EVALUATION OF ENVIRONMENTAL IMPACTS OF GORAI RIVER DREDGING

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CERTIFICATION

The thesis titled "EVALUATION OF ENVIRONMENTAL IMPACTS OF GORAI RIVER DREDGING", submitted by SHUNIL KUMAR, Roll No.: 1014042108, Session: October 2014, has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Master of Science in Civil Engineering (Environmental) on 26th September, 2022.

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It is hereby declared that this studies embodied in this thesis are the results of experiments carried out by the author under the supervision of Dr. Md. Mafizur Rahman, Professor, Department of Civil Engineering, BUET except where specified by reference to other works. Neither the thesis nor any part of it has been submitted elsewhere for any other purposes.

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DEDICATED

To

My beloved parents and teachers

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Abstract

One of the major activities of Gorai River Restoration Project-II was dredging the river for a reach of 30 km. The main objective of this research was to analyze the impacts the project on salinity, surface and ground water level, irrigation, crop productivity, fish productivity, navigation, cost of river transport and rural employment. Long- and short-term impacts of the project were assessed. In order to achieve this goal, questionnaire survey was conducted in Kushtia district. About 350 respondents were selected from three upazillas (Kushtia, Kumarkhali and Khoksha) using a simple random sampling technique. A conceptual framework was developed, and data were analyzed using evaluation values of Important Environmental Components (IECs) and prepare impact matrix.

This study found that, 99% of respondents replied that there is no salinity in Gorai River after dredging. As per questionnaire survey, availability of surface water during dry season has increased as stated by respondents (86%). Average water level in Gorai River of Phase-II is 4.48 m which is more than the average water level (4.36 m) of Phase-III. So, the availability of surface water in Gorai River is increased. Availability of water in the tube well in dry season has increased as stated by respondents (91%).

The quality of irrigation water is very much dependent on the source. It was also found that, during dredging about 2% of respondents use water using Low Lift Pumps (LLP) from Gorai River but after dredging about 15% of respondents use water through LLP from Gorai River. On the other hand, dependency of irrigation water from other sources is reduced from 82% to 70%. From questionnaire survey, farmers adjoining the Gorai River were observed to be converted from 1 crop to 2 or more crops production per year. In 2021, 93.0% of the farmers have stated that volume of production of crops increased (compared to 91% in 2013). In 2021, 52% of the fisherman stated that the volume of fish production increased (compared to 30% in 2013). During dredging about 88% (2013) of Boatman reported reduced flow in Gorai River during dry season but after dredging about 68% (2021) of Boatman reported the same. Compared to 22% in 2013, 32.0% (2021) of the boatman felt that navigability during dry season increased slightly due to dredging.

However, the water flow in Gorai River depends not only on dredging but also rain and extent of water flow from India during dry season. Rural employment scenario changed after dredging. In 2021, Rural employment of Farmer 57% (43% in 2013), Fisherman 52% (50% in 2013) and Boatman 36% (34% in 2013) has increased in the project area.

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List of Abbreviations

ADB	Asian Development Bank
BBS	Bangladesh Bureau of Statistics
BIWTA	Bangladesh Inland Water Transport Authority
BOD	Biochemical Oxygen Demand
BRAC	Bangladesh Rural Advancement Committee
BWDB	Bangladesh Water Development Board
CBOs	Community Based Organizations
CE	Chief Engineer
COD	Chemical Oxygen Demand
DAE	Department of Agricultural Extension
DC	Deputy Commissioner
DG	Director General
DoE	Department of Environment
DoF	Department of Fisheries
DO	Dissolved Oxygen
DPHE	Department of Health Engineering
DPP	Development Project Proposal
DTW	Deep Tube Well
EAP	Environmental Action Plan
ECA	ECA Environment Conservation Act
ECC	Environmental Clearance Certificate
ECR	Environmental Conservation Rules
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMU	Environmental Management Unit
FAP	Flood Action Plan
FD	Forestry Department
FGD	Focused Group Discussion
GoB	Government of Bangladesh
IECs	Important Environmental Components
IESs	Identification of Important Environmental Components
IMED	Implementation Monitoring & Evaluation Division
IWM	Institute of Water Modeling
MoA	Ministry of Agriculture
MoEF	Ministry of Environment and Forest
MoWR	Ministry of Water Resources
NGO	Non-Government Organizations
NWMP	National Water Management Plan
NWPo	National Water Policy

O&M	Operation & Maintenance
PC	Planning Commission
PD	Project Director
PCU	Project Coordination Unit
PCR	Project Completion Report
PIU	Project Implementation Unit
QS	Questionnaire Survey
RTWs	River Training Works
SC	Steering Committee
SDE	Sub-Divisional Engineer
SE	Superintending Engineer
SEIA	Summary Environmental Impact Assessment
SPSS	Statistical Package for Social Science
SWPB	Surface Water Processing Branch
TC	Technical Committee
ToR	Terms of Reference
UNO	Upazilla Nirbahi Officcer
UNDP	United Nations Development Program
UP	Union Parishad
WARPO	Water Resources Planning Organization
WHO	World Health Organization
WMO	Water Management Organization
ExEn	Executive Engineer

CHAPTER 1
INTRODUCTION

1.1 General

Bangladesh is a riverine country. Many small and big rivers are intertwined in this country. Bangladesh is called a land of rivers as it has about 700 rivers including tributaries (BWDB, 2011). River and Drainage System the rivers of Bangladesh are very extensive and distinguish both the physiographic of the country and the life of the people.

Bangladesh is in the Delta of the three great rivers, the Ganges, the Brahmaputra and the Meghna. The Ganges Dependent Area (GDA) in the south-western region of Bangladesh constitutes about 37 percent of the total area of the country. About one third of the population of the country lives in this area. The Ganges is the only source of fresh water for a vast area of this region (BWDB, 2012).

In 1975, India commissioned a barrage across the Ganges at Farakka in West Bengal to divert 40000cusec of water into Bhagirathi-Hoogli River to improve the navigability of Calcutta Port. This has decreased considerably the discharge of Ganges and Gorai in Bangladesh part. As effect of this, the off take of Gorai used to be silted up in lean period and water from Ganges to Gorai cannot flow due to this blockade. As a result, freshwater flow through Gorai-Rupsha-Passur River System gradually decreases and upward intrusion of saline water from Bay of Bengal increases due to tidal effect (Talukder, 2014).

This affected seriously agriculture, fisheries, forestry, navigation, domestic water supply and industrial development in the Ganges Dependent Area within Bangladesh. The world's largest mangrove forest, the Sundarbans is on the verge of extinction because of high salinity levels in the rivers and channels surrounding the Sundarbans during the dry season. One detailed feasibility study was carried out by DHV-Haskoning and Associates in 2001 and the Project named Gorai River Restoration Project, Phase-II was taken up in 2009 (Talukder, 2014).

1.2 Background and Present State of the Problem:

Gorai River is the right bank principal distributaries of the Ganges River, the main source of fresh water from Ganges to the south-west region of Bangladesh (Islam, and Gnauck, 2011). Owing to the reduction of upstream water flow Gorai has been facing very low flow in the dry period which was causing siltation at its bed throughout the length (Talbaria to Khoksha). The rate of siltation here was so high that the off-take of the river was used to be completely silted up, blocked and discontinued its flow from the Ganges at Talbaria under Kushtia district. This incident of blockade at the off-take and discontinuation of water from Ganges to Gorai was causing serious threat to the environmental degradation and salinity intrusion from the south (Khanam, and Navera, 2016). With a view to minimizing this, the river Gorai was dredged during 2009 to 2017 by BWDB to improve the fresh water supply through it towards south. In this study work, the salinity and environmental parameters will be investigated on the basis on dredging of the river Gorai. It is hoped that this study will help the river regulation authority (BWDB, BIWTA, WARPO etc.) to undertake appropriate future developments projects for the river restoration (Talukder, 2014).

The study is carried out based on primary and secondary data sources. The objective of this study is to investigate the shortage of fresh water in the Ganges Gorai basins and their negative impacts on socio-economy and mangrove wetland ecosystems in the Sundarbans in Bangladesh (Islam, and Gnauck, 2011).

1.3 Objectives of the Study

Objectives: The specific objectives of this study are:

1. To analyze the impacts of following parameters for dredging: salinity, surface and ground water level, irrigation, crop productivity, fish productivity, navigation, cost of river transport and rural employment in the surroundings of Gorai River.
2. To analyze long term and short-term impacts of the Gorai River Restoration Project-II.

1.4 Outline of Methodology

Outline of Methodology of this research is given below:

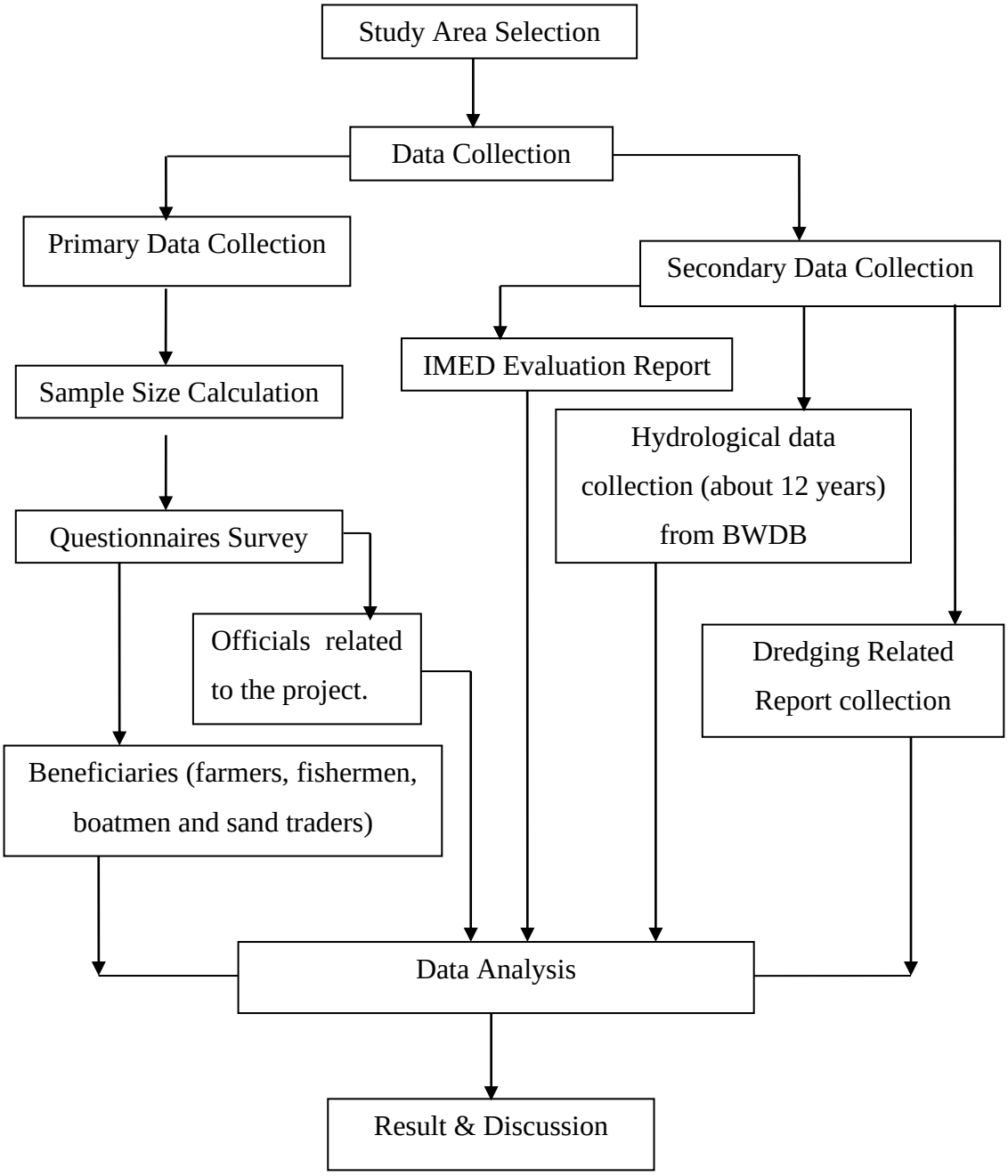

Figure 1.1: Outline of Methodology

The following steps have been taken for research (Figure 1.1):

- ✓ In this work Gorai River system throughout the length (Talbaria to Khoksha) and its surroundings has been selected for study area, where off-take is located at the Talbaria and downstream boundary is located at the Khoksha. At Talbaria, Mongol baria, Gorai Railway Bridge, Kumarkhali groyne and Khoksha has been selected for data collection.
- ✓ The salinity, surface and ground water level, irrigation, crop productivity, fish productivity, navigation, cost of river transport, and rural employment information has been collected from the beneficiaries through questionnaires in the surroundings of Gorai River.
- ✓ Two sets of questionnaires- one for the beneficiaries such as farmers, fishermen, boatmen and sand traders, and another for the offices related to the project has been collected information through questionnaires. The questionnaire has been prepared in such a way that the views of the beneficiaries and the officials are elicited.
- ✓ Analyze long-term and short-term impacts of the projects as follows:
    - Field visits and environmental survey,
    - Collected data from questionnaires,
    - Implementation Monitoring & Evaluation Division (IMED) 2014 evaluation report, various river dredging related report or paper has been collected to analyze the long term & short-term impacts of Gorai River dredging.

1.5 Organization of the Thesis

This thesis represents the analysis, results and findings of the present study. The thesis has been organized into five chapters and a list of mentioned references in the report.

Chapter 1: Introduction

This chapter contains a general introduction followed by a background statement of the problems, aims and objectives, the outline of the research methodology and finally the thesis organization.

Chapter 2: Literature Review

Introduces a brief review of river dredging, history of dredging, including a short description of dredging, dredging applications, impacts of dredging, advantage of dredging, dredging related national legislations, analyze of impacts, identification of important environmental components (IECs), evaluation of environmental impacts of study area, description of Gorai River restoration project, Gorai River morphology and hydrology and importance to Sundarbans. It also summaries the previous works that were done regarding the environmental impacts of dredging.

Chapter 3: Methodology

This chapter provides a description of the methods adopted in this study.

Chapter 4: Results and Discussion

This chapter presents the analyze, result and discussion, to analyze the questionnaire survey data, primary, secondary data and project related data and evaluate environmental impacts of Gorai River surrounding in this chapter.

Chapter 5: Conclusion and Recommendations

The conclusion and recommendations of this study are presented in this chapter, where overall findings, limitations and directions for future work have been discussed. Also, some recommendations for future research are presented in chapter 5. All raw data used in this research are attached to this report in an annexure section.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

The pride of Bangladesh is its rivers with one of the largest networks in the world with a total number of about 700 rivers including tributaries, which have a total length of about 24,140 km. Today, about only 6000 km can be used safely. In dry season it shrinks to about 3800 km, (Azhar, 2015) which means, Bangladesh can only use 16%-25% of all its river lengths as its transport viable waterway and rest 75%-84% of the waterways cannot be used. The reasons are the depth and high siltation in the river. It is assessed that, Due to relatively higher settling velocity, the large-grained sediments are deposited near the source area on the riverbeds, forming sand bars (Khalequzzaman, 1994). Simply, in the rainy season regular water-flow does not accommodate within the rivers and it overflows causing flood. Therefore, if the siltation can be controlled or, reduced in any way, the rivers can be made more useful for transportation and be made lesser threat as flood source. Dredging is a possible and best viable solution to reduce siltation, but only as a cure.

Water transport is the cheapest means of transport and communication in our country, because 60% of the population is below the poverty line and lives in the rural areas. So, improvement of IWT (Inland Water Transport) is a necessity for the economic development of our country. But the rivers and canals are reducing day by day due to silting up by sand and clay deposits and the result is directly affecting the waterways. In this situation it is very much essential to improve the waterways for socioeconomic development of the country (Sultana et al., 2017).

2.2 History of Dredging

The technology of dredging of rivers follows back to ancient time of human civilizations. In around 1575, mud mills were used to remove sedimentation. Such dredging equipment was used for digging in ports and consisted of a rotating chain with wooden boards to dig up the mud. Then came the steam-driven bucket dredgers, though they were very unreliable. By 1857, suction dredgers were being used in the

USA. Within years, many big dredging projects were being held in many countries to stimulate the development and construction of new dredging equipment. In 1867, suction dredgers designed by French engineer Henri-Émile Bazin were used in the construction of the Suez Canal. This made dredging by suction more popular. The cutter suction dredger came into work in late 1800s. It was developed to deal with harder soils. The 'trailing suction hopper dredger' became more useful after a very short time. As the number and size of oceangoing ships increased, wider and deeper channels and harbor basins were required to accommodate them. The trailing dredger can work without obstructing the ship movement in the waterway and thus, this type become a more permanent solution. Modern popular dredgers are the modified and optimized version of such dredgers. Bangladesh had it first Dredger in action by 1970s, when the Bangladesh Inland Water Transport Authority (BIWTA) bought its first dredgers (HoD, 2022).

2.3 Dredging

Dredging is the process of removing material from the bed or banks of a waterway and disposing it in another part of the waterway, where it presumably will not be readily re-suspended and return to the main channel or disposing on land. Dredging operations are primarily for the purpose of deepening or widening navigation channel or to obtain fill material for land development (Bray, 1979).

Dredging is a significant way for delivering sands and stones for construction and reclamation projects. Pressures arising from population growth and port and infrastructure developments in coastal areas have created a need to raise the elevation of low-lying areas and/or to construct new land areas (Henty, 1994). So, land reclamation projects will always require different sorts of dredging. On the other hand, an increasing quantity of marine aggregate is being used in concrete and fill, including fill for reclamation project. To create underwater foundations, facilitate the emplacement of pipelines or immersed tunnel elements, constructing flood control structures such as dams, dikes or levees, dredging is considered a convenient solution. Ensuring flood defenses (by improving or maintaining the discharge capacity of watercourses) and creating or maintaining storage capacity in water supply reservoirs are now-a-days dependent on dredging (Bray, 2004). Dredging can

benefit the environment in many ways. Dredged materials are frequently used to create or restore habitats (Padmalal and Maya, 2014).

Another environmental use of dredging is to remove contaminated sediments, thus improving water quality and restoring the health of aquatic ecosystems. This so-called “remediation” or “clean-up” dredging is used in waterways, lakes, ports and harbors in highly industrialized or urbanized areas (Edwards, 2015). If the removed material are treated and used afterwards, or disposed of under strict environmental controls, it’ll be both eco-friendly and environmentally safe.

2.4 Dredging Applications

Dredging can be divided into five major general categories:

i. Capital Dredging
ii. Maintenance Dredging
iii. Dredging for Civil Works and Energy
iv. Mining
v. Environmental Dredging

2.4.1 Capital Dredging

Capital dredging is a dredging project in which the purpose of the project is to substantially change the underwater or shoreline terrain for a commercial purpose.

Capital dredging is used to create or extend basins, harbors, marinas, canals, and other facilities. Existing waterways, channels, and harbors are maintained by maintenance dredging. Clean up dredging is associated with 'the removal of polluted material to safeguard human health and environmental protection (Bashir, 2022)

BIWTA has taken capital dredging projects in two phases as: Capital Dredging of 53 river routes in Inland waterways (1st phase: 24 river routes and 2nd phase: 29 river routes) is one of the biggest. Also, capital dredging of seven important river routes including old Brahmaputra and Lebukhali River, dredging of Jamuna River from Mawa to Ruppur, Pabna and dredging of India-Bangladesh River Protocol Routes, etc. are in the process of approval. In order to revive the dying rivers of the country Bangladesh Water Development Board has also taken Gorai Restoration Project (2nd

phase), Capital (Pilot) Dredging of the River System in Bangladesh, Buriganga River Restoration Project, etc. (Sultana et al., 2016).

2.4.2 Maintenance Dredging

Maintenance dredging is the periodic removal of shoals or sediments from existing navigational channels, berths, swinging moorings etc. in order to maintain an appropriate safe depth of water for navigation, construction or operational purposes. Maintenance dredging is a dredging project that does not substantially alter the underwater or shoreline terrain but maintains a body of water in a certain desired condition.

2.4.3 Dredging for Civil Works and Energy

Dredging is essential to many civil works, engineering, and energy projects that are vital to our cities 'infrastructures. Dredging is needed to excavate land for breakwaters, dams, bridges, piers, docks, dikes, and wharves. The process for these underwater engineering projects is like their land counterparts. For example, underwater trenches are created and filled to receive pipelines, power cables or communications cables and seabed's are prepared for foundations to support bridges or dams.

The idea that dredging can be used to increase tourism is not new. More recently, dredging makes possible many 21st Century tourist attractions. Such harbors are often only made possible with dredging. Dredging also allows tourism to come to remote areas, by making harbors and rivers passable to large tourist vessels.

Sometimes, the creation of waterside leisure facilities is coupled with other dredging projects. For example, leftover dredged material often creates land for new parks in urban areas, where harbors are frequently re-dredged (Mayer, 2023).

2.4.4 Mining

In mining dredging, the sediment itself is the desired commercial product. Dredging provides a large part of the sand and gravel that is used as aggregate for cement, or for road bedding and other construction uses. Minerals such as gold and precious gems are also mined by dredging. Mineral mining dredgers are typically highly

specialized, customized, and owned by the mining company themselves (Mayer, 2023).

2.4.5 Environmental dredging

Environmental dredging can be used to correct an adverse environmental impact, or it can create new environments and habitats where none existed before. Environmental dredging projects are often combined with, or are a natural byproduct of, capital dredging projects. For example, projects that deepen channels for navigation are often combined with flood prevention projects, as the deepened channel will naturally hold more water and reduce the amount of flooding in the surrounding areas (Mayer, 2023).

2.5 Impacts of Dredging

Anything artificial affecting the nature always has adverse effects. Dredging affects anything natural connecting to rivers. The water, the flora, the fauna – everything is affected by the dredging directly. On the other hand, indirect effects are found in riverside erosion and excessive sedimentation in riverbed further downstream. The following points can be taken into consideration in relation to dredging of rivers:

i. Dredging process kills the aquatic life in the riverbed and might cause imbalance in river ecosystem. The effect of such process might not come forward immediately, but in long-term, rivers might start producing species far more different than present time. Dredging affects in short term increases in turbidity, which can affect aquatic species metabolism and interfere with spawning.

ii. The disturbance in underwater dredging clearly mixes the clean water with silted materials and the mixed water runs long downstream from the point of dredging. It reduces the possibility of gathering fresh water from rivers.

iii. Dredging has potential to churn up old industrial pollutants like PCBs and heavy metals that have settled to the river bottom. This can increase the contamination level of the river.

iv. Bridges, flood control structures, intake pipes for public water supplies, power plants, manufacturing, etc. are built in the rivers considering the

situation of the river's overall condition. Any change of such conditions might endanger such valuable infrastructure build within the river. Dredging, if done in uncontrolled way without assessing the future effects on the river current, can change the current force and path, which is a change of condition and can affect infrastructures within the river.

v. It is observed in many countries through years of surveys and analysis that, the river fills up the holes made by the dredging by itself as soon as it can. In the process the riverbed water-current takes a new flow after the dredging and these causes the riverbank water stress to increase in several kilometers downstream. It is evident that, the effect of uncontrolled dredging in riverbank erosion is existent. Riverbanks become more susceptible to erosion (Hoey, 1995).

vi. There are secondary impacts to marsh productivity from sedimentation. Suction dredging has significant impacts on fish and amphibians, especially during reproduction. Spawning is a stressful period and fish are highly vulnerable to disturbance during this time. High levels of human activity, including swimming and boating can cause reduced fish egg success, so suction dredging most certainly can impact the reproductive success of fish. Such lampreys are particularly sensitive to disturbance (Crisp, 1989).

vii. Suspended sediment in the water affects the respiratory system of fish. Growth may also be affected since food supply and feeding success are reduced in the turbid conditions. The varying nature and size of the suspended sediment, along with the sensitivity of different species, affects the ecosystem differently.

viii. Increased turbidity reduces light penetration and therefore primary productivity, which has a knock-on effect throughout the food chain. Most fish species migrate under such increased turbidity conditions, and many will have a reduced capacity to find and capture prey. This will cause an overall imbalance in the food chain in the river (Henty, 1994).

ix. Recent satellite images prove that the dredging has widened the river channels significantly. For example, the old sandbars are nearly unrecognizable today. Natural habitats along the shorelines have been deeply

disturbed and aquatic life has disappeared due to the severity of the dredging practices. The balance of nature has been drastically changed (Brookes, 1988).

2.6 Advantages of Dredging

Depending on the function and purpose of the dredging process, you can find several advantages to using this process. Whether you are a commercial business interested in how dredging can make projects more efficient or an environmentalist wondering how it can benefit ecosystems, dredging offers many benefits (Mayer, 2023).

2.6.1 Commercial Benefits

Dredging provides numerous benefits for shipping, construction, and other projects. Dredging can be a critical process for the commercial shipping industry. Removing sediment can maintain the appropriate width and depth for enabling the safe, unobstructed passage of cargo vessels carrying oil, raw materials, and other essential commodities. When dredging, it's recommended that your materials should be no less than 7 feet below the surface.

Further, dredging can assist with various aspects of construction projects. For waterway projects, like bridges, docks, piers and underwater tunnels, dredging helps create space for construction by efficiently removing sediment. After clearing the sediment, projects can move forward with the building process.

Land projects can also benefit from dredging by using sediment removed from the water to fill in spaces where they need extra earth. After the dredging process, companies dry out the sediment and transport it to its new location where companies can apply it to the land as they see fit.

While many environmental organizations use dredging to restore beachfront and aquatic ecosystems, beach town businesses can benefit from restoration. Dredging can bring sand back to eroded beaches, making them more appealing to travelers planning their summer vacations. When you have well-maintained beaches, you can increase tourism and draw more visitors to your local business during the summer seasons.

2.6.2 Environmental Benefits

Dredging allows businesses to work with waterways to create better and healthier aquatic ecosystems. One of the largest benefits of dredging waterways is helping to reduce eutrophication, which is an excessive amount of nutrients in a water body typically caused by water runoff from the surrounding land. Eutrophication can lead to an overabundance of plant growth that results in oxygen deprivation and can cause the death of aquatic wildlife. In some cases, dredging may be the most viable remediation option when eutrophication occurs.

However, dredging offers many environmental benefits, including:

i. **Restore environments:** Sediment removal can help to restore a shoreline or beachfront to its original condition by reversing the effects of soil erosion.
ii. **Cleaning ecosystems:** Dredging can clean up a waterway after a toxic material spill or via the removal of trash, debris, decaying vegetation, sludge or other materials that can contaminate water and soil.
iii. **Preserving aquatic life:** Dredging can produce a healthier aquatic ecosystem that can result in a more suitable habitat for fish and other wildlife. It can also be used for trash and debris removal to support eco-friendly waterways.
iv. **Removing general pollutants:** Water bodies located near urban areas and industrial complexes can quickly become a receptacle for various pollutants. Sediment removal can prevent the accumulation of pollutants and keep the waterways and their wildlife clean and healthy.
v. **Reduce flood risk:** Because the dredging process removes excess sediment along the bottom and sides of waterways, rain and connecting bodies of water can better flow together with less risk of floods. Waterways can better accommodate the natural level of water coming through their watershed system, so they can move and hold water and prevent spilling over the banks and onto the land (Mayer, 2023).

2.7 Dredging related national legislations.

Most relevant national legislation concerning environment & dredging are. Bangladesh Environmental Conservation Act, 1995 and amended in 2010. Under this

act, the River Management Improvement Program (RMIP) requires clearance by the Department of Environment (DoE) before launching the project complying with procedures stipulated in the ECR-1997(Environment Conservation Rules). DoE defines ecologically critical areas under this act, which need to be considered while planning and designing the RMIP interventions. The followings are the different laws that need to be taken into consideration while carrying out dredging jobs in the context of Bangladesh (Bashir, 2022).

i. Bangladesh Environment Conservation Rules (ECR), 1997
ii. Water Act 2013
iii. Bangladesh Environment Court Act, 2010
iv. Protection and Conservation of Fish Act (1950)
v. Embankment and Drainage Act, 1952
vi. The EIA Guidelines for Industry (1997)
vii. Inland Shipping Ordinance 1976 and Amendment
viii. Related State Policies, Strategies and Plans
ix. Bangladesh National Environmental Policy 1992
x. Inland Water Transport Policy (IWTP) 2009
xi. Bangladesh National Environmental action plan (NEMAP 1995)
xii. National Water Policy (1999)
xiii. National Water Management Plan, 2001 (Approved in 2004)
xiv. National Fisheries Policy, 1996
xv. Relevant International Conventions, Treaties, and Protocols (ICTPs)
xvi. International Convention for the Prevention of Pollution from Ships (MARPOL) 1973/1978
xvii. 'Biological Diversity, Rio de Janeiro (1992)
xviii. United Nations Framework Convention on Climate Change, Rio de Janeiro (1992)
xix. Convention on Wetlands of International Importance, especially Waterfowl Habitat, Ramsar (1971) and its amending protocol, Paris (1982)

xx. Convention (BONN Convention) on Conservation of Migratory Species of Wild Animals (1979)

xxi. 'Kyoto Protocol (1997) and the Copenhagen Accord (2009) on climate change

xxii. Convention on the prevention of marine pollution by dumping of wastes and other matters,1972.

2.8 Gorai River Restoration Project (Phase-II)

Gorai River Restoration Project (Phase-II) is an on-going Project of Annual Development Program (ADP) being financed by Government of Bangladesh (GOB) and implemented by Bangladesh Water Development Board (BWDB) under the sponsorship of Ministry of Water Resources (MOWR). The Project was commenced in November 2009 and targeted for completion in June 2013, but the completion time has been extended up to June, 2017 (for specific reason). IMED has appointed an Individual Consultant to complete Mid-term Evaluation of the Project through which the latest progress as well as the implementation status of main components and the achievement of the objectives of the Project was evaluated (BWDB,2012). India commissioned a barrage across the Ganges at Farakka to divert water into the Bhahgiratthi-Hoogly Rivers in West Bengal, India for the purpose of flushing the silts to improve the navigability of the Kolkata Port to the Bay of Bengal. Due to diversion in the upstream, the flows in the Ganges downstream of Farakka reduced considerably. This affected seriously agriculture, fisheries, forestry, navigation, domestic water supply and industrial development in the Ganges Dependent Area within Bangladesh. The world's largest mangrove forest, the Sundarbans is on the verge of extinction because of high salinity levels in the rivers and channels surrounding the Sundarbans during the dry season.

The Ganges basin in the Southwest region of Bangladesh receives freshwater through two river systems: Gorai-Madhumati-Nabaganga and Mathabanga-Bhairab-Kobadak. They are also termed 'inland rivers' (Halcrow et al., 1993).

The Gorai-Madhumati-Nabaganga system, the most important, used to receive a significant amount of water from the Ganges River. Gorai-Madhumoti is one of the

longest rivers in Bangladesh and distributaries of the Ganges. In the upper reaches it is called the Gorai, and the name changes to Madhumati. Madhumati continuous stream through Kushtia, Jessore, Rajbari, Faridpur, Khulna, pirojpur and Barguna districts in Bangladesh (Addams, 1919).

Gorai River flows towards south for about 200 km up to the point at Bardia where the river Nabaganga meets Gorai. From here, Nabagnga flows towards south, and Gorai also flows towards south taking the name Madhumati. Nabaganga meets the river system of Rupsha-Passur and their waterways and finally falls into the Bay of Bengal.

Similarly, Madhumoti meets with Baleswar River and its waterways and finally falls into Bay of Bengal. The tidal effect is felt up to upstream of the confluence point at Bardia. As the fresh water from north is gradually reducing through Gorai, Madhumoti and Naboganga, the salinity is increasing due to upward flow of water caused by the tidal effect (DHI, 1993).

Particularly, heavy siltation has been observed to occur at the off-take of Gorai from the Ganges River. The rate of siltation here was so high that the off-take of the river was used to be completely silted up, blocked and discontinued its flow from the Ganges at Talbaria under Kushtia district in the month of December, 1988. The blockade of the off-take used to be continued until May next year and breached due to on-rush of water from Ganges when the water level of Ganges was on the rise in the wet season.

This incident of blockade at the off-take and discontinuation of water from Ganges to Gorai was causing serious threat to the environmental degradation and salinity intrusion from the south. With a view to minimizing this, the river Gorai was dredged during 1991 and 1992 by Dredger Directorate of BWDB under GOB funding to improve the fresh water supply through it towards south (BWDB, 2012).

Several studies were carried out to address the problem. Of them, one Study was carried out by Asian Development Bank from 1989-93 called Flood Action Plan (FAP Study) dividing Bangladesh in to eight (08) regions and conducting region-wise Study. For South-Western Region involving Ganges dependent Area falls in the Region-4 and the Study is named as FAP-4 Study.

The study recommended dredging of the Gorai off-take with ancillary structures following the objective as:

i. To prevent the environmental degradation in the GDA of south-west region, coastal belt and the Sundarbans by undertaking the restoration of Gorai River.
ii. Ensuring fresh water in the wet season and augmenting dry season flow.

The Government of the People's Republic of Bangladesh and India signed the historic treaty on the sharing of the Ganges water at Farakka Point on the 12th of December 1996. The treaty provides for sharing of water at Farakka for the period covering January 01 to May 31 every year. In order to utilize the Ganges water for the benefit of the people living in the Ganges Dependent Area and to offset the negative impacts of the continuous withdrawal of water upstream of Farakka, the dredging of Gorai River was taken up to give benefit for the Gorai basin also.

The Government of Bangladesh had undertaken the Gorai River Restoration Project (GRRP) with the assistance of Netherlands and Belgium. The Gorai River had been dredged starting from off-take to 20 km during the successive 3 years: 1998, 1999 & 2000 under a Pilot Priority Works (PPW). Maintenance dredging was not continued just after the completion of the Project in 2000. This time, one Feasibility Study was carried out by DHV-Haskoning and Associates in 2001. The Feasibility Study (FS) and detailed Engineering Design of GRRP were prepared by the Main Consultant (DHV-Haskoning and Associates). They recommended the components of works including the following which would guide more water into the Gorai during lean season while excluding sediment during monsoon season and thus minimizing maintenance dredging: -

Components of option AIR:

i. Flow divider at the off-take in the Ganges-Gorai Guide bundh.
ii. River training works along the Gorai.
iii. Dredging of clay-layer just downstream of Gorai off-take in the Gorai River.

A committee was formed in March 2009 by BWDB for technical study in the light Of the study carried outby DHV-Haskoning and Associates, 2001 and on the basis of the technical study, the DPP of the Project GRRP, Phase-II was prepared in May, 2009 and project date of commencement was November,2009 (DHV, 2001).

2.9 Description of Gorai River System

The Gorai River is the major distributaries of the Ganges River in the right bank and important provider of freshwater inflows to southwestern region of Bangladesh (Addams, 1919). It has a meandering and braiding tendencies. The length of the river is 199 km. The area of the Gorai River catchment area is 15160 km². The Gorai used to discharge into the Bay of Bengal through the Madhumati and Baleswar Rivers (Islam and Gnauck, 2011).

This River is an alluvial river and perennial in nature. Its course is wide, long, meandering and is known to adjust its slope, width, depth and velocity to achieve stable conditions at a specified supply of water and sediment (BWDB, 2011).

The Gorai-Madhumati River system has a flood discharge of nearly 7,000 cubic meters in the monsoon period but in winter the flow goes down from five cubic meters to nearly zero. These characteristics have made the river the element of concern because the agriculture, wildlife and fresh water supply to the south-west region are at risk and salinity has increased to an alarming rate (Clijncke, 2001).

2.9.1 River Morphology and Hydrology

Gorai is a meandering alluvial perennial river. Gorai River located between 21° 30’ N to 24° 0’ N latitude and89° 0’ E to 90° 0’ E longitude, covering partly or fully areas of Pabna, Chuadanga, Kushtia, Rajbari, Faridpur,Gopalgonj, Jessore, Jhenaidah, Magura, Norail, Pirogpur, Borguna, Bagerhat, Khulna and Sathkhira districts of southwestern region of Bangladesh. The river takes off from the Ganges at Talbaria, north of Kushtia town and 19kmdownstream from the Hardinge Bridgeand discharges into the Bay of Bengal through the Madhumati and Baleswar Rivers (Islam and Gnauck, 2011). River morphological and hydrodynamic parameters including discharge, velocity, water level, and total sediment transport,

cumulative erosion-deposition and chloride concentration as the salinity parameters are discussed in this study (Rahman and Yunus, 2016).

Sediment Transport

In the Ganges the transports of coarse suspended sediments during the monsoon is up to 8ton/day which means 100ton/s (RSP, 1996). In case of a discharge 50,000 m^3/s is the mean concentration will be 2 kg/m3 or 2000mg/1. The annual transport of the Ganges is estimated at 300 Mton (Halcrow, 1997).

In the Gorai the transports may rise to about 10 ton/s or 0.5 Mm3/day. With a discharge of5000m^3/s this yields the same concentration as found in the Ganges. So, the monsoons sediment transport ratios of 10% have been measured. Because of decreasing flow ratios Gorai/Ganges outside the monsoon period, the annual transport ratio is less than 10% (less than 30 Mton/year). The annual transport of the Gorai is estimated at 15 Mm3 (Halcrow, 1997).

Physical Properties of Riverbed Material

The size and composition of sediments change along a river. For the Gorai usually higherD50 values are mentioned, e.g., 170 to 200 microns. A remarkable feature is that the amount of fine material (e.g., finer than 63 micron) shows tremendous spatial variations. This was also found in connection with GRRP during the first dredging season of the project. From previous study that in 1966-69 the annual average bed material transport in the Ganges River is about $18x10^6$ metric tons (Goodbred et al., 2000).

Salinity

As regards to salinity, it is seen that there is no salinity in Kushtia, Kumarkhali and Khoksha. But in dry season salinity intrusion builds up at Khulna region. Salinity values in 1999,2000 and 2001 are considerably lower than during the other years. During these years, a major dredging program was undertaken, and the dry season flows were restored (Giardino and Winterwerp, 2012).

Discharge

Discharge of recent years at Hardinge Bridge and Gorai Railway Bridge show that the year of peak discharges at these two stations are not the same. Remarkable

observation in Ganges is the extreme peak of 1998 and in Gorai, remarkable high peak discharge was observed dolling the moderate monsoon of 1994 (GRC, 1999). During monsoon the Gorai takes about 10% from the Ganges flows. During an important of the lean season, as the Gorai flows are zero.

In 1973, 1984 and 1997 the Gorai River discharge were 190 m^3/s, 60 m^3/s and 2 m^3/s respectively. The mean peak flow in the Gorai River is 6,200 m^3/s.The minimum recorded monthly mean flow was 171m^3/s in April in 1995 (EGIS, 2000)

Water Levels

Long-term time series of water level at Hardinge Bridge show that the annual high waters are stable over the decades while annual minimum water levels show downward trend. In the last 20 years the minimum water levels dropped by more than one meter. As conditions changed that rapidly, mainly hydrometric statistics of recent years are more useful to consider for the Plumose of restoration of Gorai (GRC, 1999).

Recent water level in front of the Gorai off-take near Talbaria shows extremely high water in September 1998 and unusual peak in December 1997. The lowest waters at Talbaria were recorded in April 1995 while the low water levels near Gorai Railway Bridge in lean season do not have any physical meaning if there is no flow in the Gorai.

Velocity

It can be visualized from that during both the wet and dry season for the year 2010 there is a higher velocity of flow in the main channels and flood plains in case of dredged bathymetry. The velocity in the main channel is obviously greater than the velocity in the side channels.

During the wet season flow velocity throughout the study reach varies from 0.3 m/s-0.9 m/s in case of original depth profile whereas the range of velocity increases to 0.4 m/s-1.1 m/s in dredged bathymetry. During the lean period flow velocity falls within the range of 0.06 m/s-0.16 m/s that increases to 0.30 m/s to 0.65m/s in dredged bathymetry.

2.9.2 Importance to Sundarbans

The delta of the Ganges-Brahmaputra-Meghna River system is the sixth largest in the world with an area below -2 m MSL of 6170 km^2. The two rivers combined, Ganges and Brahmaputra, today have the largest sediment discharge capacity in the world equal to about 10^9 tons per year (Goodbred and Kuehl, 2000).

Geological evidence suggests that the main course of the Ganges has been shifting eastwards after abandoning several courses, amongst which the Gorai, which became a distributary of the main river (Sarker, 2005). The Ganges was flowing close to the present course of the Gorai River nearly 5,000 years ago.

The Ganges drains the southern slopes of the Himalayas. The annual average flow measured at the Hardinge Bridge, located at about 15 km upstream of the Gorai off-take, since the mid-1930s is about 11,000 m3/s (Sarker, 2005), with peak discharges of about40,000 m3/s. The river flow is characterized by a profound wet-dry season cycle, where the wet season runs from June through October. However, river discharges have been declining over time.

The Gorai River diverts fresh water from the Ganges River into a few distributaries, the main ones being the Pussur, Baleshwar and Sibsa rivers. These flows constitute a critical resource both for the population and the ecological habitats of the region.

In the current study, the Gorai River has been divided into three different sections, characterized by a different morphological behavior and with different economic and ecological values (Giardino and Winterwerp, 2012).

Upper Gorai River from the location of the off-take point down to Khulna. The total length of this part of the river is approximately 135 km.

Confined Gorai River system, from Khulna down to the landward Sundarbans limits, approximately where the port of Mongla is located. This part of the river is characterized by polders at the two sides of the river. The length of this river stretch is about 45 km. The Gorai is named Rupsa River here.

The Sundarbans bordering is approximately the last 90 km of the river. The Sundarbans is the largest mangrove forest in the world and a UNESCO World Heritage Site. The majority of fresh Gorai water flows through the Pussur, and small amounts (distribution is in known) through the Sibsa and Baleshwar (west and east of

the Pussur, respectively). A major part of the Sundarbans is flooded during high water, during the monsoon, when mean water levels increase by about0.7 m.
Only the Gorai River sections are analyzed in the current report, because they will benefit most from the off-take river works (Giardino and Winterwerp, 2012).

2.10 Previous Studies

The Gorai River is an important distributary of Ganges River and one of the main rivers of the south-western region of Bangladesh. With the reduction of discharge of Ganges, Gorai River has also been experiencing the same problem of reduction of discharge which was causing siltation at its bed throughout the length. Particularly, heavy siltation has been observed to occur at the off-take of Gorai from Ganges river. The rate of siltation here was so high that the off-take of the river was used to be completely silted up, blocked and discontinued its flow from the Ganges at Talbaria under Kushtia district in the month of December, 1988 (BWDB, 2012).

Blockade at the off-take and discontinuation of water from Ganges to Gorai was causing serious threat to the environmental degradation and salinity intrusion from the south. With a view to minimizing this, the river Gorai was dredged during 1991 and 1992 by Dredger Directorate of BWDB under GOB funding to improve the fresh water supply through it towards south (Halcrow, et al., 1997).

Khan (1986) analyses the sediment data of the river Gorai-Madhumati at Gorai Railway Bridge. In the study, the average daily maximum sediment concentration in the Ganges and Gorai River was found to be 2,344 ppm and 550 ppm respectively during 1975-85 periods. Also, the average sediment transport in Gorai during 1975-1981 was found to be 13.27 million Tons/yr.

Islam (1996) studied some morphological characteristics of the Gorai-Madhumati River. He analyzed water level, discharge, sediment transport, channel cross-sections and channel plan forms data. He stated that the ratio of meander wave lengths to meander belt gradually decreased with time. In some cases, strong correlation was found with average channel width with meander parameters. Bank erosion rates were

found to depend on the relative bend curvature value. Average riverbed slope, valley slope, sinuosity, channel longitudinal bed profiles, formation of cut-offs, meander development and length changes of the river with time were also studied.

Halcrow (1993) studied on Southwest Area Water Resources Management Project (FAP4). One of their important studies is on hydro-morphology of Ganges-Gorai system and the impacts on salinity intrusion for the southwest region of Bangladesh. During the development of a one-dimensional Gorai sub-model, it was realized that the correct simulation of water level at Talbaria is very important in order to simulate the split of flows into the Gorai from the Ganges. This is apparently difficult for low flows in the Ganges because the low flow hydraulic conditions of Ganges (also of Gorai) changes significantly.

FAP 24 also carried out 2D morphological modelling at Gorai off-take. Some of the findings of the 2D modelling are that during rising stage, the bed level at the off-take rises and the channel becomes wider and during falling stage, the bed level drops and the channel becomes more narrow. In the simulation the development of the bar in front of the off-take is quite sensitive to the flow resistance in the downstream reach of the Gorai. A sudden increase in bed levels at the off-take would remain in the following year after a normal flood year. This morphological model has provided valuable information about the morphological nature of the off-take.

Halcrow (1997) produced a project report entitled "Gorai River Restoration Project, priority dredging and ancillary works". In the report, morphological studies undertaken by FA P 4 and FAP 24 were reviewed and updated. The report states that morphological considerations support the premise that without intervention the decline of Gorai would continue and that interventions are required to restore the river. A program of dredging to restore flows should be carried out to work "with the river" and the route of the dredged channel and the spoil disposal areas should be carefully chosen to encourage the bend and bar features exhibited formerly. The report also mentions the specific areas which need to be dredged. Also, there are

some recommendations for guide bunds or groynes, at the mouth of the river and certain revetments works at key places along the banks.

EGIS (2000) presents the "Environmental Baseline" of the Gorai River Restoration Project. The main objective was to put on record the status of the environment in the project area especially the consequences of the disruption in the flow of water through the Gorai during the dry season. During the study, it was tried to assess the environmental, ecological, sociological, economical and resettlement effects and/or benefits for the project Both primary and secondary data were used for the assessment.

CHAPTER 3
METHODOLOGY AND DATA COLLECTION

3.1 Introduction

This chapter presents the methodology followed in carrying out this research, including rationale for site selection, data collection, and setup of questionnaire survey for evaluate the environmental impacts of Gorai River dredging.

3.2 Study Area

In this work Gorai River system throughout the length from Talbaria to Khoksha and its surroundings has been selected for study area, where off-take is located at the Talbaria and downstream is located at the Khoksha (Figure 3.1). Five locations at Talbaria, Mongol baria, Gorai Railway Bridge, Kumarkhali groyne and Khoksha has been selected for data collection (Figure 3.1).

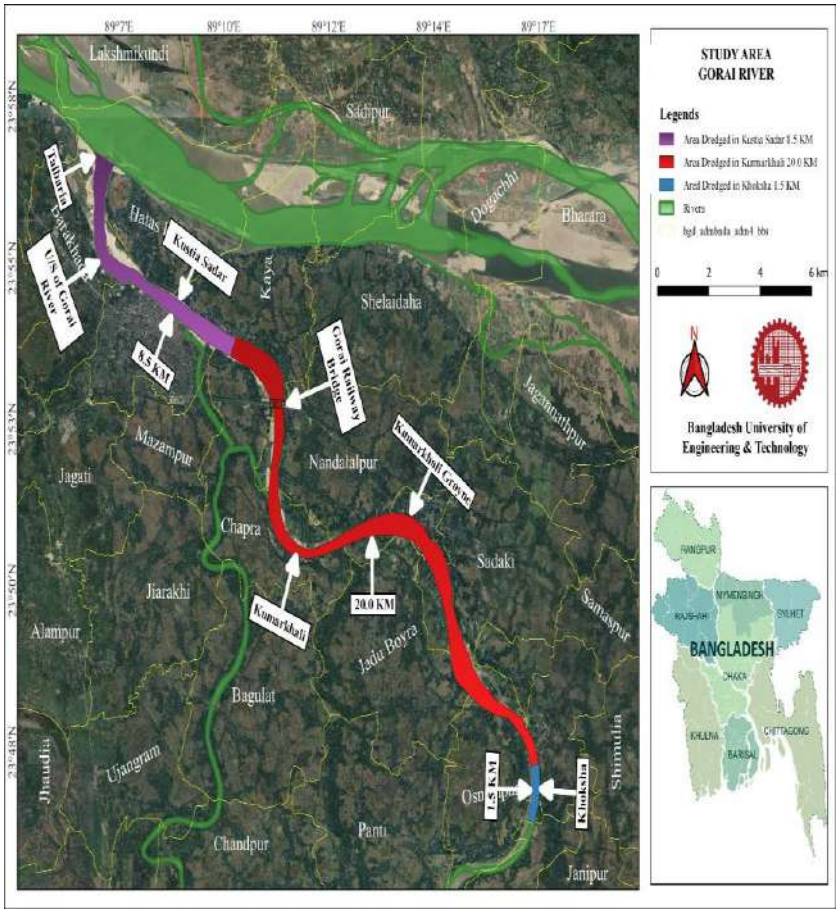

Figure 3.1: Study area

3.3 Data Collection

Data collection process is divided in two sub-categories, such as primary data collection and secondary data collection.

3.4 Primary Data Collection

Primary data collection mainly depends on questionnaire survey, such as beneficiaries (farmers, fishermen, boatmen, sand traders) and Officials of the Gorai River Restoration Project Phase-II.

3.5 Sample Size Calculation

The sample size for the study has determined by using the following statistical formula (Bartlett et al., 2001): -

$$n = \frac{z^2pq}{d^2} x \text{ Design effect} \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots 3.1$$

$$= \frac{(1.96)^2 X (0.70) X (0.30)}{(0.05)^2} \text{x } 1.0$$

$$= \frac{3.84 x 0.21}{0.0025} \text{x}1.0$$

$$= 322.5\text{x}1 = 322.5 \approx 350$$

Where, n = Sample size (to be determined)

p = Percentage occurrence of a state or condition=0.70

q = 1-p = 1.0-0.70 = 0.30

d = Error level = 5%

z = the value of standard variant at 95% confidence level = 1.96

Because of the heterogeneity in the target population across the study area, the design impact is assumed to be 1.

3.6 Category wise allocation of sample

Above the equation 3.1, the sample size has determined to be as 350. Mention here that I considered 10 Officials of the River Restoration Project Phase-II for questionnaire survey. These respondents (beneficiaries) are distributed among the five locations at Talbaria, Mongol baria, Gorai Railway Bridge, Kumarkhali groyne and Khoksha. Table 3.1 shows the total list containing the category wise allocation of sample.

Table 3.1: Category wise allocation of sample

Location	Number of respondents	Officials relating to the Project	Total respondents
Talbaria	70	10	360
Mongol baria	70		
Gorai Railway Bridge	70		
Kumarkhali groyne	70		
Khoksa	70		

3.7 Occupational status of respondents

Occupation of respondents was 61.5% involved in farming, 7.1% in fisherman, 7.1 % in boatman and 24.3% of the respondents involved as sand traders (Table 3.2). The percentage of respondents for this research is same as the Mid-term Evaluation Report, IMED, 2014 for Gorai River Restoration Project-II.

Table 3.2: Occupational status of respondents

Current study, 2021			Source: Mid-term Evaluation Report, IMED, 2014		
Types of occupation	**Number**	**%**	IMED Report, 2014, considering percentage (%) of occupation.	**Number**	**%**
i. Farmers	215	61.5		430	61.5
ii. Fisherman	25	7.1		50	7.1
iii. Boatman	25	7.1		50	7.1
iv. Sand traders	85	24.3		170	24.3
Total respondents	**350**	**100.0**		**700**	**100.0**

3.8 Questionnaire Survey for Beneficiaries

Various types of important information have collected from the beneficiaries of the project such as farmers, fishermen, boatmen; sand traders etc. through the various types of questions (appendix A) for analyzing the environmental impact. Data has been collected from 09-09-2021 to 18-09-2021.The total study area is divided in four zones. Such as:

Zone-1: Upstream dredged and non-protective area

Zone-2: Upstream dredged and protective area

Zone-3: Downstream dredged and protective area

Zone-4: Downstream non dredged and non-protective area

Also study areas are in three upazillas such as Kushtia sadar, Kumarkhali and Khoksha. Only 30 km length is dredged of Gorai River where Kushtia sadar is 8.5 km, Kumarkhali is 20 km, and Khoksha is 1.5 km. Figure 3.2 shows the questionnaire survey plan for data collection from Gorai River Restoration Project Phase-II.

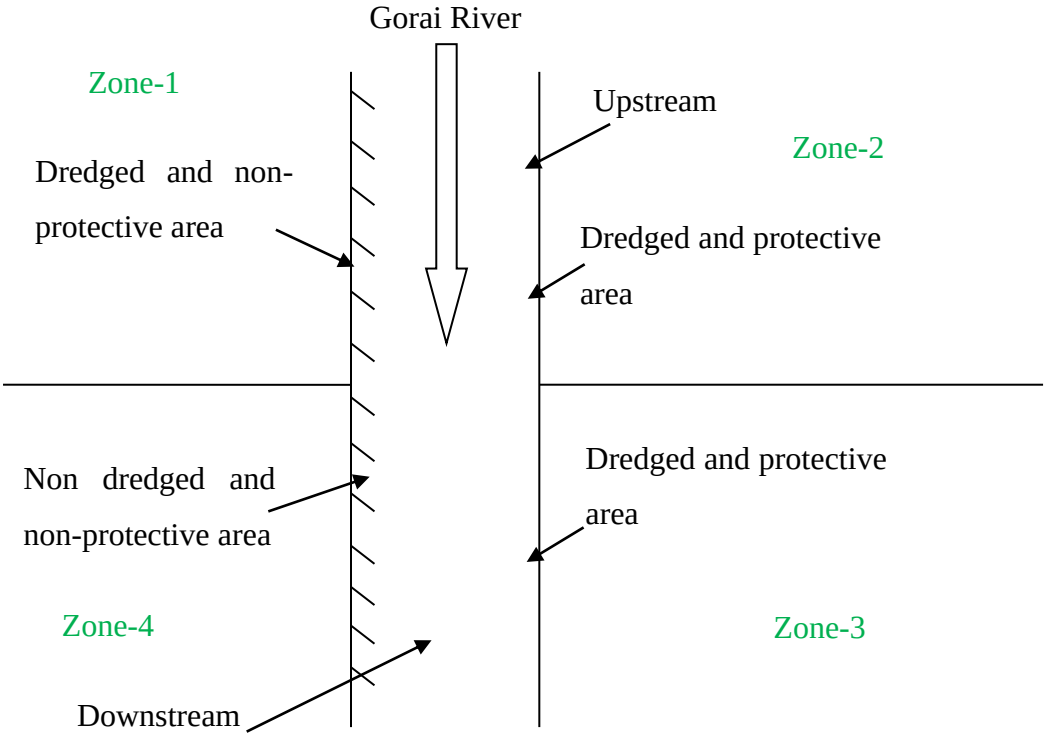

Figure 3.2: The questionnaire survey plan for Beneficiaries

Questionnaire Survey for Farmers:

In the Questionnaire Survey, Data has been collected from farmers regarding Gorai River Restoration Project Phase-II on the following issues:

i. Which water is currently used in agriculture?
ii. At present (2021) how many crops are produced in the land?
iii. At present (2021) the amount of crop production in the land has increased or not?
iv. What is the cause of increase / decrease in crop production?
v. Is there any new employment opportunity for farmers in Gorai River now?

Figure 3.3 shows the questionnaire survey for data collection from farmers in Gorai River Restoration Project Phase-II.

Figure 3.3: Questionnaire Survey from farmers.

Questionnaire Survey for Fisherman:

In the Questionnaire Survey, Data has been collected from fisherman regarding Gorai River Restoration Project Phase-II on the following issues:

i. At present (2021) in the river Gorai fish production has increased or not?
ii. What is the cause of increase / decrease in fish production?
iii. Is the water in Gorai River suitable for aquatic life during the current dry season?
iv. Is there any new employment opportunity for fishermen in Gorai River now?

Figure 3.4 shows the questionnaire survey for data collection from fisherman in Gorai River Restoration Project Phase-II.

Figure 3.4: Questionnaire Survey from fisherman.

Questionnaire Survey for Boatman:

In the Questionnaire Survey, Data has been collected from Boatman regarding Gorai River Restoration Project Phase-II on the following issues:

i. As a result of the implementation of this project in the current dry season, the Gorai River always has water.
ii. How do people cross the river in the dry season?
iii. Is the water in the Gorai River suitable for navigation during the current dry season?
iv. Has the implementation of this project created job opportunities for boatman?

Figure 3.5 shows the questionnaire survey for data collection from boatman in Gorai River Restoration Project Phase-II.

Figure 3.5: Questionnaire Survey from Boatman.

Questionnaire Survey for Sand Traders:

In the Questionnaire Survey, I was collected data from sand traders regarding Gorai River Restoration Project Phase-II on the following issues:

i. Has the amount of water in Gorai River increased during the current (2021) drought season due to dredging?
ii. What is the condition of sand lifting from Garai River during dry season?
iii. What causes decrease/increase in sand lifting?
iv. What is the condition of sand transportation from Garai River during dry season?
v. What causes decrease/increase in sand transportation?
vi. Has there been any new employment opportunity in dredging sand extraction and transportation from Gorai River?

Figure 3.6 shows the questionnaire survey for data collection from sand traders in Gorai River Restoration Project Phase-II.

Figure 3.6: Questionnaire Survey from Sand Traders.

3.9 Questionnaire Survey for Officials

Various types of important information have collected from the officials of the project through the various types of questions (appendix A) for analyzing the environmental impact. In the Questionnaire Survey, Data has been collected from

Superintending Engineer, Executive Engineer, Sub-Divisional Engineer, Assistant Engineer and Sub-Assistant Engineer who was directly involved, regarding Gorai River Restoration Project Phase-II on the following issues:

i. What is the total length of the project that is being implemented in the year 2009-2017 called Garai River Restoration Project-Phase-II?
ii. How many km of dredging was done in Kushtia sadar, Kumarkhali and Khoksa?
iii. What is a suitable location for dumping dredged soil, from the viewpoint of no future situation of riverbank by it?
iv. Whether there was enough manpower to operate and maintain Dredger?
v. When do you think the regular dredging program should start and end?
vi. Whether maintenance will be required for navigability of Garai River after the completion of the project.
vii. Is there any surface water measurement station, salinity station, discharge station, ground water station etc. in Garai River?
viii. Whether the implementation of the project has any environmental impact on Biodiversity of the surroundings of Gorai River.
ix. Do you think the duration of this project should be extended?
x. According to you, this type of project or any other type of method should be adopted where silt accumulates in the river?

Figure 3.7 shows the questionnaire survey for data collection from officials in Gorai River Restoration Project Phase-II.

Figure 3.7: Questionnaire Survey from officials.

3.10 Secondary Data Collection

All types of secondary data (Table 3.3) were collected from Processing & Flood Forecasting Circle (PFFC), under Bangladesh Water Development Board (BWDB). The following secondary data has collected from Bangladesh Water Development Board (BWDB) to analyze the impacts of dredging:

Table 3.3: Secondary Data Collection

Data	Location/ID	Period	Source
Salinity	Khulna (SW-241)	2009-2020	BWDB
Discharge	Gorai Railway Bridge (SW-99)	2009-2020	BWDB
Surface Water Level	Gorai Railway Bridge (SW-99)	2009-2020	BWDB
Ground Water Level	KustiaSadar	2009-2020	BWDB

The number of salinity stations, discharge stations, surface and ground water level stations of Gorai River in Kushtia district is collected from the project related field office and Bheramara Hydrology Section, BWDB, Kushtia (Table 3.4).

Table 3.4: Data of various stations of Garai River

Item	Discharge Stations (nos)	Salinity Stations (nos)	Surface water level stations (nos)	Ground water level stations (nos)	Rain Gauge stations (nos)	Evaporation stations (nos)
	2	0	3	45	3	3

CHAPTER 4
RESULTS AND DISCUSSION

4.1 Introduction

Gorai River Restoration Project (Phase-II) is a Project of Annual Development Program (ADP) being financed by Government of Bangladesh (GOB) and implemented by Bangladesh Water Development Board (BWDB) under the sponsorship of Ministry of Water Resources (MOWR). The Project commenced in November, 2009 and targeted for completion in June, 2013 but the completion time extended up to June, 2017. The Gorai River had been dredged starting from off-take to 30 km during the successive 9 Years (Table 4.1) under a Pilot Priority Works (PPW). For this study, during dredging 2009-2017 and after dredging 2018-2020 has considered Phase-II and Phase-III respectively.

Table 4.1: Dredging of Gorai River

Dredging of Gorai River (2009 -2017)									
Year	2009	2010	2011	2012	2013	2014	2015	2016	2017
Volume in %	0	1.96	15.32	21.53	33.65	4.58	6.90	1.89	14.16

Source: Data collected from the Project Completion Report, BWDB, 2017.

4.2 Salinity of water in Gorai River

Table 4.2 shows information from respondents related to salinity of water. One of the objectives of this evaluation study was to analyze the impact on salinity of Gorai River due to dredging.

As per questionnaire survey, about 99% respondents stated that the unavailability of saline in the drinking water and water of Gorai River and loss of crop production and related problems are almost zero in the Gorai River areas.

Table 4.2: Information related to salinity of water.

Status of salinity in study areas		Percentage of 2021 (n=350)	Percentage of 2013* (n=700)
A.	Presence of saline in the drinking water (n=350)		
	• Yes (slightly salted)	0.9	0.4
	• No	99.1	99.6
B.	Presence of saline in the water of Gorai River		
	• Yes	0.6	0.3
	• No	99.4	99.7
C.	Any health problems faced due to intake of saline water		
	• No symptoms observed	0.9	0.4
	• Not applicable because no presence of salt in the water	99.1	99.6
D.	Any problem faced in crop production due to use of saline water		
	• No problems faced	100.0	100.0

***** Source: 2013 data collected from Mid-term Evaluation Report, IMED, 2014.

4.3 Availability of surface water

4.3.1 Primary data

One of the objectives of this evaluation study was to analyze the impact on availability of surface water in dry season of Gorai River due to dredging. Table 4.3 shows that due to restoration of Gorai River, availability of surface water in dry

season during 2021 has increased as stated by respondents (86.2%). This represents that more surface water is available at location where more dredging work was done.

Table 4.3: Information related to surface water.

Status of surface water		Percentage of 2021 (n=350)	Percentage of 2013* (n=700)
A.	Is there always water in Gorai River in the current dry season?		
	• Yes	85.7	80.5
	• No	14.3	19.5
B.	Has the amount of water in Gorai River increased during the dry season?		
	• Yes	86.2	81.3
	• No	8.0	10.4
	• Same as before	5.8	8.3

***** Source: 2013 data collected from Mid-term Evaluation Report, IMED, 2014.

4.3.2 Secondary data

There are three water level measuring stations of the BWDB in Gorai River in which data of Gorai Railway Bridge station is collected for analysis. Gorai Railway Bridge station which is a station of Gorai River is selected for analysis purpose. Monthly minimum water level at Gorai Railway Bridge station during dredging (Phase-II) and monthly minimum water level at Gorai Railway Bridge after dredging (Phase-III) are shown in Table 4.4 and Table 4.5 respectively. This data is collected to analyze the availability of surface water in the Gorai River during the dry season. The secondary data is collected form Processing and Flood Forecasting Circle (PFFC), BWDB, 2021.

Table 4.4: Monthly minimum water level observed at Gorai Railway Bridge during dredging (Phase-II)

Year	Monthly minimum Water level observed in different year (m)							
Month	January	February	March	April	May	June	November	December
2009	4.21	3.84	3.76	3.73	4.24	4.69	6.04	4.83
2010	4.46	4.38	4.03	3.94	4.25	5.00	6.55	4.77
2011	4.03	3.94	3.90	3.77	3.88	5.18	6.59	5.70
2012	5.53	5.18	4.32	4.26	4.58	4.87	6.23	4.86
2013	4.14	4.01	3.95	3.79	4.04	5.55	5.59	4.55
2014	4.19	4.23	4.18	3.97	4.04	5.20	4.75	3.82
2015	3.72	3.44	3.47	4.01	4.60	5.25	5.17	4.55
2016	4.17	4.05	3.87	3.82	4.65	5.18	5.53	3.93
2017	3.80	3.62	3.85	4.22	4.46	4.90	4.96	3.90
Max	5.53	5.18	4.32	4.26	4.65	5.55	6.59	5.70
Min	3.72	3.44	3.47	3.73	3.88	4.69	4.75	3.82
Mean	4.25	4.08	3.93	3.95	4.30	5.09	5.71	4.55

Table 4.5: Monthly minimum water level observed at Gorai Railway Bridge after dredging (Phase-III)

Year	Monthly minimum water level observed in different year (m)							
Month	January	February	March	April	May	June	November	December
2018	3.68	3.66	3.59	3.70	3.84	4.53	4.85	4.07
2019	3.86	3.73	3.84	3.85	3.90	4.74	6.20	5.33
2020	4.50	3.68	3.63	3.66	4.09	6.23	6.17	5.24
Max	4.5	3.73	3.84	3.85	4.09	6.23	6.20	5.33
Min	3.68	3.68	3.59	3.66	3.84	4.53	4.85	4.07
Mean	4.01	3.69	3.69	3.74	3.94	5.17	5.74	4.88

Table 4.4 shows that generally minimum water level on April (as 3.73 in 2009) in every year but sometimes it is seen in March or May and generally increased in May or June. On the other hand, Table 4.5 shows that generally minimum water level on April (as 3.66 in 2020) in every year but sometimes it is seen in March or May and generally increased in May or June.

It also Table 4.4 and 4.5 shows that in the month of January to December (except May and June) maximum value of surface water at Gorai Railway Bridge station occurs Phase-II is more than Phase-III. So, dredging is continuing to facility Gorai River for getting more surface water in this surroundings area. In addition to the

dredging in Gorai River rainfall, sediment, upstream flow etc. are also some of the factors contributing to more availability of surface water.

Comparison of water level mean value of phase –II and phase-III are shown in Figure 4.1:

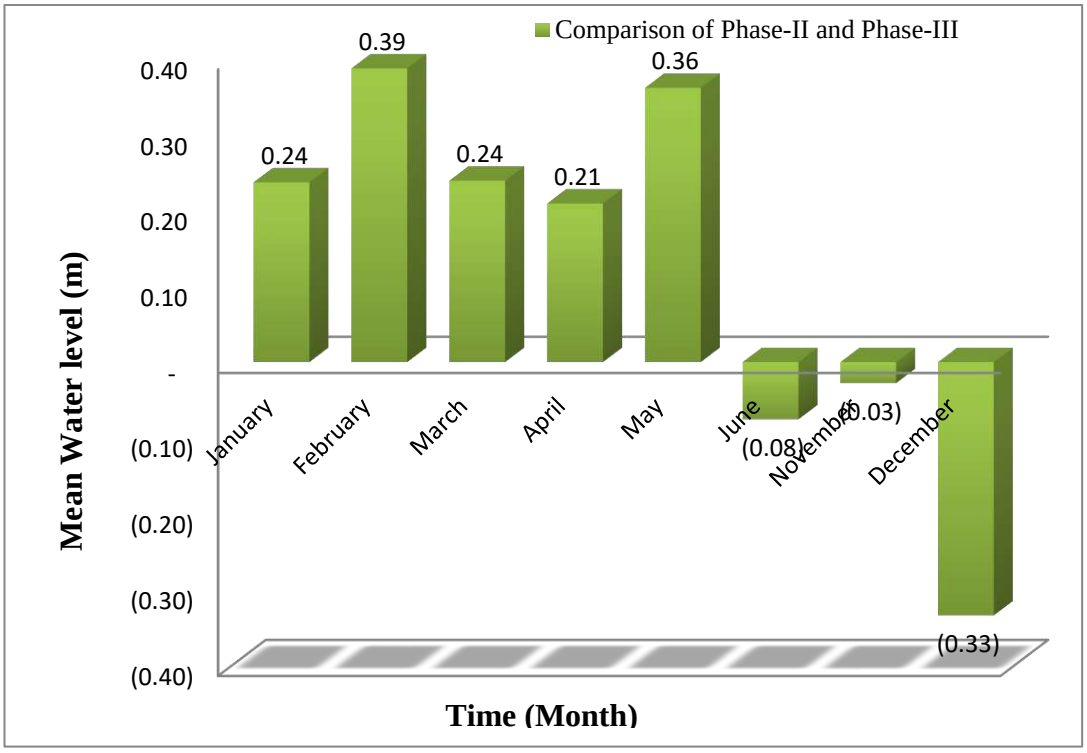

Figure 4.1: Comparison of water level mean value of phase –II and phase-III.

From Figure 4.1 it shows that water level mean value of phase-II in January to May is more than from phase-III and another month water level mean value of phase-II is approximately same as phase-III value. In the month of February water level mean value in phase-II increased maximum as 0.39 and minimum is 0.33 from phase-III. So, if dredging is going on in Gorai River system, then it is possible to get available surface water in Gorai River system.

4.3.3 Availability of discharge

There are three water flow measuring stations of the BWDB in Gorai River. For flow measurement flow measuring stations of the BWDB at Gorai Railway Bridge station is collected for analysis purpose. Monthly average discharge at Gorai Railway Bridge station during dredging (Phase-II) and monthly average discharge at Gorai

Railway Bridge after dredging (Phase-III) are shown in Table 4.6 and Table 4.7 respectively. The secondary data is collected form Processing and Flood Forecasting Circle (PFFC), BWDB, 2021.

Table 4.6: Monthly average discharge data observed at Gorai Railway Bridge during dredging (Phase-II)

Year	Monthly average discharge data observed in different year (m^3/s)							
Month	January	February	March	April	May	June	November	December
2009	278.69	40.57	12.03	5.12	5.40	212.35	681.52	189.24
2010	37.47	21.88	12.73	10.79	41.24	591.46	626.39	190.20
2011	36.20	8.71	5.80	41.20	56.30	880.80	600.38	544.18
2012	390.20	245.10	190.63	171.20	173.40	600.10	638.50	383.55
2013	205.00	127.61	147.77	102.80	170.66	505.69	482.69	230.10
2014	150.76	151.80	141.35	130.40	155.30	248.30	400.07	79.49
2015	12.00	7.95	20.05	66.77	100.06	407.91	150.33	27.48
2016	9.70	4.94	3.05	1.99	78.01	795.14	318.29	101.38
2017	26.76	23.99	29.77	37.63	45.17	142.61	755.00	294.71
Max	390.20	245.10	190.63	171.20	173.40	880.80	638.50	544.18
Min	9.70	4.94	3.05	1.99	5.40	142.61	150.33	27.48
Mean	127.42	70.28	62.58	63.10	91.73	487.15	517.02	226.70

Table 4.7: Monthly average discharge data observed at Gorai Railway Bridge after dredging (Phase-III)

Year	Monthly average discharge data observed in different year (m^3/s)							
Month	January	February	March	April	May	June	November	December
2018	143.80	7.24	5.18	48.04	47.30	109.17	321.88	172.56
2019	89.49	9.33	4.45	6.81	5.55	36.08	606.75	451.69
2020	242.42	72.52	6.48	9.28	16.46	582.67	775.60	427.44
Max	242.42	72.52	6.48	48.04	47.30	582.67	775.60	451.69
Min	89.49	7.24	4.45	6.81	5.55	36.08	321.88	172.56
Mean	158.57	29.70	5.37	21.38	23.10	242.64	568.08	350.56

Table 4.6 shows that generally minimum discharge occurs during March – May every year and generally increased in May or June. On the other hand Table 4.7 shows decrease of a flow in the respective months in Phase-III. It also Table 4.6 and 4.7 shows that in the month of January to December (except November) maximum value of discharge Gorai Railway Bridge station occurs Phase-II is more than Phase-III. So, dredging is an important part of Gorai River for getting more surface water in this surroundings area. There are other factors like rainfall, sediment, upstream flow etc. contributing to this as well.

Comparison of discharge mean value of phase –II and phase-III are shown in Figure 4.2:

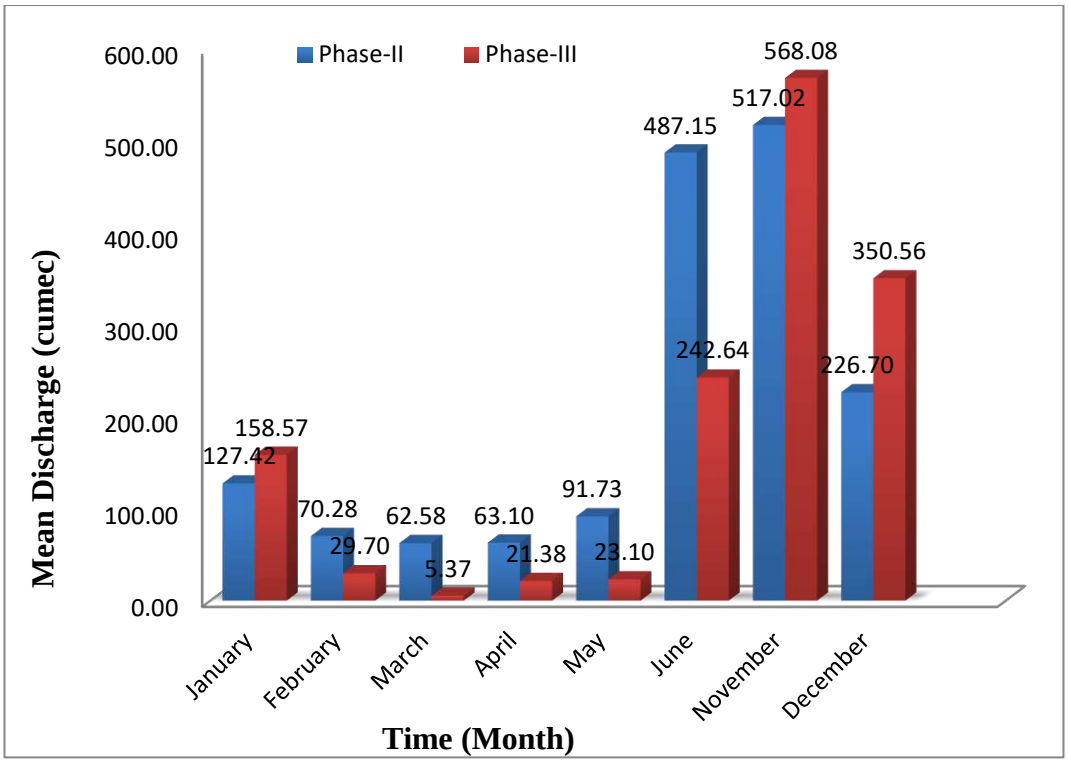

Figure 4.2: Comparison of discharge mean value of phase –II and phase-III.

From Figure 4.2 it shows that discharge mean value of phase-II in February to June is more than from phase-III and another month discharge mean value of phase-II is approximately same as phase-III value. So, if dredging is going on than it is possible to get available water in Gorai River system.

4.4 Availability of Ground Water

4.4.1 Primary data

Table 4.8 shows that due to dredging in Gorai River, availability of ground water in dry season during 2021 has increased about 5% than 2013 and 12% than 2009. So, it observed that availability of ground water for drinking purpose throughout the year is ensured.

Table 4.8: Information related to ground water.

Status of ground water in before, during and after dredging			
A.	Availability of water in the tube well during dry season (2021):	Number	%
	• Yes	319	91.1
	• No	31	8.9
B.	Availability of water in the tube well during dry season (2013):		
	• Yes (Source: Mid-term Evaluation Report, IMED, 2014)	609	87.0
	• No (Source: Mid-term Evaluation Report, IMED, 2014)	91	13.0
C.	Availability of water in the tube well before 2009 dry season		
	• Yes (Source: Mid-term Evaluation Report, IMED, 2014)	563	80.4
	• No (Source: Mid-term Evaluation Report, IMED, 2014)	137	19.6

4.4.2 Secondary data

There are forty ground water measuring stations of the BWDB in Kushtia. For measurement ground water measuring stations of the BWDB at Kushtia Sadar station is collected for analysis purpose. The Ground water table observed at Kushtia Sadar during dredging (Phase-II) and the Ground water table observed at Kushtia Sadar after dredging (Phase-III) is shown in Table 4.9 and 4.10 respectively. This data is collected to analyze the availability of ground water in dry season of tube well.

Table 4.9: Ground water table observed at Kushtia Sadar during dredging (Phase-II)

Year	Ground water table observed in different year (m)							
Month	January	February	March	April	May	June	November	December
2009	8.77	9.28	9.62	9.56	9.33	8.78	6.92	8.00
2010	8.77	9.32	9.61	9.80	9.33	8.30	6.55	6.60
2011	9.06	9.34	9.57	9.80	9.57	7.20	6.71	7.50
2012	8.50	8.87	8.90	9.40	9.50	9.05	6.69	6.75
2013	NA	NA	NA	NA	NA	7.80	NA	NA
2014	NA	NA	NA	NA	NA	NA	NA	NA
2015	9.06	9.32	9.77	9.27	8.90	8.38	3.52	2.80
2016	NA	NA	NA	NA	NA	4.64	NA	NA
2017	NA	NA	9.67	9.93	9.07	8.99	7.18	8.27
Max	9.06	9.34	9.77	9.93	9.57	9.05	7.18	9.27
Min	8.50	8.87	8.90	9.27	8.90	4.64	3.52	2.8
Mean	8.83	9.23	11.43	11.55	11.14	7.89	6.26	6.65

NA means Not Available

Table 4.10: Ground water table observed at Kushtia Sadar after dredging (Phase-III)

Year	Ground water table observed in different year (m)							
Month	January	February	March	April	May	June	November	December
2018	9.37	9.70	10.10	10.18	NA	NA	NA	NA
2019	NA	NA	9.48	9.62	9.36	8.99	6.80	NA
2020	8.49	9.09	9.34	9.35	9.08	7.50	7.50	8.39
Max	9.37	9.70	10.10	10.18	9.36	8.99	7.50	8.39
Min	8.49	9.09	9.34	9.35	9.08	7.50	6.80	8.39
Mean	8.93	9.40	9.64	9.72	9.22	8.25	7.15	8.39

NA means Not Available

From Table 4.9 shows that generally maximum ground water table in April (as 9.93) in every year but sometimes it's seen in March or May and generally increased in May or June. On the other hand, from Table 4.10 shows that generally maximum ground water table in April (as 10.18) in every year but sometimes it's seen in March or May and generally increased in May or June. So, dredging is an important part of Gorai River for getting more available ground water in this surroundings area. Not only is the water level in the Gorai River due to dredging but also rainfall, sediment, upstream flow etc. are some of the reasons for this.

Comparison of ground water maximum value of phase –II and phase-III are shown in Figure 4.3:

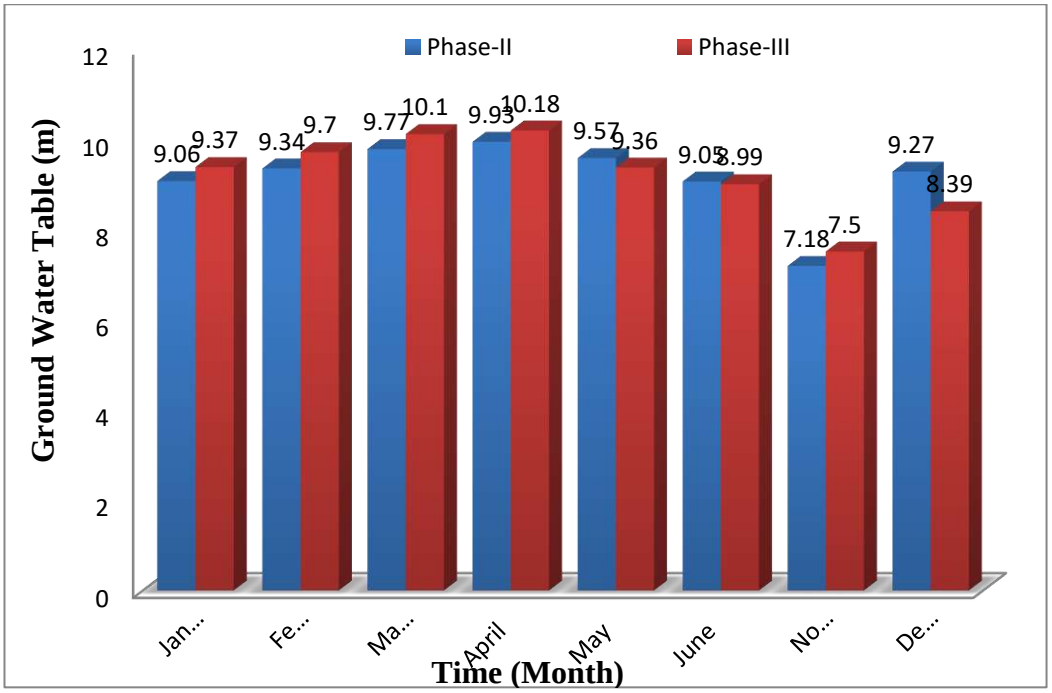

Figure 4.3: Comparison of ground water maximum value of phase –II and phase-III.

From Figure 4.3 it shows that maximum value of ground water of phase-II in January to November (except December) is less than from phase-III and another month ground water mean value of phase-II is approximately same as phase-III value. Ground water table value is less meaning ground water is available in this surrounding area. So, if dredging is going on in Gorai River system, then it is possible to get available ground water in Gorai River system.

4.5 Irrigation

4.5.1 Sources of water for irrigation

Table 4.11 shows that during dredging about 2% of respondents are use water through Low Lift Pumps LLP from Gorai River but after dredging about 15% of respondents are use water through LLP from Gorai River. On the other hand, dependency of irrigation water from other sources is reduced from 82% to 70%.

Table 4.11: Sources of water for irrigation

Sources of water	Use of water in percentage (2021) (n = 215)	Use of water in percentage (2013 *) (n = 430)
i. Brings water through LLP from Gorai River	14.9	2.0
ii. Brings water from GK project for irrigation	15.3	16.0
iii. Other sources	69.8	82.0

***** Source: 2013 data collected from Mid-term Evaluation Report, IMED, 2014.

4.5.2 Cropping intensity

Table 4.12 shows that farmers are living adjacent to the Gorai River are converted from 1 crop to 2 or more crops to produce per year due to more flow of water in Gorai River during dredging as well as slightly increased level of ground water during dry season.

Table 4.12: Number of crops produced during the years 2009 and 2013 and 2021.

Number of crops	2009* (n=430)	2013* (n=430)	2021 (n=215)
i. 1 crop	11.5%	7.7%	5.6%
ii. 2 crops	52.7%	41.6%	38.6%
iii. 3 crops	35.8%	50.7%	55.8%

*Source: 2009 & 2013 data collected from Mid-term Evaluation Report, IMED, 2014.

4.6 Crop Productivity

4.6.1 Volume of productivity

The 4.13 shows that most of respondents (93%) has state that volume of production of crops increased due to availability of surface water and ground water through the year.

Table 4.13: Volume of production increased/same as /decreased as stated by farmers during 2009 and 2013 and 2021.

Status of production (n=215)	2009* (n=430)	2013* (n=430)	2021 (n=215)
Vol. of production increased	83.1%	91.0%	93.0%
Vol. of production same as before	11.7%	05.2%	04.7%
Vol. of production decreased	05.2%	03.8%	02.3%

*Source: 2009 & 2013 data collected from Mid-term Evaluation Report, IMED, 2014.

4.6.2 Reasons for increase/decrease in the production of crops

The table 4.14 shows that reasons for increase and decrease in the production of crops are not directly attributed due to project activities. 41.9% of the farmers stated about increased supply of water during dredging period only and 39.50% of the farmers stated more use of improved seeds and fertilizers helped increase production which is beyond the effect of project activities.

Table 4.14: Reasons for increase/decrease in the production of crops

Reasons for increase/decrease in production	Percentage of 2021 (n = 215)	Percentage of 2013 * (n = 430)
Increased supply of water during dredging only	49.90	46.05
More use of improved seeds and fertilizer	31.50	29.07
Others	18.60	30.70

*Source: 2013 data collected from Mid-term Evaluation Report, IMED, 2014.

4.7 Fish productivity

The 4.15 shows that 52% of the fisherman has stated that the volume of fish production is increased in 2021 which was 30% in 2013. This is an indirect impact of project activities as the volume of fish production increased due to increase supply of water during dredging only.

Table 4.15: Information related to fish productivity.

Status of fish productivity		Percentage of 2021 (n = 25)	Percentage of 2013 * (n = 50)
A.	Volume of fish production in Gorai River		
	Has increased	52.0	30.0
	Has decreased	48.0	70.0
B.	Reasons for increase/decrease in the production of fishes.		
	Increased supply of water during dredging only	70.0	46.0
	At times lesser flow of water in river during dry season	30.0	54.0

*Source: 2013 data collected from Mid-term Evaluation Report, IMED, 2014.

4.8 Navigability of Gorai River

Table 4.16 shows that during dredging about 88% (2013) of Boatman are feeling that water flow does not remain in Gorai River during dry season but after dredging about 68% (2021) of Boatman feel that water flow does not remain in Gorai River during dry season. Only 32.0% of the boatman felt that navigability of river increased slightly due to dredging. However, the water flow in Gorai River depends not only on dredging but also due to rain and extent of water flow from India during dry season.

Table 4.16: Information related to Navigation.

Status of Navigation		Percentage of 2021 (n = 25)	Percentage of 2013 * (n = 50)
A	Whether water flow remains in Gorai River during dry season? (n = 25)		
	Yes	32.0	12.0
	No	68.0	88.0
B	If no, how people crossed the river during dry season		
	Dingy boat	17.6	8.0
	On foot	82.4	92.0
C	Reasons for crossing the river on foot		
	River becomes dry and filled with sand	85.7	95.7
	Mechanical transport cannot play on dry riverbed	14.3	4.3
D	Navigability of river transports in Gorai River in dry season		
	Yes	32.0	22.0
	No	68.0	88.0

*Source: 2013 data collected from Mid-term Evaluation Report, IMED, 2014.

4.9 Cost of River Transport

Table 4.17 shows that 88.2% of the sand traders feel that use of transport for carrying sand is increase in Gorai River during dry season because of more availability of sand.

With respect to cost of river transport, during dry season, it was observed and stated by people that restoration of Gorai River did not increase the water flow rather it

remained almost same as before the dry season in 2009. So, the movement of water transport did not improve at all as was expected from project activities.

Table 4.17: Information related to cost of river transport.

Status of cost of river transport		Percentage of 2021 (n = 25)	Percentage of 2013 * (n = 50)
B.	Use of transport for carrying sand from Gorai River during dry season		
	Has increased	88.2	87.6
	Has decreased	11.8	12.4
C.	Reasons for increase/decreased use of transport for carrying sand		
	More availability of sand- so more need for transports	90.6	89.41
	Improved roads in some places but lack of adequate transports	9.4	10.59

*Source: 2013 data collected from Mid-term Evaluation Report, IMED, 2014.

4.10 Rural Employment

Table 4.18 shows that 56.7% of the farmer said employment opportunity has increased where 72.9% of the sand traders feel increase in Gorai River during dry season because of more availability of sand- so more need for transports.

Rural employment increased for some people who are involved in sand trading/business. But for boatmen and fishermen, employment in dry season remained almost what was during dry season of 2009. As such their earning and livelihood have not improved in context to their main occupation. Their income earning during dry season was from alternative temporary usually came from fish trading, farming in others land, rickshaw pulling and in construction works in near towns and cities etc.

Table 4.18: Information related to Rural Employment.

Status of Rural Employment due to dredging		Percentage of 2021	Percentage of 2013*
A.	Has there been a new employment opportunity for farmer?		
	Employment opportunity has increased	56.7	43.3
	Employment has remained the same	24.2	35.5
	Employment opportunity has decreased	19.1	21.2
B.	Has sand extraction and transportation created new employment opportunities?		
	Employment opportunity has increased	72.9	71.8
	Employment has remained the same	20.0	27.1
	Employment opportunity has decreased	07.1	1.2
C.	Employment for boatman due to increased flow of water during dry season		
	Employment opportunity has increased	36.0	34.0
	Employment has remained the same	56.0	54.0
	Employment opportunity has decreased	08.0	12.0
D.	Has there been a new employment opportunity for fishermen?		
	Employment opportunity has increased	52.0	50.0
	Employment has remained the same	28.0	26.0
	Employment opportunity has decreased	20.0	24.0

* Source: 2013 data collected from Mid-term Evaluation Report, IMED, 2014.

4.10.1 Reasons for increase/decrease in income earning of respondents.

The table 4.19 below describes the major reasons for increased or decreased income earning of various group of respondents. The project activities did not impact equally on respondents some were benefited, and some were not at all benefited. It was almost same as before 2009. Majority of the farmers (51.4%) felt that their income earning increased due to more flow of water and due to more cropping intensity etc. And production also hampered due to lesser flow of water in dry although it was expected that due to dredging the water flow in Gorai would increase. But the situation was reverse and not what was expected. The fishermen stated that more fishes were available in the Gorai River due to dredging but when dredging stopped, the water flow reduced and so also volume of fish production. As such during dry season, they had to switch to other job for their subsistence. The boatmen had increased income during dredging when water flow in the river increased and as such, they could ply their boats more frequently and could earn income. But due to lesser flow of water in dry season, their income from boating is reduced to zero and during the dry season they must seek for alternative jobs- such as agriculture laboring, rickshaw pulling in the district towns and small trading etc.

Gorai River has not much benefited since water flow remains for a short period of time. The table shows that sand traders were the only respondents who are mostly benefited due to availability of sand during dry season.

Table 4.19: Reasons for increase/decrease in income earning of respondents.

Status of income earning of respondents	Percentage of 2021	Percentage of 2013*
Farmers:		
More production of crops due to more flow of water during dredging and embankment.	55.8	51.40
More use of seeds, fertilizer, irrigation etc.	32.6	5.58
Others	11.6	43.02

Status of income earning of respondents	Percentage of 2021	Percentage of 2013*
Fishers/fish farmers:		
Availability of more fishes due to dredging	48.0	42.0
Less number of fish due to lesser amount of water	28.0	38.0
Others	24.0	20.0
Boatman:		
Increased fare for use of boat as transport	20.0	32.0
Less income in dry season due lesser use of boat	28.0	54.0
More income in rainy season due to more use of boat	52.0	36.0
Sand traders/helpers:		
More availability of sand in dry season so more income	76.5	72.35
Increased wage and increased supply of workers	14.1	14.71
Others	9.4	12.94

* Source: 2013 data collected from Mid-term Evaluation Report, IMED, 2014.

4.11 Comparison of dredged protective area and dredged non-protective area:

The study area is divided with respect to Dredge and Non-protective areas. The comparison between Dredged Protective and Dredged Non-protective are given below:

Table 4.20: Comparison of dredged protective area and dredged non-protective area.

Status	Dredged and Protective area	Dredged and Non-Protective area
1. Sources of water		
i. Brings water through LLP from Gorai River	16%	5%
ii. Brings water from GK project for irrigation	14%	15%
iii. Other sources	70%	80%
2. Number of crops		
i. 1 crop	18%	42%
ii. 2 crops	32%	38%
iii. 3 crops	50%	20%
3. Status of production		
i. Vol. of production increased	91%	30%
4. Status of Rural Employment		
a) Has there been a new employment opportunity for farmer?		
i. Employment opportunity has increased	70%	50%
ii. Employment has remained the same	20%	30%
iii. Employment opportunity has decreased	10 %	20%
b) Has sand extraction and transportation created new employment opportunities?		
i. Employment opportunity has increased	80%	70%
ii. Employment has remained the same	15%	23%
iii. Employment opportunity has decreased	5%	7%
c) Employment for boatman due to increased flow of water during dry season		
i. Employment opportunity has increased	40%	35%
ii. Employment has remained the same	50%	55%
iii. Employment opportunity has decreased	10%	15%
d) Has there been a new employment opportunity for fishermen?		
i. Employment opportunity has increased	60%	50%
ii. Employment has remained the same	25%	30%
iii. Employment opportunity has decreased	15%	20%

4.12 Impact Assessment

Most of the development projects produce impacts on or changes in the state of natural environment. Of which some are positive, and some are negative. Similarly, some positive and negative impacts have been identified for the effect of dredging in Gorai River. This impact has been evaluated in terms of quality, seasonality and socio-economic importance by questionnaire survey.

In this research, among 20 Important Environmental Components (IECs), only 13 components are considered as below:

1. Surface water salinity
2. Surface water availability
3. Ground water table
4. River water quality
5. Drinking water Availability
6. Availability of usable domestic water
7. Employment opportunities
8. Poverty
9. Irrigated area
10. Cropping intensity
11. Crop production
12. Fish production
13. Waterway communication

Evaluation of selected Important Environmental Components (IECs) for dredging of Gorai River is given below (Table 4.20):

Table 4.21: Impact Matrix

IEC	Future Without Project	Future With Project
Surface water salinity	No impact (0)	Significant beneficial impact (7)
Surface water availability	No impact (0)	Moderate beneficial impact (6)

IEC	Future Without Project	Future With Project
Ground water table	No impact (0)	Insignificant beneficial impact (+1)
River water quality	Moderate adverse impact (-5)	Slight beneficial impact (+4)
Drinking water Availability	Slight adverse impact (-3)	Slight beneficial impact (+4)
Availability of usable domestic water	Insignificant adverse impact (-2)	Moderate beneficial impact (+6)
Employment opportunities	Insignificant adverse impact (-2)	Moderate beneficial impact (+6)
Poverty	Insignificant adverse impact (-1)	Slight beneficial impact (+4)
Cropping intensity	Slight beneficial impact (+3)	Moderate beneficial impact (+6)
Crop production	Slight beneficial impact (+3)	Significant beneficial impact (+8)
Irrigated Area	Slight adverse impact (-3)	Significant beneficial impact (+8)
Fish Production	Slight adverse impact (-3)	Significant beneficial impact (+8)
Waterway communication	Slight adverse impact (-4)	Moderate beneficial impact (+6)

Magnitude of positive (+) and negative (-) impacts:

+1 & +2 = Insignificant beneficial impact
+3 & +4 = Slight beneficial impact
+5 & +6 = Moderate beneficial impact
+7 & +8 = Significant beneficial impact
+9 & +10 = Very significant beneficial impact
0 = No impact

-1 & -2 = Insignificant adverse impact
-3 & -4 = Slight adverse impact
-5 & -6 = Moderate adverse impact
-7 & -8 = Significant adverse impact
-9 & -10 = Very significant adverse impact
0 = No impact

CHAPTER 5:
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The main objective of this research was to analyze the post impacts of salinity, surface and ground water level, irrigation, crop productivity, fish productivity, navigation, cost of river transport and rural employment and to analyze long term and short-term impacts of the Gorai River Restoration Projects-II in the surroundings of Gorai River for dredging. In order to achieve this goal, a face-to-face questionnaire survey was conducted in Kushtia district. About 350 respondents were selected from three upazilla (Kushtia, Kumarkhali and Khoksha) using a simple random sampling technique. A conceptual framework was developed, and data were analyzed using evaluation values of Important Environmental Components (IECs) and prepare impact matrix. The major findings are sated below:

i. It is found that, 99% of respondents replied that there is no salinity in Gorai River after dredging.

ii. As per questionnaire survey, availability of surface water during dry season has increased as stated by respondents (86%). Average water level in Gorai River of Phase-II is 4.48 m which is more than the average water level (4.36 m) of Phase-III. It is concluded that the availability of surface water in Gorai River is increased.

iii. Availability of water in the tube well in dry season has increased as stated by respondents (91%) of the respondents. From secondary data, ground water availability in Phase-III (GWT-8.84m) is increased than the Phase-II (GWT-9.12 m).

iv. There are two major sources of irrigation water, surface water and groundwater. The quality of irrigation water is very much dependent on the source. As per questionnaire survey, during dredging about 2% of respondents are using water through LLP from Gorai River but after dredging about 15% of respondents are use water through LLP from Gorai River. On the other hand, dependency of irrigation water from other sources is reduced from 82% to 70%. Moreover, the cost of surface water irrigation is cheaper

than that of groundwater. Due to dredging of Gorai River, the dry season water flow through the Gorai River would increase. As a result, the overall irrigated area would be increased in the study area.

v. Crop production is expected to increase due to increase of surface water irrigated area, rise of groundwater table, decrease of salinity due to the increase of upstream flow of Gorai River. From questionnaire survey, farmers adjoining the Gorai River are converted from 1 crop to 2 or more crops to produce per year due to more flow of water in Gorai River during dredging as well as slightly increased level of ground water during dry season. It also, 93.0% of the farmers have stated that volume of production of crops increased in 2021 when 91.0% of the farmers stated about increased volume of production in 2013.

vi. 52% of the fisherman has stated that the volume of fish production is increased in 2021 which was 30% in 2013. This is an indirect impact of project activities as the volume of fish production increased due to increase supply of water during dredging only.

vii. According to questionnaire survey, during dredging about 88% (2013) of Boatman feel that water flow does not remain in Gorai River during dry season but after dredging about 68% (2021) of Boatman feel that water flow does not remain in Gorai River during dry season. Only 32.0% of the boatman felt that navigability of river increased slightly due to dredging. However, the water flow in Gorai River depends not only on dredging but also due to rain and extent of water flow from India during dry season.

viii. 88% of the sand traders feel that use of transport for carrying sand is increase in Gorai River during dry season because of more availability of sand- so more need for transports. Only 12.0% of the boatman felt that navigability of river increased slightly due to dredging. However, the water flow in Gorai River depends not only on dredging but also due to rain and extent of water flow from India during dry season.

ix. Rural employment such as farmer (57% of respondents), fisherman (52% of respondents), boatman (56% of respondents) and sand trader's (73% of respondents) has increased than before dredging.

5.2 Recommendation for Future Study:

The following may be suggested for future study:

I. This research was conducted only 30 km length of Gorai River. So, it can also be conducted in full length of Gorai River (199 km) and other river of southern part of Bangladesh.

II. Hydrological & Morphological changes in Gorai River due to dredging can be studied in future.

III. Since dredging has been going on in the Gorai River for the last few decades, changes in the directions of the Gorai River have occurred. So, meandering of Gorai River can be analysed in future.

IV. A study like this can provide clues as to the possible drivers of the effectiveness and the interventions that may be required by the river regulation authority to undertake appropriate future developments projects for the river restoration of Bangladesh.

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APPENDIX

"প্রকল্পের সুবিধাভোগীদের মতামত প্রাপ্তির লক্ষ্যে প্রশ্নপত্র"

ভূমিকাঃ আসসালামু আলাইকুম। আমি মাঠ পর্যায়ে মূল্যায়ণ জরিপের উদ্দেশ্যে এসেছি। আপনারা জানেন, বাংলাদেশ পানি উন্নয়ন বোর্ড কর্তৃক ২০০৯-২০১৭ সালে গড়াই নদী পুনঃচালু করণ প্রকল্প-২য় পর্যায় নামে একটি প্রকল্পের কাজ বাস্তবায়িত হয়েছে। এ প্রকল্পের মূল উদ্দেশ্য হলো গড়াই নদী পুনঃচালু করণ, বর্ষা মৌসুমে ফ্রেস পানি প্রবাহ নিশ্চিত করা এবং শুষ্ক মৌসুমে পানি প্রবাহ বৃদ্ধি করার মাধ্যমে দেশের দক্ষিণ-পশ্চিমাঞ্চলে বিশেষতঃ খুলনা, উপকূলীয় অঞ্চল এবং সুন্দরবনে পরিবেশগত অধোঃগতি রোধ করা। প্রকল্পের মূল লক্ষ্য হলো খুলনার ভূ-পরিস্থ পানির লবণাক্ততা ০১ পিপিটি এর মধ্যে নিয়ে আশা, ভূ-পরিস্থ ও ভূ-গর্ভস্থ পানি সরবরাহ, কৃষি উৎপাদন, মৎস্য উৎপাদন, নৌ চলাচল, কর্মসংস্থান ইত্যাদি বৃদ্ধি করা, গৃহকার্যে ব্যবহৃত পানির মান উন্নয়ন করা এবং এ লক্ষ্য অর্জনে কতটুকু সহায়ক হয়েছে তা মনিটর করা। এ প্রসঙ্গে আপনাদের মূল্যবান তথ্য বর্তমান প্রকল্প মূল্যায়ণে বিশেষ ভূমিকা রাখবে। এখানে আরও উল্লেখ্য যে, আপনার মতামত শুধুমাত্র গবেষণার কাজে ব্যবহৃত হবে এবং আপনার দেয়া তথ্য সম্পূর্ণ গোপন রাখা হবে। এ ব্যাপারে আপনার আন্তরিক সহযোগিতা একান্ত ভাবে কাম্য।

উত্তরদাতার পরিচিতিঃ

নামঃ	বয়সঃ
স্বামী/পিতার নামঃ	পেশা/পদবীঃ
উপজেলাঃ	জেলাঃ

সাধারণ প্রশ্নসমূহঃ

ক্রঃ নং	প্রশ্ন	উত্তর		
১।	খাবার পানি বা রান্নার কাজের জন্য আপনি কোন পানি ব্যবহার করেন?	☐ গড়াই নদীর	☐ টিউবওয়েলের	☐ অন্যান্য
২।	আপনি যে পানি ব্যবহার করেন তাতে লবণাক্ততা আছে কি না?	☐ হ্যাঁ	☐ না	☐ কোন মন্তব্য নাই
৩।	লবণাক্ত পানি ব্যবহারের ফলে শারীরিক ভাবে কোন অসুবিধার সম্মুখীন হচ্ছেন কি না?	☐ হ্যাঁ	☐ না	☐ কোন মন্তব্য নাই
৪।	ড্রেজিং করার ফলে বর্তমানে (২০২১ সাল) গড়াই নদীর পানিতে লবণাক্ততা আছে কি না?	☐ হ্যাঁ	☐ না	☐ কোন মন্তব্য নাই
৫।	লবণাক্ত পানি ব্যবহারের ফলে ফসল উৎপাদন বা অন্য কোন অসুবিধা হচ্ছে কি না?	☐ হ্যাঁ	☐ না	☐ কোন মন্তব্য নাই
৬।	খরা মৌসুমে নদীর পাড়ের বাসিন্দাদের ও গবাদিপশু গোসল করা সহ নিত্য প্রয়োজনীয় কাজে গড়াই নদীর পানি ব্যবহারে আসে কি না?	☐ হ্যাঁ আসে	☐ আসে না	☐ কোন মন্তব্য নাই
৭।	এ প্রকল্প বাস্তবায়নের ফলে বর্তমান খরা মৌসুমে গড়াই নদীতে সবসময় পানি থাকে কি না?	☐ হ্যাঁ থাকে	☐ থাকে না	☐ একই রকম রয়েছে
৮।	ড্রেজিং করার ফলে বর্তমানে (২০২১ সাল) খরা মৌসুমে গড়াই নদীতে পানির পরিমান বৃদ্ধি পেয়েছে কি না?	☐ বৃদ্ধি পেয়েছে	☐ হ্রাস পেয়েছে	☐ একই রকম রয়েছে
৯।	বর্তমানে খরা মৌসুমে টিউবওয়েলে পানি পাওয়া যায় কি না?	☐ হ্যাঁ	☐ না	☐ একই রকম রয়েছে
১০।	বর্তমানে কৃষি কাজে কোন পানি ব্যবহার করা হয়?	☐ গড়াই নদীর	☐ জি-কে প্রকল্পর	☐ অন্যান্য

ক্রঃ নং	প্রশ্ন	উত্তর		
১১।	বর্তমানে (২০২১ সাল) জমিতে কয়টি ফসল উৎপাদন হয়?	☐ ১টি	☐ ২ টি	☐ ৩ টি
১২।	বর্তমানে (২০২১ সাল) জমিতে ফসল উৎপাদনের পরিমান বৃদ্ধি পেয়েছে কি না?	☐ বৃদ্ধি পেয়েছে	☐ হ্রাস পেয়েছে	☐ একই রকম রয়েছে
১৩।	ফসল উৎপাদন হ্রাস/বৃদ্ধি এর কারণ কি?	☐ গড়াই নদী	☐ বীজ/সার	☐ অন্যান্য
১৪।	বর্তমানে গড়াই নদীতে কৃষকদের নতুন কর্মসংস্থানের সুযোগ সৃষ্টি হয়েছে কি না?	☐ বৃদ্ধি পেয়েছে	☐ হ্রাস পেয়েছে	☐ একই রকম রয়েছে
১৫।	গড়াই নদীতে বর্তমানে (২০২১ সাল) মৎস্য উৎপাদনের পরিমান বৃদ্ধি পেয়েছে কি না?	☐ বৃদ্ধি পেয়েছে	☐ হ্রাস পেয়েছে	☐ একই রকম রয়েছে
১৬।	মৎস্য উৎপাদন হ্রাস/বৃদ্ধি এর কারণ কি?	☐ গড়াই নদী	☐ বীজ/সার	☐ অন্যান্য
১৭।	খরা মৌসুমে লোকজন নদী পার হয় কি উপায়ে?	☐ খেয়া নৌকায়	☐ পায়ে হেঁটে	☐ বাঁশের সাকোর সাহায্য
১৮।	বর্তমানে খরা মৌসুমে গড়াই নদীতে যে পানি থাকে তা নৌ চলাচলের উপযোগী কি না?	☐ হ্যাঁ	☐ না	☐ অন্যান্য
১৯।	বর্তমানে খরা মৌসুমে গড়াই নদীতে যে পানি থাকে তা জলজ প্রাণীদের জন্য উপযোগী কি না?	☐ হ্যাঁ	☐ না	☐ অন্যান্য
২০।	এ প্রকল্প বাস্তবায়নের ফলে নৌকার মাঝিদের কর্মের সুযোগ সৃষ্টি হয়েছে কি না?	☐ বৃদ্ধি পেয়েছে	☐ হ্রাস পেয়েছে	☐ একই রকম রয়েছে
২১।	গড়াই নদী হতে ড্রেজিংকৃত বালু উত্তোলন ও পরিবহনের কাজে নতুন কর্মসংস্থানের সুযোগ সৃষ্টি হয়েছে কি না?	☐ বৃদ্ধি পেয়েছে	☐ হ্রাস পেয়েছে	☐ একই রকম রয়েছে
২২।	বর্তমানে গড়াই নদীতে জেলেদের নতুন কর্মসংস্থানের সুযোগ সৃষ্টি হয়েছে কি না?	☐ বৃদ্ধি পেয়েছে	☐ হ্রাস পেয়েছে	☐ একই রকম রয়েছে
২৩।	ড্রেজিং করার সময়ে পরিবেশগত কোন অসুবিধা হয়েছে কি না?	☐ হ্যাঁ	☐ না	☐ অন্যান্য
২৪।	ড্রেজিং করার সময়ে জলজ প্রাণীর মৃত্যুর হার কেমন বলে আপনার মনে হয়?	☐ বেশি	☐ কম	☐ অন্যান্য
২৫।	ড্রেজিং করার সময়ে কোন অসুবিধা হয়েছে কি না?	☐ ভাঙ্গন	☐ মাটি রাখা	☐ অন্যান্য
২৬।	ড্রেজিংকৃত মাটি/বালু যে স্থানে রাখা হয়েছে এর ফলে কোন ধরনের অসুবিধা হয়েছে?	☐ বসবাসের	☐ চলাচলের	☐ অন্যান্য
২৭।	ড্রেজিং করার সময়ে কোন দূষণ হয়েছে কি না?	☐ শব্দ দূষণ	☐ বায়ু দূষণ	☐ জল/মৃত্তিকা দূষণ
২৮।	এ প্রকল্প বাস্তবায়নের ফলে নদীর আশেপাশের জীব ও বৈচিত্রের অবস্থার পরিবর্তন কেমন হচ্ছে?	☐ বৃদ্ধি পাচ্ছে	☐ হ্রাস পাচ্ছে	☐ একই রকম রয়েছে
২৯।	আপনি আপনার বর্তমান পেশায় সন্তুষ্ট কি না?	☐ হ্যাঁ	☐ না	☐ কোন মন্তব্য নাই
৩০।	কি কারণে আপনার পেশা পরিবর্তন করতে চান?	☐ গড়াই নদী	☐ অন্যান্য	☐ কোন মন্তব্য নাই

Figure A.1: Questionnaires from the beneficiaries such as farmers, fishermen, boatmen and sand traders

"প্রকল্পের সুবিধাভোগীদের মতামত প্রাপ্তির লক্ষ্যে প্রশ্নপত্র"

ভূমিকাঃ আসসালামু আলাইকুম। আমি মাঠ পর্যায়ে মূল্যায়ণ জরিপের উদ্দেশ্যে এসেছি। আপনারা জানেন, বাংলাদেশ পানি উন্নয়ন বোর্ড কর্তৃক ২০০৯-২০১৭ সালে গড়াই নদী পুনঃচালু করণ প্রকল্প-২য় পর্যায় নামে একটি প্রকল্পের কাজ বাস্তবায়িত হয়েছে। এ প্রকল্পের মূল উদ্দেশ্য হলো গড়াই নদী পুনঃচালু করণ, বর্ষা মৌসুমে ফ্রেস পানি প্রবাহ নিশ্চিত করা এবং শুষ্ক মৌসুমে পানি প্রবাহ বৃদ্ধি করার মাধ্যমে দেশের দক্ষিণ-পশ্চিমাঞ্চলে বিশেষতঃ খুলনা, উপকূলীয় অঞ্চল এবং সুন্দরবনে পরিবেশগত অধোঃগতি রোধ করা। প্রকল্পের মূল লক্ষ্য হলো খুলনার ভূ-পরিস্থ পানির লবণাক্ততা ০১ পিপিটি এর মধ্যে নিয়ে আশা, ভূ-পরিস্থ ও ভূ-গর্ভস্থ পানি সরবরাহ, কৃষি উৎপাদন, মৎস্য উৎপাদন, নৌ চলাচল, কর্মসংস্থান ইত্যাদি বৃদ্ধি করা, গৃহকার্যে ব্যবহৃত পানির মান উন্নয়ন করা এবং এ লক্ষ্য অর্জনে কতটুকু সহায়ক হয়েছে তা মনিটর করা। এ প্রসঙ্গে আপনাদের মূল্যবান তথ্য বর্তমান প্রকল্প মূল্যায়ণে বিশেষ ভূমিকা রাখবে। এখানে আরও উল্লেখ্য যে, আপনার মতামত শুধুমাত্র গবেষণার কাজে ব্যবহৃত হবে এবং আপনার দেয়া তথ্য সম্পূর্ণ গোপন রাখা হবে। এ ব্যাপারে আপনার আন্তরিক সহযোগিতা একান্ত ভাবে কাম্য।

উত্তরদাতার পরিচিতিঃ

নামঃ [illegible]	বয়সঃ ৫০
স্বামী/পিতার নামঃ [illegible]	পেশা/পদবীঃ [illegible]
উপজেলাঃ [illegible]	জেলাঃ [illegible]

সাধারণ প্রশ্নসমূহঃ

ক্রঃ নং	প্রশ্ন	উত্তর		
১।	খাবার পানি বা রান্নার কাজের জন্য আপনি কোন পানি ব্যবহার করেন?	☐ গড়াই নদীর	☑ টিউবওয়েলের	☐ অন্যান্য
২।	আপনি যে পানি ব্যবহার করেন তাতে লবণাক্ততা আছে কি না?	☐ হাঁ	☑ না	☐ কোন মন্তব্য নাই
৩।	লবণাক্ত পানি ব্যবহারের ফলে শারীরিক ভাবে কোন অসুবিধায় সম্মুখীন হচ্ছেন কি না?	☐ হাঁ	☑ না	☐ কোন মন্তব্য নাই
৪।	ড্রেজিং করার ফলে বর্তমানে (২০২১ সাল) গড়াই নদীর পানিতে লবণাক্ততা আছে কি না?	☐ হাঁ	☑ না	☐ কোন মন্তব্য নাই
৫।	লবণাক্ত পানি ব্যবহারের ফলে ফসল উৎপাদন বা অন্য কোন অসুবিধা হচ্ছে কি না?	☐ হাঁ	☑ না	☐ কোন মন্তব্য নাই
৬।	খরা মৌসুমে নদীর পাড়ের বাসিন্দাদের ও গবাদিপশু গোসল করা সহ নিত্য প্রয়োজনীয় কাজে গড়াই নদীর পানি ব্যবহারে আসে কি না?	☑ হাঁ আসে	☐ আসে না	☐ কোন মন্তব্য নাই
৭।	এ প্রকল্প বাস্তবায়নের ফলে বর্তমান খরা মৌসুমে গড়াই নদীতে সবসময় পানি থাকে কি না?	☑ হাঁ থাকে	☐ থাকে না	☐ একই রকম রয়েছে
৮।	ড্রেজিং করার ফলে বর্তমানে (২০২১ সাল) খরা মৌসুমে গড়াই নদীতে পানির পরিমান বৃদ্ধি পেয়েছে কি না?	☑ বৃদ্ধি পেয়েছে	☐ হ্রাস পেয়েছে	☐ একই রকম রয়েছে
৯।	বর্তমানে খরা মৌসুমে টিউবওয়েলে পানি পাওয়া যায় কি না?	☑ হাঁ	☐ না	☐ একই রকম রয়েছে
১০।	বর্তমানে কৃষি কাজে কোন পানি ব্যবহার করা হয়?	☐ গড়াই নদীর	☐ জি-কে প্রকল্পর	☑ অন্যান্য

ক্রঃ নং	প্রশ্ন	উত্তর		
১১।	বর্তমানে (২০২১ সাল) জমিতে কয়টি ফসল উৎপাদন হয়?	☐ ১টি	☐ ২টি	☑ ৩টি
১২।	বর্তমানে (২০২১ সাল) জমিতে ফসল উৎপাদনের পরিমান বৃদ্ধি পেয়েছে কি না?	☑ বৃদ্ধি পেয়েছে	☐ হ্রাস পেয়েছে	☐ একই রকম রয়েছে
১৩।	ফসল উৎপাদন হ্রাস/বৃদ্ধি এর কারণ কি?	☐ গড়াই নদী	☑ বীজ/সার	☐ অন্যান্য
১৪।	বর্তমানে গড়াই নদীতে কৃষকদের নতুন কর্মসংস্থানের সুযোগ সৃষ্টি হয়েছে কি না?	☑ বৃদ্ধি পেয়েছে	☐ হ্রাস পেয়েছে	☐ একই রকম রয়েছে
১৫।	গড়াই নদীতে বর্তমানে (২০২১ সাল) মৎস্য উৎপাদনের পরিমান বৃদ্ধি পেয়েছে কি না?	☑ বৃদ্ধি পেয়েছে	☐ হ্রাস পেয়েছে	☐ একই রকম রয়েছে
১৬।	মৎস্য উৎপাদন হ্রাস/বৃদ্ধি এর কারণ কি?	☑ গড়াই নদী	☐ বীজ/সার	☐ অন্যান্য
১৭।	খরা মৌসুমে লোকজন নদী পার হয় কি উপায়ে?	☑ খেয়া নৌকায়	☐ পায়ে হেঁটে	☐ বাঁশের সাকোর সাহায্য
১৮।	বর্তমানে খরা মৌসুমে গড়াই নদীতে যে পানি থাকে তা নৌ চলাচলের উপযোগী কি না?	☑ হাঁ	☐ না	☐ অন্যান্য
১৯।	বর্তমানে খরা মৌসুমে গড়াই নদীতে যে পানি থাকে তা জলজ প্রাণীদের জন্য উপযোগী কি না?	☑ হাঁ	☐ না	☐ অন্যান্য
২০।	এ প্রকল্প বাস্তবায়নের ফলে নৌকার মাঝিদের কর্মের সুযোগ সৃষ্টি হয়েছে কি না?	☑ বৃদ্ধি পেয়েছে	☐ হ্রাস পেয়েছে	☐ একই রকম রয়েছে
২১।	গড়াই নদী হতে ড্রেজিংকৃত বালু উত্তোলন ও পরিবহনের কাজে নতুন কর্মসংস্থানের সুযোগ সৃষ্টি হয়েছে কি না?	☑ বৃদ্ধি পেয়েছে	☐ হ্রাস পেয়েছে	☐ একই রকম রয়েছে
২২।	বর্তমানে গড়াই নদীতে জেলেদের নতুন কর্মসংস্থানের সুযোগ সৃষ্টি হয়েছে কি না?	☑ বৃদ্ধি পেয়েছে	☐ হ্রাস পেয়েছে	☐ একই রকম রয়েছে
২৩।	ড্রেজিং করার সময়ে পরিবেশগত কোন অসুবিধা হয়েছে কি না?	☐ হাঁ	☑ না	☐ অন্যান্য
২৪।	ড্রেজিং করার সময়ে জলজ প্রাণীর মৃত্যুর হার কেমন বলে আপনার মনে হয়?	☐ বেশি	☑ কম	☐ অন্যান্য
২৫।	ড্রেজিং করার সময়ে কোন অসুবিধা হয়েছে কি না?	☐ ভাঙ্গন	☐ মাটি রাখা	☑ অন্যান্য
২৬।	ড্রেজিংকৃত মাটি/বালু যে স্থানে রাখা হয়েছে এর ফলে কোন ধরনের অসুবিধা হয়েছে?	☐ বসবাসের	☐ চলাচলের	☑ অন্যান্য
২৭।	ড্রেজিং করার সময়ে কোন দূষণ হয়েছে কি না?	☐ শব্দ দূষণ	☐ বায়ু দূষণ	☑ জল/মৃত্তিকা দূষণ
২৮।	এ প্রকল্প বাস্তবায়নের ফলে নদীর আশেপাশের জীব ও বৈচিত্রের অবস্থার পরিবর্তন কেমন হচ্ছে?	☑ বৃদ্ধি পাচ্ছে	☐ হ্রাস পাচ্ছে	☐ একই রকম রয়েছে
২৯।	আপনি আপনার বর্তমান পেশায় সন্তুষ্ট কি না?	☐ হাঁ	☑ না	☐ কোন মন্তব্য নাই
৩০।	কি কারণে আপনার পেশা পরিবর্তন করতে চান?	☐ গড়াই নদী	☑ অন্যান্য	☐ কোন মন্তব্য নাই

তথ্য সমন্বয়কারীর স্বাক্ষর ও তারিখঃ [illegible] ০১/০৯/২০২১

Figure A.2: Answer from the beneficiaries such as farmers, fishermen, boatmen and sand traders

"প্রকল্পের সাথে সংশ্লিষ্ট কর্মকর্তাদের জন্য প্রশ্ন"

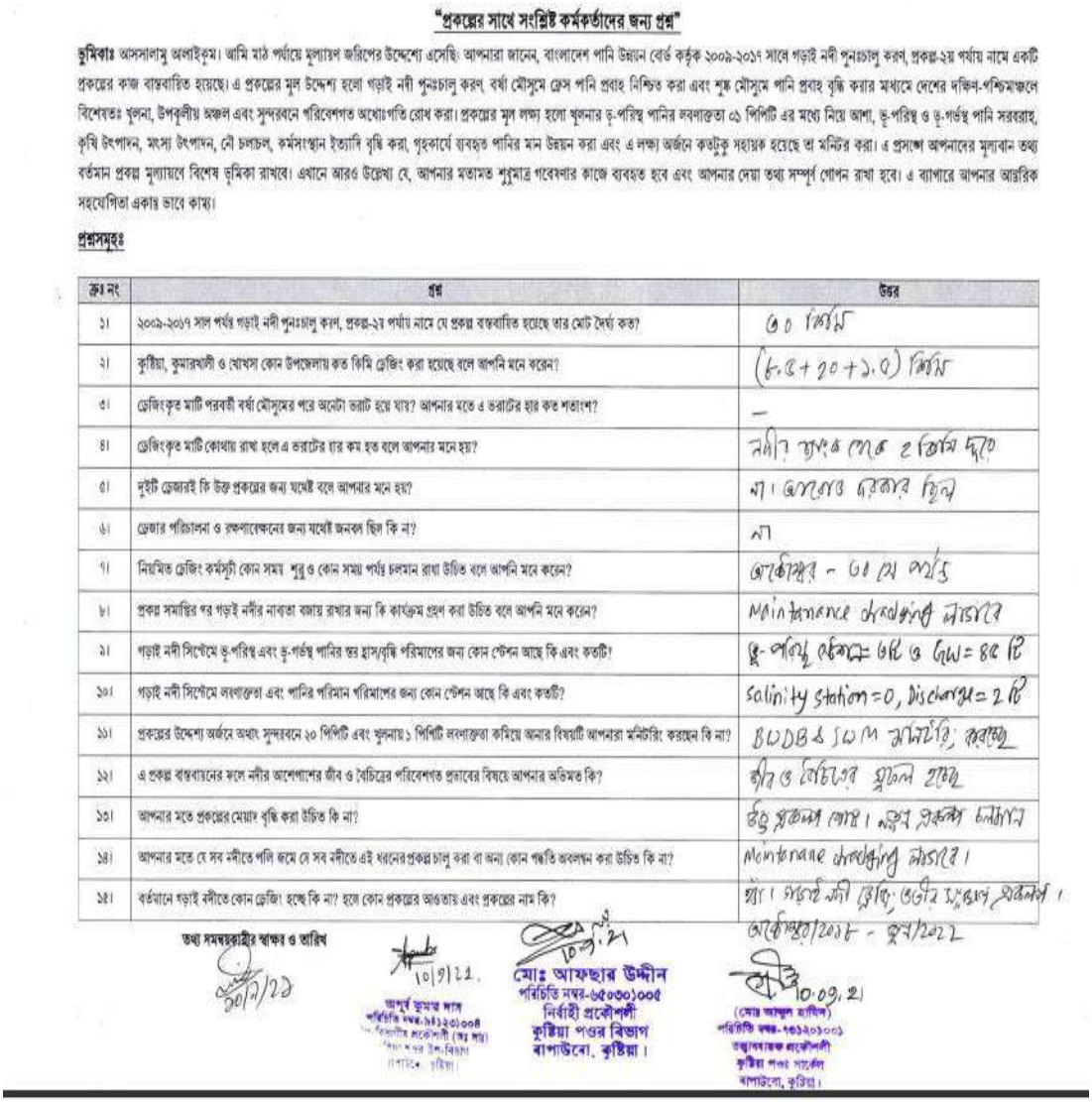
ভূমিকাঃ আসসালামু আলাইকুম। আমি মাঠ পর্যায়ে মূল্যায়ণ জরিপের উদ্দেশ্যে এসেছি। আপনারা জানেন, বাংলাদেশ পানি উন্নয়ন বোর্ড কর্তৃক ২০০৯-২০১৭ সালে গড়াই নদী পুনঃচালু করণ, প্রকল্প-২য় পর্যায় নামে একটি প্রকল্পের কাজ বাস্তবায়িত হয়েছে। এ প্রকল্পের মূল উদ্দেশ্য হলো গড়াই নদী পুনঃচালু করণ, বর্ষা মৌসুমে ফ্রেস পানি প্রবাহ নিশ্চিত করা এবং শুষ্ক মৌসুমে পানি প্রবাহ বৃদ্ধি করার মাধ্যমে দেশের দক্ষিণ-পশ্চিমাঞ্চলে বিশেষতঃ খুলনা, উপকূলীয় অঞ্চল এবং সুন্দরবনে পরিবেশগত অধোঃগতি রোধ করা। প্রকল্পের মূল লক্ষ্য হলো খুলনার ভূ-পরিস্থ পানির লবণাক্ততা ০১ পিপিটি এর মধ্যে নিয়ে আশা, ভূ-পরিস্থ ও ভূ-গর্ভস্থ পানি সরবরাহ, কৃষি উৎপাদন, মৎস্য উৎপাদন, নৌ চলাচল, কর্মসংস্থান ইত্যাদি বৃদ্ধি করা, গৃহকার্যে ব্যবহৃত পানির মান উন্নয়ন করা এবং এ লক্ষ্য অর্জনে কতটুকু সহায়ক হয়েছে তা মনিটর করা। এ প্রসঙ্গে আপনাদের মূল্যবান তথ্য বর্তমান প্রকল্প মূল্যায়ণে বিশেষ ভূমিকা রাখবে। এখানে আরও উল্লেখ্য যে, আপনার মতামত শুধুমাত্র গবেষণার কাজে ব্যবহৃত হবে এবং আপনার দেয়া তথ্য সম্পূর্ণ গোপন রাখা হবে। এ ব্যাপারে আপনার আন্তরিক সহযোগিতা একান্ত ভাবে কাম্য।

প্রশ্নসমূহঃ

ক্রঃ নং	প্রশ্ন	উত্তর
১।	২০০৯-২০১৭ সাল পর্যন্ত গড়াই নদী পুনঃচালু করণ, প্রকল্প-২য় পর্যায় নামে যে প্রকল্প বাস্তবায়িত হয়েছে তার মোট দৈর্ঘ্য কত?	
২।	কুষ্টিয়া, কুমারখালী ও খোকসা কোন উপজেলায় কত কিমি ড্রেজিং করা হয়েছে বলে আপনি মনে করেন?	
৩।	ড্রেজিংকৃত মাটি পরবর্তী বর্ষা মৌসুমের পরে অনেটা ভরাট হয়ে যায়? আপনার মতে এ ভরাটের হার কত শতাংশ?	
৪।	ড্রেজিংকৃত মাটি কোথায় রাখা হলে এ ভরাটের হার কম হত বলে আপনার মনে হয়?	
৫।	দুইটি ড্রেজারই কি উক্ত প্রকল্পের জন্য যথেষ্ট বলে আপনার মনে হয়?	
৬।	ড্রেজার পরিচালনা ও রক্ষণাবেক্ষনের জন্য যথেষ্ট জনবল ছিল কি না?	
৭।	নিয়মিত ড্রেজিং কর্মসূচী কোন সময় শুরু ও কোন সময় পর্যন্ত চলমান রাখা উচিত বলে আপনি মনে করেন?	
৮।	প্রকল্প সমাপ্তির পর গড়াই নদীর নাব্যতা বজায় রাখার জন্য কি কার্যক্রম গ্রহণ করা উচিত বলে আপনি মনে করেন?	
৯।	গড়াই নদী সিস্টেমে ভূ-পরিস্থ এবং ভূ-গর্ভস্থ পানির স্তর হ্রাস/বৃদ্ধি পরিমাপের জন্য কোন ষ্টেশন আছে কি এবং কতটি?	
১০।	গড়াই নদী সিস্টেমে লবণাক্ততা এবং পানির পরিমান পরিমাপের জন্য কোন ষ্টেশন আছে কি এবং কতটি?	
১১।	প্রকল্পের উদ্দেশ্য অর্জনে অর্থাৎ সুন্দরবনে ২০ পিপিটি এবং খুলনায় ১ পিপিটি লবণাক্ততা কমিয়ে আনার বিষয়টি আপনারা মনিটরিং করছেন কি না?	
১২।	এ প্রকল্প বাস্তবায়নের ফলে নদীর আশেপাশের জীব ও বৈচিত্রের পরিবেশগত প্রভাবের বিষয়ে আপনার অভিমত কি?	
১৩।	আপনার মতে প্রকল্পের মেয়াদ বৃদ্ধি করা উচিত কি না?	
১৪।	আপনার মতে যে সব নদীতে পলি জমে সে সব নদীতে এই ধরনের প্রকল্প চালু করা বা অন্য কোন পদ্ধতি অবলম্বন করা উচিত কি না?	
১৫।	বর্তমানে গড়াই নদীতে কোন ড্রেজিং হচ্ছে কি না? হলে কোন প্রকল্পের আওতায় এবং প্রকল্পের নাম কি?	

তথ্য সমন্বয়কারীর স্বাক্ষর ও তারিখ

Figure A.3: Questionnaires from the Offices related to the project.



"প্রকল্পের সাথে সংশ্লিষ্ট কর্মকর্তাদের জন্য প্রশ্ন"

ভূমিকাঃ অসসালামু আলাইকুম। আমি মাঠ পর্যায়ে মূল্যায়ন জরিপের উদ্দেশ্যে এসেছি। আপনারা জানেন, বাংলাদেশ পানি উন্নয়ন বোর্ড কর্তৃক ২০০৯-২০১৭ সালে গড়াই নদী পুনঃচালু করণ, প্রকল্প-২য় পর্যায় নামে একটি প্রকল্পের কাজ বাস্তবায়িত হয়েছে। এ প্রকল্পের মূল উদ্দেশ্য হলো গড়াই নদী পুনঃচালু করণ, বর্ষা মৌসুমে ফ্লেস পানি প্রবাহ নিশ্চিত করা এবং শুষ্ক মৌসুমে পানি প্রবাহ বৃদ্ধি করার মাধ্যমে দেশের দক্ষিণ-পশ্চিমাঞ্চলে বিশেষতঃ খুলনা, উপকূলীয় অঞ্চল এবং সুন্দরবনে পরিবেশগত অধোগতি রোধ করা। প্রকল্পের মূল লক্ষ্য হলো খুলনার ভূ-পরিস্থ পানির লবণাক্ততা ৫ পিপিটি এর মধ্যে নিয়ে আশা, ভূ-পরিস্থ ও ভূ-গর্ভস্থ পানি সরবরাহ, কৃষি উৎপাদন, মৎস্য উৎপাদন, নৌ চলাচল, কর্মসংস্থান ইত্যাদি বৃদ্ধি করা, গৃহকার্যে ব্যবহৃত পানির মান উন্নয়ন করা এবং এ লক্ষ্য অর্জনে কতটুকু সহায়ক হয়েছে তা মনিটর করা। এ প্রসঙ্গে আপনাদের মূল্যবান তথ্য বর্তমান প্রকল্প মূল্যায়নে বিশেষ ভূমিকা রাখবে। এখানে আরও উল্লেখ্য যে, আপনার মতামত শুধুমাত্র গবেষণার কাজে ব্যবহৃত হবে এবং আপনার দেয়া তথ্য সম্পূর্ণ গোপন রাখা হবে। এ ব্যাপারে আপনার আন্তরিক সহযোগিতা একান্ত ভাবে কাম্য।

প্রশ্নসমূহঃ

ক্রঃ নং	প্রশ্ন	উত্তর
১।	২০০৯-২০১৭ সাল পর্যন্ত গড়াই নদী পুনঃচালু করণ, প্রকল্প-২য় পর্যায় নামে যে প্রকল্প বাস্তবায়িত হয়েছে তার মোট দৈর্ঘ্য কত?	৬০ কিমি
২।	কুষ্টিয়া, কুমারখালী ও খোকসা কোন উপজেলায় কত কিমি ড্রেজিং করা হয়েছে বলে আপনি মনে করেন?	(৮.৫+২০+১০.৫) কিমি
৩।	ড্রেজিংকৃত মাটি পরবর্তী বর্ষা মৌসুমের পরে অনেটা ভরাট হয়ে যায়? আপনার মতে এ ভরাটের হার কত শতাংশ?	–
৪।	ড্রেজিংকৃত মাটি কোথায় রাখা হলে এ ভরাটের হার কম হত বলে আপনার মনে হয়?	নদীর মূল পাড় হতে ২ কিমি দূরে
৫।	দুইটি ড্রেজারই কি উক্ত প্রকল্পের জন্য যথেষ্ট বলে আপনার মনে হয়?	না। আরোও দরকার ছিল
৬।	ড্রেজার পরিচালনা ও রক্ষণাবেক্ষনের জন্য যথেষ্ট জনবল ছিল কি না?	না
৭।	নিয়মিত ড্রেজিং কর্মসূচী কোন সময় শুরু ও কোন সময় পর্যন্ত চলমান রাখা উচিত বলে আপনি মনে করেন?	অক্টোবর - ডিসেম্বর পর্যন্ত
৮।	প্রকল্প সমাপ্তির পর গড়াই নদীর নাব্যতা বজায় রাখার জন্য কি কার্যক্রম গ্রহণ করা উচিত বলে আপনি মনে করেন?	Maintenance dredging দরকার
৯।	গড়াই নদী সিস্টেমে ভূ-পরিস্থ এবং ভূ-গর্ভস্থ পানির স্তর হ্রাস/বৃদ্ধি পরিমাপের জন্য কোন স্টেশন আছে কি এবং কতটি?	ভূ-পরিস্থ স্টেশন= ৩টি ও GW= ৪৫ টি
১০।	গড়াই নদী সিস্টেমে লবণাক্ততা এবং পানির পরিমান পরিমাপের জন্য কোন স্টেশন আছে কি এবং কতটি?	salinity station=0, Discharge=2 টি
১১।	প্রকল্পের উদ্দেশ্য অর্জনে অর্থাৎ সুন্দরবনে ৫০ পিপিটি এবং খুলনায় ১ পিপিটি লবণাক্ততা কমিয়ে আনার বিষয়টি আপনারা মনিটরিং করছেন কি না?	BUDB & SWM মনিটরিং করছে
১২।	এ প্রকল্প বাস্তবায়নের ফলে নদীর আশেপাশের জীব ও বৈচিত্রের পরিবেশগত প্রভাবের বিষয়ে আপনার অভিমত কি?	জীব ও বিচিত্রের ইতিবাচক হয়েছে
১৩।	আপনার মতে প্রকল্পের মেয়াদ বৃদ্ধি করা উচিত কি না?	উক্ত প্রকল্পের মেয়াদ। নতুন প্রকল্প দরকার
১৪।	আপনার মতে যে সব নদীতে পলি জমে সে সব নদীতে এই ধরনের প্রকল্প চালু করা বা অন্য কোন পদ্ধতি অবলম্বন করা উচিত কি না?	Maintenance dredging দরকার।
১৫।	বর্তমানে গড়াই নদীতে কোন ড্রেজিং হচ্ছে কি না? হলে কোন প্রকল্পের আওতায় এবং প্রকল্পের নাম কি?	হ্যাঁ। গড়াই নদী ড্রেজিং, ওটার ইমপ্রুভমেন্ট প্রকল্প। অক্টোবর/২০১৮ - ডিসে/২০২২

তথ্য সমন্বয়কারীঃ স্বাক্ষর ও তারিখ

20/11/22

10/9/22.

অপূর্ব কুমার দাস
পরিচিতি নম্বর-৯৪১২৩১০০৪
সহকারী প্রকৌশলী (অ: দা:)
বিভাগীয় পওর উন্নয়ন বিভাগ
বাপাউবো, কুষ্টিয়া।

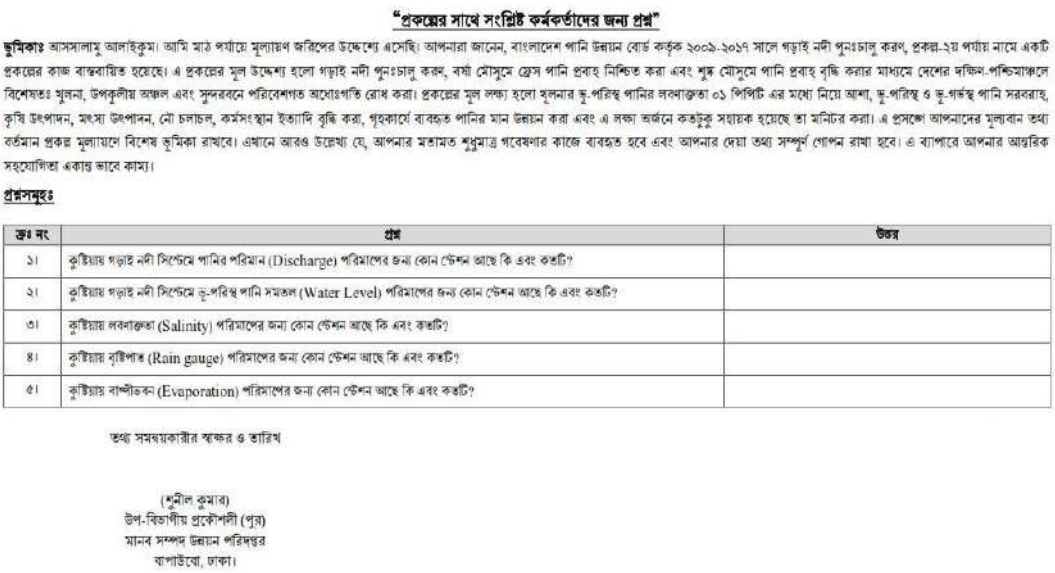
10.9.22

মোঃ আফছার উদ্দীন
পরিচিতি নম্বর-৬৫০৩০১০০৫
নির্বাহী প্রকৌশলী
কুষ্টিয়া পওর বিভাগ
বাপাউবো, কুষ্টিয়া।

10.09.22

(মোঃ আব্দুল হাদিস)
পরিচিতি নম্বর-৭৩১২৩১০০১
তত্ত্বাবধায়ক প্রকৌশলী
কুষ্টিয়া পওর সার্কেল
বাপাউবো, কুষ্টিয়া।

Figure A.4: Answers from the Offices related to the project.



"প্রকল্পের সাথে সংশ্লিষ্ট কর্মকর্তাদের জন্য প্রশ্ন"

ভূমিকাঃ আসসালামু আলাইকুম। আমি মাঠ পর্যায়ে মূল্যায়ণ জরিপের উদ্দেশ্যে এসেছি। আপনারা জানেন, বাংলাদেশ পানি উন্নয়ন বোর্ড কর্তৃক ২০০৯-২০১৭ সালে গড়াই নদী পুনঃচালু করণ, প্রকল্প-২য় পর্যায় নামে একটি প্রকল্পের কাজ বাস্তবায়িত হয়েছে। এ প্রকল্পের মূল উদ্দেশ্য হলো গড়াই নদী পুনঃচালু করণ, বর্ষা মৌসুমে ফ্লেস পানি প্রবাহ নিশ্চিত করা এবং শুষ্ক মৌসুমে পানি প্রবাহ বৃদ্ধি করার মাধ্যমে দেশের দক্ষিণ-পশ্চিমাঞ্চলে বিশেষতঃ খুলনা, উপকূলীয় অঞ্চল এবং সুন্দরবনে পরিবেশগত অধোঃগতি রোধ করা। প্রকল্পের মূল লক্ষ্য হলো খুলনার ভূ-পরিস্থ পানির লবণাক্ততা ০১ পিপিটি এর মধ্যে নিয়ে আশা, ভূ-পরিস্থ ও ভূ-গর্ভস্থ পানি সরবরাহ, কৃষি উৎপাদন, মৎস্য উৎপাদন, নৌ চলাচল, কর্মসংস্থান ইত্যাদি বৃদ্ধি করা, গৃহকার্যে ব্যবহৃত পানির মান উন্নয়ন করা এবং এ লক্ষ্য অর্জনে কতটুকু সহায়ক হয়েছে তা মনিটর করা। এ প্রসঙ্গে আপনাদের মূল্যবান তথ্য বর্তমান প্রকল্প মূল্যায়ণে বিশেষ ভূমিকা রাখবে। এখানে আরও উল্লেখ্য যে, আপনার মতামত শুধুমাত্র গবেষণার কাজে ব্যবহৃত হবে এবং আপনার দেয়া তথ্য সম্পূর্ণ গোপন রাখা হবে। এ ব্যাপারে আপনার আন্তরিক সহযোগিতা একান্ত ভাবে কাম্য।

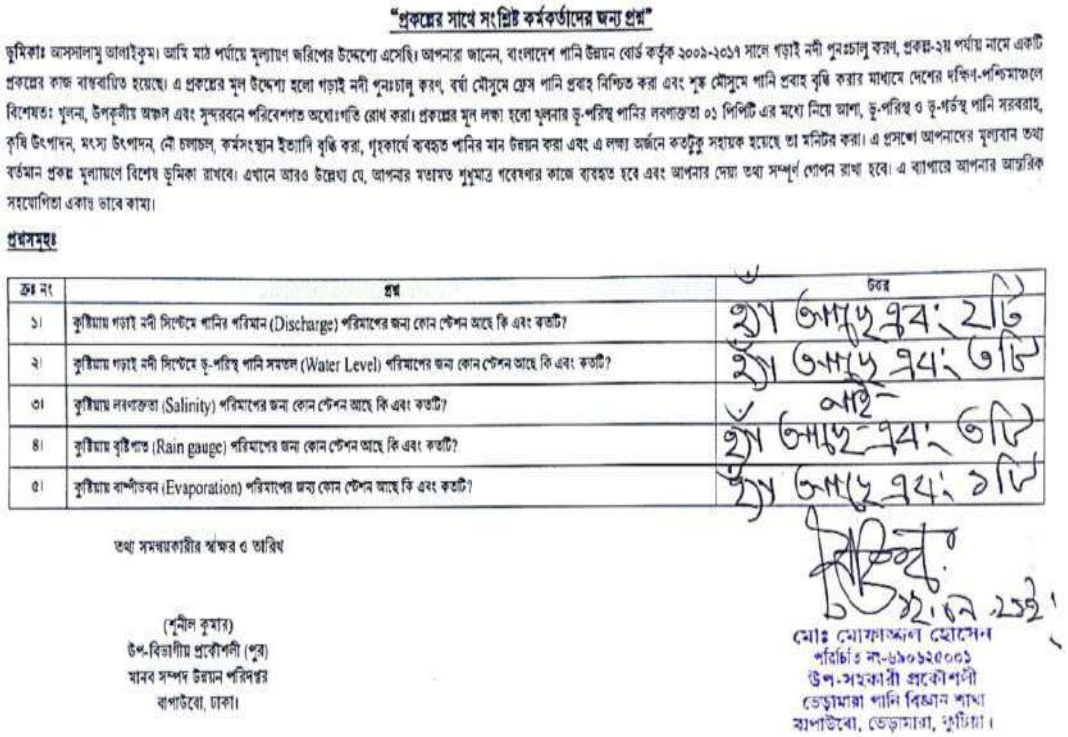
প্রশ্নসমূহঃ

ক্রঃ নং	প্রশ্ন	উত্তর
১।	কুষ্টিয়ায় গড়াই নদী সিস্টেমে পানির পরিমান (Discharge) পরিমাপের জন্য কোন ষ্টেশন আছে কি এবং কতটি?	
২।	কুষ্টিয়ায় গড়াই নদী সিস্টেমে ভূ-পরিস্থ পানি সমতল (Water Level) পরিমাপের জন্য কোন ষ্টেশন আছে কি এবং কতটি?	
৩।	কুষ্টিয়ায় লবণাক্ততা (Salinity) পরিমাপের জন্য কোন ষ্টেশন আছে কি এবং কতটি?	
৪।	কুষ্টিয়ায় বৃষ্টিপাত (Rain gauge) পরিমাপের জন্য কোন ষ্টেশন আছে কি এবং কতটি?	
৫।	কুষ্টিয়ায় বাষ্পীভবন (Evaporation) পরিমাপের জন্য কোন ষ্টেশন আছে কি এবং কতটি?	

তথ্য সমন্বয়কারীর স্বাক্ষর ও তারিখ

(শুনীল কুমার)
উপ-বিভাগীয় প্রকৌশলী (পুর)
মানব সম্পদ উন্নয়ন পরিদপ্তর
বাপাউবো, ঢাকা।

Figure A.5: Questionnaires from the Offices related to the project.



"প্রকল্পের সাথে সংশ্লিষ্ট কর্মকর্তাদের জন্য প্রশ্ন"

ভূমিকাঃ আসসালামু আলাইকুম। আমি মাঠ পর্যায়ে মূল্যায়ণ জরিপের উদ্দেশ্যে এসেছি। আপনারা জানেন, বাংলাদেশ পানি উন্নয়ন বোর্ড কর্তৃক ২০০৯-২০১৭ সালে গড়াই নদী পুনঃচালু করণ, প্রকল্প-২য় পর্যায় নামে একটি প্রকল্পের কাজ বাস্তবায়িত হয়েছে। এ প্রকল্পের মূল উদ্দেশ্য হলো গড়াই নদী পুনঃচালু করণ, বর্ষা মৌসুমে ফ্লেস পানি প্রবাহ নিশ্চিত করা এবং শুষ্ক মৌসুমে পানি প্রবাহ বৃদ্ধি করার মাধ্যমে দেশের দক্ষিণ-পশ্চিমাঞ্চলে বিশেষতঃ খুলনা, উপকূলীয় অঞ্চল এবং সুন্দরবনে পরিবেশগত অধোঃগতি রোধ করা। প্রকল্পের মূল লক্ষ্য হলো খুলনার ভূ-পরিস্থ পানির লবণাক্ততা ০১ পিপিটি এর মধ্যে নিয়ে আশা, ভূ-পরিস্থ ও ভূ-গর্ভস্থ পানি সরবরাহ, কৃষি উৎপাদন, মৎস্য উৎপাদন, নৌ চলাচল, কর্মসংস্থান ইত্যাদি বৃদ্ধি করা, গৃহকার্যে ব্যবহৃত পানির মান উন্নয়ন করা এবং এ লক্ষ্য অর্জনে কতটুকু সহায়ক হয়েছে তা মনিটর করা। এ প্রসঙ্গে আপনাদের মূল্যবান তথ্য বর্তমান প্রকল্প মূল্যায়ণে বিশেষ ভূমিকা রাখবে। এখানে আরও উল্লেখ্য যে, আপনার মতামত শুধুমাত্র গবেষণার কাজে ব্যবহৃত হবে এবং আপনার দেয়া তথ্য সম্পূর্ণ গোপন রাখা হবে। এ ব্যাপারে আপনার আন্তরিক সহযোগিতা একান্ত ভাবে কাম্য।

প্রশ্নসমূহঃ

ক্রঃ নং	প্রশ্ন	উত্তর
১।	কুষ্টিয়ায় গড়াই নদী সিস্টেমে পানির পরিমান (Discharge) পরিমাপের জন্য কোন ষ্টেশন আছে কি এবং কতটি?	হ্যাঁ আছে এবং ২টি
২।	কুষ্টিয়ায় গড়াই নদী সিস্টেমে ভূ-পরিস্থ পানি সমতল (Water Level) পরিমাপের জন্য কোন ষ্টেশন আছে কি এবং কতটি?	হ্যাঁ আছে এবং ৩টি
৩।	কুষ্টিয়ায় লবণাক্ততা (Salinity) পরিমাপের জন্য কোন ষ্টেশন আছে কি এবং কতটি?	নাই
৪।	কুষ্টিয়ায় বৃষ্টিপাত (Rain gauge) পরিমাপের জন্য কোন ষ্টেশন আছে কি এবং কতটি?	হ্যাঁ আছে এবং ৩টি
৫।	কুষ্টিয়ায় বাষ্পীভবন (Evaporation) পরিমাপের জন্য কোন ষ্টেশন আছে কি এবং কতটি?	হ্যাঁ আছে এবং ১টি

তথ্য সমন্বয়কারীর স্বাক্ষর ও তারিখ

(শুনীল কুমার)
উপ-বিভাগীয় প্রকৌশলী (পুর)
মানব সম্পদ উন্নয়ন পরিদপ্তর
বাপাউবো, ঢাকা।

১২.০৯.২০১৮
মোঃ মোফাজ্জল হোসেন
পরিচিতি নং-৬৯৬১২৫০০১
উপ-সহকারী প্রকৌশলী
ভেড়ামারা পানি বিজ্ঞান শাখা
বাপাউবো, ভেড়ামারা, কুষ্টিয়া।

Figure A.6: Answer from the Offices related to the project.

কুষ্টিয়া জেলার সদর, কুমারখালী ও খোকসা উপজেলার কৃষি বিষয়ক কিছু তথ্য ঃ

জেলার নাম ঃ কুষ্টিয়া

ক্রঃ নং	বছর	সদর উপজেলা		কুমারখালী উপজেলা		খোকসা উপজেলা		মন্তব্য
		মোট আবাদী জমির পরিমান (হেক্টর)	মোট অনাবাদি জমির পরিমান (হেক্টর)	মোট আবাদী জমির পরিমান (হেক্টর)	মোট অনাবাদি জমির পরিমান (হেক্টর)	মোট আবাদী জমির পরিমান (হেক্টর)	মোট অনাবাদি জমির পরিমান (হেক্টর)	
১	২০০৯	২৪১২০	২৫	১৭৮১৮	৪৩২	৮৬৩৩	৮১	
২	২০১০	২৪০০২	২৫	১৭৮১৮	৪৩২	৮৫৯৪	৭৮	
৩	২০১১	২৩৮৮৪	২৫	১৭৮১৮	৪৩২	৮৫৫৪	৭৬	
৪	২০১২	২৩৭৬৭	২৪	১৭৮১৮	৪৩২	৮৫১৬	৭২	
৫	২০১৩	২৩৬৫০	২৩	১৭৮১৮	৪৩২	৮৪৭৪	৭৩	
৬	২০১৪	২৩৫৩৪	২৩	১৭৮১৮	৪৩২	৮৪৩৫	৭১	
৭	২০১৫	২৩৪১৯	২৩	১৭৮১৮	৪৩২	৮৩৯৩	৭২	
৮	২০১৬	২৩৩০৪	২২	১৭৮১৮	৪৩২	৮৩৫১	৭৩	
৯	২০১৭	২৩১৯০	২২	১৮১৫০	১০০	৮৩১৪	৬৯	
১০	২০১৮	২৩০৭৬	২৬	১৮০৮৫	১৫৫	৮২৭৪	৬৯	
১১	২০১৯	২৩০৭৭	২৫	১৮০৯০	১৫০	৮২৭৩	৭০	
১২	২০২০	২৩০৭৮	২৪	১৮০৯৫	১৪৫	৮২৭৩	৭০	

২৬/২/২০২১

উপপরিচালক
কৃষি সম্প্রসারণ অধিদপ্তর
কুষ্টিয়া।
ফোন ঃ ০৭১-৬১৯৬৫

Figure A.7: Agricultural Information from the Department of Agriculture Extension, Kushtia.

বাংলাদেশ পানি উন্নয়ন বোর্ড
তত্ত্বাবধায়ক প্রকৌশলীর দপ্তর
প্রসেসিং এন্ড ফ্লাড ফোরকাস্টিং সার্কেল
৭২, গ্রীন রোড, ঢাকা-১২০৫

Bangladesh Water Development Board
Office of the Superintending Engineer
Processing & Flood Forecasting Circle
72 Green Road, Dhaka-1205, Bangladesh
Phone: +02-9110037, se.pffc@bwdb.gov.bd

Date: 23/06/2021

In voice for the Data to be supplied as
Requested by : SHUNIL KUMAR, SUB-DIVITIONAL ENGINEER,
Directorate of Human Resource Development,, BWDB, Dhaka.
Memo no : Dated: 23/06/2021
Delivery Date:

SL. No.	Nature of Data	Total Station	Period of Data	Total Year/ Record	Rate Amount (Tk.)	Amount (Tk.)
1.	Non Tidal Monthly Water Level	Total Stations: 01 Nos.	2009-2020	12 Yrs.	200 Tk./Yr.	2,400.00
2.	Monthly Discharge	Total Stations: 01 Nos.	2009-2020	143 Rec.	40 Tk./Rec.	5,720.00
3.	Monthly Salinity	Total Stations: 01 Nos.	2009-2020	73 Rec.	40 Tk./Rec.	2,920.00
4.	Ground Water Level	Total Stations: 01 Nos.	2009-2020	11 Yrs.	100 Tk./Yr.	1,100.00
					Sub Total	12,140.00
					Discount for BWDB Employee (90%)	10,926.00
					Grand Total	1,214.00

In Word: Taka One Thousand Two Hundred Fourteen Only.

N.B: This Data is not for sell, modify, and transfer to other institute/person without written permission of Bangladesh Water Development Board Authority.

Prepared By:
Tapasi
23-6-21
Tapasi
Programmer
Management & Services Branch
Processing & Flood Forecasting Circle
BWDB, 72 Green Road, Dhaka.

Recommend By:
23/6/21
(Md. Mushfiqur Rahman)
System Analyst
Management & Services Branch
Processing & Flood Forecasting Circle
BWDB, 72 Green Road, Dhaka.

Approved By:
23/6/2021
Superintending Engineer
Processing & Flood Forecasting Circle
BWDB, 72 Green Road, Dhaka

Figure A.8: Secondary data collected from Processing & Flood Forecasting Circle (PFFC), BWDB

Table B1: Types of questions and answer for impact analysis.

Qs No	Questions Type	Answers		
	Questions for everyone:	N_a	N_b	N_c
Q_1	Which water do you use for drinking or cooking?	Gorai River	Tube well	Others
Q_2	Does the water you use contain salinity?	Yes	No	No comments
Q_3	Are you experiencing any physical discomfort as a result of using salt water?	Yes	No	No comments
Q_4	As a result of dredging, is there any salinity in Gorai River water now (2021)?	Yes	No	No comments
Q_5	Is there any problem in crop production or any other problem due to use of salt water?	Yes	No	No comments
Q_5	In the dry season, the riverbank residents and cattle bathing for daily necessities, including the use of the river water is used?	Yes	No	No comments
Q_7	Has the amount of water in Gorai River increased during the current (2021) drought season due to dredging?	Increased	Decreased	It is the same.
Q_8	Is water available in tubewells during the current dry season?	Yes	No	It is the same
Q_9	Has there been any environmental problem while dredging?	Yes	No	Others
Q_{10}	What do you think of the aquatic mortality rate during dredging?	More	Less	Others
Q_{11}	Has there been any difficulty in dredging?	Breakdown	Keep the soil	Others
Q_{12}	What is the problem with the place where dredged soil / sand is kept?	Living	Of movement	Others
Q_{13}	Is there any contamination during dredging?	Sound pollution	Air pollution	Water/Soil pollution
Q_{14}	As a result of the implementation of this project, how is the situation of biodiversity around the river changing?	Increased	Decreased	It is the same.
Q_{15}	Are you satisfied with your current job?	Yes	No	No comments
Q_{16}	Why do you want to change your profession?	Gorai River	Others	No comments

	Questions for Farmer:			
Q_{17}	Which water is currently used in agriculture?	Gorai River	G-K	Others
Q_{18}	At present (2021) how many crops are produced in the land?	1	2	3
Q_{19}	At present (2021) the amount of crop production in the land has increased or not?	Increased	Decreased	It is the same.
Q_{20}	What is the cause of increase / decrease in crop production?	Gorai River	Seed / Fertilizer	Others
Q_{21}	Is there any new employment opportunity for farmers in Gorai River now?	Increased	Decreased	It is the same.
	Questions for Fisherman:			
Q_{22}	At present (2021) in the river Gorai fish production has increased or not?	Increased	Decreased	It is the same.
Q_{23}	What is the cause of increase / decrease in fish production?	Gorai River	Seed / Fertilizer	Others
Q_{24}	Is the water in Gorai River suitable for aquatic life during the current dry season?	Yes	No	Others
Q_{25}	Is there any new employment opportunity for fishermen in Gorai River now?	Increased	Decreased	It is the same.
	Questions for Boatman:			
Q_{26}	As a result of the implementation of this project in the current dry season, the river Gorai always has water?	Yes	No	It is the same.
Q_{27}	In what way do people cross the river in the dry season?	In the ferry boat	On Foot	Others
Q_{28}	Is the water in the river Gorai suitable for navigation during the current dry season?	Yes	No	Others
Q_{29}	Has the implementation of this project created job opportunities for boatmen?	Increased	Decreased	It is the same.
	Questions for Sand Traders:			
Q_{30}	Has there been any new employment opportunity in dredging sand extraction and transportation from Gorai River?	Increased	Decreased	It is the same.

Table B2: Total Number of Perticipants with answer for Impact analyzes.

Sl No	Questions Numbers	Number of Perticipants	Answer Type & Numbers of Answer			Comments
			N_a	N_b	N_c	
1	Q_1	350	2	347	1	GW is available
2	Q_2	350	3	347	0	No Salinity in tube well
3	Q_3	350	3	347	0	No harmful for health
4	Q_4	350	3	347	0	No disease in water
5	Q_5	350	350	0	0	No harmful for agriculture
6	Q_6	350	305	45	0	Domestic purposes is available
7	Q_7	350	302	28	20	Water level is increase
8	Q_8	350	319	31	0	GW is available
9	Q_9	350	250	60	40	No environmental problem
10	Q_{10}	350	10	310	30	Goods for aquatic flora & fauna
11	Q_{11}	350	10	300	40	No dredging problem
12	Q_{12}	350	15	305	30	No problems for sand filling
13	Q_{13}	350	40	50	260	Pollution is temporary
14	Q_{14}	350	270	40	40	Situation of biodiversity is increase
15	Q_{15}	350	25	275	50	People are wants to change their occupation
16	Q_{16}	350	30	280	40	Gorai River is not responsible
17	Q_{17}	215	32	33	150	Irrigated area is increased
18	Q_{18}	215	12	83	120	Cropping intensity is increased
19	Q_{19}	215	200	10	5	Crop production is increased
20	Q_{20}	215	90	85	40	Seed or Fertilizer use is increased
21	Q_{21}	215	122	41	52	Farmers opportunities is increased
22	Q_{22}	25	13	5	7	Fish production is increased
23	Q_{23}	13	9	4	0	Gorai River
24	Q_{24}	25	15	5	5	Goods for aquatic flora & fauna

Sl No	Questions Numbers	Number of Perticipants	Answer Type & Numbers of Answer			Comments
			N_a	N_b	N_c	
25	Q_{25}	25	9	2	14	Fishermen opportunities is increased
26	Q_{26}	25	8	17	0	Surface water availability is less
27	Q_{27}	17	2	15	0	Waterway communication is not increased
28	Q_{28}	25	8	17	0	Navigation facilities is not increased
29	Q_{29}	25	9	2	14	Boatman opportunities is same as before
30	Q_{30}	25	17	2	6	Sand traders opportunities is increased