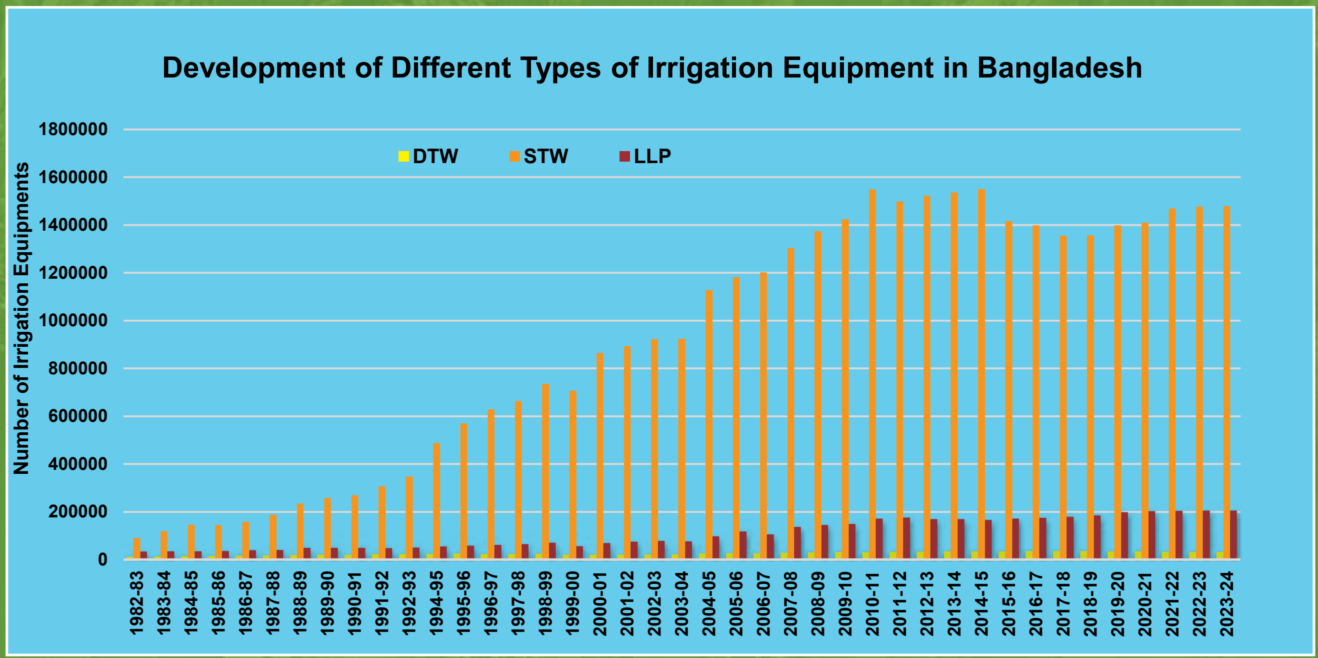
Using Smart Irrigation Technology
Ensure Sustainable Environment and Food Security



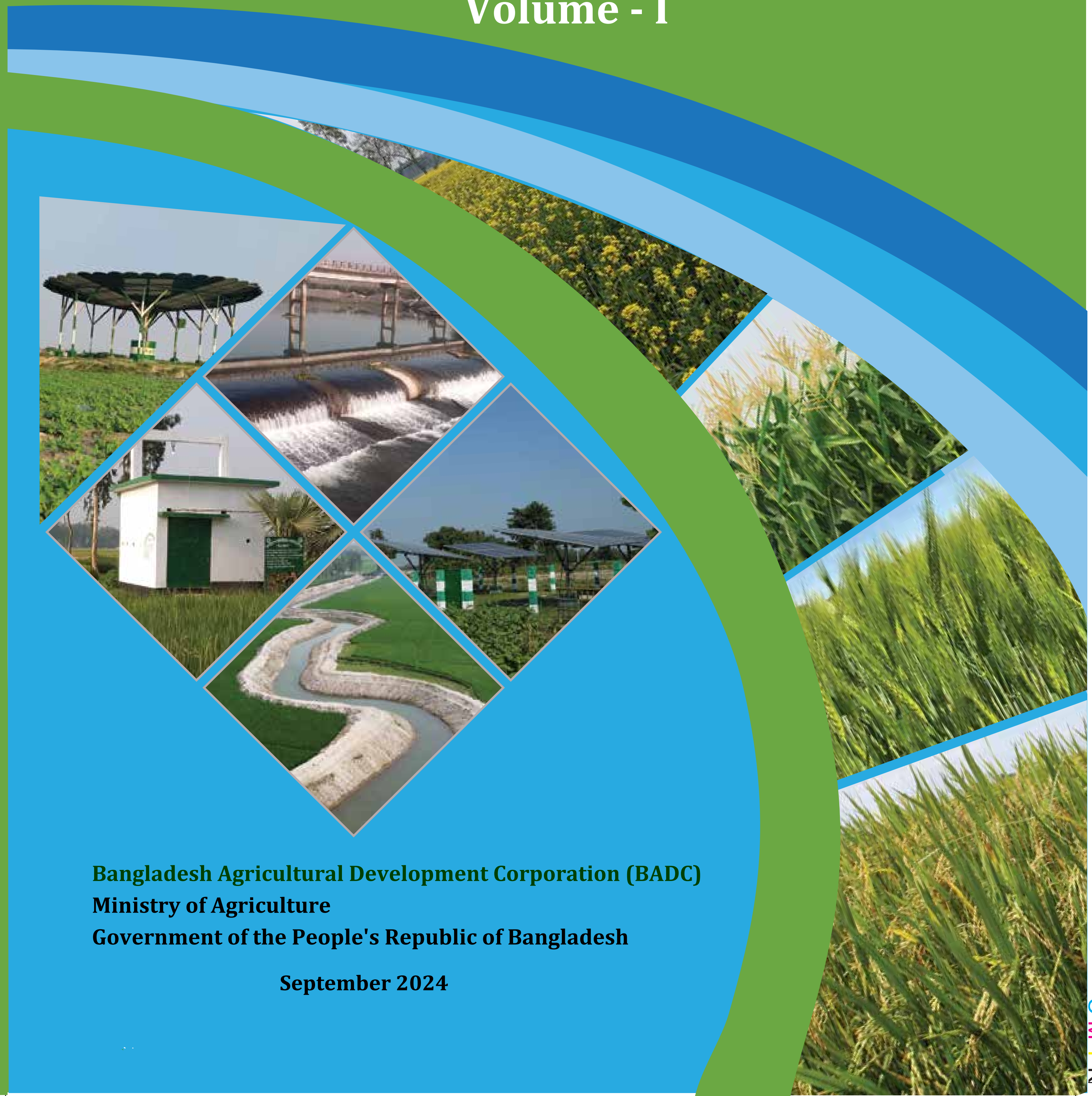

Optimize Irrigation, Maximize Crop Production

Minor Irrigation Survey Report 2023-2024
Volume - I

Agriculture is Prosperity

# Minor Irrigation Survey Report 2023-2024

## Volume - I



Bangladesh Agricultural Development Corporation (BADC)
Ministry of Agriculture
Government of the People's Republic of Bangladesh

September 2024

Government of the People's Republic of Bangladesh

**Ministry of Agriculture**

# Minor Irrigation Survey Report 2023-2024

**(Rabi Season)**

## Survey Conducted by

**Bangladesh Agricultural Development Corporation (BADC)**
**Department of Agriculture Extension (DAE)**
**Barind Multipurpose Development Authority (BMDA)**
**Centre for Environmental and Geographic Information Services (CEGIS)**

## Report Prepared by

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**June, 2024**

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| Copy Right | : | Additional Chief Engineer (MI), Western, BADC,<br>Shech Bhaban, 22 Manik Mia Avenue, Sher-e-<br>Bangla Nagar, Dhaka. |
| Publisher | : | Additional Chief Engineer (MI), Western, BADC,<br>Shech Bhaban, 22 Manik Mia Avenue, Sher-e-<br>Bangla Nagar, Dhaka. |
| Date of Publication | : | |
| Price | : | |

# Foreword

Irrigation development is pivotal for enhancing food security, agricultural productivity, and climate resilience in Bangladesh through sustainable water use and farming practices. Since its inception in 1961, the Bangladesh Agricultural Development Corporation (BADC) has promoted minor irrigation advancements by expanding irrigated areas, installing various irrigation equipment, and meticulously collecting and monitoring irrigation-related data. I am pleased to announce the publication of a comprehensive report on Minor Irrigation Equipment Survey 2023-2024 under the "Digitalization of Survey and Monitoring for the Development of Minor Irrigation" Project.

This report includes key insights into Bangladesh's minor irrigation systems, covering annual and time-series data on irrigated areas, irrigation equipment used, power sources and benefited farmers. It provides detailed data on various irrigation systems, including low-lift pumps, deep tube wells, shallow tube wells, rubber dams, solar pumps & dug-wells, traditional methods, gravity flow irrigation, and agency-specific evaluations. Furthermore, the report addresses crucial aspects such as the present state of groundwater levels, salinity intrusion in coastal regions, and the potential utilization of surface water resources through GIS mapping. These findings will significantly support sustainable water resource management and serve as a valuable resource for planners, researchers, and policymakers in developing and enhancing irrigation strategies.

I would like to thank my colleagues in the Minor Irrigation Wing of BADC and the teams from BMDA, DAE, and CEGIS, whose dedication made this report possible.

Abdullah Sazzad ndc

Chairman (Grade-1), BADC.

# Preface

We are pleased to announce the publication of the **Minor Irrigation Survey Report 2023-24**, prepared under the recently completed Digitalization of Survey and Monitoring for Development of Minor Irrigation Project. Since 2005, the BADC, BMDA, and DAE have conducted regular surveys of minor irrigation equipment to assess the irrigation status, trend and identify development potentials across the country. To enhance these routine evaluations with in-depth analysis and more detailed reporting, BADC engaged the Center for Environmental and Geographic Information Services (CEGIS) to prepare a comprehensive report on the irrigation state in Bangladesh.

Since its establishment in 1961, BADC has led the way in introducing, developing, and expanding minor irrigation across the country. Currently, minor irrigation accounts for approximately 95% of the country's irrigated land, playing a vital role in boosting food production. The report reveals that during the Rabi season, Bangladesh's total irrigation coverage is approximately 5.77 million hectares, with 72.07% (4.16 million hectares) reliant on groundwater and 27.93% (1.61 million hectares) dependent on surface water.

This report provides a comprehensive overview of irrigation practices in Bangladesh during the 2023-2024 Rabi season, with detailed data on equipment, irrigated areas, surface & groundwater usage, and irrigation methods. It highlights the increasing dependence on groundwater for irrigation, especially in northern regions where deep and shallow tube wells are prevalent. This practice raises concerns about groundwater depletion and in southern regions increased saline water intrusion.

To address these challenges, BADC is implementing a comprehensive water management strategy encompassing promoting sustainable practices like alternate wetting and drying, improving efficient conveyance systems, and adopting climate-smart technologies, including solar operated dug-well, drip, and sprinkler irrigation. Additionally, BADC is expanding surface water irrigation through canal excavation and the construction of rubber dams.

These insights will prove invaluable for the Government in developing more efficient irrigation policies and plans. Additionally, planners, policymakers, researchers, academics, and administrators will find this report valuable for understanding irrigation trends and challenges in Bangladesh.

I extend my heartfelt gratitude to the CEGIS, BADC, BMDA, and DAE officials for their dedicated efforts in preparing and publishing this important report.

Muhammad Badiul Alam Sarker

Chief Engineer (Minor Irrigation)

BADC, Dhaka

# Preface

I am pleased to announce the publication of the "Minor Irrigation Survey Report 2023-24," a comprehensive assessment of minor irrigation systems across Bangladesh. This report provides an in-depth analysis of the current state of minor irrigation, covering key aspects such as the types of irrigation equipment used, the total irrigated area, the number of farmers benefiting, and the quality of irrigation water. It also evaluates the potential of surface water resources for irrigation, identifies groundwater stress zones, and highlights regions vulnerable to saline water intrusion. This crucial data will assist in formulating sustainable water management strategies by addressing climate change and rising water demands in agriculture sector.

The task adopted a robust, multifaceted approach to achieve its objectives. Extensive field surveys were meticulously conducted across all 64 districts, gathering detailed data on various irrigation equipment, including low-lift pumps, deep and shallow tube wells, solar pumps, dug wells and gravity flow methods. This primary data was supplemented with secondary information from key partners such as BADC, BMDA, and DAE. Advanced statistical techniques and GIS software were used to analyze the data, revealing trends, patterns, and correlations in irrigation practices nationwide.

The Centre for Environmental and Geographic Information Services (CEGIS) played an indispensable role in the execution of this survey and the compilation of the report, with invaluable support provided by BADC, BMDA, and DAE field offices. Furthermore, a dedicated validation workshop convened in Dhaka ensured the report's accuracy and relevance by incorporating feedback from a diverse array of stakeholders, including representatives from relevant ministries and esteemed agricultural research institutions.

I extend my heartfelt thanks to the CEGIS team and my colleagues, both in the field and at the project office, for their dedication to this publication. I am especially grateful to Dr. Md. Monirul Islam, Deputy Director of DAE, and Md. Jahangir Alam Khan, Additional Chief Engineer of BMDA, for their committed efforts in preparing the report.

My sincere appreciation goes to the Chief Engineers of the Irrigation Wing and the Member Director (MI) of BADC for their valuable suggestions and guidance.

I sincerely thank Mr. Abdullah Sazzad, NDC, Chairman of Bangladesh Agricultural Development Corporation, for his unwavering support and valuable feedback throughout the survey. I am equally thankful to Md. Tajul Islam Patwary, Director General of DAE, and Md. Shafiqul Islam, Executive Director of BMDA, for their significant contributions.

Khan Faisal Ahmed

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# Executive Summary

For over six decades, the Bangladesh Agricultural Development Corporation (BADC) has been a leading organization in agricultural advancement, earning farmers' trust through its commitment to expanding irrigation areas, transferring modern technology, and efficiently utilizing ground and surface water resources. BADC plays a crucial role in disseminating high-yielding seed varieties and quality fertilizers, while actively promoting minor irrigation techniques such as LLP, DTW, STW, floating pumps, solar pumps, dug wells, rubber dams, and gravity flow systems. Since 2005, the BADC, BMDA, and DAE have conducted regular surveys of minor irrigation equipment to assess the irrigation status, trend and identify development potentials across the country.

With technical support from the Centre for Environmental & Geographical Information Services (CEGIS), a Public Trust under the Ministry of Water Resources, BADC had developed the Bangladesh Irrigation Equipment Survey & Monitoring (BIESM) software. CEGIS has been entrusted with publishing the latest Minor Irrigation Survey Report for 2023-24, further solidifying BADC's commitment to informed agricultural practices.

The report provided the annual irrigation coverage by agency for the nation as well as time series of the irrigation area, operational irrigation equipment, power sources, farmers' participation in irrigation activities, and the trend of surface and ground water consumption.

The main objectives of this report to update database of BIESM software and prepare Minor Irrigation Survey Report 2023-24 (Rabi Season). Field data collectors have surveyed irrigation equipment at the Upazila level, collaborating with officials from BADC, BMDA, and DAE. The survey has been conducted on Boro, Wheat, Potato, Maize, Spices and vegetables. Draft data sheets have been prepared, and a regional level meeting was validate the data, with representatives from relevant organizations providing valuable comments and suggestions. A validation workshop was then arranged at Sech Bhaban, Dhaka, with representatives from the MoA, Mop, BADC, BMDA, BRRI, BARI, and other relevant stakeholder organisations in attendance. The report included comments and suggestions from the validation workshop.

The survey showed that about 5.77 Mha of crop land have the irrigation facilities, with 27.93% surface water and 72.07% ground water. Approximately 28.59% of NCA, comprising mostly hilly, coastal, and char regions, currently lacks irrigation facilities. A total of 207368 LLPs, 34040 DTWs, 1479266 STWs, 3128 solar pumps, 930 solar dug wells, 73 rubber dams were in operation and benefiting 20248566 farmers. Surface water irrigation was performed by LLP, solar pump, floating pump, rubber dam, gravity flow method and traditional methods. DTW, STW, solar pump, dug well, artesian well, and manual methods were used for ground water irrigation. The North-West and North-Central hydrological zones have a scarcity of surface water; therefore, crop production depends on ground water irrigation. In the hydrological zones of the North East, South Central, and South West, there are abundance of surface water resources available to farmers for the production of agricultural products.

The findings of the report will aid the government in developing policy choices for minor irrigation planning, which is essential to boosting food grain production. In order to plan efficiently in minor irrigation subsectors, this report will provide the planner, policy makers, researchers, and administrators with the information and data they need.

## Organization Wise Summary of Irrigation Equipment Used, Area Irrigated and Benefited Farmers
## Rabi Crops (Boro, Wheat, Potato, Maize, Onion and Vegetables) 2023-24

| Type of Equipment | Name of organization | Operated by Electricity | | | | | Operated by Diesel | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Unit | | | Irrigated Area (ha) | Benefitted Farmers | Unit | Irrigated Area (ha) | Benefitted Farmers | Unit | Irrigated Area (ha) | Benefitted Farmers |
| | | PDB | REB | TOTAL | | | | | | | | |
| DTW | BADC | 616 | 10655 | 11271 | 336536 | 1221627 | 292 | 8065 | 23551 | 11563 | 344601 | 1245178 |
| | BMDA | 902 | 14637 | 15539 | 514575 | 1075461 | 17 | 355 | 745 | 15556 | 514930 | 1076206 |
| | Others | 308 | 6143 | 6451 | 178793 | 682179 | 470 | 9718 | 44481 | 6921 | 188511 | 726660 |
| | Total | 1826 | 31435 | 33261 | 1029904 | 2979267 | 779 | 18138 | 68777 | 34040 | 1048042 | 3048044 |
| STW | BADC | 15 | 171 | 186 | 1488 | 4968 | 11 | 66 | 342 | 197 | 1554 | 5310 |
| | BMDA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Others | 33623 | 402307 | 435930 | 1160927 | 3877496 | 1043139 | 1923438 | 9174799 | 1479069 | 3084365 | 13052295 |
| | Total | 33638 | 402478 | 436116 | 1162415 | 3882464 | 1043150 | 1923504 | 9175141 | 1479266 | 3085919 | 13057605 |
| LLP | BADC | 298 | 3863 | 4161 | 114862 | 263685 | 5320 | 126336 | 246178 | 9481 | 241198 | 509863 |
| | BMDA | 54 | 574 | 628 | 16369 | 42408 | 10 | 155 | 750 | 638 | 16524 | 43158 |
| | Others | 3185 | 15129 | 18314 | 202166 | 639389 | 178935 | 890654 | 2565892 | 197249 | 1092820 | 3205281 |
| | Total | 3537 | 19566 | 23103 | 333397 | 945482 | 184265 | 1017145 | 2812820 | 207368 | 1350542 | 3758302 |
| DTW +STW +LLP | | 39001 | 453479 | 492480 | 2525716 | 7807213 | 1228194 | 2958787 | 12056738 | 1720674 | 5484503 | 19863951 |
| Manual & Artesian Well | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6303 | 27670 |
| Traditional Method | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5444 | 20578 |
| Gravity Flow | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 244092 | 283147 |
| Solar Pump | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3128 | 27813 | 49229 |
| Dug Well | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 930 | 1118 | 3991 |
| COUNTRY TOTAL | | 39001 | 453479 | 492480 | 2525716 | 7807213 | 1228194 | 2958787 | 12056738 | 1724732 | 5769273 | 20248566 |

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# Table of Contents

# List of Tables

# List of Figures

# Abbreviations and Acronyms

| | |
|---|---|
| Agri | Agricultural |
| ATIA | Assisting Transformation to Irrigated Agriculture |
| AWD | Alternate Wetting and Drying |
| BADC | Bangladesh Agricultural Development Corporation |
| BARI | Bangladesh Agricultural Research Institute |
| BBS | Bangladesh Bureau of Statistics |
| BIESM | Bangladesh Irrigation Equipment Survey and Monitoring System |
| BMDA | Barind Multipurpose Development Authority |
| BPDB | Bangladesh Power Development Board |
| BRRI | Bangladesh Rice Research Institute |
| BRDB | Bangladesh Rural Development Board |
| BWDB | Bangladesh Water Development Board |
| CEGIS | Center for Environmental and Geographic Information Services |
| DAE | Department of Agriculture Extension |
| DTW | Deep Tube well |
| FW | Fresh Water |
| FY | Financial Year |
| GIS | Geographical Information System |
| GWT | Ground Water Table |
| HYV | High Yielding Variety |
| LGED | Local Government Engineering Department |
| LLP | Low Lift Pump |
| Mha | Million Hectare |
| MoA | Ministry of Agriculture |
| MoP | Ministry of Planning |

| | |
|---|---|
| NAP | National Adaptation Plan |
| NCA | Net Cultivated Area |
| PVC | Polyvinyl Chloride |
| REB | Rural Electrification Board |
| SDG | Sustainable Development Goal |
| STW | Shallow Tube well |

# 1. Introduction

## 1.1 Background

Agriculture is the largest employment sector in Bangladesh. As of 2023, it employs 45.33% of total labor force and comprises 11.38% (FY 2022-23) of the country's GDP (BBS 2022). Irrigation development in Bangladesh has been pivotal in the country's agricultural progress and economic growth. About 95% of irrigated land of the country is covered by minor irrigation. Introduction of minor irrigation has increased food grain production about three times in last six decades. It is playing a significant role in increase of food production during Rabi season. Different types of irrigation equipment like Deep Tube Wells (DTWs), Shallow Tube Wells (STWs), Low Lift Pumps (LLPs), Dug-well, Floating Pump, Solar Operated Pump and Rubber Dam, Weir Diversion Structure are used for irrigation. Modern technologies like puried pipe, sprinkler, drip etc. are used in the crop land to convey and apply irrigation water. The data about total irrigated area, irrigation equipment used in Rabi season are important for policy planning, development and expansion of minor irrigation.

Bangladesh Agricultural Development Corporation (BADC) has been pioneering in utilization, expansion and development of minor irrigation throughout the country. It has mastered experience on irrigation activities and developed vast resourceful data/information storage. Different projects on minor irrigation at Government and non-Government level are being prepared on the basis of these data/information. In 1961, BADC began its irrigation activity, fielding 1555 Low Lift Pumps. Deep tube wells were later installed in 1967–1968 for irrigation in areas with scare surface water. Similar installations were made for the same reasons in shallow tube wells in 1973–1974, floating pumps in 1987–1988, rubber dam and solar pumps in 2011–2012, and dug wells in 2015–2016. In addition to these technologies, irrigation work is carried out in some parts of the country using gravity flow, conventional methods, manual pumps, and artesian wells.

The Bangladesh Agricultural Development Corporation (BADC) has been collecting data on irrigation equipment since 2000 and published annual reports from 2000 to 2004. Following a directive from the Ministry of Agriculture, BADC has been publishing minor irrigation survey report collaborating with the Department of Agricultural Extension (DAE) and the Barind Multipurpose Development Authority (BMDA) to conduct these surveys. The annual minor irrigation survey report published by BADC are important for the government's decision-making process, particularly for effective planning in minor irrigation, which significantly impacts food grain production. In 2018, the BADC engaged the Center for Environmental and Geographic Information Services (CEGIS) to develop the Bangladesh Irrigation Equipment Survey & Monitoring (BIESM) web application as part of the Digitalization of Survey and Monitoring for Development of Minor Irrigation.

Considering the technological advancement of information arena all existing and surveyed information regarding minor irrigation sources can be integrated into a Web-enabled System for making information available to every level of users from decision makers to the general users with proper authentication. The BIESM software contains detailed information on approximately eighteen lakh irrigation equipment, including location, specifications (make, model, pump capacity), energy source, power supply, irrigation canals, and seasonal and crop-wise irrigation areas. It also details operating hours, irrigation costs, and information about the farmers who benefit from these schemes.

## 1.2 Relevance of Survey

The amount of agricultural land has been decreasing due to urbanization, constructing roads infrastructure industrial facilities with many other factors; while the country's population is growing at a pace of 1.12% annually (BBS 2022), cultivable agricultural land is declining at a rate of 0.5% annually (Yearbook of Agricultural Statistics 2022). For this expanding population, the production of food is a significant concern. In order to increase agricultural output, progressive irrigation management is required because average irrigation efficiency is only 37% (Mu et al., 2009). Water resources are becoming scarce worldwide, and Bangladesh is no exception. Surface water supply is decreasing day by day while demand for irrigation is increasing. The country receives a huge amount of surface water during monsoon. However, this water flows down to the Bay of Bengal due to a lack of planned storage and efficient infrastructure. Thus, the irrigation demand scored at its top in the Rabi season. For proper management of the irrigation water considering both surface and ground water availability understanding of present irrigation status is mandate.

The irrigation related information plays a vital role to aligning the agriculture as well as food security with the Sustainable Development Goals (SDGs), Bangladesh Delta Plan 2100, National Adaptation Plan (NAP) 2023–2050, the Eighth Five-Year Plan (2020-2025), Perspective Plan (2021-2041), and the Integrated Minor Irrigation Policy-2017. The SDGs emphasize key areas such as ending poverty (SDG 1), achieving food security and improved nutrition, and promoting sustainable agriculture (SDG 2). Along with this, it focuses on ensuring the availability and sustainable management of water and sanitation for all (SDG 6). The Bangladesh Delta Plan 2100, with its Fresh Water (FW) Strategies, aims to ensure water availability by balancing supply and demand. This includes optimal water resources management (FW 1.1), the introduction of new irrigation schemes for major rivers (FW 1.2), excavation of local water reservoirs (FW 1.3), and preservation of groundwater levels (FW 1.7). The National Adaptation Plan (NAP 2022) aims to develop climate-resilient agriculture for food, nutrition, and livelihood security, with an investment plan focused on augmenting surface water for irrigation and multipurpose use.

Irrigation water is a vital resource for agricultural development. Every season, more and more information on irrigation is required for demand-based planning in the irrigation subsector to enhance the irrigated area and ensure the country's sustainable food grain production. A database, GIS maps, reports, and pertinent information on irrigation systems must be prepared for future use.

Bangladesh Agricultural Development Corporation (BADC) played a key role collecting, analysis, storing and publishing irrigation data/information through survey. The survey would meet the requirement of some basic information on irrigated agriculture covered by Low Lift Pumps, Deep Tube Wells, Shallow Tube Wells, Solar Operated Pumps, Dug-wells, Artesian Wells, Manually Operated Pumps, Traditional and by Gravity flow.

The findings of the survey report will help the Government in formulation of decisions for effective minor irrigation planning which played a key role in the production of food grains. This report will furnish the planners, researchers and administrators necessary irrigation related data for effective planning in irrigation sub-sector. Beside this, the BIESM software contains detailed information on approximately eighteen lakh irrigation equipment, including location, specifications (make, model, pump capacity), energy source, power supply, irrigation canals, and seasonal and crop-wise irrigation areas. The user (BADC officials, planners, researchers and administrators) of this software can easily generate the analytical table, graph, pai-chart etc., which is very fruitful work of BADC for national research and planning.

Due to the dynamic nature of this data, this database requires annual updating. Consequently, it is vital to update the BIESM database and publish the minor irrigation survey report for 2023-24.

## 1.3 Study Area

The survey of the study covered 8 divisions and 64 districts of the entered country. The area is presented in **Figure 1.1.**

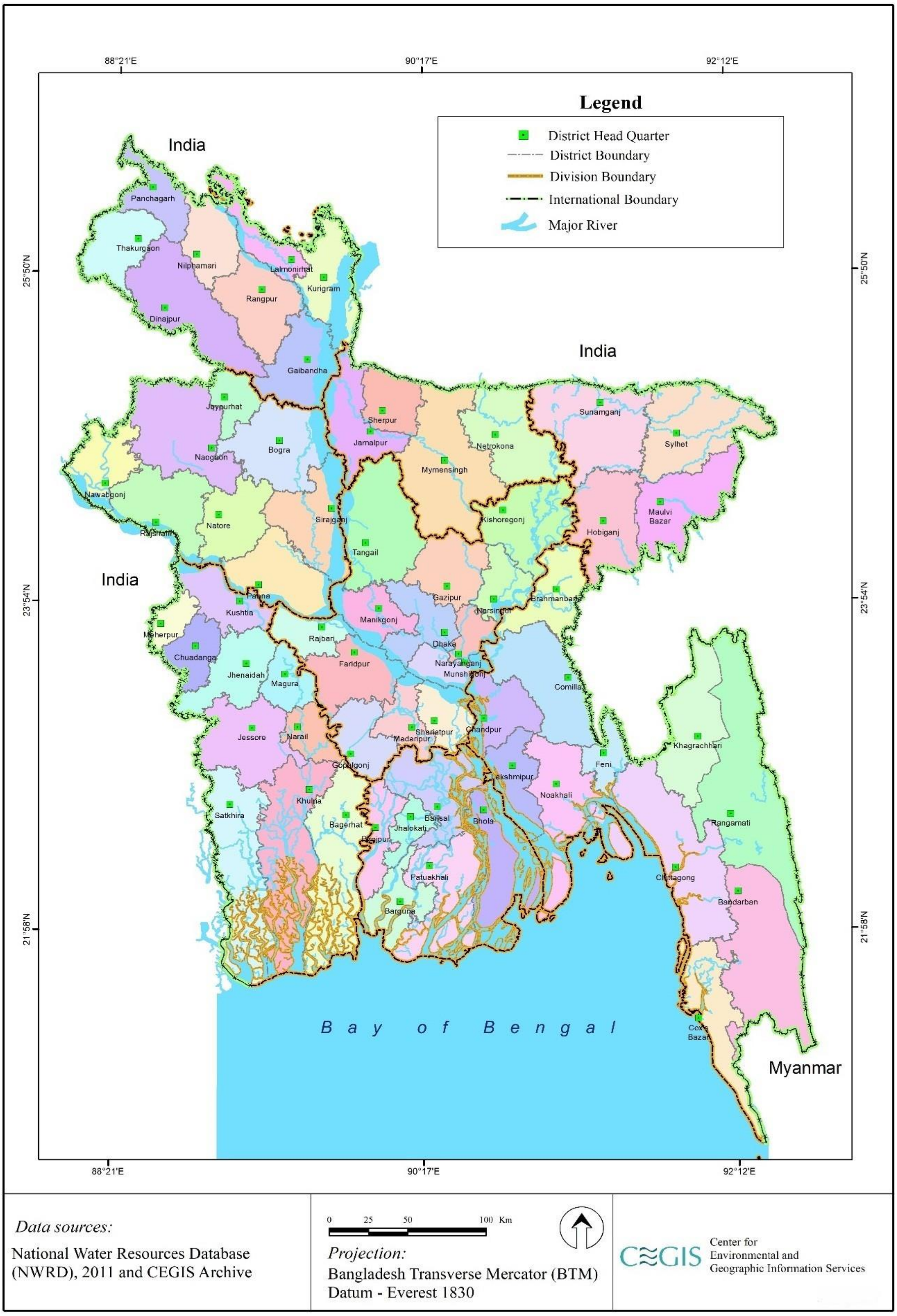


**Figure 1.1: Map Showing Districts of the Study Area**

## 1.4 Objectives and Outcomes

Bangladesh is one of the world's biggest deltaic country. Compared to its population, it has a small amount of arable land. There is an abundance of water throughout the wet season (June to September), but a scarcity during the Rabi season (October to March). The primary tool for raising production from agriculture is irrigation. In Bangladesh, small-scale irrigation is essential for increasing the irrigated area, producing more food for the nation's food security. Plan for agricultural development, adequate and reliable statistical data about the number and types of irrigation equipment (both diesel and electric), irrigated area, irrigation cost and benefiting farmers are very much essential. The main outcomes of this study are to update the BIESM software with the latest information and prepare the Minor Irrigation Survey Report for 2023-24.

The specific objectives of the minor irrigation survey 2023-24 are outlined below:

- To collect information on minor irrigation equipment, irrigated areas, benefited farmers;
- To assess irrigation water quality for identifying saline zones
- To identify groundwater stress areas and surface water potential for zoning.
- To prepare the Minor Irrigation Survey Report for 2023-2024.

This report will include comprehensive databases that cover irrigation equipment statistics, such as the number of irrigation equipment categorized by power source and area coverage. It will also provide beneficiary data detailing the information on farmers who directly benefit from the irrigation systems. Additionally, the report will feature key mapping with visual representations of potential surface water lifting areas, salinity levels, groundwater stress zones, and other relevant zoning maps. These resources will offer a clear and up-to-date understanding of Bangladesh's current irrigation status.

# 2. Review of Related Information of Survey

## 2.1 Policy and Plan of Irrigation

A good number of national and international policies related to agriculture, irrigation and water resources management have been formulated by the government and international agencies to boost food production as well as food security. The key features of some relevant policies are reviewed in bellow:

### *2.1.1 National Policies and Plan*

*National Agriculture Policy 2018*

The National Agriculture Policy was formulated in 1999 to make the country self-sufficient in food by increasing the production of all crops, including cereals, and ensuring a reliable food security system. It was amended in 2013 to address other challenges, including the adverse impact of climate change on the agricultural sector. The new agriculture policy (2018) emphasizes investment in irrigation management, agricultural cooperatives and marketing, safe and nutritious food production, information and communication technology, etc. It has a separate section on irrigation and water management, primarily focusing on increasing irrigation efficiency and water productivity. Increasing irrigation demand and limiting groundwater use are essential for maintaining environmental balance and reducing irrigation costs. Ongoing activities to increase the availability and utilization of groundwater include the construction of rubber dams in small and medium rivers. To increase the groundwater level and to get enough water for irrigation during the dry season, monsoon is being prioritized for the preservation of groundwater along with rainwater. The brief of the policy related to the irrigation and water management is presented below-

- Increase irrigation efficiency and water productivity using pipelines instead of irrigation drains in all possible areas;
- Emphasize the balanced use of groundwater and encourage the cultivation of less water-consuming crops in drought-prone areas;
- Conservation of rainwater to enhance surface water availability for irrigation;
- Expansion of Aus, Aman, and vegetable cultivation, coupled with the introduction of water-saving crops, by increasing supplementary irrigation;
- Excavation of canals, ponds, and wetlands to preserve and optimize the use of surface water;
- Prioritizing reasonably priced electricity for irrigation systems and promoting solar energy for irrigation;
- Development of an irrigation management zoning plan, considering the assessment of surface water availability, geographical characteristics of various areas, and future water demands across different sectors;
- Use the water balance model to determine the quantity of surface and groundwater and future water demand for different sectors, including agriculture, considering future extension of irrigable areas.

*Integrated Minor Irrigation Policy 2017*

The policy has been formulated to ensure food security and alleviate poverty within the country. It aims to increase crop production while reducing irrigation costs by modernizing the irrigation system and enhancing capacity building. The policy mentions increasing surface water use for irrigation purposes and suggests extending irrigation facilities in remote agricultural lands by constructing irrigation canals, infrastructure, and installing high-capacity pumps. Additionally, a strong emphasis is on harnessing and conserving rainwater to decrease dependence on groundwater. Where groundwater usage is inevitable, the policy recommends positioning tube wells in such a way that it can supply irrigation water to at least two sides simultaneously. It also recommended the construction of recharge wells to augment groundwater replenishment. Brife of this policies presented bellow:

- Build an area-based irrigation systems i.e. floodplain, char, haor, barind, hilly and costal area for increased crop production;
- Re-excavate water bodies, construct embankments, irrigation infrastructure and promote fish cultivation where appropriate;
- Use medium/high capacity pumps to withdraw sureface water for irrigation;
- Ensure proper repair and maintenance of all irrigation infrastructure and equipment;
- Installation of buried pipeline, drip and sprinkler irrigation system to enhance convence and water use efficiancy.
- Increase use of surface water rather than groundwater for irrigation;
- Enphasis use of renewable energy (solar/wind power) for irrigation pumps
- Construct reservoirs for rainwater/flood water conservation by dredging or re-excavating rivers, khals, beels, haors, and baors.
- Construct the necessary infrastructure to conserve excess rainwater during the monsoon and utilize it during the dry season.
- Conserve monsoon water for irrigation during the dry season, take the necessary steps to construct submerged weirs, rubber dams, hydraulic elevated dams, embankments, etc.;
- Update the groundwater zoning map every 3 to 5 years to predict future groundwater demand and guide the establishment of irrigation infrastructure and instruments;
- Promote the extension of irrigation areas through rainwater conservation and sureface water.
- Promote use of conjunctive use of sureface and ground water for irrigation
- Ensure that AWD (alternate wetting and drying) technology is utilized for optimal irrigation water use and to decrease crop production costs;
- Encourage everyone to establish new water sources, promote conservation, and minimize water wastage;
- Introduce Geographic Information System (GIS) and Remote Sensing (RS) for data collection and analysis;
- Introduce micro smart irrigation practice for climate smart agriculture.
- Strengthen upazila irrigation committee

*Bangladesh Water Act 2013*

The Water Act 2013 is based on the National Water Policy 1999, and designed for integrated development, management, extraction, distribution, usage, protection and conservation of water resources in Bangladesh. As per this Act, all forms of water (e.g., surface water, ground water etc.) within the territory of Bangladesh belong to the government on behalf of the people. A worthwhile initiative is the requirement for permits/ licenses for large scale water withdrawal by individuals and organizations beyond domestic use. Without prior permission issued by the Executive Committee, no individual or organization will be allowed to extract, distribute, use, develop, protect, and conserve water resources, nor they will be allowed to build any structure that impede the natural flow of water course.

*National Water Policy, 1999*

The National Water Policy (NWP) was adopted in 1999 to guide both public and private actions, ensuring the optimal development and management of water for the benefit of individuals and society. Notably, this policy highlighted the significance of groundwater and surface water irrigation facilities. It emphasized the need to enhance water use efficiency through methods such as drainage-water recycling, rotational irrigation (where feasible), and the conjunctive use of groundwater and surface water. Specifically, the government's policy aims to encourage and promote the ongoing development of minor irrigation and the prospective utilization of groundwater for irrigation by both public and private sectors. Moreover, it seeks to strengthen crop diversification programs for efficient water use. Irrigation related tasks are presented in section **4.7 (water and Agriculture)**. Brief is presented below-

- Encourage and promote the continued development of minor irrigation, where feasible, without compromising drinking water supplies.
- Enhance water resource utilization efficiency through the conjunctive use of surface water and groundwater for irrigation and urban water supply.

*Bangladesh Delta Plan 2100*

The Bangladesh Government approved the Bangladesh Delta Plan 2100 (BDP 2100) on September 4, 2018, to achieve a 'safe, climate-resilient, and prosperous Delta' by 2100. The plan's backbone emphasizes the sustainable use of water resources and the prevention of water-related natural disasters. Two national strategies have been formulated to aid in water resource management: i) the Flood Risk Management Strategy and ii) the Freshwater Strategy. The freshwater strategies consist of two distinct but related strategies: Water Availability and Water Quality. Each strategy addresses three key aspects: Infrastructure, Institutions, and Innovation.

***Strategy FW 1: Ensure Water Availability by Balancing Supply and Demand for Sustainable and Inclusive Growth***

The freshwater strategy ensures water availability by balancing supply and demand for sustainable and inclusive growth.

***Sub Strategy 1.1 Supply management and additional irrigation***

Agriculture sector is the key beneficiary of this strategy where Sustainable O&M of irrigation systems is particularly an essential feature of this strategy.

***Sub-strategy FW 1.2: Demand management and efficient water use***

It focused on mixed interventions consisting of less water-consuming crops to more efficient irrigation and more effective management and pricing. The plan suggested conjunctive use of surface and groundwater, based on multi-annual groundwater reservoir management, a series of small- and medium-sized storage and diversion schemes, productive aquifer storage and recovery techniques and efficient irrigation technology, reuse of wastewater for irrigation purposes to ensure effective and efficient use of our scare water resources.

*National Adaptation Plan of Bangladesh, (2023-2050)*

In 2022, Bangladesh has approved its National Adaptation Plan, which outlines essential adaptive initiatives and strategies to focus on climate action adaptation (CCA). Notably, within Volume II, Chapter 03, under the heading 'Adaptation Priorities for Combating Adversities of Climate Change' found on Page 50, the plan also covers concerns in the irrigation sector. The plans are detailed out in Volume-III, Chapter-03 Investment portfolio on Page 106. Details are presented below-

***CSA 01: Extension of climate-smart technologies for increasing irrigation water use efficiency***

- Major activities involved-
    - Improvement of water conveyance and use efficiency,
    - Extension of AWD,
    - Introduction of sprinkler and drip etc.

***CSA 02: Augmentation of surface water for irrigation and multipurpose use***

- Major activities involved-
    - Rehabilitation of existing surface water irrigation projects, particularly Muhuri, Manu, Bhola, Barisal, Chandpur, Meghna-Dhonogoda, Testa, and Ganges-Kobadak (GK) Irrigation Project.
    - Implementation of Padma Barrage and North Rajshahi Irrigation Project,
    - Rainwater harvesting through periodic re-excavation of perennial water bodies (ponds, beels, canals, rivers, etc.) for the round year surface water availability etc.

*Bangladesh Perspective Plan (2021-2041)*

Bangladesh Perspective Plan (2021-2041) states all the aspects towards achieving a higher income country. Chapter 6 discusses irrigation water management, which is considered the second most crucial driver of agricultural development. To achieve sustainability goals, the plan highlights several key issues. Among these, the economical use of groundwater and enhanced water use efficiency are deemed essential. Brief is presented below-

- Modernized irrigation methods, such as smart and sensor-based irrigation, will be introduced to farmers to enhance irrigation efficiency. These methods are particularly beneficial for horticultural crop production as alternatives to flood irrigation.
- Sustainable use of both surface and groundwater.

*8th Five Year Plan (2020-2025)*

Water sector planning on the 8th Five-year plan is prepared based on vision 2041 and Bangladesh Delta Plan, 2100. The main goals are to increase proportionate water conservation and management practices and implement more comprehensive integrated water management, including flood control and prevention planning, flood early warning systems, improvement of irrigation systems, and on-demand management. The proposed project is prepared to increase the use of surface water. The similarities with the proposed project are stated on Page-325 and Page 259-283. Brief is presented below-

- Increasing the efficiency of irrigation in crop production and increasing the use of surface irrigation water;
- Ensuring coordinated use of surface and groundwater for permanent irrigation, securing groundwater conservation;
- Adopting climate change mitigation strategies;
- Rainwater harvesting;
- Strengthening institutional capacity in water resource management (Pages-282, 283);
- Ensuring sustainable agricultural growth through more efficient and balanced use of land, water and other resources and encouraging the use of groundwater for irrigation by reducing groundwater use through existing irrigation systems and associated infrastructure development (Page-259);
- Ensuring efficient management of natural resources including groundwater, with special emphasis on groundwater availability and use (Page-260);
- Providing necessary skills and awareness training to farmers to make them interested in using modern technology (Page-261).

*Bangladesh Climate Change Strategy and Action Plan (2009)*

The Bangladesh Climate Change Strategy and Action Plan (BCCSAP) (2009) is a 10-year program (2009-2018) to build the capacity and resilience of the country to meet the challenges of climate change. The BCCSAP has six main pillars with several related programs and objectives. Under the theme T1 Food Security, Social Protection and Health, the programme P2 focuses on developing a climate-resilient cropping system appropriate for different agro-climatic regions and sub-regions. Climate change will result in increasingly frequent and severe flooding and flash floods in the north-eastern and eastern parts of Bangladesh, where farmers may need to modify their current cropping system. Under the theme T5, Mitigation of Low Carbon Development, several programs are linked to issues related to the water sector. Under this theme, Program P5 focuses on raising agricultural land's productivity and lowering methane emissions through efficient use of water and land-use practices.

*National Water Management Plan (NWMP) 2001*

The National Water Management Plan (NWMP) was formulated in 2001 and set forth development indicators for the subsequent 50 years. This plan is structured as a rolling 25-year strategy divided into three phases. The short-term phase (2000-05) is considered a firm plan, the medium-term phase (2006-10) as an indicative plan, and the long-term phase (2011-25) is regarded as a perspective plan. The implementation of the NWMP will undergo regular monitoring and updates every five years. The primary purpose of the NWMP is to bring into action the directives established in the National Water Policy, aligning with the Government Development Strategy.

Within the context of Agriculture and Water Management, the NWMP suggests the expansion and support of minor irrigation development. The expansion of tube well irrigation will persist in areas where over-exploitation is not a concern and where arsenic contamination does not pose a health risk when the water is utilized for irrigation. Financing for minor irrigation development and structural components of on-farm water management will be the responsibility of the private sector and the farmers. In this sector, the NWMP recommends eight programs. Out of these, four are centered on irrigation management, and three specifically focus on surface water irrigation management.

- **Promotion of Expanded Minor Irrigation and Improved On-farm Water Management:** This program involves the improvement of irrigation pumping efficiency, promotion of lower-cost force-mode tube well pumps, and a farmer education/training component to improve on-farm water management and the wise use of water;
- **Improved Performance of Existing Public Surface Water Irrigation Scheme:** This program is intended to ensure full participation of beneficiaries, command area development, conjunctive use of surface and groundwater, rehabilitation, etc.
- **New Public Surface Water Irrigation Schemes:** This program intends to reduce demand for groundwater abstraction;
- **New Public Deep Tubewell Irrigation Schemes:** This program will deal with installing an estimated 2000 new deep tube wells through subsidized DTW irrigation development in socially deprived areas where irrigation is unaffordable, drilling is difficult or costly and where surface water is limited.

### *2.1.2 International Policies and Plan*

*Sustainable Development Goals (SDG)*

The 2030 Agenda for Sustainable Development was adopted in 2015 by all United Nations Member States. This agenda sets forth 17 Sustainable Development Goals and 169 targets, building upon the Millennium Development Goals and aiming to accomplish what these goals have yet to achieve. These goals encompass and balance the three dimensions of sustainable development: economic, social, and environmental. The Goals and targets are intended to guide action through the next fifteen years, culminating in 2030. Among these 17 goals is the objective of achieving Zero Hunger, which emphasizes ensuring sustainable food production systems. This goal also promotes the implementation of resilient agricultural practices, bolstering the capacity for adaptation to climate change, extreme weather events, droughts, floods, and other related disasters. Brief is presented below-

- **Target 2.3:** By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment.
- **Target 6.4:** By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.

## 2.2 Past History

The irrigation system in Bangladesh underwent a significant transformation in the 1950s. Large-scale water resources development in Bangladesh began in the early 1950s with the construction of dams, barrages, reservoirs and other irrigation structures, embankments and drainage channels for bulk water supply to communities and irrigation. BWDB is the pioneer/founder organization in Bangladesh for both surface and groundwater resources development leading to major canal irrigation, DTW and LLP irrigation in the early sixties. Over the past six decades, the Bangladesh Agricultural Development Corporation (BADC) has been unwavering in its support for the irrigation system in Bangladesh. This support has manifested in various ways, including the fielding of advanced irrigation equipment and technologies, expansion of irrigation areas, optimal utilization of surface water resources, judicial management of groundwater resources, and the enhancement of irrigation efficiency to boost agricultural productivity. BADC actively engages in minor irrigation initiatives, employing methods such as Low Lift Pumps (LLP), rubber dams, floating pumps, solar pumps, dug wells, Deep Tube Wells (DTW), Shallow Tube Wells (STW), and gravity flow systems.

In 1961, the Bangladesh Agricultural Development Corporation (BADC) initiated its irrigation endeavours with 1,555 low-lift pumps. From 1967 to 1968, deep tube wells were established by BADC due to surface water shortages (https://badc.gov.bd/). After the 1971 liberation war, BADC and BWDB prioritized modernizing their irrigation to enhance agricultural production and ensure food security by constructing dams, barrages, and embankments. These infrastructures ensure consistent water supply during droughts and reduce flood impacts in the monsoon. BADC's subsequent introductions were shallow tube wells (1973-74), floating pumps (1987-88), rubber dams and solar pumps (2011-12), and dug wells (2015-16). In addition to these techniques, various parts of the nation use manual and artesian wells, traditional methods, and gravity flow techniques for irrigation. Modern methods like drip and sprinkler irrigation have gained popularity due to their emphasis on water efficiency and conservation. While sprinkler systems simulate natural rainfall, drip irrigation delivers water directly to the plant roots, minimizing water waste. However, to ensure proper monitoring and strategic planning of the irrigation development, comprehensive survey reports are indispensable to assess the historical development, present trends and status of minor irrigation systems.

Presently, BADC releases an annual minor irrigation survey report as part of its routine activities. Since 1999-2000, BADC has consistently conducted the Survey of Minor Irrigation equipment, power sources, benefited farmers, irrigation area, and related costs to foster sustainable agricultural development by effectively harnessing surface and groundwater resources. The "Survey of Minor Irrigation Equipment in Rabi season" is part of the Digitalization of Survey and Monitoring for the Development of Minor Irrigation (Phase IV) Project, aimed at continuing the progress of minor irrigation development programs. After completion of project (Phase IV) survey of minor irrigation equipment in Rabi season has been continuing from revenue budget of ministry of agriculture leaded by BADC.

This survey work has been conducted collaboratively by three organizations - Bangladesh Agricultural Development Corporation (BADC), Barind Multipurpose Development Authority (BMDA), and Department of Agricultural Extension (DAE) since the 2004-05 period up until now. Moreover, BADC has taken significant strides by developing the Bangladesh Irrigation Equipment Survey & Monitoring (BIESM) software, with technical assistance from the Centre for Environmental & Geographical Information Services (CEGIS), a Public Trust under the Ministry of Water Resources, facilitating more efficient data management and analysis in irrigation-related activities.

Since the launch of the BIESM software, a significant portion of Deep Tube Wells (DTW), 75,000 Shallow Tube Wells (STW), and a segment of solar equipment and dug wells were identified and recorded with GPS coordinated along with relevant information in 2018. Throughout the survey period of 2021-22, the remaining DTWs and solar equipment (including DTWs, STWs and dug wells) underwent comprehensive updates, with special attention to DTW locations for complete integration into the BIESM software. Progressing into the 2022-23 survey cycle, a focused initiative targeted collecting data on all government-owned Low Lift Pumps (LLP) with buried pipe locations, encompassing those managed by BADC and BMDA, alongside pertinent information. Moreover, the recording of solar-powered LLP locations and the remaining solar-powered STWs, DTWs, and dug wells was conducted, significantly enhancing the completeness and accuracy of the database within the BIESM software.

## 2.3 Trend of Minor Irrigation

Bangladesh, a primarily agrarian country, mainly depends on agriculture as a vital sector for both its economy and food security. In spite of its extensive river system and mostly flat geography, the nation is well-suited for agricultural pursuits. However, agricultural production and food security have historically been hampered by the difficulty of providing reliable and efficient irrigation. The use of Low Lift Pump (LLP) irrigation systems is one potential solution for this problem. In Bangladesh, Low-Lift Pump (LLP) irrigation systems have become increasingly popular since 1961.

One of the most notable benefits of LLP irrigation systems is their cost-effectiveness. LLPs are relatively inexpensive compared to other irrigation technologies such as DTW, STW, double lifting or high-lift pumps. LLP systems are especially useful in sureface water potential areas, which enable efficient use of these pumps. Their cost-effectiveness, adaptability, and energy efficiency make them a valuable tool for small-scale farmers. Since small and marginal farmers make up a significant portion of Bangladesh's agricultural population, they can afford them and find them simple to use. Presently, 207,368 LLPs are working in Bangladesh to provide water for irrigation purposes. LLP irrigation supports improved lives and increased food security by empowering these farmers to water their crops more effectively.

With the development of high-yielding rice varieties ideal for Boro rice in Bangladesh during the 1980s and 1990s, these rice types responded well to fertilizer and irrigation. The focus was shifted to the development of groundwater resources because the Teesta, Brahmaputra-Jamuna, and Ganges River floodplains all have favorable aquifer conditions. Deep tube well (DTW) construction began in the late 1960s, but it picked up steam in the late 1980s. BADC installed over 25,500 DTWs across the country up to 1992. Presently, 34,040 DTWs are working in Bangladesh to provide water for irrigation purposes. Those are installed by BADC, BMDA and private sectors. Discharge capacity of DTWs is 28-56 lit/sec mostly. Considering the climate change issues and environmental condition of Bangladesh, government discouraged ground water used for irrigation and approved Ground Water Management Act -2018 in parliament, because in some area of Bangladesh excessive groundwater withdrawal is found. Now the installation of new DTW by the government fund is suspended.

Following the growth of DTWs, shallow tube wells (STWs) with discharge capacities ranging from 10 to 21 lit/sec were developed since 1973-74. However, limitations on tube well spacing prevented STWs from being implemented initially, despite the obvious advantages of groundwater irrigation. Following the destructive 1988 floods and the cyclones that followed in the early 1990s, it became clear that agricultural machinery was necessary to get farming economics back on track. Since Irrigation by STW is totally driven by private sector. Presently, 1,479,266 STWs are working in Bangladesh to provide water for irrigation purposes.

The government lifted all restrictions and embargos on the import of irrigation equipment. Consequently, local markets were flooded with inexpensive and easy to operate irrigation pumps and small engines (<12 HP), mainly imported from India and China.

### *2.3.1 Operational Equipment and Irrigated Area*

The trend of operational irrigation equipment and irrigated area from 1961-62 to 2023-24 is shown in Table 2.1 and Table 2.2.

**Table 2.1: Trend of Minor Irrigation Equipment 1961-62 to 2023-24**

| Boro/Rabi Season | Annual Operating (Nos.) | | | Annual Change in Percentage (%) | | |
|---|---|---|---|---|---|---|
| | DTW | STW | LLP | DTW | STW | LLP |
| 1961-62 | | | 1555 | | | 0.00 |
| 1962-63 | | | 2024 | | | 30.16 |
| 1963-64 | | | 2477 | | | 22.38 |
| 1964-65 | | | 2239 | | | -9.61 |
| 1965-66 | | | 3420 | | | 52.75 |
| 1966-67 | | | 3990 | | | 16.67 |
| 1967-68 | 102 | | 6558 | 0.00 | | 64.36 |
| 1968-69 | 380 | | 10852 | 272.55 | | 65.48 |
| 1969-70 | 980 | | 17846 | 157.89 | | 64.45 |
| 1970-71 | 796 | | 24483 | -18.78 | | 37.19 |
| 1971-72 | 906 | | 24243 | 13.82 | | -0.98 |
| 1972-73 | 1237 | | 32917 | 36.53 | | 35.78 |
| 1973-74 | 1494 | 998 | 35243 | 20.78 | 0.00 | 7.07 |
| 1974-75 | 2699 | 1029 | 35534 | 80.66 | 3.11 | 0.83 |
| 1975-76 | 3828 | 2162 | 36382 | 41.83 | 110.11 | 2.39 |
| 1976-77 | 4461 | 3045 | 28361 | 16.54 | 40.84 | -22.05 |
| 1977-78 | 7453 | 6447 | 36730 | 67.07 | 111.72 | 29.51 |
| 1978-79 | 9329 | 8379 | 35895 | 25.17 | 29.97 | -2.27 |
| 1979-80 | 9795 | 11280 | 37389 | 5.00 | 34.62 | 4.16 |
| 1980-81 | 10131 | 20931 | 35951 | 3.43 | 85.56 | -3.85 |
| 1981-82 | 11491 | 42955 | 41153 | 13.42 | 105.22 | 14.47 |
| 1982-83 | 13800 | 93100 | 35500 | 20.09 | 116.74 | -13.74 |
| 1983-84 | 15500 | 120300 | 36000 | 12.32 | 29.22 | 1.41 |
| 1984-85 | 16900 | 147000 | 37000 | 9.03 | 22.19 | 2.78 |
| 1985-86 | 17900 | 146900 | 37500 | 5.92 | -0.07 | 1.35 |
| 1986-87 | 18700 | 160300 | 40600 | 4.47 | 9.12 | 8.27 |
| 1987-88 | 20300 | 188700 | 42300 | 8.56 | 17.72 | 4.19 |
| 1988-89 | 22400 | 235900 | 50800 | 10.34 | 25.01 | 20.09 |
| 1989-90 | 22600 | 260000 | 51000 | 0.89 | 10.22 | 0.39 |
| 1990-91 | 21500 | 270300 | 51600 | -4.87 | 3.96 | 1.18 |
| 1991-92 | 25500 | 309300 | 50300 | 18.60 | 14.43 | -2.52 |
| 1992-93 | 25700 | 348900 | 52200 | 0.78 | 12.80 | 3.78 |
| 1993-94 | 24500 | 359200 | 52600 | -4.67 | 2.95 | 0.77 |
| 1994-95 | 26700 | 488900 | 57100 | 8.98 | 36.11 | 8.56 |
| 1995-96 | 27300 | 571200 | 60600 | 2.25 | 16.83 | 6.13 |
| 1996-97 | 25200 | 629800 | 62900 | -7.69 | 10.26 | 3.80 |
| 1997-98 | 25300 | 664700 | 66300 | 0.40 | 5.54 | 5.41 |
| 1998-99 | 26700 | 736100 | 72900 | 5.53 | 10.74 | 9.95 |
| 1999-00 | 23530 | 707570 | 58050 | -11.87 | -3.88 | -20.37 |
| 2000-01 | 23180 | 865210 | 71310 | -1.49 | 22.28 | 22.84 |
| 2001-02 | 23000 | 893360 | 77000 | -0.78 | 3.25 | 7.98 |
| 2002-03 | 23430 | 924020 | 79870 | 1.87 | 3.43 | 3.73 |
| 2003-04 | 24720 | 925150 | 77790 | 5.51 | 0.12 | -2.60 |

| Boro/Rabi Season | Annual Operating (Nos.) | | | Annual Change in Percentage (%) | | |
|---|---|---|---|---|---|---|
| | DTW | STW | LLP | DTW | STW | LLP |
| 2004-05 | 27180 | 1128990 | 99250 | 9.95 | 22.03 | 27.59 |
| 2005-06 | 28280 | 1182520 | 119130 | 4.05 | 4.74 | 20.03 |
| 2006-07 | 29170 | 1202720 | 107290 | 3.15 | 1.71 | -9.94 |
| 2007-08 | 31300 | 1304970 | 138630 | 7.30 | 8.50 | 29.21 |
| 2008-09 | 32170 | 1374580 | 146790 | 2.78 | 5.33 | 5.89 |
| 2009- 10 | 32910 | 1425140 | 150610 | 2.30 | 3.68 | 2.60 |
| 2010- 11 | 33670 | 1549150 | 173670 | 2.31 | 8.70 | 15.31 |
| 201 1-12 | 34050 | 1498390 | 177220 | 1.13 | -3.28 | 2.04 |
| 2012-13 | 35320 | 1523610 | 170570 | 3.73 | 1.68 | -3.75 |
| 2013-14 | 36034 | 1563791 | 171041 | 2.02 | 2.64 | 0.28 |
| 2014-15 | 36566 | 1549711 | 167175 | 1.48 | -0.90 | -2.26 |
| 2015-16 | 36979 | 1417008 | 173179 | 1.16 | -9.36 | 3.46 |
| 2016-17 | 37175 | 1398960 | 176478 | 0.53 | -1.27 | 1.90 |
| 2017-18 | 37538 | 1355852 | 181469 | 0.98 | -3.08 | 2.83 |
| 2018-19 | 37634 | 1357532 | 187188 | 0.26 | 0.12 | 3.15 |
| 2019-20 | 37007 | 1398706 | 199914 | -1.67 | 3.03 | 6.80 |
| 2020-21 | 36955 | 1409689 | 204391 | -0.14 | 0.79 | 2.24 |
| 2021-22 | 33896 | 1469980 | 205212 | -8.28 | 4.28 | 0.40 |
| 2022-23 | 33968 | 1477454 | 206548 | 0.21 | 0.51 | 0.65 |
| 2023-24 | 34040 | 1479266 | 207368 | 0.21 | 0.12 | 0.40 |

*Note: Data from 1961-62 to 1981-82 Taken from Year wise Progress Report of BADC, data from 1982-83 to 1999-2000 taken from Census of Irrigation in Bangladesh by ATIA Project and data from 2000-01 to 2023-24 taken from Minor Irrigation Survey Report of BADC.*

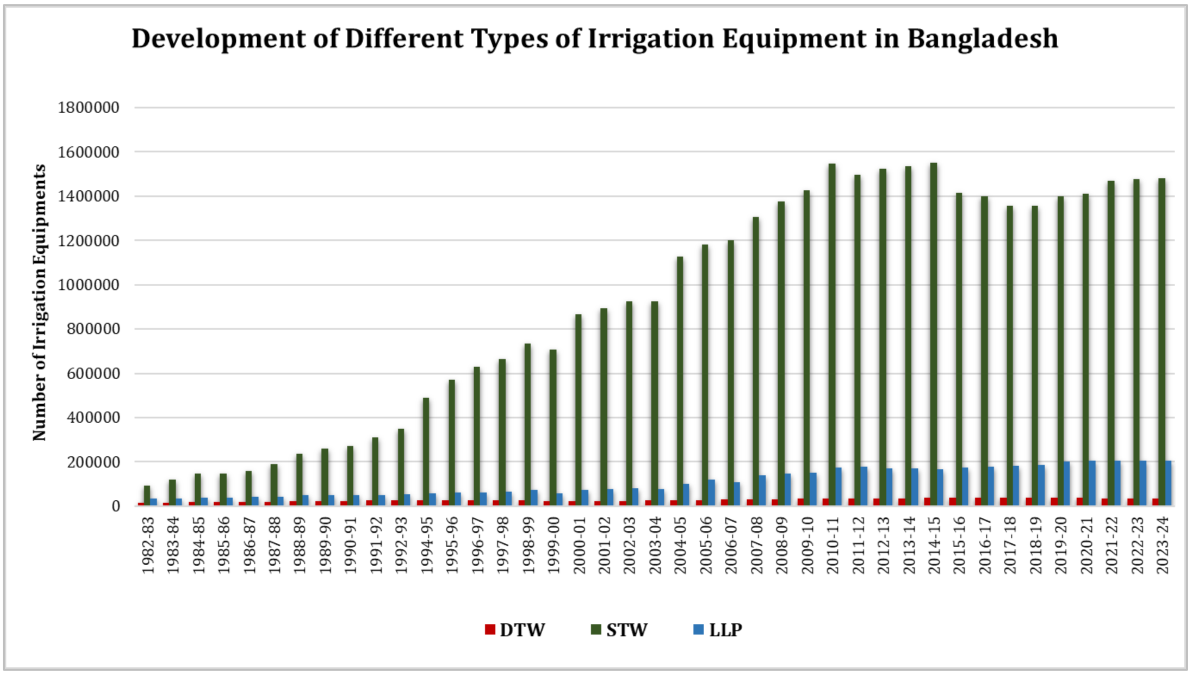


**Figure 2.1: Development of Different Types of Irrigation Equipment in Bangladesh**

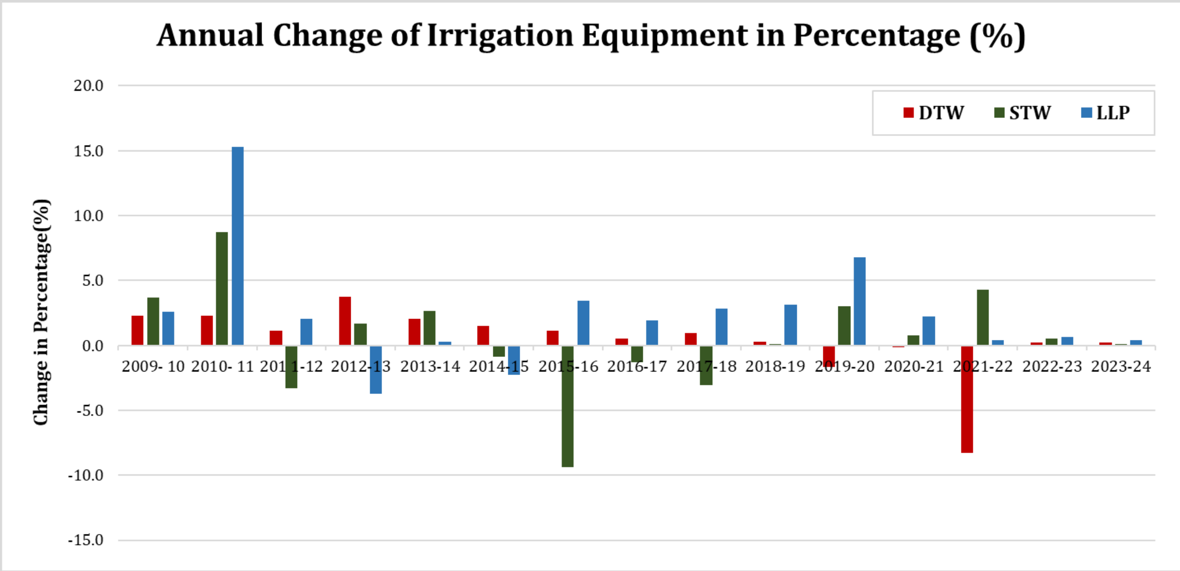


**Figure 2.2: Trend of Minor Irrigation Equipment in last Fifteen Rabi season (2009-10 to 23-2024)**

**Table 2.2: Trend of Irrigated Area by Different Minor Irrigation Mode (1961-62 to 2023-24)**

| Irrigation Season | DTW | STW | LLP | Manual & Artesian Well | Traditional Method | Gravity Flow Method | Solar Pump | Dug Well | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1961-62 | | | 29928 | | | | | | 29928 |
| 1962-63 | | | 53864 | | | | | | 53864 |
| 1963-64 | | | 63462 | | | | | | 63462 |
| 1964-65 | | | 53547 | | | | | | 53547 |
| 1965-66 | | | 70248 | | | | | | 70248 |
| 1966-67 | | | 91136 | | | | | | 91136 |
| 1967-68 | 1667 | | 130373 | | | | | | 132040 |
| 1968-69 | 6510 | | 180620 | | | | | | 187130 |
| 1969-70 | 13004 | | 273227 | | | | | | 286231 |
| 1970-71 | 12984 | | 373230 | | | | | | 386214 |
| 1971-72 | 11874 | | 369745 | | | | | | 381619 |
| 1972-73 | 15287 | | 508715 | | | | | | 524002 |
| 1973-74 | 24881 | 1806 | 565477 | | | | | | 592164 |
| 1974-75 | 47716 | 2726 | 576963 | | | | | | 627405 |
| 1975-76 | 62246 | 5220 | 603425 | | | | | | 670891 |
| 1976-77 | 66477 | 7168 | 519479 | | | | | | 593124 |
| 1977-78 | 137034 | 27929 | 708959 | | | | | | 873922 |
| 1978-79 | 204186 | 35827 | 820470 | | | | | | 1060483 |
| 1979-80 | 235748 | 55400 | 894775 | | | | | | 1185923 |
| 1980-81 | 259557 | 99029 | 912099 | | | | | | 1270685 |
| 1981-82 | 323152 | 202180 | 1089873 | | | | | | 1615205 |
| 1982-83 | 234000 | 371000 | 337000 | 16000 | 405000 | 160000 | | | 1523000 |
| 1983-84 | 263000 | 480000 | 342000 | 16000 | 372000 | 136000 | | | 1609000 |
| 1984-85 | 287000 | 586000 | 351000 | 16000 | 384000 | 147000 | | | 1771000 |

| Irrigation Season | DTW | STW | LLP | Manual & Artesian Well | Traditional Method | Gravity Flow Method | Solar Pump | Dug Well | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1985 -86 | 304000 | 586000 | 356000 | 16000 | 314000 | 163000 | | | 1739000 |
| 1986-87 | 318000 | 639000 | 386000 | 16000 | 326000 | 155000 | | | 1840000 |
| 1987-88 | 345000 | 753000 | 402000 | 16000 | 433000 | 115000 | | | 2064000 |
| 1988-89 | 380000 | 941000 | 482000 | 16000 | 391000 | 170000 | | | 2380000 |
| 1989-90 | 384000 | 1037000 | 484000 | 16000 | 478000 | 176000 | | | 2575000 |
| 1990-91 | 365000 | 1078000 | 513000 | 18000 | 498000 | 316000 | | | 2788000 |
| 1991-92 | 434000 | 1234000 | 500000 | 19000 | 316000 | 251000 | | | 2754000 |
| 1992-93 | 437000 | 1392000 | 496000 | 22000 | 323000 | 291000 | | | 2961000 |
| 1993-94 | 389000 | 1388000 | 458000 | 29000 | 348000 | 326000 | | | 2938000 |
| 1994-95 | 502000 | 1638000 | 538000 | 25000 | 250000 | 352000 | | | 3305000 |
| 1995-96 | 540000 | 2004000 | 568000 | 51000 | 207000 | 355000 | | | 3725000 |
| 1996-97 | 475000 | 2159000 | 570000 | 38000 | 186000 | 333000 | | | 3761000 |
| 1997-98 | 465000 | 2182000 | 622000 | 64000 | 201000 | 285000 | | | 3819000 |
| 1998-99 | 507000 | 2522000 | 628000 | 101000 | 232000 | 358000 | | | 4348000 |
| 1999-00 | 529640 | 2122510 | 581800 | 18650 | 76520 | 227400 | | | 3556520 |
| 2000-01 | 538260 | 2295660 | 603280 | 6530 | 71730 | 250850 | | | 3766310 |
| 2001-02 | 530290 | 2355030 | 628750 | 7460 | 36900 | 286010 | | | 3844440 |
| 2002-03 | 587930 | 2409410 | 664020 | 11710 | 32510 | 309650 | | | 4015230 |
| 2003-04 | 589490 | 2429130 | 630670 | 13340 | 25570 | 355670 | | | 4043870 |
| 2004-05 | 654190 | 3159900 | 838380 | 1250 | 24250 | 109380 | | | 4787350 |
| 2005-06 | 700660 | 3120610 | 803170 | 2110 | 26130 | 107040 | | | 4759720 |
| 2006-07 | 725260 | 3196120 | 810020 | 2250 | 12150 | 137060 | | | 4882860 |
| 2007-08 | 785680 | 3197180 | 903870 | 5210 | 19040 | 138800 | | | 5049780 |
| 2008-09 | 790115 | 3245143 | 957035 | 15448 | 43965 | 75145 | | | 5126851 |
| 2009-10 | 773323 | 3336652 | 964902 | 17412 | 40186 | 85151 | | | 5217626 |
| 2010-11 | 719206 | 3505287 | 1009981 | 6381 | 3814 | 19071 | | | 5263740 |
| 2011-12 | 758963 | 3418147 | 1084594 | 11858 | 28326 | 20447 | | | 5322335 |
| 2012-13 | 934342 | 3242440 | 1035736 | 34560 | 28320 | 97707 | | | 5373105 |
| 2013-14 | 876803 | 3278838 | 1083535 | 33778 | 28318 | 101060 | | | 5402332 |
| 2014-15 | 962039 | 3235184 | 1106705 | 27718 | 20232 | 96274 | | | 5448152 |
| 2015-16 | 1194177 | 2954949 | 1164603 | 29718 | 18336 | 128564 | | | 5490347 |
| 2016-17 | 1063486 | 3079001 | 1187823 | 27518 | 14553 | 154885 | | | 5527266 |
| 2017-18 | 1072539 | 2981646 | 1220879 | 26856 | 12769 | 241925 | | | 5556614 |
| 2018-19 | 1076141 | 2994466 | 1248616 | 8780 | 8065 | 238871 | 11960 | 583 | 5587482 |
| 2019-20 | 1084245 | 3001120 | 1269661 | 7852 | 6825 | 242356 | 14524 | 1015 | 5627598 |
| 2020-21 | 1085431 | 3006076 | 1287013 | 6752 | 6124 | 245136 | 16524 | 1735 | 5654791 |
| 2021-22 | 1038113 | 3070155 | 1310917 | 6552 | 5824 | 247636 | 9939 | 444 | 5689580 |
| 2022-23 | 1045582 | 3081813 | 1327972 | 6332 | 5414 | 253996 | 26406 | 1019 | 5748534 |
| 2023-24 | 1048042 | 3085919 | 1350542 | 6303 | 5444 | 244092 | 27813 | 1118 | 5769273 |

*Note: Data from 1961-62 to 1981-82 Taken from Year wise Progress Report of BADC, data from 1982-83 to 1999-2000 taken from Census of Irrigation in Bangladesh by ATIA Project and data from 2000-01 to 2023-24 taken from Irrigation Equipment Survey Report of BADC.*

### 2.3.2 *Comparative Study of Area Coverage (ha) per Equipment (DTW, STW, LLP)*

A comparative study of area coverage (ha) per equipment (DTW, STW & LLP) is given below in the Table 2.3.

**Table 2.3: Comparative Study of Area Coverage Hectare per Equipment (DTW, STW & LLP)**

| Irrigation season | Irrigated Area ('000 ha) | | | Operational Equipment ('000 No.) | | | Area Coverage per Equipment | | |
|---|---|---|---|---|---|---|---|---|---|
| | DTW | STW | LLP | DTW | STW | LLP | DTW | STW | LLP |
| 1982-83 | 234 | 371 | 337 | 13.8 | 93.1 | 35.5 | 16.96 | 3.98 | 9.49 |
| 1983-84 | 263 | 480 | 342 | 15.5 | 120.3 | 36 | 16.97 | 3.99 | 9.50 |
| 1984-85 | 287 | 586 | 351 | 16.9 | 147 | 37 | 16.98 | 3.99 | 9.49 |
| 1985-86 | 304 | 586 | 356 | 17.9 | 146.9 | 37.5 | 16.98 | 3.99 | 9.49 |
| 1986-87 | 318 | 639 | 386 | 18.7 | 160.3 | 40.6 | 17.01 | 3.99 | 9.51 |
| 1987-88 | 345 | 753 | 402 | 20.3 | 188.7 | 42.3 | 17.00 | 3.99 | 9.50 |
| 1988-89 | 380 | 941 | 482 | 22.4 | 235.9 | 50.8 | 16.96 | 3.99 | 9.49 |
| 1989-90 | 384 | 1037 | 484 | 22.6 | 260 | 51 | 16.99 | 3.99 | 9.49 |
| 1990-91 | 365 | 1078 | 513 | 21.5 | 270.3 | 51.6 | 16.98 | 3.99 | 9.94 |
| 1991-92 | 434 | 1234 | 500 | 25.5 | 309.3 | 50.3 | 17.02 | 3.99 | 9.94 |
| 1992-93 | 437 | 1392 | 496 | 25.7 | 348.9 | 52.2 | 17.00 | 3.99 | 9.50 |
| 1994-95 | 502 | 1638 | 538 | 26.7 | 488.9 | 57.1 | 18.80 | 3.35 | 9.42 |
| 1995-96 | 540 | 2004 | 568 | 27.3 | 571.2 | 60.6 | 19.78 | 3.51 | 9.37 |
| 1996-97 | 475 | 2159 | 570 | 25.2 | 629.8 | 62.9 | 18.85 | 3.43 | 9.06 |
| 1997-98 | 465 | 2182 | 622 | 25.3 | 664.7 | 66.3 | 18.38 | 3.28 | 9.38 |
| 1998-99 | 507 | 2522 | 628 | 26.7 | 736.1 | 72.9 | 18.99 | 3.43 | 8.61 |
| 1999-00 | 529.64 | 2122.51 | 581.8 | 23.53 | 707.57 | 58.05 | 22.51 | 3.00 | 10.02 |
| 2000-01 | 538.26 | 2295.66 | 603.28 | 23.18 | 865.21 | 71.31 | 23.22 | 2.65 | 8.46 |
| 2001-02 | 530.29 | 2355.03 | 628.75 | 23 | 893.36 | 77 | 23.06 | 2.64 | 8.17 |
| 2002-03 | 587.93 | 2409.41 | 664.02 | 23.43 | 924.02 | 79.87 | 25.09 | 2.61 | 8.31 |
| 2003-04 | 589.49 | 2429.13 | 630.67 | 24.72 | 925.15 | 77.79 | 23.85 | 2.63 | 8.11 |
| 2004-05 | 654.19 | 3159.9 | 838.38 | 27.18 | 1128.99 | 99.25 | 24.07 | 2.80 | 8.45 |
| 2005-06 | 700.66 | 3120.61 | 803.17 | 28.28 | 1182.52 | 119.13 | 24.78 | 2.64 | 6.74 |
| 2006-07 | 725.26 | 3196.12 | 810.02 | 29.17 | 1202.72 | 107.29 | 24.86 | 2.66 | 7.55 |
| 2007-08 | 785.68 | 3197.18 | 903.87 | 31.3 | 1304.97 | 138.63 | 25.10 | 2.45 | 6.52 |
| 2008-09 | 790.12 | 3245.14 | 957.04 | 32.17 | 1374.55 | 146.79 | 24.56 | 2.36 | 6.52 |
| 2009-10 | 773.323 | 3336.65 | 964.9 | 32.91 | 1425.14 | 150.61 | 23.50 | 2.34 | 6.41 |
| 2010-11 | 719.206 | 3505.287 | 1009.981 | 33.67 | 1549.149 | 173.669 | 21.36 | 2.26 | 5.82 |
| 2011-12 | 758.963 | 3418.147 | 1084.594 | 34.045 | 1498.386 | 177.216 | 22.29 | 2.28 | 6.12 |

| Irrigation season | Irrigated Area ('000 ha) | | | Operational Equipment ('000 No.) | | | Area Coverage per Equipment | | |
|---|---|---|---|---|---|---|---|---|---|
| | DTW | STW | LLP | DTW | STW | LLP | DTW | STW | LLP |
| 2012-13 | 934.342 | 3242.44 | 1035.736 | 35.322 | 1523.609 | 170.569 | 26.45 | 2.13 | 6.07 |
| 2013-14 | 876.803 | 3278.838 | 1083.535 | 36.034 | 1536.791 | 171.041 | 24.33 | 2.13 | 6.33 |
| 2014-15 | 962.039 | 3235.184 | 1106.705 | 36.566 | 1549.711 | 167.175 | 26.31 | 2.09 | 6.62 |
| 2015-16 | 1194.177 | 2954.949 | 1164.603 | 36.979 | 1417.008 | 173.179 | 32.29 | 2.09 | 6.72 |
| 2016-17 | 1063.486 | 3079.001 | 1187.823 | 37.175 | 1398.96 | 176.478 | 28.61 | 2.20 | 6.73 |
| 2017-18 | 1072.539 | 2981.646 | 1220.879 | 37.538 | 1355.852 | 181.469 | 28.57 | 2.20 | 6.73 |
| 2018-19 | 1076.141 | 2994.466 | 1248.616 | 37.634 | 1357.532 | 187.188 | 28.59 | 2.21 | 6.67 |
| 2019-20 | 1084.245 | 3001.12 | 1269.661 | 37.007 | 1398.706 | 199.914 | 29.30 | 2.15 | 6.35 |
| 2020-21 | 1085.431 | 3006.074 | 1287.013 | 36.955 | 1409.649 | 204.391 | 29.37 | 2.13 | 6.30 |
| 2021-22 | 1038.113 | 3070.155 | 1310.917 | 33.896 | 1469.98 | 205.212 | 30.63 | 2.09 | 6.39 |
| 2022-23 | 1045.582 | 3081.813 | 1327.972 | 33.968 | 1477.454 | 206.548 | 30.78 | 2.09 | 6.43 |
| 2023-24 | 1048.042 | 3085.919 | 1350.542 | 34.040 | 1479.266 | 207.368 | 30.79 | 2.09 | 6.51 |

*Note: Data from 1982-83 to 1999-2000 taken from Census of Irrigation in Bangladesh by ATIA Project and data from 2000-01 to 2023-24 taken from Irrigation Equipment Survey Report of BADC.*

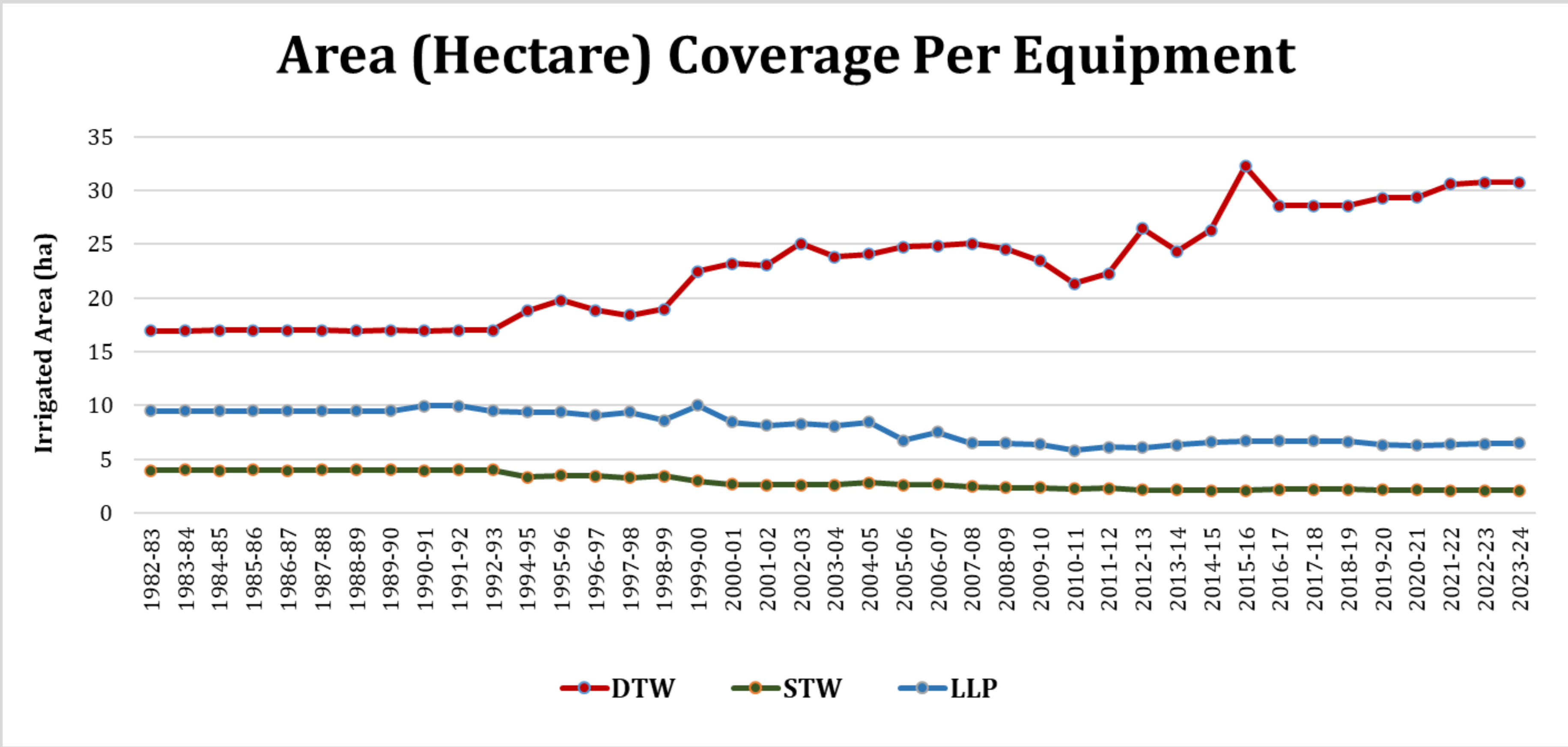


**Figure 2.3: Area Coverage per Irrigation Equipment during Rabi 1982-83 to 2023-2024**

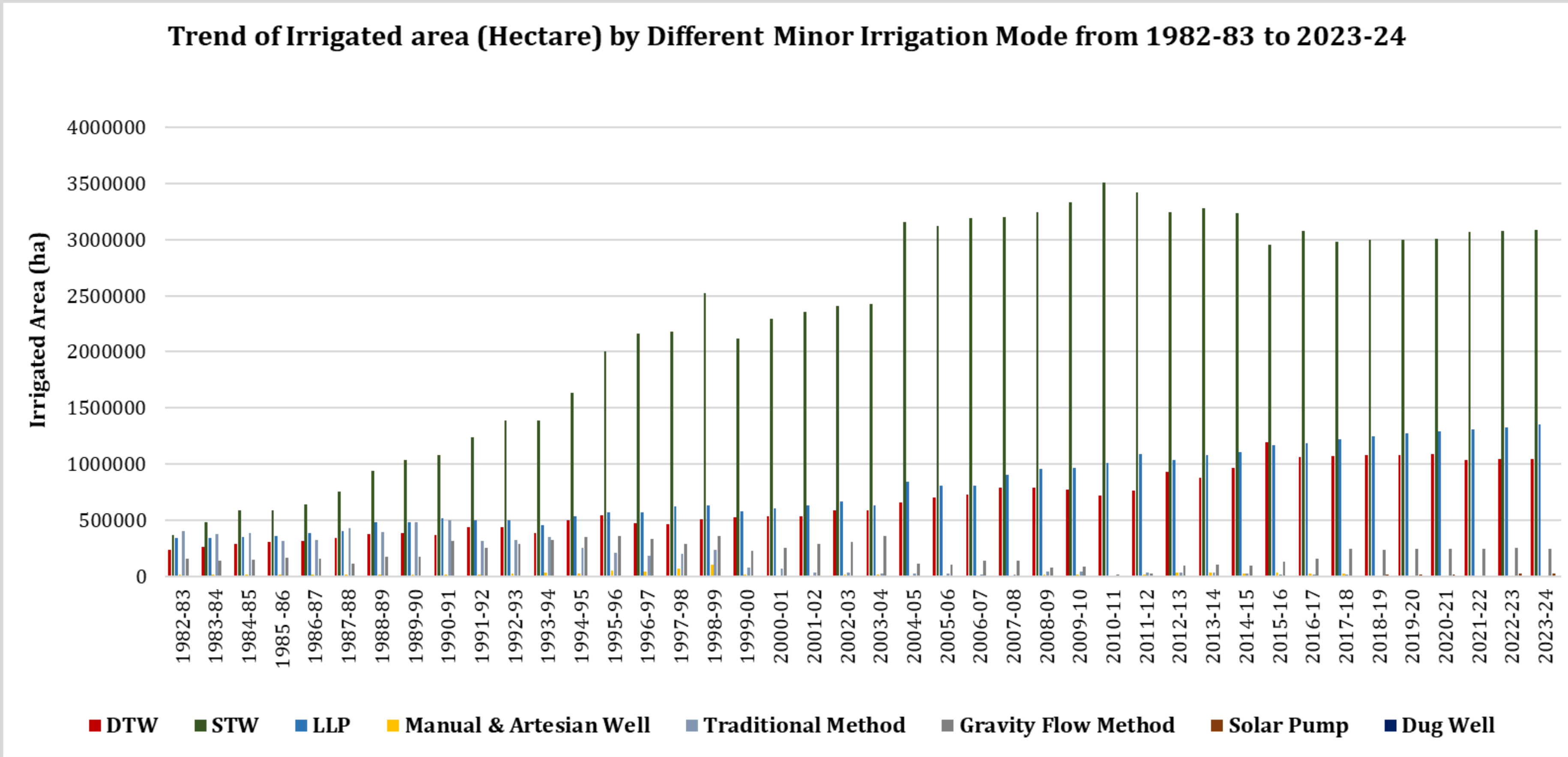


**Figure 2.4: Trend of Irrigated Area (ha) during Rabi 1982-83 to 2023-2024**

# 3. Approach and Methodology

## 3.1 Study Approach

The methodology implemented in this study ensured an effective and comprehensive approach, allowing for the successful achievement of the study's objectives. The study collected extensive data on minor irrigation equipment in Bangladesh and updated the BIESM software database. Information was gathered on LLPs, DTWs, STWs, floating pumps, dug wells, solar pumps, and rubber dams. Additionally, maps and graphs illustrating water stress areas and surface water potential were developed, and the groundwater zoning map was updated. The outcome of this effort was the preparation of the "Minor Irrigation Survey Report 2023–2024."

The study thoroughly assessed and enhanced irrigation management in Bangladesh through a multi-faceted approach. It began with an exhaustive review of existing literature and data, establishing a conceptual framework for collecting irrigation equipment data and upgrading the BIESM software. This framework was shared with the client and stakeholders to obtain expert opinions, which guided the finalization of the methodology, ensuring full alignment with the study objectives.

A major task was the collection of primary data through field surveys and secondary data from relevant sources. Primary data, collected through field surveys in all 64 districts, focused on gathering detailed information about irrigation equipment. Secondary data from sources such as BADC, BMDA, and DAE complemented the primary data for analysis and mapping purposes. The field data collection teams, trained in data collection procedures, operated at the Upazila level in collaboration with local authorities. Data validation occurred at the regional level to guarantee accuracy.

All collected data underwent digitization, cleaning, and verification before analysis and mapping. Statistical techniques and GIS software were employed to identify trends, patterns, and correlations in irrigation practices. Detailed maps were generated to visualize the distribution of irrigation equipment and other pertinent parameters. Additionally, the BIESM software was upgraded to integrate the newly collected data and enhance its functionalities. This included improvements in data integration, user interface, and the addition of features to make the software more informative and user-friendly.

A final report was prepared, summarizing the study’s findings, analyses, and recommendations. This report provided detailed information on irrigation systems, equipment types, power sources, and beneficiary farmers at various administrative levels. Visual aids such as maps and graphs were included to improve clarity. Furthermore, a one-day training program built the capacity of BADC Executive Engineers in using the BIESM software. A validation seminar was also conducted to ensure the accuracy and relevance of the project outcomes.

The study was conducted by following the steps of approaches presented in **Figure 3.1** and description of each step has been given in **Section 3.2**.

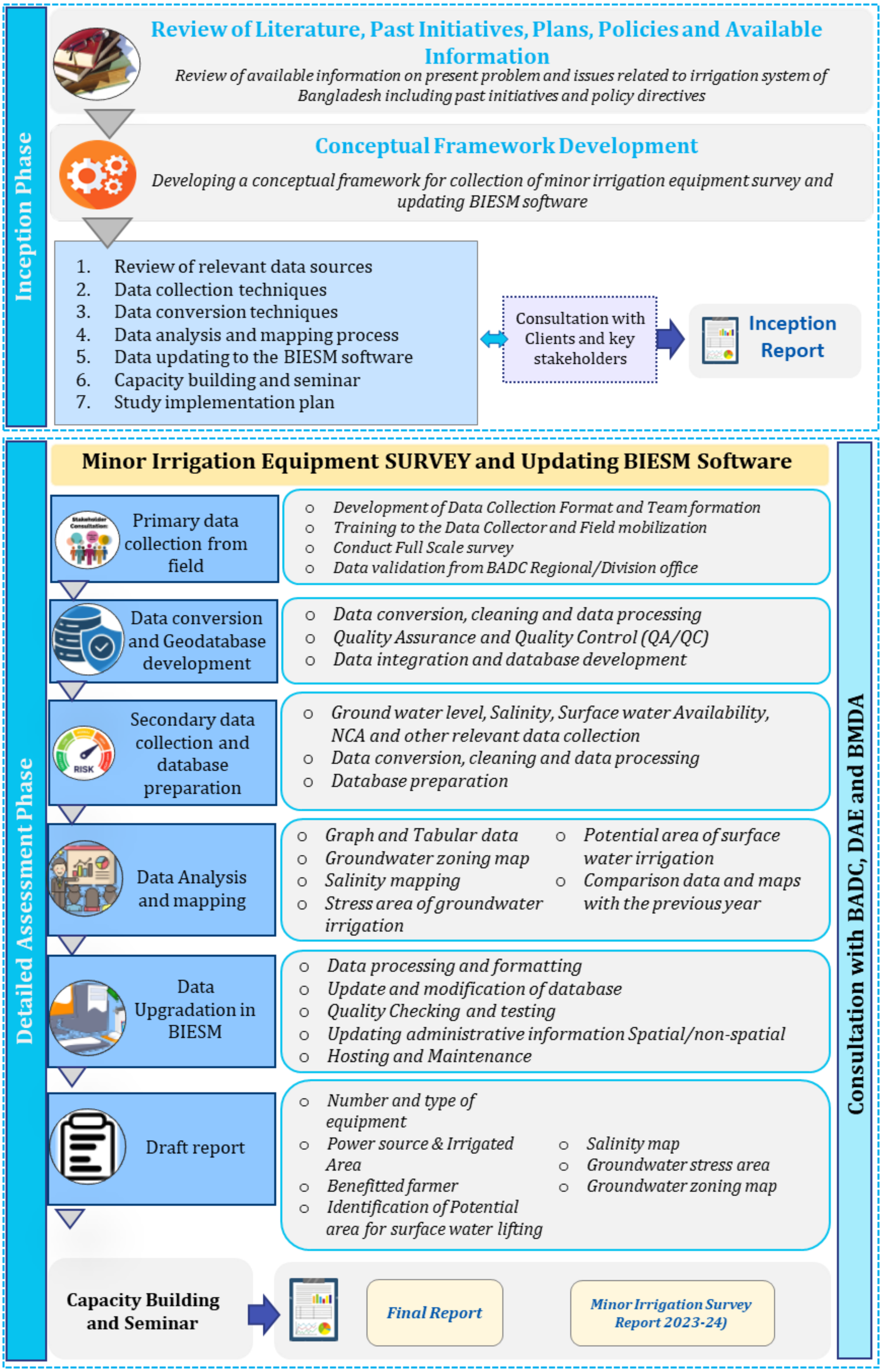


**Figure 3.1: Brief Approach and Methodology**

## 3.2 Methodology

### *3.2.1 Preparatory/Inception Phase*

In the preparatory or inception phase, activities included reviewing relevant literature, such as policies, plans, and previous reports related to minor irrigation surveys, along with the development of a conceptual framework for the collection of irrigation equipment data and the updating of the BIESM software. The study's approach involved the review of relevant data sources, the development of data collection and processing techniques, the outlining of data analysis and mapping methods, the methodology for updating the BIESM software, capacity development for relevant stakeholders, and the preparation of a detailed work plan and team composition. The developed framework was shared with the client and relevant stakeholders to gather expert opinions, ensuring that the framework met the study objectives. The methodology was finalized after incorporating the appropriate comments and suggestions.

*Review of Literature, plans, Policies, Guidelines and Available Information*

A comprehensive analysis of past initiatives and policy directives for minor irrigation equipment surveys was undertaken through a multi-faceted approach. This included a thorough review of current and past minor irrigation survey reports, data collection processes, policies, and programs. Engaging with key stakeholders through interviews proved crucial in gathering diverse perspectives on irrigation development. Existing policies and programs were meticulously evaluated to assess their effectiveness and alignment with current needs.

Data collection was conducted to gather information on current irrigation strategies, plans, policies, and programs. This process included a desk study, which involved reviewing national and sectoral plans, policies, strategies, and other relevant documents.

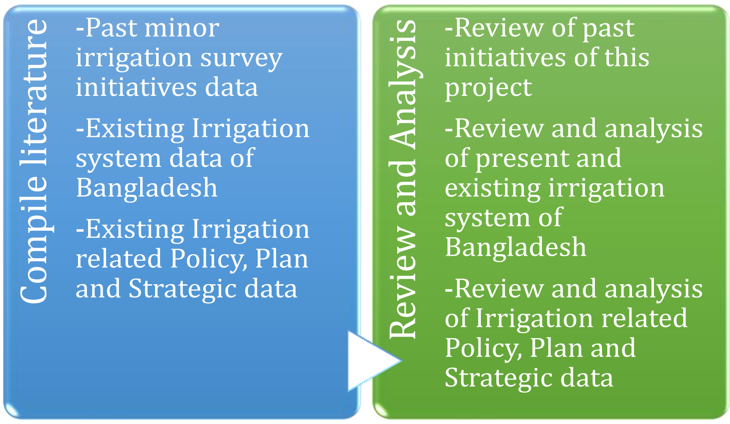


**Figure 3.2: Steps of Past Initiatives and Policy Directives**

*Development of Conceptual Framework*

A detailed conceptual framework have been developed, incorporating findings from the literature review and outlining how the review, analysis, field data collection method, and sources of information will be integrated into the study. The framework detailed the study's approach and methodology, including the review of relevant data sources, techniques for data collection, processing, and analysis, as well as data visualization and mapping. Additionally, it covered procedures for updating the BIESM software, capacity-building initiatives (such as training and seminars), and the overall plan for implementing the study.

### 3.2.2 Detailed Assessment Phase

*Primary data collection from the field*

One of the project's major tasks is to collect primary and secondary irrigation from relevant sources. Primary data will be collected through field surveys, while secondary data will be obtained from appropriate sources. Additionally, secondary data will be used for publishing the report, updating the BIESM database, and producing various maps. These maps will include salinity maps, groundwater zoning maps, groundwater irrigation stress area maps, and prospective surface water irrigation maps.

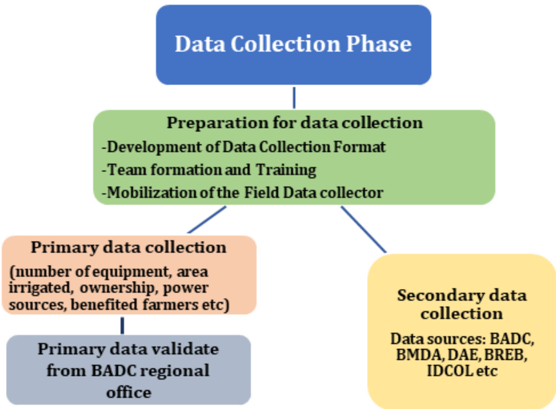


**Figure 3.3: Different Stages of Data Collection Phase**

*Data Collection Sheet Development and Team Formation*

Before starting the field survey, a data collection sheet was developed based on the previously published "Minor Irrigation Survey Report 2022-23". This sheet was shared with the Project Director and includes details like the number of irrigation equipment, power sources, irrigated areas, benefitted farmers, and ownership status. After finalization, CEGIS formed a survey team under the guidance of the team leader and deputy team leader.

The field data collection team is designed to gather irrigation equipment data from 64 districts across 8 divisions. This data will update the BIESM software and the Minor Irrigation Reports 2023-24. The team's size was determined during the study's inception phase. The field team conducts survey work as directed by the team leader, deputy team leader, and data analyst.

It is mentioned here that, CEGIS has a substantial number of experienced field data collectors working on various projects. Additionally, CEGIS maintains a pool of data collectors who work on a project basis; these will be engaged in the study. To ensure timely completion, the team will also hire data collectors from the local level.

*Training to the data collector and Field mobilization*

After field data collectors are appointed, a training program on "how to collect minor irrigation equipment and other irrigation-related data" will be organized. CEGIS has irrigation and agricultural experts, along with GIS experts, who will conduct the training. Additionally, CEGIS has well-experienced professionals who will be engaged to monitor field data collection for this project. The field data collection progress will also be monitored by the BADC's Executive Engineer office.

Following the training, field data collectors will be mobilized with a survey plan to conduct surveys at the upazila level. Each data collector will be equipped with the necessary resources and posted at BADC regional offices. The data collection team will operate under the supervision of the BADC's

Executive Engineer office. An official letter from the PD office (Additional Chief Engineer, Minor Irrigation, Western) of BADC will be issued for the team's identification.

Team members will carry identity cards specifying their identities. The field team will maintain communication with relevant CEGIS and BADC officials to ensure smooth field activities and to resolve any issues.

*Conduct full scale survey*

Field data collectors will survey the Upazila level. The data collection team will be mobilized at this level with specific forms tailored to the number of irrigation equipment to be surveyed. They will prepare draft data sheets at the Upazila level after consulting with officials from BADC, BMDA, and DAE. Both BADC and CEGIS will cooperate to ensure the team receives any necessary help from governmental, non-governmental organizations, and individuals.

Data collectors will gather information about DTW, STW, LLP, and other minor irrigation equipment from BADC, BMDA, DAE, other relevant organizations and individuals.

*Data Validation from BADC Regional/Division office*

A regional/ division level meeting will be arranged to validate the data, with participation from representatives of BMDA, DAE, and other relevant irrigation organizations (if any). These participants will provide valuable comments and suggestions to finalize the data.

*Data conversion and Geodatabase development*

Information from each surveyed entity (DTW, STW, LLP, and other minor irrigation equipment) will be digitized using a predefined format. After conversion, the field data will undergo a thorough "cleaning" and verification process. Data editing will be performed using Microsoft Access, applying necessary data normalization rules to the non-spatial (tabular or attribute) data.

In addition to the tabular data, the surveyed entity will be converted into a GIS platform based on available geographic locations. This digital data will then be compatible with GIS analysis and mapping. GIS data will be organized into layers with appropriate symbology. The final map entity symbolization will be determined in consultation with the client to ensure consistency and adherence to standards.

*Secondary Data Collection*

In addition to primary data, various secondary data and information will be collected from relevant organizations and agencies, utilizing both open and proprietary sources. BADC, BMDA, DAE, and all Minor Irrigation Survey Reports will be considered as major secondary data sources. This dataset will be used for generating and updating the GW zoning map, salinity map, stress area of groundwater irrigation map, potential area of surface water irrigation map, and trend analysis of irrigation equipment and area.

Groundwater level data from BADC monitoring wells across the country will assess groundwater table impacts within the region and contribute to the 2023 GW zoning map. Salinity data, also collected from BADC monitoring wells, will be used for salinity mapping. River network data with associated information will be gathered from available sources to identify potential surface water irrigation areas.

Before analysis, the reliability, accuracy, and consistency of all data will be rigorously assessed. Time series data will undergo thorough checks for gaps, missing data, or inconsistencies. Missing data will be filled in through correlation with neighbouring measurement stations, and detected outliers will be eliminated.

*Data Analysis and Mapping*

Data analysis and mapping are major components of this study, providing a deep understanding of the current state of irrigation systems in Bangladesh. This approach will facilitate trend analysis of irrigation equipment and area, assisting irrigation engineers and planners in decision-making. Collected data will be meticulously analysed using statistical techniques and advanced software tools to reveal trends, patterns, and correlations within the irrigation sector.

Geographic Information Systems (GIS) software (ArcGIS) will be utilized to generate detailed maps that present the spatial distribution of irrigation equipment (DTWs, STWs, LLPs, solar irrigation, etc.), as well as areas of groundwater zoning, stress, salinity, and potential surface water irrigation. The Spatial Analyst tool in ArcGIS will be used for creating raster grids/surfaces on various themes. Additionally, charts (such as pie charts, bar graphs, and line graphs) and tables will be generated to present irrigation system data, enhancing its interpretability and usability.

The insights derived from this analytical and mapping effort will serve multiple purposes, including trend analysis to inform future projections and planning, supporting the development of effective irrigation policies and strategies, optimizing resource allocation to target areas in need of improvement, and aiding investors and stakeholders in making informed decisions about irrigation projects. These applications highlight the integral role of comprehensive data analysis and effective mapping in shaping the future of irrigation management and development.

*Upgradation of BIESM Software*

Upgrading the BIESM software is the major component of the project, aimed at enhancing its capabilities and integrating newly collected data. This process encompasses several crucial stages:

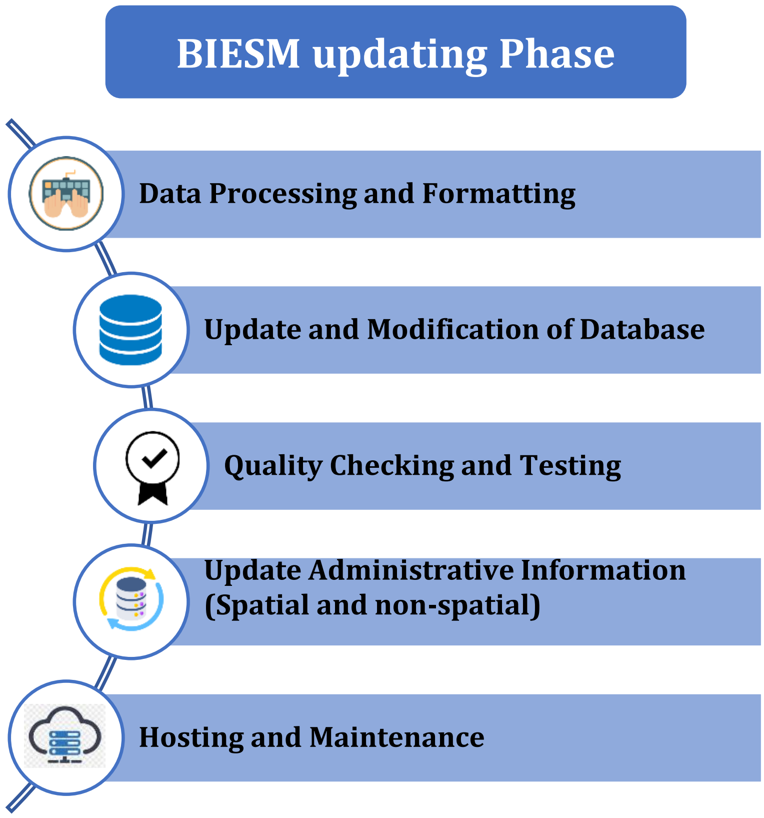


**Figure 3.4: Process of Software Upgradation**

*Data processing and formatting*

This stage includes data cleaning to remove errors, inconsistencies such as outliers and missing values, and formatting issues. Data validation ensures that all data aligns with expected ranges and formats based on logical rules. Additionally, data is standardized into formats compatible with the BIESM database structure, which involves aligning date formats, unit conversions, and ensuring terminology consistency.

*Update and modification of the database*

The existing database was originally designed based on past requirements. To accommodate the newly collected data, the database schema will be carefully assessed. New data fields or tables may be added if necessary, ensuring they are integrated without compromising existing data relationships. Additionally, the software may be upgraded to support new data types, enable complex calculations, and handle advanced queries.

*Update administrative information (Spatial or Nonspatial)*

The administrative boundary with associated updated information (spatial or nonspatial) will be incorporated in BIESM software. In this regard, BBS administrative boundary information will be used as the background information.

*Quality Checking and Testing*

Rigorous data accuracy checks will be conducted throughout the process to minimize errors. Unit testing is performed on software components to ensure functionality before full integration. Black box testing assesses the software's functionality from a user's perspective by inputting data and verifying outputs, while white box testing delves into the software's internal structure (code) to identify potential errors or vulnerabilities.

*Hosting and maintenance*

The updated database and software will be deployed to the live server, ensuring all dependencies are properly managed. Regular backups will be created to safeguard against data loss, and ongoing upgrades are planned to accommodate technological advancements or new data collection efforts. Security measures will also be implemented to prevent unauthorized access and data breaches.

### 3.2.3 Reporting Phase

*Inception Report*

As partial fulfilment of the ToR, CEGIS has prepared an Inception Report (this report) and delivered it to BADC. The Inception Report describes the objectives, scope of work, methodology, implementation plan and schedule, delivery plan, resources to be utilized and work progress.

*Draft Report*

The draft final report integrated all collected data and analytical results to provide comprehensive insights into various aspects of irrigation. It covered irrigation metrics like inter-administrative area, net cultivated area, irrigated area, groundwater and surface water usage, detailing the numbers and types of irrigation equipment, power sources, and the number of benefiting farmers at the upazila, district, division, and national levels. Visualizations like maps and graphs has illustrated the distribution and location of minor irrigation equipment, groundwater zoning, salinity patterns, potential surface water areas, and groundwater stress areas. Expert input from all team members has been incorporated to refine and enhance the draft “Minor Irrigation Survey Report 2023-24”. Additionally, these analyses has utilized to update the BIESM software's database, ensuring the system's continued effectiveness.

*Capacity Building and Seminar*

**A day-long program** with two key components will facilitate this goal: capacity building and a validation seminar. The capacity building component will consist of a 3-hour in-class training session in the first session for all BADC Executive Engineers, focusing on the effective use of BIESM software. This training will cover user guidelines for efficient data entry, search functionality, data analysis by different administrative area and information retrieval. Following the training, a validation seminar will be held at the same venue. In collaboration with the Project Director, participants will be selected from BADC, BMDA, DAE, and other relevant irrigation organizations. During the seminar, the draft final "Minor Irrigation Survey Report 2023-24" will be presented, and participant feedback will be incorporated into the final report to ensure its accuracy and relevance.

*Final Report*

This is the final stage of the project, where the comments and suggestions of the project director and seminar participant will be incorporated in the final report. In this stage, a full-length final report will be submitted to the client (BADC) which includes a finalized database and all required documents for the annual report. This report will be published as “Minor Irrigation Survey Report 2023-24”.

*Printing and publication*

Printing of 400 copies of the final “Minor Irrigation Survey Report 2023-24” for submission to BADC.

# 4. Irrigation Water Availability/Irrigation Water Potential

## 4.1 Groundwater Zoning

The groundwater zoning map is a crucial tool for the sustainable management, use, and protection of groundwater resources by visually representing the depth of the water table in a specific area. This map illustrates the distance from the ground level to the water table, indicating regions where groundwater extraction may be in suction, critical, or force mode. Typically, it uses color-coding or contour lines to show different depth ranges, making it easier to understand the groundwater availability across the country or hydrological regions.

The groundwater zoning map is invaluable for the sustainable management and protection of groundwater, particularly in areas such as agriculture, irrigation planning and environmental conservation. This map plays a vital role in Bangladesh, where approximately 72% of irrigation depends on groundwater. It enables the identification of areas with declining water tables, allowing authorities to implement measures that prevent over-exploitation, ensuring long-term groundwater availability and water security. This sustainable approach helps prevent depletion and potential conflicts over water use.

The groundwater zoning map is essential for monitoring groundwater table fluctuations over time and identifying over-extraction prone and potential recharge areas. It guides the optimal placement of wells and pumps, promotes sustainable irrigation practices, and selects suitable cropping patterns based on water availability. Additionally, this map helps identify safer depths for water extraction, reducing the risk of arsenic exposure in drinking water and highlighting regions vulnerable to saltwater intrusion. Government agencies and policymakers can utilize this map to make informed decisions about water resource management, land use planning, and environmental protection, providing critical data for developing policies aimed at sustainable development.

The Bangladesh Agricultural Development Corporation has installed a nationwide network of real-time online groundwater monitoring systems, utilizing data from 460 groundwater observation wells since 2020. This system measures static groundwater levels and water quality through automated data loggers. The groundwater zoning map (2023) was developed using the highest static water level depth recorded in 2023. The Spatial Analyst tool in Geographic Information Systems (GIS) software (ArcGIS) has been utilized to create the raster surface.

Based on the irrigation equipment used in Bangladesh, the groundwater extraction zone can be classified into three categories.

- **Safe Zones (< 7.6 m):** This zone is characterized by shallow groundwater with a depth of less than 7.6 meters round the year, which is easily accessible for extraction.
- **Critical Zones (7.61 m - 11.3 m):** In this zone, groundwater is found at a moderate depth of 7.61 to 11.3 meters in particular period of the year, requiring the use of deep-set shallow tubewells (STWs) for irrigation.
- **Force mode Zones (> 11.31 m):** This zone represents areas with deep groundwater tables exceeding 11.31 meters round the year, where submersible or vertical turbine pumps are required for pumping.

The **Safe Zone** is highly favorable for irrigation due to the shallow water table, which makes water extraction relatively easy and cost-effective, mainly through Shallow Tubewells (STWs). The practical suction limit for centrifugal pumps, commonly used in Bangladesh, is typically around 7.6 meters.

Beyond this depth, specialized pumps or alternative technologies are required for lifting water, potentially leading to increased irrigation costs. This readily accessible water source has significantly contributed to agriculture in Bangladesh, particularly during the dry seasons when surface water availability is limited.

- ✓ In 2023-24, approximately 1.479 million Shallow Tubewells (STWs) irrigated 30.86 million hectares (53.49%) of the total irrigated area from the Safe Zone in Bangladesh, accounting for about 74.22% of the total groundwater usage for irrigation;
- ✓ The quality of groundwater is generally suitable for irrigation, except in coastal regions where salinity poses a significant challenge;
- ✓ Around 75% of the Northwest, 65% of the North Central, 73% of the Northeast, and 85% of the Southeast hydrological regions are covered by safe zones for groundwater irrigation;
- ✓ Approximately 90% of the Southwest, 95% of the South Central, and 75% of the Eastern Hill hydrological regions are covered by safe zones for groundwater irrigation. However, about 1.28 million hectares, primarily in these regions, are unsuitable for irrigation due to groundwater salinity levels reaching up to 3000 µS/cm. The areas affected by groundwater salinity include the major parts of Satkhira, Khulna, Bagerhat, Pirojpur, Barguna, Patuakhali, Bhola, Noakhali, Feni, Chittagong, and Cox's Bazar;
- ✓ The groundwater Safe Zones offer significant advantages for irrigation in Bangladesh; however, its long-term viability relies on promoting efficient irrigation practices and implementing effective groundwater management policies. Over-extraction due to ease of access can deplete the water table, potentially transforming these areas into Critical Zones over time;
- ✓ Shallow aquifers are also more susceptible to contamination from surface pollutants, impacting water quality and posing health risks;
- ✓ Moreover, excessive groundwater extraction in coastal areas can lead to saltwater intrusion, making the water unusable for irrigation;
- ✓ This area needs continuous monitoring of groundwater level and quality,

The **Critical Zone** for groundwater irrigation in Bangladesh is characterized by a moderate groundwater depth, which presents a more challenging for irrigation compared to the Safe Zones. In these areas, the water table typically ranges between 7.61 meters and 11.3 meters in a particular period of year, requiring the use of more specialized equipment, such as deep-set shallow tubewells (STWs), for effective groundwater extraction. The depth of the groundwater in this zone fluctuates seasonally, remaining within the suction limit during the months of December to March, which allows for relatively easier access. However, from April to May, the groundwater table often drops beyond the suction limit, making it increasingly difficult to extract water and necessitating additional energy and irrigation cost.

- The Critical Zone is not uniformly distributed across Bangladesh but is concentrated in specific hydrological regions. Approximately 15% of the North West and 12% of the North Central agricultural land falls within this zone. These areas are significant for agricultural production, particularly for the cultivation of Boro rice, which is a staple crop in Bangladesh.
- This zone encompasses about 19% of the total irrigated area in the country, which is about 0.1 million hectares dedicated to Boro rice cultivation. This substantial portion of irrigated land underscores the importance of managing the Critical Zone effectively to ensure the sustainability of rice production, which is vital for the country's food security.

- Despite the challenges associated with groundwater extraction in the Critical Zone, the quality of irrigation water in these areas is generally considered feasible for agricultural use.
- The moderate depth of the water table in the Critical Zone presents several challenges, particularly in terms of energy consumption and the long-term sustainability of irrigation practices. The deeper water table requires more energy to pump water, leading to increased operational costs for farmers. Additionally, the seasonal fluctuation in groundwater levels exacerbates these challenges, making it difficult to maintain consistent irrigation practices throughout the year.

The **Force Mode** zone represent the most significant challenges for groundwater extraction, with water tables deeper than 11.31 meters. In these areas, submersible pumps and vertical turbine pumps are required to pump water from such considerable depths. The Deep tubewell (DTW) irrigation is vital for supporting agricultural production in Bangladesh, particularly in regions where surface water is scarce. However, this method demands high energy consumption to pump water from these depths, leading to increased operational costs that can burden smallholder farmers. Over-extraction of groundwater is another critical concern, as it can cause a rapid decline in water tables, threatening the sustainability of irrigation and leading to long-term environmental consequences. Besides, the significant fluctuation in groundwater levels, particularly during the dry season, creates water stress for the Boro crop, adversely impacting agricultural productivity.

- In 2023-24, approximately 34,040 Deep Tubewells (DTWs) irrigated 10.48 million hectares (18.16%) of the total irrigated area from the Force mode Zone in Bangladesh, which is about 25.21% of the total groundwater usage for irrigation;
- The Force Mode zone primarily covers the North West and North Central hydrological regions of Bangladesh. This zone includes major parts of Rajshahi, Naogaon, Chapai Nawabganj, and some parts of the Pabna district in the North West hydrological region. Additionally, it includes significant portions of Mymensingh, Tangail, Gazipur, Sherpur, Narshindi, Kishoreganj, Netrakona, and Dhaka district in the North Central hydrological region.
- In the Force Mode zone, the overall irrigation cost is higher than in other parts of the country.

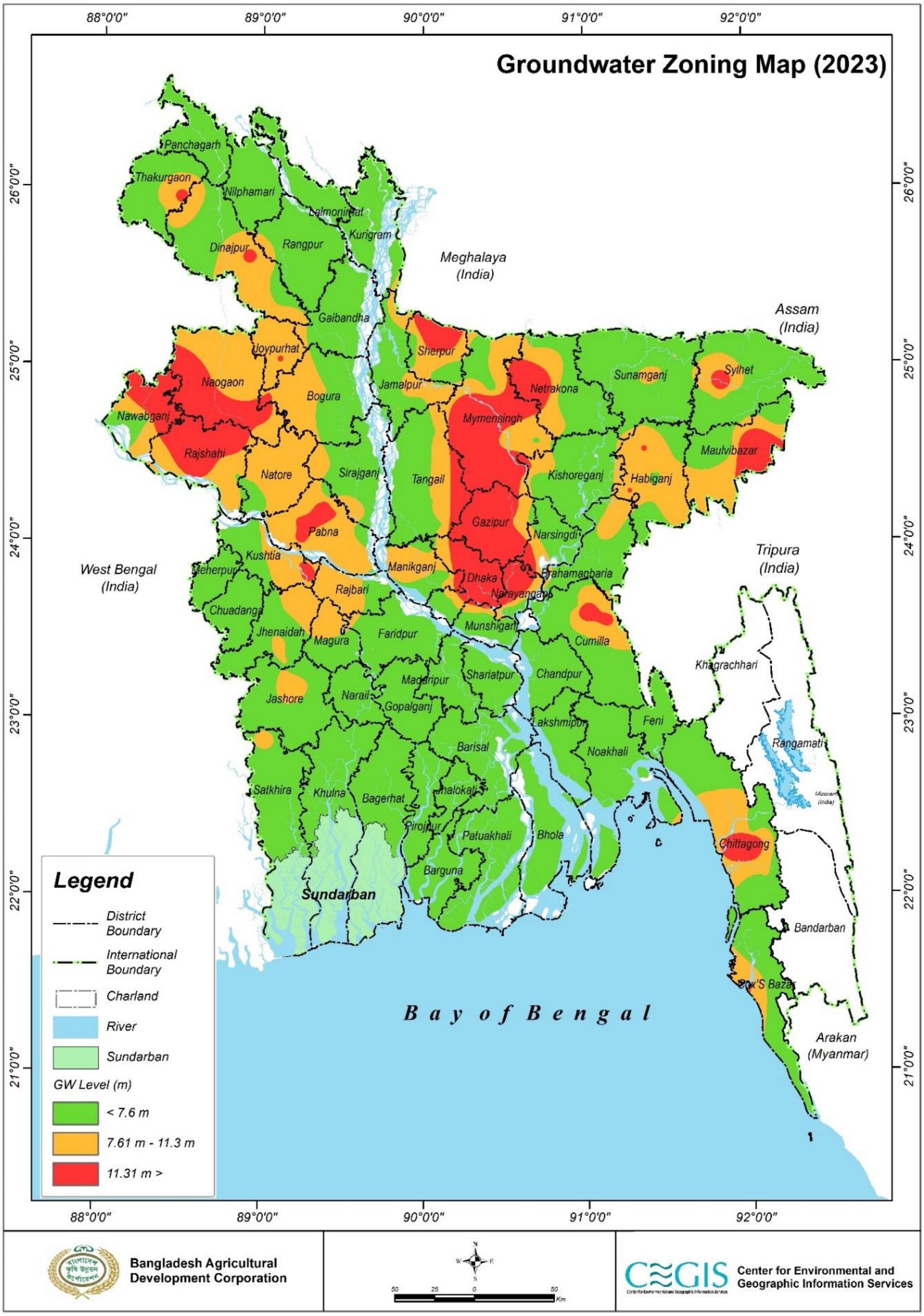


**Figure 4.1: Ground Water Zoning Map, 2023**

## 4.2 Groundwater quality

Salinity poses a significant threat to agriculture and irrigation in Bangladesh, particularly in coastal regions. This issue is driven by factors such as tidal water intrusion, sea-level rise, and reduced upstream freshwater flow during the dry season, which are further exacerbated by anthropogenic activities. Coastal areas experience severe salinization, which significantly hampers agricultural productivity. The increased concentration of salts in soil and water sources hinders crop growth and reduces yields, impacting staple crops like rice, wheat, maize, and vegetables (Haque & Rahman, 2023). Due to these adverse conditions, farmers are compelled to switch to salt-tolerant crops, such as certain rice varieties, sunflower, and watermelon, as traditional crops struggle to thrive under high salinity levels (Mondal et al., 2019).

Moreover, using saline water for irrigation leads to the gradual accumulation of salt in soils, deteriorating soil structure and reducing plants' water uptake efficiency, lowering crop yields and posing a significant threat to sustainable agriculture in these regions (Haque et al., 2020). Additionally, salinity intrusion limits the freshwater availability for irrigation, thereby intensifying water scarcity and compounding the detrimental effects on agricultural productivity (CCC, 2010). The complexity of this challenge is amplified by the demand for irrigation water, which is significantly influenced by both the extent of salinity intrusion in surface water and the accumulation of salt within the soil's root zone (Gowing & Islam, 2015).

The BADC has installed 760 ICT-based groundwater monitoring wells throughout the country. Of these, 60 are nested wells (clusters of 5 wells at a single location) specifically placed in saline zones to monitor salinity levels at various depths. Groundwater salinity data were collected from 37 of these nested wells at a depth of 100 meters from January 2023 to December 2023, and the yearly maximum salinity event was analyzed. The Spatial Analyst tool in ArcGIS was used to generate salinity raster grids/surfaces and visualize the spatial distribution of groundwater salinity levels in the coastal region.

Ayers and Westcot (FAO, 1985) conducted a comprehensive review of water quality data for irrigation and subsequently developed practical guidelines to evaluate its suitability. These guidelines provide a preliminary assessment of key water quality factors, such as salinity and specific ion toxicity, which can significantly impact both irrigation practices and crop production. The author specifies that water with an electrical conductivity (EC) exceeding 3000 µS/cm faces severe restrictions in its usability for irrigation, as high salinity levels can hinder water uptake by plants, leading to reduced growth, lower yields, and potential soil degradation. Based on the literature and existing irrigation practices, the following salinity classification has been established:

1. None (<1200 µS/cm) - No restrictions for irrigation.
2. Moderate (1200 µS/cm to 3000 µS/cm) - Limited use, with slight yield reduction possible.
3. Severe (>3000 µS/cm) - High restrictions, leading to significant adverse effects on crop growth.

The map illustrating groundwater salinity distribution reveals that, excluding the Sundarbans, salinity is prevalent across 19 coastal districts of Bangladesh, encompassing approximately 43,245 sq km. Approximately 7% of the area exhibits groundwater salinity levels below 1200 µS/cm, indicating suitability for irrigation.

Moderate salinity levels (1200 to 3000 µS/cm) are found in approximately 38% of the area, primarily in parts of Jashore, Narail, Gopalganj, Shariatpur, Chandpur, Lakshmipur, Barisal, Pirojpur, and Jhalokathi districts. In these moderately saline regions, slight yield reductions can occur as salinity affects crop water absorption, leading to stunted growth and reduced productivity.

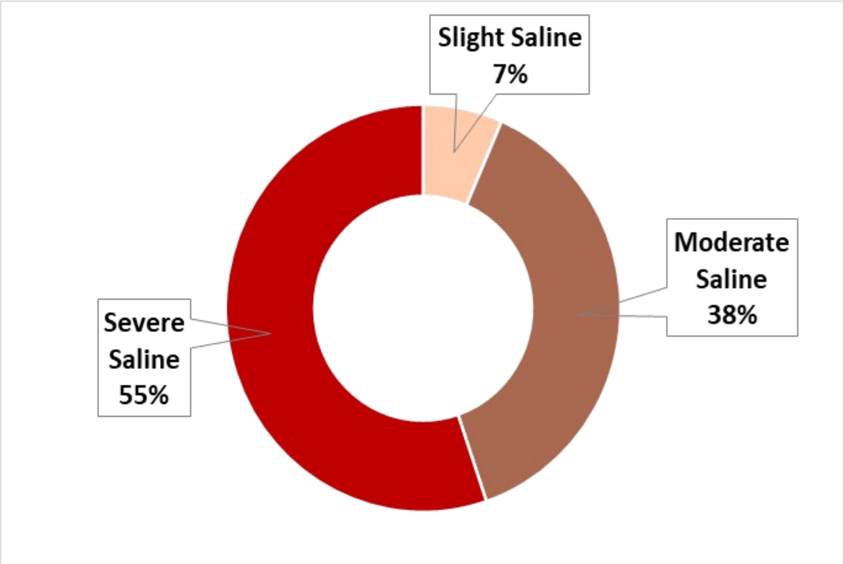


**Figure 4.2: Salinity Affected Area**

Severe salinity-prone areas, covering about 55% of the coastal districts, extend across major parts of Satkhira, Khulna, Bagerhat, Barguna, Patuakhali, Bhola, Noakhali, Feni, Laksmipur, Chattogram, and Cox's Bazar. In these regions, groundwater salinity levels exceed 3000 µS/cm, severely affecting crop growth. The high salt concentration in irrigation water leads to salt accumulation in the soil, disrupting its structure and reducing its permeability. This makes it difficult for roots to absorb water and nutrients, resulting in stunted growth, lower yields, and reduced crop quality. Furthermore, prolonged exposure to saline water can degrade the soil and decrease its fertility.

Traditional staple crops (rice, wheat, maize, and vegetables) are particularly vulnerable to high salinity, especially during the critical ripening stage. Consequently, farmers have adopted cultivation strategies that prioritize salt-tolerant rice varieties and less water-intensive crops like pulses, watermelon, sunflower, and groundnuts. These adaptations enhance resilience to salinity stress and reduce reliance on irrigation, often supplemented by manually sourcing from canals and ponds. However, even with salt-tolerant varieties, farmers experience lower-than-expected yields, as salinity affects the critical phases of crop development, such as flowering and grain filling.

Beyond its direct impact on crops, salinity presents challenges for irrigation infrastructure. The use of saline water for irrigation exacerbates soil salinization and accelerates the corrosion of equipment and drainage structures, increasing maintenance costs and reducing operational efficiency. The scarcity of freshwater necessitates the implementation of alternative irrigation strategies, including drip, sprinkler, rainwater harvesting, canal and pond re-excavation and efficient water management practices.

The consequences of salinity are profound for coastal communities in Bangladesh. Reduced agricultural yields lead to lower incomes and economic hardship. The increased labor and costs associated with managing salinity add to their burden. Farmers face the added pressure of investing in costly salt-tolerant seeds and adapting traditional farming practices, often with limited economic returns.

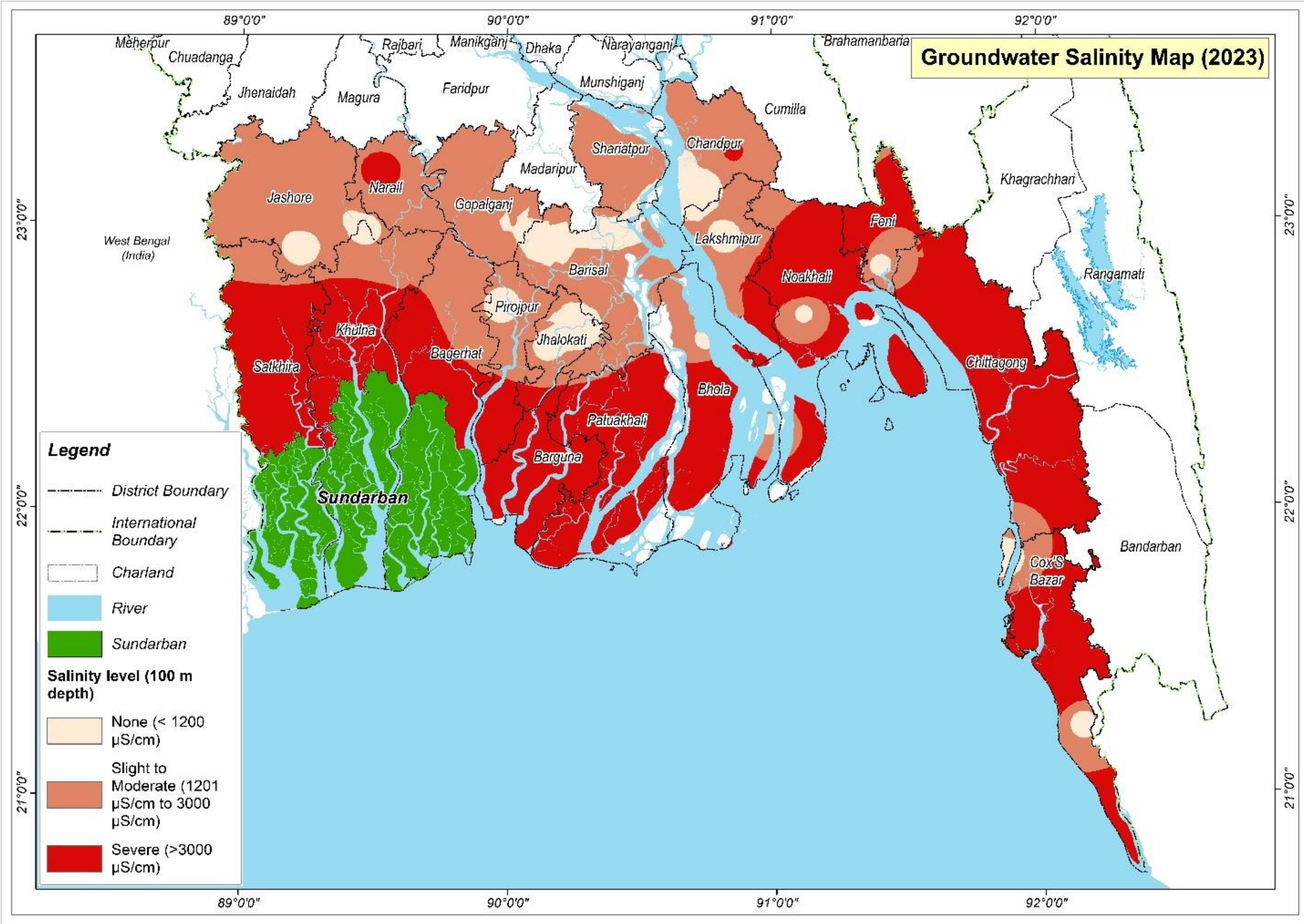


**Figure 4.3: Ground water Salinity Map**

# 5. Irrigation Status Report 2023-24

The practice of artificially watering crops with the use of canals, pipes, sprinklers, or any other man-made infrastructure, rather than to only relying on rainfall, is known as irrigation (www.studysmarter.co.uk). When there isn't enough water for plant growth, irrigation is usually necessary. This can be because of drought, seasonal rainfall, or other climatic factors. Even regions with moderate rainfall can benefit from irrigation in order to maintain stable soil moisture levels. Given that climate change and global warming are still big problems and will alter worldwide rainfall patterns, irrigation's importance in agriculture and food production is probably only going to increase.

A minor irrigation system is made up of non-mechanized, semi-mechanized, and mechanized irrigation systems. The non-mechanized irrigation systems include conventional systems like swing baskets and doans. The category of semi-mechanized irrigation systems includes gravity flow systems and manually operated pumps like hand tube wells, treadle pumps, artesian wells, etc.; mechanized irrigation systems include low lift pumps, shallow and deep tube wells, solar pumps, floating pump and rubber dams. Mechanized systems mostly used solar, electricity, or diesel power for irrigation equipment.

In 1961, BADC began its irrigation operations, fielding 1555 Low Lift Pumps. Deep tube wells were later installed in 1967–1968 for irrigation in areas with scare surface water. Similar installations were made for the same reasons in shallow tube wells in 1973–1974, floating pumps in 1987–1988, rubber dam and solar pumps in 2011–2012, and dug wells in 2015–2016. In addition to these techniques, irrigation work is carried out in some parts of the country using gravity flow, conventional methods, manual pumps, and artesian wells. Table 5.1 summarizes irrigation using various modes of surface and groundwater utilization.

**Table 5.1: Surface and Ground water Irrigation by Different Modes in Rabi 2023-24**

| SL | Methods/Modes of Irrigation | No of Equipment | Area Irrigated (ha) | Percent age (%) of | % of Total Irrigated Area | Area Irrigated per equipment (ha) |
|---|---|---|---|---|---|---|
| **A** | **By Surface water** | | | **Surface Water** | | |
| 1 | Low Lift pump | 207,368 | 1,350,542 | 83.82 | 23.41 | 6.51 |
| 2 | Gravity flow | | 244,092 | 15.15 | 4.23 | |
| 3 | Traditional method | | 5,444 | 0.34 | 0.09 | |
| 4 | Solar pump | 977 | 11,125 | 0.69 | 0.19 | 11.39 |
| | **Sub Total** | **208,345** | **1,611,203** | **100.00** | **27.93** | |
| **B** | **By Ground water** | | | | | |
| 1 | Deep tube well | 34,040 | 1,048,042 | 25.21 | 18.17 | 30.79 |
| 2 | Shallow tube well | 1,479,266 | 3,085,919 | 74.22 | 53.49 | 2.09 |
| 3 | Manual & Artesian Well | | 6,303 | 0.15 | 0.11 | |
| 4 | Solar Pump | 2,151 | 16,688 | 0.40 | 0.29 | 7.76 |
| 5 | Dug Well | 930 | 1,118 | 0.03 | 0.02 | 1.20 |
| | **Sub Total** | **1,516,387** | **4,158,070** | **100.00** | **72.07** | |
| | **Grand Total** | **1,724,732** | **5,769,273** | | **100.00** | |

From **Table 5.1,** it is revealed that during the Rabi 2023-24, total 17,24,732 numbers of irrigation equipment's are used for irrigation in the country which is 0.17% higher than that of 2022-23 Rabi season in which 17,21,834 nos. of irrigation equipment were operated. On the other hand, irrigated area was 5.77 million ha in Rabi 2023-24 which is also 0.36 % higher than that of 2022-2023 Rabi season irrigated area was 5.75 million hectares. Out of total 5.77 million hectares irrigated area, 5.48 million ha irrigated by DTW, STW & LLP and 0.28 million ha irrigated by Manual and Artesian well, traditional method, gravity flow, solar pump and dug well. Out of total 5.77 million ha Irrigated area 4.16 million ha through the utilization of groundwater i.e. 72.07% of total Irrigated area and 1.61 million ha through utilization of surface water i.e. 27.93% of total Irrigated area.

The groundwater and surface water irrigated area are shown in **Figure 5.1**.

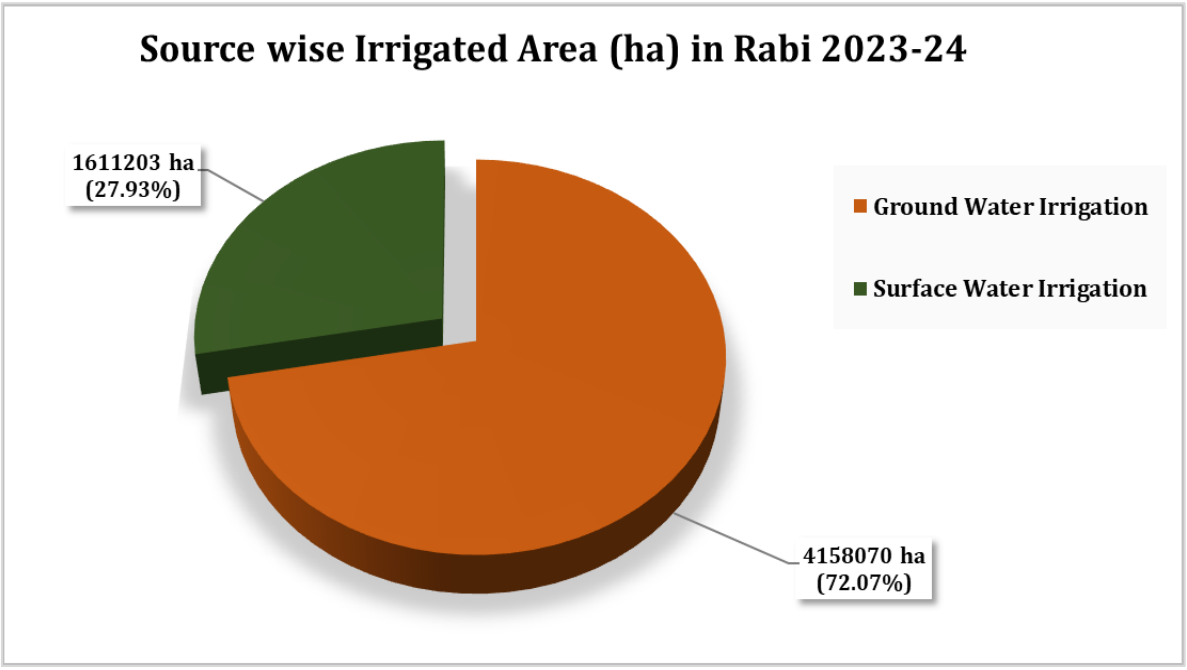


**Figure 5.1: Source wise Irrigated Area (ha) in Rabi 2023-24**

Distribution of irrigated area during the Rabi 2023-24 is shown in **Figure 5.2**.

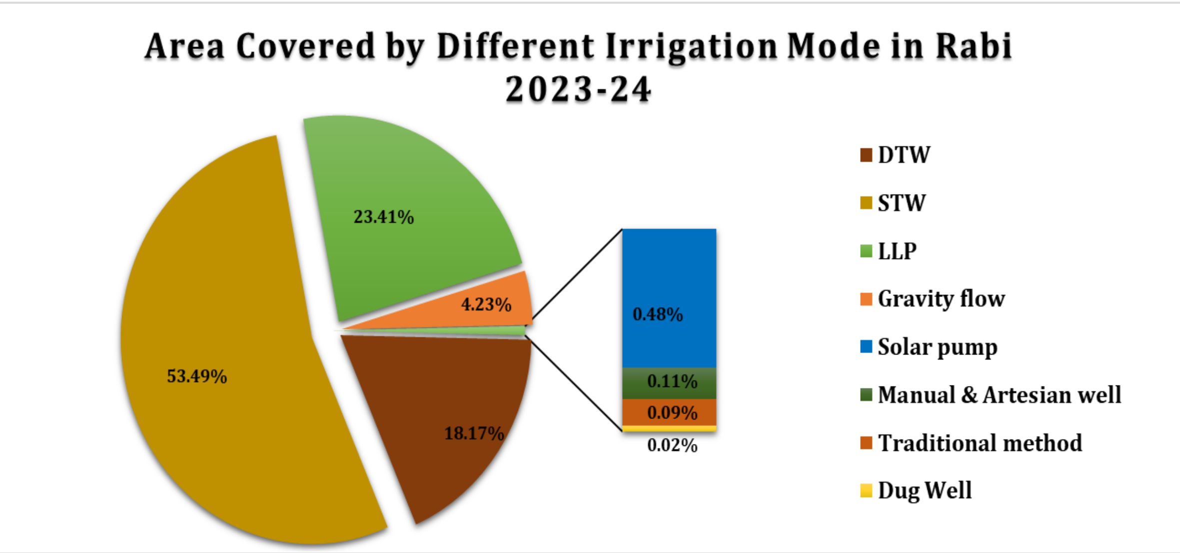


**Figure 5.2: Area Covered by Different Irrigation Mode in Rabi 2023-24**

Distribution of irrigation equipment's used during Rabi 2023-24 is shown in bellows-

**Table 5.2: Division-wise irrigation equipment used in Rabi 2023-24**

| Name of Division | Nos. of Irrigation equipment in Rabi 2023-24 | | | | | |
|---|---|---|---|---|---|---|
| | DTW | STW | LLP | Solar | Dug Well | Total |
| Dhaka | 2,145 | 208548 | 25,951 | 152 | 25 | **236,821** |
| Mymensingh | 4,115 | 184,935 | 12,439 | 83 | 61 | **201,633** |
| Rajshahi | 15,030 | 307,366 | 12,880 | 617 | 632 | **336,525** |
| Rangpur | 7,904 | 391,042 | 2,648 | 1,319 | 77 | **402,990** |
| Chattogram | 1,561 | 80,423 | 47,063 | 256 | 42 | **129,345** |
| Khulna | 3,116 | 281,473 | 33,075 | 579 | 91 | **318,334** |
| Sylhet | 169 | 25,322 | 46,365 | 56 | 2 | **71,914** |
| Barishal | - | 157 | 26,947 | 66 | - | **27,170** |
| **Total** | **34,040** | **1,479,266** | **207,368** | **3,128** | **930** | **1,724,732** |

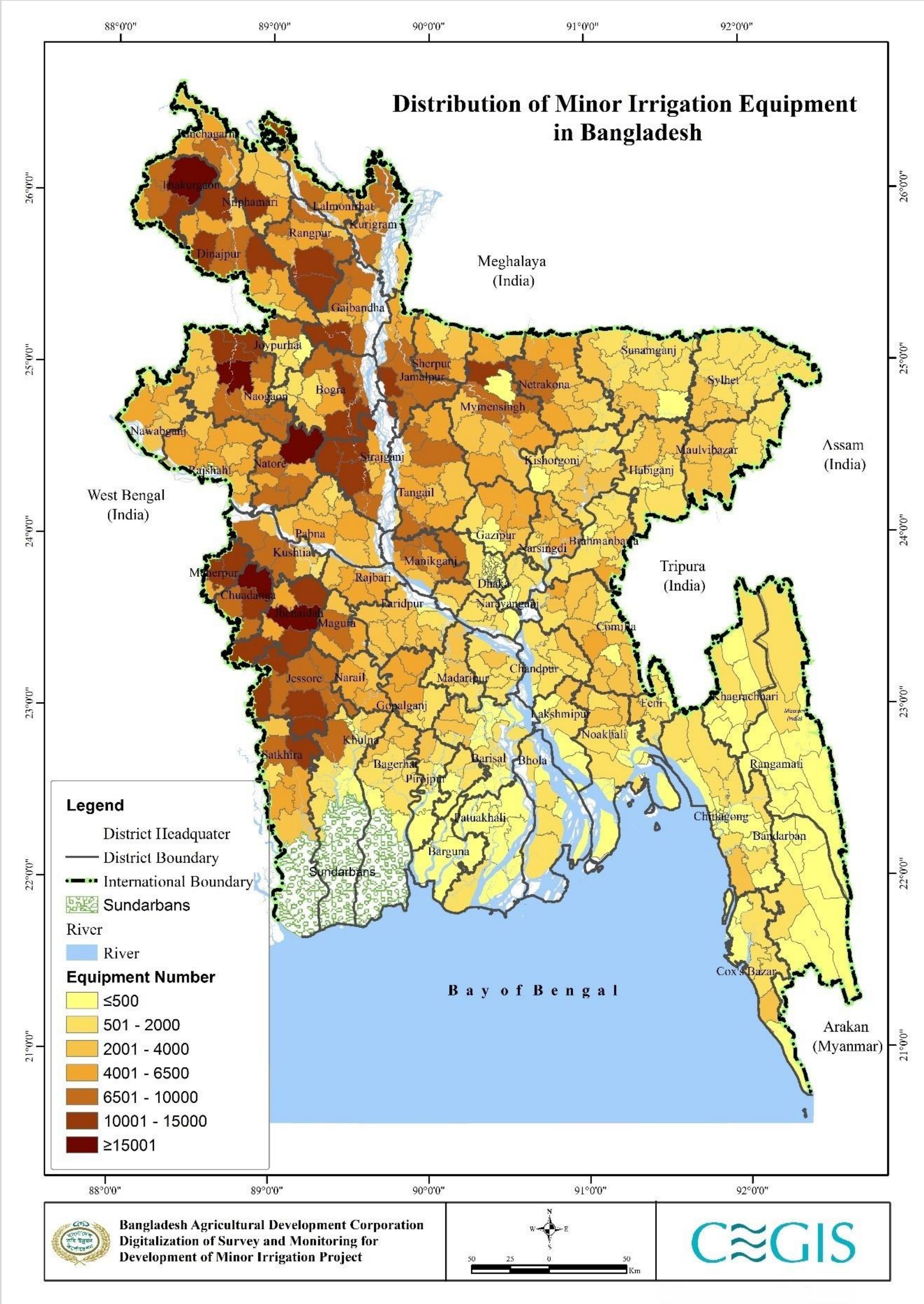


**Figure 5.3: Distribution of minor irrigation equipment in Bangladesh**

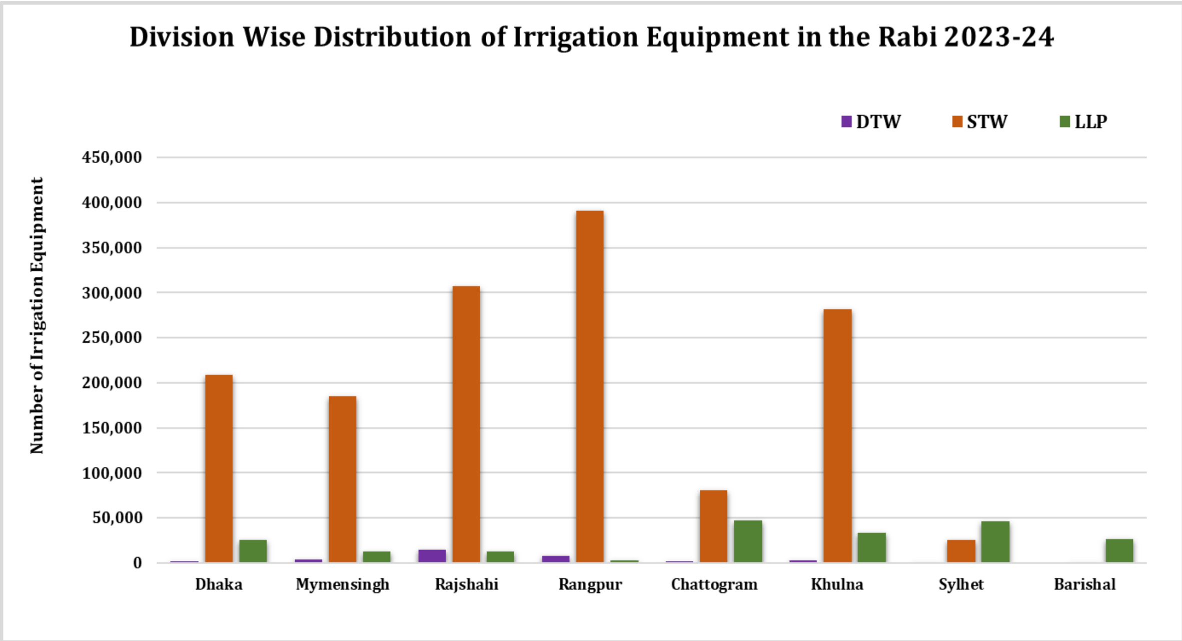


**Figure 5.4: Division wise Irrigation Equipment in Rabi 2023-24**

Distribution of irrigation area during Rabi 2023-24 are shown bellows-

**Table 5.3: Division wise Irrigated Area (ha) in Rabi 2023-24.**

| Division | Irrigation Year 2023-24 | |
|---|---|---|
| | Irrigated Area (ha) | % of Total Area |
| Dhaka | 765,153 | 13.26 |
| Mymensingh | 619,777 | 10.74 |
| Rajshahi | 1,214,341 | 21.05 |
| Rangpur | 1,081,714 | 18.75 |
| Chattogram | 651,736 | 11.30 |
| Khulna | 784,943 | 13.61 |
| Sylhet | 425,902 | 7.38 |
| Barishal | 225,706 | 3.91 |
| **Total** | **5,769,273** | **100.00** |

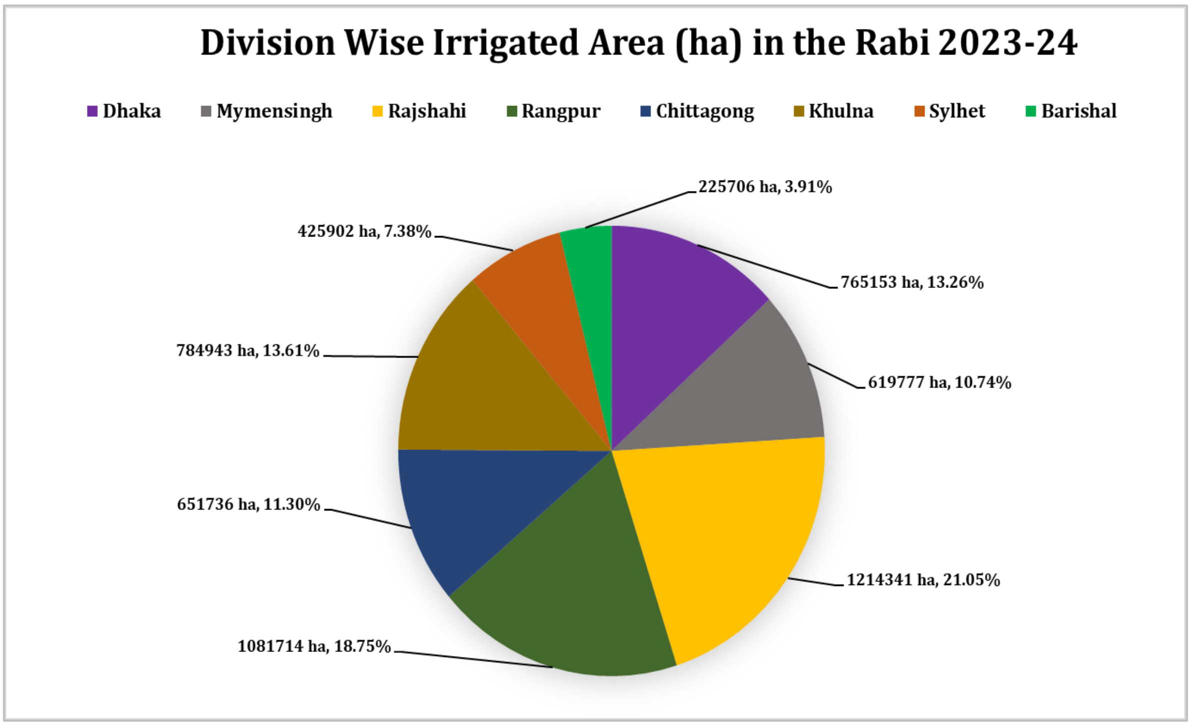


**Figure 5.5: Division wise Irrigated Area (ha) in Rabi 2023-24**

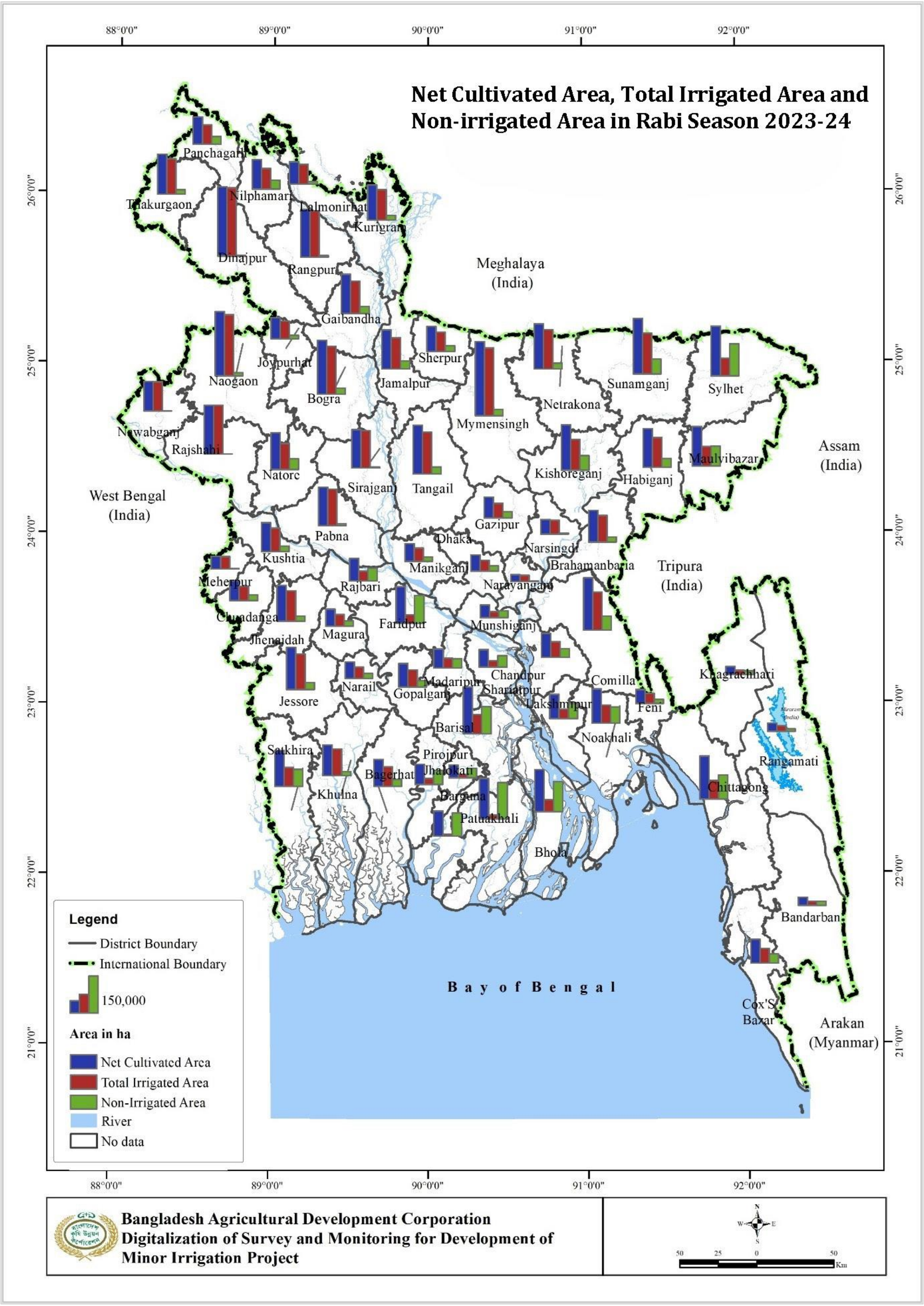


**Figure 5.6: Net Cultivated Area, Total Irrigated Area and Non-irrigated Area**

## 5.1 Surface water

In Bangladesh, surface water, sourced mainly from rivers, creeks, and reservoirs, is vital for irrigation. Although, abundant in the rainy season, it become scarce in the dry period. To enhance surface water availability, the government of Bangladesh has initiated multiple projects through agencies like the Bangladesh Agricultural Development Corporation (BADC), the Bangladesh Water Development Board (BWDB), and the Barind Multipurpose Development Authority (BMDA). These projects encompass canal excavation, river dredging, and rubber dam construction. While groundwater remains the prevalent source for farmers, surface water irrigation contributes to 27.93% of the total irrigated land during the Rabi season. The South-Central, South-East, and North-East hydrological zones, primarily in the Barishal, Chattogram, and Sylhet divisions, experience the most frequent use of surface water. Barishal and parts of the Chattogram division act as the major discharge points for the Ganges-Brahmaputra-Meghna (GBM) basin which ensure fresh water for Rabi season irrigation. The Eastern hill hydrological zones also offer abundant fresh surface water for agricultural purposes in rivers and estuaries.

Surface water irrigation is less expensive and crop friendly than groundwater. Currently, diesel engine is used for operation of 88.86% of LLPs. BADC and BMDA fielded 2-5 cusec LLP to farmers for surface water irrigation. Moreover, floating irrigation pump is also supplied by BADC to double-lifting irrigation schemes. Seventy-three numbers Rubber dam/ Hydraulic elevator dam are constructed by BADC, BMDA, BWDB, LGED in perennial rivers and creeks to make available surface water for irrigation. Besides this, excavation/ re-excavation of canal is done by the government to increase surface water availability. By increasing the availability of electricity, this cost might be further reduced. Diesel pumps usually have higher costs and lower water extraction capacity than electric. But despite subsidies on electricity, some cases diesel pumps are preferred by farmers due to low capital costs and mobility ease within small and fragmented farm lands.

Surface water irrigation requires less amounts of energy than ground water. In the Rabi season 2023-24 about 184265 LLPs are diesel operated; the rest 23103 are electrically operated. In the South-central and North-east, diesel operated LLPs are used primarily for irrigating Boro rice, and partially for supplementary irrigation to T. Aman, Aus and other crops. Division-wise irrigated area (ha) of different method of surface water irrigation in the Rabi Season is shown in the **Table 5.4**.

**Table 5.4: Area irrigated by Surface water in eight divisions of Bangladesh, Rabi 2023-24**

| Name of Division | Irrigated Area (ha) by LLP | Irrigated Area (ha) by Traditional Method | Irrigated Area (ha) by Gravity Flow | Irrigated Area (ha) by Solar | Total Irrigated Area (ha) |
|---|---|---|---|---|---|
| Dhaka | 227,443 | 1,387 | 10,312 | 1,639 | **240,781** |
| Mymensingh | 114,336 | 502 | 7,028 | 847 | **122,713** |
| Rajshahi | 85,848 | 76 | 2,970 | 5,501 | **94,395** |
| Rangpur | 30,448 | 233 | 16,420 | 10,997 | **58,098** |
| Chittagong | 321,634 | 1,472 | 62,499 | 2,688 | **388,293** |
| Khulna | 122,471 | 701 | 38,248 | 4,866 | **166,286** |
| Sylhet | 269,656 | 709 | 61,767 | 601 | **332,733** |
| Barishal | 178,705 | 364 | 44,848 | 674 | **224,591** |
| **Total** | **1,350,542** | **5444** | **244,092** | **27,813** | **1,627,891** |

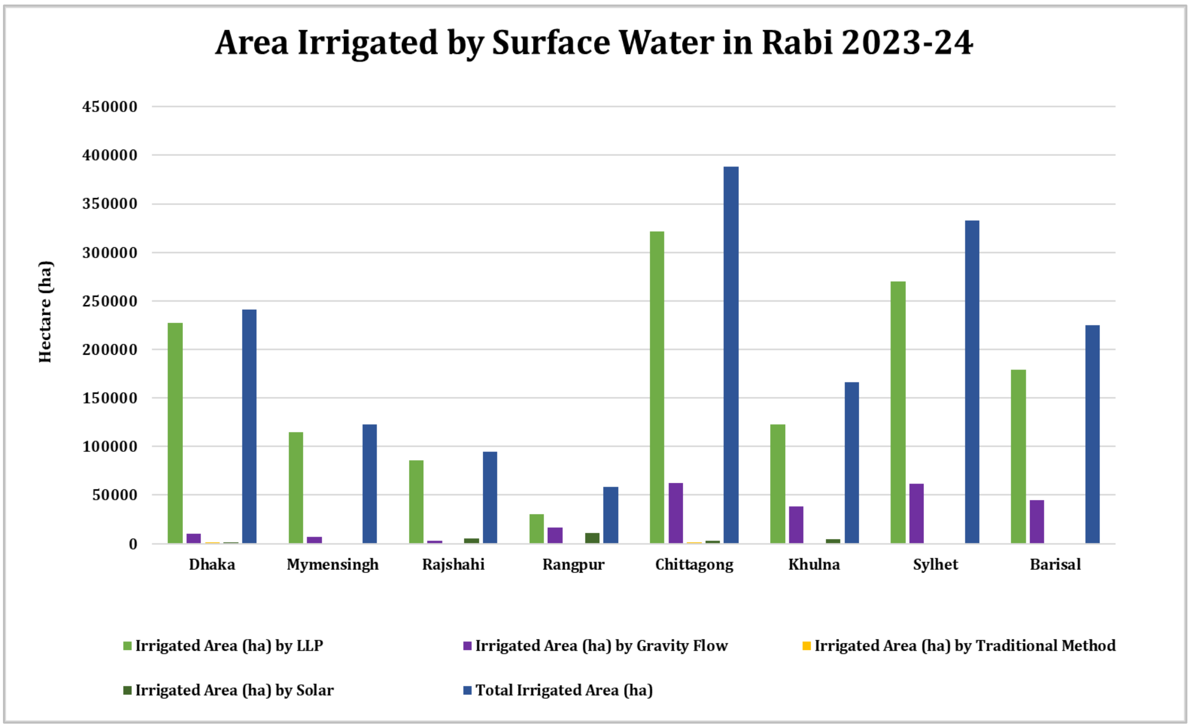


**Figure 5.7: Division wise Area Irrigated by Surface Water in Rabi 2023-24**

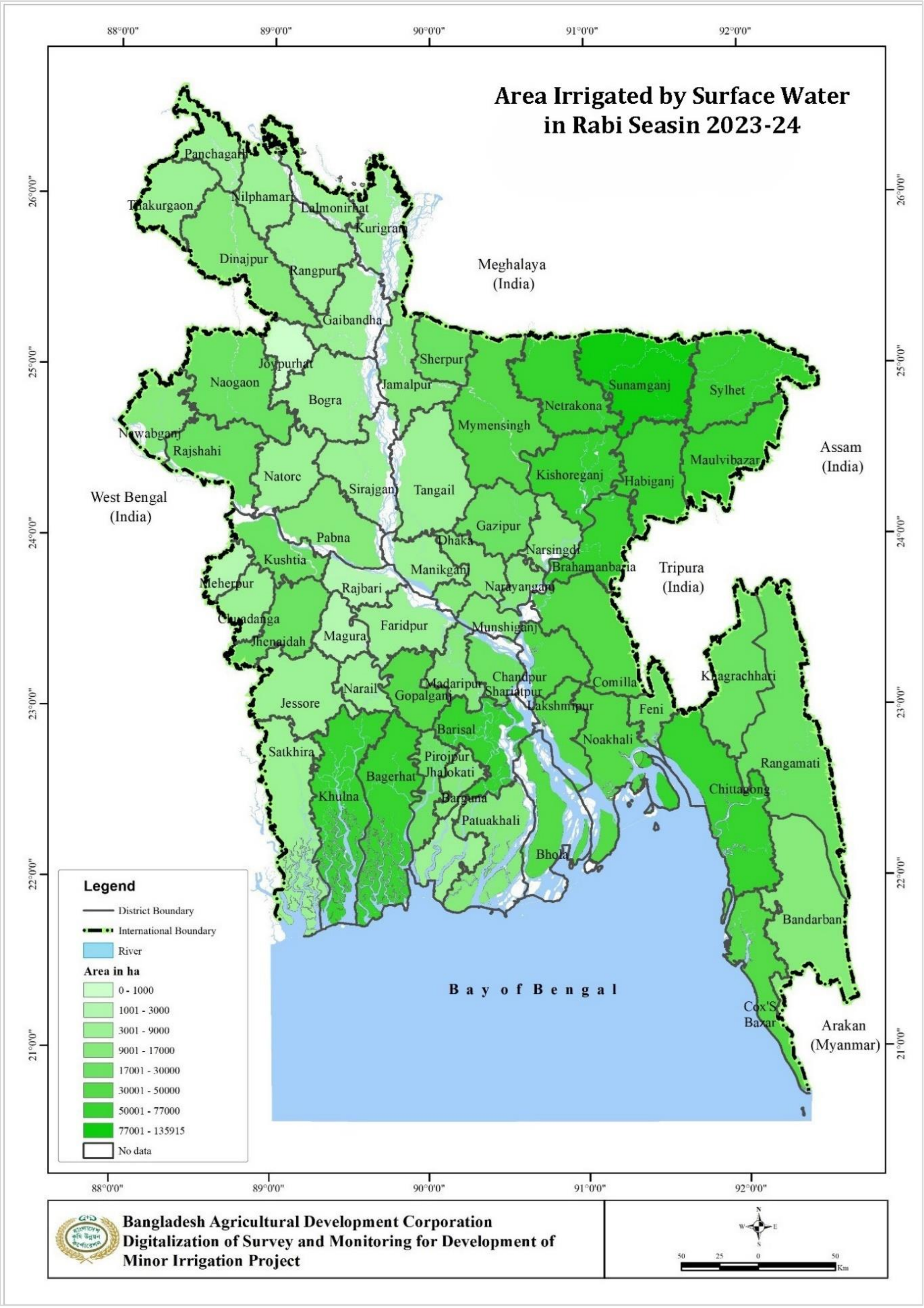


**Figure 5.8: Irrigated Area by Surface Water**

### 5.1.1 *Low lift Pump*

A Low Lift Pump (LLP) is one in which water is lifted between two open water surfaces through a pump total head up to about 10m. Pump is coupled with an electrical or diesel-driven power source. Mostly centrifugal pump is used for LLP with a capacity of 14-140 L/sec. In 2023-24, about 207368 nos. of LLP were operated for irrigation purpose and 1.35 million ha irrigated which is 23.41% of total irrigated area. Of the 207368 LLPs, 9481 were operated by BADC and 638 by BMDA under various projects, irrigating 232207 ha and 16524 ha of land, respectively. Division wise irrigated areas in Rabi 2023-24 are shown in **Table 5.4**.


**Figure 5.9: LLP with Buried Pipe, Sadar Upazila, Manikganj by BADC**

**Figure 5.10: Solar LLP at Sonatola Upazila, Bogra by BADC**

**Figure 5.11: Solar LLP at Khanshama Upazila, Dinajpur by BADC**

**Figure 5.12: Solar LLP at Sadullapur Upazila Gaibandha by BADC**

**Figure 5.13: 25 Cusec Floating Pump at Atpara Upazila, Netrokona by BADC**


**Figure 5.14: 10 Cusec Floating Pump at Adarsha Sadar Upazila, Cumilla by BADC**

**Figure 5.16: Barge Mounted Floating LLP at Godagari Upazila, Rajshahi by BMDA**

**Figure 5.17: 5.0 cusec LLP at Sunamganj by BADC**

**Figure 5.18: Solar LLP at Rajshahi by BMDA**

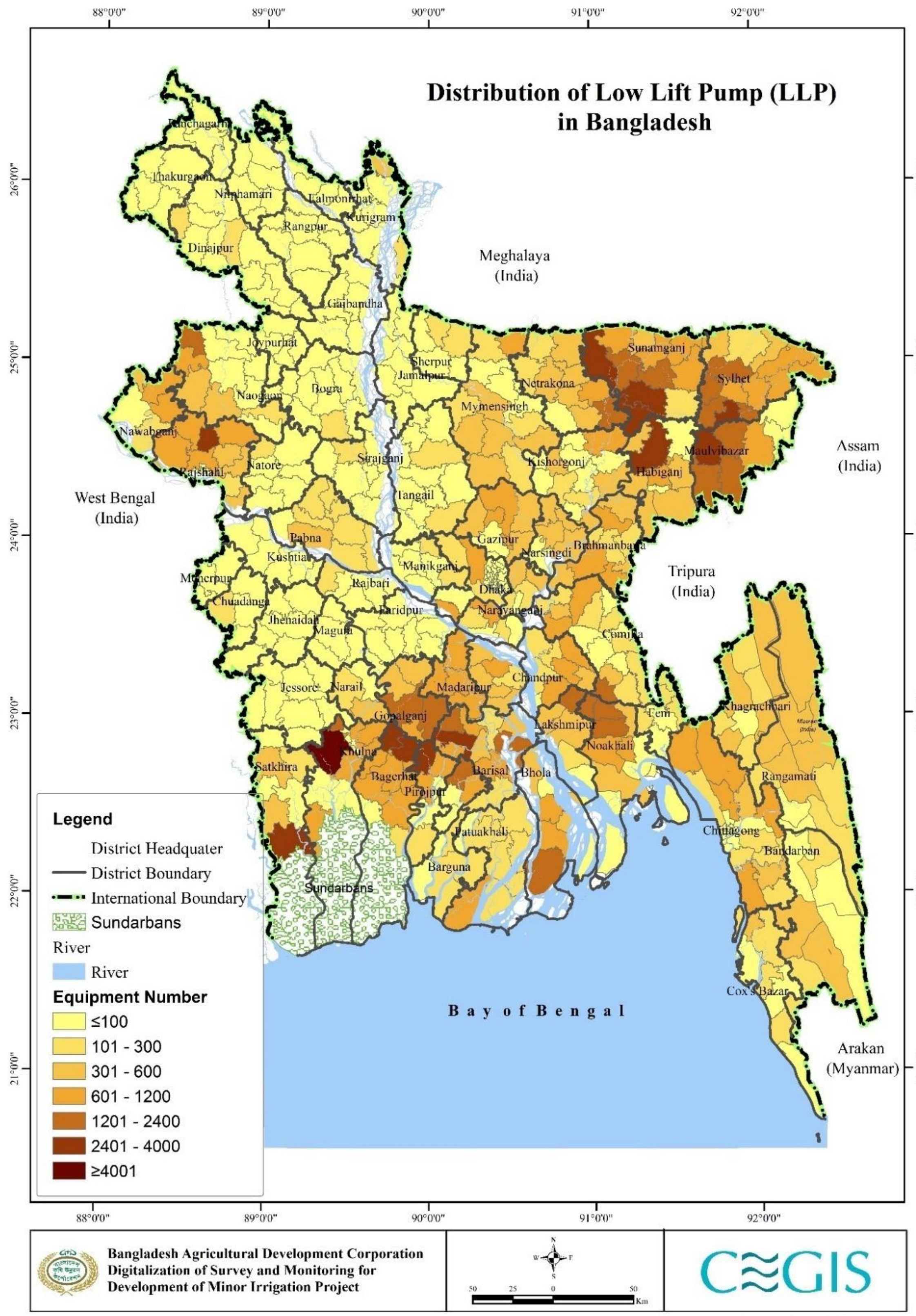


**Figure 5.19: Distribution of LLP in Bangladesh**

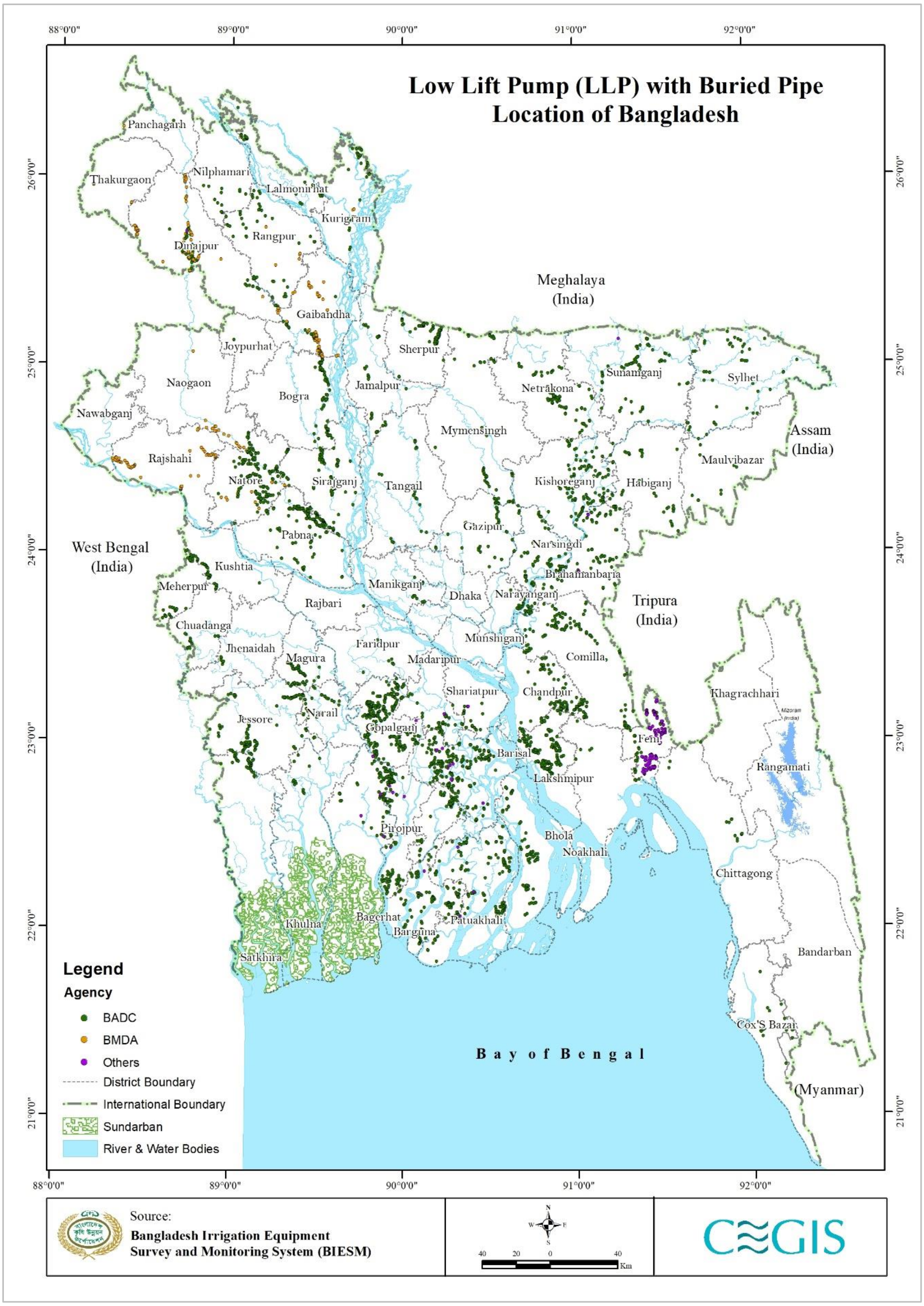


**Figure 5.20: Location of LLP with Buried Pipe**

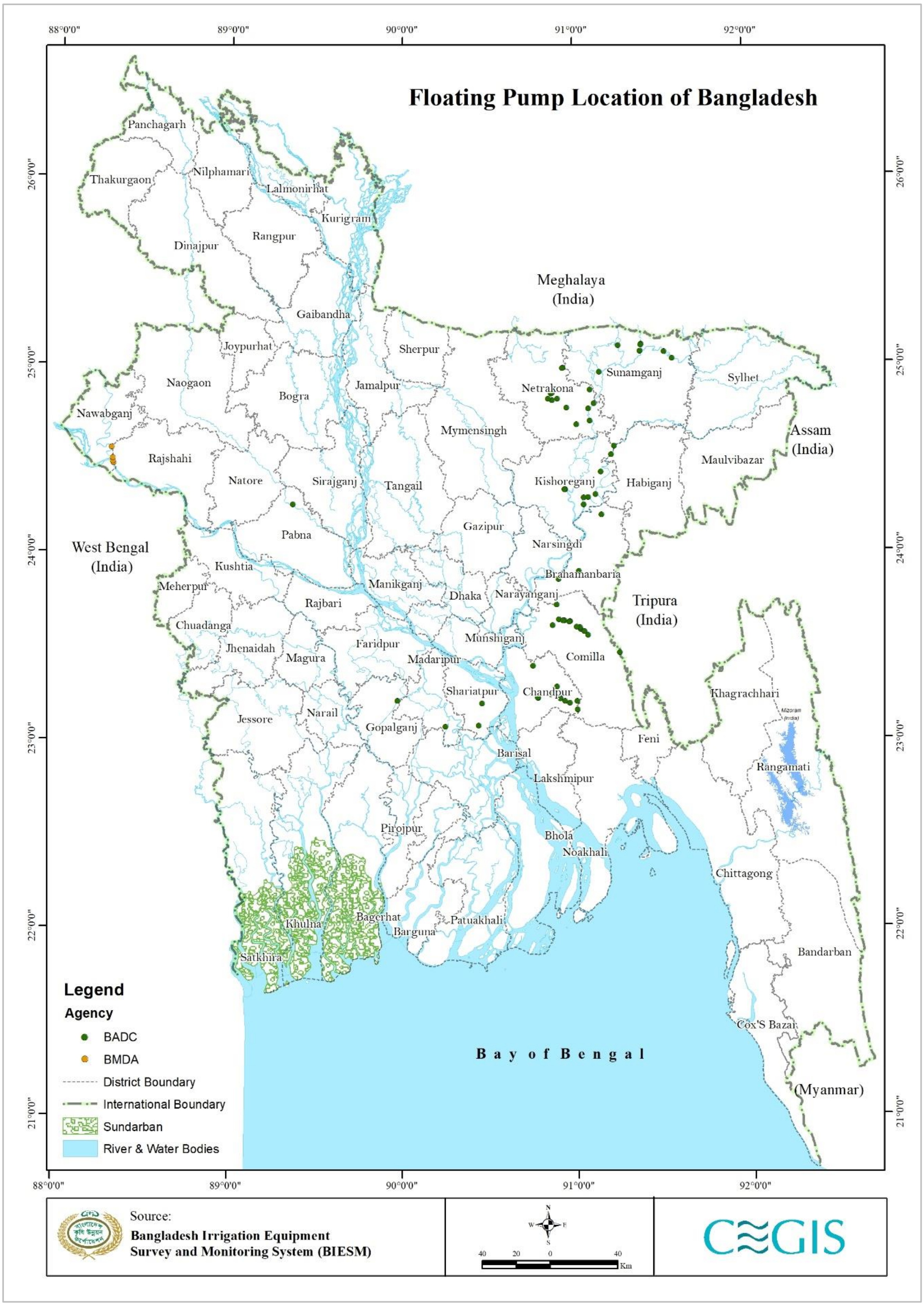


**Figure 5.21: Location of Floating Pump**

### *5.1.2 Rubber Dam*

Rubber Dam is a hydraulic structure usually built to river/creeks perpendicular to flow direction and store surface water for irrigation/ recharge/ salinity control/ recreation/ flood control purpose. A total 73 Rubber Dam is constructed in Bangladesh. These dam ware constructed by LGED, BADC, BWDB and BMDA.

**Figure 5.22: Kaledha Khal Rubber Dam at Nalchity, Jhalakathi by BADC**

**Figure 5.23: Sonai River Rubber Dam at Chatak, Sunamganj by BADC**

**Figure 5.24: Mohanpur Rubber Dam at Sadar upazila, Dinajpur by LGED.**

**Figure 5.25: Pekua Rubber Dam at Pekua Upazila, Cox's bazar by BWDB.**

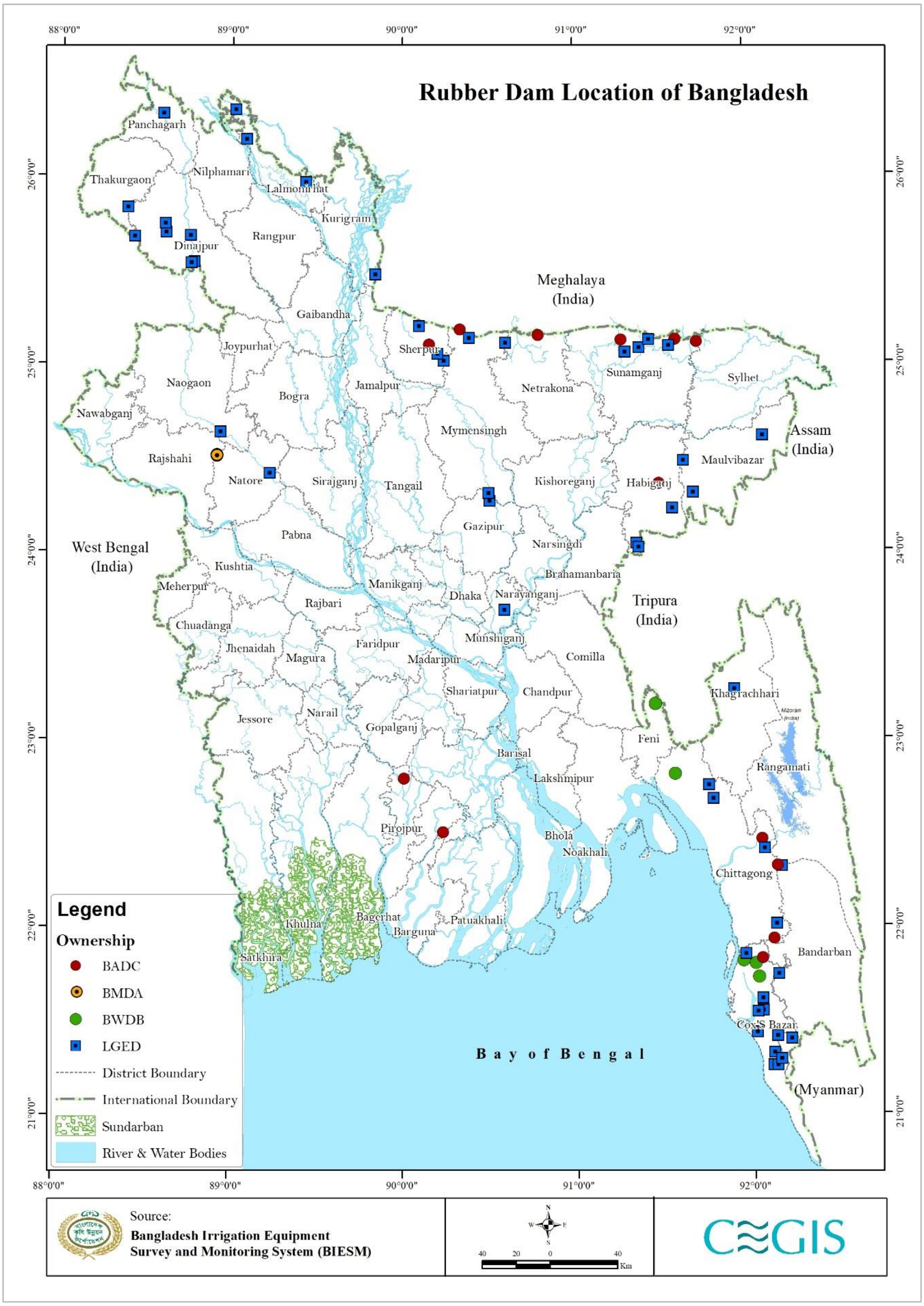


**Figure 5.26: Location of Rubber Dam**

### *5.1.3 Gravity Flow Irrigation*

In gravity flow irrigation, a dam, barrage, weir, or other water holding and controlling structure is used to provide water head. Surface water is the main source of gravity flow irrigation, in some part of the country, irrigation carried out by gravity flow through major irrigation projects. This type of irrigation projects mainly implemented and operated by BWDB, LGED and BADC. Some of the irrigated areas under gravity flow are also covered by constracring earthen dam by individual farmers. It has been observed that during 2023-24 irrigation seasons, 244092 ha of land were irrigated by gravity flow method. Division wise irrigated area (ha) by Gravity Flow is shown in **Table 5.4.**


**Figure 5.27: Gravity flow irrigation at Ashuganj-Polash agro-irrigation project by BADC**

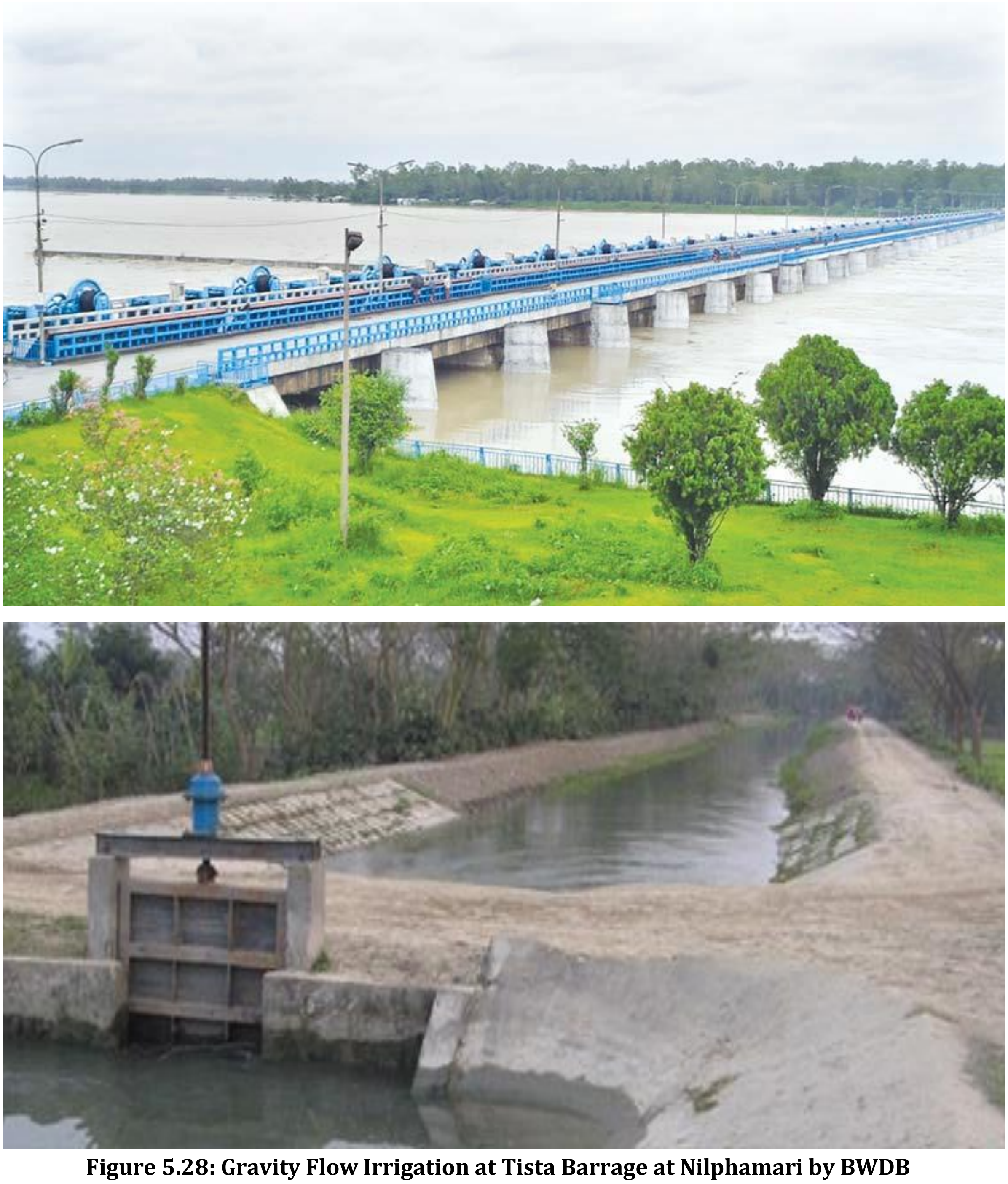

**Figure 5.28: Gravity Flow Irrigation at Tista Barrage at Nilphamari by BWDB**

### *5.1.4 Traditional Irrigation*

Bangladesh was dependent on traditional means of irrigation, up to 1960s, when irrigation was applied by swing basket, shewty, doan etc. Swing basket or shewty is capable of lifting water up to 3 feet approximately and doans up to 5 feet. After introduction of modern irrigation technology, the use of traditional method irrigation is decreasing day by day. During 2023-24 Rabi season, 5444 ha of land has been irrigated by traditional method. Division-wise irrigated area (ha) by Traditional Method in the Rabi Season is shown in the **Table 5.4**.

**Figure 5.29: Doan**

**Figure 5.30: Swing Basket**

**Figure 5.31: Different Types of Traditional Irrigation Methods**

## 5.2 Groundwater

Bangladesh's shallow (unconfined) and deep (confined, semi-confined) aquifers are the country's sources of groundwater. There are medium sand to gravel in these aquifers. The hydraulic conductivity and storage capacity are sufficient for groundwater withdrawal. wells sinking to a depth of 30 to 180 metres. DTW, STW, hand tubewel and dugwell are the major equipments used for withdraw groundwater. The Rajshahi Division has the highest concentration of deep tube wells (44.15%), followed by Rangpur, Mymensingh, Khulna, and Dhaka Division. Rangpur Division has the highest concentration of STW, followed by Rajshahi, Khulna, Dhaka, and Mymensingh Divisions. About 73.86% of the total groundwater is used in four divisions in the North-Central and North-Western hydrological zones i.e. Dhaka, Mymensingh, Rajshahi and Rangpur division. It is probable that groundwater irrigation in the North-West will persist until land limitations or sustainable groundwater withdrawals are accomplished. A sufficient recharge during the five-month monsoon period is necessary for groundwater irrigation during the seven-month dry period. Over the course of the year, irrigation by groundwater accelerate depletion of water table and cause an unsustainable fall in water levels if recharge is not greater than or at least equal to discharge. However, due to increasing groundwater extraction in the former zones, it is discovered that groundwater recharge is higher in the North-West than in the South and North-East, respectively. These regions' farmers have already begun to transition to less water-intensive and more profitable crops including vegetables, wheat, and maize.

In Bangladesh, diesel engines power almost 70.21% of the pumps. Most of the STW operated by diesel engine, the remaining 28.55% use electricity and 0.24% solar energy. Electric pumps are typically less expensive than diesel ones. However, in certain instances, farmers favour diesel pumps over other types because of their lower initial costs and ease of mobility in tiny, dispersed farmlands, even in the face of power cuts. Farmers' preferences for diesel pumps may also be influenced by the prevalence of power cuts and the generally poor electricity network in many rural locations. The owners of STWs irrigate not just their own land but also those of their neighbors for a set seasonal charge that can be paid in cash or by growing crops.

Groundwater irrigation requires large amounts of energy to lift water from underlying aquifers. In the Rabi 2023-24 about 33261 DTWs are electrified; the rest 779 are diesel operated. Out of the 1.48 million STWs in Bangladesh, only 0.44 million are electrified whereas the remaining 1.04 million are diesel operated. In the North-west, diesel operated STWs are used primarily for irrigating Boro rice, and partially for supplementary irrigation to Aman and Aus rice and other crops. Since there is little genetic and agronomic potential to boost rice yield, rising irrigation costs will lower farmers' net profits.

During the **Rabi 2023-24**, DTWs and STWs covered irrigated area were 1.05 million ha and 3.09 million ha respectively. In the previous Rabi season 2022-243, total of 1.05 million DTWs and STWs were in operation and 3.08 million ha land were irrigated. Deep Tube Well contributed 18.17% and Shallow Tube Well is contributed 53.48% of the total area irrigated during **Rabi 2023-24**. Division-wise Irrigation by DTWs & STWs is shown in **Table 5.5** along with graphical representation in **Figure 23**.

**Table 5.5: Area Irrigated by DTWs and STWs in Eight Divisions of Bangladesh, 2023-24**

| Division | Irrigation Year 2023-24 | | |
|---|---|---|---|
| | Area Irrigated (ha) by DTW | Area Irrigated (ha) by STW | Total Irrigated Area (ha) |
| Dhaka | 63,890 | 459,335 | 523,225 |
| Mymensingh | 134,194 | 362,493 | 496,687 |
| Rajshahi | 488,895 | 630,097 | 1,118,992 |
| Rangpur | 240,360 | 782,975 | 1,023,335 |
| Chattogram | 46,156 | 216,484 | 262,640 |
| Khulna | 69,379 | 548,452 | 617,831 |
| Sylhet | 5,168 | 85,677 | 90,845 |
| Barishal | - | 406 | 406 |
| **Total** | **1,048,042** | **3,085,919** | **4,133,961** |

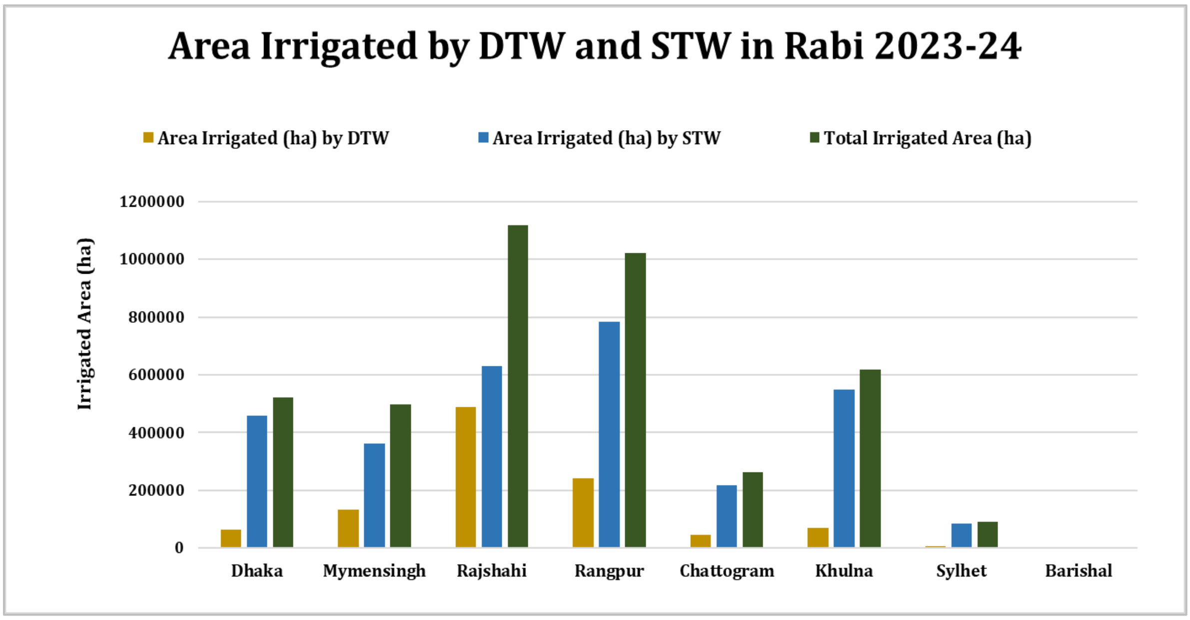


**Figure 5.32: Area irrigated by DTWs and STWs in Rabi, 2023-24**

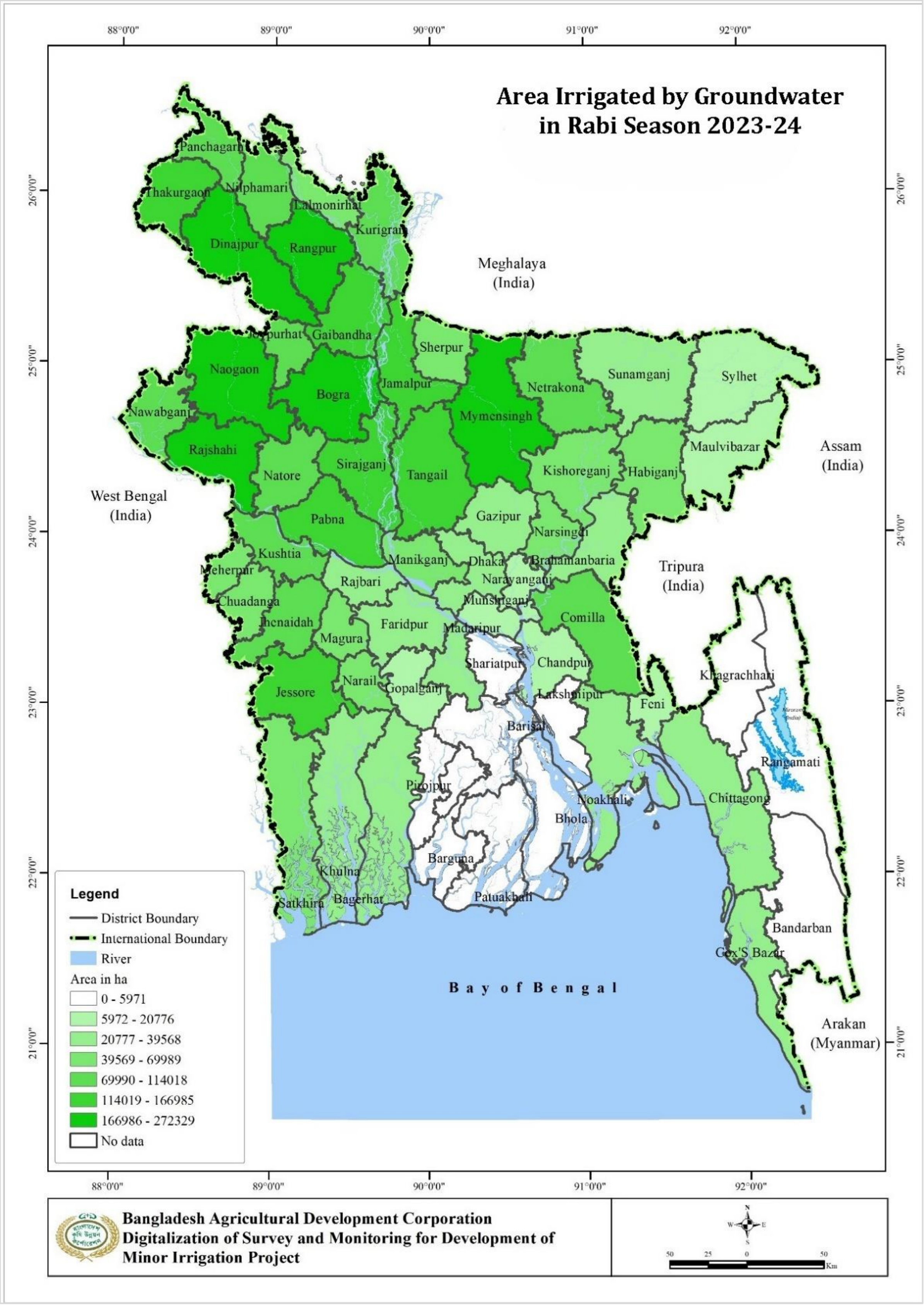


**Figure 5.33: Irrigated Area by Groundwater**

### *5.2.1 Deep Tubewell*

Well with electricity or diesel driven pump lifts water from aquifer. Deep Tubewells (DTW) are of large well diameter (15.24-20.32 cm) and pumped water by a submersible turbine pump having capacity 20-56 L/sec mostly. DTWs are called deep wells not because of large depth but because of the type of pump (force mode) used, the capacity of the well and position of groundwater table (>7.0 m).

Total 34040 number of Deep Tubewells are operated in 2023-24 Rabi season for irrigation in agricultural land. About 1.05 million ha of land is irrigated by Deep Tubewell, which is 25.21 percent of ground water irrigation and 18.17 percent of total irrigated area of Bangladesh. The average irrigated area coverage of DTW is 30.79 ha. Irrigation by deep tubewells decreasing because many DTWs are installed in the decade of seventy-eighty with 80' housing pipe. Those became technically unfit for lift water due to depletion of groundwater level. Details of irrigated area of Deep Tubewells are presented in Table 5.5 and Figure 23.

**Figure 5.34: BADC Deep Tubewell at Lakhai Upazila, Habiganj**

**Figure 5.35: BADC Deep Tubewell at Damurhuda Upazila, Chuadanga**

**Figure5.36: BADC Solar Deep Tubewell at Derai Upazila, Sunamganj**

**Figure 5.37: BADC Deep Tubewell at Lakhai Upazila, Habiganj**

**Figure 5.38: BMDA DTW in Baliadangi Upazila, Thakurgaon**

**Figure 5.39: BMDA DTW at Tanor Upazila, Rajshahi**

**Figure 5.40: Private DTW at Sherpur Upazila, Bogra**

**Figure 5.41: BMDA Solar DTW at Joypurhat District**

**Figure 5.42: Solar DTW at Birampur Upazila, Dinajpur**

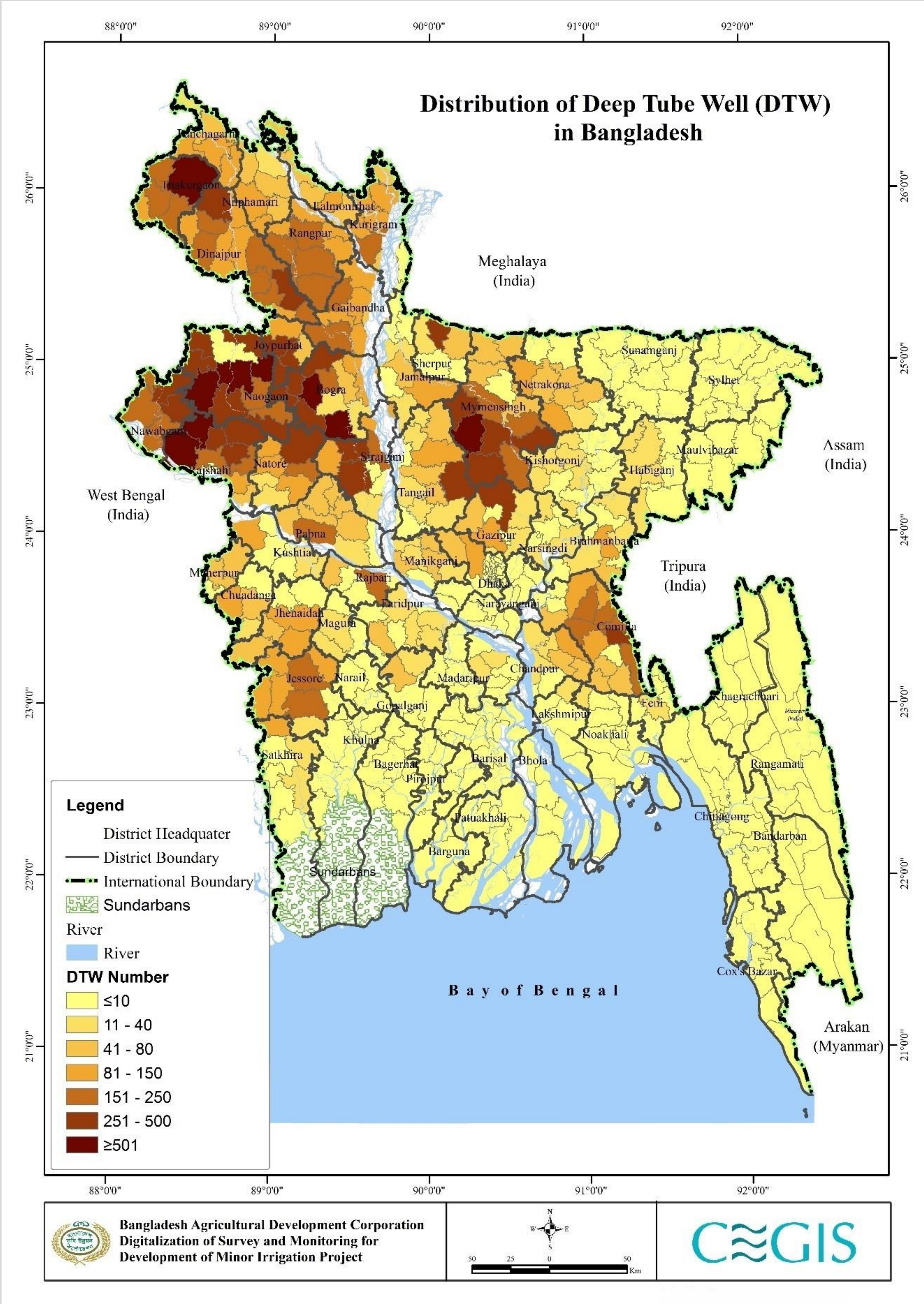


Figure 5.43: Distribution of DTW in Bangladesh

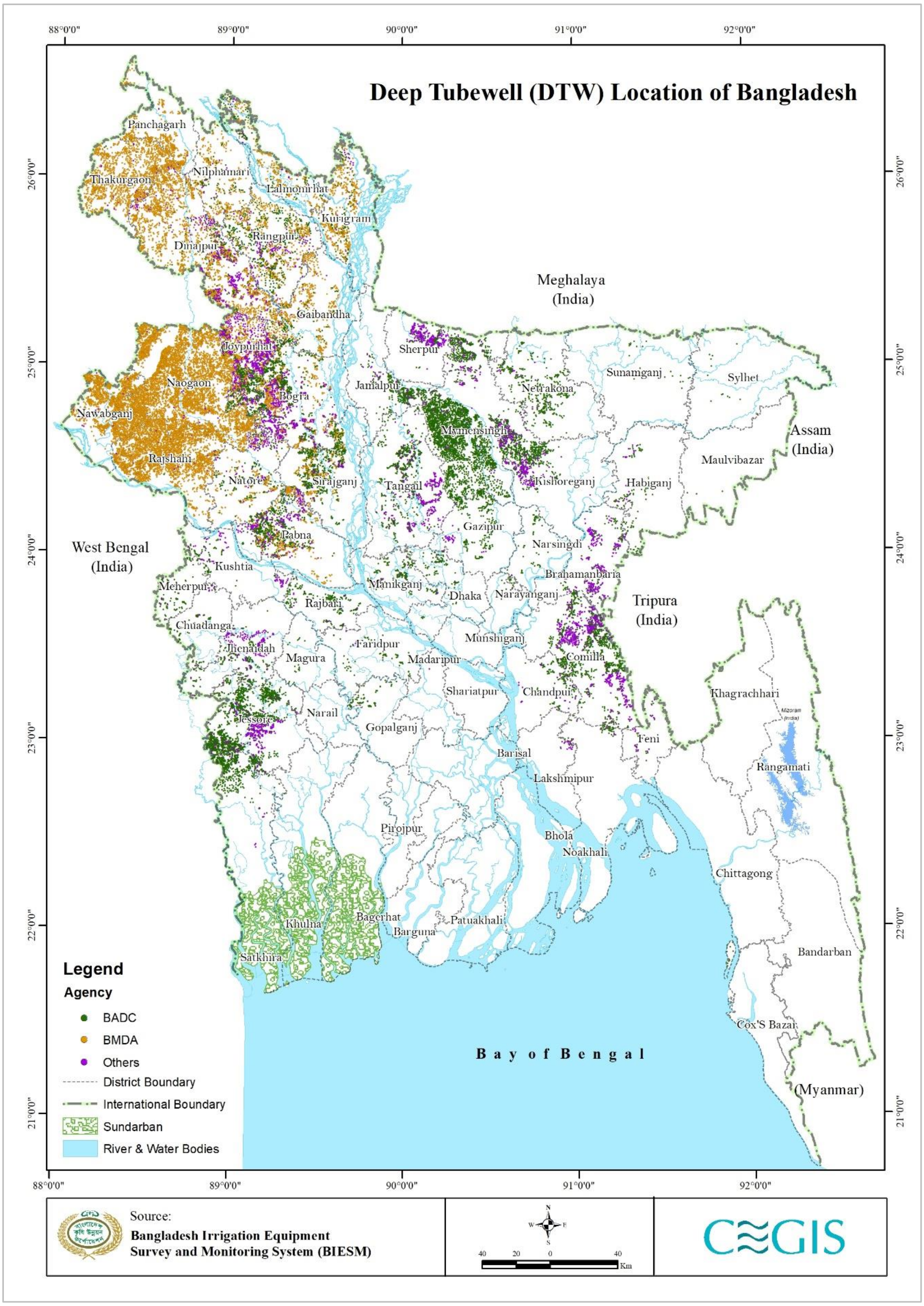


**Figure 5.44: Location of Deep Tubewell**

### *5.2.2 Shallow Tubewell*

Shallow tubewell (STW), mostly used for irrigation have 5.08-10.16 cm well diameter with a capacity of 10-21 liter/sec and abstract water from aquifer with the help of land based electrical/ diesel driven centrifuged pump when groundwater table lies within 7.0 m from ground surface. A total of 1.48 million shallow tubewells are operated in rabi season of 2023-2024. The irrigated area of shallow tubewell was about 3.09 million ha, 2.09 ha average per STW. About 74.22 percent of ground water irrigation is covered with Shallow Tubewells, which is 53.49 percent of total irrigated area of Bangladesh. Division-wise irrigated area coverage of STW is presented in **Table 5.5** and **Figure 23**.

**Figure 5.45: Shallow Tubewell at Hossainpur Upazila, Kishoreganj**

**Figure 5.46: Electrified Shallow Tubewell at Sadar Upazila, Mymenshigh**

**Figure 5.47: Shallow Tubewell (pit) at Patnitola Upazila, Naogaon**

**Figure 5.48: Shallow Tubewell with Fita pipe at Sadar Upazila, C. Nawabganj**

**Figure 4.49: Portable Solar system for STW operated by BADC at Char area of Rangpur**

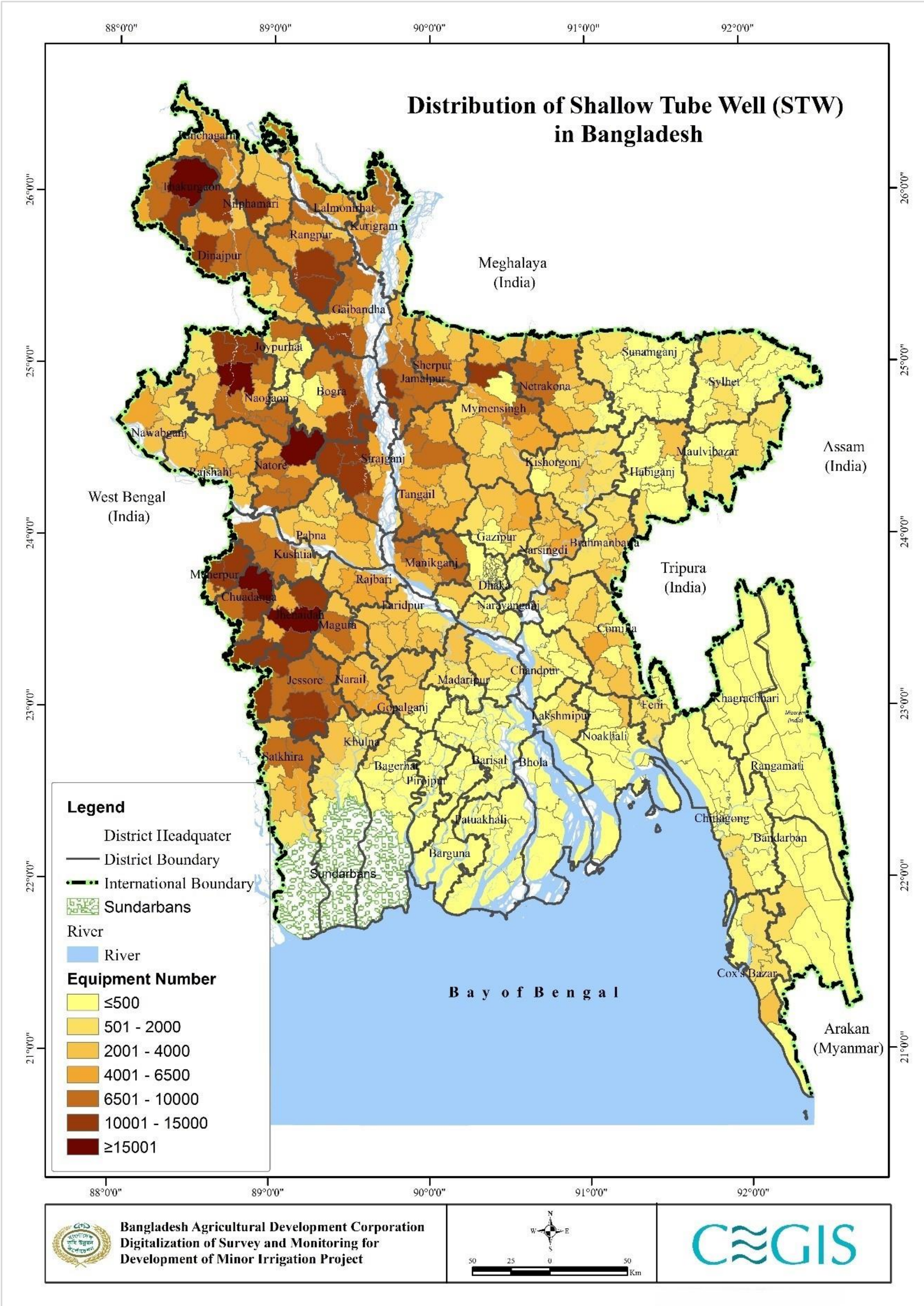


**Figure 5.50: Distribution of STW in Bangladesh**

### *5.2.3 Dug well*

Dug well is a well for lift water, constructed by excavating a large-diameter (mostly 122-132 cm) and installing a casing with opening. Water pumped from the well by an electrically operated submersible pump. Rain water is harvested and stored in dug well by a funnel-type structure with solar panel placed on the upper face of the structure. In recent years, dug well irrigation is becoming popular adoptive options in the water-scarce areas especially in Barind Tract, hilly and vegetable growing areas. A total of 930 Dug wells are operated in rabi season of 2023-2024.

**Figure 5.51: BADC Solar operated Dug well at Gangni Upazila, Meherpur**

**Figure 5.52: BADC Solar operated Dug well at Pakundia Upazila, Kishoreganj.**

**Figure 5.53: BADC Solar operated Dug well at Alamdanga, Chuadanga.**

**Figure 5.54: BMDA Solar operated Dug well at Bagatipara Upazila, Natore**

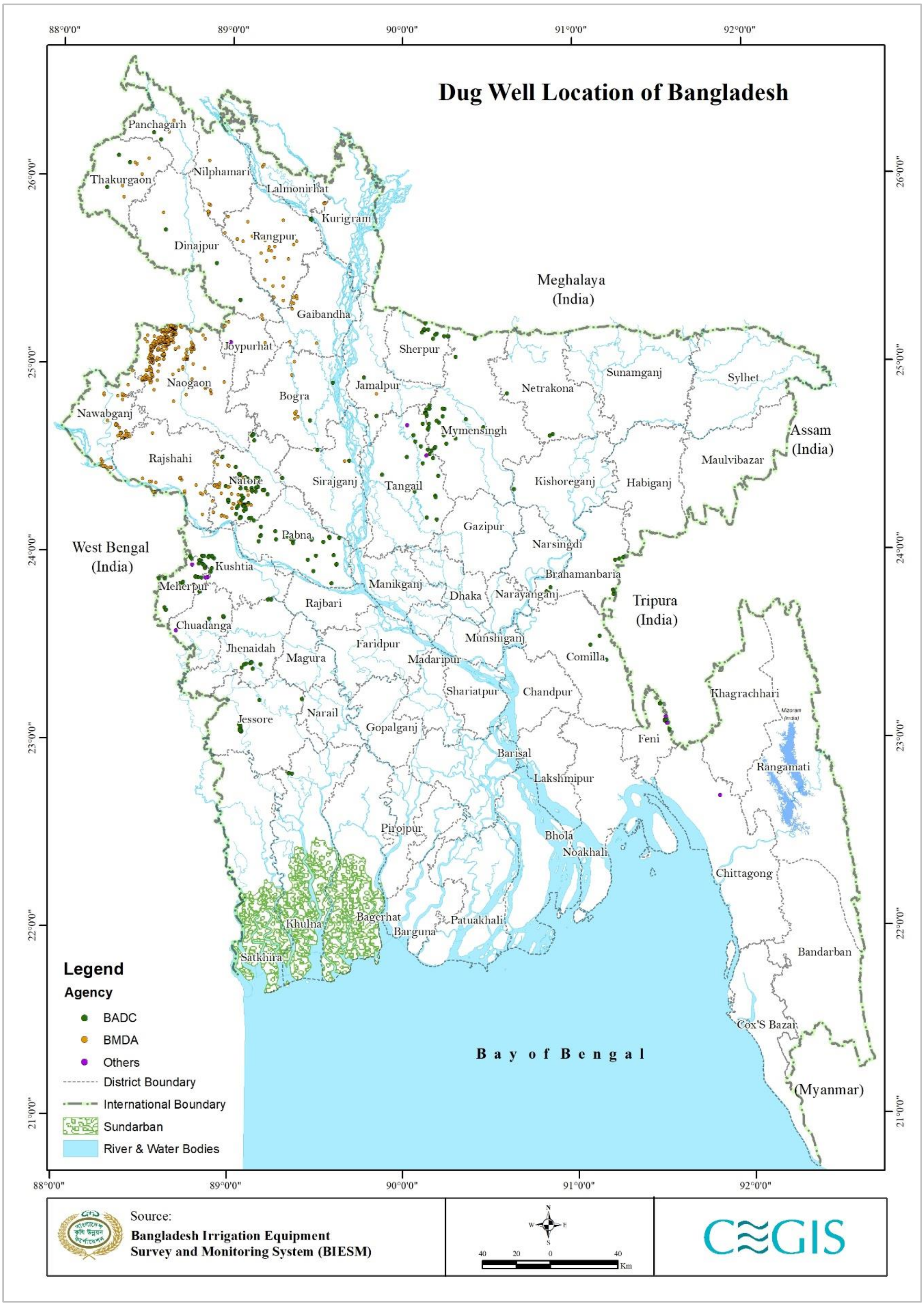


**Figure 5.55: Location of Dug Well**

### *5.2.4 Manually Operated Pump in well*

Manual irrigation systems are easy to handle, require no technical equipment and are therefore generally cheap. But these types of pumps need high labor inputs. A common and very simple technique for manual irrigation is Treadle pump, Diaphragm Pump, and Hand Pump etc. These types of pump mainly used for low water demand crops in small farm land.

**Figure 5.56: Treadle Pump**

**Figure 5.57: Diaphragm Pump**

**Figure 5.58: Hand Pump**

### *5.2.5 Artesian well*

A water table higher than the well ensures water pressure will consistently force water from an artesian aquifer. An artesian aquifer is an underground layer which holds groundwater under pressure. This causes the water level in the well to rise to a point where the pressure is equal to the weight of water putting it under pressure. Water may even reach the ground surface if the natural pressure is high enough, in which case the well Is called a flowing artesian well. An aquifer is a geologic layer which can hold water such as sand and gravel, limestone, or sandstone, through which water flows and is stored. An artesian aquifer is trapped between rocks or clay which causes pressure. Water returns to the aquifers when the water table at Its recharge zone is at a higher elevation than the head of the well.

**Figure 5.59: Artesian well, BADC**

**Figure 5.60: Artesian well, Private**

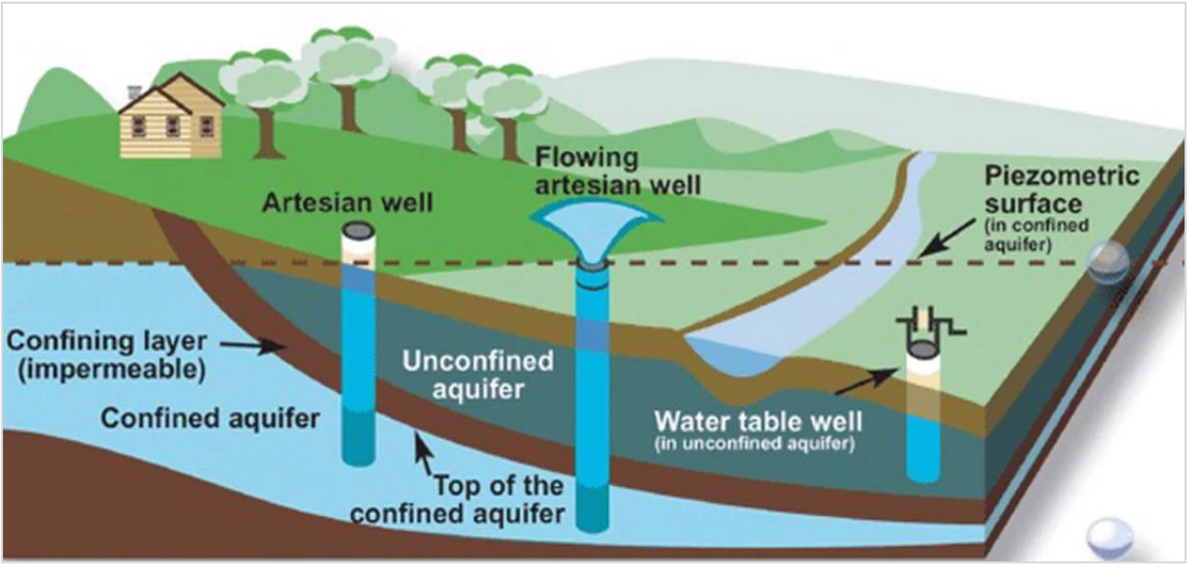


**Figure 5.61: Diagram of Artesian Aquifer**

## 5.3 Power Source

During the 2023-24 Rabi season, 1720674 number of power operated irrigation equipment are used all over the country. Power-operated equipment's are operated either by diesel or electricity. Recently solar energy is used to generate electricity to operate the small capacity irrigation pumps. A total of 4058 solar-powered equipment was found, including Dug-well 930. The survey has been made to determine number of diesel or electricity-operated various types of equipment's used all over the country. Irrigation equipment based on Power Source are shown in **Table 5.6** and graphical presentation in **Figure 58**

**Table 5.6: Division Wise Irrigation Equipment and Irrigated Area based on Power Source**

| Division | Electric | | Diesel | | Total | |
|---|---|---|---|---|---|---|
| | Number | Area (ha) | Number | Area (ha) | Number | Area (ha) |
| Dhaka | 85,604 | 344,440 | 151,040 | 406,228 | 236,644 | 750,668 |
| Mymensingh | 75,316 | 309,222 | 126,173 | 301,801 | 201,489 | 611,023 |
| Rajshahi | 108,387 | 769,534 | 226,889 | 435,306 | 335,276 | 1,204,840 |
| Rangpur | 114,230 | 507,966 | 287,364 | 545,817 | 401,594 | 1,053,783 |
| Chittagong | 46,456 | 285,260 | 82,591 | 299,014 | 129,047 | 584,274 |
| Khulna | 49,524 | 227,089 | 268,140 | 513,214 | 317,664 | 740,303 |
| Sylhet | 11,261 | 61,014 | 60,595 | 299,487 | 71,856 | 360,501 |
| Barishal | 1,702 | 21,191 | 25,402 | 157,920 | 27,104 | 179,111 |
| **Total** | **492,480** | **2,525,716** | **1,228,194** | **2,958,787** | **1,720,674** | **5,484,503** |

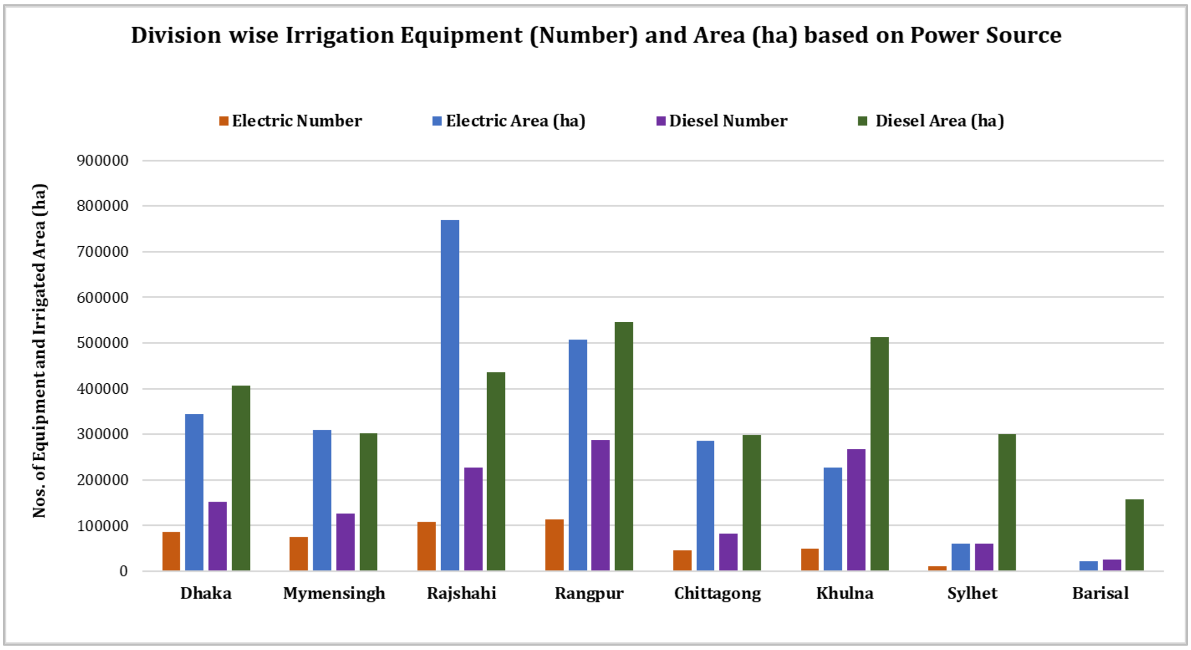


**Figure 5.62: Bar Diagram showing Number of Electrical and Diesel Operated Equipment's and Irrigated Area (ha) in Rabi 2023-24**

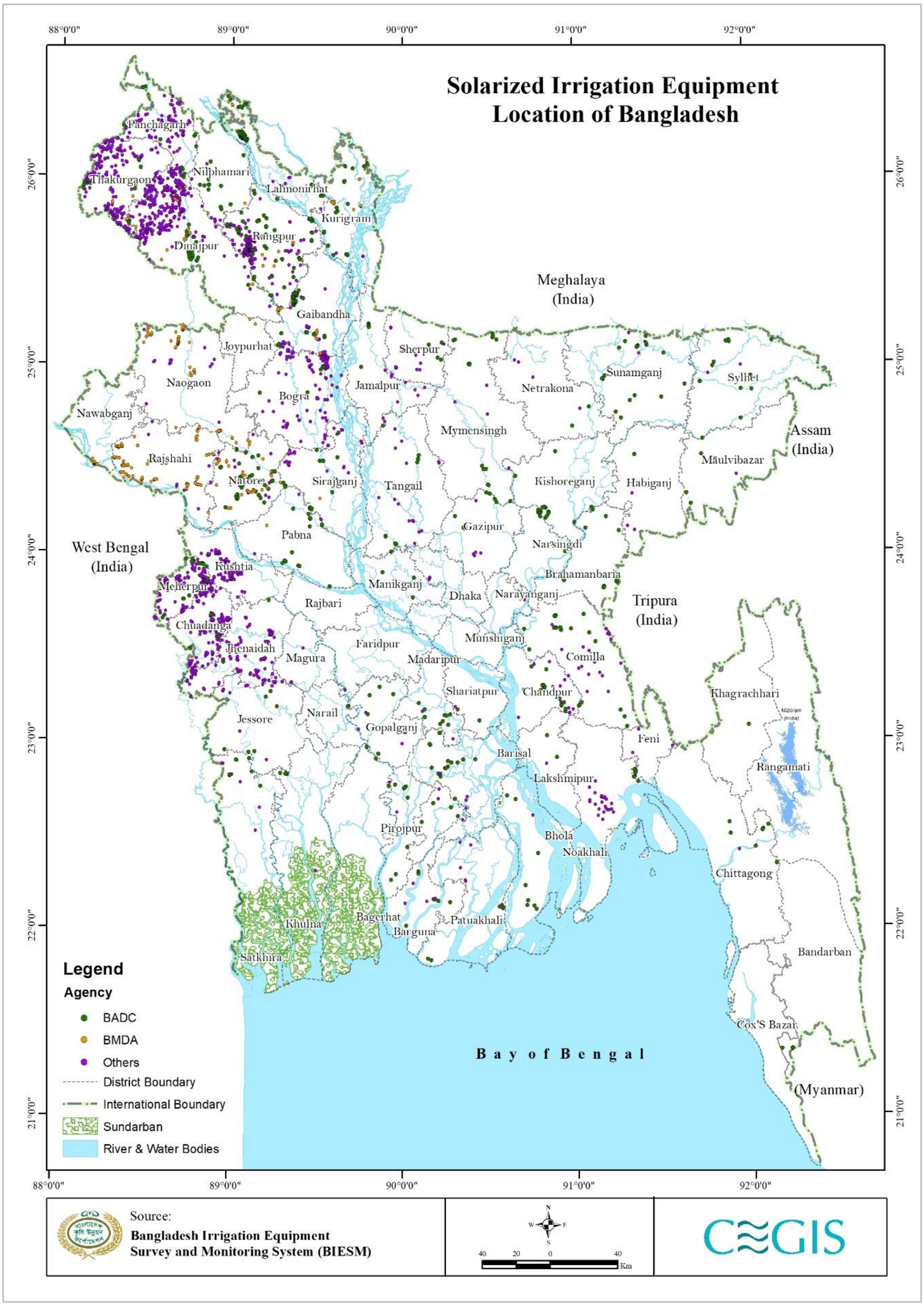


**Figure 5.63: Location of Solar Irrigation Equipment**

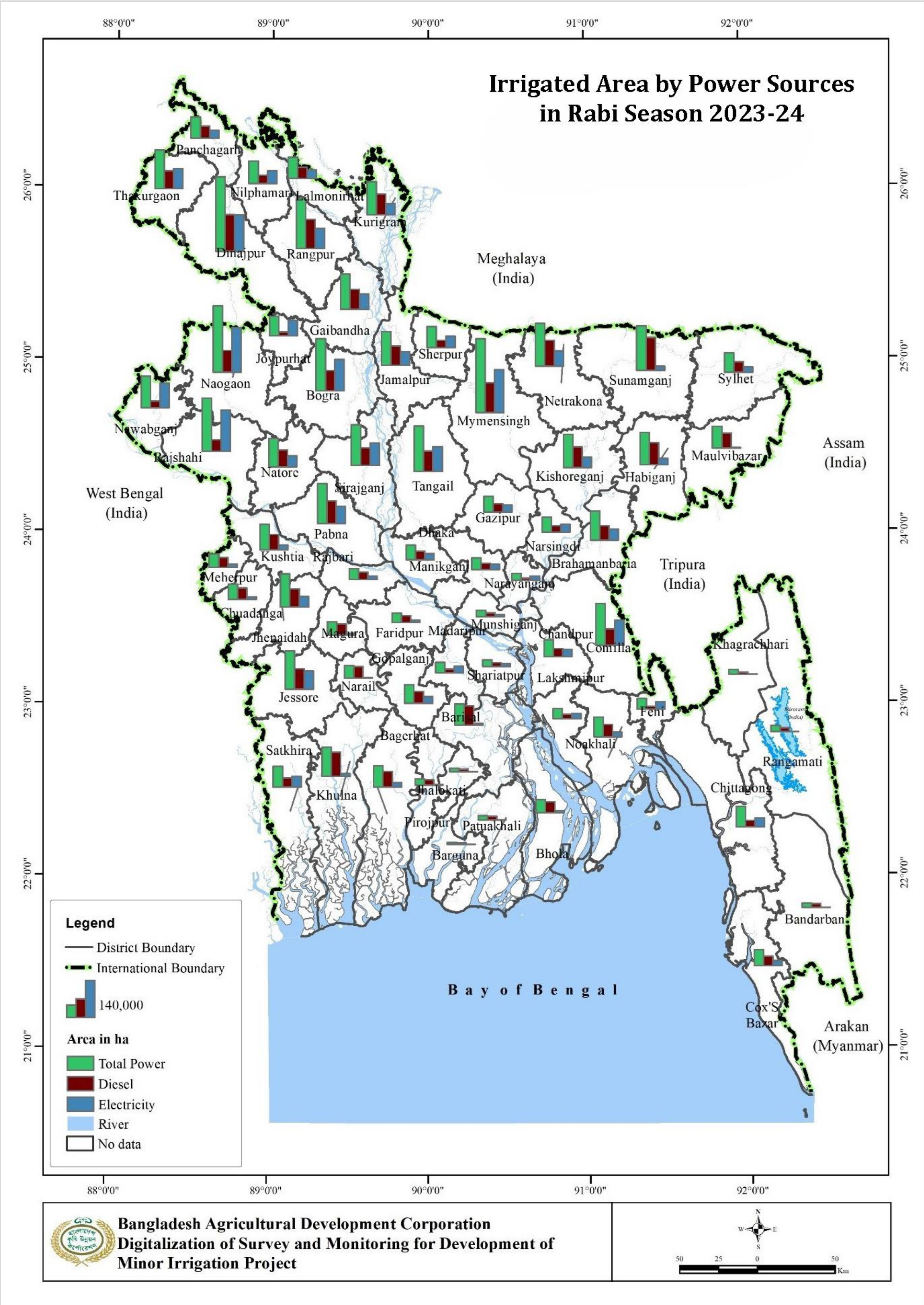


**Figure 5.64: Irrigated Area by Power Sources**

## 5.4 BIESM

Since 1999, BADC has conducted surveys and monitored several aspects of the country's agricultural sector, including pump capacity, source of power, irrigation mode, irrigated area, irrigation equipment, and benefits to farmers. Enumerators and field staff from BADC, BMDA, and DAE were appointed in order to carry out the survey. The government and legislators have received technical support and recommendations for the development and implementation of minor irrigation policies through the publication of Annual Survey Reports based on the data gathered over the past 22 years.

The preparation of a GIS database, which includes maps and 3D geometrical maps for surface water and ground water sources of irrigation, is crucial in the age of digitization for processing, preserving, or storing the aforementioned collected information and data. Additionally, web-based software development and database creation are essential for surveying and monitoring minor irrigation activities. Primary information such as tables, graphs, maps, and GIS databases are required for updating database.

Digitalization of Survey & Monitoring for Development of Minor Irrigation Project under BADC has been taken a program named Irrigation Equipment Survey & Monitoring System to establish a database on about 1.72 million irrigation equipment through questionnaire incorporated with 49 columns needful information's and also develop a web base software to meet necessary queries about irrigation. Under this program, BADC appointed CEGIS a trusty board of the Water Resources Ministry as a consulting firm to accomplish the above assignment. Under this task, the database and Bangladesh Irrigation Equipment Survey and Monitoring System (BIESM) software were prepared. Although the database has a compact and unique dataset but it still needs some attention interims of data consistency. Moreover, a few more features have been suggested by experts and stakeholders during the disclosure meeting. Therefore, an updating has been carried out to strengthen the database as well as the BIESM software.

In 2021-2022, The Bangladesh Irrigation Equipment Survey and Monitoring System (BIESM) software were update with all DTW, rubber dam, solar pump (DTW, STW, LLP) and dug-well location data. The Suggestion of experts and BADC officials were also incorporated in the software.

During 2022-2023, the BIESM software is updated with all low lift pump those where buried pipe line installed, rubber dam, solar pump (DTW, STW, LLP), floating pump and dug-well location data as per ToR. With this location data BIESM software also updated with collected details data of minor irrigation equipment, which is required to publish as Minor Irrigation Report 2022-2023. The searching option of software is updated. The region office of BADC is added in the searching option. Except this the yearly data was also separated and past year data can be finding out by this BIESM software. The report is also updated with new picture, graph, map and arrangement. The reporting system of BIESM is also updated in this phase. Now user can generate all kind of irrigation data related pie chart, graph, table up to union or mouza level.

The updated software has all the datasets to meet any queries about irrigation. It has also had the ability to analyze data and present it to the audience. The homepage is presented in **Figure 5.65**. Each user must have a password and user ID in order to log in to this software **Figure 5.66**. The database has four major modules that are presented in **Figure 5.67.** As mentioned earlier, a number of data and information will be available for any user which is ranging from equipment type and location to benefited farmer and labor level data **(Figure 5.68)**. Data was collected by 49 columns questionnaire to gather all the information related to irrigation and every specific equipment **(Figure 5.69)**. A glimpse of the analysis capacity of the software is presented in **Figure 5.70**. Some unique features are added to this software. These are- i) irrigation equipment data could be visible with its picture and brief information **(Figure 5.71),** ii) Overall irrigation equipment and related information could be viewed even at union level **(Figure 5.72)**, iii) distance between the equipment is being measured **(Figure 5.73)**.

In this year 2023-2024, database is update with some new features. These are- i) to monitor user level information, a user log-in system is introduced, ii) Administrative data is updated as per present administrative unit, iii) Those LLP scheme where buried pipe line installed, iv) Solar and Dug well scheme of BADC, BMDA, SREDA and other agencies, v) Location of Floating pumps and Rubber dam is also updated etc.


**Figure 5.65: Homepage of BIESM software**

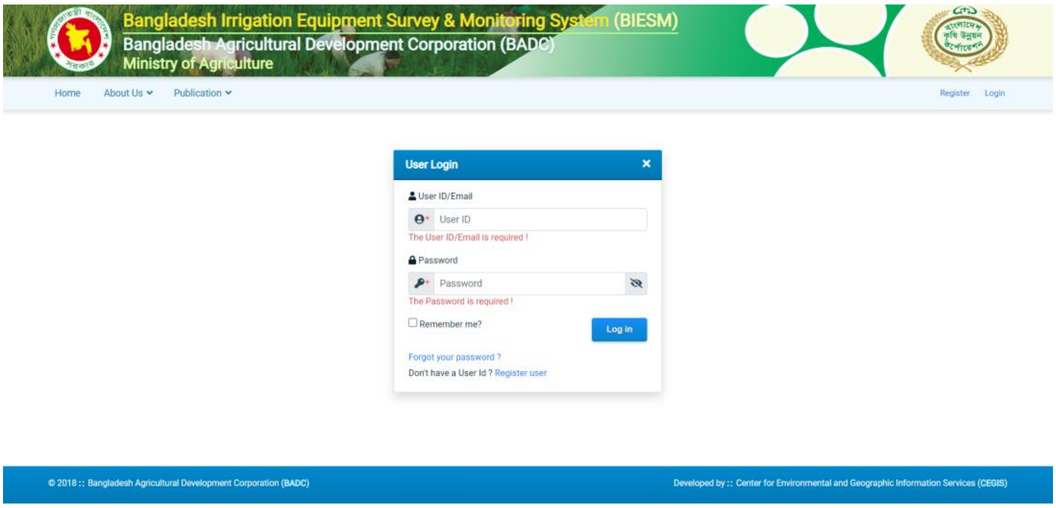


**Figure 5.66: User Login page of BIESM software**

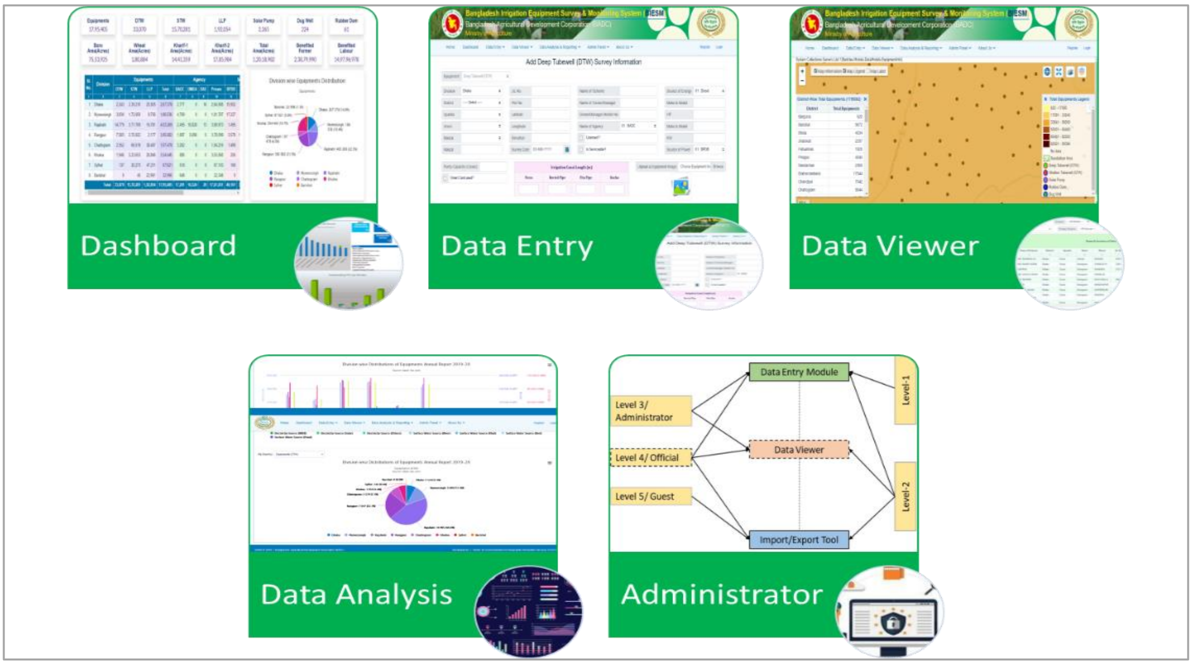


**Figure 5.67: Modules of the BIESM software**

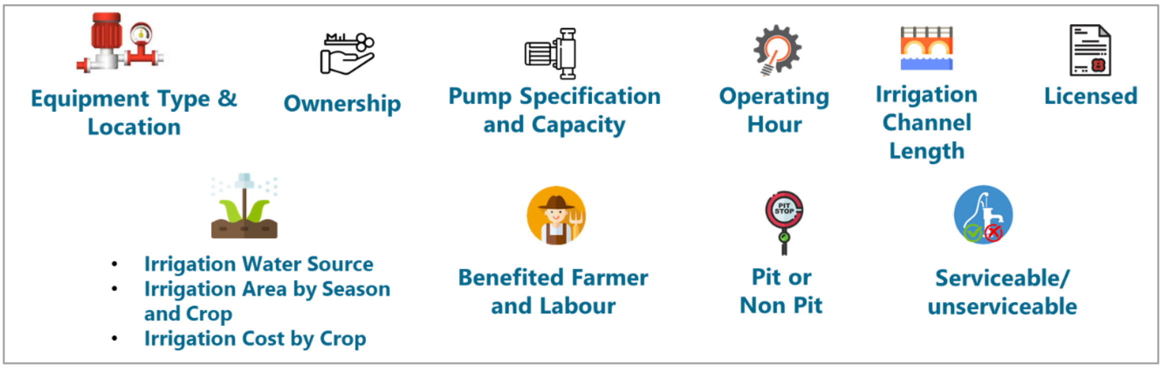


**Figure 5.68: Information of software at a glance**

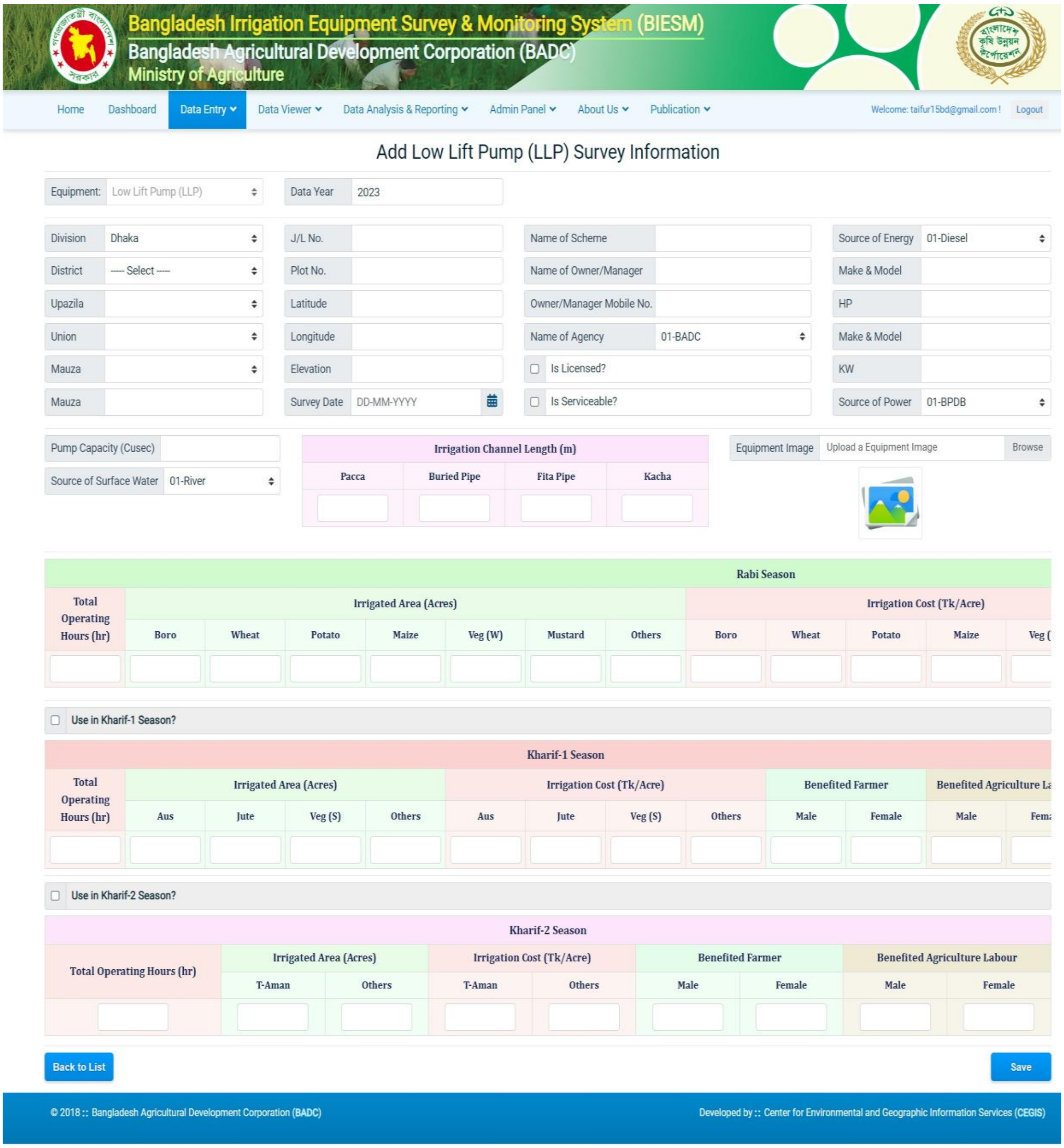


**Figure 5.69: Data entry form for BIESM software**

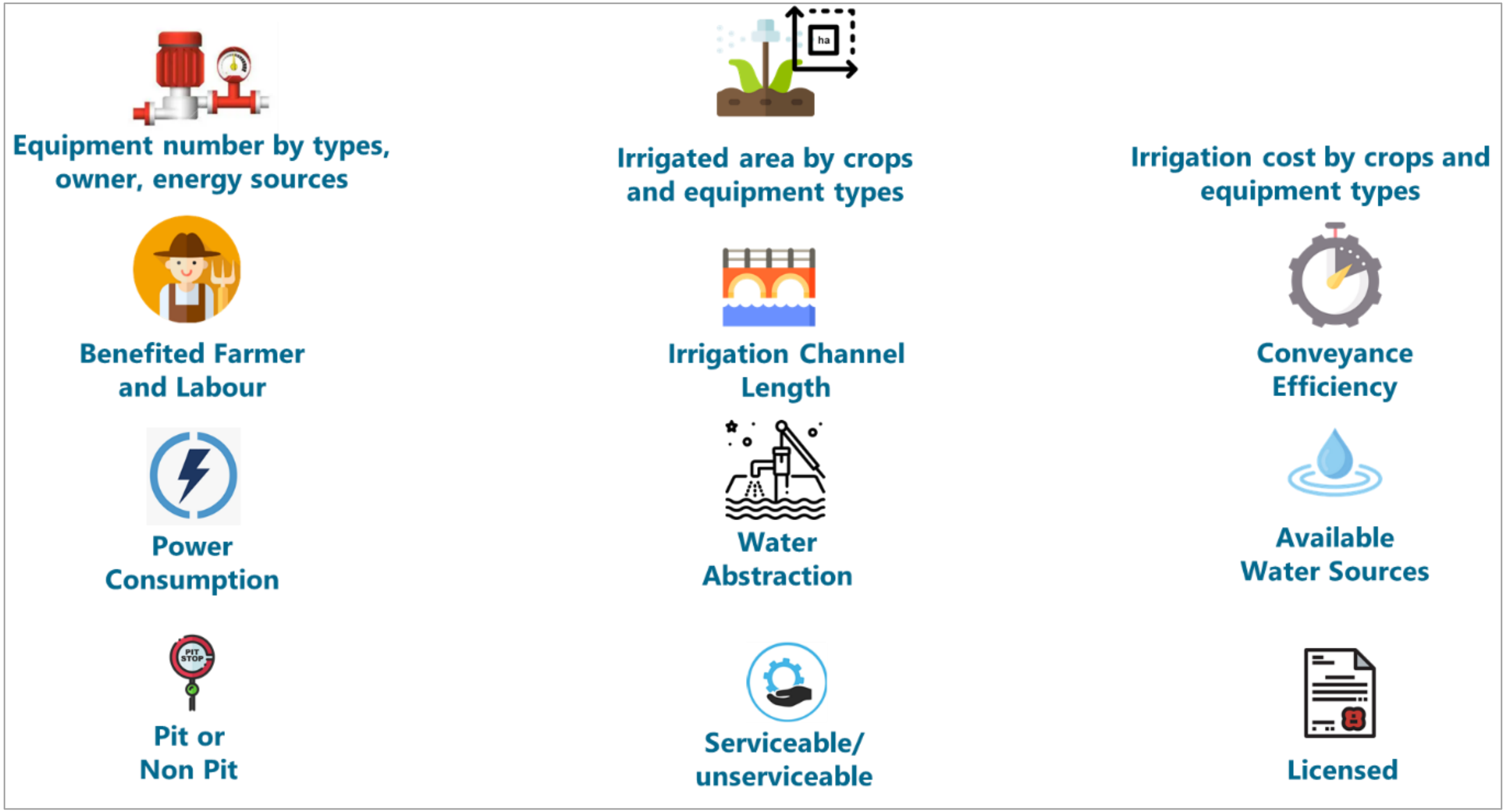


**Figure 5.70: Brief Data analysis capacity of BIESM software**

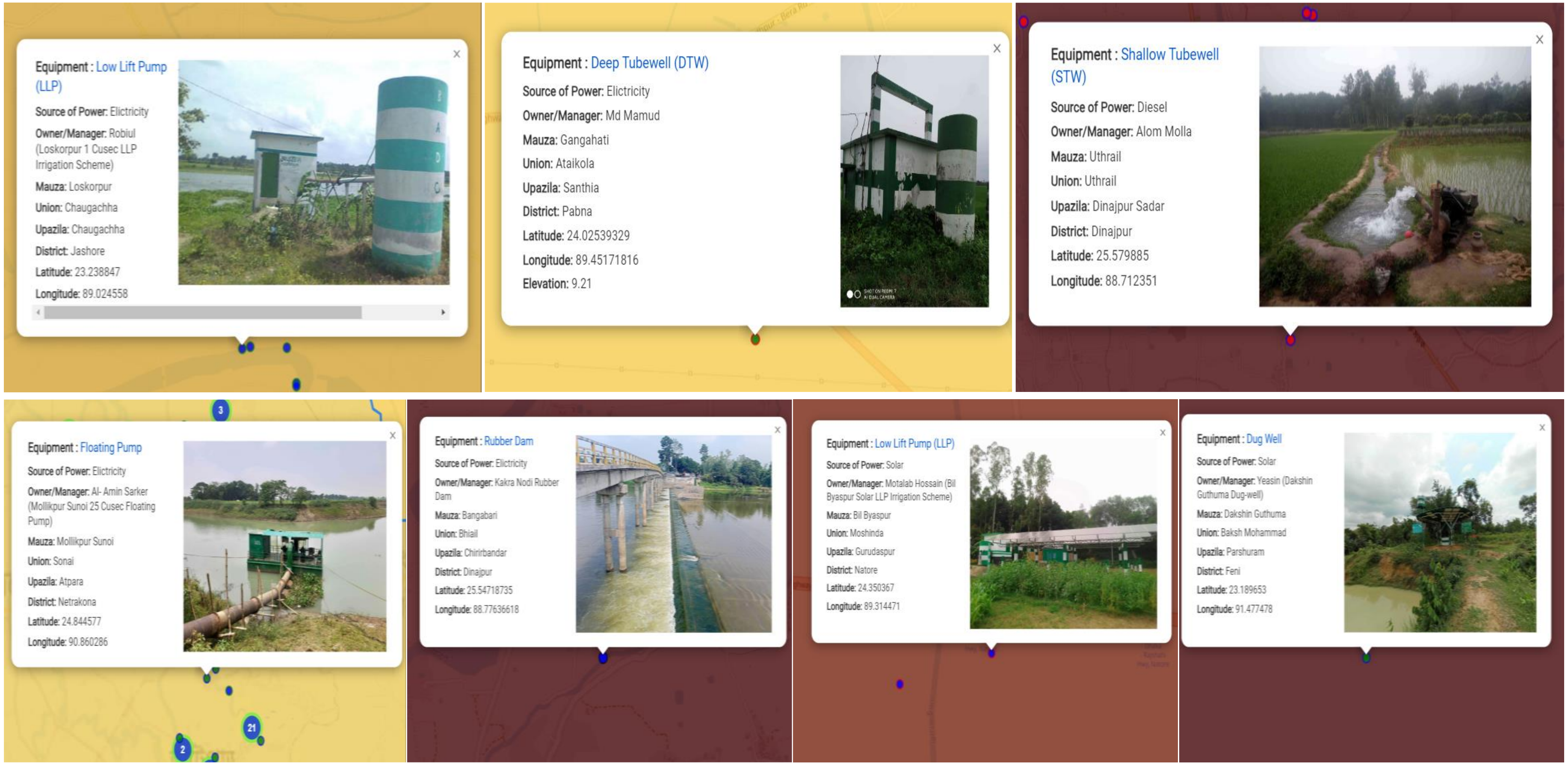


**Figure 5.71: Location information extracted from BIESM software**

Union Wise Survey Information data source

| | | |
|---|---|---|
| **01. Division** | : | Rajshahi |
| **02. District** | : | Rajshahi |
| **03. Upazila** | : | Godagari |
| **04. Union** | : | Gogram |
| **05. Rivers Name** | : | Ganges |
| **06. Rivers Length(Km)** | : | **2.10 (Km)** |
| **07. Waterbodies Name** | : | Patikhola Beel |
| **08. Waterbodies Area(ha)** | : | **1.12 (ha)** |

| Equipment Name | Equipment (Count) | Irrigated Area (Acre) | | | | | | | | Irrigation Cost (Tk/Acre) | | | | | | Benefi Farm (Cou |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Boro | Wheat | Potato | Maize | Mustard | Veg (W) | Other4 | Total | Boro | Wheat | Potato | Maize | Veg (W) | Other4 | |
| Deep Tubewell (DTW) | 75 | 2,538.20 | 725.20 | 1,159.20 | 323.40 | 0.00 | 472.85 | 182.00 | 5,400.85 | 5,976.55 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3, |
| Shallow Tubewell (STW) | 420 | 300.64 | 87.35 | 138.35 | 37.20 | 14.00 | 55.72 | 22.26 | 655.52 | 11,056.06 | 2,064.94 | 2,665.22 | 1,959.31 | 2,239.66 | 2,564.80 | 2, |
| Low Lift Pump (LLP) | 151 | 531.89 | 153.00 | 242.21 | 65.24 | 0.00 | 101.05 | 39.26 | 1,132.65 | 11,476.98 | 1,924.10 | 2,510.26 | 1,981.76 | 2,111.96 | 2,101.34 | 1, |
| **All Equipments** | **646** | **3,370.73** | **965.55** | **1,539.76** | **425.84** | **14.00** | **629.62** | **243.52** | **7,189.02** | **7,297.55** | **491.70** | **634.35** | **474.77** | **537.16** | **573.22** | **7,** |

Close

**Figure 5.72: Union level data extracted from BIESM software**

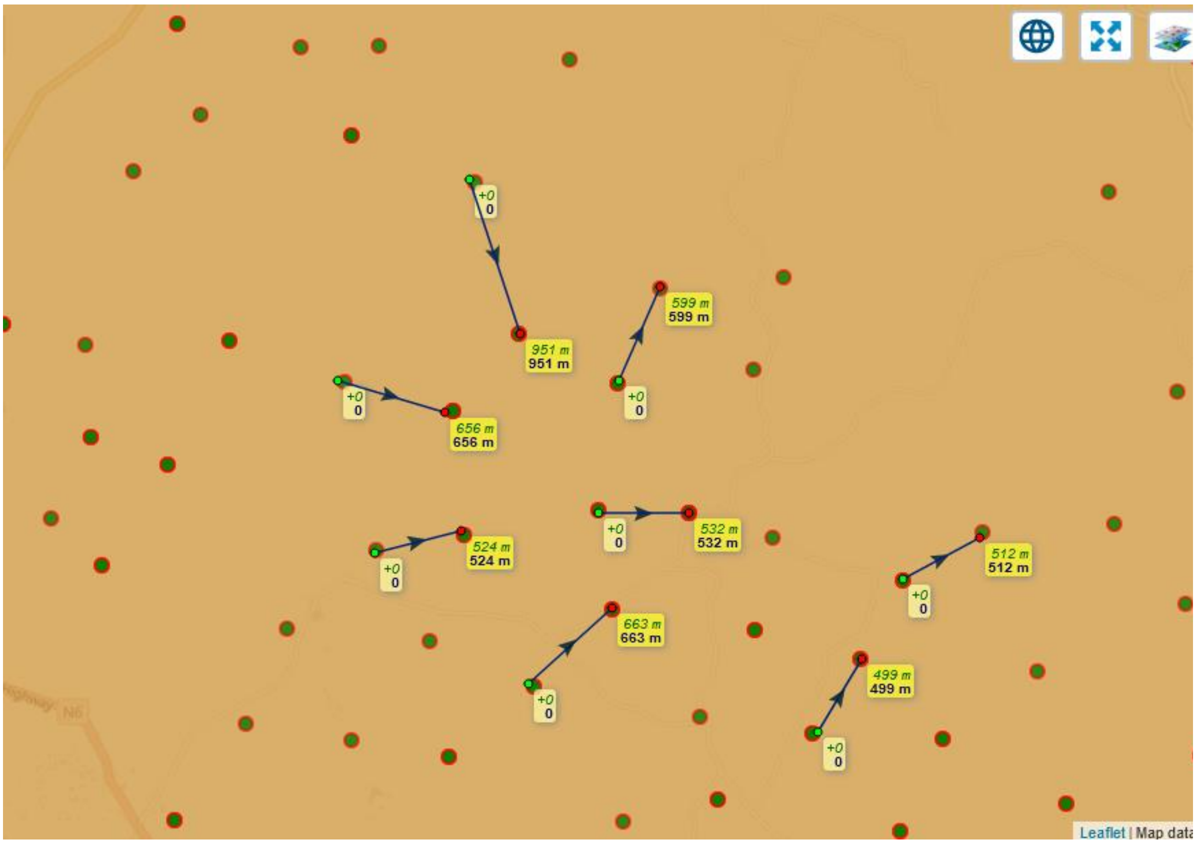


**Figure 5.73: Distance measurement between irrigation equipment from BIESM software**

# 6. Conclusion

This survey's primary goal was to determine the number of different irrigation equipment in use, the area that was irrigated, and the beneficiaries. BADC, DAE, BMDA and CEGIS-appointed field staffs are collected the information. We are aware that the lack of a set technique for calculating the area made it very difficult to determine the area accurately. Thus, information was gathered by interviewing with farmers who might benefit from the equipment and by the owners' statements. It is claimed that the amount of land that is irrigated per piece of equipment can differ depending on the equipment capacity, conveyance system, the location as well as type of irrigated crop.

The main findings of this survey report are:

- In the 2023-24 Rabi season, total irrigated area was 5.77 million ha, of which groundwater irrigation covered 4.16 million ha (72.07% of the total irrigated area); while surface water irrigation covered 1.61 million ha (27.93% of total irrigated area). To compare with the previous year, Surface water used for irrigation is increased in the Rabi season.
- During the Rabi 2023–2024, there was a noticeable increase in the use of low lift pumps (0.40%), shallow tube wells (0.12%), and deep tube wells (0.21%) in comparison to the previous year.
- The irrigated area increased by 0.36% in Rabi 2023–2024 over the previous year.
- About 97.71% (33,261) DTWs were operated by electric motors and 2.29% (779) DTWs were operated by diesel engines. In case of shallow tube wells, 29.48% (436,116) STWs were operated by electric motors and 70.52% (1,043,150) STWs were operated by diesel engines.
- Low Lift Pumps were mainly operated by diesel engines, which is 88.86% (184,265) and the rest were operated by electric motors, which is only 11.14% (23,103).
- The average area under each low lift pump was 6.51 hectares, 2.09 hectares for STW, and 30.79 hectares for DTW.

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