of Engineering and Technology (BUET)), dr. Frank van Steenbergen (MetaMeta), David Mornout (MetaMeta), Dr. Long Hoang (MetaMeta)

It seems the hardest thing to do preserving the assets after creating them. Globally, a lack of operation and maintenance of water infrastructure has been seen as a major obstacle to rendering sustained economic growth. What is common instead is the "BNR cycle": build something, then neglect its upkeep, causing it to deteriorate and become unreliable. And then have another cycle of rehabilitation and rebuilding, followed by the same lack of asset management. It is a pity as some have estimated that 1 USD of maintenance is worth 7 USD of rebuilding costs.

Continue reading here.

Blog 2:
In-polder water management towards the future

Authors: Prof. Mashfiqus Salehin *(IWFM BUET), Prof. Anisul Haque (IWFM BUET), Associate Prof. Ahmed Ishtiaque Amin Chowdhury (IWFM BUET), Catharien Terwisscha van Scheltinga (WUR),* dr. Frank van Steenbergen *(MetaMeta),* David Mornout *(MetaMeta)*

Water is the key factor, shaping Bangladesh. It is at the heart of millions of livelihoods, in agriculture, fisheries and beyond. Nowhere is this more manifest than in the coastal zone, at the interface of low-lying land, intricate network of rivers, and the Indian Ocean. Here, over the last eighty years, polders have been developed to protect the land from flooding and saline water intrusion, by constructing embankments and dikes. A main concern has been the flood protection and their upkeep. This latter has been an enormous challenge, as the mainly earthen embankments stretch over many thousands of kilometres and the crest level degraded appreciably, sedimentation occurs and the resulting situation barely giving protection against high or spring tide levels. The embankments are moreover under threat from shifts in the river, undermining the fragile structures.

Continue reading *here*

ANNEX 3
SPECIAL SESSION AT ICWFM – 16 OCTOBER 2023

Flyer of the event

Reactive O&M to Asset Management of Water Infrastructure in Bangladesh:

Challenges, Root Causes and Way forward

You are cordially invited to attend this session on Sunday morning, 15th October (9 AM).

9th International Conference on Water and Flood Management
With special focus on
Climate Extremes and Resilient Development
October 14-16, 2023 | Dhaka, Bangladesh

Introduction to the session

The main objective of this session is to create a common and shared understanding of O&M and asset management, and to particularly discuss how to go away from the current pattern of reactive and under-resourced Operation and Maintenance, and to move to Planned and Pro-active Asset Management in the water system in Bangladesh. In the session, it is aimed to engage different stakeholders in this important topic and build partnerships to work on better Asset Management. The preliminary outcomes of a Root Cause Analysis will be presented, and in an interactive session more inputs for this will be gathered, capturing insights and interest from the participants.

Program

- Opening by Neeltje Kielen (Delegated Representative Water Affairs at the Embassy of the Kingdom of the Netherlands in Bangladesh)
- Setting the scene by chair dr. Shamal Chandra Bas (BWDB)
- Keynotes by prof. Salehin (IWFM BUET) and Harry Lammeretzen (Rijkswaterstaat) on O&M and asset management
- Panel discussion, led by dr. Shibly Sadik (Embassy of the Kingdom of the Netherlands in Bangladesh) with Dr. Robin Kumar Biswas (BWDB), A. T. M. Khaleduzzaman (World Bank), Md Taufiqul Islam, Joint Secretary, Cabinet Decisions Implementation Coordination Branch, Prof. Salehin (IWFM BUET), Harry Lammeretz (Rijkswaterstaat)
- Q&A and interactive poster session

Kingdom of the Netherlands
পানি ও বন্যা ব্যবস্থাপনা ইন্সটিটিউট
Institute of Water and Flood Management
Bangladesh University of Engineering and Technology
META

ANNEX 4
WORKSHOP AT BWDB – 23 NOVEMBER 2023

Invitation for the workshop

Subject: Workshop: Addressing the recurring "build, neglect, and rebuild" cycle in Bangladesh's water sector

Dear Sir/Madam,

We hope this message finds you well. We would like to invite you for a workshop to discuss the recurring "build, neglect, and rebuild (BNR)" cycle in Bangladesh's water sector and agree on a joint agenda for collaborating on addressing this.

The workshop will take place on the **23rd of November**, at the BWDB office in Dhaka (Conference room, Pani Bhaban, BWDB, Panthapath), from **10 AM to 1 PM**, followed by lunch. An outlook invitation will follow shortly, which you are requested to kindly confirm.

This workshop is organized by BWDB, IWFM BUET and MetaMeta, who have in the past months drafted a shared agenda and action plan, based on interviews, stakeholder consultations, literature review, and discussions at the ICWFM in October. This collaboration has been supported the Partners for Water Program of the Netherlands Enterprise Agency (RVO).

The main objective of this workshop is to confirm interest in, reach consensus on and finetune the shared agenda and action plan (incl. concrete steps and ideas for immediate action). This to break the BNR cycle in the water system in Bangladesh, based on a short- and medium-term vision for water management / water infrastructure that moves away from the current reactive O&M.

Agenda:

- Opening and Introduction by Neeltje Kielen (Delegated Representative Water Affairs at the Embassy of the Kingdom of the Netherlands in Bangladesh)
- Overview presentation on findings and challenges by IWFM BUET (prof. Salehin) and MetaMeta (dr. Frank van Steenbergen)
- Session to guide the development of short- and medium-term vision in which is moved away from the current reactive O&M
- Agreeing upon short public report and working group
- Closure by Neeltje Kielen

We look forward to meeting you at this workshop, and to collaborating on this important topic.

Yours sincerely,

Neeltje Kielen - *Partners for Water Program by the Netherlands Enterprise Agency (RVO)*
A.K.M. Tahmidul Islam- *Bangladesh Water Development Board*
Prof. Mashfiqus Salehin - *Professor Institute of Water and Flood Management (IWFM) | BUET*
Dr. Frank van Steenbergen – *MetaMeta*

PARTNERS FOR WATER
CO-CREATING IMPACT

পানি ও বন্যা ব্যবস্থাপনা ইন্সটিটিউট
Institute of Water and Flood Management
Bangladesh University of Engineering and Technology

META META

LinkedIn post of the workshop

MetaMeta
2,058 followers
2w •

🌊 Last week, a collaborative effort unfolded at the Bangladesh Water Development Board (BWDB), IWFM, Bangladesh University of Engineering and Technology, and MetaMeta-organized workshop. Government representatives, and stakeholders from water, infrastructure, and agriculture sectors, alongside financiers and NGOs, came together to address the persistent "build, neglect, and rebuild" cycle in Bangladesh's water sector.

🔍 The workshop's initial focus was on achieving a shared understanding of the root causes leading to inadequate sustainable water services. The identified challenges included the absence of a robust asset management system, insufficient funding for operations and maintenance (O&M), delayed emergency responses, and the lack of strategic river desiltation and dredging.

🤝 The second part of the workshop was marked by collaborative efforts to forge a shared agenda. Participants brainstormed emerging ideas for immediate action, aiming to break free from the current reactive O&M approach. The result is a forthcoming public report co-created by workshop attendees, highlighting core findings and proposing actionable steps to address the identified root causes.

📑 Stay tuned for the release of the report, which will provide valuable insights and strategic directions. It will serve as a guiding document for implementing the Partners for Water Bangladesh strategy in the years to come.

This workshop and collaboration have been supported by the Partners for Water Program of the Netherlands Enterprise Agency (RVO).

ANNEX 5
BACKGROUND INFORMATION AND ELABORATIONS

5.1 O&M guidelines and manuals

Early initiatives- System Rehabilitation Project (SRP)
The System Rehabilitation Project (SRP) (1990 – 1997) was initiated in 1990 because of the need for rehabilitating already completed BWDB infrastructure sub-projects/schemes, co-financed by the World Bank, European Union, GoN, and GoB. The objectives of the project were to protect and increase agricultural production and incomes of the rural poor, particularly women, through rehabilitation and improved operation and maintenance (O&M) of BWDB's flood control, irrigation and drainage works, and to increase beneficiary participation and funding for O&M and improve BWDB's O&M capability. The project gradually shifted its focus from rehabilitation to institutional development over the implementation period, with finding ways to come to improved O&M based on previous experiences receiving more attention (Blue Gold, 2021). The SRP eventually produced an operational approach to strengthening maintenance and an approach for participatory water management (PWM) - which later informed the development of Guidelines for PWM.

Although the degree of success of the project was less than desired (e.g., Soussan and Datta, 1997; IWMI, 2004), the SRP project is still viewed by the former and senior BWDB professionals as a very promising project, as people's participation gained momentum during the project and involved introduction of Water User Organisations (WUOs) for the first time, and later extended to Embankment Maintenance Group (EMG) and Canal Maintenance Group (CMG). The project introduced a documentation mechanism for O&M (register to be maintained and regularly updated). Preventive maintenance of embankments, an integrated component of O&M, was executed through Embankment Maintenance Groups (EMG) throughout the year, with the EMG members being paid for the working days. BWDB was responsible for the selection of an embankment reach to be assigned to an EMG for preventive maintenance. The activities involved were suitable to female labourers, and therefore, the implementation of preventive maintenance provided an opportunity for women belonging to the poorest of the rural poor (IWMI, 2004).

O&M guideline for BWDB
"Guidelines for O&M of permanent structures of BWDB", earlier prepared by BWDB and approved by the Ministry of Water Resources in October 2010 (MoWR, 2010). The guidelines were prepared to provide helpful guidance for transparent and efficient use of financial resources received for maintenance works of permanent structures. The document explains the applicable activities for the budget allocation as "Maintenance allocation (Economic Code-5974). It stipulated that the maintenance budget can be applied to the works of repair and maintenance of the permanent structures, maintenance dredging and excavation, and repair and maintenance of the office and residential buildings. Collection of the hydraulic and other data is to be met from the general budget allocation (finance code 5901). Unexpected demand of emergency riverbank erosion is to be met from the "unexpected expenditure management fund". The category of the maintenance works is provided based on technical specifications and the frequency of requirement. It is stated that the periodical re-section works of embankments and drainage channels are required every 5 to 10 years and every 3 to 5 years, respectively.

The guideline document provides a description of operation and maintenance works and itemizes the work of the respective structures. It also explains the management (organization, implementation, and monitoring procedure, etc.) of the maintenance works, and stipulated that the deficit of O&M budget can be covered by utilizing the local resources. Expected maintenance plan within the budget and the complementary work program after flood are explained with a form of the work plan. It recommends preparing a medium-term maintenance plan, to prepare an efficient and effective annual work plan. The expected prioritization of the O&M works is explained at national level and the field office level. Budget preparation and distribution to the respective O&M works including allocation policy, guidelines of budget allocation by categories and communication technology as the tools are also explained.

JICA (2017) conducted a thorough review of those guidelines from 2010. The review observed that the maintenance dredging/excavation, as emphasized within the maintenance works, may be debatable. It is also debatable whether the completed projects are feasible or not under the resection with those mentioned frequencies (i.e., every 5 to 10 years for embankments and every 3 to 5 years for drainage channels). The general guidelines of the implementation and monitoring procedures need to be detailed, and the same applies to other internal regulations in respective O&M zones and circles. The situation of the medium-term maintenance plan also needs a detailed explanation. There is no description of the medium-term maintenance plan in case of inappropriate budget conditions, which causes confusion to the field officials of BWDB. While the basic idea of prioritization is clarified, there are few technical explanations for the prioritization of the projects and structures at the field office level. Technical references or samples would be useful for prioritization in the respective field offices. While the basic policy of the budget allocation to the respective O&M works is explained, the actual application of these guidelines to the O&M activities in the field depends on the consideration of the field office. It will be useful to give a detailed explanation, including the samples of the activities to facilitate the activities in the field

.

O&M manual for BWDB

An O&M manual of hydraulic structures was prepared along with a design and construction manual for river embankment by JICA (Japan International Cooperation Agency) and BWDB (JICA, 2017), as a technical reference for “Guidelines for O&M of permanent structures of BWDB”. The O&M manual explains O&M works within the framework of an integrated O&M (Fig. 21). The framework of integrated O&M is accepted by BWDB but not widely applied yet (JICA, 2017).

The O&M framework emphasizes reliable and regularly updated Basic Scheme data (actual status, including maps and inventories of all components) as a prerequisite for planning and conducting the O&M activities, as well as for promoting budget reinforcement for O&M activities.

To support the planning of O&M and to protect project infrastructure and water management interests, the timely reservation and release of O&M funds is required. Well-defined short and long-term budgeting procedures must be in place at the national and field-level O&M agencies. The procedures must reflect the actual requirements emerging from the field at all levels. The O&M budget procedures shall include needs-based budgets to support long- and short-term O&M planning and budgeting. The actual O&M budget should be allocated in accordance with the Needs Basis Budget for sustainable water management.

Timely, efficient, and transparent planning is required to ensure that actual water management priorities are met, that the requirements and demands of the system beneficiaries are adequately taken care of and that maintenance activities can start on time. The procedures for the planning of scheme operation and the planning of maintenance must ensure the critical participation of the system users, to guide BWDB in the communications with system users and to protect the water management interests of the farmers.

Lastly, the quality of O&M services to be provided by BWDB, i.e., the quality, efficiency, and cost-effectiveness of scheme O&M activities, must be ensured, safeguarded, and adapted to the actual water management requirements of the schemes. Therefore, effectual monitoring and supervision must be in place.

Without the scheme data, the activities of the O&M of the structures would be inefficient and inflexible, and the performance of the project scheme could not be attained. Since the scheme data becomes great volume, it is better to establish the database system in respective field offices of BWDB, securing data compatibility with the system in the head office of BWDB. A GIS database established in a field office as a model activity of the Project could be a good reference for BWDB.

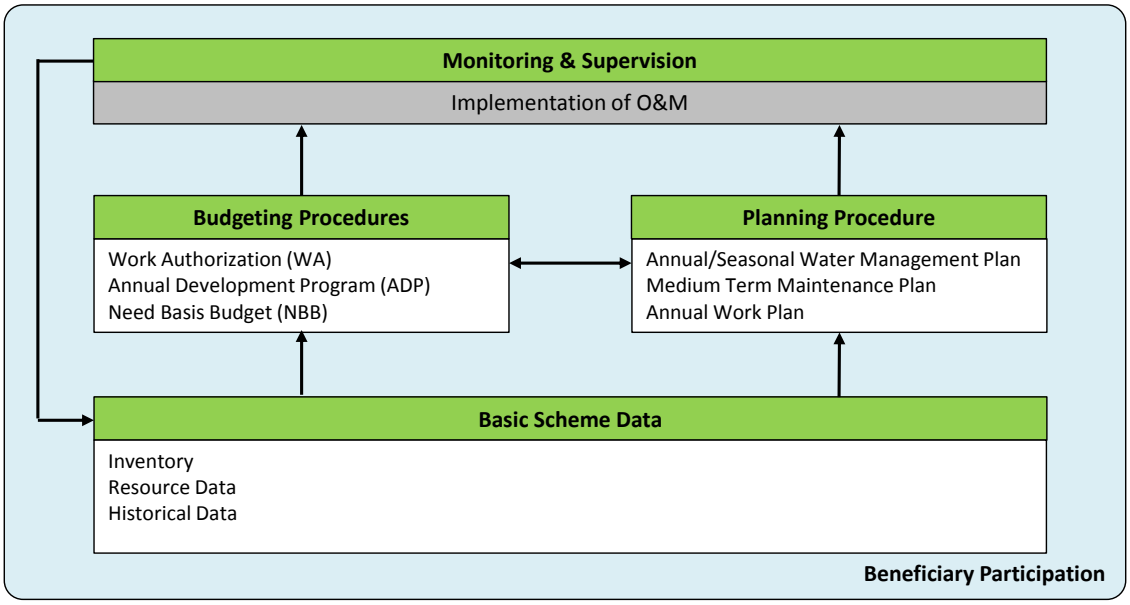

Figure 21 Framework of Integrated O&M (Source: JICA, 2017)

The **scheme inventory data**, needed to know for the activities of the O&M of the structures, would include (but not limited to) the following:

- Hydraulic infrastructure (managed by BWDB, but also by LGED and RHD) (functions of facilities, design and existing dimensions, and those drawings)
- A complete list of real state (BWDB offices, houses, guest houses, stores, water tanks, sheds, etc.), O&M facilities (inventory of the respective buildings and the equipment and transport facilities)
- An updated staffing lists.
- All sorts of data related to O&M (e.g., policy papers and directives, approved as well as actual staffing and defined responsibilities, O&M manuals and plans of respective schemes, operation plans and basis of operation plan, maintenance plan including ADPs, reports of feasibility and other studies and detailed design, etc.)
- The ownership of the infrastructure
- Historical data
  - *Agro-hydrological*: Rainfall, river levels, reservoir levels, river flow data, water quality and salinity measurements, depths of water table, groundwater level; *Maintenance records*: completed maintenance works including ADPs, work contents, the costs, contractors, period of maintenance, etc.
  - *Operation records*: old operation plans and their amendments, gate or pump operation records, operated water level records, operated groundwater level records, irrigated areas, etc.

- *Financial records*: staff costs, cost of operation, cost of maintenance, ratio of planned and executed O&M works, revenue from lease of lands such as borrow pits/ embankment slopes and from cost recovery activity, etc.

The **'*operation*'** part of the manual gives a detailed account of the planning procedure, including the responsibilities of BWDB and WMOs and the specific steps to be followed, and monitoring and observation needs for channels/canals and water control structures. The **'*maintenance*'** part of the manual focuses on maintenance planning, which includes the identification and selection of items to be maintained and repaired, clarification of timing of maintenance works, physical planning of maintenance works, preparation of medium-term maintenance plan, and Preparation of annual maintenance plan.

The planning procedure for the maintenance works, as per the O&M manual, is as follows:

1 **Identification and selection of items to be maintained and repaired:** Based on the inventory prepared by the WMOs in collaboration with the field office of BWDB, identification and selection of items to be maintained and repaired are ranked and prioritized. Identification, ranking and prioritizing of the maintenance works are the recurrent activities of the planning. Ranking and prioritizing shall be conducted based on the damage degree, temporary countermeasure of damage, importance, and benefit of the facility in the scheme. For example, high priority shall be given to possible breach sites of embankments, and damaged sluice/regulator along the rivers.
2 **Clarification of timing of maintenance works:** This is an important issue in maintenance planning, i.e., when what type of maintenance works can be carried out without hampering the water management in the scheme.
3 **Physical planning of maintenance works:** This activity is to draw up the physical work plans prior to the start of the work.
4 **Preparation of medium-term maintenance plan:** In order to implement the maintenance works efficiently and effectively, the medium-term maintenance plan shall be prepared annually as a three (3) year moving plan.
5 **Preparation of annual maintenance plan:** Based on the medium-term maintenance plan, the annual maintenance plan shall be prepared and implemented.

If there is accumulated damage of the structures in the scheme and it is difficult to implement the maintenance works within budgets for 3 to 5 years, it is recommended to propose those corrective maintenance works as a rehabilitation project.

5.2 Global recognition of effective asset management

The need for better asset management systems in flood protection is acknowledged across the world, given the great extent of damages that keep happening to the assets despite huge investments and the growing need for improved responses to the current and emerging threats.

For Pacific Island countries, an estimated average of 3.1 per cent of GDP is required for the maintenance of existing infrastructure, equating to USD634 million per annum. Pacific island countries must also address the backlog of delayed maintenance and budget for the maintenance of planned infrastructure. Data on current maintenance spending is not available, but there is common agreement that maintenance is being avoided within the 'build-neglect-rebuild' paradigm (PIAC, 2013).

Collectively EU Member States invest an average of €3 billion per year on flood protection infrastructure, but a combination of climate and socio-economic change is increasing the annual average damage caused by flooding. It is understood that complex and difficult decisions will need to be taken in response to these threats, especially in coastal regions, as rising sea levels challenge the sustainability of existing policies and plans, with an improved approach to the planning, design and

management of new and existing flood protection assets will be central to addressing this challenge (EU, 2012).

New ideas and methods are being developed to ensure best value asset management options are identified for both existing and new infrastructure. For example, following widespread flooding in England in 2007, strategic oversight and local delivery, arrangements were put in place to enable more effective working between the main agencies involved in managing risks, with the Environment Agency given the responsibility of strategic oversight of all floods related planning, while delivery devolved to local municipalities. In Belgium, a multi-functional and adaptive dike reinforcement mechanism was brought into the asset management system, wherein an existing dike wall was augmented with a dune system to provide a natural habitat and enhanced recreational opportunities. In the Netherlands, there is an example of coordinated efforts for improving the reliability of the dike along embankments and storm surge barrier (reliability of which decreases the pressure or vulnerability of the dike) through managing trade-off of costs and benefits between dike and barrier improvements to reduce whole life-cycle costs without compromising standards (EU, 2012).

The Government of Bihar has developed an Embankment Asset Management System (EAMS) for Kosi River with assistance from the World Bank to assist the Water Resources Department in rationalizing decision-making processes at various levels in maintenance and strengthening of existing embankments, anti-erosion works, and flood protection works (GoB, 2015). The system has been developed on a GIS platform with the capability of populating the information/data to GIS-based applications, which have the capacity to house multiple file types that may be used for different activities related to the embankment. During inspection, all the information about embankments would be collected along with photographs of the affected portion of embankments or its assets on an Android Tablet with the GIS platform. There is a database capable of tracking and linking to multiple file types and incorporating records of information continuously with time. The engineering information records (year-wise and river/site-wise data on rainfall, water level, discharge, soil type, bore logs, inundation location and area, topographical survey, morphological and floodplain topographical data, etc.) are available on a web-based system with user-defined access. Post-flood inspection of the entire embankment is performed by field engineers using a handheld device (Android tablet) along with photographs of the damaged works, which are uploaded. Based on this information, damage assessment reports are prepared, and appropriate schemes are formulated.

5.3 Asset management system in the water sector of Bangladesh

Dhaka Water Supply and Sewerage Authority (DWASA)

Dhaka Water Supply and Sewerage Authority (DWASA) lacked skills in financial and infrastructure planning and asset management for operations and maintenance. In its bid to reduce non-revenue water, DWASA started rehabilitating the distribution network and developing a new asset management system, 'District Metered Area' (DMA), was included in DWASA Master Plan 2014, to be implemented during 2014-2017 (DWASA, 2014). Dividing Dhaka City into a number of District Metering Areas (DMAs), the DMA approach had the principal objective of reducing NRW (Non-Revenue Water) which remained high at around 35% in 2012. For the implementation of this management plan, DWASA had undertaken a project named Dhaka Water Supply Sector Development Project (DWSSDP). The project activity encompasses the rehabilitation or replacement of the existing water supply system with the pressurized system for the predicted year of 2030.

DWASA is continuously working to develop water management strategies that focus on a range of actions with a major emphasis on the District Metered Area (DMA) approach. A DMA is a smaller cluster of a water distribution network that is hydraulically isolated and more easily manageable. Each DMA distribution network will be sufficiently metered to monitor and account for water flow. Any anomaly in the system due to leakage, pilferage etc. will be quickly identified and remedied. DWASA plans

to construct 175 DMAs in Dhaka city, 78 of which have been completed. Such an extensive network is operated by an intricate system of valves and appurtenances. These assets need to be regularly operated and maintained in order for the network to remain in service. The system is built upon GIS mapping, an online billing system, the installation of smart water meters and a data-sharing mechanism on a global platform named GeoDASH. The program also involved training and capacity development of a DMA caretaker team, which is an essential requirement.

Recently, DWASA has launched the "DWASA Turn Around" program to address challenges and develop an action plan. As part of this program, they aim to introduce a "Digital WASA Green WASA" culture to promote green practices. To achieve this, DWASA is digitalizing its asset management process and adopting good governance in financial management by developing a financial management system. The project has involved identification, comprehensive listing, classification, codification, valuation/ revaluation, reconciliation, recording, developing policies and procedures manual and developing, implementing, installing and commissioning integrated software on Oracle ERP system for DWASA's Non-Current Assets and Inventories and review and reconciliation of Grants and Other Funds.

Khulna Water Supply and Sewerage Authority (KWASA)
Khulna Water Supply and Sewerage Authority (KWASA) has recently initiated a project to a GIS-based water supply Asset Management System (AMS) solution, funded by the Asian Development Bank (ADB). It aims to enhance the digitalization of infrastructure asset data and the use of digital tools for evidence-based decisions. A GIS-based asset geodatabase will facilitate KWASA's daily operation and maintenance activities and enable long-term planning, non-revenue water reduction, water demand management, and other operation and maintenance (O&M) processes and procedures. At the core of the system will be a GIS-based water supply geodatabase of all assets and their attributes. The AMS will reside in a cloud-based virtual machine, accessible via the internet, encompassing a wide array of water supply assets, from reservoirs and treatment plants to pipelines, valves, and customer connections, as well as connectivity and hierarchical relationships between assets. Furthermore, the system will feature essential functions such as data visualization, topological queries, data export, secure user access, and ease of use for non-GIS technical staff.

Local Government Engineering Department (LGED)
The Local Government Engineering Department (LGED) under the Ministry of Local Government, Rural Development & Cooperatives is responsible for planning, developing, maintaining, and managing local-level rural, urban, and small-scale water resources infrastructure nationwide. Being one of the largest implementing arms of the, LGED, through its country-wide operation, recognizes that it is essential to manage assets to sustainably deliver appropriate levels of services to the community and to meet the expectations and needs of the present and future generations (LGED, 2019a). In 2019, it was reported that LGED's commitment to those goals is evidenced by the development of an AMS, which would be overseen by the Chief Engineer and supported by the Asset Management Committee. So far, it seems that LGED is working towards an Asset Management Policy (AMP), including a Strategic Asset Management Plan (SAMP), defining the key principles and mandated requirements applicable to LGED's Asset Management System (AMS). In 2019, a roadmap for the further establishment of LGED's AMS was created (Fig. 22).

In July 2020, LGED published its SAMP (LGED, 2020), stating that LGED will develop a SAMP Improvement Plan identifying areas which require further investigation, analysis and synthesis. In the plan, the interdependency, precedence and priorities of the activities will be considered, including risks and mitigating actions - resources, cost, etc., to be incorporated in the next SAMP iteration.

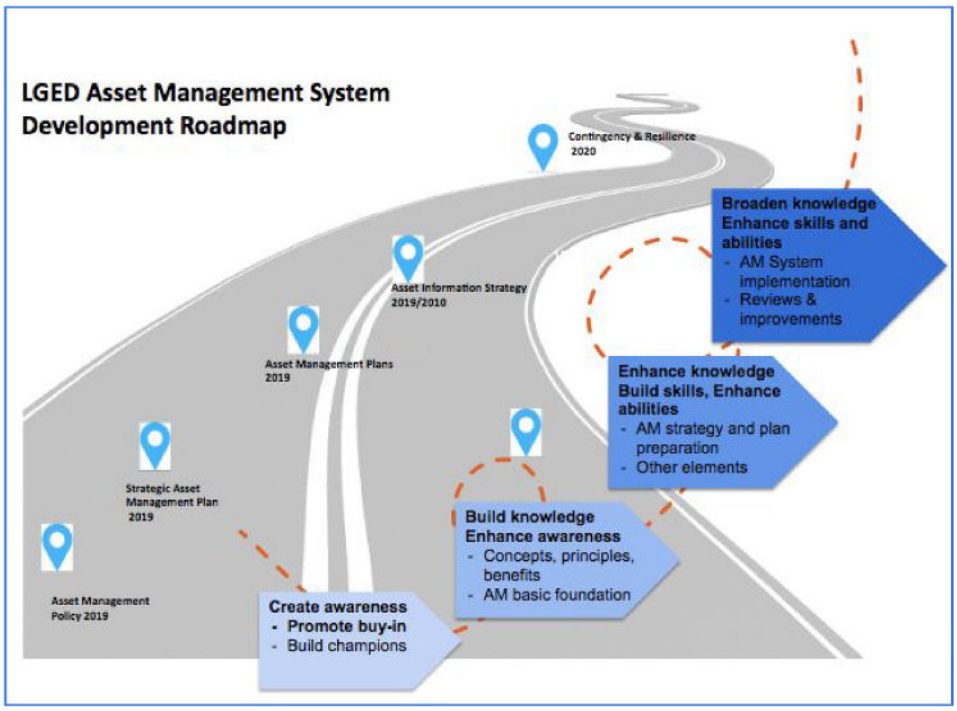

Figure 22 LGED Asset Management System Development Roadmap, linked to LGEDs Professional Development Strategy (blue boxes) (LGED, 2019b)

PARTNERS FOR WATER
CO-CREATING IMPACT

This report is published by:

Partners for Water
The Netherlands Enterprise Agency (RVO)
Prinses Beatrixlaan 2 | 2595 AL The Hague, the Netherlands
Postbus 93144| 2509 AC The Hague, the Netherlands
t +31 (0)88 042 42 42
e administratiepvw@rvo.nl
www.partnersforwater.nl | www.rvo.nl

This publication was produced by MetaMeta Research and the Bangladesh University of Engineering and Technology, on behalf of Partners for Water.

The Partners for Water programme is implemented by The Netherlands Enterprise Agency (RVO) on behalf of the following Dutch ministries: Infrastructure and Water Management; Foreign Affairs; Economic Affairs, Agriculture and Innovation.

The Netherlands Enterprise Agency (RVO) helps business owners run sustainable, agricultural, innovative and international businesses. It also helps them arrange grants, find business partners, access expertise and comply with legislation and regulations.