

Working Paper

The nexus between economic, social and environmental sustainability

The case of Bangladesh's water sector

Fahmida Khatun, Mizan R Khan, Foqoruddin Al Kabir and
Towrin Zaman Raya

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About the authors

Fahmida Khatun is Executive Director of the Centre for Policy Dialogue, Bangladesh. She is currently a Board Director of the Central Bank of Bangladesh. She was also a Member of the Task Force on Re-Strategising the Economy and Mobilising Resources for Equitable and Sustainable Development, formed by the current interim government of Bangladesh. Her expertise includes macroeconomic policy, financial sector, aid effectiveness and climate change, among others. She was the lead author of the Bangladesh case study on inclusive and sustainable economic transformation (ISET) in the water sector.

Mizan R. Khan is the Technical Lead for the Least Developed Countries Universities Consortium on Climate Change. He has worked in academia while working closely with the government and the development sector in Bangladesh and beyond. He has worked extensively on climate change, climate challenges and climate negotiations. He was the co-author of the Bangladesh case study on inclusive and sustainable economic transformation (ISET) in the water sector.

Foqoruiddin Al Kabir is a Senior Research Associate at the Centre for Policy Dialogue, Bangladesh. His areas of research interest include macroeconomics, climate change and environmental economics, among others, with theoretical application and development. He is also skilled in qualitative and quantitative research and policy development. He was a co-author of the Bangladesh case study on inclusive and sustainable economic transformation (ISET) in the water sector.

Towrin Zaman Raya is a researcher and climate policy professional working on climate finance, loss and damage and adaptation. Her work focuses on bridging local realities with global climate policy processes. At the International Centre for Climate Change and Development (ICCCAD), she contributes to research, policy analysis, and advocacy - closely following the UNFCCC processes on adaptation and the Fund for Responding to Loss and Damage (FRLD). Towrin's work aims to strengthen inclusive, locally grounded adaptation practices that inform equitable global climate action.

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Abbreviations and acronyms

BDP	Bangladesh Delta Plan
BOD	Biochemical Oxygen Demand
BWDB	Bangladesh Water Development Board
CMSMEs	Cottage, Micro, Small, Medium Enterprises
CSO	Civil Society Organisation
CETP	Chemical Effluent Treatment Plant
DO	Dissolved Oxygen
ETP	Effluent Treatment Plant
GDP	Gross Domestic Product
GED	General Economics Division
HDI	Human Development Index
ISET	Inclusive and Sustainable Economic Transformation
KII	Key Informant Interview
LGED	Local Government Engineering Department
LDC	Least Developed Country
MoA	Ministry of Agriculture
MoEFCC	Ministry of Environment, Forestry and Climate Change
M&E	Monitoring and Evaluation
MoWR	Ministry of Water Resources
MoLGRD&C	Ministry of Local Government, Rural Development and Cooperatives
MCPP	Mujib Climate Prosperity Plan
MDG	Millennium Development Goal
MPO	Monthly Pay Order
NAP	National Adaptation Plan
NBSAP	National Biodiversity Strategy and Action Plan of Bangladesh
NDC	Nationally Determined Contribution
NGO	Non-Governmental Organisation
NRCC	National River Conservation Commission
NWP	National Water Policy
NWRC	National Water Resources Council
RMG	Readymade Garment
SDG	Sustainable Development Goal
STEM	Science, Technology, Engineering and Mathematics
USGBC	US Green Building Council

Executive summary

Bangladesh's development outcomes are the result of economic and social transformations over the last five decades. However, this development has not always been achieved in an environmentally sustainable manner. In many cases, social inclusion and environmental sustainability are compromised, and instead the focus is on economic growth and development.

This study explores how policies are aligned with Inclusive and Sustainable Economic Transformation (ISET), and whether the nexus between economic, social and environmental indicators is considered in the policy process. While exploring this triple nexus, the study will examine governance issues as a fourth but cross-cutting pillar of sustainable development.

The water sector is chosen as a case study on account of its importance to the country's economic transformation, social inclusion and environmental sustainability. Agriculture is the backbone of Bangladesh's economy, and relies heavily on groundwater irrigation. Likewise, one of the main drivers of the economy, the textile industry, is increasingly moving towards higher-value production processes that require large volumes of water for washing, dyeing and finishing.

Excessive groundwater extraction for agricultural and industrial use means that groundwater levels are falling sharply across the country. The heavy dependence on water for industrial, agricultural and domestic use often leads to pollution, while disparities in access to treated drinking water and modern sanitation facilities are evident across different income brackets in both urban and rural areas.

Bangladesh's regulatory and policy frameworks for the water sector focus on management and governance, aligned with environmental sustainability and economic transformation, and largely neglect considerations of social inclusion. Policies, plans and regulatory frameworks are comprehensive, but implementation is a long-standing challenge. The lack of alignment between targets for environmental sustainability and the implementation of policies, plans and regulatory frameworks was specifically highlighted in the stakeholder consultation for this study. Weak links between governing bodies and implementing agencies and limited resources for monitoring environmental issues at the grassroots level were cited as significant obstacles. Besides, social inclusion has often been overlooked in policymaking and development planning in Bangladesh. The welfare of lower-income groups is frequently

neglected. As a result, challenges remain in the implementation of the environmental and development policies and plans for the water sector. Sociopolitical challenges continue to obstruct in executing these plans.

The study proposes a set of recommendations for the integration of social inclusion into economic development plans and policies, prioritising the welfare of vulnerable groups. This will involve collaboration among relevant stakeholders, updating the National Water Policy of 1999, and formulating a comprehensive regulatory framework for the water sector for improving nexus decision-making. Governance in the water sector should be improved through enhancing the transparency and accountability of government agencies. Investment in capacity-building for government agencies and relevant institutions will play a vital role, alongside a collaborative and coordinated effort between water/delta professionals and delta expert stakeholders with in-depth local familiarity. Local communities should be encouraged and empowered to participate in water management and conservation.

1 Introduction

Bangladesh's development has been driven by economic and social transformations over the last five decades. Economic growth coupled with social progress has enabled the country to qualify for graduation from the Least Developed Country (LDC) category by 2026. However, this growth, as is the case with many other countries, has not always been achieved in an environmentally sustainable manner (Almeida et al., 2017; Sethi et al., 2020; Ahmed et al., 2021). Increased economic activity has created pressure on limited natural resources. Over-exploitation of these resources has resulted in environmental degradation. For instance, Bangladesh's textile industry consumes around 1,500 billion litres of groundwater every year for dyeing and washing (Apparel Resources, 2019; Al Hasnat, 2022). A large amount of groundwater is also used in agricultural irrigation (Bangladesh Agricultural Development Corporation, 2021). Runoff containing industrial chemicals and agricultural inputs such as fertilisers and pesticides leads to water pollution, disrupting the ecological balance and accelerating land degradation and desertification.

Environmental sustainability is frequently sacrificed in favour of short-term economic growth (Datta, 2024). In addition, economic decisions and policy-making are strongly influenced by powerful interest groups such as the private sector and industry, and opinions from lower social strata are often overlooked (Institute of Governance Studies, 2012). The policy focus on higher growth neglects Inclusive and Sustainable Economic Transformation (ISET), which aims to balance economic growth with social inclusion and environmental sustainability (see definitions in Box 1). The environmental aspects of development are also challenged by the pressure of high population density, particularly in urban areas (Hassani-Mahmooei & Parris, 2012; Siddiqui & Billah, 2014; Chen & Mueller, 2018; among others).

Box 1 Key definitions

Economic transformation: moving employment to higher-productivity and higher-value activities that enable increases in human and physical capital. This may encompass improvements in productivity within sectors through innovations and efficiencies.

Environmental sustainability: economic and social activity occurs while conserving biodiversity and ecosystem functions, reducing pollution (including GHGs) and using natural resources in ways that take account of the needs of future generations.

Social inclusion: the benefits of transformation reach the bottom of the distribution, especially those facing discrimination and multiple disadvantages.

Source: Colenbrander & Shepherd (2022)

The neglect of environmental concerns in Bangladesh's development path has critical implications, especially as the country prepares to graduate from LDC status by 2026. Graduation will result in the phasing out of preferential treatment, such as duty-free and quota-free market access and other unilateral preference arrangements (UNCTAD, 2021). Under these preferential trade benefits, Bangladesh currently enjoys market access with limited conditionalities, particularly regarding environmental standards. Once Bangladesh graduates from LDC status, it will be subject to standard trade regimes that increasingly incorporate environmental and sustainability requirements, especially in high-value markets such as the European Union and North America (Roy, 2023). Meeting these requirements will require investment in the green transition of production processes and raising awareness among business stakeholders regarding environmental sustainability and post-LDC graduation challenges (Khatun, Kamal, Kabir, Nawrin & Hoque, 2023).

Against this backdrop, this study explores how and to what extent the triple nexus – economic transformation, social inclusion and environmental sustainability – is considered in policies, development plans and regulatory frameworks, with a particular focus on Bangladesh's water sector. The study investigates the extent to which actors involved in economic strategy coordinate with counterparts in environmental and social ministries, and how effectively they integrate environmental and social considerations into strategic planning and implementation. The study also examines governance issues as a fourth, cross-cutting pillar of sustainable development. Social inclusion has largely been overlooked in policy-making and development planning, and the welfare of lower-income groups is often neglected, leading to adverse social impacts from the implementation of environmental policies.

The rest of the paper is organised as follows. Section 2 discusses the methodology. Section 3 discusses the relevance of the water sector in ISET in Bangladesh. Section 4 provides an analysis of the policy and regulatory framework around economic transformation, environmental sustainability and social inclusion. Section 5 concludes.

2 Methodology

The study used a mixed methodology combining qualitative and quantitative (trend data) analysis. Data for various indicators related to the nexus between economic transformation, environmental sustainability and social inclusion were analysed. A thorough review of policy documents, development plans and regulatory frameworks was conducted. Key Informant Interviews (KIIs) and an Expert Group Meeting (EGM) with relevant stakeholders were conducted to test the recommendations and validate the findings. The specific details of the methodology are outlined below.

i) Trend analysis of nexus pillars. The study analysed data related to various indicators under the nexus pillars of economic transformation, environmental sustainability and social inclusion, focusing on the water sector (Table 1). The aim was to understand trends in the various nexus pillars, their current state and the links to implementation targets set out in policy documents, development plans and regulatory frameworks for the water sector.

Table 1 Description of indicators and data used in the analysis

Indicators	Short description	Coverage	Source
Economic transformation			
Agriculture, forestry, fisheries, value added (% of GDP)	Contribution of agricultural sector to GDP as a percentage of total GDP	1972–2022	World Development Indicators
Service, value added (% of GDP)	Contribution of service sector to GDP as a percentage of total GDP	1972–2022	World Development Indicators
Industry, value added (% of GDP)	Contribution of industrial sector to GDP as a percentage of total GDP	1972–2022	World Development Indicators
GDP per capita (current USD)	GDP per capita average equivalent to USD	1972–2022	World Development Indicators

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Employment in agriculture (% of total employment)	Contribution of agricultural sector to total employment as a percentage of total employment	1991–2021	World Development Indicators
Employment in industry (% of total employment)	Contribution of industrial sector to total employment as a percentage of total employment	1991–2021	World Development Indicators
Employment in services (% of total employment)	Contribution of service sector to total employment as a percentage of total employment	1991–2021	World Development Indicators
Total exports in USD billion	Total exports in a fiscal year	FY 2005-06- FY 2021-22(p)	Ministry of Finance, Bangladesh
Total imports in USD billion	Total imports in a fiscal year	FY 2005-06- FY 2021-22(p)	Ministry of Finance, Bangladesh
Environmental sustainability			
pH level	pH level in selected rivers (Maximum value)	2011–2016 (as per availability)	BBS, Bangladesh
DO level	Dissolved Oxygen level in Selected rivers (mg/L)	2011–2016 (as per availability)	BBS, Bangladesh
BOD	Biochemical Oxygen Demand (BOD) level in selected rivers (mg/L)	2011–2016 (as per the availability)	BBS, Bangladesh
Groundwater table	Groundwater table hydrographs (Maximum depletion in metres)	5-year intervals between FY 2005-06-FY 2020-21	Bangladesh Agricultural Development Corporation (2022)
Social inclusion			
Poor people (%)	Percentage of poor people in total population	2004–2019 (as per the availability)	Ministry of Finance, Bangladesh
Extreme poor (%)	Percentage of extreme poor people in total population	2004–2019 (as per the availability)	Ministry of Finance, Bangladesh
Access to clean water (% of population)	Percentage of people having access to clean water	2004–2019 (as per the availability of time series data)	World Development Indicators

Sources of household drinking water	Sources of household drinking water	Survey data for 2007, 2011, 2014 and 2017–2018	National Institute of Population Research and Training
Treatment of household drinking water	Percentage of households using treated drinking water	Survey data for 2007, 2011, 2014 and 2017–2018	National Institute of Population Research and Training
Sanitation	Percentage of households having sanitation facilities	Survey data for 2017–2018 (as per availability)	National Institute of Population Research and Training

Source: Authors' compilation

ii) Policy document analysis. An analysis of policy documents, national plans and regulatory frameworks related to economic growth/transformation was conducted to assess their internal integration within a policy framework of Economic Transformation (ET)/Environmental Sustainability (ES)/Social Inclusion (SI); and external integration (integration with other policies) - e.g. the extent to which there are synergies between the policies on economic transformation and environmental sustainability or inclusion. The objective of this analysis was to understand the consistency within the framework of economic transformation, environmental sustainability, and social inclusion, as well as external integration with other related policies. The assessment was done based on examining the coherence and relevance of the sustainability with other plans and policy documents.

iii) Key Informant Interviews (KIIs). Eleven KIIs were conducted with government officials, representatives of development partners, private sector professionals, non-governmental organisations (NGOs) and civil society organisations (CSOs) working on relevant issues, to investigate the key factors facilitating progress across these pillars, and the potential for further opportunity and innovation.

3 The water sector in Bangladesh's economic, social and environmental transition

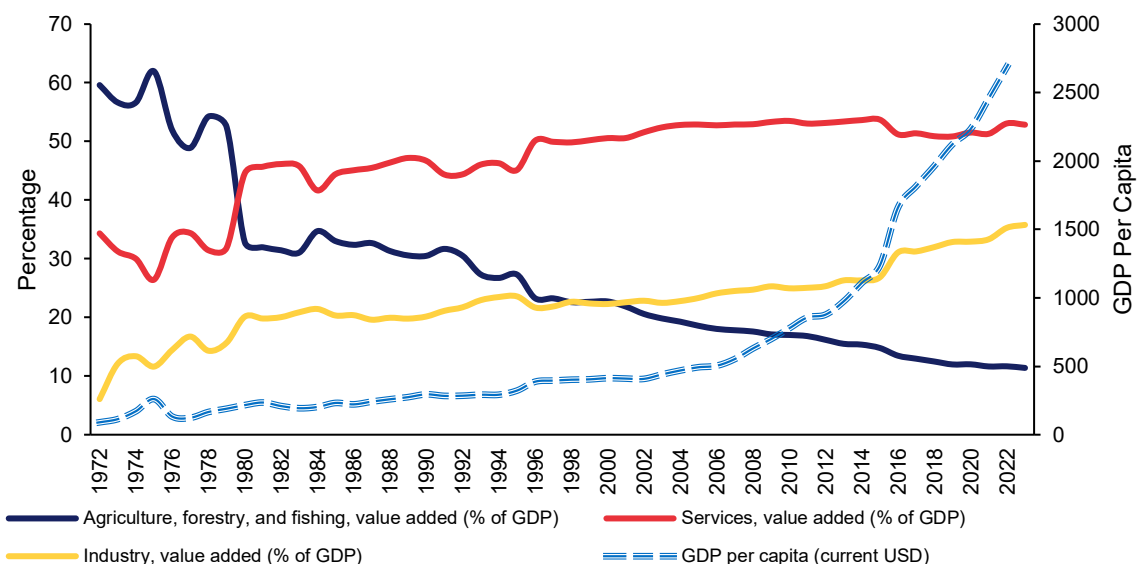
After successfully achieving many of the Millennium Development Goals (MDGs), Bangladesh has now committed to the Sustainable Development Goals (SDGs) (UNDP, 2019). It is set to graduate from LDC status by 2026 and aims to become a middle-income country by 2031 and a developed country by 2041 (General Economics Division, 2020). The water sector has been critical for agricultural production and industrial output (Joshi, Sarker & Basnet, 2024). The textile sector, which is water-intensive due to processes such as dyeing and finishing, depends heavily on reliable water sources (Apparel Resources, 2019). At the same time, water is important for protecting biodiversity and combating climate change. Equitable access to clean water fosters social inclusion by improving health outcomes and reducing poverty in marginalised communities (Biswasa & Shahid, 2024). The following sections examine the critical role of water in Bangladesh's economic, social and environmental transitions.

3.1 Water and economic transformation

Bangladesh has enjoyed robust economic growth for the last decade (World Bank, 2024). Agriculture, industry and services are the three major sectors contributing to the country's economic growth (World Development Indicator, 2022). Trend analysis shows that the agricultural sector was the leading contributor to GDP until the 1980s, when the service sector started to grow more rapidly than both agriculture and industry. After 2000, the industrial sector – driven by the RMG industry – overtook agriculture to become the second-largest contributor to GDP. Since 2000, the contribution of agriculture to GDP has continued to fall, reaching 12% in 2022 against nearly 60% in 1972, 30.49% in 1990, and 17% in 2010. In 2016, industry's contribution to GDP was 31%, compared to 25% in 2010. Per capita GDP increased to \$2,688 in 2022 compared to \$777 in 2010 and \$413 in 2000 (World Development Indicators, 2022).

Figure 1 presents sectoral contributions and GDP per capita over the period 1972–2022.

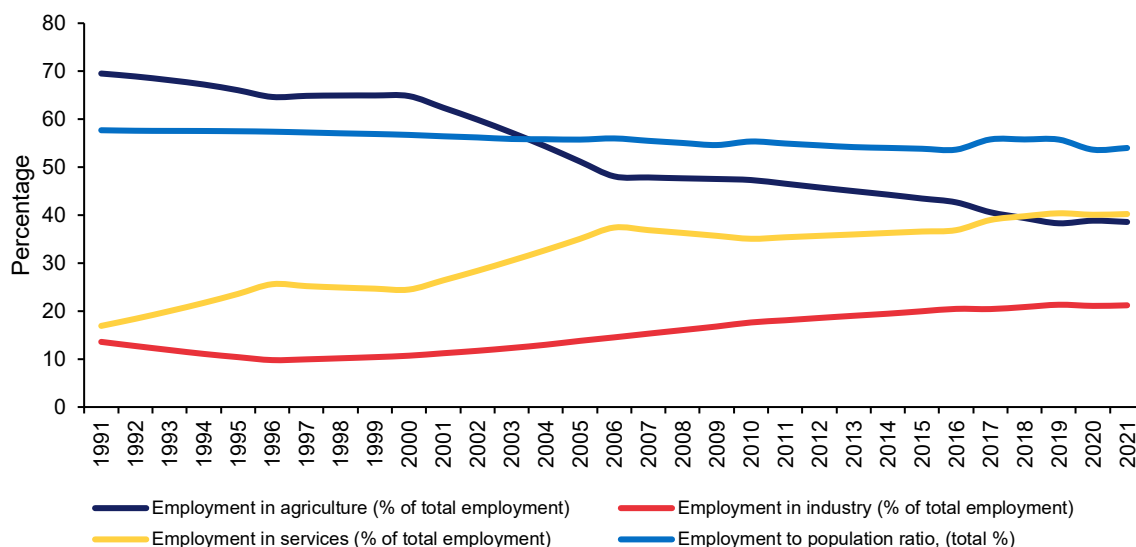
Figure 1 Sectoral contributions to GDP and GDP per capita in Bangladesh (1972–2022)



Source: World Development Indicators (2022)

Agriculture had the highest share of total employment until 2018, when it was overtaken by the service sector. Between 2000 and 2006 the share of agriculture in total employment dropped sharply, from 64.81% to 48.08% – a decline of 16.73 percentage points. As of 2021, the share of total employment in services, agriculture and industry was 40.23%, 38.57% and 21.20% respectively (Figure 2).

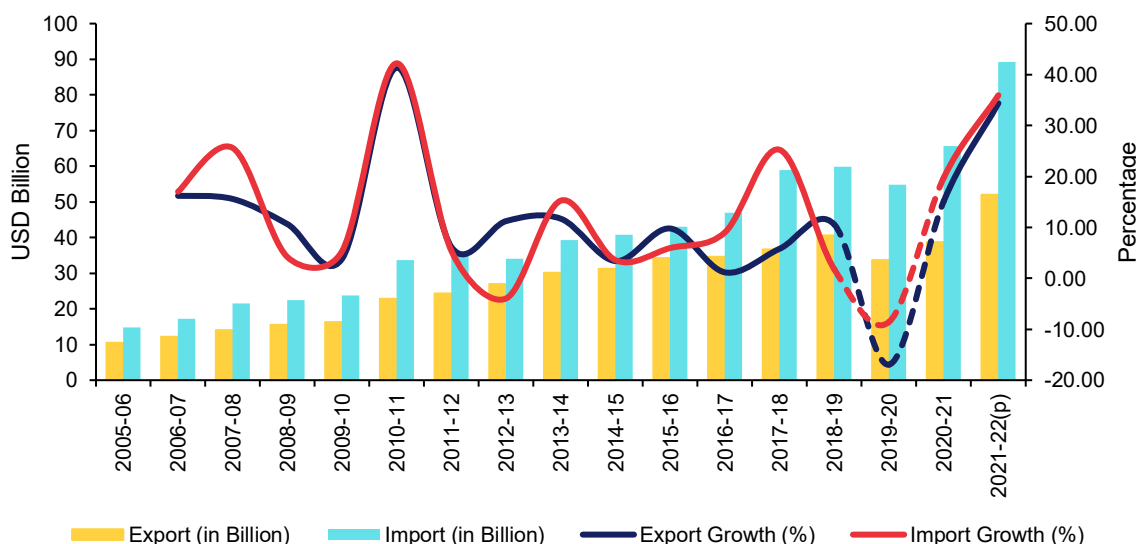
Figure 2 Sectoral contribution to employment in Bangladesh (1972–2021)



Source: World Development Indicators (2022)

Export earnings have grown substantially over the last two decades. In FY2021–22, the value of export earnings was \$52.08 billion with a growth rate of 35.93%, a significant increase from \$16.2 billion in FY2009–10 and \$10.5 billion in FY2005–06. In FY2021–22 imports stood at \$89.16 billion with a growth rate of 35.91% (Figure 3).

Figure 3 Exports and imports (FY2005–06 to FY2021–22)



Source: Authors' calculation based on Ministry of Finance (2022)

The water sector is essential for Bangladesh's economic transformation, supporting critical sectors like agriculture, industry and urban development. The backbone of Bangladesh's economy, agriculture relies heavily on groundwater, which accounts for 88% of

total water use in the sector (World Bank, 2022). The country's apparel sector, which contributes more than 80% of total export earnings, also drives significant demand for water. The textile industry is moving towards higher-value production processes that require washing, dyeing and finishing. This is heavily water-consuming, requiring 250–300 litres of water per kilogram of fabric. The global benchmark for water in fabric production is 100 litres per kilogram (Sagris & Abbott, 2015).

3.2 Water and environmental sustainability

The water sector plays a crucial role in environmental sustainability in Bangladesh, influencing climate change, agricultural production, public health, biodiversity, economic development, coastal erosion and groundwater contamination (Haque et al., 2023; Hadi, 2019; Hasan et al., 2019; Gain et al., 2017). These interconnected issues highlight the importance of addressing water-related challenges to ensure environmental sustainability.

Water pollution is a pressing concern, stemming from a combination of industrial, agricultural and domestic sources. Rapid urbanisation and industrialisation have led to the discharge of untreated waste and chemicals into water bodies, severely degrading water quality (Tariq & Mushtaq, 2023). The textile and tannery industries contribute to the contamination of rivers with toxic substances (Islam & Mostafa, 2018). Analysis of water quality indicators (pH,¹ dissolved oxygen,² biochemical oxygen demand³ and chemical oxygen demand⁴) shows an alarming trend. The pH level from collected water samples of selected rivers between 2001 and 2016 shows that the Shitalakshya, Turag, Dhaleshwari and Meghna rivers are highly alkaline (Figure 4). A large number of leather processing and leather industries, RMG and textiles factories are located around the Shitalakshya, Turag and Dhaleshwari rivers (Box 2). Chemical runoffs from these industries may be causing the increased level of pH in the water. Cement factories around the Meghna River may also be contributing to increased alkalinity (Rahman et al., 2021; Karmaker et al., 2022).

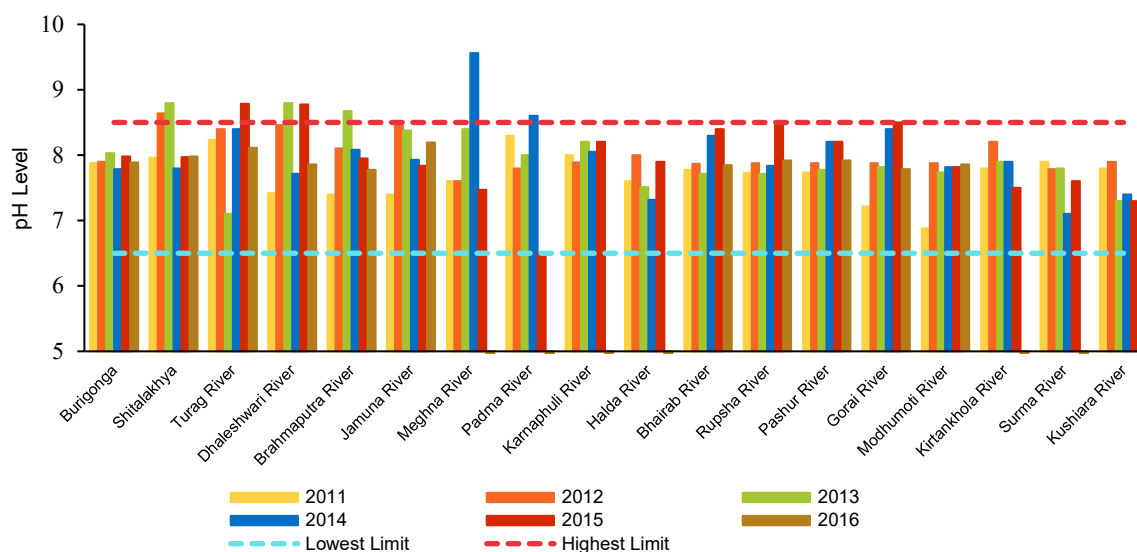
¹ The pH level is tested to assess the acidity or alkalinity of the substance, most commonly for water and soil.

² Dissolved Oxygen is tested to assess the amount of oxygen available in water for aquatic organisms and chemical processes.

³ Biochemical oxygen demand is tested to assess the amount of oxygen required by microorganisms to break down organic matter in water.

⁴ Chemical oxygen demand is tested to assess the amount of oxygen required to chemically oxidise both organic and inorganic substances present in water.

Figure 4 pH levels in selected rivers (maximum values)



Note: The Environmental Quality Standard for pH ranges from 6.5 to 8.5.

Source: Bangladesh Bureau of Statistics (2020).

Box 2 Water quality

The pH level is used for measuring the acidity or alkalinity of water on a logarithmic scale. The value of pH is expressed on a scale ranging from 0 to 14, with an Environmental Quality Standard (EQS) for pH ranging between 6.5 and 8.5 (Nys et al., 2017; Huang et al., 2017; Cardwell et al., 2017; Gurreri et al., 2020; Chen et al., 2020).

Another significant indicator of water quality in rivers and lakes is the amount of Dissolved Oxygen (DO) present, which is vital to support aquatic life (Heddam & Kisi, 2017; Blaszczyk et al., 2018). All species and sizes of fish can survive in water with DO concentrations between 9.5 mg/L and 12 mg/L (Misra & Chaturvedi, 2016; Vaage & Myrick, 2022).

Biochemical oxygen demand (BOD) refers to how much oxygen is used by bacteria and other micro-organisms during the aerobic (oxygen-containing) decomposition of organic matter at a certain temperature (Ahmed, 2017; Vigiak et al., 2019).

Another water quality indicator is Dissolved Oxygen (DO). The standard for DO in Bangladesh is 6mg/L, set by the Department of Public Health Engineering (DPHE). Between 2011 and 2016, the DO level was below this standard or near zero for the Buriganga, Shitalakshya, Turag, Dhaleshwari, Meghna and Halda rivers (see Annex Figure A1). Industrial factories surround these rivers, and

untreated discharge is the main source of water pollution (Hasan et al., 2019; Rahman et al., 2020).

BOD data indicates high demand for oxygen in rivers in industrial settings (particularly RMG, textiles and leather) (see Annex Figure A2). The standard for BOD is ≤ 6 mg/L for inland surface water for fisheries. However, analysis indicates a high level of BOD, which implies low water quality. Increased levels of BOD are linked to industrial discharge into the rivers (Aktar & Moonajilin, 2017; Rahman et al., 2021; Nafsin & Li, 2022).

Dhaka's freshwater quality has long been a concern because of pollution and health risks (Table 2; Islam et al., 2015; Miah et al., 2016; Sarker et al., 2019).

Table 2 Freshwater quality in Dhaka (2019)

Lake	Station	Organic matter		Physical and chemical characteristics	
		Biochemical Oxygen Demand (BOD)	Chemical Oxygen Demand (COD)	pH/Acidity/Alkalinity	Dissolved Oxygen (DO)
Gulshan Lake	Near United Hospital, Kalachadpur	35.55	93.33	7.45	3.12
	Near Housing, South Bridge	34.17	98.77	7.48	5.91
	Near Lake View Clinic	30.40	98.00	7.41	5.64
	North Side Gulshan Baridhara Lake	23.93	80.44	7.46	4.48
	Taltola Shooting Complex, South Side	26.44	80.66	7.51	6.16
	North Side of Gulshan-1, Gudara Ghat	34.50	104.75	7.25	6.55
	South Side of Gulshan-1, Gudara Ghat	26.16	88.50	7.46	6.03
	Gulshan-Banani Connection Bridge	29.87	81.87	7.39	4.96
	Banani Bridge	29.23	91.33	7.38	3.43
	Baridhara DOHS, Kalachadpur Bridge	-	-	-	-
	Chairman Bari	-	-	7.44	-
	Near Banani Graveyard, Road No. 18	-	-	-	-
	Banani DOHS	-	-	-	-
Mohakhali DOHS	-	-	-	-	
Dhanmondi Lake	8 No. Road Bridge	3.84	24.00	7.57	6.18
	Near Jhigatola Pilkhana	3.80	23.25	7.60	5.38
	Near Dhanmondi-32, Bangabandhu Museum	4.40	30.00	7.66	6.40
	Near Dhanmondi-32 Bridge	4.20	25.25	7.55	5.82
Hatirjheel Lake	Badda-Gulshan Link Road Bridge	27.60	107.40	7.32	3.44
	Raampura Bridge	27.76	94.60	7.26	3.14
	FDC Bridge	33.04	88.00	7.30	1.78

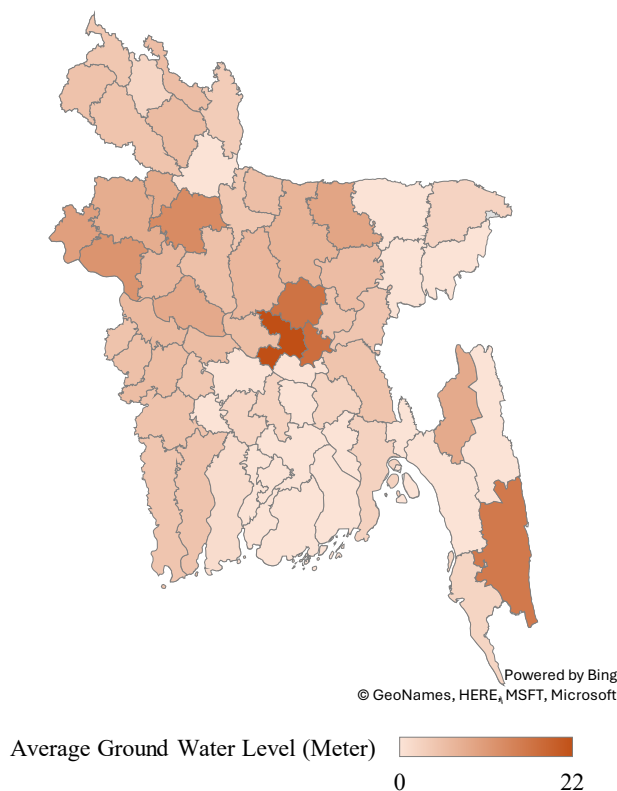
Note: Environmental Quality Standard for pH ranges from 6.5 to 8.5. Environmental Quality Standard for COD (4 mg/L), Dissolved Oxygen (DO) Standard (6 mg/L) as per Department of Public Health Engineering. Biochemical Oxygen Demand (BOD) Standard (≤ 6 mg/L) as per Department of Public Health Engineering.

Source: Bangladesh Bureau of Statistics (2020)

Agricultural runoffs carry pesticides and fertilisers into waterways, impacting aquatic ecosystems and human health. The presence of pathogens and heavy metals in water sources poses significant risks to public health, leading to waterborne diseases such as cholera, typhoid fever, dysentery, hepatitis A and diarrheal diseases. Exposure to heavy metals like arsenic, lead and mercury can cause long-term health problems, including neurological disorders, kidney damage and cancer.

The use of groundwater for irrigation has significantly improved the country's food grain production, and this has had a positive impact on poverty reduction in rural areas. Groundwater is essential for drinking water in urban areas and for irrigation in rural areas. Groundwater irrigation accounts for 72.65% of total irrigation (Bangladesh Agricultural Development Corporation, 2021). Groundwater levels are falling due to excessive extraction (Figure 5), particularly in central, northern and parts of the north-east of the country (see Annex Figure A3).

Figure 5 Average depth of groundwater level in Bangladesh

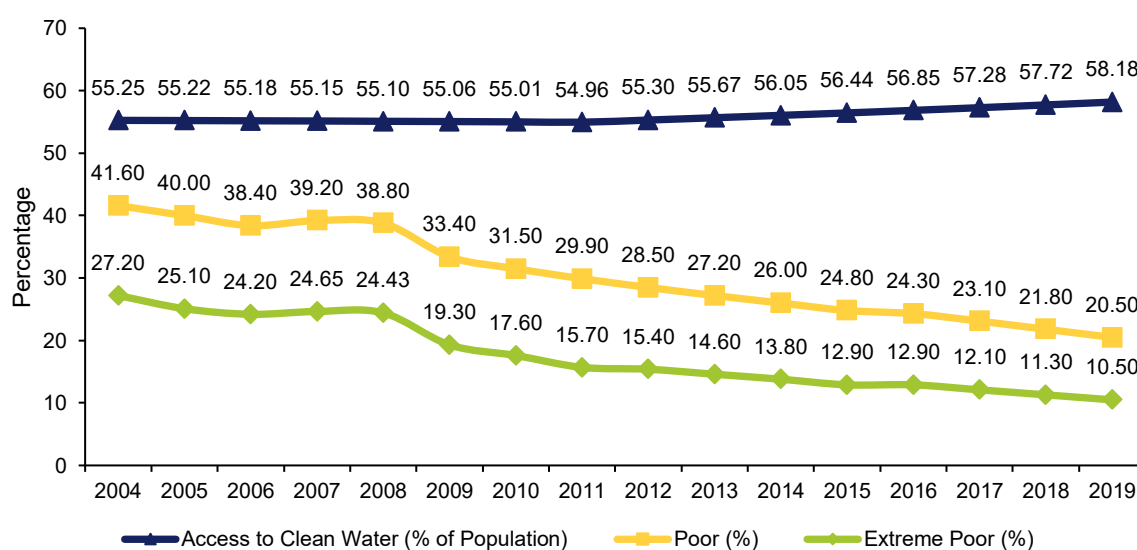


Source: Authors' illustration based on Bangladesh Agricultural Development Corporation (2022)

3.3 Water and social inclusion

In 2005, 40% of people in Bangladesh lived in poverty; by 2019, this had fallen to around 20.5%. The rate of extreme poverty was 10.5% in 2019, down from 25.1% in 2005 and 17.6% in 2010 (Figure 6). According to the Bangladesh Demographic and Health Survey (2017–18) published in 2020, 98% of households had access to improved sources of drinking water, 65% had access to improved sanitation facilities (75% in urban areas and 62% in rural areas), and 39% of households had basic handwashing facilities, up from 37% in 2014 (National Institute of Population Research and Training (NIPORT) and ICF, 2020). Overall, 47% of the population has access to basic sanitation.

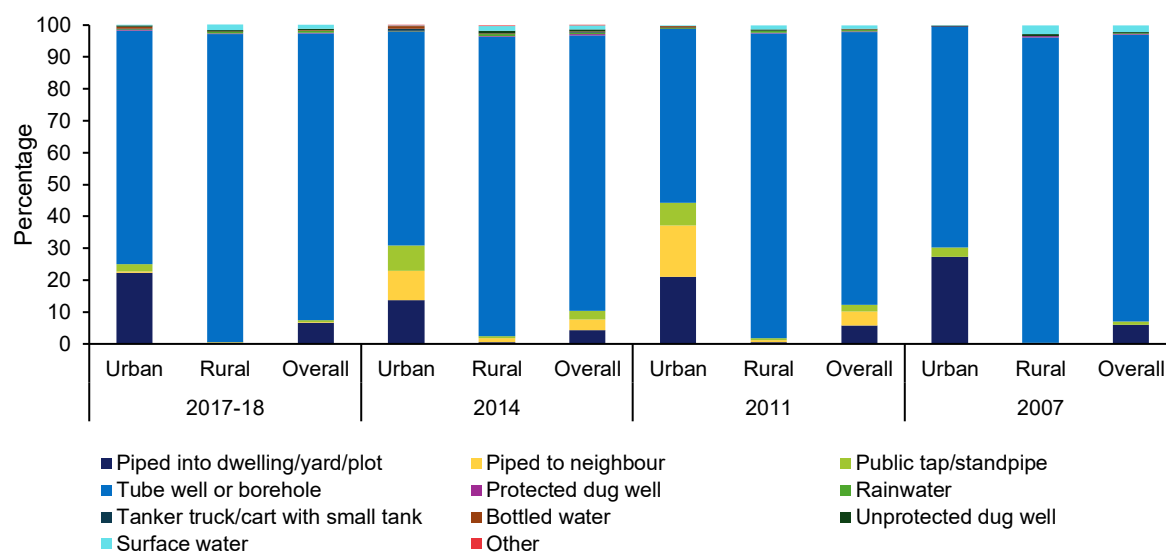
Figure 6 Poverty trends in Bangladesh



Sources: Authors’ illustration based on Ministry of Finance (2022) and World Development Indicators

Tube well or borehole water is the main source of household drinking water across the country. Overall, 90% of households use tube well or borehole water as the primary source of drinking water (Figure 7). In rural areas, more than 96% of households, and in urban areas 73.20% of households, use tube well or borehole water. Only around 6% of households have piped water sources for drinking water. The percentage of households with piped water sources in urban areas and rural areas is 22.20% and 0.40%, respectively.

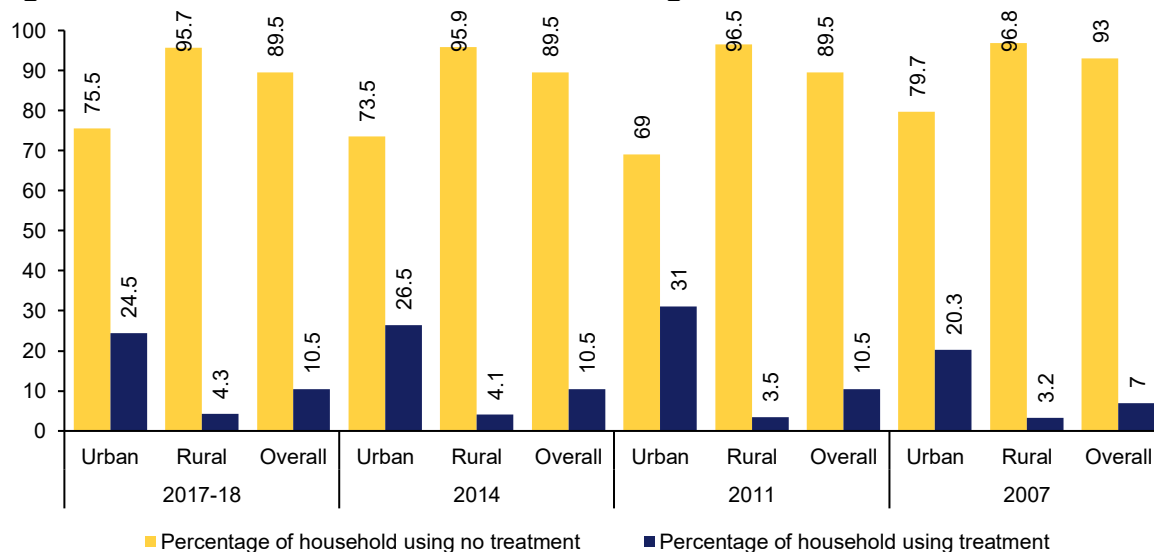
Figure 7 Sources of household drinking water



Sources: National Institute of Population Research and Training (NIPORT) and ICF (2020)

Treated drinking water significantly reduces health risks associated with waterborne diseases. However, the percentage of households in Bangladesh using treated drinking water is low. The data shows that, overall, only 10.50% of households used treated water for consumption in 2017–2018 (Figure 8). In urban areas, 24.50% of households use treated water for consumption; the figure in rural areas is 4.30%. Such inequalities exist because urban utilities are typically managed by city corporations or water supply bodies, while rural water services fall under fragmented institutions with less accountability and technical capacity (ADB, 2020).

Figure 8 Treatment of household drinking water



Source: National Institute of Population Research and Training (NIPORT), and ICF, (2020).

Households with higher incomes tend to have improved sanitation facilities (Table 3), while lower-income households are more likely to have inadequate sanitation. Although utilisation of sanitation facilities is increasing, the inequality between high-income and low-income brackets in accessing improved sanitation facilities persists (Ahmed et al., 2023).

Table 3 Households with sanitation facilities

Income bracket	Percentage of households having improved sanitation facilities	Percentage of households having unimproved sanitation facilities	Percentage of households practicing open defecation
Lowest	32.7	62.9	4.4
Second	50.7	48.1	1.2
Middle	72.7	26.9	0.4
Fourth	83.3	16.7	0.0
Highest	88.3	11.7	0.0

Sources: National Institute of Population Research and Training (NIPORT); ICF (2020)

In summary, the water sector in Bangladesh plays a pivotal role in driving economic transformation, ensuring environmental sustainability and fostering social inclusion. It is fundamental to agricultural productivity through irrigation, and to industrial expansion, particularly in the water-intensive RMG and textile sectors that dominate the country’s export earnings, and to the provision of essential urban services such as drinking water and sanitation. Despite its centrality, the sector also faces several challenges including groundwater over-extraction, widespread pollution from industrial effluents and agricultural runoff, and persistent inequalities in access to safe water across income groups and between rural and urban areas. The unsustainable use of water resources also threatens public health and the ecological balance. Existing policy gaps, especially in addressing social inclusion, underscore the urgent need for integrated and enforceable water governance frameworks. Strengthening institutional capacity, enhancing water-use efficiency and aligning industrial, agricultural and urban water management with sustainability standards are critical to securing ISET outcomes of inclusive growth, equity and resilience.

4 The policy and regulatory framework of the water sector

This section looks at national policies, development plans and the regulatory framework for the water sector, focusing on its core principles and institutional arrangements and its role in the nexus among economic, social and environmental indicators. Existing national policies and plans targeting the water sector address environmental and economic issues such as ensuring water safety, improving water management, addressing climate change impacts and channelling investments in water management improvements. However, there is a notable gap in the framework's focus on social inclusion.

4.1 The national policy and regulatory framework for the water sector

There are three primary ministries assigned to water management: the Ministry of Water Resources (MoWR), the Ministry of Agriculture (MoA) and the Ministry of Local Government, Rural Development and Cooperatives (MoLGRD&C) (GED, 2020). The MoWR is responsible for the development and management of the water sector. The MoLGRD&C is responsible for designing and implementing water-related policies through divisions within local government. The National Water Resources Council (NWRC) is tasked with policy-making, direction and coordination to ensure water resource planning (Sagris & Abbott, 2015). The Ministry of Finance allocates resources, and the Ministry of Planning provides planning and logistical support.

The Water Pollution Control Ordinance was introduced in 1973. The Department of Pollution Control (latterly the Department of Environment (DoE)) was established in 1985. The Environment Policy was introduced in 1992, followed by the Forest Policy (1994), the New Agriculture Extension Policy (1995), the Fisheries Policy (1999) and the National Water Policy (1999). The National Water Policy was designed to ensure effective management of water resources, the improvement of surface and groundwater, access to water and institutional organisation for water governance (Ministry of Water Resources, 1999). The Bangladesh Water Act 2013 was formulated to improve coordination in water resource management

and strengthen administration (Legislative and Parliamentary Affairs Division, 2013). The Bangladesh Delta Plan (BDP) 2100, published in 2018, sets out a long-term investment plan focused on climate resilience and economic growth, concentrating on water investments and water management (GED, 2018). The National Adaptation Plan (NAP) (2022) focuses on scaling up adaptation priorities related to water resources, such as the management of water, land and sediment, the rehabilitation of polders, climate-resilient drinking water and sanitation (MoEFCC, 2022).

Bangladesh's regulatory and policy framework for the water sector focuses on management and governance aligned with environmental sustainability and economic transformation. However, the framework lacks adequate focus on social inclusion. For instance, the National Water Policy (1999) stipulated that government would mandate social and environmental assessments for all development planning initiatives. However, the policy lacks a clear strategy for ensuring social inclusion and conducting environmental assessments. Similarly, BDP 2100 emphasised safe and prosperous delta, climate change (in chapter 3 of BDP 2100), water and food security (in chapter 6 and 8 of BDP 2100), economic growth, and environmental sustainability (in chapter 7 of BDP 2100), but specific focus on social inclusion and road map was not clearly stated in the plan. This deficiency was also highlighted during stakeholder consultations on water sector governance and management. Respondents, including government stakeholders involved in water governance, noted the comprehensive nature of existing policies, while also expressing concern regarding the implementation of those policies. In particular, respondents noted a lack of alignment between targets for environmental sustainability and the implementation of policies, plans and the regulatory framework. For instance, Bangladesh has set a target for reducing industrial pollution under the National Sustainable Development Strategy (NSDS), in line with SDG6 (clean water and sanitation) and SDG12 (responsible consumption and production). However, due to policy mismanagement this target has yet to be achieved. A key example of policy implementation failure concerns the Centre Effluent Treatment Plant (CETP) at Savar, which has been non-functional for years, leading to continued discharge of untreated waste from tanneries into nearby water bodies (Howes et al., 2017). Key reasons for such policy failure are the weak links between governing bodies and implementing agencies and limited resources for monitoring environmental issues at the grassroots level.

4.2 The integration of economic transformation, environmental sustainability and social inclusion in the policy and regulatory framework for the water sector

The literature review and stakeholder consultation reveal that the water sector in Bangladesh faces a complex web of challenges. The sector grapples with issues that affect both the safety of drinking water and agricultural productivity, such as water scarcity, uneven distribution, contamination, seasonal fluctuations in water supply and pollution of surface and groundwater resources. Extended droughts and declining groundwater levels in the north affect agricultural productivity. Salinity intrusion is another problem triggered by rising sea levels and freshwater flow reduction (Chanda et al., 2016). The migration of river channels is an emerging problem caused by insufficient maintenance of water infrastructure, inadequate drainage and reduced upstream river flow (World Bank, 2022). Rapid urbanisation and industrialisation have led to the discharge of untreated waste and chemicals into water bodies, severely degrading water quality (Yin et al., 2021; Rahman et al., 2021). The textile and tannery industries contribute to the contamination of rivers with toxic substances (Ahsan et al., 2019). Agricultural runoff carries pesticides and fertilisers into waterways, impacting aquatic ecosystems and human health (Hossain et al., 2022).

Although the challenges facing the water sector are acknowledged in many policy documents, rules and regulations, Bangladesh has yet to achieve the meaningful policy integration and inter-ministerial coordination necessary to fully comprehend the scope of the issue. Legislative gaps, overlaps in policy and a lack of institutional capacity to govern water resources are prevalent (Sagris & Abbott, 2015).

Economic transformation in the policy and regulatory framework of the water sector

The water sector underpins sustainable development and growth as a cornerstone of economic transformation. Water is a vital resource for irrigation, food production, industrial development and environmental conservation. The Bangladesh Water Act (2013) established a foundation for integrated and sustainable water resources management. More recent national plans and policies acknowledge the importance of the water sector from the perspective of climate change and its impact on development. For example, BDP 2100 focuses on climate change adaptation measures to ensure water and food security. With a holistic and integrated approach to water management, inclusive and sustainable management of water resources might be achieved. While progress has been made, financing, coordination and governance and data and knowledge challenges remain in implementation.

BDP 2100 provides a comprehensive and forward-looking strategy to address the challenges and opportunities presented by the country's geographical position and climate. The plan was successful in attracting private sector investment in riverbank and delta development. For example, the private sector has been involved in the development and operation of the Mongla Port Private Inland Container Terminal (ICT) and the Pangaon Container Terminal. These investments have facilitated efficient cargo handling, improved trade connectivity and stimulated economic growth in the surrounding areas. Private companies have developed resorts, hotels and recreational facilities along rivers such as the Padma and the Meghna. These investments promote tourism, create employment and contribute to the local economy (Amin, 2021).

The Mujib Climate Prosperity Plan (MCP) was formulated in 2021 with the aim of transforming Bangladesh from a climate-vulnerable country to a climate-resilient one. It also considers nexus issues in the water sector as part of the plan (see Box 3). The 2022 NAP outlines a range of adaptation strategies and measures specific to the water sector to address the challenges posed by climate change. In the plan, the priority was given to water, land and sediment management. Key priorities in the NAP are integrated with BDP 2100 for water sector adaptation, including flood management and early warning systems, water resource management, coastal zone management, water supply and sanitation and water governance and institutional strengthening.

Box 3 Nexus considerations within the Climate Prosperity Plan

The main goal of Bangladesh's Climate Prosperity Plan is to secure green economic growth through resilience to climate change, prioritising the water sector. The plan promotes locally led adaptation through government projects such as the Local Government Initiative on Climate Change (LoGIC). This includes activities that focus on climate-proofing investments in community-based adaptation schemes to make local infrastructure, including drinking water, irrigation, water management systems and watersheds, 'more resilient and gender-responsive'. The plan also provides conditional grants directly to vulnerable households to support resilient livelihoods on and off the farm. Under the Mujib CPP, 225 of the most climate-vulnerable wards have been identified, from which the most vulnerable 35,000 households and moderately vulnerable 10,000 households are selected for skill development in climate-resilient livelihoods. In this way, the plan promotes social inclusion while strengthening environmentally sustainable economic growth.

There are more specific water-related success stories under LoGIC that point to nexus issues. For example, when farmers in Bagerhat district in south-western Bangladesh experienced lower crop yields,

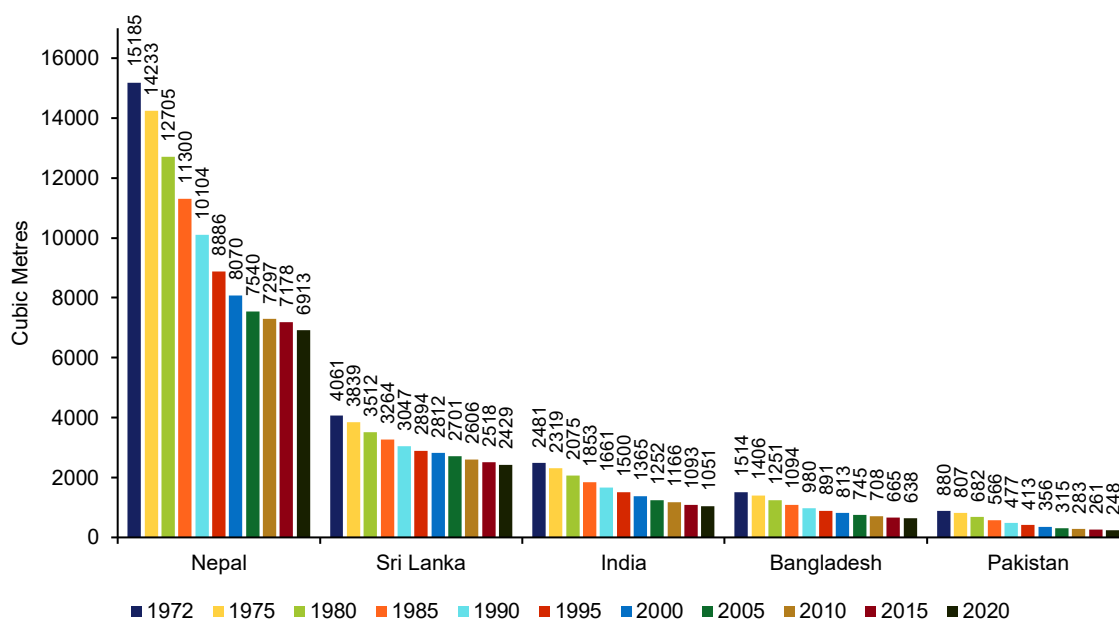
LoGIC, through its PBCRG scheme, facilitated the implementation of a solar-based agricultural irrigation plant that redirects water from nearby natural canals. This water irrigation system uses solar-based pumps to bring water to the surface and disperse it through valves distributed across the 2,000-acre site. While climate hazards often disrupt the electric supply in the area, the solar panels provide more consistent power for better crop cultivation. The irrigation plant offers a nature-based solution that uses clean energy and surface water and thus avoids the harmful environmental impacts of groundwater extraction.

Sources: MCPP (2021): https://mujibplan.com/wp-content/uploads/2021/09/Mujib-Climate-Prosperity-Plan_26Sept2021.pdf; Bangladesh Local Government Initiative on Climate Change Consolidated Annual Progress Report 2021: <https://mptf.undp.org/fund/ibd40#:~:text=amounts%20in%20US%24-.Results,solutions%20in%20climate%20vulnerable%20areas>

Stakeholder consultations identified fragmented governance of the water sector across multiple ministries and authorities. The lack of clear responsibilities in relevant ministries and authorities often hinders policy implementation. Although urban local governments possess a broad legal mandate for cross-sectoral interventions under the Local Government Act (2009), their authority overlaps with decentralised bodies like the Bangladesh Water Development Board (BWDB), city corporations and city development authorities, particularly in urban flood management (World Bank, 2022).

At the same time, the country is expected to experience increasing demand for fresh water, driven by the growth of industrial activities and rising household consumption. For instance, in 2019 46,291 industrial units were recorded, up from 42,792 in 2013 (BBS, 2019), and this increase is expected to continue (Arifuzzaman et al., 2019). Urban populations are expected to grow, as will the demand for water and sanitation. Freshwater availability per capita in Bangladesh compares poorly with other South Asian countries (Figure 9). Updated and integrated planning is required to address the growing demand for water for industry and household use.

Figure 9 Availability of freshwater in Bangladesh and selected South Asian countries



Source: World Development Indicators (2022)

Environmental sustainability in the regulatory and policy framework of the water sector

The NWP was formulated in 1999 with the main aim of ensuring the efficient use of water for irrigation. However, rapid urbanisation, population growth, industrialisation, economic development and many other emerging issues required a more integrated policy approach. The NWP has not been updated, and over time many emerging issues have gone unaddressed. A holistic approach is required (including both the public and private sectors) in the management of the water sector management.

Existing national acts and laws provide a foundation for safeguarding inland waters from pollution. The government has undertaken initiatives to protect riverbanks and construct embankments to prevent erosion and maintain the stability of river systems. Dredging activities are carried out in major rivers to maintain their navigability, especially for transportation and trade purposes. Initiatives are in place to control pollution and improve the water quality of rivers. Regular monitoring of water quality is conducted by the Department of Environment (DoE) to identify pollution sources and take appropriate measures for pollution control.

However, these acts and laws cannot prevent water pollution. Several studies highlight the lack of accountability and poor enforcement of environmental laws and acts (Arifuzzaman et al., 2019; Dhar et al., 2021; Numan & Mahabubul, 2022). Conserving water resources is prioritised in Bangladesh’s environmental policy, laws and regulations including the NWP, the Environment

Conservation Act 1995, the Environment Conservation Rules 1997 and the Water Act 2013. It is however clear that there has not been appropriate, timely and effective enforcement of the relevant legislation by the DoE, partly due to a lack of monitoring capacity. DoE officials also highlight sociopolitical factors that often hinder the enforcement of environmental laws designed to prevent water pollution. Stakeholder consultations noted how some earlier laws had insufficient penalties, and since they have not been properly amended they are now virtually defunct. The lack of effective enforcement of industrial wastewater treatment is another gap, leading to untreated wastewater and the discharge of effluent waste into water bodies (Sagris & Abbott, 2015).

Social inclusion in the regulatory and policy framework of the water sector

Local communities are engaged in river management through River Management Committees (RMCs). These committees work closely with government authorities to ensure community involvement in decision-making processes, river cleaning campaigns and river conservation: see Box 4 for an example of local community engagement.

Box 4 Local community engagement to save the River Louhajang

The Louhajang River originates within the Tangail districts and flows through Tangail city. The river once experienced severe environmental degradation due to industrial pollution and illegal encroachment. This degradation of the river caused to halt the natural flow of the river water and hence, the river lost its natural shape and functionality. As a result, waterlogging during the rainy season became a persistent issue since the river could not hold the rainwater due to its reduced capacity for water reservation. Urban infrastructure and livelihood were severely affected due to persistent waterlogging in the city.

In response, the local government authority initiated a massive awareness campaign among the local people to mobilise public support. The initiative successfully engaged thousands of community members, including students, educators, journalists, intellectuals, and political leaders. Their involvement in the decision-making process laid the foundation for inclusive and effective restoration efforts.

With strong local backing, the government undertook dredging and excavation activities to revive the river. These short-term interventions restored the Louhajang River's natural flow and navigability, alleviating waterlogging and improving environmental conditions in Tangail.

Inclusive stakeholder participation can ensure social justice in the policy-making process, and hence equity in water resource management. Insufficient stakeholder participation is often a barrier to the efficient and effective implementation of environmental policies and plans in Bangladesh. For instance, the welfare of lower-income groups is often not considered, and the adverse social impacts of implementing environmental policies often go unaddressed (Box 5). As a result, it has been difficult to address the sociopolitical issues involved in preventing environmental and water pollution.

Box 5 The tannery industry in Bangladesh

The tannery industry in Bangladesh is an important part of the country's leather industry, with a history dating back to the nineteenth century. The leather industry involves the processing of raw hides and skins into finished leather products. Currently, the domestic leather market is worth \$3 billion, and accounts for around 3% of the global market (Bangladesh Investment Development Authority, 2023). It is the second largest contributor to export earnings. In FY2021–22, export earnings from the industry were \$1,245 million (Export Promotion Bureau, 2022).

Tanneries are a significant source of environmental pollution. The industry has faced criticism for its lack of compliance with environmental regulations and for its negative impact on human health. To address these issues, the government has implemented various policies and initiatives to improve the environmental performance of the industry and to ensure workers' safety. One of the most significant initiatives was the relocation of many tanneries from Dhaka to Savar. The relocation was prompted by growing concerns over pollution in the city and the need to relocate tanneries to a more suitable environment. However, the relocation has caused problems for tannery workers, who have to travel longer distances from their homes, and growing demand for housing has encroached on arable land. Chemical effluent treatment plants (CETPs) were not built properly, and river pollution has continued at the new location.

Workers' representatives were not consulted during the planning process, and their welfare and basic amenities were not fully taken into account. Tannery workers and their families suffered significantly in terms of accommodation, education for their children, healthcare and other basic services such as water and sanitation. Many workers left the industry after the relocation to Savar. These issues are currently being discussed with the relevant stakeholders, and are included in the draft National Action Plan on the Labour Sector of Bangladesh (2021–2026).

In many cases, the private sector has played an effective role in water resource management. This is a positive change for social inclusion identified during stakeholder consultations. The drivers for

this appear to be stronger where there is international pressure or financial incentives are in place that require improved compliance. Box 6 provides an example of how the textile and RMG sector in Bangladesh has been pioneering sustainability in its production processes, driven in large part by international environmental compliance requirements. At the same time, the challenge remains in ensuring that smaller downstream firms have similar support to engage in green initiatives.

Box 6 The textile and RMG sector in Bangladesh

The textile and RMG sector has been a leader in green industrial production in Bangladesh. More than 190 factories are LEED-certified by the US Green Building Council (USGBC) and more than 500 are in the pipeline for certification. Certification requires that sustainable water consumption and efficient water use processes are embedded in factory set-ups, for instance through the use of Effluent Treatment Plants (ETPs) and machinery. In many cases, large factories are required to follow such sustainability requirements as a prerequisite for environmental compliance by international buyers.

5 Conclusion and recommendations

Bangladesh has made significant economic and social progress over the past five decades. However, this has often come at the expense of the environment, resulting in significant environmental degradation. Policy-making processes in Bangladesh prioritise economic growth over social inclusion and environmental sustainability. This has internal and external implications as Bangladesh is set to graduate from LDC status by 2026.

This study examines the interplay between economic transformation, social inclusion and environmental sustainability in Bangladesh's water sector. National policies, development plans and regulatory frameworks were assessed for the integration of economic transformation, environmental sustainability and social inclusion. A trend analysis of indicators related to the three nexus pillars was carried out to understand the status of the water sector in Bangladesh. Lastly, the study conducted several KIIs with relevant stakeholders. The study highlights the following findings.

- 1 While recent economic development plans such as the MCPP, BDP 2100 and the NAP address economic transformation, water sector policy was last updated in 1999. The discrepancy between outdated water sector policies and newer economic development plans leads to inconsistencies in the regulatory framework, hindering effective implementation of water management initiatives.
- 2 Existing national acts and laws provide a foundation for safeguarding inland waters from pollution and ensuring environmental sustainability. Water resources are protected and conserved by laws and regulations such as the National Water Policy 1999, the Environment Conservation Act 1995, the Environment Conservation Rules 1997 and the Water Act 2013. Despite these legal frameworks, the country is ill-equipped to address emerging issues, not least the need for a holistic approach to water sector management involving both the public and private sectors. Such an integrated approach is essential to ensure the sustainable use and protection of water resources in the face of growing demands and environmental challenges.
- 3 Social inclusion has been largely overlooked in policy-making and development planning in Bangladesh. The welfare of lower-

income groups is often neglected. As a result, challenges remain in the implementation of environmental and development policies and plans for the water sector.

The study identified five major action areas for inclusive and sustainable economic transformation in the water sector. These are: a holistic approach in water sector management; inclusive stakeholder engagement in planning; stronger implementation of environmental laws and acts; improved water governance and institutional capacity; and futures planning to meet the water demands of industrial and population growth.

Based on the findings, the study proposes the following recommendations:

- 1 Integration of social inclusion into economic development plans and policies should be considered. In such a process, the welfare of vulnerable groups, especially people from low-income brackets, should be prioritised. Collaboration among government agencies, the private sector, civil society organisations, representatives of marginalised groups and other relevant stakeholders should be encouraged to promote sustainable development and address environmental challenges during the policy and planning process.
- 2 Environmental sustainability should be part of the planning process in all development initiatives. Priority should be given to environmental impact assessments before implementing new projects.
- 3 The National Water Policy of 1999 should be urgently revised to address emerging challenges, incorporate modern water management practices, integrate economic transformation and social inclusion and align with broader economic development plans.
- 4 A comprehensive, clear and enforceable regulatory framework for the water sector should be formulated. This should be regularly reviewed and updated to keep pace with evolving needs and challenges.
- 5 Improve governance in the water sector by enhancing the transparency and accountability of relevant government agencies. In this process, investing in capacity-building for government agencies and institutions will play a vital role in improving their ability to implement sustainable development policies and programmes.
- 6 Local communities should be empowered and encouraged to participate in water management and conservation efforts. Raising awareness among local communities about water conservation and promoting efficient water use practices will ensure an inclusive voice in the process.

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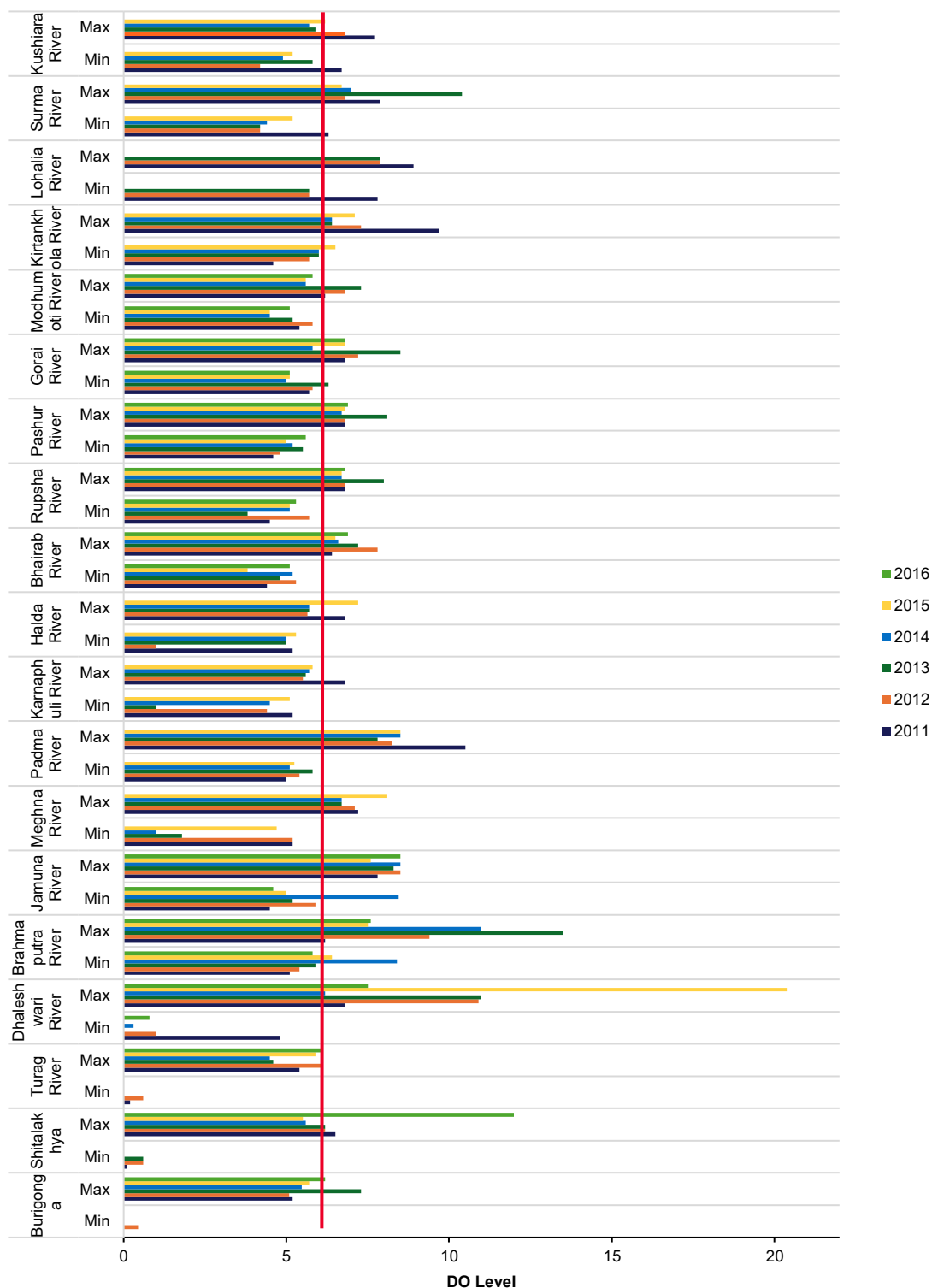
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Annex

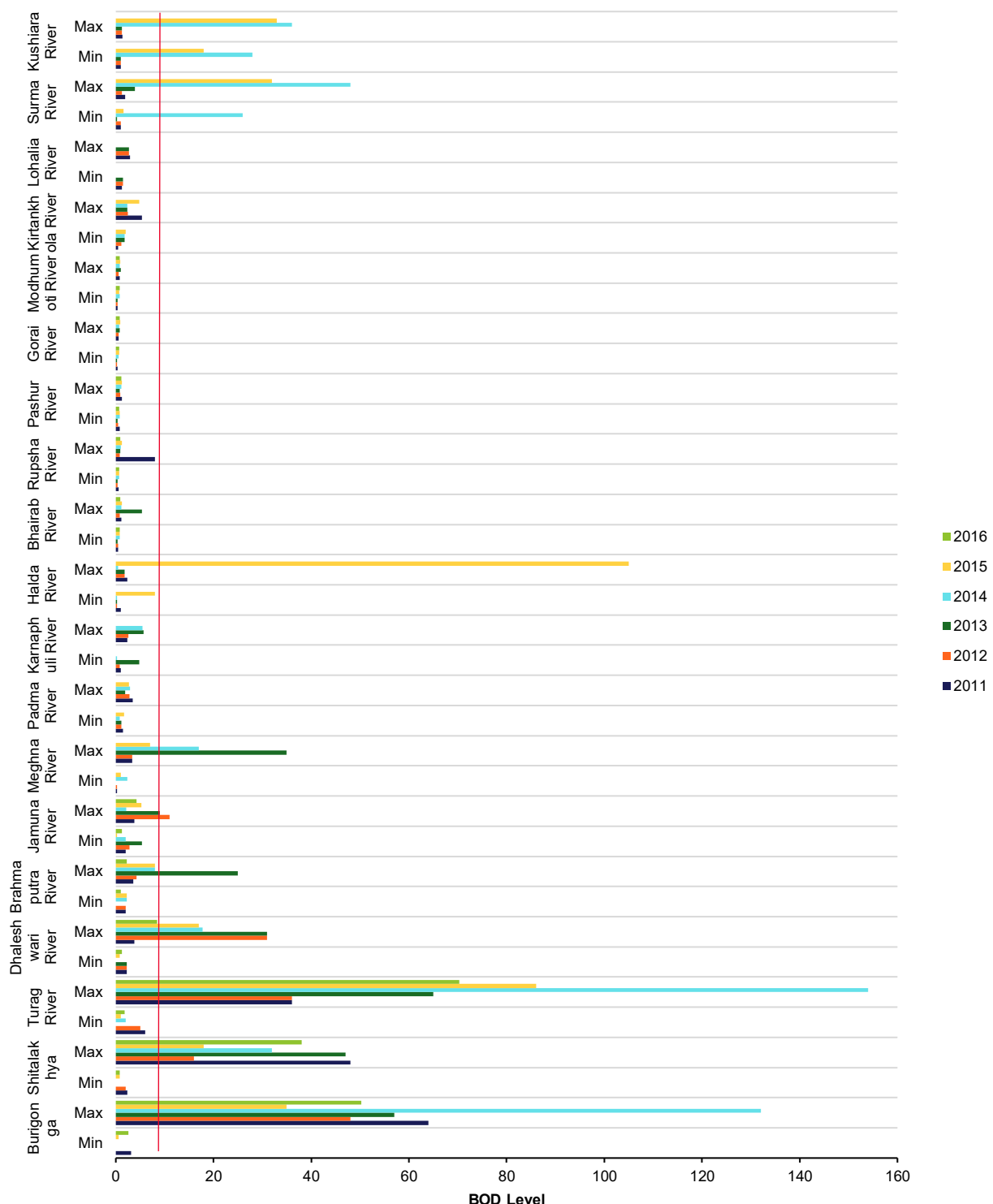
Figure A1 Dissolved Oxygen levels in Selected rivers (mg/L)



Note: The ideal limit for Dissolved Oxygen (DO) in healthy water generally is 6 mg/L as per Department of Public Health Engineering.

Source: Bangladesh Bureau of Statistics (2020)

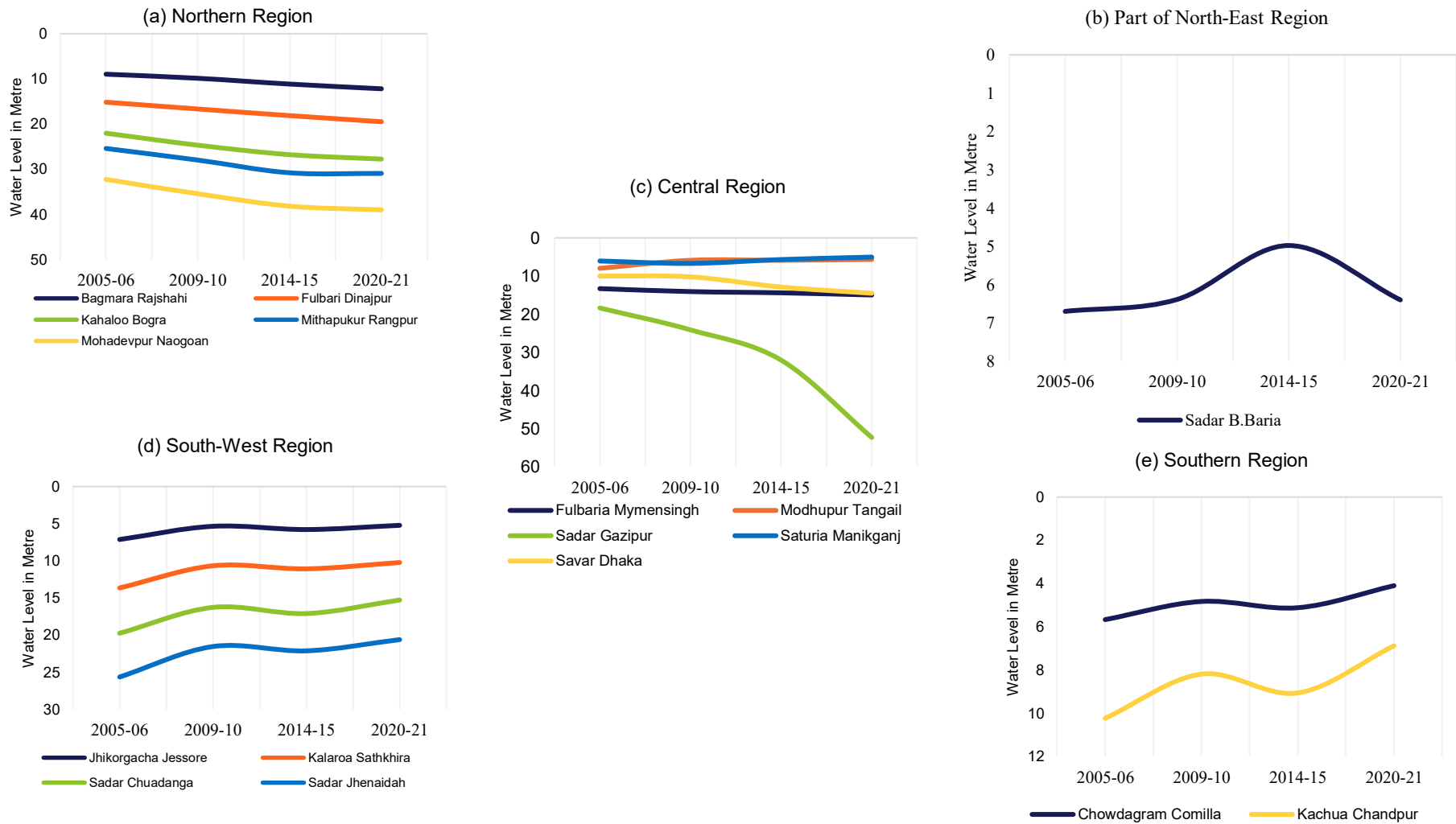
Figure A2 Biochemical Oxygen Demand (BOD) level in selected rivers (mg/L)



Note: The ideal limit for Biochemical Oxygen Demand (BOD) in healthy water is generally (≤ 6 mg/L) as per Department of Public Health Engineering.

Source: Bangladesh Bureau of Statistics (2020)

Figure A3 Ground water table hydrographs of various parts of the country (maximum depletion in metres)



Source: Authors' illustration based on Bangladesh Agricultural Development Corporation (2022)

Table A1 Divisional distribution of total irrigated area (ha) during Rabi season 2020–2021

Name of Division	Irrigated area (ha)	Percentage of total area
Dhaka	696,697	12.32
Mymensingh	609,570	10.78
Rajshahi	1,233,277	21.82
Rangpur	1,067,345	18.88
Chattogram	645,100	11.41
Khulna	790,412	13.98
Sylhet	425,203	7.52
Barishal	185,460	3.28
Total	5653054	100

Source: Bangladesh Agricultural Development Corporation (2021)

Table A2 Percentage distribution of household sanitation facilities by residence, wealth index and education

	2007 (n = 10,400)			2011 (n = 17,141)			2014 (n = 17,300)			2017-18 (n = 19,457)		
	Improved	Not improved	p-value	Improved	Not improved	p-value	Improved	Not improved	p-value	Improved	Not improved	p-value
Place of residence												
Urban	37.83	62.17	<0.001	39.57	60.43	<0.001	49.76	50.24	0.007	45.26	54.74	0.354
Rural	21.99	78.01		31.67	68.33		43.65	56.35		43.47	56.53	
Wealth index												
Poorest	6.80	93.20	<0.001	8.80	91.20	<0.001	18.38	81.62	<0.001	17.02	82.98	<0.001
Poorer	12.72	87.28		22.76	77.24		35.48	64.52		30.97	69.03	
Middle	20.40	79.60		33.46	66.54		50.70	49.30		50.25	49.75	
Richer	34.06	65.94		46.55	53.45		53.84	46.16		51.07	48.93	
Richest	57.22	42.78		60.83	39.17		69.28	30.72		73.00	27.00	
Educational status of household head												
No education	14.28	85.72	<0.001	22.08	77.92	<0.001	33.54	66.46	<0.001	31.86	68.14	<0.001
Primary	21.79	78.21		29.47	70.53		40.73	59.27		38.75	61.25	
Secondary	34.51	65.49		42.66	57.34		53.63	46.37		50.43	49.57	
Higher	62.72	37.28		63.69	36.31		74.32	25.68		73.16	26.84	

Source: Authors' compilation from Ahmed et al. (2023)