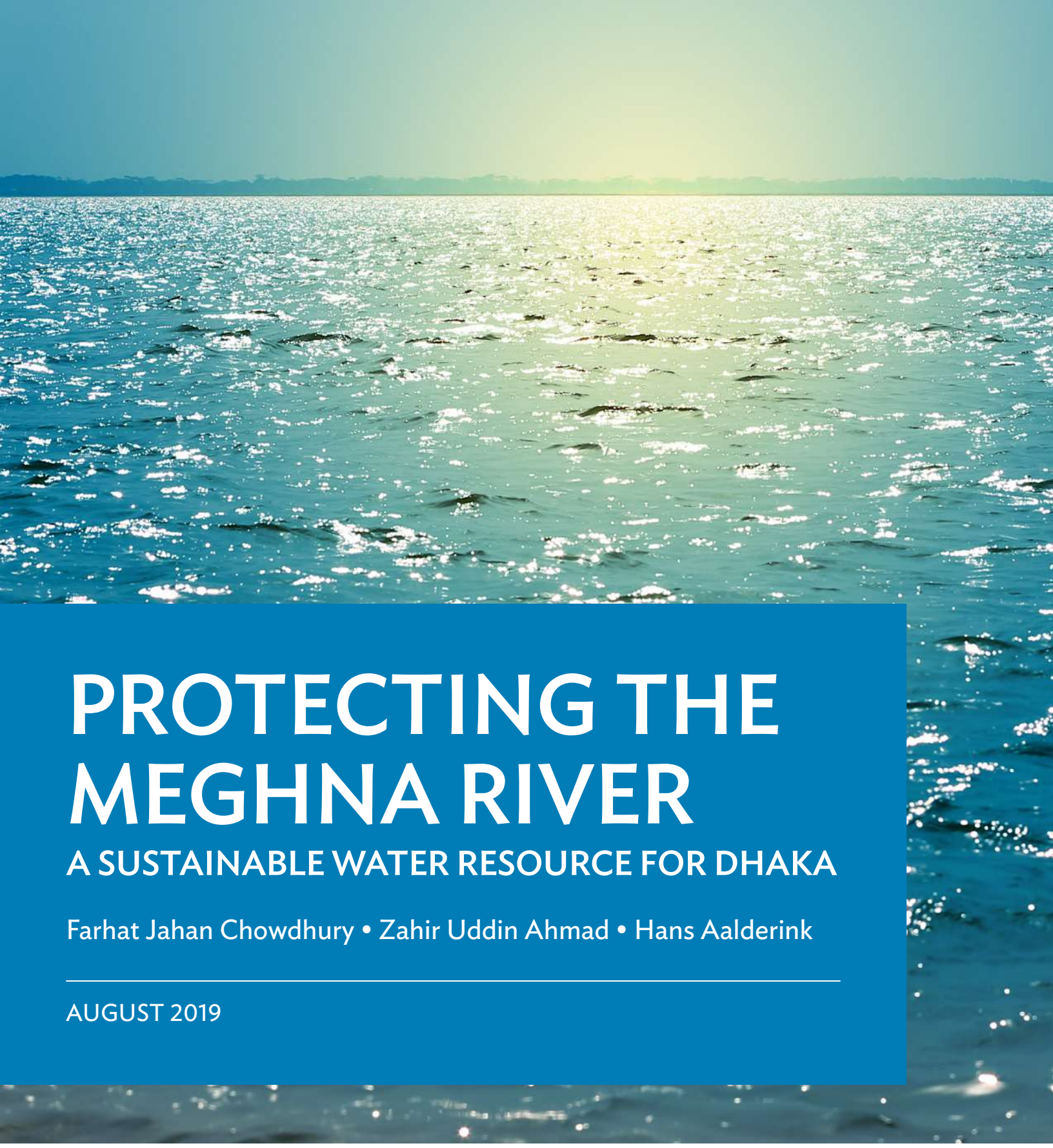

PROTECTING THE MEGHNA RIVER

A SUSTAINABLE WATER RESOURCE FOR DHAKA

Farhat Jahan Chowdhury • Zahir Uddin Ahmad • Hans Aalderink

AUGUST 2019

ASIAN DEVELOPMENT BANK

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On the cover: The Meghna River is a new source of drinking water for 20 million residents in Dhaka, Bangladesh (photo by Masud Al Mamun).

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Fishing boat anchored at the bank of the Meghna during low tide.

Local fishing boats at the bank of the Meghna River.

Foreword

Today, conventional water sources in Dhaka are under severe stress due to increased water demand. Several of the city's alternative water sources have been lost due to encroachment, pollution, and unplanned development. Currently, 20.6 million residents require 2,485 million liters per day, a 62 % increase from 1,550 million liters per day in 2000. Almost 87% of this need is met through groundwater sources, whereas earlier, Dhaka's water supply used to come largely from the Buriganga River, first developed in 1874. The river is now highly polluted, as are nearby water bodies like the Balu, Shitalakhya, and Turag rivers. This has led to increased dependence on groundwater, but continuous extraction is depleting the water level by 2–3 meters per year. Thus, there is a need to look for alternative sources. The Meghna River, located 30 kilometers east of Dhaka, is abundant in supply, reasonably clean, and could be an option.

This publication is an output of a Technical Assistance grant (TA 8803-BAN: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply) received from the Japan Fund for Poverty Reduction financed by the Government of Japan through the Asian Development Bank. The report looks at the potential of the Meghna River as a source of water for Dhaka City, assesses its water quality, and provides recommendations on sustainable development and protection of the water source.

The TA finds that preservation of water quality in the Meghna River should be given high priority to ensure that investments made are fully realized. The TA proposes designating an ecological critical area around two proposed drinking water intake points and using the creation of economic zones as an opportunity to install state-of-the-art treatment systems for industrial users. Promoting clean industries, monitoring pollution, controlling wastewater discharge and pesticide use, collaborating with local administration, and empowering local stewardship at the Meghna River catchment are key approaches recommended. A joint institutional setup is proposed, with the Department of Environment (DOE) charged with the protection of river water quality and the Dhaka Water Supply and Sewerage Authority (DWASA) with the provision of safe drinking water supply.

DOE and DWASA were actively involved in TA implementation. I thank Mustafizur Rahman Akhand, project director; Sultan Ahmed, DOE director general; Taqsem Khan, DWASA managing director; and the Ministry of Environment, Forest and Climate Change for their support. I also acknowledge ADB staff that helped to prepare and review this publication—Farhat Jahan Chowdhury, senior project officer (TA implementation officer); Zahir Uddin Ahmad, senior project officer, Ricardo Carlos V. Barba, principal safeguards specialist; Tika Limbu, senior portfolio management specialist; Ninette Pajarillaga, environment specialist; and Hans Aalderink, team leader, Deltares. Gobinda Bar, Edith Creus, April-Marie Gallega, and Raynal Squires from the Department of Communications helped with publication.

Manmohan Parkash
Country Director
Asian Development Bank
Bangladesh Resident Mission

Abbreviations

ADB	Asian Development Bank
BPA	bisphenol A
DOE	Department of Environment (Bangladesh)
DWASA	Dhaka Water Supply and Sewerage Authority
ECA	ecologically critical area
EQS	environmental quality standard
ETP	effluent treatment plant
IUCN	International Union for Conservation of Nature
km	kilometer
km^2	square kilometer
LGB	local government body
mld	million liters per day
TA	technical assistance

Executive Summary

Protecting water sources is everyone's responsibility. In fact, our survival depends on it. It is not enough to have sufficient water; if it is of poor quality or highly contaminated, it cannot meet our needs. This is why it falls on all of us to protect water sources for ourselves and for future generations.

In Dhaka, Bangladesh, mounting pressures have forced decision makers and planners to look for alternate sources of drinking water. Surface water near the city is heavily contaminated, and groundwater under the city is insufficient to meet current demand. Furthermore, rapid population growth is putting additional strain on an already scarce resource.

Fortunately, a viable solution exists in the Meghna River, which is located a mere 30 kilometers east of Dhaka. In the coming years, this source is expected to provide more than 40% of the drinking water for Dhaka's 20 million residents. For this to be a feasible solution, a number of steps need to be taken in order to ensure the sustainability of this water source. The quality of Meghna River water is still reasonably good, but scenarios suggest it could become too polluted for drinking within the next 5 years.

This report provides background on the Meghna River (water quality, its importance, what is needed to protect it), and context on current and prospective development of the resource. It makes clear that water quality in the Meghna River is heavily threatened, and proposes a number of actions that need to be taken to preserve water quality and reduce the risk of further contamination. These actions aim to strengthen government capacity for monitoring and maintaining water quality in the river, and include key measures such as designating ecological critical areas, promoting cleaner industrial production, monitoring pollution, controlling waste water discharge and pesticide use, and empowering local stewardship of the Meghna River as an important resource.

The consequences are clear-cut. If the proposed actions are taken immediately, and sustained, the Meghna River will continue to be a reliable source of drinking water for Dhaka. If no actions are taken and we continue with a "business as usual" approach, then the Meghna River may cease to be a suitable option for quality water.

The future is in our hands; we must all work together to do our part to preserve water quality in the Meghna River. This report aims to provide the necessary information for action.

Katha, bush trap, a type of fish aggregating device.

1 Background

Dhaka Water Supply and Sewerage Authority (DWASA) provides water across a service area of about 400 square kilometers (km^2) in Dhaka City and its surroundings. Groundwater accounts for 87% of the drinking water it provides, with the rest coming from surface water sources.[1] Water demand by the population in and around Dhaka is too high. In Dhaka City alone, water demand is 2,485 million liters per day (mld), slightly exceeding the present supply of almost 2,400 mld. As population and demand for water supply grow, cities respond by expanding the water supply sources.[2] Dhaka City began sourcing public water supply from the Buriganga River before slowly transitioning to groundwater to meet demand. Groundwater became the prime supply source as the reserve was abundant and of good quality, while surface water deteriorated. As demand increased, Shitalakhya River was included to complement supply.[3]

Current groundwater abstraction is beyond sustainable yields, as evidenced by a rapidly falling water table. Dhaka's domestic water supply is obtained from its middle aquifer, abstracted by 605 deep tube wells throughout the city. Groundwater resources are being depleted. With the water table falling by 2–3 meters per year, the lifetime of deep tube wells is shorter, and some 40–60 wells become inoperable each year. Groundwater extraction, as high as 1,900 mld in 2012, needs to be reduced to 1,360 mld by 2020 and 1,260 mld by 2025, even though the overall supply needs to be increased to cater to the growing population in larger service areas. Recent studies have shown that the aquifer may be changing from a confined to an unconfined condition, which could make it vulnerable to contamination. The groundwater quality is slightly acidic, and its nitrate content is exceeding the permissible limit of national environmental quality standards (EQS).[4,5]

The main source of surface water is also becoming rapidly polluted. Out of the 2,400 mld currently provided by DWASA, 450 mld is provided by the Saidabad water treatment plant, which abstracts surface water from the nearby Shitalakhya River. River water quality is deteriorating, particularly in terms of high ammonia concentration during the dry season owing to uncontrolled industrial effluent discharge into the river. The ammonia concentration is starting to exceed the design standard that a pre-treatment unit can adequately manage, putting the sustainable operation of the water treatment plant at serious risk. This makes it essential for DWASA to find an adequate and sustainable source of raw water for achieving its long-term development objectives.[4,5]

Depleting groundwater resources in and around Dhaka have made the development of a new surface water source essential. As nearby water bodies such as the Balu, Buriganga, Shitalakhya, and Turag rivers are unsuitable because of poor and deteriorating water quality, the Meghna River has been selected as a new source, as it has good water quality and ample quantity even during the dry season. While DWASA supplies water to about 90% of the population (10.7 million) in its service area, it is unable to provide water of sufficient quality and quantity. DWASA plans to secure more surface water from the Meghna and Padma rivers to expand its service area to about 500 km^2 by 2020 and 600 km^2 by 2035, to meet the needs of a projected population of about 29 million.[5]

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1 Asian Development Bank (ADB). 2011. *Feasibility Study for Augmentation of Water Supply to Dhaka. A Report of Design & Management Consultancy Services for Dhaka Water Supply Sector Development Project*. Manila.

2 F. Chowdhury, C. Lant, and B. Dziegielewski. 2013. A Century of Water Supply Expansion for Ten US Cities. *Applied Geography*. 45. pp. 58–76.

3 K. M. Ahmed, M. S. Islam, and S. Sultana. 2016. Changes in the Groundwater Regime of Dhaka City: A Historical Perspective. In S. U. Ahmed and G. Rabbani, eds. *Celebration of 400 Years of Capital Dhaka*. Dhaka: Asiatic Society of Bangladesh. pp. 383–400.

4 ADB. 2013. *Report and Recommendation of the President of the Board of Directors. Proposed Loan and Administration of Loan People's Republic of Bangladesh: Dhaka Environmentally Sustainable Water Supply Project*, Manila.

5 DWASA. 2014. *Dhaka Environmentally Sustainable Water Supply Project, Roadshow Brochure*. Dhaka. https://www.adb.org/sites/default/files/project-document/79167/42173-012-ban-dpta-01.pdf.

The Meghna River, located 30 kilometers (km) east of Dhaka, has been identified as one of the major new sources of water for Dhaka and two intake points for water withdrawal and supply have been proposed (Figure 1). Currently, the Asian Development Bank (ADB) is providing financial support to DWASA to implement the Dhaka Environmentally Sustainable Water Supply Project, approved in 2013, for the development of one of the intake points along with a raw water transmission pipeline and a water treatment plant. Once the two water intake points and associated infrastructure are developed, the Meghna River will account for more than 40% of the DWASA's water supply by 2021. With the operation of new water treatment plant, groundwater use is expected to be reduced by 1,360 mld.

At present, Meghna River water quality is good. To avoid deterioration in water quality and ensure sustainable supply to Dhaka, it is critical to strengthen monitoring and enforcement mechanisms for the river. However, DWASA does not have the authority to regulate pollution in water bodies. The Department of Environment (DOE) under the Ministry of Environment, Forest and Climate Change is mandated to monitor and control water, air, and soil pollution, and enforce the Environment Conservation Act, 1995 (amended in 2010) if any violation by industries or others occurs. Although DOE is the sole authority for issuing and renewing environmental clearances for potentially polluting activities, it does not have enough staff to regularly monitor such activities and enforce necessary actions like suspending factory operations or imposing fines. Therefore, a joint effort of all stakeholders, especially between DOE and DWASA, is essential for the preservation of water quality in the Meghna River.

Given rapid urbanization and increasing industrialization in Dhaka and its surrounding areas, monitoring and enforcement mechanisms for the Meghna River need to be strengthened to avoid deterioration of water quality and ensure a sustainable supply of water to Dhaka. This requires (i) boosting the capacity of DOE; (ii) establishing a more collaborative, innovative, and enforceable system by involving all key stakeholders, including industries; and (iii) raising public awareness of the importance of maintaining the quality of water bodies like the Meghna River.

To address these challenges, ADB financed a technical assistance (TA) project, Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply (TA-8803 BAN), that started in November 2015. DOE was the executing agency and DWASA the direct beneficiary. The TA explored improvements in policy and regulatory requirements to protect the water quality of the Meghna River. These included declaring a section of the river an ecologically critical area (ECA) as a means of maintaining water quality at the proposed intake points, and amending or developing relevant regulations, standards, or policies.

The project found that maintaining good water quality will not only benefit Dhaka's population in general, but also a large number of people whose livelihoods fully or partially depend on the Meghna River, such as fishers, farmers, and the poor. The impact would be that a sustainable water supply from the Meghna River to Dhaka City is ensured, and the outcome that government capacity for monitoring water quality of the Meghna River and enforcing laws to maintain it is strengthened.

The outputs[6] of the project were:

(i) a monitoring and reporting system, including water pollution mapping, was strengthened in the relevant section of the Meghna River;

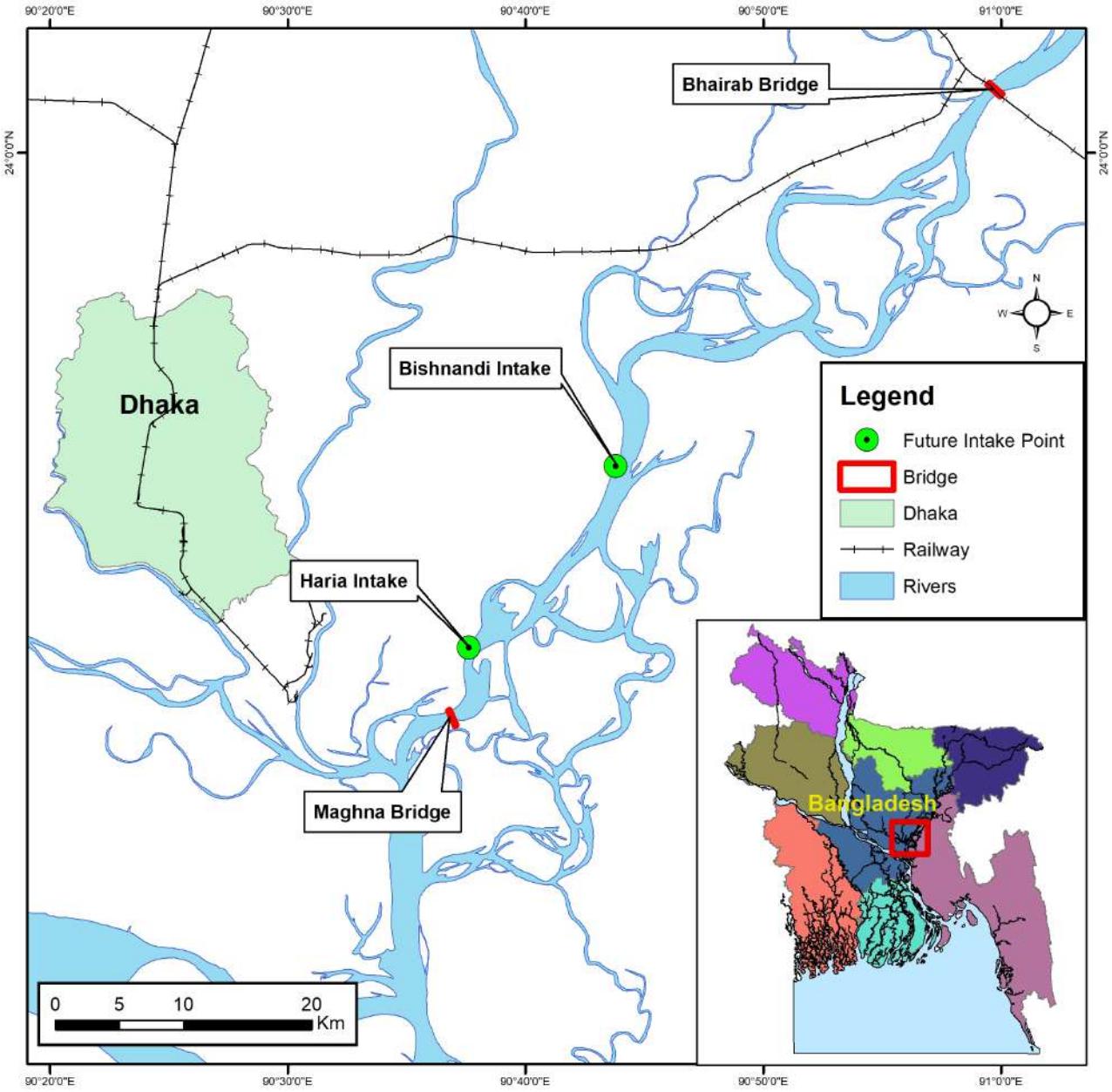
(ii) an incentive system for pollution control was piloted;

[6] ADB. 2019. Technical Assistance Completion Report: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

(iii) an ECA was identified and prepared for designation; and

(iv) several training programs were completed to enhance the capacity of DOE and DWASA.

Figure 1: Two Proposed Water Intake Points in the Meghna River



Source: ADB. 2019. Technical Assistance Completion Report: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

Solid waste and industry at the bank of the Meghna

2 Current Situation

Water Quality

The water quality of the main stream of the upper Meghna River and the two proposed intake points was assessed using several data sets: (i) historical water quality data from the DOE, (ii) monitoring data collected by the DWASA at the Bishnondi intake point, and (iii) hazardous pollutants screening data collected by the TA project.

From the data, it is evident that Meghna River water quality is good and suitable for production of drinking water. A compliance check with the DOE's revised water quality standards shows that most of the parameters meet the environmental quality standard (EQS) for the production of drinking water, though nitrate and total coliform concentrations occasionally exceeded the standards (Table 1). This might be due to agricultural runoff during the monsoon season. Figure 2 illustrates additional positive trends. Turbidity[7] increase during the monsoon season—indicative of an enhanced suspended load transport in the river at higher flow rates—is a natural pattern for a free-flowing river like the Meghna, while the seasonal pattern of dissolved oxygen shows that the Meghna River is still functioning as a natural ecosystem, and not as a heavily polluted river.

Ecological Value of the Meghna River

The Meghna River, and its tributaries and distributaries, comprise a globally significant ecosystem for biodiversity, resources, and unique habitats for different species of fish and wildlife including amphibians, reptiles, Gangetic dolphins and other mammals. It is a biodiversity corridor linking the coast with the upstream Haor Basin of Greater Sylhet. The stretch of river between the Meghna and Bhairab bridges in the upper Meghna is high in ecological value and biodiversity. As part of this TA project, an ecological survey was conducted from the Meghna Bridge to Nazarpur (near Narsingdi and Morichakandi) from November 2016 until March 2017.

A minimum of 30 International Union for Conservation of Nature (IUCN)-listed[8] threatened and vulnerable species were present in the study area.[9] Table 2 presents an overview of the species protected under Bangladesh's Wildlife (Conservation and Security) Act, 2012 that occur in the upper Meghna River. Five sensitive habitats were identified in the survey (Figure 3), each with different characteristics supporting ecosystems, fisheries, wildlife, and vegetation: (i) *char*[10] land near Narsingdi, (ii) *char* land river area near Gopaldi-Bishnondi, (iii) *char* land and river channels on the east bank of the Bishnondi, (iv) Nunertek, and (v) Kalapaharia in the Haria area.

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7 Turbidity is the cloudiness or haziness of a fluid caused by large numbers of individual particles that are generally invisible to the naked eye. The measurement of turbidity is a key test of water quality.

8 The IUCN is an international authority on matters of nature conservation and sustainable use of natural resources.

9 ADB. 2018. Fisheries Report: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

10 *Char* refers to sediment accretion in a river course or estuary that forms new land.

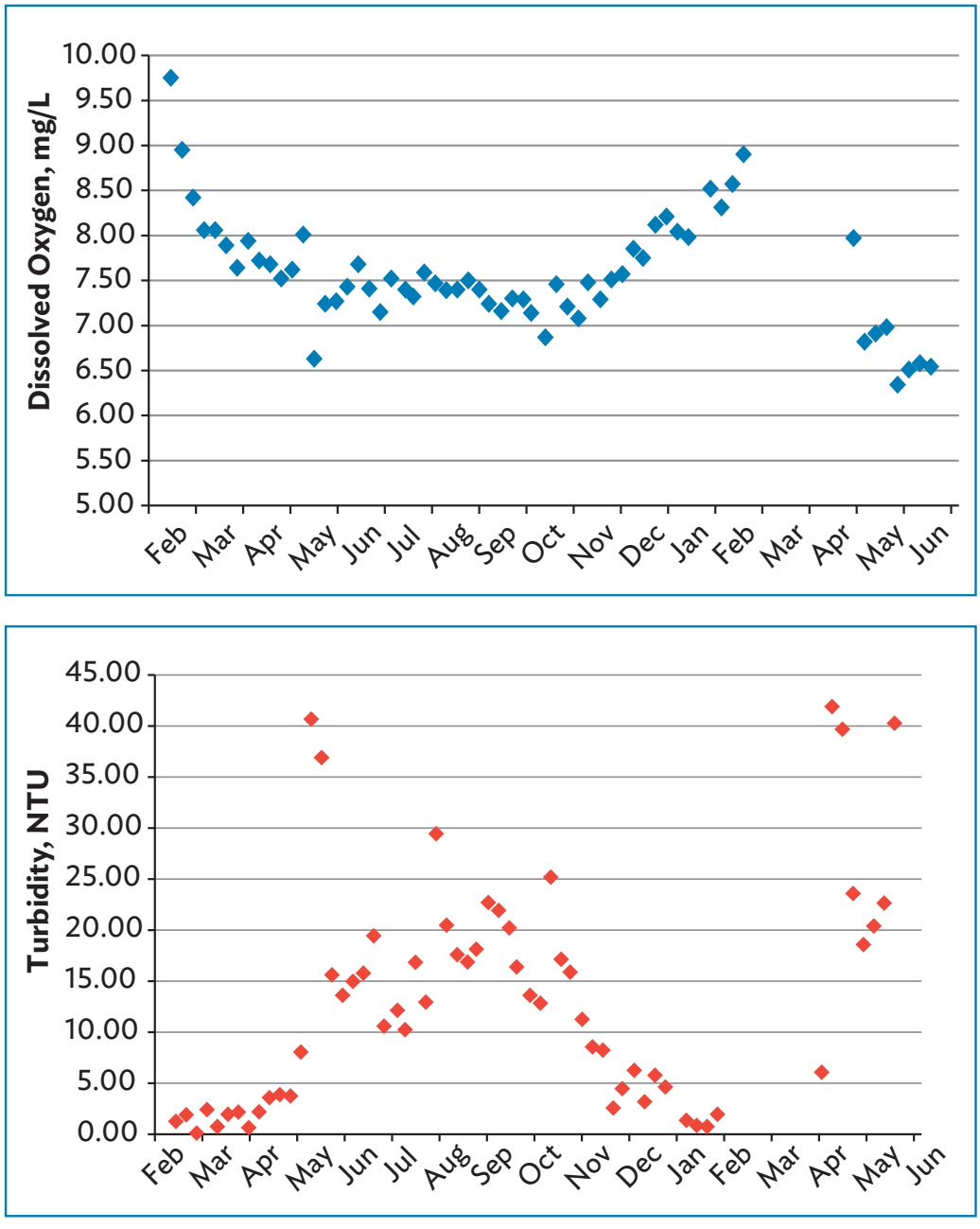
Table 1: Compliance of Water Quality with Environmental Quality Standards for Drinking Water at the Bishnondi and Haria Intakes, May 2016–January 2017

Monitoring program	Parameters	Monitoring Frequency	Range	Compliance Y/ N	Number of Exceedances
Bishnondi intake	BOD mg/L	Monthly	–	–	
	COD mg/L	Monthly	<10	Y	
	Cr µg/L	Monthly	0.33–4.61	Y	
	DO mg/L	Monthly	6.40–8.00	Y	
	NO_3-N mg N/L	Monthly	0.07–20.10	N	2
	NH_4-N mg N/L	Monthly	0.07–0.31	Y	
	PO_4-P mg P/L	Monthly	0–0.02	Y	
	Pb µg/L	Monthly	0–2.29	Y	
	pH	Monthly	6.90–7.90	Y	
	Total coliform n/100ml	Monthly	92–24,000	N	3
	TDS mg/L	Monthly	–	–	
Haria intake	BOD mg/L	Monthly	–	–	
	COD mg/L	Monthly	0–45	N	2
	Cr µg/L	Monthly	0.57–3.68	Y	
	DO mg/L	Monthly	6.40–7.80	Y	
	NO_3-N mg N/L	Monthly	0.11–14.0	N	1
	NH_4-N mg N/L	Monthly	0.08–0.17	Y	
	PO_4-P mg P/L	Monthly	0–0.02	Y	
	Pb µg/L	Monthly	0–2.76	Y	
	pH	Monthly	7.10–7.90	Y	
	Total coliform n/100ml	Monthly	0–4000	N	2
	TDS mg/L	Monthly	–	–	

µg/L = microgram/liter, BOD = biological oxygen demand, COD = chemical oxygen demand, Cr = chromium, DO= Dissolved Oxygen, mg/L = milligram/liter, ml = milliliter, N = nitrogen, NH4-N = ammonium-n, NO3-N = nitrate-N, P = phosphorus, Pb = lead, PO4-P = phosphate-p, TDS = total dissolved solids.

Source: ADB. 2019. Technical Assistance Completion Report: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

Figure 2: Seasonal Variation in Dissolved Oxygen and Turbidity near the Bishnondi Intake Point (Weekly Sampling, 2014–2015)



mg/L = milligram/liter, NTU = Nephelometric Turbidity Unit.

Source: ADB. 2019. Technical Assistance Completion Report: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

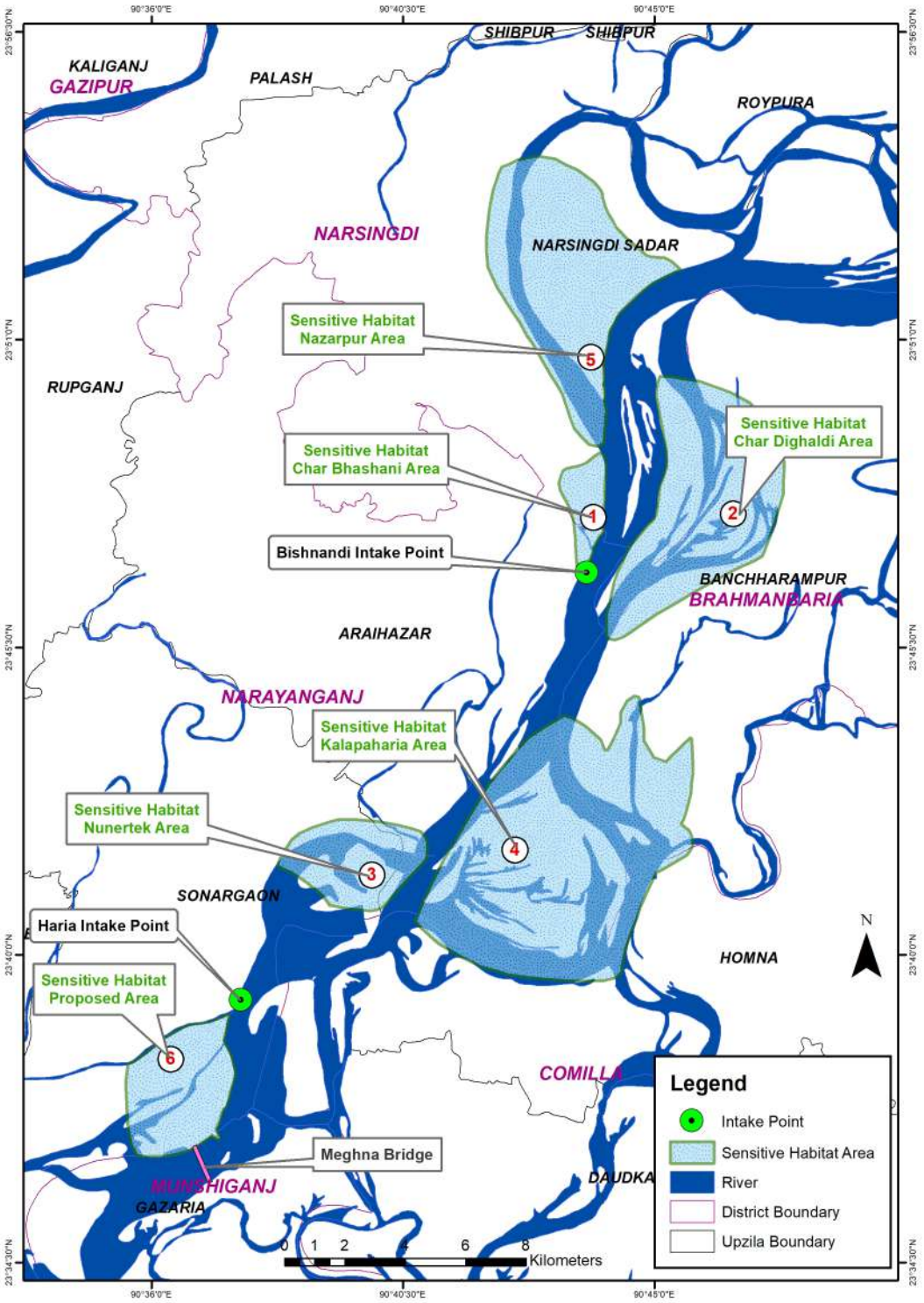
Table 2: Species Protected Under the Wildlife Conservation Act, 2012 that Occur in the Upper Meghna River

Local Name	Scientific Name	Listing
Schedule I		
Sabuj Bang	*Euphlyctis hexadactylus*	Amphibians, No. 2
Kala Badur/Indian Khechor Shial	*Pteropus giganteus*	Mammals, No. 27
Bon Biral	*Felis chaus*	Mammals, No. 62
Boro Bagdas	*Viverra zibetha*	Mammals, No. 69
Choto Indian Beji	*Herpestes auropunctatus*	Mammals, No. 75
Pati Shial	*Canis aureus*	Mammals, No. 78
Dolphin/Shushuk	*Platanista gangetica*	Mammals, No. 110
Schedule II		
Khek Shial	*Vulpes bengalensis*	Mammals, No. 3
Pipla Shoal/Tila Shoal	*Channa baraca*	Fish, No. 1
Bhangon	*Labeo boga*	Fish, No. 4
Boggut Labio	*Labeo boggut*	Fish, No. 5
Calbaus	*Labeo calbasu*	Fish, No. 6
Bagha Aor	*Bagarius yarrellii*	Fish, No. 7
Telo Taki, Cheng	*Channa orientalis*	Fish, No. 10
Tara Baim	*Macrognathus aral*	Fish, No. 11
Koi Bandi	*Badis badis*	Fish, No. 12
Naftani	*Ctenops nobilis*	Fish, No. 13
Kuicha	*Monopterus cuchia*	Fish, No. 14
Rita	*Rita rita*	Fish, No. 15
Joia/Chedra/Koksa	*Barilius bendelisis*	Fish, No. 17
Batia	*Botia dario*	Fish, No. 18
Shillong	*Silonia silondia*	Fish, No. 21

Source: ADB. 2018. Fisheries Report: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

Variety of local fish captured from the Meghna River.

Figure 3: Ecologically Sensitive Habitats and Location of Potential Threats in the Meghna River Around the Bishnandi and Haria Intake Points



ADB. 2019. Technical Assistance Completion Report: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

Turtles can be found living near the Haria intake point.

Pond heron near *char* land.

Fish-eating eagle found in Dayakandir, along the Meghna River.

Comorant, Haria.

These sensitive areas include riverine, *char* land habitats, and a combination of both, that support "mother fishery" habitats that replenish fish and aquatic life at the onset of the monsoon, similar to the side channels of the Meghna River. The species of dolphin known as the South Asian river dolphin (*Platanista gangetica*), Gangetic dolphin, or Bling river dolphin—found in the Meghna River—is endangered. Of the two species of turtles found in the Meghna River, the Indian Roofed turtle (Pangshura tecta or Kachuga teca) and the Northern River terrapin (Batagur baska), the latter is listed as critically endangered by the IUCN.

The study found that future development on the area's river banks, flood plain and canals, and increased levels of pollutants will negatively impact the ecosystems and lead to a decrease in biodiversity. During the dry season, the upstream sections of the canals are highly polluted and oxygen-depleted, hampering their function as mother fishery habitats. The number of fish species and the density of plankton are significantly lower in the polluted part of Gopaldi, Haria and Meghna Ghat area on the right bank, compared to non-polluted areas.

In light of these findings, degradation of water quality in the Mengha River is likely to negatively impact a wide variety of animal species (including protected species) dependent on the river, in addition to humans.

Public consultation and data collection at Kalapaharia in Haria.

Economic Value

An economic valuation of the important water and environmental resources of the Meghna River, including their direct and indirect use value, conducted during the TA project identified the following fisheries resources:

(i) An annual fish production rate of about 2,500 tonnes for the main river (based on Department of Fisheries data), which is a huge economic benefit to the region.

(ii) Fourteen fish landing spots, many fish markets and hundreds of *katha*[11] in the river, which are linked directly and indirectly with the livelihoods of thousands of fishers (see photos).

The total annual value of fish production in the area is $15,625,000, demonstrating its economic importance. In addition to the river's fisheries directly or indirectly providing a livelihood for several thousand fishers, destitute women and poor people depend on its reeds for fire fuel and as commodities to sell for income. Furthermore, the river offers some indirect value through its biodiversity and educational, ecological, and carbon storage functions. In total, the economic value of the Meghna River is estimated to be $182,935,791 per year (Table 3).

Table 3: Estimated Total Annual Economic Value of the Meghna River

Value Type	Description	$/year
Direct Use Value	Water supply to Dhaka Water Supply & Sewerage Authority	45,510,000
	Navigation services	116,800,000
	Wood fuel (reeds)	14,375
	Fisheries	15,625,000
	Tourism	53,250
	Genetic material	75,540
	Education	77,000
	Human habitat	41,376
Indirect Use Value	Watershed protection of fisheries	575,100
	Protection of endangered species (dolphins, turtles, etc.)	575,100
	Carbon storage	3,195,000
Optional Value	Future uses; medical importance	170,400
Existence Value	Biodiversity	223,650
Total Annual Economic Value		**182,935,791**

Source: ADB. 2018. Economic Valuation on the Segment of Meghna River: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

[11] *Katha* is a bush trap that is used to attract and aggregate fish as a habitat. Usually, tree branches and roots, bamboo, water hyacinth and grass are used to make *katha*.

Fishing trap in the Meghna River.

Fishing activities on the Meghna River.

Transporting harvested paddy by local boat.

The polluted Bishanondi canal carries and discharges industrial effluents into the Meghna River.

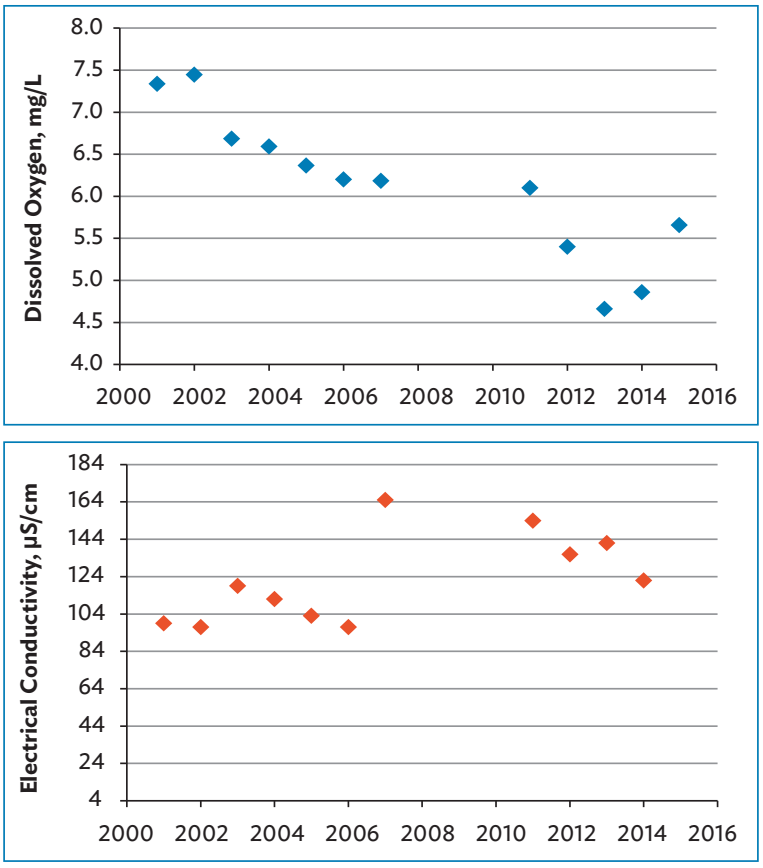
3 Issues

The study identified a trend in water quality deterioration in the Meghna River and forecasts its impact on the economy and freshwater ecology.

Negative Trend in Water Quality

The water quality deterioration in the Meghna River over the last decade is evident from the analysis of historical data collected by the DOE. The concentration of dissolved oxygen has decreased significantly over time at Meghna Bridge, while the level of electrical conductivity has trended slightly upward (Figure 4). Dissolved oxygen is necessary for the survival of fish, invertebrates, bacteria, and underwater plants, whereas electrical conductivity provides a measure of the dissolved pollutants in the water.

Figure 4: Trend in Annual Dissolved Oxygen Concentration and Electrical Conductivity at Meghna Bridge, 2001–2012

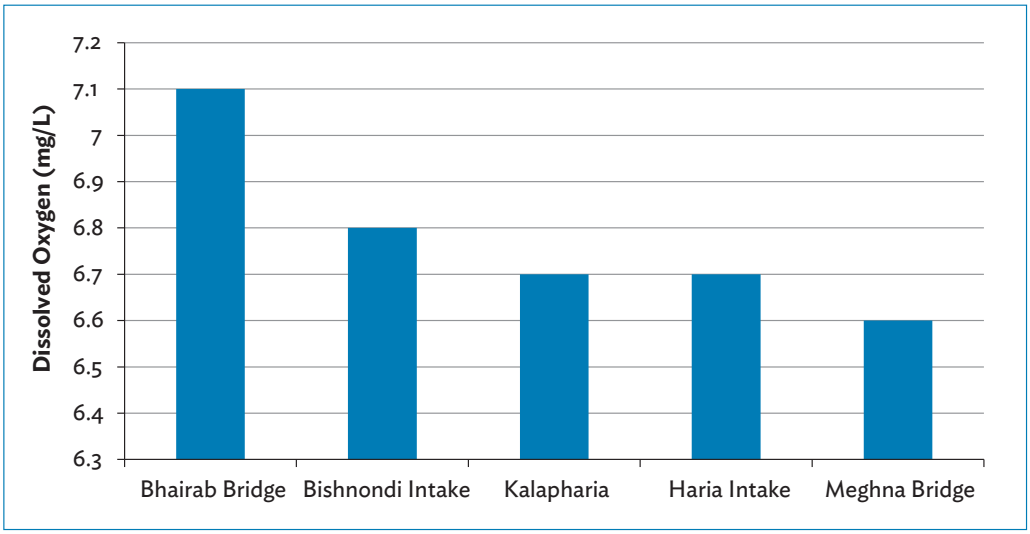


µS/cm = microsiemens/centimeter, mg/L = milligram/liter.

Source: ADB. 2019. Technical Assistance Completion Report: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

River water quality monitoring conducted by the TA project from 2016 and 2017 also shows that dissolved oxygen levels decrease between the Bhairab and Meghna bridges, indicating pollution loads in this stretch of the Meghna River (Figure 5).

Figure 5: Average Dissolved Oxygen Concentration at Five Monitoring Locations Along the Meghna River



mg/L = milligram/liter.

Source: ADB. 2019. Technical Assistance Completion Report: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

Hazardous Pollutants

The study utilized passive sampling by Speedisk® and silicone sheets as an alternative detection technique for groups of organic micro-pollutants (including pharmaceuticals) in the river water. This method was chosen over grab sampling because it provides a more complete picture of pollutant concentrations in the environment and has a lower detection limit. For 42 days through December 2017 and January 2018 during the rabi crop (winter crop) season, passive samplers sat at three surface water points: (i) the Bishnondi intake point, (ii) the mouth of the Bishnondi Canal, and (iii) about 0.5 km upstream of the confluence of the Meghna River and west branch of the Meghna River near Narsingdi (Figure 6).

The screening list comprised some 340 compounds, including polychlorinated biphenyls, polycyclic aromatic hydrocarbons, pesticides, and pharmaceuticals. A total of 87 compounds were found above the detection limit (Table 4), a small number compared to results from around the globe. Most were detected at very low concentrations, although a few polycyclic aromatic hydrocarbons, pesticides, and pharmaceuticals were detected at relatively high concentrations (>2.5 nanograms/liter). Box 1 highlights different classes of micro-pollutants detected.

Table 4: Hazardous Pollutants Found in the Meghna River

Number of Compounds Found	
Polychlorinated biphenyls	7
Polycyclic aromatic hydrocarbons	16
Organochlorine pesticides	12
Other pesticides	35
Pharmaceuticals	17
Total	87

Source: ADB. 2019. Technical Assistance Completion Report: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

Box 1: Types of Micro-Pollutants in the Meghna River

Polycyclic Aromatic Hydrocarbons

The occurrence of this group of compounds in the aquatic environment is mostly the result of atmospheric deposition and a number of diffuse sources related to combustion in households, industry, traffic and transport. In general, the concentrations found in the Meghna River are lower than in other parts of the world, probably due to the lower intensity of industrial activity and traffic in the region, combined with the high flow rate in the Meghna River.

Pesticides

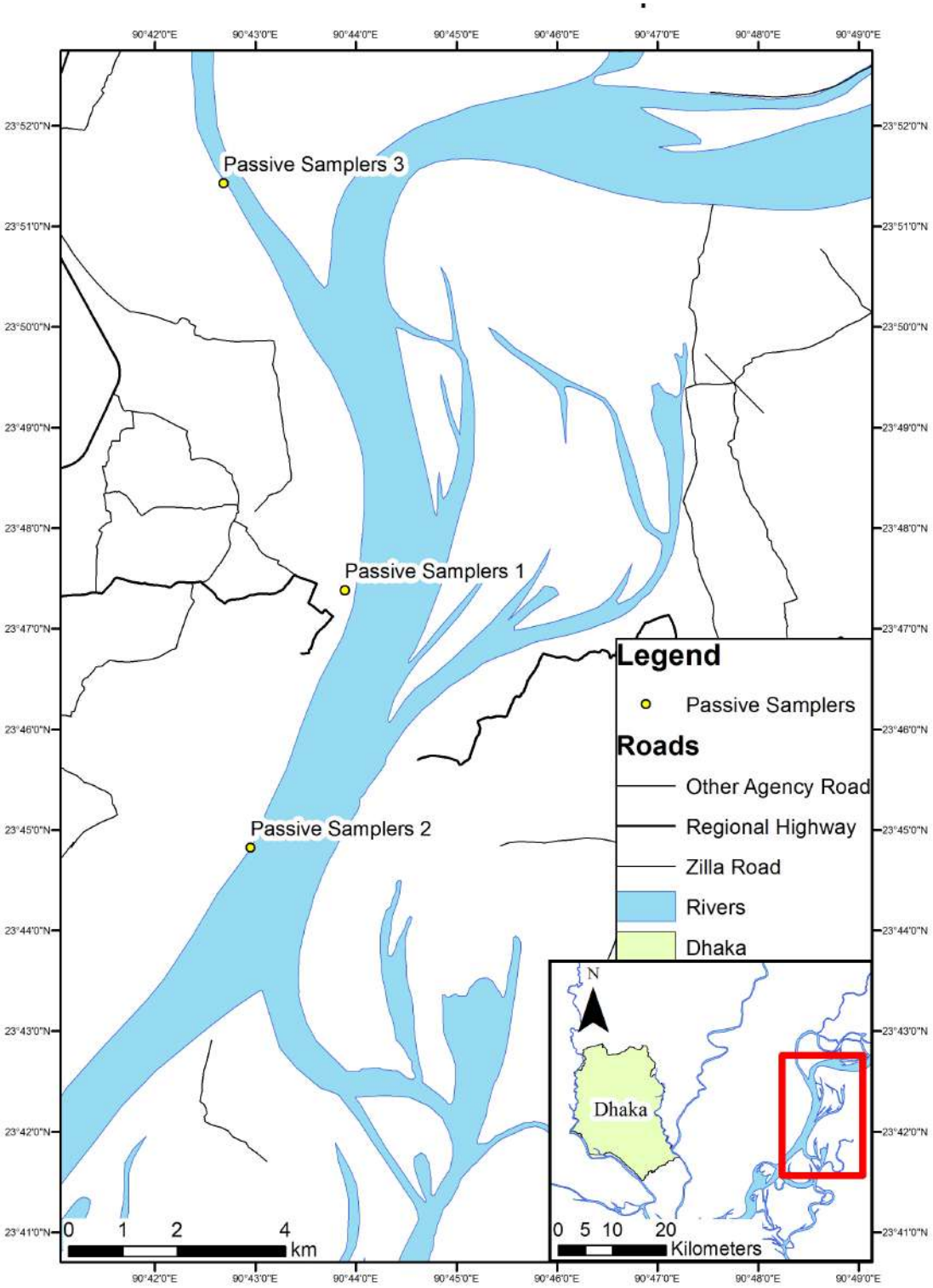
A small number of pesticides were detected in relatively high concentrations in the Megha River, particularly the insecticide dimethoate. Dimethoate is associated with the growing of rabi crops (like oil seed), vegetables, spices, and fruit. An excess of dimethoate detected at sampling location 1 represents an ecological risk. Other compounds found were the herbicide diuron, and the fungicide carbendazim. The compound 2-aminoacetophenone (not a pesticide, but a flavoring agent likely originating from many kinds of food products) was also detected in high concentrations.

Pharmaceuticals

Though no environmental quality standard exists as yet for this compound, the pharmaceutical detected at the highest concentrations was lidocaine, which is mostly used in dermal anaesthesia. The compounds bisphenol A (BPA) and caffeine were also found at relatively high levels. BPA is a plasticizer, commonly used in all kinds of consumer products, and has hormone disrupting activity. The levels observed, however, likely pose little risk. Caffeine is a stimulating agent, associated with the consumption of coffee and tea (most probably the source in Bangladesh). A striking result was the presence of paracetamol in the Meghna River, likely due of the absence of wastewater treatment plants in the catchment areas. This compound can be almost completely removed during the wastewater treatment process, and is therefore hardly detected in surface water in other parts of the world.

Source: ADB. 2019. Technical Assistance Completion Report: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

Figure 6: Location of Passive Samplers for Hazardous Pollutant Screening

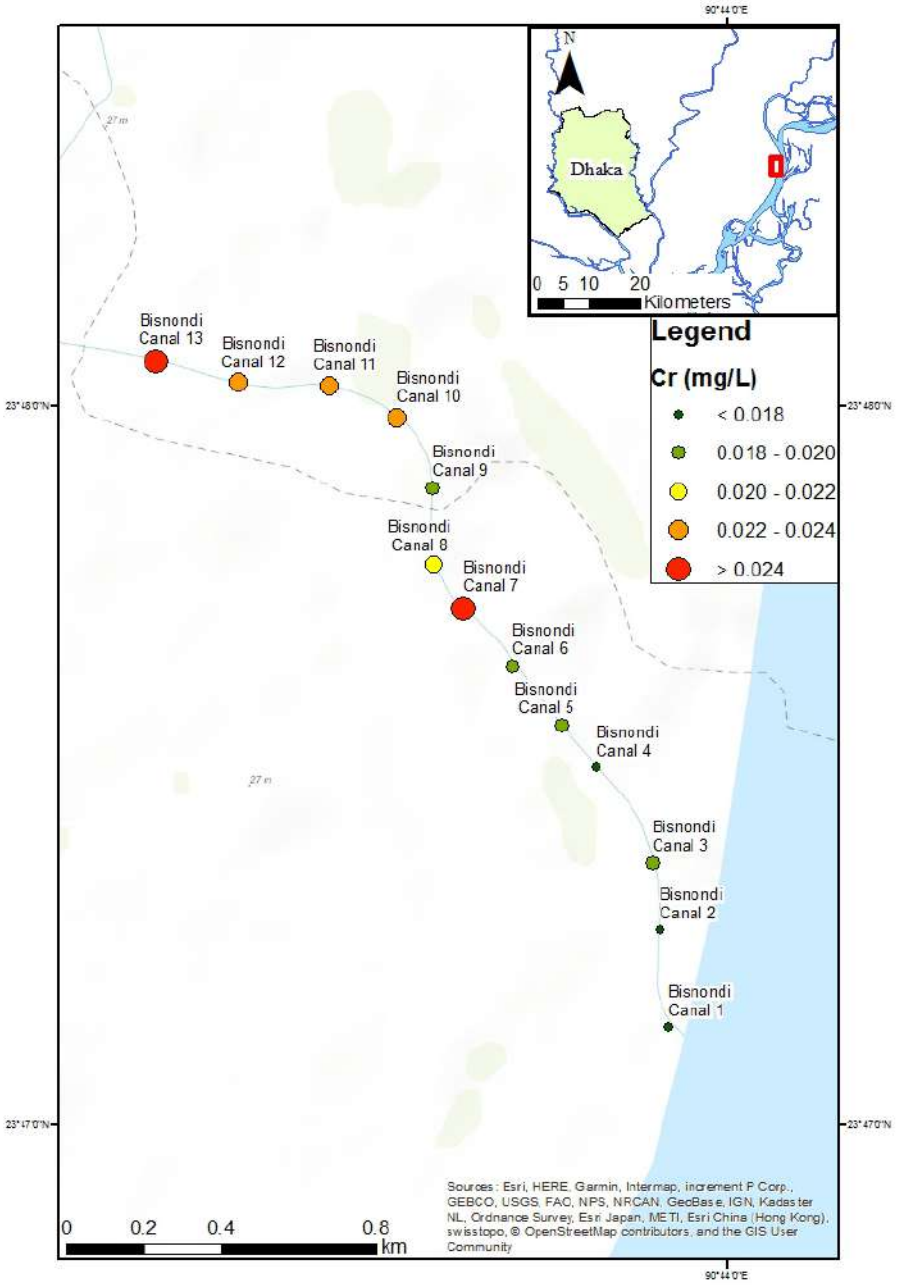


Source: ADB. 2019. Technical Assistance Completion Report: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

Heavy Metals

Of 30 different elements analyzed during a one-time screening for the presence of heavy metals, only chromium reached the detection threshold. The level of chromium exceeded drinking water standards at a number of locations in the Bishnondi Canal, just upstream of a drinking water intake point, and should be treated as a potential risk (Figure 7). The source of this chromium was not evaluated during the study.

Figure 7: Chromium Levels Observed in the Bishnondi Canal



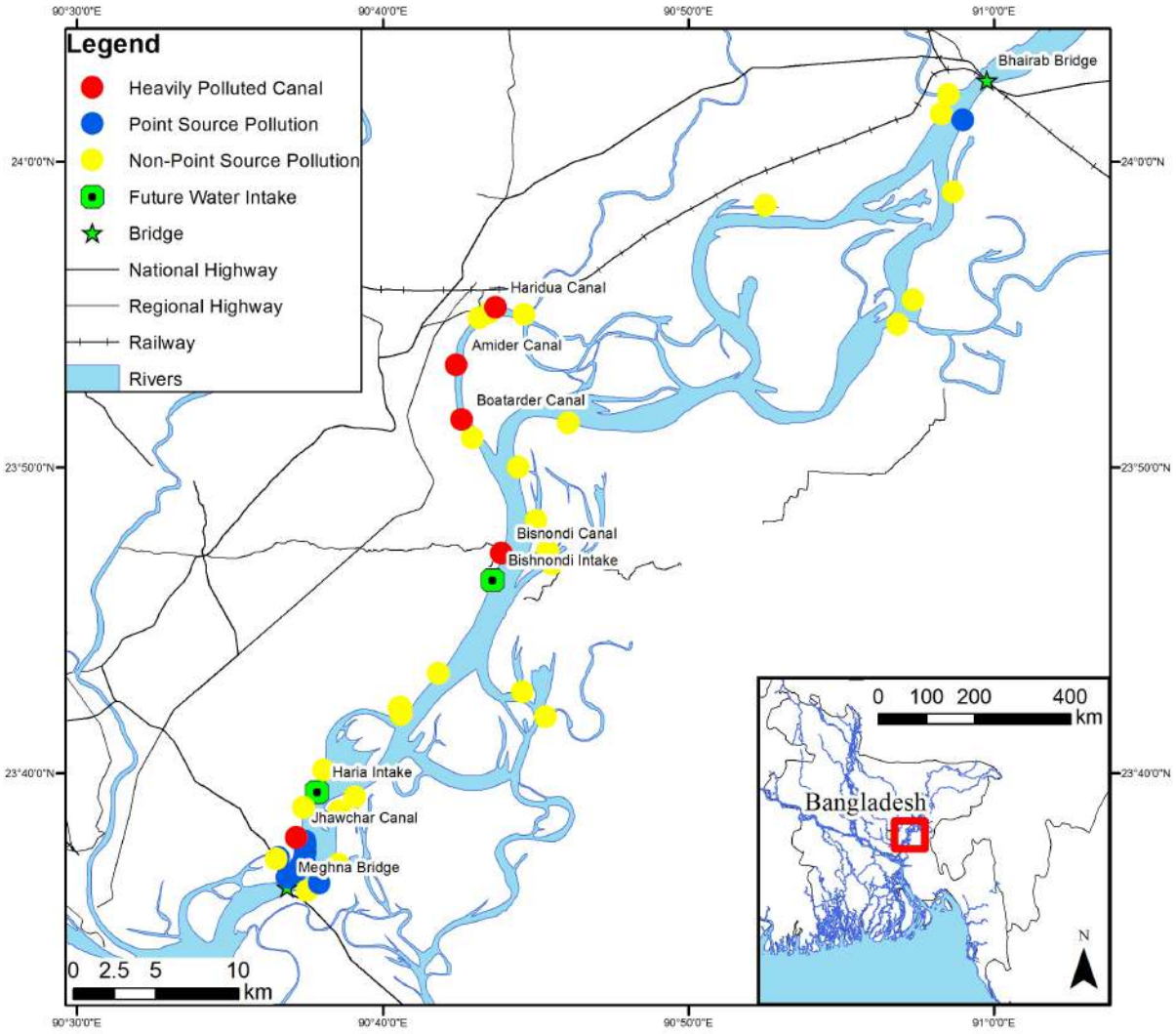
mg/L = milligram/liter.

Source: ADB. 2019. Technical Assistance Completion Report: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

Sources of Pollution

Water pollution in the Meghna River is occurring from both point and nonpoint sources.[12] An investigation of the sources revealed five heavily polluted tributary canals (Amider, Bishnondi, Boatarder, Haridua, and Jhawchar) on the west bank of the Meghna River that discharge directly into the river (Figure 8). These canals are loaded with both domestic and industrial wastewater.

Figure 8: Point and Nonpoint Source Pollution Locations



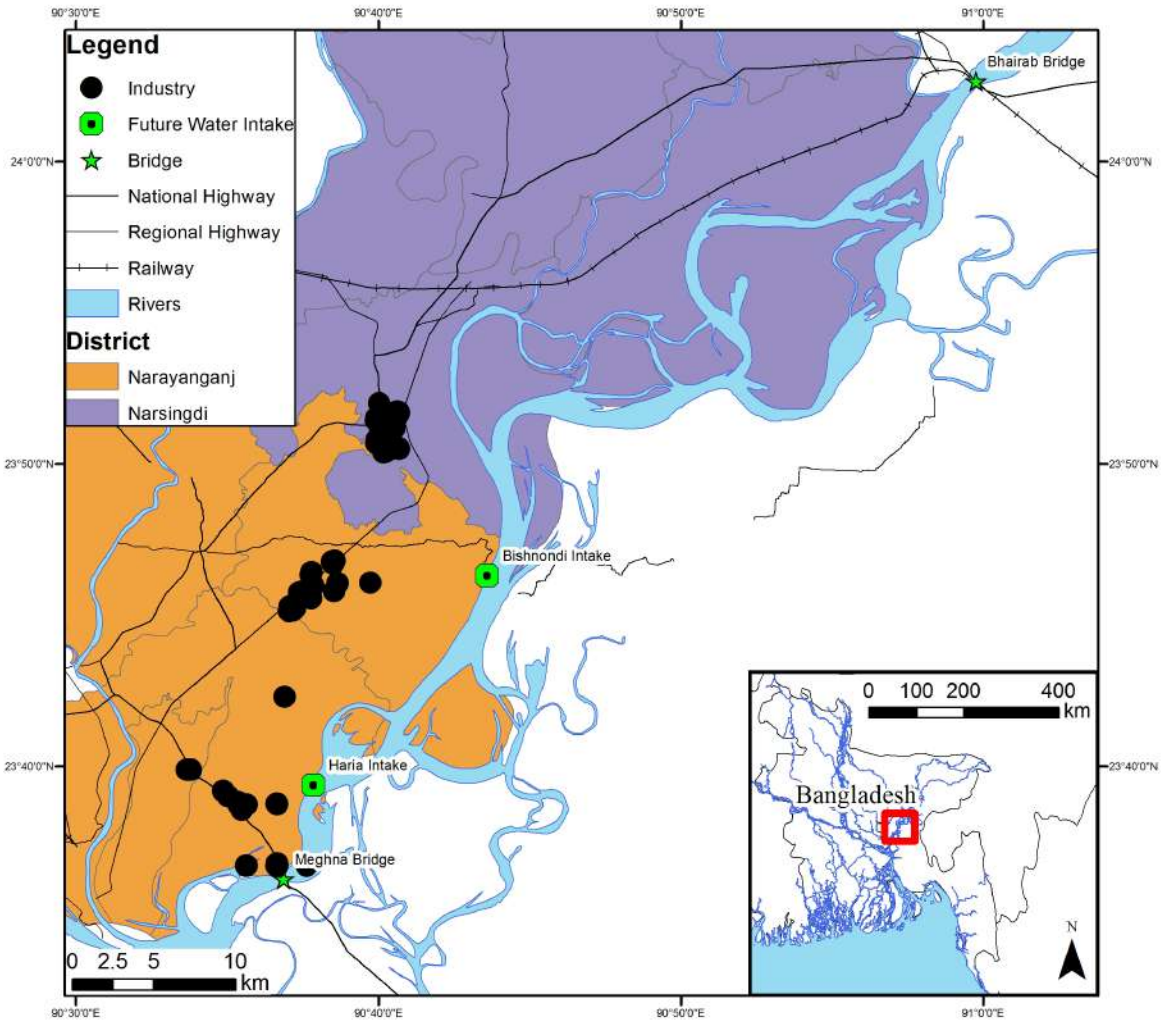
Source: ADB. 2019. Technical Assistance Completion Report: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

[12] Point source pollution results from a single identifiable source (e.g., factories, power plants, sewage treatment plants, some farms), whereas nonpoint source pollution results from many diffuse sources (e.g., runoff, precipitation, atmospheric deposition, drainage, and seepage).

In the catchment area of the relevant stretch of the Meghna River, 3.4 million people generate approximately 135 tonnes of biological oxygen demand per day and 338,000 cubic meters of wastewater, of which a considerable volume ends up directly in the five canals.[13] The tributary canals become highly polluted during the dry season, and are then flushed during the monsoons, discharging large amounts of pollutants into the Meghna River.

On the west bank of the river, there are over 2,000 factories located in industrial clusters, mainly in the Narayanganj and Narsingdi Districts. There are also 13 direct industrial outfalls that discharge into the Meghna River, 10 of which are located on the west bank near the Meghna Bridge (Figure 9). These direct outfalls have an adverse impact on the water quality locally.

Figure 9: Clusters of Polluting Industries on the West Bank of the Meghna River



Source: ADB. 2019. Technical Assistance Completion Report: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

[13] The five canals are Amider, Bishnondi, Boatarder, Haridua, and Jhawchar.

Factories along the Meghna River, with the Meghna Bridge in the background.

Direct industrial outfall into the Meghna River at the west bank near Meghna Bridge

Sample of polluted water from the polluted Jhawchar canal.

Pesticides

The use of pesticides in agriculture may be considered a threat to water quality. A screen for hazardous pollutants during the rabi crop season showed elevated levels in the water (Table 4). A wide range of pesticides is used for different crops grown around the Meghna River and Table 5 lists those used in its adjacent four *upazilas*.[14]

Table 5: Pesticides Used for Crops in the Meghna River Area

Crop	Pesticide used	Crop	Pesticide used
Boro	Carbofuran	Spices	Sulphur S
	Cartap		Paraquat dichloride
	Diazinon		Mancozeb
	Carbosulfan		Carbendazim
	Carbendazim		Dimethoate
	Pendimethalin		Imidacloprid
	Cyhalothrin	Fruit	Cypermethrin
	Sulphur S		Dimethoate
Potato	Chlorpyrifos		Chlorpyrifos
	Cyhalothrin		Sulphur S
	Propiconazole		Carbendazim
	Phenthoate		Propiconazole
	Pretilachlor		Mancozeb
	Mancozeb		Cypermethrin
	Sulphur S	Vegetable	Dimethoate
	Carbendazim		Sulphur S
	Cypermethrin		Paraquat dichloride
Oil seed	Cyhalothrin		Carbendazim
	Mancozeb		Mancozeb
Pulse	Malathion		Chlorpyrifos
	Difenoconazole		Carbendazim
	Paraquat dichloride		Mancozeb
	Chlorpyrifos		Dimethoate
	Sulphur S	Chili	Sulphur S
	Cypermethrin		Chlorpyrifos
	Quinalphos		Carbendazim

Source: ADB. 2019. Technical Assistance Completion Report: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

Some of the pesticides still available and in use have been proscribed in Europe and the United States because of their detrimental impacts on the environment (e.g., the European Commission ban on the use of diazinon, malathion, carbofuran, and others).

[14] An *upazila* is a subdistrict.

Pesticide use in the catchment area of the Meghna River.

Threats at the Meghna River Water Intake Points

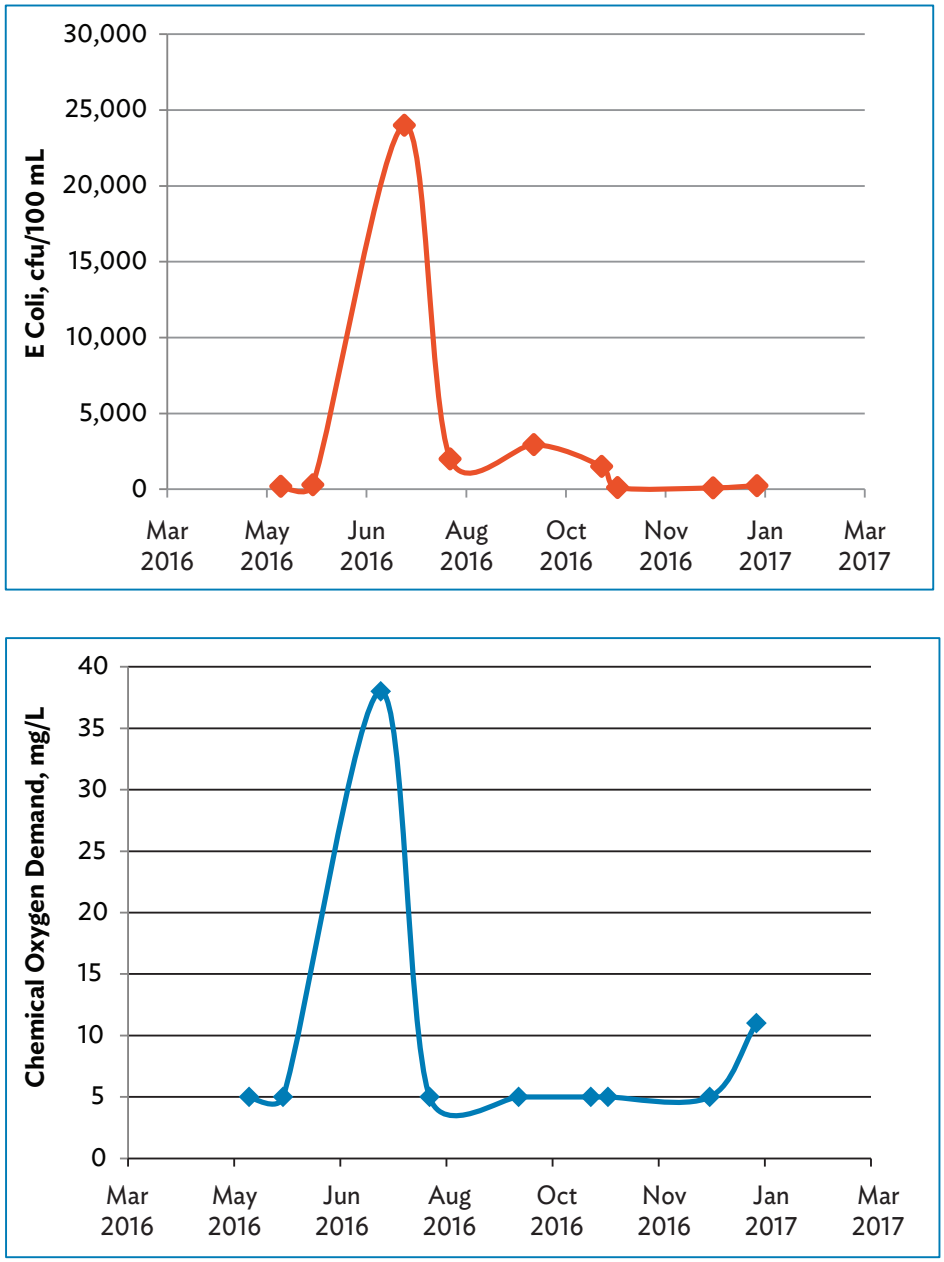
The proposed future drinking water intake locations are at Bishnondi and Haria. Polluted tributaries are the main threat to water quality at these two intake points. Pollution loads from industry and other sources accumulate in the tributary canals during the dry season and are discharged into the Meghna River in large amounts early in the monsoon season.

Bishnondi Intake Point

The Bishnondi Canal is the main threat to water quality, but other canals located upstream (Amider, Boatarder, and Haridua) are also heavily polluted and pose a danger. The Bishnondi Canal receives discharge from numerous small and medium-sized textile industries, as well as untreated domestic wastewater from housing areas located alongside it.

The study shows high bacteria and chemical oxygen demand concentrations at the Bishnondi intake point at the beginning of the monsoons (Figure 10). These originate from the Bishnondi Canal, which discharges 2 km downstream into the Meghna River. These results suggest that a considerable amount of pollutants are discharged into the river.

Figure 10: Coliform Bacteria Concentration and Chemical Oxygen Demand at the Bishnondi Intake Point, 2016–2017



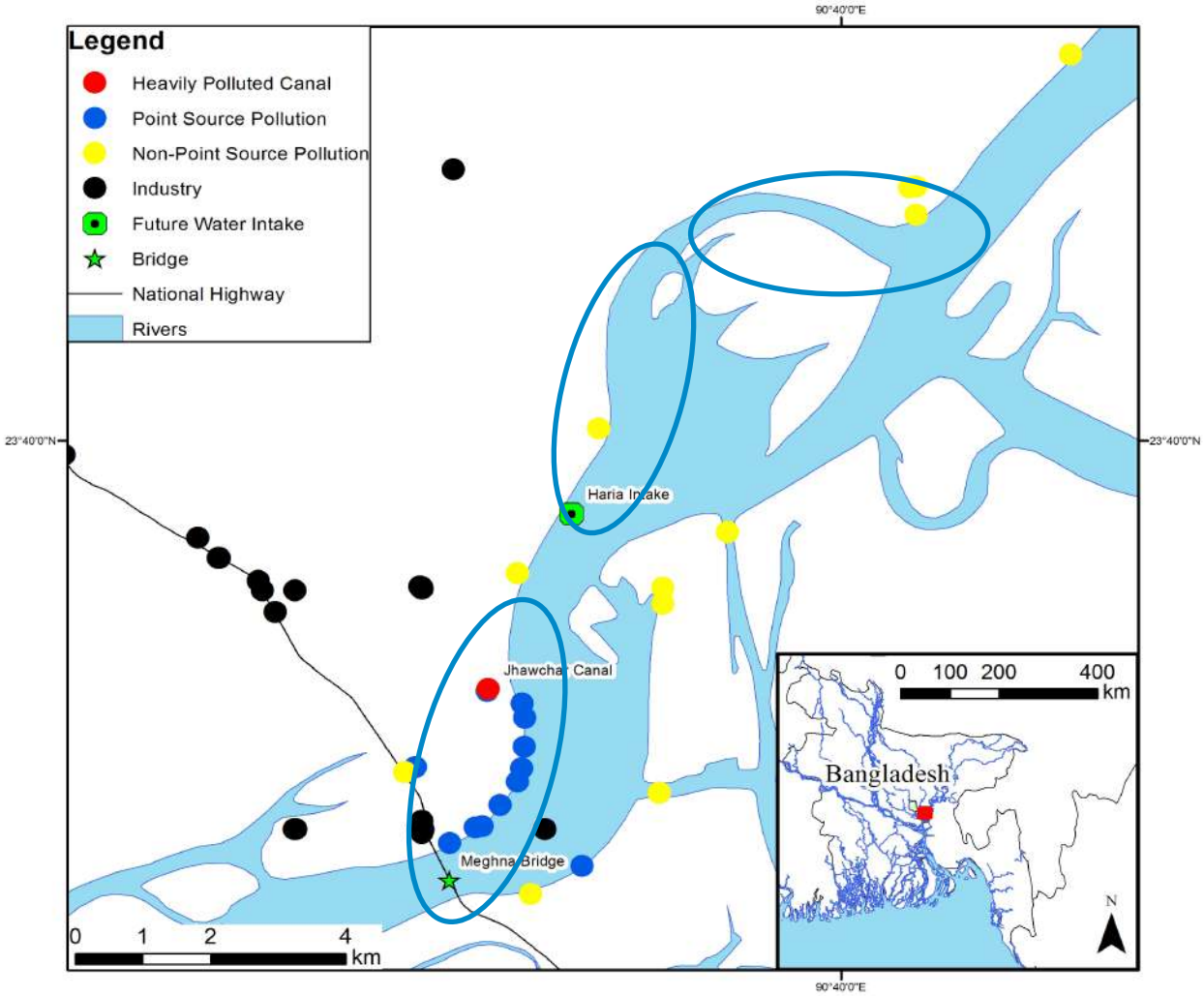
cfu = colony-forming unit; E. coli= Escherichia coli, a type of bacteria common in human and animal intestines; mg/L = milligram per liter; ml = millileter.

Source: ADB. 2019. Technical Assistance Completion Report: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

Haria Intake Point

The proposed Haria intake point is located just upstream of the Jhawchar Canal (Figure 11). This tributary is heavily polluted by discharge from paper mills and domestic waste water. Further downstream at the west bank near Meghna Bridge, 10 industrial outfalls discharge directly into the Meghna River. During the study, a plug of pollutants, likely derived from incomplete mixing of pollution loads with the main stream of the river, was even observed near the river bank. Due to the impact of tides on the Meghna River (tidal excursion), plugs of pollutants in the Jhawchar Canal could affect drinking water quality at the intake point at Haria. There are also a number of economic zones that have been planned both upstream and downstream of Haria (indicated by blue ovals in Figure 11).

Figure 11: Pollution Sources and Industries near the Proposed Haria Intake Point



Source: ADB. 2019. Technical Assistance Completion Report: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

Pollution plugs in the Meghna River.

Box 2: Major Risks and Concerns at Two Intake Points

Special attention should be given to the following areas and risks to ensure that the production of drinking water from the Meghna River is not negatively impacted:

(i) General:

- (a) presence of chromium; potential risk for drinking water production;
- (b) high concentrations of herbicide (diuron), fungicide (carbendazim), and flavoring (2-aminoacetophenone); and
- (c) presence of pharmaceuticals: lidocaine, BPA (hormone disrupting agent), and caffeine (stimulant).

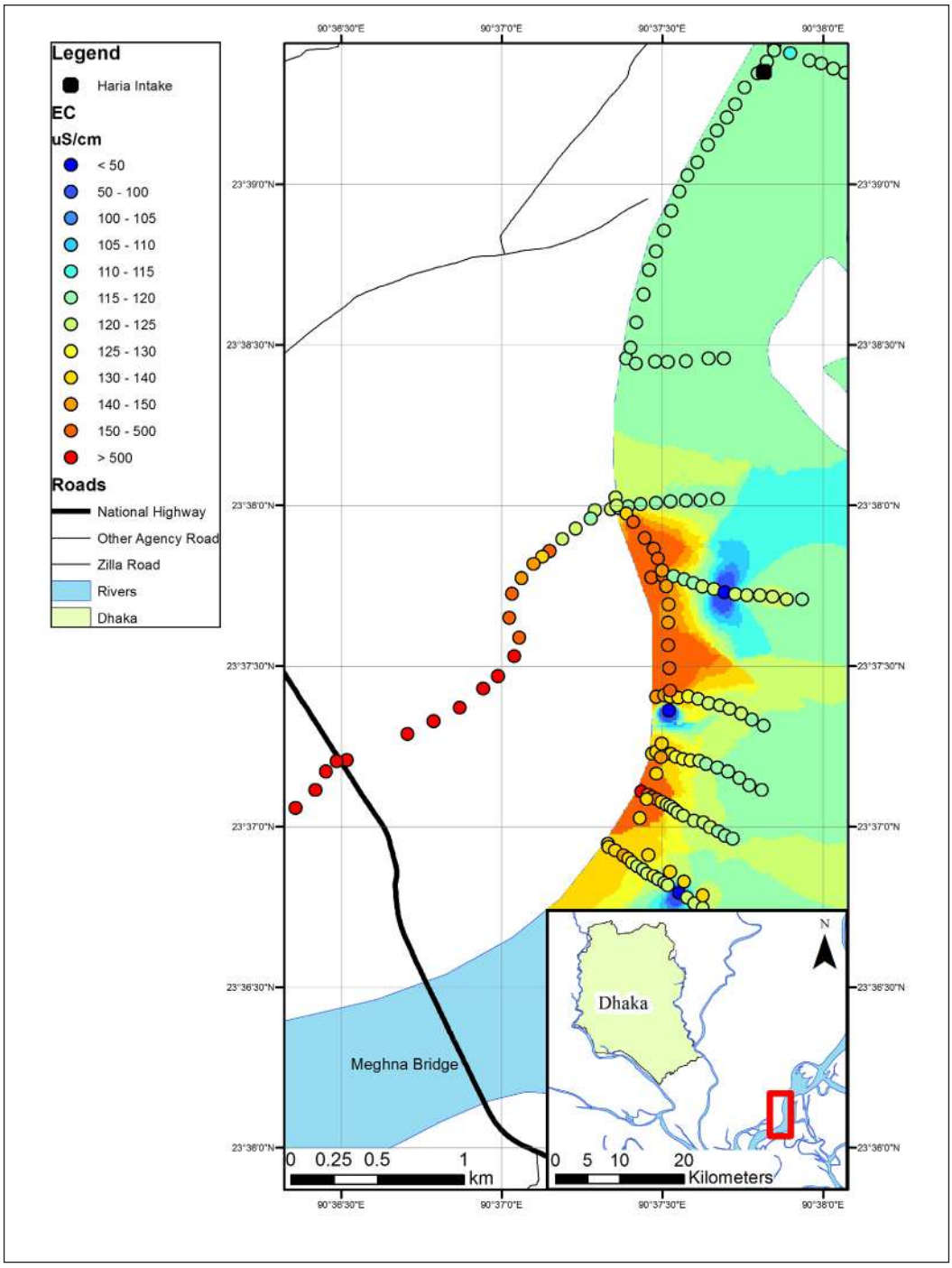
(ii) Bishnondi intake point:

- (a) Bishnondi and three tributary canals (Amider, Boatarder, and Haridua) heavily influenced by domestic and industrial pollutant discharge upstream of the Bishnondi intake point;
- (b) elevated levels of coliform bacteria (evidenced by chemical oxygen demand), numerous heavy metals, and the insecticide dimethoate (indicates ecological risks) found at the Bishnondi canal; and
- (c) discharge of high pollution loads from tributary canals to the Meghna River during monsoons.

(iii) Haria intake point (west bank of the Meghna River, near Meghna Bridge):

- (a) pollution plugs, low dissolved oxygen and high electrical conductivity values; and
- (b) tidal excursion could bring contaminants from the Meghna River and Jhawchar Canal upstream to the Haria intake point.

Figure 12: Plug of Pollutants at the West Bank of the Meghna River near the Meghna Bridge



Source: ADB. 2019. Technical Assistance Completion Report: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

Additional Treatment Costs

DWASA is making investments to use the Meghna River as a source of drinking water. The investments are needed to build and maintain two pipelines to transport the water to Dhaka (capital expenditures), as well as to build and operate drinking water treatment plants (operating expenses). Three different scenarios have been considered to calculate capital expenditures and operating expenses (Table 6):

(i) a conventional surface water treatment plant;

(ii) advanced surface water treatment, including ion exchange or the use of activated carbon and additional disinfection, in case water quality in the Meghna River further deteriorates; and

(iii) a membrane water treatment system using reverse osmosis, if additional degradation of surface water quality requires it.

Table 6: Capital Expenditures and Operating Expenses under Three Treatment Scenarios for the Consumption of Meghna River Water ($ million)

	Haria intake Saidabad STP Phase III			Bishnondi intake DESWSP		
	CAPEX	OPEX		CAPEX	OPEX	
Scenario	$	$/m³	$/year	$	$/m³	$/year
Conventional surface water treatment plant, design based on current water quality	238	0.29	47.60	262	0.29	52.90
Advanced surface water treatment, including ion exchange or the use of activated carbon and additional disinfection	333	0.48	78.80	367	0.48	87.60
Membrane water treatment system using reverse osmosis	476	0.96	157.70	524	0.96	175.20

CAPEX = capital expenditures, DESWSP = Dhaka Environmentally Sustainable Water Supply Project, m³ = cubic meter, OPEX = operating expenses, STP = sewage treatment plant.

Source: ADB. 2019. Technical Assistance Completion Report: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

Based on this information, it is clear that the treatment costs will significantly increase if the water quality in the Meghna River further deteriorates.

Future Development and Construction

The stretch of the Meghna River between the Bhairab and Meghna bridges is of great economic importance as it connects mainland transport routes with the main sea port of Bangladesh. The Government of Bangladesh recently declared development economic zones in locations with transport corridor facilities, including areas surrounding the Bhairab and Meghna bridges. Eight areas have been identified for the development of major projects; two of these may directly impact water quality at the two proposed intake points:

(i) **Haria intake point.** Land has been purchased by a number of developers along the vicinity to build industrial sites, and 150 acres of land are already under development for a dry dock, and packaging, ready-made garments, and other industries; and

(ii) **Bishnondi intake point.** There is planned construction of buildings for the Bangladesh Applied Nutrition Institute headquarters near the Bishondi Ferryghat, located just upstream of the intake point.

Many of the proposed developments are still in their planning phases. Therefore, the impact of these activities, such as wastewater production capacity or direct loads on the Meghna River, cannot be fully assessed. Different scenarios have been created to assess the impact of various developments coupled with the implementation of proposed actions. The foreseeable impacts of future developments have been assessed for two mid-term and two long-term scenarios.

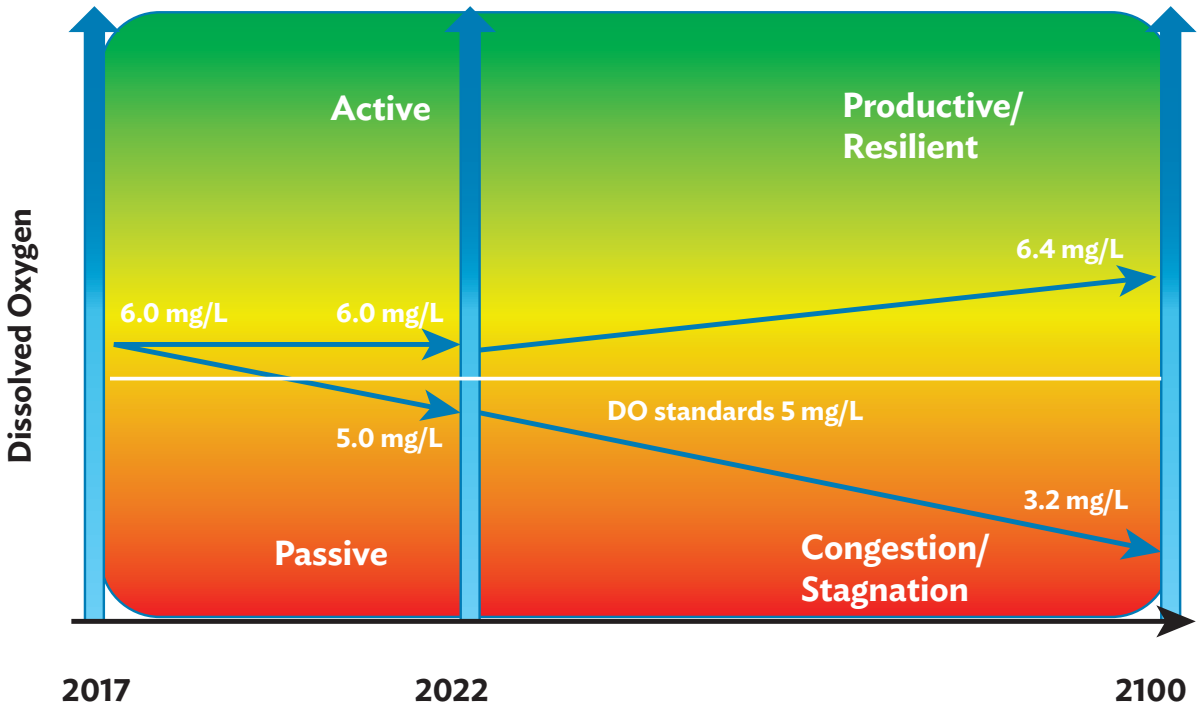
The two mid-term scenarios have a timeline of 5 years (2017–2022), and are divided into an active and a passive scenario. In the active scenario, strong enforcement is in place and sufficient pollution control measures are taken. In the passive scenario, the current situation is maintained. The active scenario shows no further degradation of water quality, whereas the passive scenario shows a decrease in water quality and a threat to the sustainable production of drinking water (Figure 13).

The long-term scenarios have a time horizon until 2100 and are based on two economic scenarios the government developed for the Bangladesh Delta Plan: (i) a productive/resilient scenario with market-driven demand, and (ii) a congestion/stagnation scenario characterized by traditional growth and strong population growth in Dhaka City.[15] The study used these two scenarios to assess the long-term pollution load and water quality. The productive/resilient scenario leads to a significant reduction of the pollution load and a slight improvement of the present, acceptable water quality. The congestion/stagnation scenario results in a further increase of the pollution load and leads to water quality of an unsuitable level for the production of drinking water.

The conclusion from both the mid- and long-term scenarios is that if no actions are taken, there is a risk that Meghna River water will be unsuitable for drinking in the near future.

[15] Government of the People's Republic of Bangladesh, Planning Commission. 2018. *Bangladesh Delta Plan 2100 (Bangladesh in the 21st Century)*. Dhaka.

Figure 13: Impact of Mid- and Long-Term Scenarios on Dissolved Oxygen in the Meghna River



mg/L = milligram/liter.

Source: ADB. 2019. Technical Assistance Completion Report: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

$175.2
MILLION PER YEAR

additional cost to clean the Meghna water

Open dumping of municipal waste into the Meghna River.

4 Solutions and Recommendations

The study recommends a range of solutions to overcome potential pollution risks in the segment of the Meghna River with the two water intake points.

Designation of Ecological Critical Areas

History clearly demonstrates that pollution prevention—by regulating and controlling industrial development and other pollution-prone activities—is essential and far more cost-effective than cleaning up polluted water bodies. The government recently designated ECAs in four ecologically degraded rivers (Balu, Buriganga, Shitlakhya, and Turag) to facilitate cleanup and restoration. Learning from this, as a precautionary measure, the TA looked into improvements in policy and regulatory requirements to protect the water quality of the Meghna River, such as declaring an ECA in a section of the river near the proposed intakes and amending or developing relevant regulations, standards, or policies.

ECA designation is considered to be the appropriate instrument to both ensure a sustainable, quality water supply for Dhaka, and protect the ecological status of the river and its sensitive habitats. The TA project identified and proposed an ECA after assessing the present ecological status of the upper Meghna River, water quality trends, and prediction of pollution impacts on habitats and biodiversity. This allows for the protection of the ecosystem and future water quality of the river. It is proposed to declare the river stretch between Nazarpur and Meghna Bridge as an ECA. The delineation of the ECA is presented in Figure 14. The ECA includes five locations that have been identified as sensitive habitat areas: (i) *Char* Bhasani, (ii) *Char* Dighaldi, (iii) Nunertek, (iv) Kalapaharia, and (v) Nazarpur. In addition, a 1 km strip on each side of the bank is included in the ECA which will function as a buffer zone.

The following are characteristics of the upper Meghna River that justify declaring it as an ECA:

(i) **Biodiversity richness.** The area is high in biodiversity, including endangered animals like the South Asian River dolphin and the Indian Roofed turtle. In the area under study, there are a minimum of 30 fish species the IUCN Red List categorizes as Threatened and Vulnerable, indicating the area's importance and the need to manage it to maintain biodiversity.

(ii) **Reserve fisheries and presence of endangered dolphins.** The side channels at Bishnondi are mother fishery areas that replenish fish and other aquatic life at the onset of each monsoon. Endangered South Asian River dolphins are found year-round in the upper Meghna River where the water level is deep enough to support them. The water level in the Titas River, a tributary of the upper Meghna, is insufficient for dolphins during the dry season, but they return there during the monsoons.

(iii) **Sensitive habitats.** The study identified five sensitive habitats: *Char* Bhasani, *Char* Dighaldi, Kalapaharia area, in the vicinity of the proposed Haria intake point, Nazarpur, and Nunertek. These sites contain riverine habitats, *char* land, and a combination of both types of habitats.

(iv) **Fish landing centers.** The livelihoods of several thousand fishers are directly and indirectly dependent on 14 fish landing spots, hundreds of *katha*, and many fish markets in the study area.

(v) **Annual fish production.** Based on data from the study and government sources, the estimated fish yield from *kathas* and landing spots is approximately 2,500 metric tons per year. The estimated financial value of *katha* fishing alone, and only in the areas around the proposed Bishnandi and Haria intake points, is $209.17 million.

The proposed ECA notification specifies restrictions and prohibitions on polluting activities in the proposed ECA to protect the biodiversity of the area in general, and the sensitive habitats in particular, and to help maintain the quality of the water in the river for sustainable water supply for Dhaka City. The following restrictions and prohibitions are proposed within the ECA for controlling water pollution:

(i) Establishing new industries that are listed in the Red Category of Schedule I of the Environment Conservation Rules, 1997 and any future amendments to the same, shall be prohibited within the ECA.[16]

(ii) Direct discharge of effluents and solid waste in any location of the river and canals, by new and existing industries and activities, shall require an Environmental Clearance Certificate from the DOE and shall comply with national EQS.

(iii) Vessels of any kind are prohibited from discharging waste water and oil and dumping waste of any kind in the main river and all connected canals. Vessels shall travel at a designated speed, follow defined routes, and keep noise to a minimum.

(iv) Dumping solid waste in any location is prohibited.

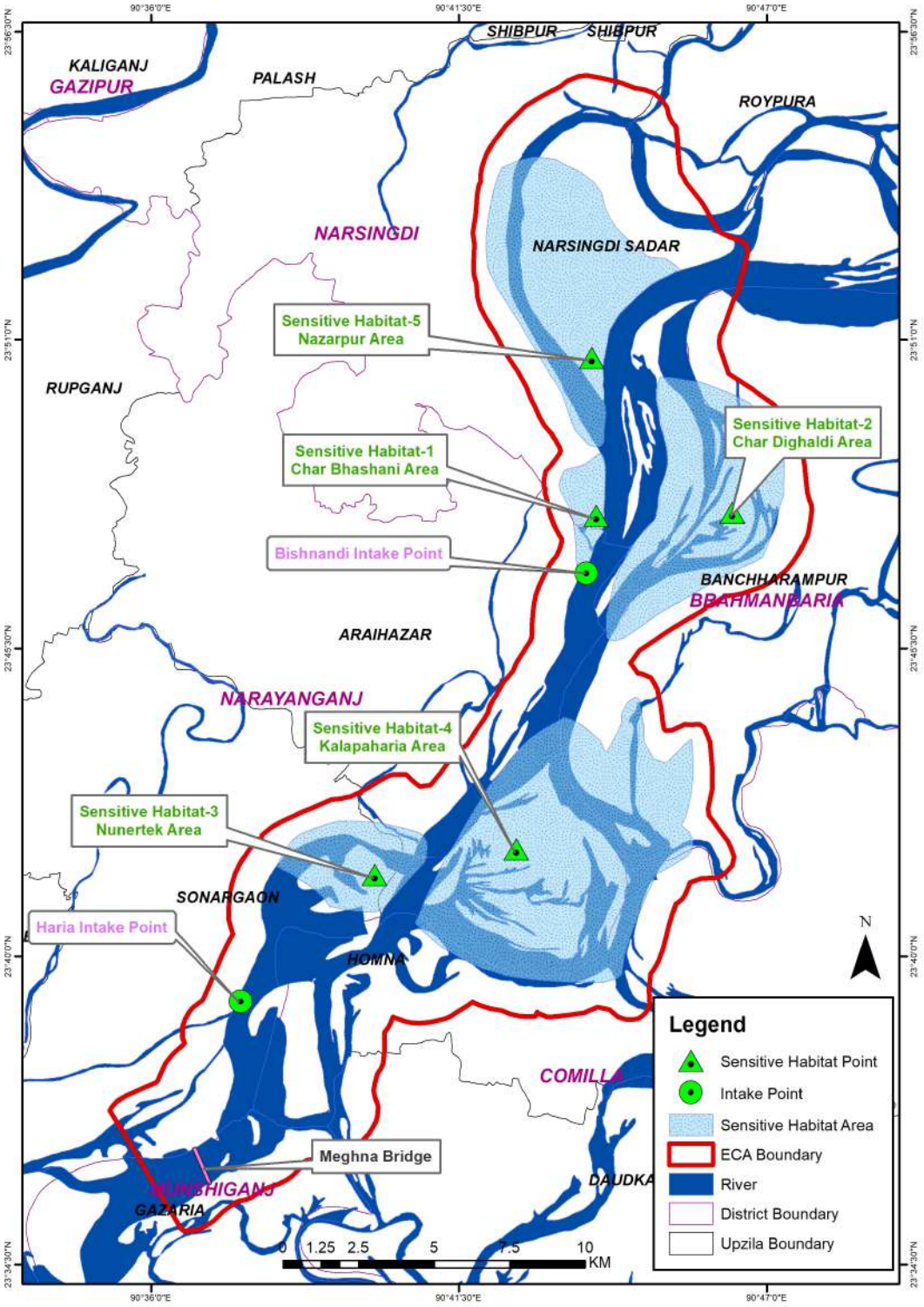
(v) The use of chemical pesticides and fertilizers shall be restricted.

As per Water Act 2013, DWASA may propose to the National Water Resource Council, which is headed by the Prime Minister, to declare the upper Meghna River ECA as a "water supply zone" (under section 5a) with restrictions on land development, conversion, industrialization, and commercial agriculture. This will require innovative interpretation as section 5(a) does not provide for zoning but provides for policies and guidance for safe collection, protection, and conservation of water resources.

Fish at local market at Meghna Ghat.

[16] Government of the People's Republic of Bangladesh, Ministry of Environment, Forest and Climate Change. 1997. The Environment Conservation Rules. Dhaka.

Figure 14: Ecological Critical Areas Proposed for the Protection of the Water Quality of the Meghna River



Source: ADB. 2019. Technical Assistance Completion Report: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

Promotion of Cleaner Production for Pollution Minimization

Introduction of cleaner production principles in industries could reduce the amount of waste water discharged into the river. A pilot study in four industries and a global assessment of the industrial clusters in Narayanganj and Narsingdi districts showed that production processes could be optimized with limited investment, resulting in significant savings in energy cost, and chemical and water use. Accordingly, the amount of waste water produced would be reduced, leading to an increased efficiency of effluent treatment plants (ETPs) and load discharge.

As knowledge on cleaner production in the industries is limited, the TA suggested setting up an advisory center to provide expert support to stakeholders. For large scale implementation, cooperation could be sought from the International Finance Corporation's project, Partnership for Cleaner Textile, which is working towards best practices in the textile sector. A similar approach could be proposed for the small- and middle-sized enterprises in the industrial clusters.

Savings potentials and payback periods for four companies (three textiles, and one pulp and paper) were calculated in the pilot study to determine the benefits of investing in cleaner production methods. The results show that by implementing specific measures, resource consumption can be noticeably decreased. These reductions represent a considerable cost savings; the payback period of the estimated investment to achieve these savings is also short (less than 1 year for most companies sampled). The calculations below are based on reduced resource consumption compared to baseline (current) consumption and the estimated investment, savings potential, and payback period (Table 7).

Table 7: Reduction in Resource Consumption

Items	Textile 1	Textile 2	Textile 3	Paper Mill
A. Reduction in resource consumption				
1. Water consumption	16.3	52.2	65.4	-
2. Natural gas consumption	10.1	8.2	12.2	21.8
3. Steam consumption	14.2	8.6	17.0	5.0
4. Electricity consumption	10.3	0.1	2.7	15.7
B. Savings potential and payback				
1. Estimated annual investment ($)	337,335	217,098	259,960	287,235
2. Annual savings potential ($)	327,888	1,656,172	1,849,169	1,135,203
3. Payback period	1.03	0.13	0.14	0.25

Source: ADB. 2018. Summary Report on Cleaner Production: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

Early Warning System

It is strongly advised to establish automatic monitoring stations at the two intake points to continuously monitor electrical conductivity, dissolved oxygen, pH and turbidity (and to conduct biomonitoring, if resources are available). These parameters can be used to detect sudden changes in water quality and can serve as an alarm for incidents. Using continuous monitoring at Haria could identify the transport of pollution plugs to the intake point by tidal excursion. At Bishnondi, baseline threshold values should be set, so that when flushing of polluted upstream tributaries by rainfall causes sudden changes in water quality, the intake of water can be stopped. This requires a real time monitoring system that automatically uploads data to DWASA.

Comprehensive Monitoring Plan

Pollution control measures to guarantee the future quality of Meghna River water will require an integrated approach that combines monitoring and enforcement. The environmental monitoring plan for the upper Meghna River is designed to help both DOE and DWASA establish an effective long-term monitoring program to ensure a sustainable drinking water supply of good quality and to maintain functioning ecosystems in the river basin. The monitoring area in the upper Meghna River extends over 75 km from the Bhairab Bridge to the Meghna Bridge. Five water quality sampling points are proposed along this river stretch, inclusive of the proposed intake points at Bishnandi and Haria. The monitoring plan comprises three monitoring activities and a participatory approach. The complete operational monitoring plan, with comprehensive specifications for monitoring frequency, techniques, and parameters, and with cost estimates for each component of the plan, is as follows:

(i) Surveillance monitoring of Meghna River water quality is to be executed by the DOE, with monthly monitoring at three locations in the relevant stretch of the river.

(ii) Monitoring at the two intake points is to be executed by DWASA, including the establishment of an early warning system and weekly, monthly and quarterly monitoring for relevant parameters.

(iii) Monitoring water pollution loads is to be done by DOE, including monthly assessment of the loads of the five polluted tributary canals discharging into the Meghna River. In addition, it is proposed that industries be responsible for monitoring their effluent loads. DOE will determine the monitoring and reporting procedure and conduct regular cross check of reported results to prevent fraud.

(iv) Watchdog committees will conduct participatory monitoring. During the TA project, eight watchdog committees were established to report pollution events to the DOE and play an important role in getting commitment from the general public. Two of these committees have been provided with simple equipment for monitoring water quality in the tributary canals and drains and it is proposed to extend it to the others. DOE should coordinate the activities and guide the watchdog committees.

The total investment cost for implementing the four monitoring programs is estimated to be $0.39 million. The operation of the plan will also require approximately seven fulltime equivalent staff, at the scientific and field assistant levels. The summary of costs is presented in Table 8. It is estimated that introducing this plan will take 1–2 years and require a dedicated team of 4–5 staff working for a period of 24 months.

Table 8: Investment and Operational Cost for Monitoring Pollution Control ($)

Description	Annual Cost
River water quality monitoring	3,112
Monitoring at two intake points	7,407
Primary investment for early warning system and yearly operational costs	102,560
Monitoring tributary loads	7,155
Primary investment and operational costs of watch dog committees	50,893
Operational costs for joint monitoring committee	2,612
Yearly expenditure for regular manpower required for the activities other than already established divisions of DOE and DWASA	148,286
Expenditure for watchdog group and joint monitoring committee	25,714
Awareness campaign programs	11,429
Capacity enhancement and refresher trainings	26,667
Total	**385,833**

DOE = Department of Environment, DWASA = Dhaka Water Supply and Sewerage Authority.

Source: ADB. 2019. Technical Assistance Completion Report: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

Pollution Advisory Center

According to the Environment Conservation Rules, 1997, each industry discharging into surface water should have an ETP. However, it is well known that some of the industries do not comply with this. The main pollution threats are the thousands of small and medium-sized enterprises that lack ETPs or well-functioning ETPs, and that discharge effluents into tributary canals flowing into the Meghna River. One of these polluted tributaries is the Bishnandi Canal that enters the Meghna River just upstream of the proposed Bishnandi intake point.

To verify if its ETP is operating, each industry should have a device that measures effluent flow continuously at the critical point of discharge. The real time data should be uploaded automatically to the DOE office. In case the ETP is not working, the DOE should be informed by mobile text messaging so that it can take appropriate action. The equipment should be checked by the DOE during unannounced annual visits. Knowledge on how to operate ETPs by the industries is also low. It is therefore recommended that in addition to their role of enforcement, DOE should also advise industries on treatment of waste water, possibly through a pollution advisory center established at the DOE.

Controlling Domestic and Municipal Waste Water Discharge

Economic development in Dhaka is expected to spur population growth, necessitating adequate treatment capacity for domestic waste water. A detailed study should be carried out to gather information on the solid waste and wastewater generated from the municipality and proper treatment facilities should then be installed to minimize pollution. The dumping of household or municipal solid waste in the canals and river should be prevented through an appropriate system of waste management. DWASA should include these developments in their masterplan for waste water treatment.

Controlling Pesticide Use

Banned pesticides used in some *upazilas* are discharged into the Meghna River through rainfall runoff. To prevent pollution by pesticides, an integrated pest management system needs to be promoted widely among the farmers by the Department of Agriculture Extension. DOE should coordinate with the local government bodies (LGBs), Ministry of Agriculture, Agricultural Extension Offices, and the Bangladesh Crop Protection Association for implementation of the pest management system.

Local Stewardship

Maintaining water quality will benefit a large number of people whose livelihoods partially or fully depend on the Meghna River, such as fishers, farmers, and the poor, and preserve a resource essential for Dhaka's drinking water supply. Public awareness, as well as the creation of local "watchdog committees" by engaging LGBs and local communities, are important steps in maintaining good water quality in the Meghna River. Within the scope of the TA project, eight watchdog committees comprising LGBs and local communities in six union *parishads*[17] (Madhabdi, Pirojpur, Sonargaon, Bishnondi, Baluakinadi, and Narshingdi) and two *upazilas* (Ashuganj and Meghna) were formed to support DOE's monitoring and enforcement efforts. Public consultation meetings were organized with concerned LGBs to raise local stakeholders' awareness of domestic and industrial wastewater directly or indirectly discharged into the Meghna River.

Fishers in the traditional fishing boat.

[17] Lowest local government body in rural areas.

Water transport in the Meghna River.

5 Way Forward

Although water quality in the Meghna River remains good at present, it has deteriorated over time. At the proposed Bishnandi and Haria intake points, most of the quality parameters measured comply with revised EQS, though occasionally the standards for biological oxygen demand/chemical oxygen demand and total coliforms are exceeded, indicating the impact of urban pollution. The EQS for nitrate is also occasionally exceeded at both locations, which might be due to agricultural runoff during the wet season. New development and construction are a potential threat to water quality in the future, however, and necessary steps must be made to preserve it. The study revealed that the cost of water treatment will increase if the quality of water in the Meghna River deteriorates. For example, the operating cost for a 450 mld water treatment plant will reach $78.84 million if poor water quality necessitates advanced surface water treatment compared to just $47.63 million for conventional treatment of cleaner surface water.

Protection of river water quality is the responsibility of DOE while supply of adequate safe water to the Dhaka residents is the responsibility of DWASA. Local government also plays an important role in river water quality protection through implementation of relevant policies. These entities, particularly, DOE and DWASA, need to work jointly and effectively to maintain the water quality of the Meghna River. Taking the lessons learned from the degradation of Dhaka's former surface water sources, protection of Meghna River water quality should be a priority at the highest management levels.

A joint steering committee—an apex body of DOE and DWASA and hosted by DOE—has been proposed to take responsibility for implementing the recommendations of the TA project, with cooperation from other stakeholders (Department of Public Health Engineering, Department of Fisheries, Bangladesh Economic Zones Authority). The steering committee will be jointly headed by the director general of DOE and the managing director of DWASA. The next tier of the joint arrangement will be the DOE laboratory and enforcement directorates, and DWASA's project management unit/water treatment plant operation and maintenance circle. DOE will get on-site support from its regional offices and the already-formed watchdog groups. DWASA will draw upon internal assistance (e.g., from its Chemical and Microbiology Division, Environment Monitoring Division, etc.), as well as the project consultant and external expert, if necessary (Figure 15). The committee should ensure that sufficient resources and staff workforce are available, and request additional resources, if required. The TA proposed that one-year operation of the system along with primary investment will require $0.39 million.

The immediate steps and resources required for operationalization are:

(i) officially form the apex body;

(ii) activate the watchdog and joint monitoring committees;

(iii) recruit professionals (chemist, microbiologist, water quality assessment specialist, water sampler, laboratory technician) to perform the tasks;

(iv) procure or enhance the capacity of the existing computer hardware, software, automatic water quality recorder, server, etc.;

(v) work with the Ministry of Environment, Forest and Climate Change for the designation of ECAs to protect the Meghna River ecosystem by reducing pollution load;

(vi) operationalize the monitoring system;

(vii) establish an online ETP monitoring system at the DOE to strengthen enforcement;

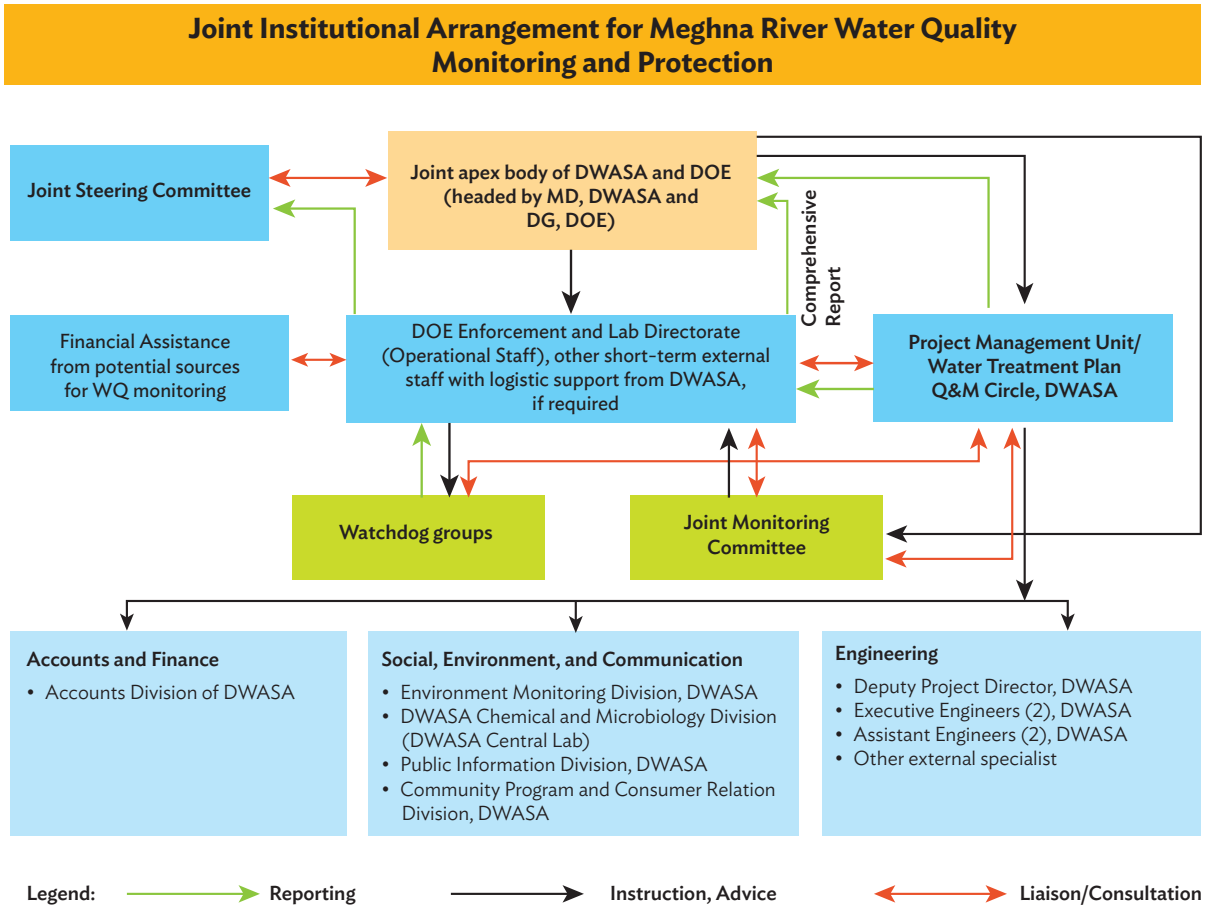
(viii) complete a study on the municipal solid waste in the secondary towns around the two intake points of the Meghna River and prepare a solid waste management plan following 3Rs (reduce, reuse, recycle) strategies for implementation;

(ix) complete a detailed study on polluting small and medium-sized industries and work with DOE and relevant ministries to bring them under compliance;

(x) reduce pollution load by small and medium-sized enterprises through the introduction of cleaner production; and

(xi) design and implement an integrated pest management system to stop agro-chemical pollution.

Figure 15: Proposed Joint Institutional Arrangement for the Protection of Meghna River Water Quality



DG = director general, DOE = Department of Environment, DWASA = Dhaka Water Supply and Sewerage Authority, MD = managing director, O&M = operation and maintenance, WQ = water quality.

Source: ADB. 2019. Technical Assistance Completion Report: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply. Consultant's Report. Dhaka (TA 8803-BAN). Unpublished.

Water quality test at the Department of Environment lab.

Water quality monitoring by watchdog committee members.

Traditional fishing technique – boat with fishing net

6 Conclusion

To avoid pollution and maintain good water quality supply in the Meghna River, strong monitoring and enforcement by the government will be necessary. The joint institutional setup by DOE and DWASA, and collaboration with local administration should be an effective arrangement, and avoiding river pollution by declaring an ECA for the protection of biodiversity will in turn protect the two water intake points.

The newly declared economic zones in the Meghna River area should have state-of-the-art production methods with adequate treatment facilities or central ETP to minimize the waste load to the river. Small and medium-sized industries that do not have an ETP or operate poorly must be brought under compliance, and cleaner production is recommended to reduce discharge load and maximize profit. Municipal solid waste and wastewater should not be directly discharged into the river.

The DOE should take appropriate action in applying its regulatory instruments like site clearances and environmental clearance certificates. It should require all new development proposals along the Meghna River to include assessment of the cumulative impacts on water quality. The river water quality monitoring program conducted under the TA should be continued by government and a continuous monitoring system with an early warning facility should be established at both intake points. Together, these measures executed in earnest should help in protecting the water quality of the Meghna River for Dhaka's sustainable water supply.

Inaugural ceremony of the national seminar to share the TA results on 10 October 2018. From left: Munjurul Hannan Khan, Ministry of Environment, Forest and Climate Change additional secretary; Yasuharu Shinto, Embassy of Japan chargé d'affaires ad interim and counsellor; Manmohan Parkash, ADB country director, Bangladesh Resident Mission; Anisul Islam Mahmud, MP, former Minister of the Environment, Forest and Climate Change; Abdullah Al Mohsin Chowdhury, Ministry of Environment, Forest and Climate Change secretary; and Taqsem A. Khan, Dhaka Water Supply and Sewerage Authority managing director.

Project Director Mustafizur Rahman Akhand delivers a speech at an awareness raising workshop.

Project team for the technical assistance (TA 8803: Strengthening Monitoring and Enforcement in the Meghna River for Dhaka's Sustainable Water Supply).

Protecting the Meghna River

A Sustainable Water Resource for Dhaka

This publication explores the potential of the Meghna River as an alternative water source for Dhaka. It also describes the fragile state of the city's current drinking water supply due to increasing demand and surface contamination. The authors assess the threats facing the Meghna River and identify protection measures needed to ensure that it can provide a sustainable and safe supply of drinking water. These measures include designating ecological critical areas, promoting cleaner industrial production, monitoring pollution, controlling wastewater discharges and pesticide use, and empowering local stewardship of the river.

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