Final Report
on

Development of Digital Elevation Model (DEM) and delineation of Catchment boundaries for Polder 22 of Blue Gold Program

Khulna O&M Division



November 2016
Dhaka

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1. Introduction

1.1 Background of the Study

The coastal region of Bangladesh is regarded as a zone of multiple vulnerabilities. About 38% of the population in this region live below the poverty line and face high vulnerabilities in terms of insecurity of food, income, water and health. Water is the blessings as well as curse for the coastal population. Management of this natural resource is very crucial for achieving wellbeing of the coastal population. Participatory water resources management is successfully operating in coastal area of Bangladesh by BWDB, where Government of the Netherlands (GoN) participates as a development partner. Blue Gold is a collaboration program between the Government of the Netherlands (donor) and the Government of Bangladesh which is undertaken to uplift the socio-economic status of households living in coastal polders and its surroundings.

Blue gold is such a project of GoN and GoB which emphasizes active involvement of rural communities concerned and other stakeholders. Under the Blue Gold project the consultant Euroconsult Mott MacDonald assigned CEGIS to prepare Digital Elevation Model (DEM) and catchment boundaries for seven polders in Patuakhali and Khulna Districts. Under this project CEGIS has been assessed certain parameters, (topography, hydrology, drainage system, interventions and cropping practice) that usually govern overall drainage and hydrological dynamics within the polders.

1.2 Study area

Polder 22 is a part of the study area (Figure 1.1) which is located in Deluti union under Paikgachha upazila of Khulna district. The geographical coordinates of the polder ranges from 22°35’03.3”N to 22°38’39.3”N as latitudes and 89°24’24.6”E to 89°27’32.2”E as longitudes. The Polder 22 is 75 km away from the Bay of Bengal and it undergoes tidal influence. The polder is surrounded by Bhadra and Habrakhali rivers. The gross area of the polder is 1,485 ha including Net Cultivable Area (NCA), rivers and water bodies, settlements and roads.

1.3 Objectives

The overall objective is to assess the existing condition of topography, hydrology, drainage system, interventions and existing cropping practice of selected polders coastal areas of Bangladesh.

Specific objectives:

The specific objectives of the study are:

- To identify detail topographic features, landforms and elevation;
- To assess the drainage pattern and tidal dynamics within the delineated catchment boundary;
- To identify the present condition of cropping pattern;

1.4 Scope of works

The scope of works as per the ToR is as follows:

- Digital Elevation Model development based on contour and point data from FINNMAP/BWDB Maps.
- Catchment area delineation including updated water management infrastructure layout along with roads and culverts/bridges.
- Tidal dynamics assessment around the polders and suggest drainage plans.

1.5 Deliverables and outcomes

As per the ToR and Scope of works a number of deliverables and outcomes identified. The major deliverables and outcomes are stated bellows:

- Inception Report
- DEM preparation & Elevation Mapping
- Catchment area delineation and detail mapping.
- Drainage pattern/direction maps
- Technical Report

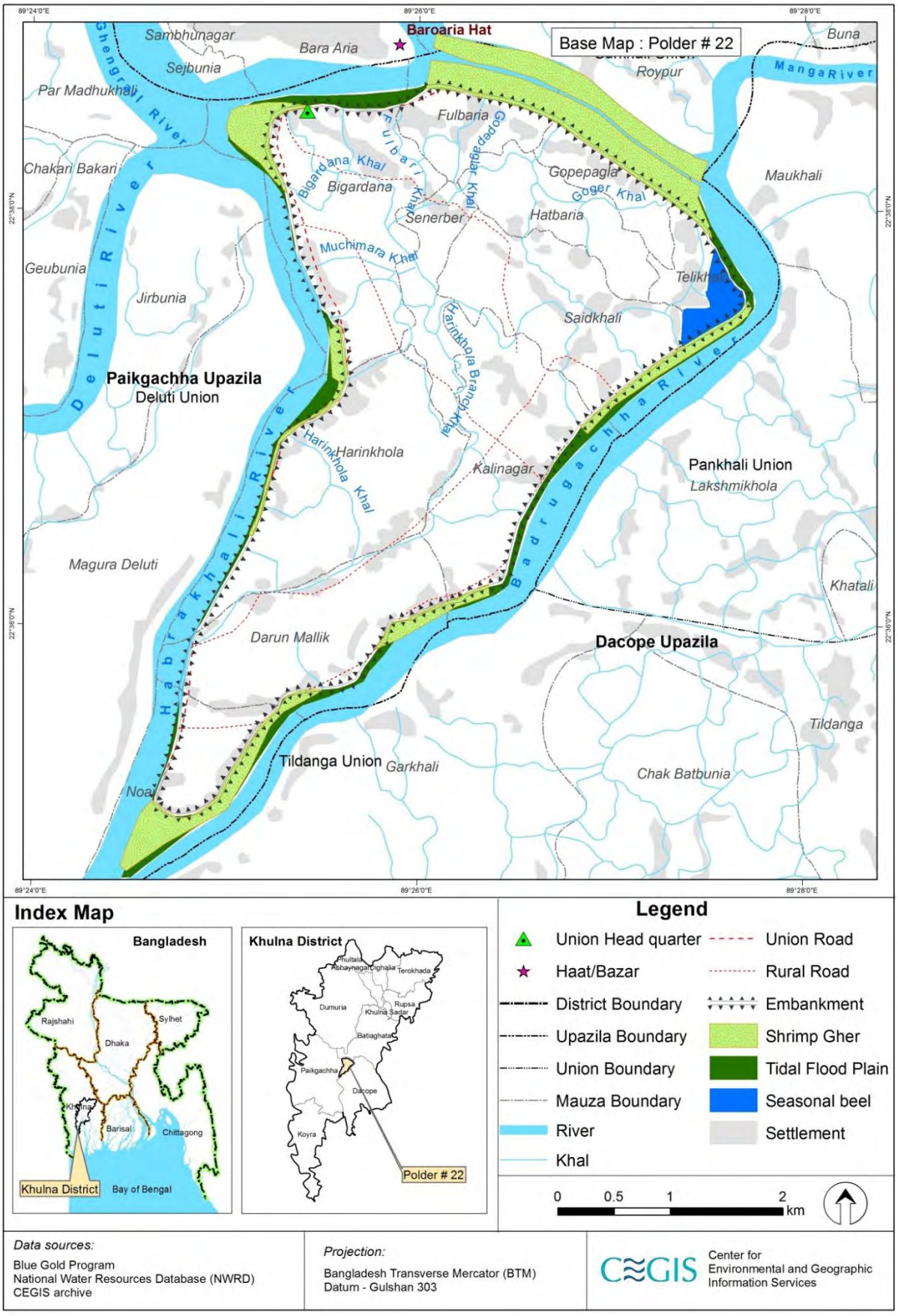

Figure 1.1: Study area of Polder 22

2. Approach and Methodology

2.1 Initial consultation meeting

At the inception phase all works have been identified and a step-by-step approach and methodology has been developed. The major activities are presented in Figure 2.1 and described in the following sections.

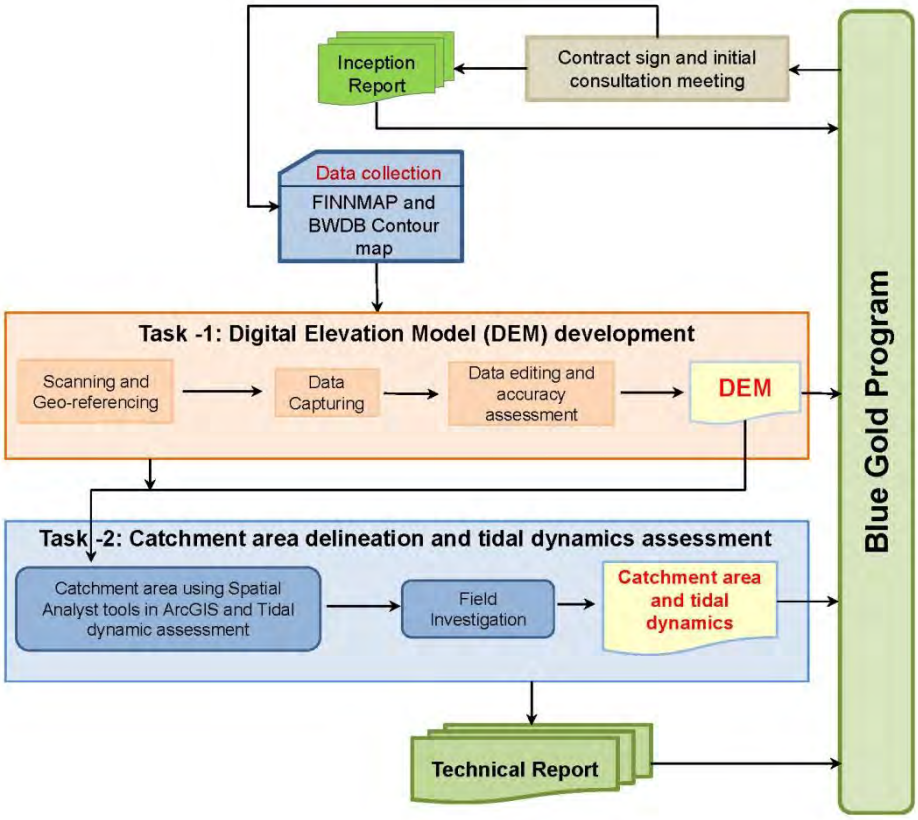

Figure 2.1: Overall methodology of the activities

2.2 Contract Signing

The contract was signed between Euroconsult Mott MacDonald and Center for Environmental and Geographic Information Services (CEGIS) on 27 March 2016. Mr. Guy Jones, Team Leader, Blue Gold Project and Engr. Md. Waji Ullah, Executive Director, CEGIS signed the contract.

2.3 Initial consultation meeting

After signing of the contact an initial consultation meeting was organized with the officials and relevant professionals of the client on 14 April 2016 to finalize the understanding of the requirements; identify the data sources, data format, spatial resolution, coordinate system, probable outcomes and priorities.

2.4 Inception Report

The Inception Report (this report) consists of detail activities, methodology, deliverables, and work plan for performing the project activities was prepared and submitted on 29 July 2016.

2.5 Data collection

The contours and spot elevations have been collected from FINNMAP. The FINNMAPs were published by Bangladesh Inland Water Transport Authority (BIWTA) in 1998 at 1:10000 scale. Twenty seven (27) numbers sheets have been collected under this study. The collected FINNMAPs are shown in Table 2.1.

Table 2.1: FINMAP collection from BIWTA

SL No.	FINNMAP	Number of Sheet
1	2450 – 520, 525, 530, 535, 540	5
2	2455 – 520, 525, 530, 535, 540	5
3	2460 – 520, 525, 530, 535, 540	5
4	2465 – 520, 525, 530, 535, 540	5
5	2470 – 525, 530, 535, 540	4
6	2495 – 435, 440	2
7	2500 - 440	1
Total		**27**

The contour intervals of FINNMAP is 0.25 m. East-west spacing of spot elevation is about 300 m and spacing in north-south direction is about 100m. Sample of a FINNMAP is shown in Figure 2.2. Rivers and khal networks will be digitized from these maps.

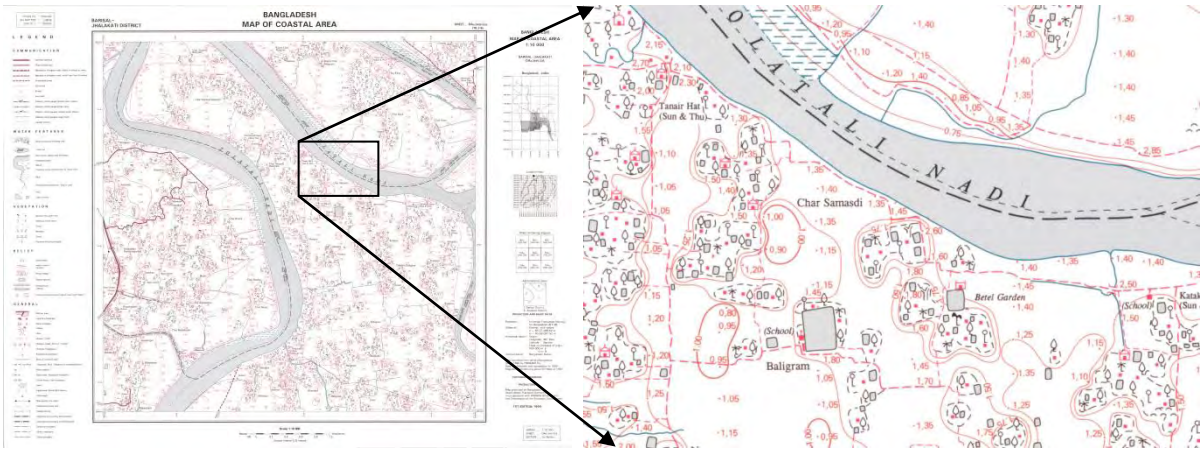

Figure 2.2 : Sample of BIWTA FINNMAP

2.6 Digital Elevation Model (DEM) development

2.6.1 Scanning and geo-referencing

All the collected FINNMAP sheets have been scanned using a high precision scanner at 300 dpi in JPG file format. The maps are scanned in such a way, that all the features are clearly visible and digitization done accurately. Geo-referencing are done using ArcGIS software.

Bangladesh Transverse Mercator (BTM) projection has been preferred by the client and used to geo-reference those images.

Projection parameters

Bangladesh Transverse Mercator (BTM) projection parameters will be used to geo-reference those images. The parameters of BTM projection are:

Projection Type	Transverse Mercator
Datum Name	Everest
Scale Factor at central meridian	0.99960000
Longitude of central meridian	90:00:00.000000E
Latitude of origin of projection	0:00:00.000000N
False easting	500000.000000 meters
False northing	-2000000.000000 meters

2.6.2 **Data capturing**

FINNMAP Maps are very reliable source for providing contour lines, spot height with fine details and accuracy. These data were captured from geo-referenced FINNMAP Maps. Settlement, detail roads network, rivers, khals, water bodies and water management infrastructure (Drainage and flushing regulators) were captured from these maps. The features were identified considering size, shape, pattern, texture and description available in the map.

2.6.3 **Data editing and accuracy assessment**

The good quality of the report was ensured from data accuracy, authentic source of information and inclusion of necessary parameters of accuracy. Data editing and accuracy assessment were carried out for quality output. The accuracy assessment was done through visual inspection and interpretation by comparing with the original FINNMAP maps. The contour values for each digitized map sheet were checked visually. GIS Expert and Quality Control Specialist were involved in accuracy assessment.

2.6.4 **Develop Digital Elevation Map (DEM)**

From the objectives it is clear that the study is deemed to be assessing topographic features, landforms, elevation, drainage patterns and tidal dynamics within the delineated catchment areas. The cropping patterns were assessed within all 7 polders. As per the undulating nature of the landform the drainage systems are governed. To get ideas about the landform variation within the study area appropriate Digital Elevation Maps were be prepared.

Original elevation of FINNMAP is in SoB datum, which is in Mean Sea Level (MSL). After capturing, the MSL values have been transferred to PWD datum. Roads and embankments are elevated based on the surrounding elevations and survey. The rivers, khals and other water bodies were lowered considering lowest elevation. Road were considered as dominant factor where khal are closed. Digital Terrain Model (DTM) were prepared using Spatial Analyst tool of ArcGIS. The DEM are prepared with 50m X 50m spatial resolution.

2.7 Field Investigation

After data capturing and initial assessment based on secondary data (FINNMAPs, Topo Sheet, Google Images and development of initial DEM) a field investigation were conducted to verify the collected ground information of flow pattern and structure with parameters. The field office of Blue Gold Project has identified consult to identify the available information and location of features in the field.

- Collection of detail information on Hydraulic structures (Drainage sluices, Outlets, Bridge and Culvert) in the study area.
- Flow direction and pattern assessment through visual inspection in stream and public consultation with local people for overland flow.
- Identify man made obstruction/barrier on the khal through visual inspection and satellite image
- Identify the location name, hat-bazars etc. through physical visit and public consultation.
- Considering all these collected information and knowledge gained from the BWDB officials, Blue Gold professionals, local people and direct field inspection were incorporated. These parameters are considered in DEM and catchment delineation.

Considering all these collected information and knowledge gained from the BWDB officials, Blue Gold professionals, local people and direct field inspection are incorporated. These parameter are considered in DEM and catchment delineation.

2.8 Catchment Area and tidal dynamics assessment

Catchment/watershed delineation is one of the most commonly performed activities in hydrologic analysis. A catchment of an outlet or pour point is the upslope area which drains its accumulated runoff through that point. Watershed delineation was performed with the Spatial Analyst Tools of ArcGIS using the Developed Digital Elevation Model (DEM) and rivers/khals network as inputs. All the watershed delineation steps such as filling sink, defining flow direction and accumulation will be done in ArcGIS using SWAT (Soil and Water Assessment Tool) hydrological model. Catchment wise drainage pattern and area elevation curves were derived from the DEM and watersheds.

CEGIS team installed ten (10) water level gauge stations to understand the tidal water level variations in and around the study area. Daily water level data at one (01) hour interval (from 6:00 AM to 6:00 PM) for 1 tide cycle (15 days) has been collected during monsoon. This water level data has been used to analyses the tidal dynamics.

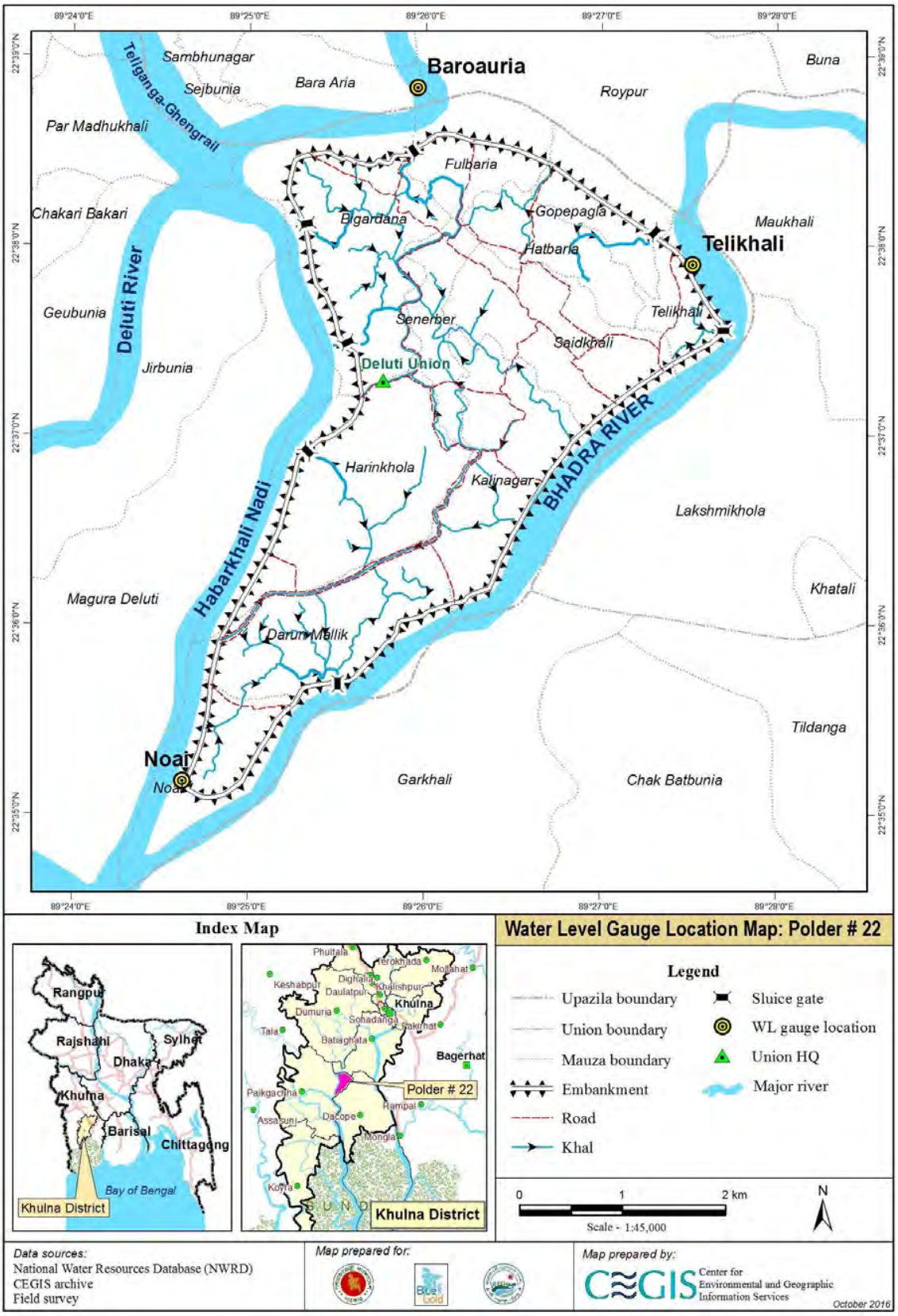

Figure 2.3: Water level gauge stations around the Polder 22

2.9 Catchment of Polder 22

In this study, for polder 22, Catchment has been delineated for two (02) drainage outlets. The drainage outlets were selected at two (02) hydraulic structure locations. Figure 2.4, 2.5 and 2.6 shows the Base map, Intervention with catchment and Digital Elevation Model (DEM) map of Polder 22. Area of each catchment boundary has been presented in Table 2.2. From the Figure 2.5 and Table 2.2 shows that catchment of Durgapur Sluice is the largest catchment which is about 873 ha.

Table 2.2: Drainage outlet/ hydraulic Structure wise drainage catchment for polder 22

Description of Catchment 1

Catchment Name	Cat – 1 (Darun Malik Catchment)
Location (mauza wise)	Harinkhola (247 ha), Darun Mallik (174 ha), Kalinagar (86 ha) and Noai (61 ha)
Catchment area (ha)	587 ha
Drainage Outlet	Darun Malik Sluice at Ch. 4+483 km (1V- 1.5 m X1.8 m), Harinkhola outlet at Ch. 10+180 km (0.9 m dia)
Main Drainage Canal	Darun Malik khal, Harinkhola khal
Land elevation of Catchment (m PWD)	Max: 2.82 Min: 0.77
Length of Stream within catchment (Km)	16.056
Drainage Density (m/ha)	27.35
Catchment Description	➢ *Outfall* • Outfall Khal: **Badurgachi River** Condition: **Active** ➢ *Condition of Drainage Khal* • Main drainage Khal: **Active** • Branch khal: **Partially** silted up (**Harinkhola khal** has been re-excavated during 2015) ➢ *Drainage Congestion* • Drainage congestion problem: **Minor** (usually takes 2-3 days to properly drain out rain water) • Permanent Water logging: **Not found**. ➢ *Agricultural condition* • Crop damage: **Minor** • Water Scarcity: **Not found**. ➢ *Structure Condition* • **Functional** (R/S and C/S gate has been replaced during 2015) ➢ *Erosion* • Around 1000m embankment at Kalinagar mauza is vulnerable to river bank erosion due to wave action. At present about 750m embankment has been retired at Kalinagar however R/S of

	embankment is vulnerable to erosion. • About 150m embankment at Darun Mallik mauza is vulnerable to river bank erosion. About 200 m embankment has been retired during 2015. • Low cost bank protection works would be required by installing bamboo fencing and placing geo-bags at these vulnerable locations. Launching apron with geo-bags will be placed at severe erosion locations.

Figure: C/S of Darun Malik Sluice

Figure: Darun Malik khal

Figure: Erosion at Darun Mallik (22°35'48.00"N, 89°25'28.90"E, Dated: 01 Oct 2016)

Figure: Erosion at Kalinagar (22°36'43.00"N, 89°26'27.70"E, Dated: 01 Oct 2016)

Description of Catchment 2

Catchment Name	Cat – 2 (Durgapur Catchment)
Location (mauza wise)	Bigardana (213 ha), Saidkhali (189 ha), Kalinagar (112 ha), Hatbaria (102 ha), Senerber (75 ha), Fulbaria (65 ha), Gopepagla (53 ha), Telikhali (52 ha) and Harinkhola (11 ha)
Catchment area (ha)	873 ha
Drainage Outlet	Main drainage sluice: Durgapur Sluice at Ch. 11+530 km (1V- 1.5 m X1.8 m), Outlets: Muchimara outlet at Ch. 11+990 km (0.9 m dia), Fulbari outlet at Ch. 14+723 km (0.9 m dia), Gopipagla pipe sluice (0.9 m dia), Teli khali pipe sluice at Ch. 18+570 km (0.9 m dia)
Main Drainage Canal	Durgapur khal
Land elevation of Catchment (m PWD)	Max: 2.96 Min: 1.01
Length of Stream within catchment (Km)	23.28
Drainage Density (m/ha)	26.67
Catchment Description	➢ *Outfall* • Outfall Khal: **Habarkhali River** Condition: **Active** ➢ *Condition of Drainage Khal* • Main drainage Khal: **Active** • Branch khal: **Active** (About 8.165 km i.e. Goger khal, Fulbari khal, Muchimara khal, Horinkhola branch khal, Gopipagla simanar khal (storage) and Bigordana simanar khal (storage) has been re-excavated during 2015-2016 fiscal year) ➢ *Drainage Congestion* • Drainage congestion problem: **Minor** (usually takes 2-3 days to properly drain out rain water) • Permanent Water logging: **Not found**. ➢ *Agricultural condition* • Crop damage: **Minor** • Water Scarcity: **Minor** (Gopipagla simanar khal, Bigordana simanar khal and others internal khal has been re-excavated to enhance the sweet water capacity inside the polder area) ➢ *Structure Condition* • Functional ➢ *Erosion* • Around 220m at Bigardana mauza and 550m embankment at Durgapur mauza is vulnerable to river bank erosion due to wave action. • Low cost bank protection works would be required by installing bamboo fencing and placing geo-bags

	at these vulnerable locations.

Figure: C/S of Durgapur Sluice

Figure: Durgapur khal

Figure: Erosion at Bigordana (22°38'32.30"N, 89°25'17.10"E, Dated: 01 Oct 2016)

Figure: Erosion at Durgapur (22°37'47.60"N, 89°25'15.10"E, Dated: 01 Oct 2016)

2.10 Tidal dynamics assessment (Polder 22)

CEGIS team installed three (03) water level gauge stations (shown in Figure 2.10) to understand the tidal water level variations Daily water level data at (01) hour interval (from 6:00 AM to 6:00 PM) for 1 tide cycle (15 days) from 01 October 2016 to 15th October 2016 has been collected presented in Table 2.3. All water level data was collected in mPWD datum.

Daily water level data were collected on an hourly basis. Water level hydrographs were plotted as water level versus time. The water level hydrograph at Baroauria, Telikhali and Noai stations are shown in Figure 2.7 to 2.9 respectively. The highest water level is found to be about +3.0 m PWD and the lowest water level to be about (-)1.4 m PWD.

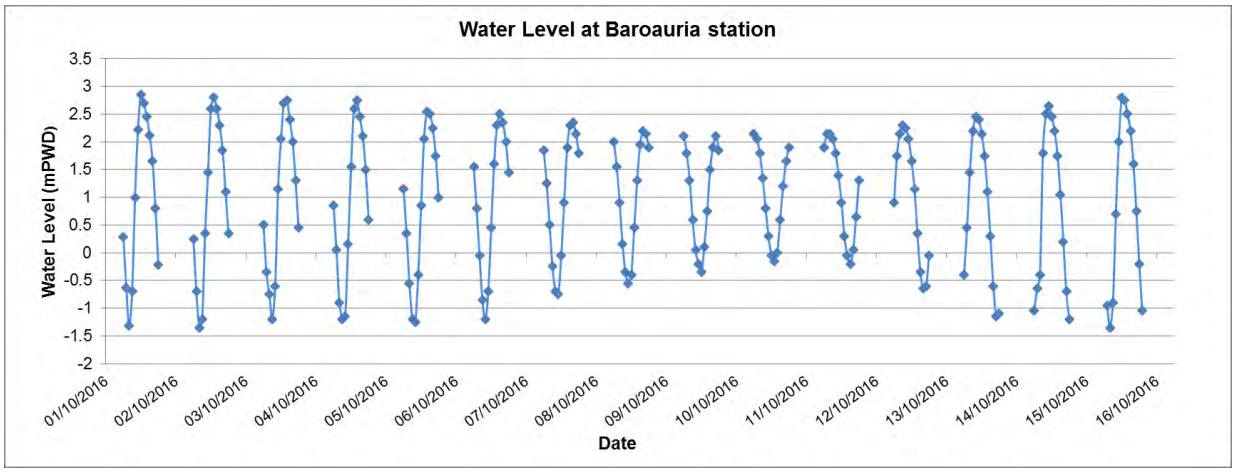

Figure 2.7: Water level analysis at Baroauria station

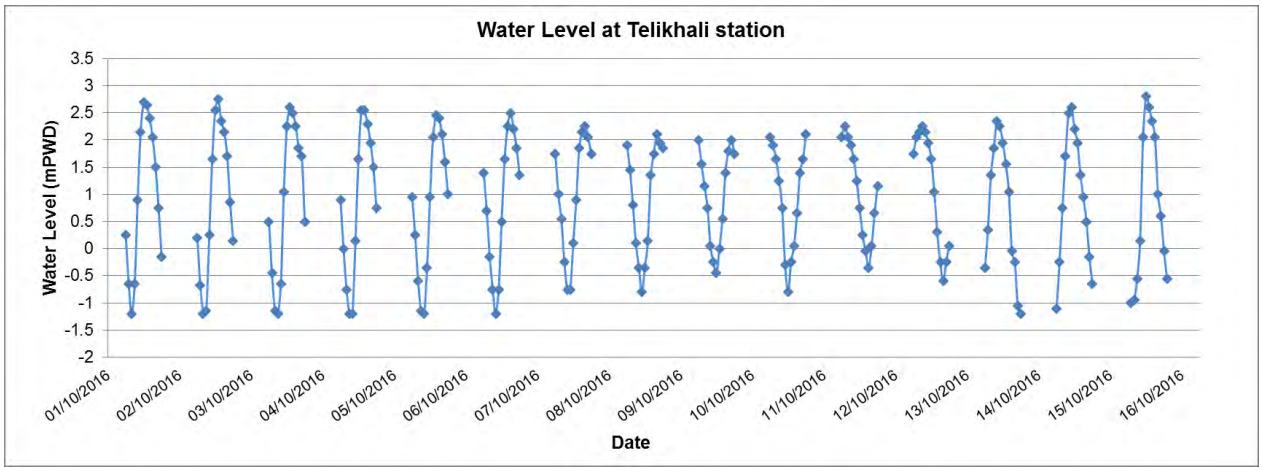

Figure 2.8: Water level analysis at Telikhali station

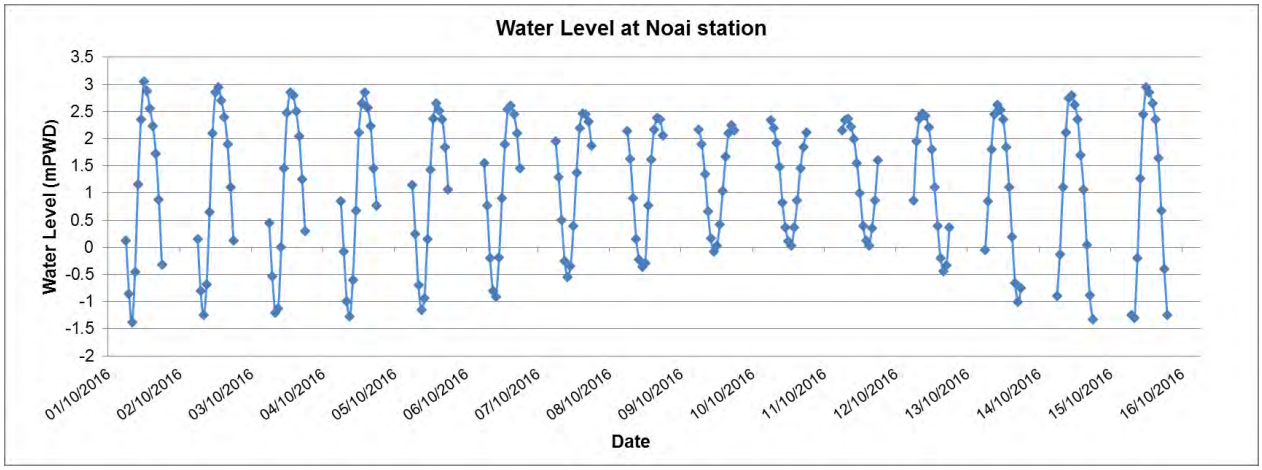

Figure 2.9: Water level analysis at Noai station

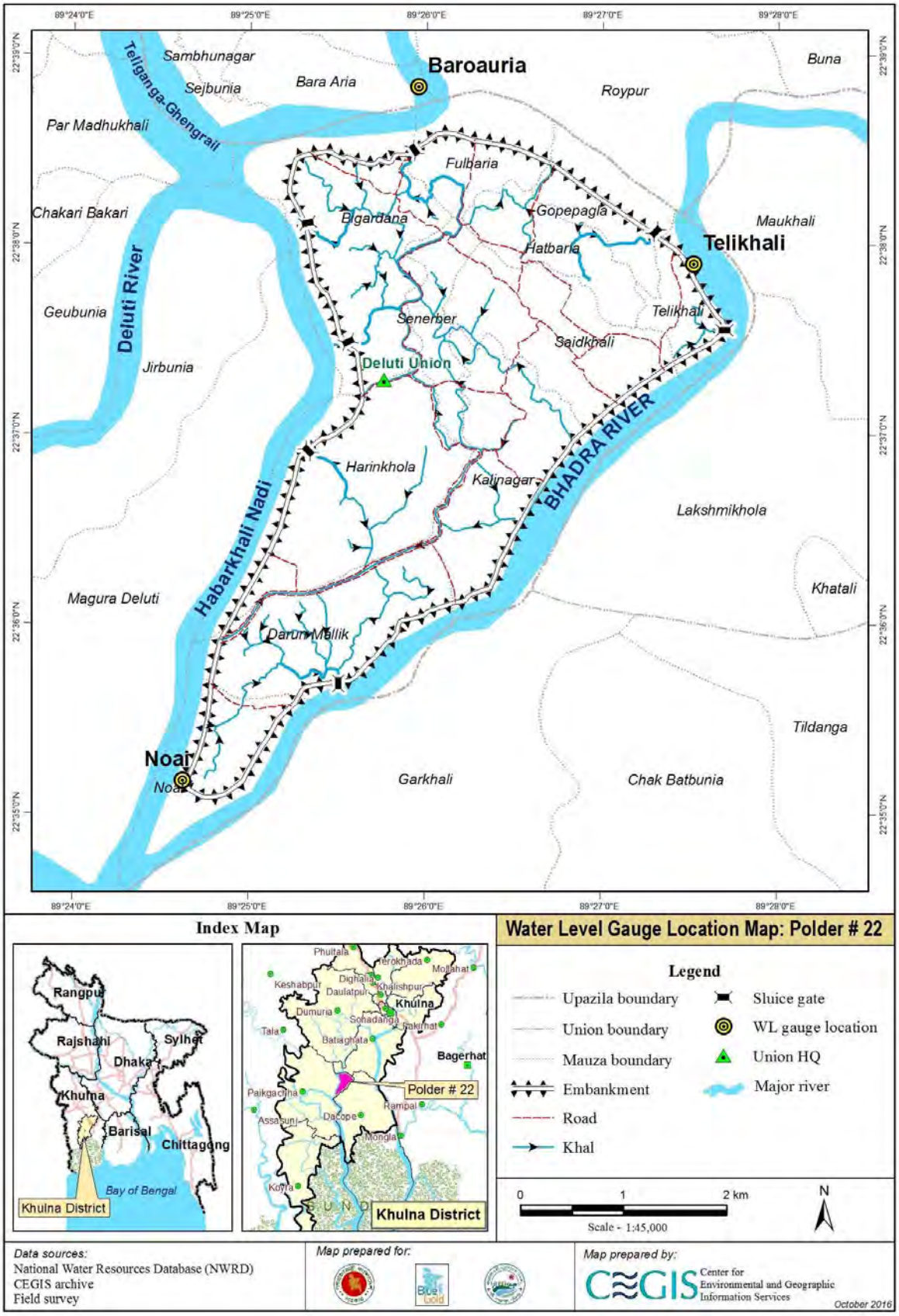

Figure 2.10: CEGIS installed gauge location at Polder 22

Table 2.3: Water level gauge data from 01/10/2016 to 15/10/2016

Date	Time	Baroauria	Telikhali	Noai	Date	Time	Baroauria	Telikhali	Noai
01/10/2016	6:00	0.28	0.25	0.12	02/10/2016	6:00	0.25	0.2	0.15
	7:00	-0.63	-0.65	-0.85		7:00	-0.7	-0.68	-0.8
	8:00	-1.32(LTL)	-1.2(LTL)	-1.38(LTL)		8:00	-1.35(LTL)	-1.2(LTL)	-1.25(LTL)
	9:00	-0.7	-0.65	-0.45		9:00	-1.2	-1.15	-0.68
	10:00	1	0.9	1.16		10:00	0.35	0.25	0.65
	11:00	2.22	2.15	2.36		11:00	1.45	1.65	2.1
	12:00	2.85(HTL)	2.7(HTL)	3.05(HTL)		12:00	2.6	2.55	2.85
	13:00	2.7	2.65	2.88		13:00	2.8(HTL)	2.75(HTL)	2.95(HTL)
	14:00	2.45	2.4	2.56		14:00	2.6	2.35	2.7
	15:00	2.12	2.05	2.23		15:00	2.3	2.15	2.4
	16:00	1.65	1.5	1.72		16:00	1.85	1.7	1.9
	17:00	0.8	0.75	0.88		17:00	1.1	0.85	1.1
	18:00	-0.22	-0.15	-0.32		18:00	0.35	0.15	0.12

Date	Time	Baroauria	Telikhali	Noai	Date	Time	Baroauria	Telikhali	Noai
03/10/2016	6:00	0.5	0.5	0.45	04/10/2016	6:00	0.85	0.9	0.85
	7:00	-0.35	-0.45	-0.53		7:00	0.05	0	-0.07
	8:00	-0.75	-1.15	-1.2(LTL)		8:00	-0.9	-0.75	-0.99
	9:00	-1.2(LTL)	-1.2(LTL)	-1.12		9:00	-1.2(LTL)	-1.2(LTL)	-1.27(LTL)
	10:00	-0.6	-0.65	0		10:00	-1.15	-1.2	-0.6
	11:00	1.15	1.05	1.45		11:00	0.15	0.15	0.67
	12:00	2.05	2.25	2.48		12:00	1.55	1.65	2.11
	13:00	2.7	2.6(HTL)	2.85(HTL)		13:00	2.6	2.55	2.65
	14:00	2.75(HTL)	2.5	2.8		14:00	2.75(HTL)	2.55(HTL)	2.85(HTL)
	15:00	2.4	2.25	2.5		15:00	2.45	2.3	2.57
	16:00	2	1.85	2.05		16:00	2.1	1.95	2.23
	17:00	1.3	1.7	1.25		17:00	1.5	1.5	1.45
	18:00	0.45	0.5	0.3		18:00	0.6	0.75	0.77

Date	Time	Baroauria	Telikhali	Noai	Date	Time	Baroauria	Telikhali	Noai
05/10/2016	6:00	1.15	0.95	1.15	06/10/2016	6:00	1.55	1.4	1.55
	7:00	0.35	0.25	0.25		7:00	0.8	0.7	0.77
	8:00	-0.55	-0.6	-0.7		8:00	-0.05	-0.15	-0.2
	9:00	-1.2	-1.15	-1.15(LTL)		9:00	-0.85	-0.75	-0.8
	10:00	-1.25(LTL)	-1.2(LTL)	-0.93		10:00	-1.2(LTL)	-1.2(LTL)	-0.91(LTL)
	11:00	-0.4	-0.35	0.15		11:00	-0.7	-0.75	-0.19
	12:00	0.85	0.95	1.43		12:00	0.45	0.5	0.9
	13:00	2.05	2.05	2.37		13:00	1.6	1.65	1.9
	14:00	2.55(HTL)	2.45(HTL)	2.65(HTL)		14:00	2.3	2.25	2.54
	15:00	2.5	2.4	2.52		15:00	2.5(HTL)	2.5(HTL)	2.61(HTL)
	16:00	2.25	2.1	2.35		16:00	2.35	2.2	2.45
	17:00	1.75	1.6	1.85		17:00	2	1.85	2.1
	18:00	1	1	1.07		18:00	1.45	1.35	1.45

Date	Time	Baroauria	Telikhali	Noai	Date	Time	Baroauria	Telikhali	Noai
07/10/2016	6:00	1.85	1.75	1.95	08/10/2016	6:00	2	1.9	2.14
	7:00	1.25	1	1.3		7:00	1.55	1.45	1.63
	8:00	0.5	0.55	0.5		8:00	0.9	0.8	0.9
	9:00	-0.25	-0.25	-0.25		9:00	0.15	0.1	0.15
	10:00	-0.7	-0.75	-0.55(LTL)		10:00	-0.35	-0.35	-0.23
	11:00	-0.75(LTL)	-0.75(LTL)	-0.34		11:00	-0.55(LTL)	-0.8(LTL)	-0.36(LTL)
	12:00	-0.05	0.1	0.4		12:00	-0.4	-0.35	-0.29
	13:00	0.9	0.9	1.37		13:00	0.45	0.15	0.77
	14:00	1.9	1.85	2.2		14:00	1.3	1.35	1.62
	15:00	2.3	2.15	2.47(HTL)		15:00	1.95	1.75	2.17
	16:00	2.35(HTL)	2.25(HTL)	2.45		16:00	2.2(HTL)	2.1(HTL)	2.38(HTL)
	17:00	2.15	2.05	2.32		17:00	2.15	1.95	2.35
	18:00	1.8	1.75	1.87		18:00	1.9	1.85	2.06

Date	Time	Baroauria	Telikhali	Noai	Date	Time	Baroauria	Telikhali	Noai
09/10/2016	6:00	2.1	2	2.17	10/10/2016	6:00	2.15(HTL)	2.05(HTL)	2.34(HTL)
	7:00	1.8	1.55	1.9		7:00	2.05	1.9	2.2
	8:00	1.3	1.15	1.35		8:00	1.8	1.65	1.93
	9:00	0.6	0.75	0.66		9:00	1.35	1.25	1.48
	10:00	0.05	0.05	0.16		10:00	0.8	0.75	0.82
	11:00	-0.2	-0.25	-0.07(LTL)		11:00	0.3	-0.3	0.37
	12:00	-0.35(LTL)	-0.45(LTL)	0.03		12:00	-0.05	-0.8(LTL)	0.11
	13:00	0.1	0	0.42		13:00	-0.15(LTL)	-0.25	0.03(LTL)
	14:00	0.75	0.55	1.04		14:00	0	0.05	0.37
	15:00	1.5	1.4	1.67		15:00	0.6	0.65	0.86
	16:00	1.9	1.8	2.1		16:00	1.2	1.4	1.45
	17:00	2.1(HTL)	2(HTL)	2.25(HTL)		17:00	1.65	1.65	1.85
	18:00	1.85	1.75	2.16		18:00	1.9	2.1	2.12

Date	Time	Baroauria	Telikhali	Noai	Date	Time	Baroauria	Telikhali	Noai
11/10/2016	6:00	1.9	2.05	2.15	12/10/2016	6:00	0.9	1.75	0.87
	7:00	2.15(HTL)	2.25(HTL)	2.34		7:00	1.75	2.05	1.95
	8:00	2.15	2.05	2.37(HTL)		8:00	2.15	2.15	2.37
	9:00	2.05	1.9	2.22		9:00	2.3(HTL)	2.25(HTL)	2.46(HTL)
	10:00	1.8	1.65	1.99		10:00	2.25	2.15	2.42
	11:00	1.4	1.25	1.55		11:00	2.05	1.95	2.21
	12:00	0.9	0.75	1		12:00	1.65	1.65	1.8
	13:00	0.3	0.25	0.4		13:00	1.15	1.05	1.1
	14:00	-0.05	-0.05	0.13		14:00	0.35	0.3	0.4
	15:00	-0.2(LTL)	-0.35(LTL)	0.03(LTL)		15:00	-0.35	-0.25	-0.2
	16:00	0.05	0.05	0.35		16:00	-0.65(LTL)	-0.6(LTL)	-0.44(LTL)
	17:00	0.65	0.65	0.87		17:00	-0.6	-0.25	-0.33
	18:00	1.3	1.15	1.6		18:00	-0.05	0.05	0.37

Date	Time	Baroauria	Telikhali	Noai	Date	Time	Baroauria	Telikhali	Noai
13/10/2016	6:00	-0.4	-0.35	-0.05	14/10/2016	6:00	-1.05(LTL)	-1.1(LTL)	-0.9(LTL)
	7:00	0.45	0.35	0.85		7:00	-0.65	-0.25	-0.13
	8:00	1.45	1.35	1.8		8:00	-0.4	0.75	1.1
	9:00	2.2	1.85	2.45		9:00	1.8	1.7	2.12
	10:00	2.45(HTL)	2.35(HTL)	2.62(HTL)		10:00	2.5	2.5	2.75
	11:00	2.4	2.25	2.53		11:00	2.65(HTL)	2.6(HTL)	2.8(HTL)
	12:00	2.15	1.95	2.35		12:00	2.45	2.2	2.62
	13:00	1.75	1.55	1.84		13:00	2.2	1.95	2.35
	14:00	1.1	1.05	1.1		14:00	1.75	1.35	1.7
	15:00	0.3	-0.05	0.19		15:00	1.05	0.95	1.07
	16:00	-0.6	-0.25	-0.65		16:00	0.2	0.5	0.05
	17:00	-1.15(LTL)	-1.05	-1(LTL)		17:00	-0.7	-0.15	-0.88
	18:00	-1.1	-1.2(LTL)	-0.75		18:00	-1.2(LTL)	-0.65(LTL)	-1.33(LTL)

Date	Time	Matibhanga	Titkata	Kanta
15/10/2016	6:00	-0.95	-1(LTL)	-1.25
	7:00	-1.35(LTL)	-0.95	-1.3(LTL)
	8:00	-0.9	-0.55	-0.2
	9:00	0.7	0.15	1.27
	10:00	2	2.05	2.45
	11:00	2.8(HTL)	2.8(HTL)	2.95(HTL)
	12:00	2.75	2.6	2.85
	13:00	2.5	2.35	2.65
	14:00	2.2	2.05	2.35
	15:00	1.6	1	1.65
	16:00	0.75	0.6	0.67
	17:00	-0.2	-0.05	-0.4
	18:00	-1.05	-0.55	-1.25