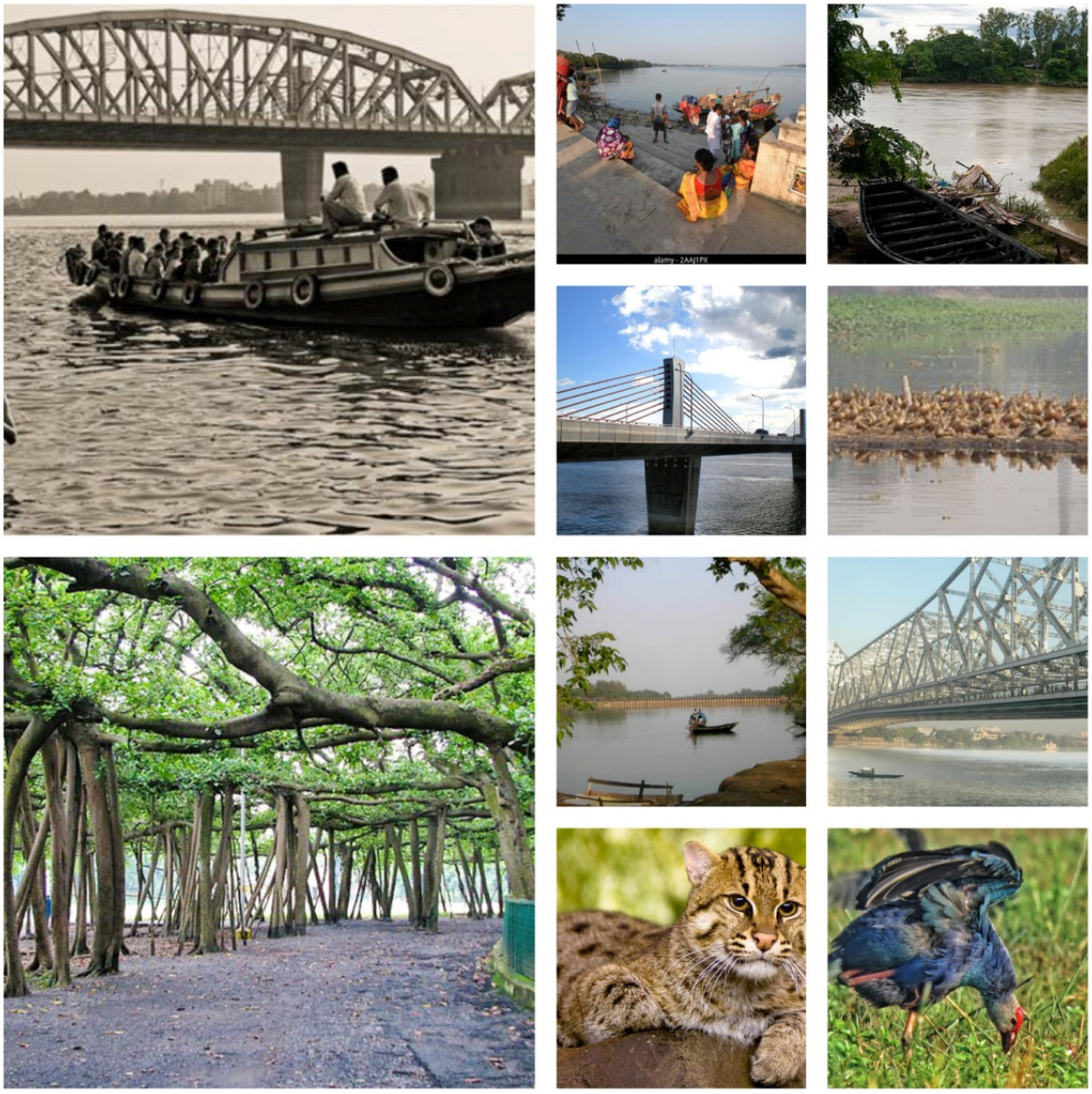
HAORA

DOCUMENTATION OF GANGA FROM GOMUKH TO GANGASAGAR



Report submitted by:

The Natural Heritage Division

GANGA CULTURAL DOCUMENTATION

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Intangible Cultural Heritage Documentation

December, 2021

Sponsored by :

NAMAMI GANGE

National Mission for Clean Ganga

Authored By :

INTACH

Contents

Images

Maps

Abbreviations

AISLUS	All India Soil & Landuse Survey
As	Arsenic
ASI	Archaeological Survey of India
BGL	Below Ground Level
BOD	Biochemical Oxygen Demand
CGWB	Central Ground Water Board
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
CPT	Calcutta Port Trust
DEM	Digital Elevation Model
DO	Dissolve Oxygen
DPMS	District Planning Map Series
DWF	Dry Water Flow
E-Waste	Electronic Waste
EC	Electrical Conductivity
EKW	East Kolkata Wetlands
EMP	Environmental Management Plan
ETM	Enhance Thematic Mapper
FCC	False Colour Composite
GAP	Ganga Action Plan
GCP	Ground Control Point
GIS	Geographic Information System
GOI	Government of India
GoWB	Government of West Bengal
GPS	Global Positioning System
GSI	Geological Survey of India
HWL	High Water Level
IMD	Indian Meteorological Department
INTACH	Indian National Trust for Art & Cultural Heritage
IWMED	Institute of Wetland Management & Ecological Design

K	Potassium
KEIP	Kolkata Environment Improvement Project
KIT	Kolkata Improvement Trust
KMA	Kolkata Metropolitan Area
KMC	Kolkata Municipal Corporation
KMDA	Kolkata Metropolitan Development Authority
LULC	Landuse Land cover
LWL	Low Water Level
MSL	Mean Sea Level
MSS	Multi Spectral Scanner
MWL	Mean Water Level
N	Nitrogen
Na	Sodium
NATMO	National Atlas & Thematic Mapping Organisation
NBSS&LUP	National Bureau of Soil Survey & Landuse Planning
NDVI	Normalised Differential Vegetation Index
NH	Natural Heritage
NMCG	National Mission for Clean Ganga
NTFP	Non Timber Forest Product
pH	Hydrogen Ion Concentration
PPT	Precipitation
RF	Rainfall
RGB	Red Green Blue
RS	Remote Sensing
SPM	Suspended Particulate Matter
SRTM	Shuttle Radar Topographic Mission
SWID	State Water Investigation Directorate
TM	Thematic Mapper
UNDP	United Nations Development Programme
USGS	United Nations Geological Survey
WBPCB	West Bengal Pollution Control Board
WF	Wetland Fauna

1. Introduction

1.1 Background of the Project

Namami Gange Programme', is an Integrated Conservation Mission, approved as 'Flagship Programme' by the Union Government in June 2014 with the twin objectives of effective abatement of pollution, conservation and rejuvenation of National River Ganga.

1.1A. Key achievements under Namami Gange programme:

a. **Creating Sewerage Treatment Capacity:-** 63 sewerage management projects under implementation in the States of Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal.12 new sewerage management Projects Launched in these states. Work is under construction for creating Sewerage capacity of 1187.33 (MLD).Hybrid Annuity PPP Model based two projects has been initiated for Jagjeetpur, Haridwar and Ramanna, Varanasi.

b. **Creating River-Front Development:-**28 River-Front Development projects and 33 Entry level Projects for construction, modernization and renovation of 182 Ghats and 118 crematoria have been initiated.

c. **River Surface Cleaning:-**River Surface cleaning for collection of floating solid waste from the surface of the Ghats and River and its disposal are afoot and pushed into service at 11 locations.

d. **Bio-Diversity Conservation:-** Several Bio-Diversity conservation projects are namely: Biodiversity Conservation and Ganga Rejuvenation, Fish and Fishery Conservation in Ganga River, Ganges River Dolphin Conservation Education Programme has been initiated. 5 Bio-Diversity center's at Dehradun, Narora, Allahabad, Varanasi and Barrackpore has been developed for restoration of identified priority species.

e. **Afforestation:** Forestry interventions for Ganga through Wildlife Institute of India; Central Inland Fisheries Research Institute and Centre for Environment Education has been initiated. Forestry interventions for Ganga have been executed as per the Detailed Project Report prepared by Forest Research Institute, Dehradun for a period of 5 years (2016-2021) at project cost of Rs.2300 Crores. Work has been commenced in 7 districts of Uttarakhand for medicinal plants.

f. **Public Awareness:** A series of activities such as events, workshops, seminars and conferences and numerous IEC activities were organized to make a strong pitch for public outreach and community participation in the programme. Various awareness activities through rallies, campaigns, exhibitions, *shram daan*, cleanliness drives, competitions, plantation drives and development and distribution of resource materials were organized and for wider publicity the mass mediums such as TV/Radio, print media advertisements, advertorials, featured articles and advertorials were published. Gange Theme song was released widely and played on digital media to enhance the visibility of the programme. NMCG ensured presence at Social Media platforms like Facebook, Twitter, YouTube etc.

g. **Industrial Effluent Monitoring:** The number of Grossly Polluting Industries (GPIs) in April, 2019 is 1072. Regulation and enforcement through regular and surprise inspections of GPIs is carried out for compliance verification against stipulated environmental norms. The GPIs are also inspected on annual basis for

complianceverification of the pollution norms and process modification, wherever required through third party technical institutes. First round of inspection of GPIs by the third-party technical institutes has been carried out in 2017. Second round of inspection of GPIs has been completed in 2018. Out of 961 GPIs inspected in 2018, 636 are complying, 110 are non-complying and 215 are self-closed. Action has been taken against 110 non-complying GPIs and is issued closure directions under Section 5 of the E(P) Act. Online Continuous Effluent Monitoring Stations (OCEMS) connectivity established to CPCB server in 885 out of 1072 GPIs.

h. **Ganga Gram:** Ministry of Drinking Water and Sanitation (MoDWS) identified 1674 Gram Panchayats situated on the bank of River Ganga in 5 State (Uttarakhand,Uttar Pradesh,Bihar,Jharkhand,West Bengal). Rs. 578 Crores has been released to Ministry of Drinking Water and Sanitation (MoDWS) for construction of toilets in 1674 Gram Panchayats of 5 Ganga Basin States. Out of the targeted 15, 27,105 units, MoDWS has completed construction of 8, 53,397 toilets. Consortium of 7 IITs has been engaged in the preparation of Ganga River basin Plan and 65 villages have been adopted by 13 IITs to develop as model villages. **UNDP** has been engaged as the executing agency for rural sanitation programme and to develop Jharkhand as a model State at an estimated cost of Rs. 127 Crore.

National Mission for Clean Ganga(NMCG) endeavors to deploy best available knowledge and resources across the world for Ganga rejuvenation. Clean Ganga has been a perennial attraction for many international countries that have expertise in river rejuvenation. Countries such as Australia, United Kingdom, Germany, Finland, Israel etc. have shown interest in collaborating with India for Ganga rejuvenation. Memorandums of Understanding (MoUs) were signed with various Central Ministries viz.- Ministry of Human Resource Development, Ministry of Rural Development, Ministry of Railways, Ministry of Shipping, Ministry of Tourism, Ministry of Ayush, Ministry of Petroleum, Ministry of Youth Affairs and Sports, Ministry of Drinking Water & Sanitation and Ministry of Agriculture for synergizing the Government schemes.

1.1B. Why we need "Namami Gange" programmes:

a. River Ganga has significant economic, environmental and cultural value in India.

b. Rising in the Himalayas and flowing to the Bay of Bengal, the river traverses a course of more than 2,500 km through the plains of north and eastern India.

c. The Ganga basin - which also extends into parts of Nepal, China and Bangladesh - accounts for 26 per cent of India's landmass.

d. The Ganga also serves as one of India's holiest rivers whose cultural and spiritual significance transcends the boundaries of the basin.

1.1C. Aim & Objective of NMCG

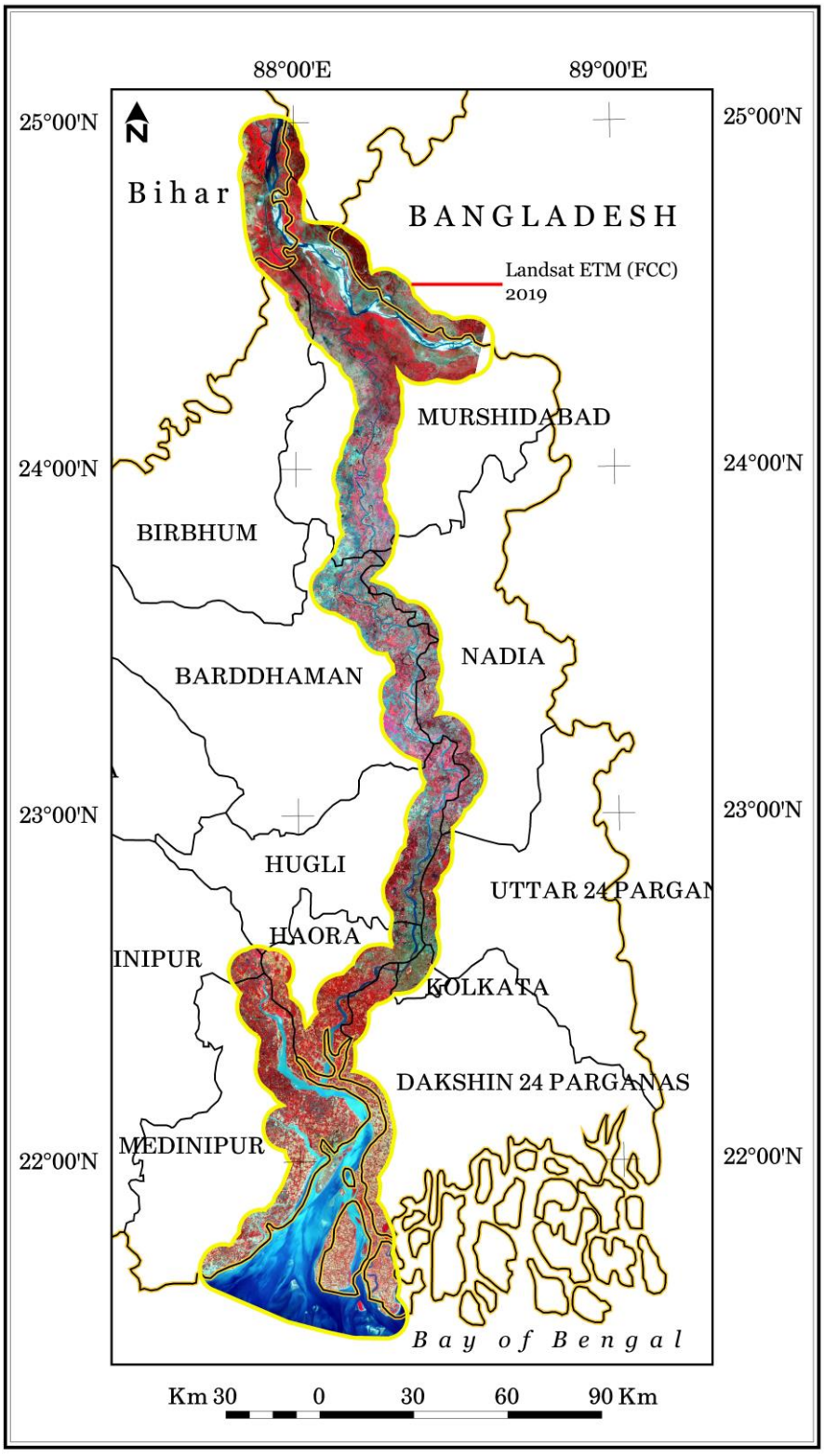
The aims and objectives of NMCG are to accomplish the mandate of National Ganga River Basin Authority (NGRBA) are:

1. To ensure effective abatement of pollution and rejuvenation of the river Ganga by adopting a river basin approach to promote inter-sectoral co-ordination for comprehensive planning and management and
2. To maintain minimum ecological flows in the river Ganga with the aim of ensuring water quality and environmentally sustainable development.

1.2Ganga Cultural Documentation

India is endowed with rich water resources with approximately 45,000 km long riverine systems criss-cross the length and breadth of the country. The Ganga river basin is the largest of the basins of India with an area of 8,61,452 Sq.km in India, draining into the 11 states of the country, Uttarakhand, Uttar Pradesh, Haryana, Himachal Pradesh, Delhi, Bihar, Jharkhand, Rajasthan, Madhya Pradesh, Chhattisgarh and West Bengal. The Ganga river has many tributaries, both in the Himalayan region before it enters the plains at Haridwar and further downstream before its confluence with the Bay of Bengal. The basin has a total drainage length of about 624235.73 Sq.km. The Ganga basin lies between east longitudes 73°2' to 89°5' and north latitudes 21°6' to 31°21' having maximum length and width of approx. 1,543 km and 1024 km. The average water resource potential of the basin has been assessed as 525020 Million Cubic Meters (MCM).

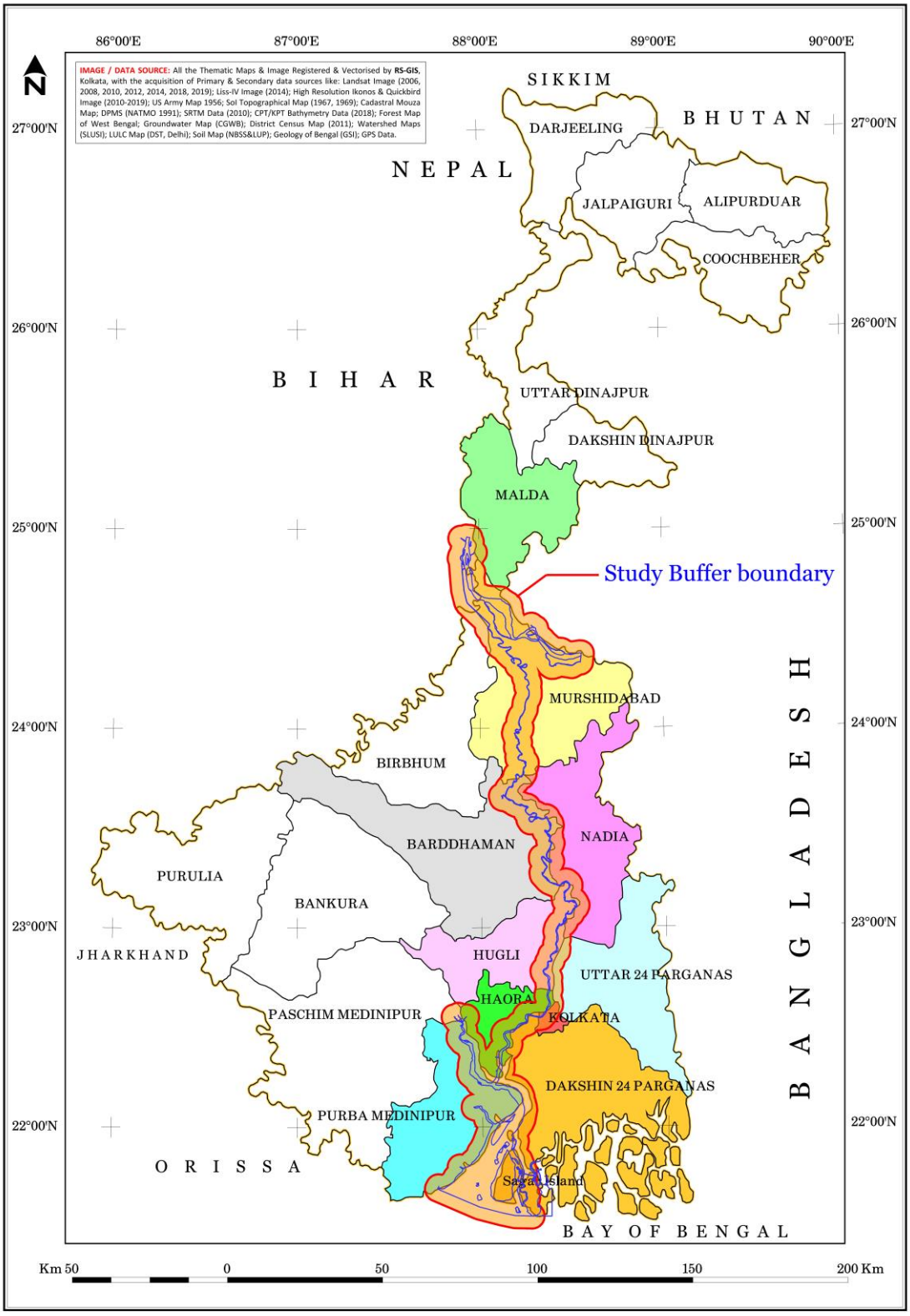
Sl.	Head Details			Quantitative Information		Remarks
1.	State Name: West Bengal			-	-	
2.	Geographical Extension of Bhagirathi-Hugli			N N	E E	
3.	Areal coverage in 5km Buffer					
4.	Areal coverage in 10km Buffer					
5.	Total Number of Districts coverage			10		
6.	District wise Police Station & Ward coverage	**District**		Number of PS/ Wards	Length of Hugli River	
		A	Malda	04	88 Km	
		B	Murshidabad	13	520 Km	
		C	Nadia	09	112 Km	
		D	Barddhaman	04	138 Km	
		E	Hugli	09	91 Km	
		F	Haora	09	69 Km	
		G	North 24 Parganas	09	42 Km	
		H	South 24 Parganas	09	110 Km	
		I	Kolkata	144 Wards	20Km	
		J	Purba Medinipur	06	92 Km	
7.	Total Length of the Bhagirathi-Hugli River in the Lower Part			1282 Km.		



Map No1: Map of West Bengal showing the study area

WEST BENGAL

Showing the area of Study along Bhagirathi - Hugli River



Map No 2: Map of West Bengal showing the overall location of the Study area

1.3Documenting Natural Heritage & Ecological Interdependencies

Natural Heritage would not replicate the work of scientific institutions Biodiversity Conservation is being studied and implemented by Wildlife Institute of India to cover Golden Mahseer, Dolphins, Crocodiles, Turtles and Otters and other fauna under conservation programme. These studies would be referred to.

1.3A. Changes in Flows, Water Levels: The documentation of natural heritage at several sites and banks will look at the changes in flows, earlier course of the river if any and observable changes in water level as revealed in discussions with resource persons and local communities.

1.3B. Floodplains Crops and natural riparian flora and fauna, ox-bow lakes would be recorded

1.3C. Species-Fauna, Flora, Birds and others: Observations of riparian communities regarding changes in flora and fauna both riparian and in-stream would be recorded

1.3D. Sacred Groves: Landscapes that have both ecological and religious significance, where religion has ensured conservation of natural landscapes shall be noted

1.3E. Sacred Species: Certain species and specific trees are considered sacred because of associated religious beliefs or biological significance. It is because of their presence that several landscapes and sites stand safe. Many of these trees have a close association with the river during performance of some rituals. For instance, Bhojapatra is a birch tree native to the Himalayas, growing at elevations up to 4,500 m. The specific epithet, *utilis*, refers to the many uses of the different parts of the tree. The white, paper-like bark of the tree was used in ancient times for writing Sanskrit scriptures and texts. It is still used as paper for the writing of sacred mantras, with the bark placed in an amulet and worn for protection. In the sacred forests of Bhojwasa, around Gaumukh, such forests have been protected by pilgrims and resident communities, for eons.

1.3F. Community Understanding of Riparian Rights: Several communities, like the fishermen of the lower delta regions, have been caught in conflict with incumbent authorities in British and Independent India over riparian rights. The project aims to develop an understanding of what constitutes community riparian rights and whether communities are in conflict with authorities over the same.

1.3G. Confluence Points: The course of the Ganga is dotted with several confluence points of lower order streams which will be marked geospatially to understand the catchment and wider system of this river. The documentation also aims to name the minor tributaries that flow within this system and join it at various places.

1.3H. Review of Scientific Research on the Waters: Many scientific papers have been published on the Ganga and features of its water that keep it free of decay. These papers will be referred to recording what they suggest in terms of keeping the waters pristine.

1.4Methodology

1.4A. Capacity Building:

a. **Training arrangement:**Two phases of training have given to the Field Coordinators, Field survey staff and the Project Resource persons. First phase of training has conducted by the Project Funding Authority i.e. INTACH, Delhi and second phase of training will be conducted by the Project Implementing Agency i.e. RS-GIS, Kolkata.

b. **Development of Project Team:**A Project team has formed according to the need of the objective of the present Project. It is formed headed by the coordinator and the Social Scientist. Other members of the Project team are the GIS-Remote Sensing Expert, Field assistant (Geography background), Local Resource persons, Camera person and Hydrologist, Soil Scientist, Botanist, Zoologist & Agriculture scientist.

c. **Acquisition / Procurement/ Purchase of Gadgets /Equipments / Analysis:** FollowingGadgets/Equipments have been purchased for the implementation of the Project work: GPS machine, Satellite Image (Two seasons, Recent Data), Soft / hard copy Cadastral maps, Soil / Water storage Kit, Measuring Tape/ Compass/ Dumpy level, Topographical / DPMS, Laboratory Test / Analysis, procurement of other secondary Data / Information / Maps from Census, Irrigation, Ground water, Soil, Agriculture, Forest etc. Purchase of Books, Reproduction of Survey formats & Stationeries etc.

1.4B. Pre-Field Survey:

a. **Literature review:** Library work, Study of published and unpublished reports, News paper articles, Journals and Research papers.
b. **Collection of Secondary Data/ Information (Maps) from Govt. Departments:** GSI, NATMO, CGWB, NBSS & LUP, IMD, SWID, PHED, KMC Office, Survey of India (SoI), KOPT, West Bengal Fisheries Corporation, Irrigation & Waterways GoWB, West Bengal Forest Deptt. PWD, Census of India, AISLUS etc.
c. **Satellite Data Acquisition (Real-time):** NRSA Hyderabad, University of Calcutta (Deptt. of Geography), USGS Earth Explorer.
d. **Base-Map Preparation** (for whole Project area)**:** Consulting Topographical maps, Census maps, DPMS & Recent Multi spectral Satellite Image.

1.4C. Field Survey:

a. **Data-Information Collection & Measurements:**Collection of detail information with GPS locations, related to- Surface Morphology /Relief/ Physiography, Geology, Climatic conditions, Bank erosion, Embankment condition, Depth of river Bhagirathi-Hugli, Shifting river course and Paleo-channels, Status of Confluence and Off-take points of rivers, Canals, Flood events and Tide levels, Heritage water structures, Wetlands, Ground water regime, Soil, Water quality, Riparian Flora-Fauna, Sacred trees, Landuse-Land cover types, Impact of Dams/Barrages/Mining, Utilization of Flood plain, Riparian Rights etc.

b. Photo & Videogrpahy: Professional photographers having enough experience of Physical, Social, Ecological & Environmental issues will be engaged for Digital documentation of different events related to the Natural phenomenon.

1.4D. Post Field Analysis:

a. Collection & Scrutinization of Field Data/Survey sheets: Region / Block/ PS/ Mouza wise *Proforma for Listing the Natural Heritage* survey sheets will be checked / verified with the concern persons.

b. GPS Data analysis: Collecting the Ground Control Points (GCP's) & GPS-Tracks of Land surface & Waterbodies, the database will be processed through Map-Source Software

c. Water & Soil Sample data analysis: Sample will be supplied for analysis in reputed Govt. Departments or Private agencies.

d. Preparation of Theme Maps: Location, Administrative, Relief, Geology, Geomorphology, Drainage, Waterbody, Canals, Groundwater, Soil, Rainfall-Temperature, Vegetation, Tidal fluctuations, Landuse-Land cover, Shifting of Rivers, Embankment status, Population growth, Flood condition, Watershed divisions, GPS locations of specific units, Urbanization level etc.

1.4E. Validating Field & Analised Data:

a. Landuse Land cover units: Physical & Cultural units on land surface to be verified after revisit the area with recent Satellite Image.
b. GPS locations: After Overlaying the data on Satellite Image (Google Earth Image) Cross-checking will be done
c. Water Sample analysis data: COD, BOD, pH, EC, DO, Turbidity analysis of Water samples.
d. Flora/Fauna: Riparian, Sacred Species with their environment.

1.4E. Preparation & Submission of Report

a. Preparation of Draft Report: Preliminary Draft Report in Soft & Hard copy mode (1 Colour Printed) of each District will be submitted to INTACH, Kolkata Convener for Verification / Correction

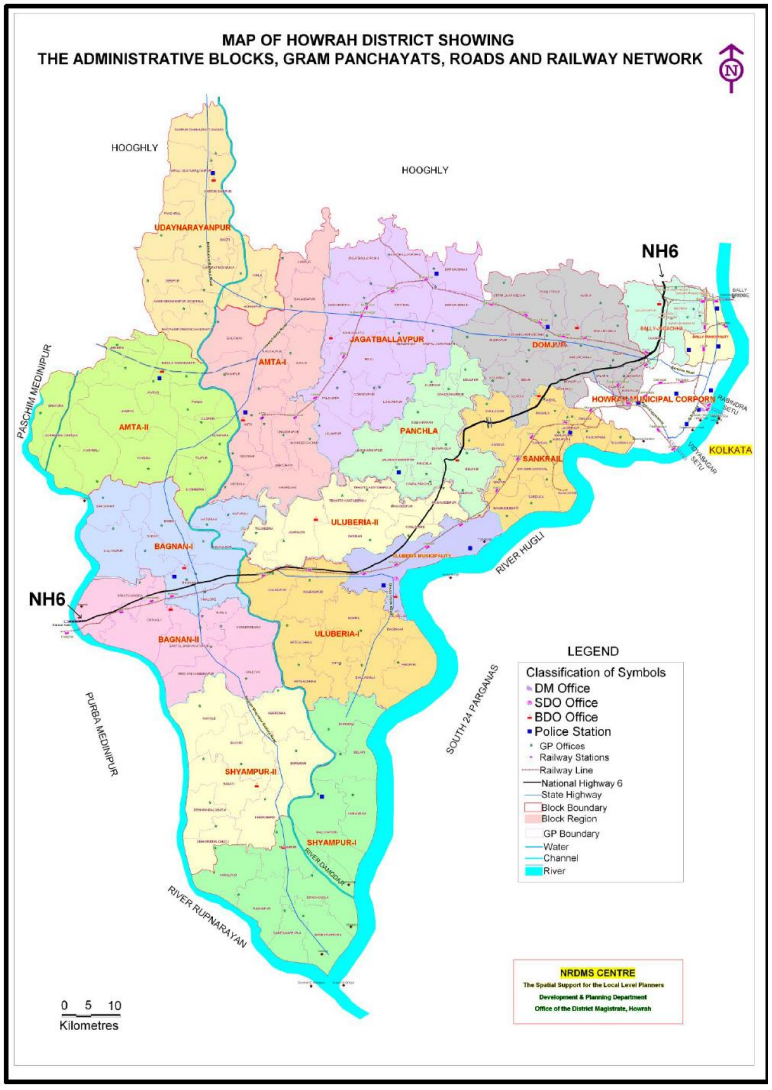
b. Report Correction: Any corrections made by the funding authority will be incorporated judiciously into the Final Report.

c. Final Report Submission: Final Report in form of Soft Copy will be submitted District wise and Hard copy Report will be submitted after completing the all Districts in three phases.

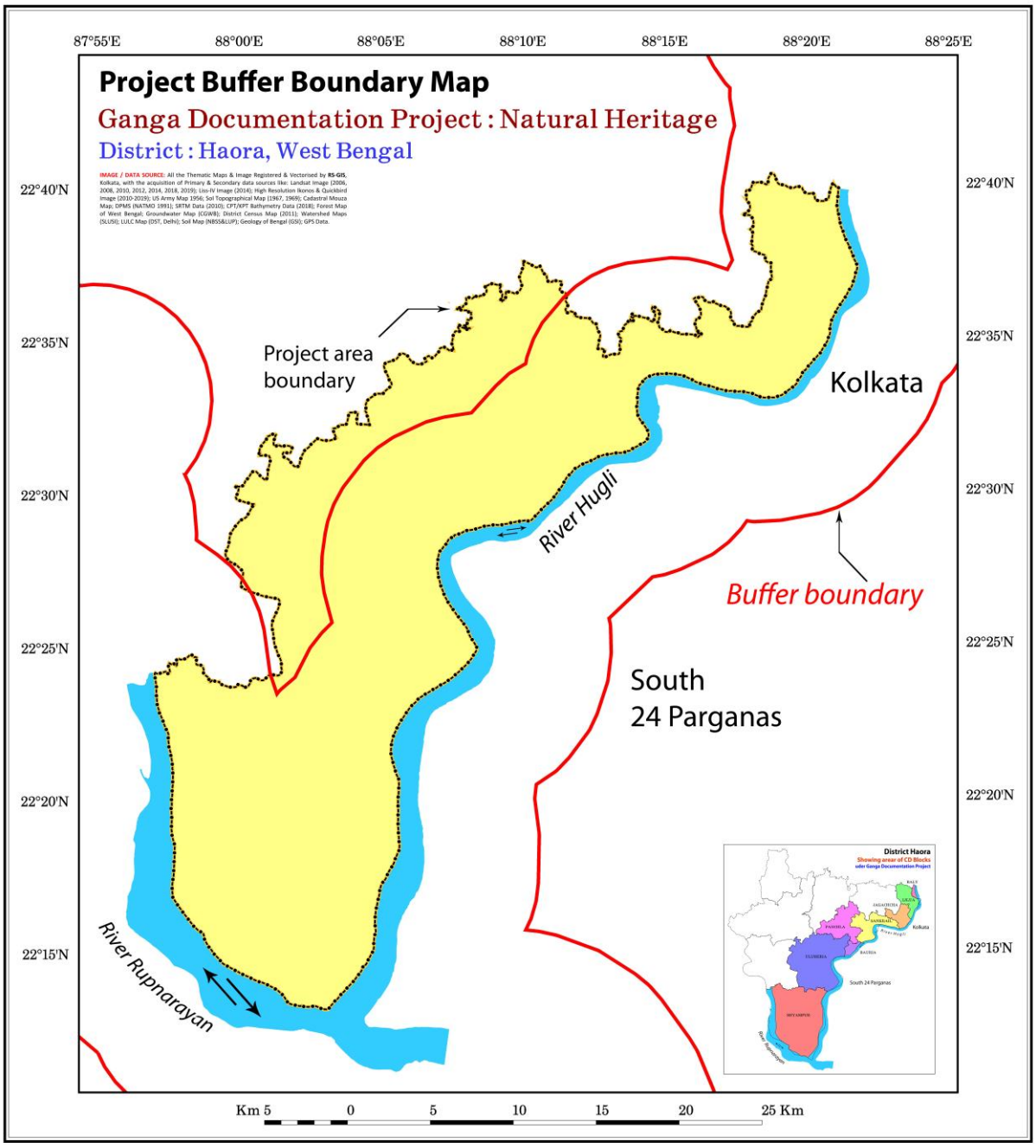
2. Locational Setting

2.1. Haora district is one of the highly urbanized area of West Bengal. The urbanised sectors gradually increase the slum populations. Haora is the second smallest district after Kolkata. It has thousands of years of rich heritage in the form of the great Bengali kingdom of Bhurshut. The district is named after its headquarters, the city of Haora.

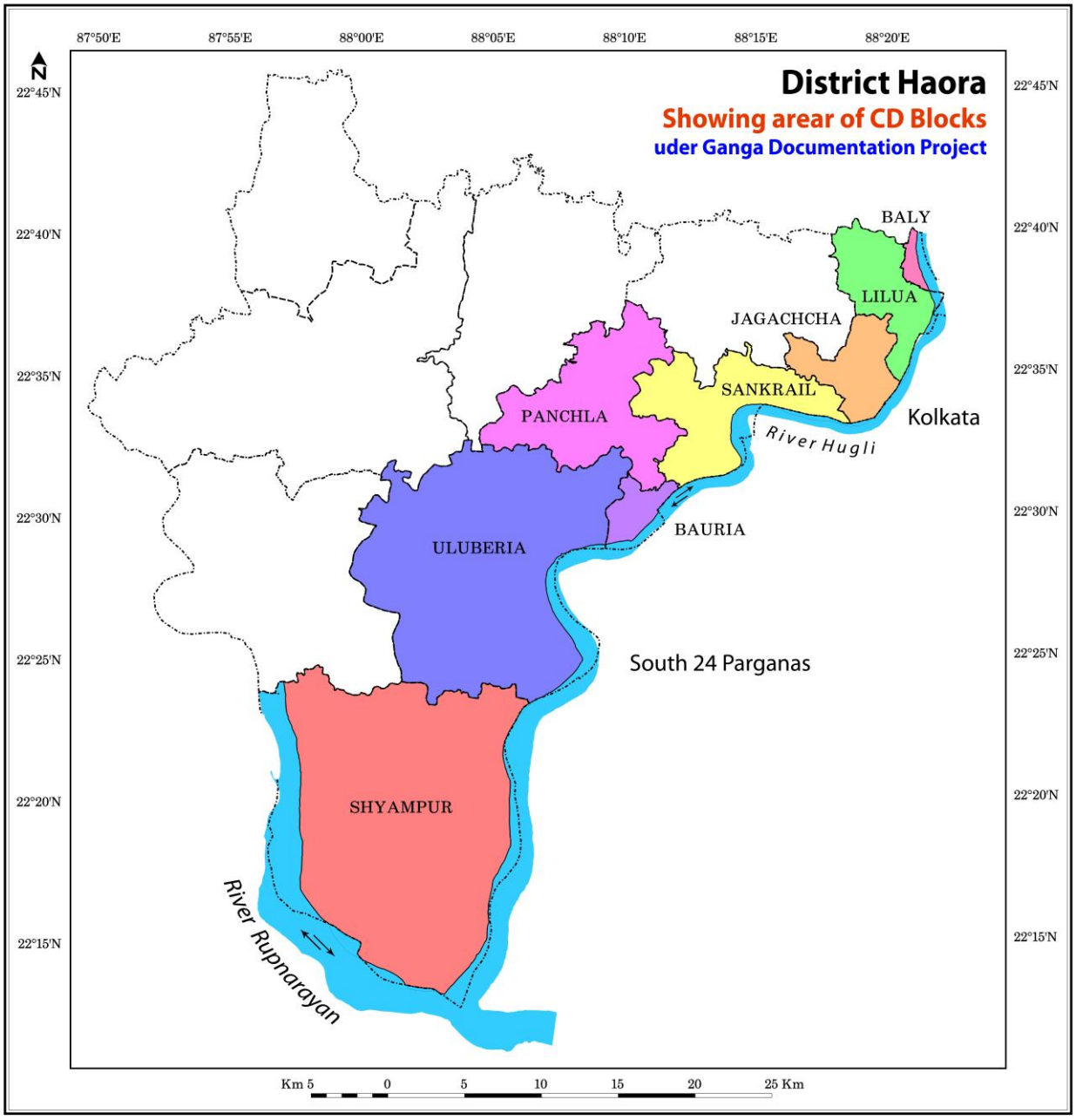
2.2. The Haora district lies between 22°48′ N and 22°12′ N latitudes and between 88°23′ E and 87°50′ E longitudes.The district is bounded by theHugliRiver and the North 24 Parganas and South 24 Parganas districts on the east, on the north by theHuglidistrict (Arambagh and Shrirampur sub-divisions), and on the south by Midnapore East district (Tamluk sub-division). On the west Haora district is bordered by the Ghatal sub-division of Midnapore West district, and partly by the Arambagh sub-division ofHuglidistrict to the north-west, and the Tamluk sub-division of Midnapore East district to the south-west.Boundaries of the district are naturally determined by Rupnarayan River on west and south-west, and by Bhagirathi-Hugli river on east and south-east side. On north side, the boundary is an artificial one except for Bally Canal on north-east and Damodar River on north-west.



Map No 3: District Map with Blocks, Source: District Census



Map No4: Study area, Haora district



Map No 5: Haora District study area blocks and municipalities

2.4. In general shape, the district of Haora is an irregular angle bounded on two sides by great rivers, the apexwhich lies at their confluence near Fort Momington. Its extremelength from east to west is about 28 miles, and its extremelength from north to south is nearly 40 miles. Hemmed in between theHuglion the east and the Rnpnarayan on the west,and intersected by fhe Damodar, the Haora district consists of aflat alluvial plain, with a gradual, almost imperceptible, risetowards the north and north-west, the general flow of drainagebeing consequently to the south and south-east. The product ofthese rivers and their branches, it comprises two main divisions,viz., the raised river banks and the large marshes or lowlandsthat separate them. In this way three distinct tracts are formed,each with a depression in the centre bounded by the high banks ofthe rivers, viz., an eastern tract stretching away from theHugliand its branch the Saraswati a central tract traversed hy theDamodar and its branch the Kana Damodar or Kausiki, and awestern tract consisting of the country between the Damodar andthe Rupnarayan. The upper courses of the Damodar and theRnpnarayan are somewhat higher than theHugli; and in theintervening country are numerous watercourses or creeks, called khals which run dry or are very shallow in the hot weather.

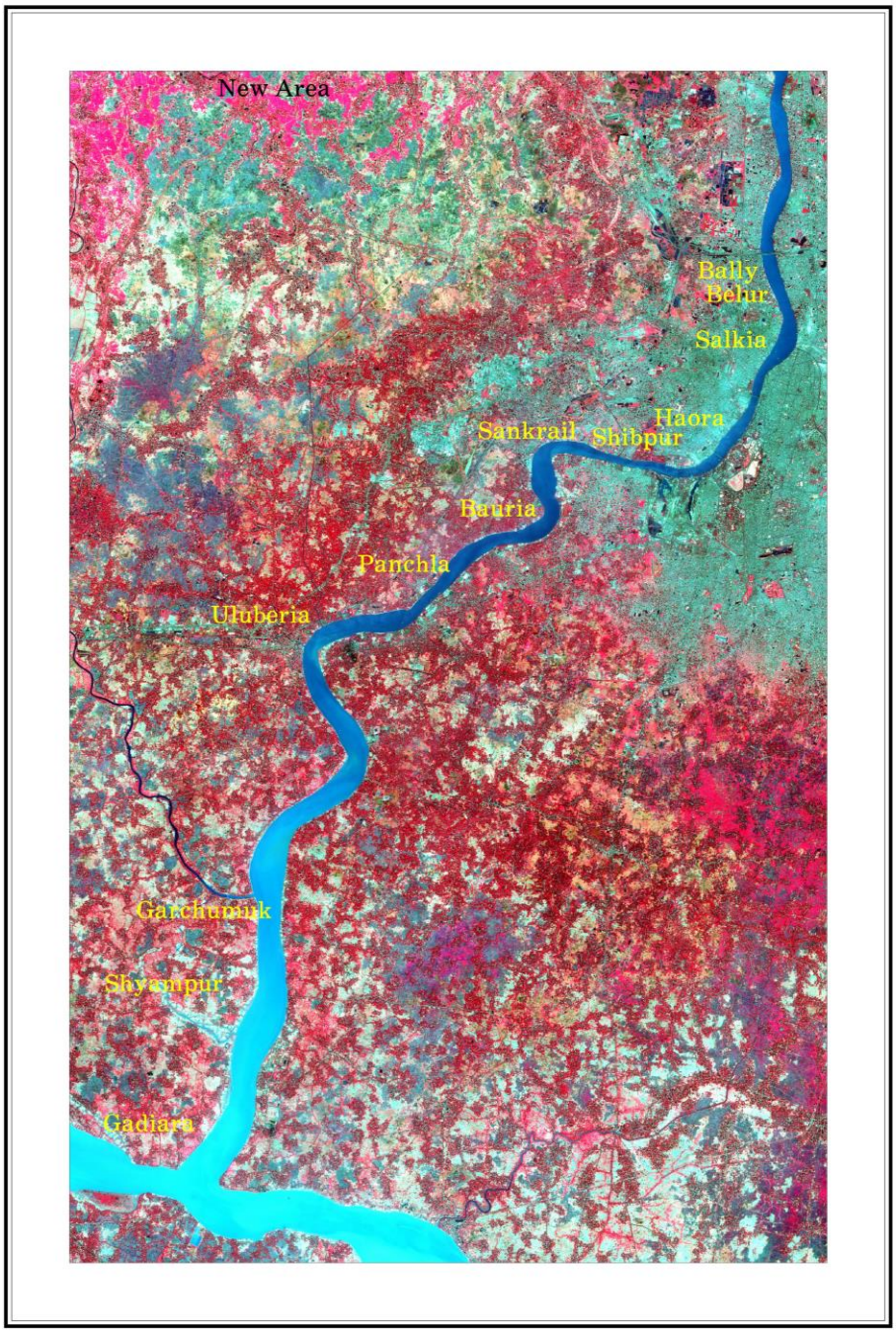
2.5.Study Area: River Ganga in form of its most important distributary, Bhagirathi - Hugli covers about **69 km stretch** bordering this mighty district . For our Study area (7km along the bank of the river) we have 4 Blocks – 1.Sankrail - 2.Panchla 3.Bally-Jagacha 4.Uluberia I & II 6.Shyampur I.

Sl.No	Blocks/Municipalities	Area (ha)
1.	**Bally Municipality**	11.81 sq.km
2	**Bally-Jagacha**	39.76 sq. km
3.	**Haora Municipal Corporation**	63.55 sq.km
4.	**Sankrail**	36.65 sq.km
5.	**Panchla**	53.42 sq.km
6.	**Uluberia Municipality**	34 sq.km
7.	**Uluberia II**	62.99 sq.km
8.	**Uluberia I**	114.4 sq.km
9.	**Shyampur I**	100.25 sq.km

Image No 1 – Bhagirathi –Hugli,Shyampur. 22°14'50.47"N 88° 4'14.25"E

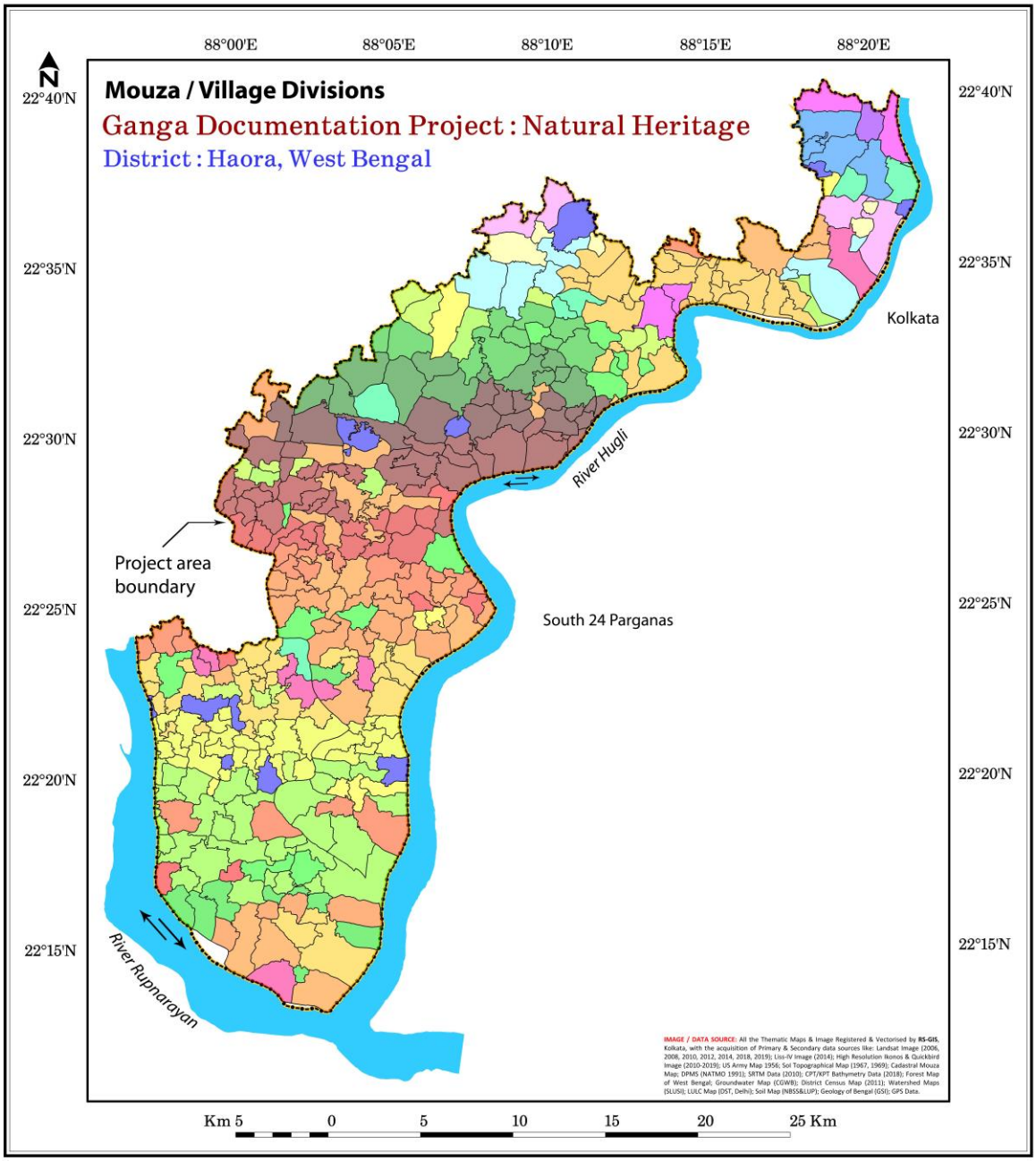
Image No2:Gadiara,Shyampur, the confluence of Bhagirathi –Hugli & Rupnarayan 22°13'14.99"N 88° 2'53.60"E

2.8. The Bhagirathi first touches Haora a little south of the Uttarpara where Bally Khal opens up to Bhagirathi-Hugli 22°39'18.12"N ,88°20'58.30"E,. Thence it flows southwards as far as Gadiara , Shyampur Block where it is joined by Rupnarayan River 22°13'14.25"N 88° 2'51.19"E. The river is then jacketed from both sides beyond Tribeni as it coincides with the boundary of Kolkata Metropolitan Development Authority. Some of the major municipalities are found along Hugli River in this district. They are – a. Bally-Jagacha b. Haora c. Sankrail d. Uluberia and the adjoining populated blocks of e. Sankrail f. Uluberia g. Shyampur etc.



Map No6: The Landsat, FCC image shows the highly meandering course of Bhagirathi-Hugli,Hugli

In this district, Bhagirathi-Hugli receives the tributaries of Saraswati, Damodar & Rupnarayan. The dense urbanized settlement with industries has number of canals opening up in the river discharging urban wastes, industrial effluents.



Map No7: Haora District with mouza or villages within our study area

3. Natural /Physical Background of The Study Area

3.1Relief: Hemmed in between theHugli (Bhagirathi) on the east and Rupnarayana on the west and intersected by the Damodar, the Howrah district consists of a flat alluvial plain, with a gradual, almost imperceptible, rise towards the north and the north west, the general flow of drainage being consequently to the south and the south east. The product of these rivers and their branches, it compromises two main divisions, viz, the raised riverbanks and the large marshes or lowlands that separate them. In this way ,three districts tracts are formed each with a depression in the center bounded by their high banks in the rivers.viz, an eastern tract stretching away from the Hugli(Bhagirathi); and in the intervening country and numerous watercourses' or creeks,called "Khaals" which run dry or very shallow in the hot weather . The characteristic feature of this riverine landscape is the levee formations along all the rivers in between which there are extensive swamps (jheels) or depression (jalas) forming vast sheets of water during the rains.

However, the district is not entirely devoid of relief variations. Micro level variations are discernible which are related with the variations in the depositional environments of the existing and past rivers. As generally expected the riverside s are characterised by the formation of slightly higher levees and the intervening areas are lowlands. These lowlands are mostly ill-drained and usually form marshes. These slightly higher river levees and the low-lying areas have a great impact on the land use and agricultural pattern of the study area.

The highest elevation of the study area from the sea-level is 16 m and the lowest is 2 m. A cursory view of the relief map of the district shows that the north-western part is slightly higher and the land imperceptibly slopes towards the east and south-east.Rivers like Hugli, Rupnarayan, Damodar, Kana Damodar, Saraswatt are flowing from north-west to south-east and east. This trend of relief variation has much saying on the divisions of the study area into a number of tracts. Thus rivers and the interfluvial areas generally form topographical units and four tracts can be identified in the district viz. **(1) Rupnarayan Damodar tract (2) Damodar-Kana Damodar tract (3) Kana DamodarSaraswati tract and (4) Saraswati-Hugli tract)** Brief descriptions of the tracts are given in the following lines which will help tn understanding the suitability of the tracts in respect of agriculture.

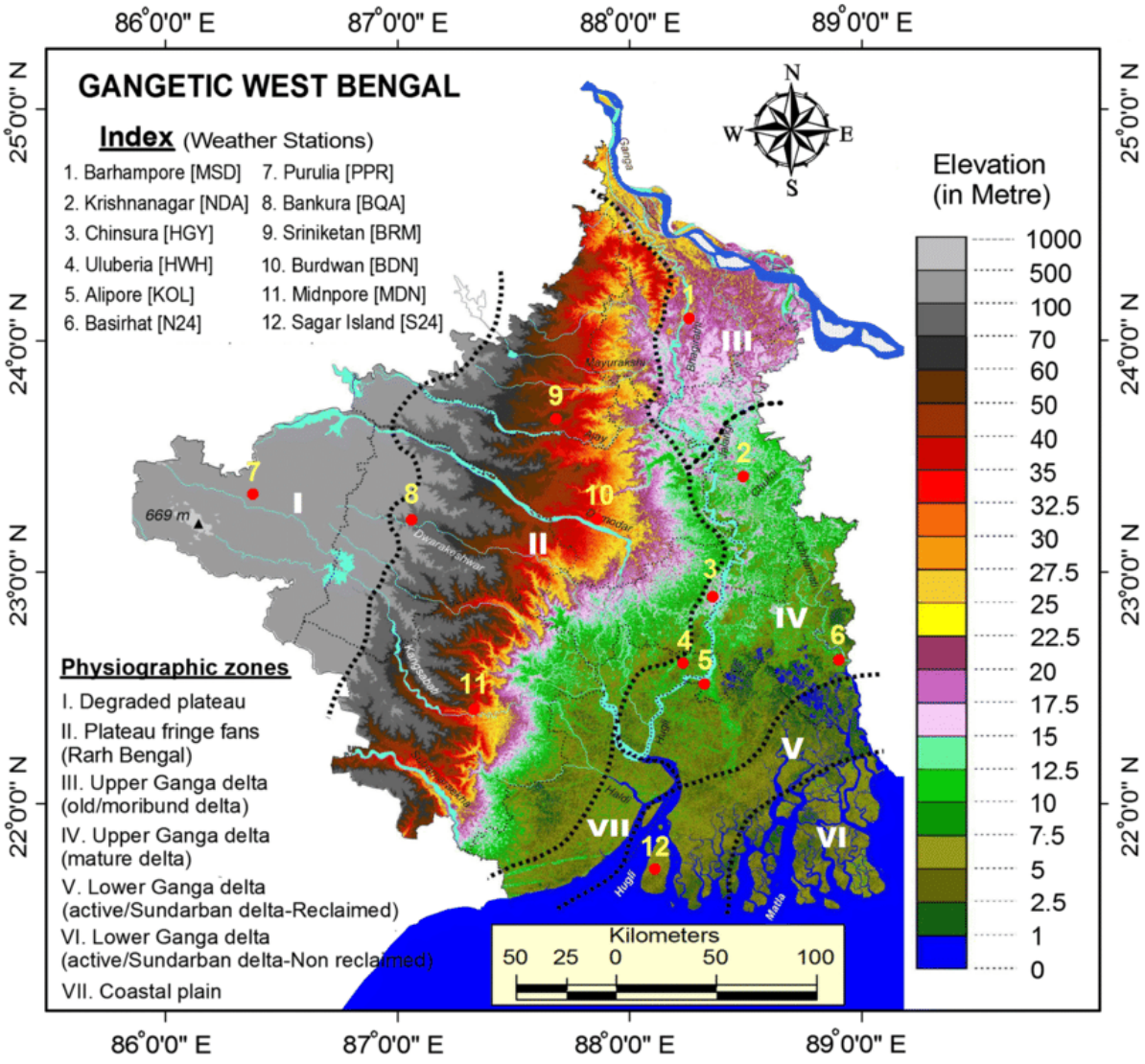
3.1.a.Rupnarayan Damodar tract : It lies between the river Rupnarayan and Damodar and occurs in the western part of the district. Along the eastern bank of the river Rupnarayan and western bank of the river Damodar the lands are higher than the intervening parts of the tract. The bench-mark readings from the topographical maps show that the riverside areas are 5 to 7 m above the sea-level. Man-made embankments along the river valleys are constructed to check overflowing. The embankments are higher in elevation from the general ground level of the tract. The north-western part of this tract is remarkably higher than any other parts of the district. The elevation is between 7 to 15 m. However, in the central part of this tract there is a slightly elevated zone stretching from east to west. The 6 m contour line marks this area, lying close to the town of Bag nan. Between the levees of the Rupnarayan and Damodar there lies a low-lying area stretching parallel to both the rivers. The elevation of this part ranges from 2 to 5 m. above the sealevel. The low-lying tract is nothing but a number of interconnected depressions. Some of the depressions are— Western Amta Depression (south of Bakshi Khal), Southern Bagnan Depression (North-east of Nakall Khal) and Southern Shampur Depression (Southern most part of Shampur PS). It should be noted that the depressions or marshes have elevations which are generally 3 m above the sea-level. They lie parallel to the contour lines mostly.

3.1.b.Damodar – Kana Damodar Tract : It is an interfluvial region occurring between the rivers Damodar and Kana Damodar. The central part of this tract lies north of Uluberia Canal. There is also a slightly elevated part in the central part of the tract which is bounded by 6 m contour line. This elevated part or ridge divides the central low-lying area into two segments— one lying to the north and the other to the south. The riverside levees have elevations of 8 m in the north and 4 m to the south. The Hurhuria (north of Uluberia Canal) and Uluberia marshes (south of Uluberia Canal) have the least elevation in the tract. The marshes are bounded by 3 m contour line. Hurhuria marsh is also known as Amta Swamp

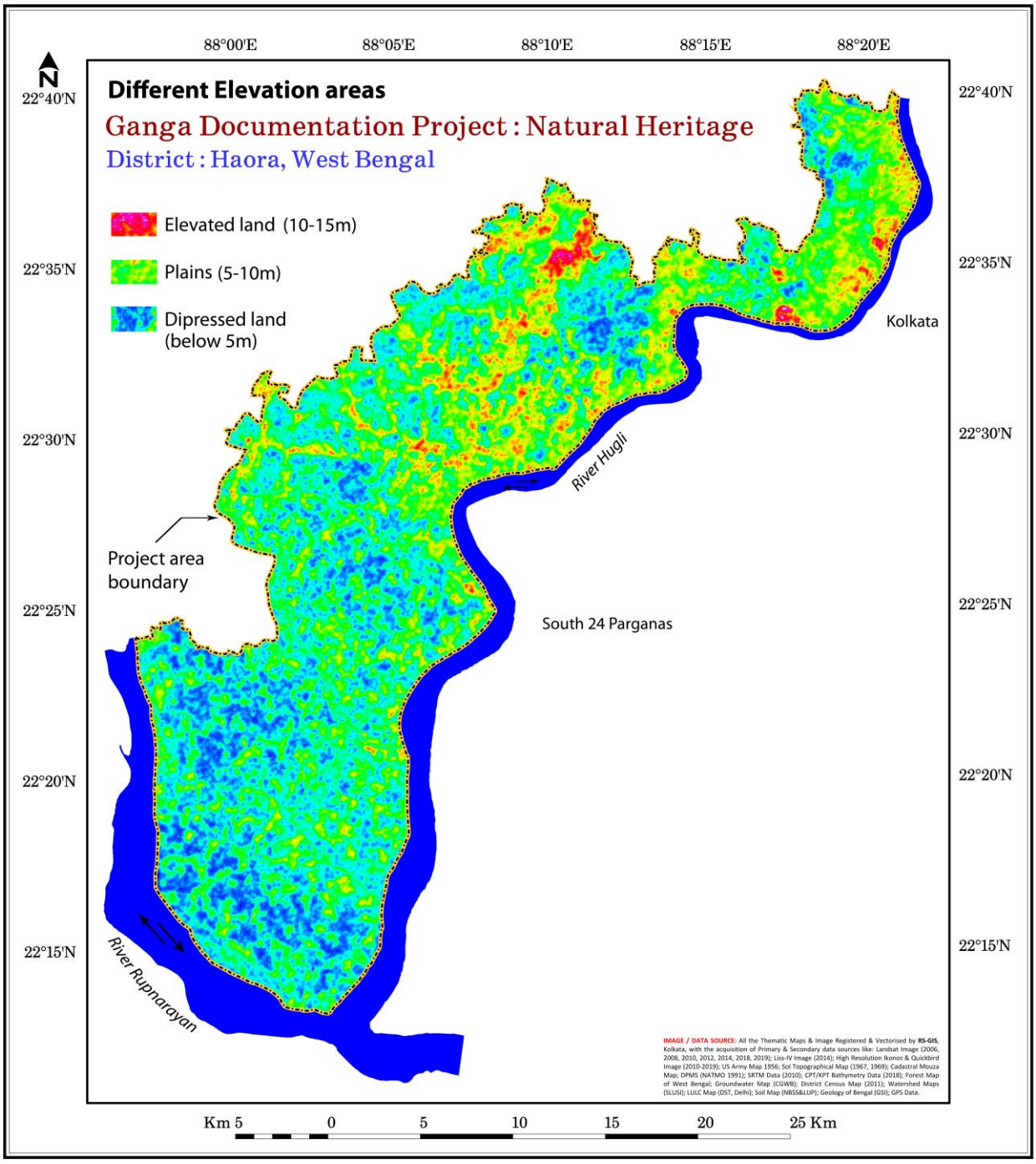
3.1.c.Dana Damodar - Saraswati Tract - The -tract is marked by large swamps of the district. Apartfrom these swamps, an area with higher elevation lies in the southernpart of this tract i.e. on the Hugli levee. It's averageheight is 5 m. A major part of this tract is bounded by 3 m contourline. In the central part, the area has an elevation of only2 m. Therefore, a marshy land has developed covering a large portionof north-central part of this tract. This marshy land ordepression is known as Bargachhia marsh or Rajapur Swamp.

3.1.d.Saraswati-Hugli Tract -The highest elevation of this tract is 5 m. from the sea-level. The river levees again form the higher lands while theintervening central parts are lower in elevation (below 3 m).Haora swamp is located in this intervening area.Along the western bank of the Huglt river, a conspicuouslevee has been formed with however, occasional breaks. The leveehas an elevation not exceeding 5 m. and it has an averagewidth of 2kms. The overall slope of the levee is towards the westi.e. towards the chain of marshes.

It is observed from the above study that though the districtis a flat alluvial plain, all lands are not equally suitablefor crop cultivation. Higher levees are generally free from flood.Some of them are sandy and therefore not suitable for agriculture.The lands which have low elevations from the sea-level get waterlogged.These are also left out of agriculture. The lands whichare not too high and too low from the sea-level are highly suitablefor crop cultivation.

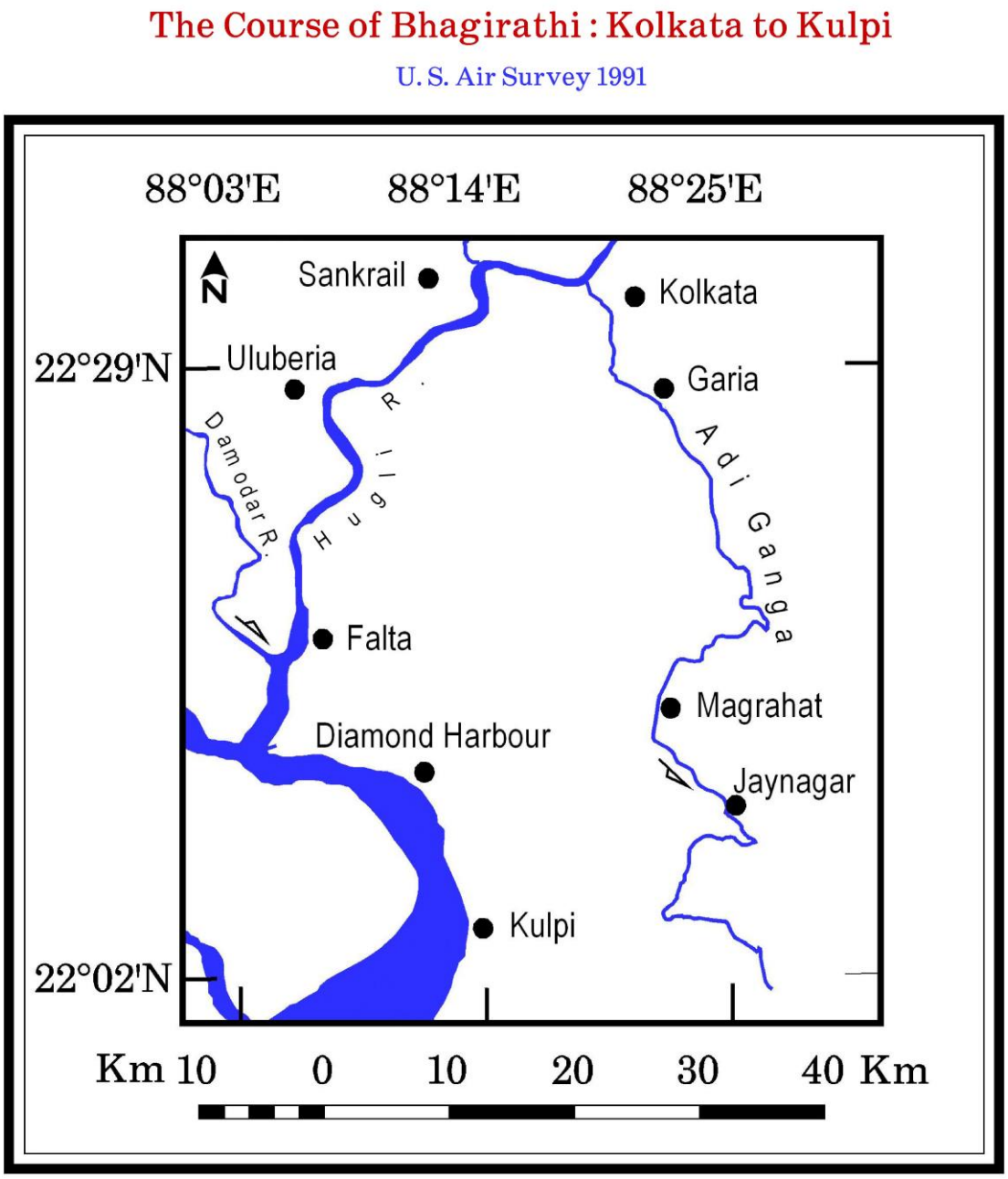


Map No8: Lower Gangetic West Bengal showing elevations



Map No9: The study area of Haora District showing the range of elevation. Source: SRTM

3.2River System: Haora district is essentially *riverine* in character,beingembraced by the two remarkable rivers of West Bengal, the Hugli in the east and the Rupnarayan in the west. The Damodar traverses the district from north to south. The contributionof these rivers to the formation of the land canhardly be under estimatedoriginally the district was a marshy tract, which wasgradually filled up with alluvium brought down by the abovementioned rivers. A study of the behaviour of these threeprincipal rivers - the Hugli, the Damodar and the Rupnarayan,and their tidal effects may fruitfully be elaborated for assessingthe mode of draining in the district



Map No 10: Course of Bhagirathi-Hugli from Kolkata – Haora to Gadiara-Diamond Harbour

Image No3: Second Hugli Bridge, RamkrishnapurGhat,Haora

Image No 4: Kolkata Landscape from Haora

3.3Climate: It is true that the influence of climate is most conspicuousin traditional agriculture, particularly in underdevelopedor developing regions. It puts limit to cultivation and alsodetermines the type of soil and natural vegetation. The characteristicsof the soils are the product of present and pastclimate i.e. conditions along with the vegetations that flourish over those soils. Therefore, climate is considered to be the mostimportant geographical factor which influences the distribution and nature of agricultural activities and type of crops to becultivated. Like the whole of India, the agrarian life of Haorais heavily dictated by the seasonal distributions of temperatureand rainfall. Every crop has its own optimum temperature andrainfall conditions. So, every crop is cultivated in particularseasons only. Therefore, a study of climate and its seasonalityis of paramount importance.

Haora district, like the rest of West Bengal, falls underthe influence of tropical monsoon climate. The tropic of cancerpasses through a few kms north of the area, and therefore, the district is open to the full blasts of the monsoonal winds. Thedistrict is situated on the eastern part of the Indian subcontinentand on the western flank of the Ganges delta. Though variationsin regional distribution of rainfall and temperature arewell marked in India, the variations are not well marked in thedistrict like Haora of its smaller size.

3.3.1. Temperature and Pressure

There is not even a single temperature recording stationwithin the study area. Therefore, an idea of climatic conditionscan be made from the data available from the adjoining area. The mean annual temperature of the district varies between 25° to26°c. The mean monthly temperature is shown in table 2 ,

Considering the seasonal variations, it is observed thatthe mean summer temperature of the district is 28.75°C. Duringthis period the isotherms generally trend from north-east to south-west and the temperature increases from east to west.In winter the mean temperature is 18°C. The isothermsgenerally trend from east to west and the temperature increasesfrom north to south. The mean monthly range of temperature duringthis season varies from 2° to 3°D. However, the range is slightlygreater in the southern part of the district than in the north. It appears from the mean monthly temperature distributionthat although cropping seasons are governed or dictated mainlyby temperature conditions, temperature remains above thresholdtemperature throughout the year i.e. the crop cultivation neversuffers from the lack of temperature.

3.3.2. Wind and the Occurrence of Rainfall - It is the wind which carries moisture bearing air that ultimately cause rainfall, much required for crop cultivation.However, it may also carry dry winds which are antagonistic toprecipitation. Whether it carries rain bearing air or dry airdepends upon the direction from which it is blowing. And thedirection of wind is determined by the variations in temperatureand pressure conditions.

3.3.3. Air Temperature, Pressure and Wind From - the start of the month of March, the temperaturerises perceptibly. Consequent in this there is fall of air pressure.During the month of April and May air temperature risesrapidly due to intense surface heating. This leads to thedevelopment of cyclones which are locally called nor'westers orKal-baisakhis. Few centimetres of rainfall occur. This amountof rainfall is useful for the cultivation of aus and jute.From the middle of May air temperature rises very rapidly.

Consequent to this, there is rapid fall in air pressure, especiallyin the interior of the landmass. This leads to the developmentof sea-breeze which makes the condition less trying for thepeople in the afternoon. By the end of May the low pressure.trough developed in the west India is greatly accentuated anddraws winds from the Indian ocean which are supercharged withmoisture. Precipitation starts all of a sudden in the 1st or 2ndweek of June. This sudden start of rain is known as the (onsetof monsoon". The rainy season lasts for about 3 months. Nearly90 per cent of rainfall occurs during this season and constitutes

the main cropping season in the district.

From mid August to September, temperature starts fallingand from the month of November a cool weather season begins. Thisseason of low temperature is known as winter. In winter cool drywinds blow generally from the north and north-west. Wind velocityis least in November and December and greatest in the summermonths.

Though the winds during this season remain dry, the seasonis not entirely devoid of rainfall. Little amount of rainfallassociated with western disturbances occurs during this season.

This rainfall, though little in amount helps the maturing of rabjcrops.

3.3.4- Distribution of Rainfall -Though there are no temperature recording stations in the study area, there are six rain-gauge stations, located in differentparts of the district. These are Jagatballavpur, Ulube ria-I,Shampur-II, Amta-I, Bagnan-I and Udaynarayanpur. The data whichare collected from these stations are extremely effective andmeaningful for the study area so far as agriculture is concerned.The mean annual rainfall distribution in the area

indicates perceptible spatial variations. The disparity is mainly related withthe passage of depressions from the south-east and east. Rainfallis generally greater along the path of the depressions.Mean annual rainfall (mean of 12 years i.e. from 1976 to1987) of the district is 1554 mm. From the study of the distributionof rainfall it is observed that in the eastern part, rainfallis higher which varies between 1600 mm to 1700 mm. The policestations which receive higher amounts of rainfall are Domjur, Liluah,Sankrail, Panchla, Bawria, Uluberia and the eastern half of theBagnan PS. In the remaining police stations of Jagatballavpur, Badynarayanpur, Amta, Shyampur and western part of Bagnan which aresituated in the loestern half of the district, the rainfall variesbetween 1400-1600 mm.. Thus the mean annual rainfall graduallydecreases from east to west.

During the hot weather season from March to May, someamount of rainfall occurs due to norwesters and the isohyets lines for norwesters rainfall run in a north-south direc tion showing that the amount of rainfall decreases from east to west. So, Jagatballavpur receives the highest amount of rainfall (229mn)while Shampur gets the least amount of rainfall (204mm). The dirtrict'saverage rainfall is 218mm during this season.

The south-west monsoon season i.e. during the period from June to September is the most important season so far as theamount of rainfall is concerned. During this period, the average rainfall in the major part of the district ranges between 1150to 1250 mm. In a narrow belt of western and northern parts of the district it varies between 1000-1500 mm. Uluberia (located in tiesouth-east) receives the highest amount of rainfall of 1232 mmand Udaynarayanpur located in the north-west records the lowestrainfall of 1023 mm in the district . The average rainfallduring this rainy season is about 1150 mm. It will not beover saying to say that the success or failure of agriculture inthis district is primarily dependent upon the pattern of rainfallduring this season of south-west monsoon.During the cool weather season (October to February) thehighest amount of rainfall occurs in the western part of thedistrict from which rainfall decreases in all directions . The Amta PS receives the highest amount of rainfall of 215 mm.The minimum rainfall is experienced in Udaynarayanpur where rainfall is to the extent of 153 mm. The district average in thisseason is 179 mm. This rainfall, though small in amount is importantfor the maturing of rabi crops.

3.4 Soil: The entire districtof Haora is covered with alluvium, brought down by the existingor past rivers. So transported alluvial soils are the characteristicof the district. However, the character of the alluvium visa-vis alluvial soils varies from place to place depending upon thesource regions of alluv ium. The three mighty rivers which contribute to the alluvial character of the district are—the Hugli,the Damodar and the Rupnarayan. However, the deposits carried by the Damodar are quite different from that of the Hugli. The alluviumof ' the Hugli is generally marked by its fineness as a consequence of the rivers long Journey from the source to the mouth.

This type of alluvium is generally whitish in colour and occursmostly in the eastern parts of the district.In the western part the alluvium is generally brought down from the Chotanagpur plateau. This type of alluvium is slightly coarser in texture and slightly reddish in colour. Here the alluvium is brought down by Damodar, Rupnarayan and few other east-flowingrivers.The alluvium, covering this district is very great inthickness. Keeping in mind the nearness of the Chotanagpurplateau to the west it may be presumed that the thickness ofalluvium is greater to the east and less to the west. Fewborings in some selected spots could not find any hard rockbed even far below the surface.From time immemorial, man has depended on soil for food, whether it is obtained from forests or from agriculture. Theimportance of soil for agriculture cannot be under estimatedin any way. An intimate knowledge of soil is a pre-requisite forall agricultural operations and planning.Soil is the source of practically all man's food, clothingand ever increasing list of other needs. Agriculture generallyflourish in areas of fertile soils, while poor soils donot encourage good agriculture. Hence, geographical investigationof soil characteristics in agricultural geography is of greatsignificance.However, it may be bourne in mind that, fertilityis a relative term. Some soils may be fertilecrops while the same soil may not be fertile for otherTherefore, the concept of fertility and productivity iscomplex and is used in different senses or in different contexts. But in brief, fertility refers to a quality that enables the soil to provide the proper plant nutrients in proper amounts for thegrowth of the specified plants, especially crop bearing plants.Soil productivity is however to be taken in more comprehensiveway where all production related factors are associated including the techniques in management.

Let us now have a look into the types of soils and theircharacters prevailing in the study area. This will help in understandingthe impact of soils on agriculture in different parts of the district.It has already been stated that the low-lying plains ofthe district are built-up by the combined alluvial deposits ofthe Hugli, Damodar and Rupnarayan rivers. River-borne

alluviumand micro variation in relief play an important part in thedevelopment of soils of this region. The low flood plains receivethick blankets of sediments regularly while areas of higherelevations remain partially or entirely unaffected. The fundamentalpedogenic processes of eluviation and illuviation (i.e.leaching and deposition), give rise to different soil types. Theeffect of topography i.e. relief is either to accelerate or retardthe pedogenic processes. Based on the physico-chemical characteristicsthe soils of the district (Gazetteer, 1972) can tentativelybe grouped into four categories viz.

(a) Damodar riverine,(b) Damodar flatlands, (c) Ganga lowlands and (d) Saline soils

(a) Damodar riverine : This category forms a particular soilassociation and occurs in the north-western part of the districti.e. Udaynarayanpur and western Amta police stations. It is dominatedby continuous siltation resulting from annual floods. Thesoils are generally loamy to clay loam in texture while sandyloam soils are found along the bank of the Damodar. The colourvaries from yellowish brown to ash grey.

(b) Damodar flatlands : Jagatballavpur, eastern Amta and northernparts of Panchla PS form this type of soil association. Here, thesoils are formed from the alluvium which is deposited by the riverDamodar at an earlier date. The soils are mostly clay loam intexture and the colour is dark grey to brownish grey and even black.

c) Ganga lowlands : The police stations3 located in the northeasternand east-central parts of the district i.e. Liluah,Domjur, Sankrail, western Uluberia and north-eastern parts ofShampur PS fall in this category. Here, the older alluvium i.e.the sediments of Damodar are buried under the newer alluvium ofGanga. The soils are loamy to clay loam in texture and the colouris dark grey to grey brown or olive brown.

(d) Saline soils : Some soils are saline due to the effect of theincursion of saline water from tidal inflow and chemical processesoccurring in the soils. These types of soils occur in the southern part of the district under the police stations of Bagnan,Bawria and parts of Shampur, Uluberia and Panchla. The soils arelight clay to heavy clay and the colour varies from reddish to nolive grey or brownish grey to blackish grey and light black.

Cultivators from their long experience have grouped thesoils which are mostly related to the texture of the soils.According to them the soils are divided into ‘bele* or sandysuitable for the growth of vegetables. <‘Entelt or clayey soil is best suited for paddy. Penko* or muddy soil is often usedfor manuring. ‘Bhasa* or marshy lands^the soils of which needreclamation.

(e)Soil pH: The mobility of soil nutrients is related with soil reaction. An idea of soil reaction of the study area can be had from the soil reaction survey, conducted by the Departme nt of Geography, Calcutta University from which the following results are obtained (Chatter jee and Mukherjee, 1956).

In Haora district the pH value ranges from 5-2 to 8,8. A cursory look at the pH map (Mukherjee, 1960) shows the following characteristics.

i) More than 50 per cent of the area has got soils with neutral reactions.

ii) The soils of north-central portion of the district is acidic, in some places it is strongly acidic. The southern andeastern parts have however neutral to alkaline soils, but for a small patch in Sankrail it is strongly alkaline.

iii) The soils in the south and adjoining areas of Hugli river are predominantly alkaline in reaction.

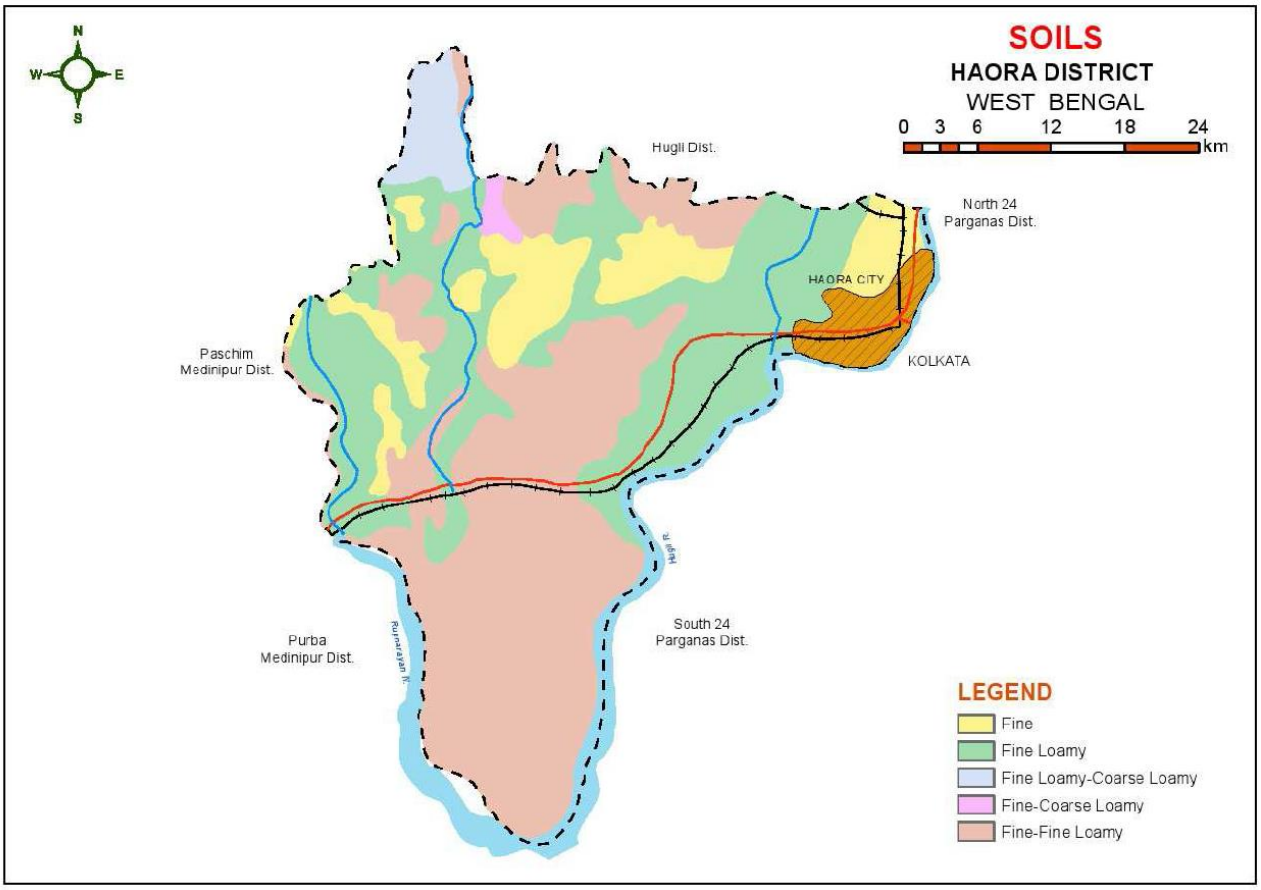
The variations in soil reaction in different parts of the district may be explained by the following points.

(1) Geologically, the area is comparatively younger, having no steep slope to disfavour percolation of basic materials(Chatterjee & Mukherjee, 1957)• The area neither has wide deposits of basic material, like limestone, as a parent material, nor has it got any impeded drainage. As such, the soils are not alkaline in general. Moreover, the deposition of silt in the low-lying areas favours the deposition of minerals and hence check the fail of pH value of soil.

(2) The north-western part of the district bears an area whichis slightly higher in elevation and possesses steep slope. Soils are sandy in texture. These have led to comparatively greater degree of percolation. Besides, with intensive cultivation, year

after year, without any liming, the soils has become more and more acidic. But the condition is quite different in the south, where a bulk of the land gets inundated almost every year. So the mineral deficiency is replenished accordingly.

(5) The higher pH of the soils adjoining Hugli river, can be explained by the fact that the water of this river has a high proportion of sodium bicarbonate. The continuous deposition of sodium bicarbonate raises the pH of the soils in this part. The greater amounts of skeletons of dead snails, which are composed wholly of calcium carbonate, tend to increase the soil pH. This latter body is also responsible for maintaining pH value within8.5 .



Map No11: Soil Map of Haora District,Source: AISLUS

3.5 Geology: Quaternary sediments (i.e. newer alluvium and older alluvium) of huge thickness cover entire district. Four types of geologic lithology namely a) sand, silt and dark grey clay (83.36%) (Chinsurah formation) b) sand, sandy loam, silt and silty clay (11.72%) (Sijua formation) c) Very fine sand (1.51%) (Present day deposit) d) Lateritised boulder, conglomerate (3.42%) (Lalgrah formation) arefound in the study area (Fig. 5a). The alluvial sediments in the area viz, the Sijua formation, the Chinsurah formation, and Present-day flood plain deposits are identified along the Dwarakeswar, Damodar and Hugli rivers. Chinsurah formation covers the central and eastern part of the district. It is thin in the central part and generally thickness to the east. Sediments vary from fine sand, silt and clay to plastic

clay. The oldest of the alluvium is Sijua formation and it covers the major portion along the western part of the area and lies unconformably over the Lalgrah formation. It is composed mainly of sand, sandy loam which is gradually change to silt and silty clay in the lower reaches. Present day flood plain deposits occur along the course and banks of the river flowing in the area (GSI, 2006). The sediments range from loose unconsolidated, sub angular, coarse vary to coarse grey sands and gravels grading gradually to greyish white silt and clay. The lateritic uplands designated as Lalgrah formation present to the west and north of the Kamarpukur. It consist of lateritised boulder conglomerate, rework secondary laterite and lateritised grit and is frequently capped by brownish red [1 me3 m thick residual soil (latosol)]. Over the flatted top eroded surface of the Archaean basement estuarine to deltic sediments were deposited during the late tertiary period which have been grouped as Bhairab Banki formation. Laterization of this formation gave rise to the Lalgrah formation.

3.6 Natural Vegetation: The natural vegetation of the area is very difficult toascertain since the whole area is under plough for a long timeback. Being a riverine tracts the area has been formed by thedeposition of sediments brought down by the Ganges and the eastflowing rivers like Rupnarayan, Mundeswari etc. These sedimentsmay have also brought considerable amounts of seeds from distantareas, and caused an intense mixing of the native vegetation ofthe area with the vegetation coming from outside the area. D. Pain(op.cit.) has rightly pointed out while speaking about the naturalvegetation of Hugli, Haora and 24-Parganas that uihere is a sensein which, except perhaps in the Goghat subdivision of the Huglidistrict, no species can be indigenous to the area. The whole ornearly the whole tract consists of land laid down by the greatriver Ganga or its distributaries and therefore all the plantsgrowing on its surface must be immigrants from elsewhere."

From a very early time, the whole of Haora district belongsto the rice swamp of central Bengal. There is nothing thatcould possibly be termed genuine forest in the whole of this area. The influence of forest vegetation, if there was any, onthe nature of the soil cannot be traced now. For a long periodpaddy has been grown here with some isolated trees here and there.The roots and stubbles of the paddy go to form the chief sourceof organic material. Grasses cover the land while it remainsfallow during rotation, also go to supply some organic matter fromtime to time.

From field investigations it has been found that the presentdistribution of the vegetation is not uniform in the region.The riversides and the former levees of the dead river channelsof the

police stations of Amta and Bagnan are conspicuous in having a comparatively denser tree stand than other areas ofthe Haora district. Slightly higher lands as we observe in
Amta and Bagnan police stations are provided with trees, whilethe low-lying areas are areas of paddy cultivation or are occupiedby marshes. Periodic flood and inundation are the two retardingfactors for the growth of tree vegetation. However, treescheck soil erosion.
A broad stretch of land and an another old *levee* area,running north-east to south-west in the police stations of Panchlaand western Domjur have denser tree stands. Trees in Liluah3 eastern Domjur and Sankrail are however of moderate density.
Low elevation, annual inundations and higher percentagesof arable lands are the factors responsible for sparse vegetationin Uluberia and Shampur police stations.
The species of trees, which are dominant in the Hugli andRupnarayan Doab area vary to a considerable extent. The upperparts of the river channels of this tract or the levees abound in Palm (Palm Hue ifera), Coconut (Cocos-Hucifer), bamboo (BambusaArundinaceae), Babul (Acacia Arabica), and Tamarind (TamarindusIndica). The levees meet together near the confluence of theRupnarayan and Hugli rivers.
Outside the Eoyal Botanic Garden at Sibpur, of which a Botany.there is little ofespecial interest to a botanist. The vegetation is composedalmost exclusively of the aquatic and marsh plants to be metwith in the alluvial rice fields of Bengal, such as Hydrilk^Utricuhria, or of those semi*spontaneous plants thatform the village shrubberies of Central Bengal, such as O/ycosmis,Trema^ Urena^ Sohnum, Batura^ Lemiotn and the like. Wasteplaces are generally covered by a weedy vegetation, and one ofthe striking features of the district is the extent to which theweeds which occur in these places are exotic so far as Bengal isconcerned. Many of them, indeed, such as *Scoparia, Ageratum, EvolvulusNummularius* and *Peperomia peliucida*though nowremarkably abundant, were originally natives of America.

A Special Report on Acharya Jagadish Chandra Bose Botanical Garden : The Acharya Jagadish Chandra Bose Indian Botanic Garden, previously known as Indian Botanic Garden and the Calcutta Botanic Garden, is situated in Shibpur, Haora near Kolkata. They are commonly known as the Calcutta Botanical Garden and previously as the Royal Botanic Garden, Calcutta. The gardens exhibit a wide variety of rare plants and a total collection of over 12,000 specimens spread over 109 hectares. It is under Botanical Survey of India (BSI) of Ministry of Environment and Forests, Government of India.

Image No5:The Great Banyan Tree of Acharya Jagadish Chandra Bose Botanical Garden

But little did people know that the 225-year-old garden sprawling over an area of more than 270 acres and housing more than 12,000 trees has history hidden in its every nook and corner. "Each plant in the garden has its own history and each story is more interesting than the other. People do not know that several trees, which they now see all around them, had at some point in time been cultivated in the garden and then spread to the entire country and some even to other parts of the world," said joint director of the garden, HS Debnath.

From the very beginning, all sorts of trees yielding flowers, timber, fuel or fruits were introduced into India through the Botanic Garden and distributed throughout the country.
The first salaried superintendent of the garden **William Roxburgh** reported in 1806 that two plants of Mahogany came to the garden from West Indies way back in 1795," he added.Within a few years the scientists reared at least 500 trees from those two plants. These were then distributed across north India."By the year 1797 the authorities had built up an entire avenue (a road flanked by Mahogany trees on both sides) named Mahogany Avenue in the garden. The avenue exists till date and is a flag bearer of the garden's rich history," said S S Hamid, senior scientist of the Indian Botanic Garden.

Image No6: Entrance of Acharya Jagadish Chandra Bose Botanical Garden

Image No7:It has a large collection of palms representing about 116 species under 53 genera and 8 subfamilies of Arecaceae (Palmae).

Image No8: Bust of Acharya Jagadish Chandra Bose at the entrance.

Image No9: Number of waterbodies are present within the Botanical Garden

Similarly the **Casuarinas**, which are now abundantly found along almost all seashores such as Digha, were at one point in time been first cultivated in the garden and then spread to the other parts of the country.

Cinchona: India had for many years known of the success of Cinchona barks in the treatment of malaria. But the history of this plant, when and how did this plant come to India, still remains embedded in the shady ambience of the garden.

Sources said that the first official suggestion to introduce Cinchona in India was made in March 1852. The objective was simple - to provide a home supply of the drug which was indispensable for the treatment of 'Indian fevers'.

In 1853 six Cinchona plants were sent from London to Calcutta. The plants were doing well in the Botanic Garden but all of them died when transferred to Darjeeling. Six years later a British government officer in South America was asked to procure seeds of various Cinchona plants found in South America. Later a few plants were brought to India and taken to Ootacamund in the Nilgiris. A few plants were later forwarded to the Botanic Garden. In 1862 the garden could boast of more than 280 Cinchona plants in the garden.

Corypha Taliera: The tree was endemic to West Bengal and could be found abundantly in most areas in the Bengal region till the 18th century. But now it is extinct in the wild. Official records point out that only two specimens of the species are now found in the entire world. While one is growing in the Dhaka University, the other one could be found in the Botanic Garden in Shibpur. It is the only one in India. But how did the species become extinct?
The tree stands several feet tall and bears flowers only after it attains 60 years of age. The tree stands tall and with its enormous leaves and flowers which bloom once in several years villagers often call it the ghost tree. Soon after the Bengal Famine, which struck in the 1770s, villagers started to cut down the trees indiscriminately after a rumor spread that it was because of this tree and its flowers that the famine had occurred.

"The last record of this palm growing in the wild was in a village near Shantiniketan where it was in an early fruiting stage in 1979, but the seeds could not be saved as the villagers cut

down the tree along with its 6m tall pyramidal inflorescence fearing it to be a ghost tree," Debnath said.

The last one in India growing inside the garden was born just 15 years ago from its mother. The mother had flowered in the year 1994 and produced seeds after which she died.

Rubber tree: In India, the British planters introduced commercial cultivation of natural rubber, although the experimental efforts to grow rubber on a commercial scale in India were initiated as early as 1873 at the Botanical Gardens.

"Rubber tree initially grew in South America in countries such as Brazil. It was an offence to bring seeds of a rubber tree from Brazil. The British however employed a man who somehow managed to bring four plants. Unfortunately all the trees died within a span of few years," said Debnath.Later two to three sacks of seeds of rubber plants were procured and the British started experiments with rubber plants in the garden

Image No10,11,12 & 13: The Great Banyan Tree of Shibpur Botanical Garden

Wetland Vegetation : In ponds, jheels and marshy areas floating, fixed and' amphibious macrophytes occur in abundance. This vegetation type includes emergent plants comprising mostly of the family *Cyperaceae* (Mutha grass) and *Gramineae* (fodder grass). The root and Iower part of the stem of these hydrophytes are usually submerged under water while the leaves are exposed to the air. A 'number of species belonging to this vegetation type are commercially important such as Shola I (*Aeschynomene indica*), Madurkathi and Muthagrass (*Cyperus spp*.), Kalmi shak (*Ipomoea aquatica*) and Hogla (*Typha elephantina*). Some rooted floating forms viz ... Sushni shak (*Marsilea quadrifoliata*) and Paniphal (*Trapa bispinosa*), natural1y grown or cu1tivated in wetland areas are also known for their commercial value. Besides their commerci.al value, wetland plants are being increasingly recognized for their ecological values in recent years. They provide feeding, breeding, spawning and nesting sites for a large number of fishes, prawns, birds and other aquatic animals. While several plant species, namely, water hyacinth, water lettuce and duckweeds, natural1y grown in wetlands of Haora and Hugli districts, are being used in the pol1ution abatement. of east Calcutta's sewage-fed wetlands

Categorization of floral diversities with examples

Sl.No.	Categories	Examples
1	**Free Floating Forms** **a. Floating Hydrophytes** **b.** Suspended hydrophytes	Kochuripana (*Eichhorllia crass;pes*), Tokapana (*Pistia*), Khudipana (*LeI111la*). Guripana (*Wo/ffia*). Kutipana (*Azolla*), etc. Jhanji (*Ceratophyllll1l, Utricularia*).
2	**Fixed Anchor Form** a. Anchored submerged hydrophytes b.Anchored floating hydrophytes	Patashaola (*Vallisneria spiralis*), Panikola (*Ottelia*). Kureli/Jhanji (*Hydrilla*), Shaolaghas (*Najas*) etc. Padma (*Neltllllbo 1lucijera*). Shapla (*Nynlphaea* spp.). C. Amphibious forms: Panchuli (N*ynlphoides* spp.), Paniphal (*Trapa* spp.). etc.
3	Emergent amphibious hydrophytes	Sushni shak (*Marsilea qlladrifoliata*), Kalmi shak (*Iponloea aquatica*), Halencha (*E1lhydra fluctualls*),. Senchi (*Alterlla1lthera sessi/is*), Shola (*AeschYllonlene spp.*), Kochu (*Colocasia esculerrta*). Ghechu (*Apollogeton spp*.), etc.
4	Facultative forms: Reeds Sedge Weeds	 NolKhagra (*Phragnlites karka*), Hogla (*Typha spp,*). Muthaghas (*Cyperus spp*.), etc. Thulkuriffhankuni (*Celltellella asiatica*).
5	Algal forms : Solitary unicellular algae Colony forming algae Filament9ns algae Branched coenocytic algae	 *Euglella, Microcystis, Diatoms.* *Volvox.* *Spirogyra, Oscillatoria.* *Chara, Nitella.*

Image No 14: Water Hyacinth, Santragachi Jheel

Image No 15: Reeds and sedges are common in marsh land

Table : List of Trees in the Study area :

Sl.1	Name of the species	Scientific name	Family
1	African Tulip	*Spathodia campanulata*	Bignoniaceae
2	Allspice Tre	*Pimenta dioica*	Myrtaceae
3	Amla	*Emblica officinalis*	Euphorbiaceae
4	Ashoka Tree	*Saraca asoka*	Fabeceae
5	Bahera	*Terminalia bellirica*	Combretaceae
6	Banyan Tree	*Ficus benghalensis*	Moraceae
7	Bhawarmal, BoharBiharukh	*Hymenodictyon orixense*	Rubiaceae
8	Buddha Coconut	*Pterygota alata*	Sterculiaceae
9	Burma Teak	*Tectona grandis*	Verbenaceae
10	Butterfly Tree	*Bauhinia purpurea*	Caesalpiniaceae
11	Caledonia Pine/ Christmas Tree	*Araucaria cookii*	Arucariaceae
12	Banana	*Musa*	Bananas
13	Chhatiyan / Devil's Tree	*Alstonia scholaris*	Apocynaceae
14	Cluster Fig	*Ficus glomerata*	Moraceae
15	Copper Pod Tree	*Peltoforum pterocarpum*	Caesalpiniaceae
16	Custard Apple	*Annona reticulata*	Annonaceae
17	Drumstick Tree	*Moringa oleifera*	Moringaceae
18	Dysoxylum	*Dysoxylum sp. Dysoxylum costulatum Miq.*	Miliaceae
19	Elephant Apple	*Dillenia indica*	Dilleniaceae
20	Eucalyptus	*Eucalyptus spp.*	Myrtaceae
21	False White Teak	*Trewia nudiflora*	Euphorbiaceae
22	Ficus	*Ficus sp.*	Moraceae
23	Flame tree	*Butea monosperma*	Faboideae
24	Gardenia,	*Cape jasmine Gardenia jasminoides*	Rubiaceae
25	Gliricidia	*Gliricidia sepium*	Fabaceae
26	Gold Mohur	*Flame Tree Delonix regia*	Caesalpiniaceae
27	Golden Apple	*Aegle marmelos*	Rutaceae
28	Golden Shower	*Acacia auriculiformis*	Fabaceae
29	Guava	*Psidium guajava*	Myrtaceae
30	Gulab Jamun	*Syzygium jambos*	Myrtaceae
31	Haritaki	*Terminalia chebula*	Combretaceae
32	Indian Almond	*Terminalia catappa*	Combretaceae
33	Indian Blackberry	*Syzygium cumini*	Myrtaceae
34	Indian Blackberry (Small)	*Syzygium sp.*	Myrtaceae
35	Indian Cork Tree	*Millingtonia hortensis*	Bignoniaceae
36	Indian Fir / Cementry Tree	*Polialthia longifolia*	Annonaceae
37	Indian Jujube	*Ber Ziziphus mauritiana*	Rhamnaceae
38	Indian Lilac Tree	*. Melia azedarach*	Meliaceae
39	Indian Mehoginy	*Cedrela toona*	Meliaceae
40	. Indian Rubber Tree	*Ficus elastica*	Moraceae
41	Indrajao	*Holarrhena pubescens*	Apocynaceae
	Jack Fruit	*Artocarpus heterophyllus*	Moraceae
42	Kadam	*Anthocephalus chinensis*	Rubiaceae
43	Lichi	*Litchi chinensis*	Sapindaceae
44	Longan	*Euforia longan*	Sapindaceae
45	Mango	*Mangifera indica*	Anacardiaceae

46	Neem Tree	*Azadirachta indica*	Meliaceae
47	Pomelo	*Citrus maxima*	Rutaceae
48	Pongam Tree	*Pongame Oil Tree Pongamia pinnata*	Fabaceae
49	Pride of India	*Lagerstroemia speciosa*	Lythraceae
50	Putranjiva / Lucky Bean Tree	*Putranjiva roxburghii*	Euphorbiaceae
51	Queen of the night	*Nyctanthes arbortristis*	Oleaceae
52	. Rain Tree	*Samanea saman*	Mimosaceae
53	Red Jasmine Tree	*Plumeria rubra*	Apocynaceae
54	Red Silk Cotton Tree	*Bombax ceiba*	Malvaceae
55	Sabeda	*. Manikara sapota*	Sapotaceae
56	Sand Paper Tree	*Streblus asper*	Moraceae
57	She-Oak / Indian Christmas Tree	*Casuarina equisetifolia*	Casuarinaceae
58	Small-leaved Mahogany	*Swietenia mahagoni*	Meliaceae
59	Spanish cherry / Bakul	*. Mimusops elengi*	Caesalpiniaceae
60	. Star Fruit	*Averrhoa carambola*	Averrhoaceae
61	Subabul Leucena	*leucocephela*	Mimosaceae
62	Tamarind	*Tamarindus indica*	Caesalpiniaceae
63	Vilayati Babul	*Pithecolobium dulce*	Mimosaceae
64	Water Apple Bay Cedar	*Guazuma ulmifolia*	Malvaceae
65	White Fig	*Ficus infectoria*	Moraceae
66	Wild Mango	*Spondias pinnata*	Anacardiaceae

Sl	**Aquatic Plants**	**Scientific Name**	**Family**
79	Alligator weed	*Alternanthera philoxeroides*	Amaranthaceae
80	Duck lettuce	*Ottelia alismoides*	Hydrocharitaceae
81	Tape grass	*Vallineria spiralis*	Hydrocharitaceae
82	Taro	*Colocasia esculenta*	Araceae
83	Water hyacinth	*Eichhornia crassipes*	Pontederiaceae
84	. Water lily	*Nymphea nouchali*	Nymphaeaceae
85	Waterthyme	*Hydrilla verticillata*	Hydrocharitaceae

Table 1b- List of Grasses in the study area

Sl	**Grasses**	**Scientific name**	**Family**
74	Bamboo	*Bambusa sp.*	Poaceae
75	Common Carpet grass	*Axonopus sp*	Poaceae
76	Durba	*Cynodon dactylon*	Graminae
77	Hogla Grass	*Typha elephantine, T. Latifolia*	
78	Kans Grass	*Saccharum spontaneum*	

Table 1c– List of Herbs in the study area

	Herbs	**Scientific Name**	**Family**
86	Achyranthes	*Achyranthes aspera*	Amaranthaceae
87	Ageratum	*Ageratum conyzoides*	Asteraceae

88	Alocasia	*Alocasia indica*	Arecaaceae
89	Aloe Vera	*Aloe barbadensis*	Liliaceae
90	Alternanthera	*Alternanthera philoxeroides*	Amaranthaceae
91	Alternanthera	*Alternanthera paronychioides*	Amaranthaceae
92	Alternanthera	*Alternanthera sessilis*	Amaranthaceae
93	Amaranthus	*Amaranthus viridis*	Amaranthaceae
94	Amaranthus	*Aerva javanica*	Amaranthaceae
95	American Mint	*Anisomeles indica*	Lamiaceae
96	Asian Spiderflower	*Cleome viscosa*	Cleomaceae
97	Bachelor Button Flower	*Gomphrena globosa*	Amaranthaceae
98	Ban Dhone / Mitha Pata	*Scoparia dulcis*	Scrophulariaceae
99	Banana Tree	*Musa sp.*	Musaceae
100	Bengal Arum	*Typhonium trilobatum*	Areceae
101	Bhringaraj	*Wedelia trilobata*	Asteraceae
102	Bhuin Okra	*Phyla nodiflora*	Verbenaceae
103	Black Nightshade	*Solanum*	Solanaceae
104	Bluebell	*Ruellia prostrata*	Acanthaceae
105	Boatlily,	*Moses-in-the-cradle Tradescantia spathacea*	Commelinaceae
106	Bon Tepari	*Physalis minima*	Solanaceae
107	Bon Tulshi	*Croton bonplandianum*	Euphorbiaceae
108	Calendula,	*Common Marigold Calendula officinalis*	Asteraceae
109	Chrysanthemums	*Chrysanthemum sp.*	Asteraceae
110	Coat Buttons	*Tridax Daisy Tridex procambens Asteraceae*	Lamiaceae
111	Coleus	Coleus *sp.*	Lamiaceae
112	Commelina	*Commelina benghalensis*	Commelinaceae
113	Dahlia	*Dahlia sp.*	Asteraceae
114	Diamond Flower	*Corymbose hedyotis Hedyotis corymbosa*	Rubiaceae
115	Famine Weed	*Parthenium hysterophorus*	Asteraceae
116	Gerbera	*Gerbera jamesonii*	Asteraceae
117	Graceful Pouzalz's Bush	*Pouzalzia indica*	Urticaceae
118	Heartleaf Fanpetals	*Sida humilis*	Malvaceae
119	Holy Basil	*Tulasi Ocimum sanctum*	Lamiaceae
120	Impatiens, Touch-me-not	*Impatiens*	Balsaminaceae
121	Indian Cress	*Nasturtium indicum*	Brassicaceae
122	Indian Water Navelwort	*Centella asiatica*	Apiaceae
123	Kalmegh., Green chirayta	*Andrographis paniculata*	Acanthaceae
124	Keshut	*Eclipta alba*	Asteraceae
125	khirika	*Euphorbia hirta*	Euphorbiaceae
126	Krishna Tulsi	*Ocimum tenuiflorum*	Lamiaceae
127	Kukurshoka	*Blumea laciniata*	Asteraceae
128	Kulekhara	*Hygrophila schulli*	Acanthaceae
129	Lobster claw Hanging heliconia	*Strelitzia reginae*	Musaceae
130	Marigold Flower	*Tagetes sp.*	Asteraceae

131	Agave sp.	*Agave sp.*	Asparagaceae
132	Ban jamir	*Glycosmis pentaphyla*	Ruraceae

133	Bleeding Heart	*Clerodendrum thomsoniae*	Lamiaceae
134	Castor Oil Plant	*Ricinus communis*	Euphorbiaceae
135	China Rose	*Hibiscus rosa*	Malvaceae
136	Chitrak , Plumbago,White leadwort	*Plumbago zeylanica*	Plumbaginaceae
137	Citrus	*Citrus acida*	Rutaceae
138	Citrus/	*Citron Citrus medica*	Rutaceae
139	Clerodendrum	*Clerodendrum viscosum*	Verbenaceae
140	Common Wireweed	*Sida acuta*	Malvaceae
141	Croton	*Codiaeum sp var.*	Euphorbiaceae
142	Devil's cotton	*Abroma augustum*	Sterculiaceae
143	Devil's Trumpets	*Datura sp.*	Solanaceae
144	Dracaena	*Pleomele reflexa 'Variegata'*	Asparagaceae
145	Duranta	*Duranta repens*	Verbenaceae
146	Fever tea	*Lemon Bush Lippia javanica*	Verbenaceae
147	Fever tea/	*Lemon Bush Lippia javanica*	Verbenaceae
148	Garden Cosmos	*Cosmos bipinnatus*	Asteraceae
149	Giant Milkweed	*Calotropis gigantea*	Asclepiadaceae
150	Green Chili	*Capsicum sp.*	Solanaceae
151	Ground Fig	*Ficus heterophylla*	Moraceae
152	Heliconia	*Strelitzia. sp.*	Musaceae
153	Indian heliotrope	*Heliotropium indicum*	Boraginaceae
154	Ixora	*Ixora sp*	Rubiaceae
155	Jasmine	*Jusminum pubescens*	Oleaceae
156	Karipata	*Murraya koenigii*	Rutaceae
157	Kasunda	*Baner Cassia sophera*	Fabaceae
158	. Lagerstroemia	*Lagerstroemia indica*	Lythraceae
159	Lantana	*camara*	Verbenaceae
160	Lime	*Citrus acida*	Rutaceae
161	Milk Flower (Double)	*Tabernaemontana coronaria Apocynaceae*	Apocynaceae
162	Milk Flower (Dwarf)	*Tabernaemontana divaricata Apocynaceae*	Apocynaceae
163	Milk Flower (Plain)	*Tabernaemontana divaricata Apocynaceae*	Apocynaceae
164	Milli	*Euphorbia milli Ericaceae*	Ericaceae
165	Muktojhuri	*Acalypha indica*	Euphorbiaceae
166	Musaenda	*Mussaenda sp.*	Rubiaceae
167	Oleander	*Nerium oleander*	Apocynaceae
168	Orange Jasmine	*Murraya paniculata*	Rutaceae
169	Philippine Violet	*Barleria strigosa Acanthaceae*	Acanthaceae
170	Plumed Cockscomb	*Woolflower Celosia argentea*	Amaranthaceae
171	Poinsettia	*Euphorbia pulcherrima*	Euphorbiaceae
172	Powder Puff	*Calliendra sp.*	Euphorbiaceae
173	Ravenia Pink	*Lemonia Ravenia spectabilis*	Fabaceae
174	Roast Potato	*Phyllanthus reticulatus*	Rutaceae
175	Plant Poir.	*Euphorbiaceae*	Euphorbiaceae
176	Rose	*Rosa*	Rosaceae
177	Salparni	*Desmodium gangeticum*	Fabaceae
178	Scarlet Sage	*Salvia splendens*	Lamiaceae
179	Shooting Star Star Flower	*Pseuderanthemum sp*	Acanthaceae
180	. Siam Weed	*Bitter bush Eupatorium odoratum*	Asteraceae

181	Slipper Plant	*Pedilanthus tithymaloides*	Euphorbiaceae
182	Spicy Jatropha	*Jatropha panduraefolia*	Euphorbiaceae
183	Stinking Cassia	*Cassia tora Fabaceae*	Fabaceae
184	Tecoma	*Tecoma gaudichaudi*	Bignoniaceae
185	Thuja	*Thuja orientalis*	Cupressaceae
186	Wild Eggplant	*Solanum torvum*	Solanaceae
187	Bridal Bouquet	*Plumeria pudica*	Apocynaceae
188	Yellow Cosmos	*Cosmos sulphureus*	Asteraceae
189	Yellow oleander	*Cascabela thevetia*	Apocynaceae

Table 1d : List of Creepers in the Study Area

	Creepers	**Scientific Name**	**Family**
189	Allamanda	*Allamanda* sp.	Apocynaceae
190	Aparajita	*Clitoria ternatea*	Fabaceae
191	Bengal Trumpet Vine,	*Thunbergia grandiflora*	Acanthaceae
192	Birdfoot Grape	*Cayratia pedata*	Vitaceae
193	Birdfoot Grape-	*Cayratia* sp.	Vitaceae
194	Bougainvillea	*Bougainvillea* sp.	Nyctaginaceae
195	Cayratia	*Cayratia trifolia*	Vitaceae
196	Chinese creeper	*Micania micrantha*	Asteraceae
197	Climbing Mallotus	*Mallotus repandus*	Euphorbiaceae
198	Coral Creeper / Antigonum	*Antigonon leptopus*	Polygonaceae
199	Corkystem Passionflower	*Passiflora suberosa*	Passifloraceae
200	Gulanchalata	*Tinospora cordifolia*	Menispermaceae
201	Hemigraphis	*Hemigraphis hirta*	Acanthaceae
202	Indian Stinging Nettle	*Tragia involucrata*	Euphorbiaceae
203	Ipomoea	*Ipomoea aquatica*	Convolvulaceae
204	Justicia	*Justicia simplex*	Acanthaceae
205	Money Plant, Ivy A	*Epipremnum aureum*	Areceae
206	Passion Flower	*Passiflora suberosa*	Passifloraceae
207	Philodendron	*Philodendron* sp.	Areceae
208	Rangoon Creeper	*Combretum indicum*	Combretaceae
209	Roundleaf Bindweed	*Evolvulus nummularius*	Convolvulaceae
210	Small White Morning Glory	*Ipomoea obscura*	Convolvulaceae
211	Snake Vine	*Stephania japonica*	Menispermaceae
212	Telakuchu	*Coccinia grandis*	Cucurbitaceae
213	Tiliacora	*Tiliacora racemosa*	Menispermaceae

3.7Fauna of the Study Area

The district being fringed with factories and under cultivationelsewhere, wild animals are scarce. The larger species are practicallyunrepresented, for there is no jimgle which could furnish coverfor big game. Wild pigabound in parts of the Uluberia subdivision, and a few are saidto be found in the Jagatballabhpur . Crocodiles are sometimesto be seen on the banks of the Hugli and Damodarrivers during the winter months; and during the rains theyfrequently find their way into tanks and flooded lowlands near theriver. In the cold weather snipe of two or three varieties arefairly numerous in the paddy fields within the Dumjor, Sankrailand Jagatballabhpur thanas in the headquarters subdivision, andalso in the Uluberia subdivision. The common, whistling andcotton teal are found in fair numbers in the flooded area betweenMaju and Anita, and sometimes two or three of the commonervarieties of duck.

The principal varieties of river fish netted in the Hugli river are hilsa bhetki, tangra, and, during the season, tapsi or mango-fish (*Polynemm parndmm*). The Hugli River from Uluberia to Diamond Harbour is. in fact, noted for the delicious fish last named, which is described by Walter Hamilton (1820), “as the best and highest flavoured fish not only in Bengal, but in the whole world.” It is caught with or without roe in large numbers from April to June ; and Uluberia is a centre for its export. Members of the carp family are found in almost every tank, and *rui , mirgel and katla* spawn are reared extensively. The impregnated eggs float in small lumps near the shallow edges of rivers and are collected in pieces of cloth by certain low caste people and also by fishermen. In about a month’s time, it becomes possible to distinguish the various kinds. The fry are then caught with fine nets, sorted and put in different tanks ; some also are disposed of to hawkers, who carry them about, for sale to stockers of tanks. **Amta** is a centre of this business.

Image No16: Fish Market at Santragachi, Haora municipality

A total of 48 species of fishes belonging to ·15 families have been recorded. Of these, only two species of estuarine fishes Apocryptes bato and Ophiocara porocepha/a have been encountered in floodplain wetlands of Khanakul under Hugli district. Whi1e different varieties of gobiid fishes (Bla~k, white and red varieties of Gul~ fish) and estuarine flat fishes (locally known as Banspata) are also reported to Qccur in the Garerght-Khanakul areas (Jagatpur bee/). The tidal waters from Rupnarayan river nearby sometimes inundate this area and the irrigation waters of this region also bring estuarine element in the fish fauna of this floodplain wetland.

The cyprinid fishes as well as Oreochronlis, Allabas, Clarias and Heteroplleustes are extensively cultured in the freshwater wetlands of Haora and HugJi districts. The cyprinid fishes include major carps °like Catla catla (Ham.), Labeo ro!tita (Ham.), Labeo calbasu (Ham.) and Cirrhi1lus mr;gala (Ham.), minor carps like Labeo bata (Ham.) and exotic craps like Cypr;llus carpio Linn. Ctellop!tarYllgodoll idella (Va1.) and H)pophtiJalanlichthys nlolitrix (Val.). Some weed fishes belonging to the genera PUlltius, Esonlus, Rasbora and Lepidocephalus under the family Cyprinidae 'ahound in these wetlands. During March-April the local fisherwomen are found to catch Lepidocephalus species in plenty along with the freshwater gobiid fish (GloSsogobius giuris) and shrimps in their scoop nets. The juveniles of the' weed fish species occur i~ large numbers during rainy, season which indicates that they are high fecund species and breeds naturally during summer months. 'However, a number.of other weed fishes like Chanda "anza (Ham.) and C. rallga (Ham.) (Family Chandidae), CoUsa /asciatus (Schneider) (Family Belontidae) and Badis badis (Ham.) (Family Nandidae) also breed in summer and abound in monsoon months. The channid, bagrid, silurid, clariid, anabantid and mastacembelid fishes are available in good numbers in these wetlands. These predatory species mostly abound in flood plain wetlands and are harvested from October to April prior to drying up of the temporary wetlands.

In Haora district, Of the total 5,554.66 ha impounded water area, 76.34% are in cultivable condition, 7.48% .and 16.17% are in semiderelict and derelict conditions respectively. While in the Hugli district, though it has nearly three times greater impounded water area (16,268.01 ha) than Haora district the cultivable water area is 56.70%, the semi-drelict and derelict areas are 27.94% and 15.35% respectively (Anony'mous, 1986). It indicates that a greater proportion of inland impounded water resource is in semi-derelict condition in Hugli district. It can be made suitable for pisciculture with little improvement. In fact, now-a-days, a large number of rural ponds are being desiltedre-excavated through Government schemes/assistance in HugJi district. However, most of the large beels and dighies which once constituted a major source of internal fish supply, have progressively gone into dereliction requiring heavy capital investment for reclamation. The cuIturable fishes in these two districts can be categorised as folJows : i) Major carps Catla catla, Labeo rohita, Cirrhinus mrigala, Labeo c~lbasu. ii) Minor carps Labeo bata, Puntius sarana iii) Siluroid species *Clarias batrachus, Heteropneustes Jossilis*

The cuIturable fishes in these two districts can be categorised as follows : i) Major carps *Catla catla, Labeo rohita, Cirrhinus mrigala, Labeo calbasu*. ii) Minor carps *Labeo bata, Puntius sarana* iii) Siluroid species *Clarias batrachus, Heteropneustes Jossilis*iv) Exotic species *Cyprinus carpio, Ctenopharyngodoll idella, Hypophthalamichthys molitrix, Puntius javallicus, Oreochromis mossambica, Oreochromis llilotica.*

Almost all the major carps and a number of exotic species are grown in ponds in various combinations. This process of composite fish farming usually yields relatively higher production even though very little attention is paid to supplementary feeding and management of most of these ponds. As the yield of water is much more than that of the same acreage of land, the enterprising youngsters and local bodies are taking much interest in piscicultural practices in ·these two districts. However, virtually, no attempt is made of mono and/or synergestic culture of giant freshwater prawn, Macrobrachium rosenbergii, a highly priced species, in freshwater wetlands. Similarly, attempts to culture freshwater pearl in mussel, Lamellidens marginalis, have not so far been made in the private sector though there is a report on the occurrence of pearl in freshwater nlussel (2.37%) in Hugli district (Raut and Biswas, 1989). It is worthmentioning that the Fishery Department, Government of West Bengal is trying to develop standard methods for culturing fres.hwater pearJ in West Bengal (Sengupta, 1992).

Some important places where wild lives can be observed:

A. Garchumuk Deer Park: Garchumuk is located on the district of Haora of West Bengal at the confluence of RiverHugliRiver Damodar enhancing the scenic beauty of the location. The spot, offering the spectacular view of the Ganges is gradually emerging as a popular tourist destination ideal for a weekend tour. The area of the zoo is approx.13.40 Ha under Haora Zilla Parishad. A man made forests was created within the said area earlier by Haora Forestry Division, WB under Social forestry Scheme of Forest Directorate.

Considering its scenic beauty as well as suitability for wild animal, a Deer Park was established on 31.01.1991, which are the main attractions of the tourists and the local people. The Park is recognised by the Central Zoo Authority. Main objective of the Park is to provide awareness on the conservation and education of our wildlife to the visitors. The Park is under the charge of Divisional forest officer, Haora Forest Division , who is the Ex-Officio Director.Presently the Zoo houses 97no. Mammals, 4nos. Birds and 477 nos. of Reptiles including one female crocodile. The zoo is well connected with road and rail. It is 60 km away by road from Howrah District Head Quarters and 15 km from Uluberia Railway Station. It will take 2.5 hours from Esplanade by bus heading Gadiara. From Uluberia Rly. Station by local road to Zoo. Average yearly visitors is 3, 62,288. The zoo is opened from 9.30 am to 5.00pm except weekly holidays on Saturday and Sunday. Present address of the zoo is Stadium Complex, Dalmia Park, P.O. Howrah – 1, Dist : Howrah, Pin: 711101.Nearest place of interest is Gadiara, 58 Gates and official contact no. is 033-26411772

Image No17: Spotted deers are found at Garchumuk Deer Park

B. Dankuni Wetlands

Locally known as Mullarbaer or Janai, these marshlands are dotted with ponds interspersed with stretches of reed beds or hogla vegetation. The wetlands are rich in biodiversity. They are home to winter migrants like the *bluethroat*, *clamourous reed warbler*, *Siberian ruby throat*, *yellow breasted bunting* (whose sighting is very rare) *and even the IUCN-Red-Listed vulnerable ferruginous poachard.* Residential species like avadavats, jacanas, moorhens, herons and munias nest here. High avian concentration has made these wetlands a popular destination for birders of Kolkata.

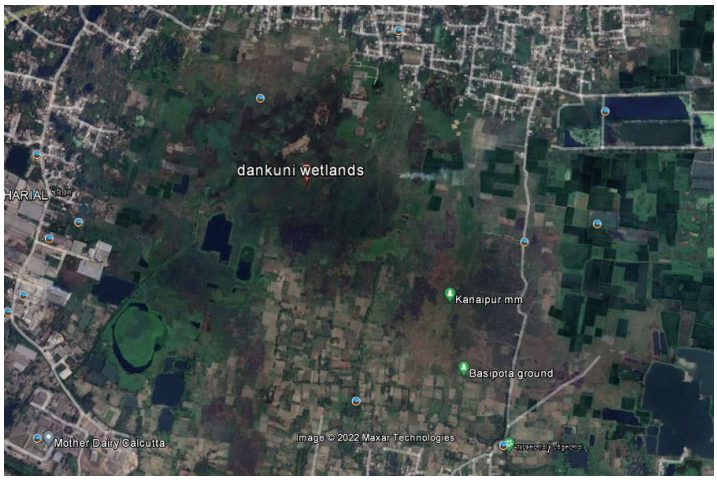


Image No18: Dankuni Wetlands, 22°41'27.02"N 88°18'52.60"E

Image No19: Tricolour Munia,Basipota, Dankuni Wetlands

Image No20: Blue Throat, Dankuni Wetland

Image No21 & 22: Red Avadavet Male &Female,Basipota, dankuni wetlands

A total of 54 species of birds, either as wetland dependants or as wetland associates, including both resident and migratory species, belonging to 14 families have been recorded in these two districts (Table 6). Of these, 27 species are resident and 17 species are migratory birds depending on wetlands, while 10 species, comprising 3 resident and 7 migratory. are referred herein as wetland associates. Only 5 species of resident birds, 3 species of the family Ardeidae, viz., ArdeoLa gray;; (Sykes), Bubulcus ibis (Linnaeus)., Egretta garzetta (Linnaeus) and two species of the family Anatidae, viz., Dendrqcygna javanica (Horsfield) and Nettapus coromandelianus (Gmelin) have been found to occur in abundance. Of the 17 wetland dependent and 7 wetland associated migratory species, some birds even though they are occasional1y abundant have been recorded here as common for not being avai1able throughout the year/season.

The avian species, either resident or migratory, depending on wetlands are comprised of swimmers, divers, 'waders and some fish eating aerial predators like kites and kingfishers. These wetland dependent birds belong to 11 families viz., Podicipedidae, Phalacrocoracidae, Ardeidae, Ciconiidae, Anatidae, Accipitridae, Rallidae, Jacanidae, Rostratulidae, Charadriidae and Alcedinidae. However, the resident birds show greater diversity of species (representing 27 species), while the migratory birds depending on wetlands, especially the anatids, occur in small or large flocks and represent sessonal numerical abundance of individual birds of a few species, namely, Anas crecca Linnaeus, A. strepera Linnaeus, A. quequedula and A. clypeata Linnaeus. The large flocks of migratory birds in Santragachi jheel of Haora district visiting between October to February over the years have helped to declare the area a sanctuary. A study of avian fauna made by the Zoological Survey of India in early 1980's indicates the occurrence of 68 species of birds including 27 migratory species has helped to designate the wetland as "S.E. Rly.Centenary Sanctuary for Birds" (Ghosh and Chattopadhyay, 1994).

C. Fishing Cats of Amta Wetlands:

The fishing cat or the state animal of West Bengal is a greyish coloured cat covered with black spots. Black lines run from the top of its forehead and run to the back of its neck and break into dotted lines on the back of its body. The tail is short and is dotted with spots that look like rings from a distance. It has small ears and the back of the ears are totally black with a white spot.

The cat has very coarse hair, unlike our domestic cats whose hair feels soft to the touch. The thicker bristles most likely can shake water off faster and keep the cat dry. The male fishing cat has a larger body size than the female cat. The cat has short legs and looks thick like a barrel. It toes are connected with small webbing that allows it to swim well and also grip slippery fish.

Interestingly fishing cats are also found in human-dominated landscapes and live in close proximity to villages. Sometimes, living close to human settlements can have negativeconsequencesfor both people and the cats. Addressing and keeping in checkthese negativehuman influences is the core focus of our research and conservation work.

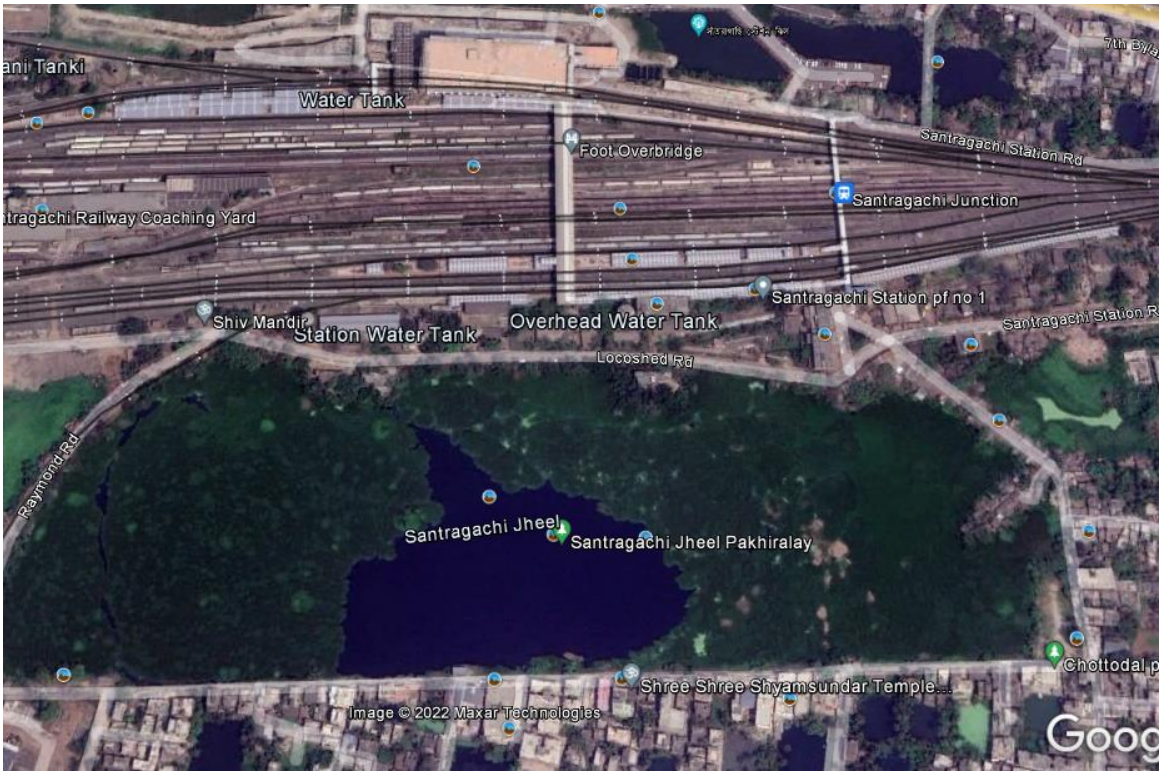
The fishing cat's range in India is large and covers the east coast and the flood plains and mangrove areas of West Bengal state. It also extends into central India and the Himalayas where the cats exist next to smaller rivers and their catchments that eventually confluence with the main rivers likes Godavari, Krishna, Ganga and Brahmaputra. Within its range in India, the Indian Wildlife Protection Act 1972 lists fishing cat as a Schedule I species meaning Endangered and globally the IUCN Red List classifies it as Vulnerable (WPA-India 1972, Mukerjee et al. 2016). The fishing cat is a wetland specialist and half its population in India is thought to live in protected areas, with the rest in unprotected habitat (Mukerjee et al. 2016). There are a few large coastal wetland protected areas that could support more than 100 individuals of the species, such as the Coringa Sanctuary in Andhra Pradesh and the Sundarbans in West Bengal (Sathiyaselvam & Satyanarayana 2016). The majority of the inland protected areas within the fishing cat range, like the Kaziranga National Park NP, Nameri Chitwan NP and others, though large, have small habitats suitable for this wetland specialist. Both the coastal and inland protected areas are fragmented, where areas surrounding these NPs are mosaics of human-used lands including villages, towns, cities and intensively farmed landscapes.

The Hughli River and the Damodar river have many wetland habitatsin the district of Haora where people raise fish in seasonally-flooded areas. This area is relatively rich in biodiversity and home to several mammal species including numerous mammal, bird, reptile, fish and insect species adapted to wetland habitats. Fishing Cat Prionailurus vivverinus are found both in protected and unprotected landscapes. To ensure the continued survival of fishing cats in the unprotected human-dominated Amta block of West Bengal state, local conservation enthusiasts started the 'Bhagrol Basa Fishing Cat Project' in 2016. Their efforts to safeguard the fishing cat revealed fascinating findings into the lives of this felid species that appears to be able to live alongside humans. The project's efforts to increase interest within the local community to support fishing cats in the 30 km² area show first results. In this case study, we provide insights into the progress of the project. The experiences offer optimism that, in India, human-fishing cat coexistence may be less concerning than survival of leopards or tigers in human-used lands. To roll out this project further and help protect fishing cats in other unprotected areas, the Bhagrol Basa Fishing Cat Project plans to look beyond its current work area to similar adjoining human-dominated lands of West Bengal.

In a human-dominated landscape, the conflict between people and wildlife is likely if wildlife and people utilise the same resources. Clearly identifying conflicts and their root causes is critical (Madden & McQuinn 2015). Innovative and adaptive ways of addressing conflicts and minimising collateral damage are central to conservation success in human-dominated lands (Kolipaka 2018). The project experience shows that financial incentives to people help but more low cost and non-monitory ways of soliciting support need to be found. The project personnel are being trained to adapt to this need and to maintain a good relationship with local communities to ensure that there is local buy-in for this conservation project. This process of building and maintaining good relations could help to limit conflicts being redirected at fishing cats, given that most "human-wildlife conflicts" are instead conflicts between different groups of people over how to manage wildlife (Redpath et al. 2013). If this species is to survive in the long-term, conserving fishing cats outside protected areas can help ensure gene flow between protected areas.

Image No23,24, 25 &26: Fishing Cats are mostly seen during night time adjoining wetlands.Photo: Baghrol Basa Website, Amta

D.Santragachi Jheel: The Santragachi Jheel is located beside the Santragachi Railway Station which is a part of the South Eastern Railway. It is a huge lake. The total area of this lake is more than 1375000 square feet. The lake is a property of the South Eastern Railway. The Forest Department of West Bengal as well as the South Eastern Railway maintain the lake and its surroundings. The number of migratory birds has been increasing every year since the lake is an ideal habitat for them.



Map No12: showing the location of the Santragachi Jheel

The environment around the lake is absolutely pristine and perfect for the birds from cooler climates. The fresh air around the lake is a very good place for morning walkers and other health conscious people. Other water bodies in the city are slowly getting polluted and hence the number of birds is increasing in this particular lake.

Migratory Species :A large number of birds fly in from across the Himalayas and other cold countries every year. There are birds from distant places like North America and Australia as well. Rare birds like the Gadwall, Northern Pintail, Northern Shoveler and Garganey fly in from the cold Siberian region as Siberia becomes unbearably cold during the winter season. Saras Cranes migrate from North America. Some of the other bird species that fly in are Comb Duck, Ferruginous Pochard, Swinhoe's Snipe and Fulvous Whistling Duck. The Swinhoe's Snipe is a major attraction among the bird watchers and photographers. Among the famous bird species from Siberia, the Baikal Teal is found. This diversity of migratory

birds of varied colours and characteristics is what makes this Santragachi Jheel a rare habitat for birds.

Image No 27&28: Migratory Birds like Northern Pintail, Santragachi Wetland 22°34'50.97"N 88°16'58.07"E

Local Birds in Santragachi Jheel:There are obviously a lot of local species of birds which inhabit the lake all-round the year, unlike the migratory birds which leave the lake at the end of the winter season. The Comb Duck and the Cotton Pygmy Goose are among the local migratory birds which fly in from other parts of India. The most widely found bird species in this lake is the Lesser Whistling Duck which is a local bird and is present in the lake permanently. The local breeding birds inhabiting the lake are the Bitterns and the Jacanas. The birds can breed and roost in this lake without any external disturbance.

A large number of birds fly in from across the Himalayas and other cold countries every year. There are birds from distant places like North America and Australia as well. Rare birds like the Gadwall, Northern Pintail, Northern Shoveler and Garganey fly in from the cold Siberian region as Siberia becomes unbearably cold during the winter season. Saras Cranes migrate from North America. Some of the other bird species that fly in are Comb Duck, Ferruginous Pochard, Swinhoe's Snipe and Fulvous Whistling Duck. The Swinhoe's Snipe is a major attraction among the bird watchers and photographers. Among the famous bird species from Siberia, the Baikal Teal is found. This diversity of migratory birds of varied colours and characteristics is what makes this Santragachi Jheel a rare habitat for birds.

Maintenance of the Santragachi Jheel

The lake is under the management of the South Eastern Railway and the Forest Department of West Bengal as is already mentioned earlier. The two managing bodies have maintained the lake for a number of years. They have done a very commendable job for a number of years. There has been a persistent problem of water hyacinths growing all over the lake. The railway staffs have been clearing the water hyacinths to make the lake suitable for the birds. However, this year the authorities from either the South Eastern Railway or the Forest Department of West Bengal did not take any initiative to clean the lake. The water hyacinths overgrew all over the lake and it was totally unsuitable for the migratory as well as local birds. However, a group of concerned citizens from the locality brought this to the notice of some eminent environment activists like Mudar Patherya and others. They took the initiative and made arrangements for cleaning up the lake on time for the migratory birds to come. At one point of time, there was serious doubt whether the Santragachi Jheel would have visiting birds any more. But due to the timely actions taken by a responsible group of citizens, a large number of migratory birds have visited the lake this year as well.

Image No 29: Lesser Whistling Ducks, Santragachi Jheel

Image No 30: Flocks of Lesser Whistling Ducks

Table 2– Different Species of animals in our study area

Sl.no	Mammals	Scientific Names
1	Asian Palm Civet	*Paradoxurus hermaphroditus*
2	Common Pipistrelle	*Pipistrellus pipistrellus*
3	Five-striped Palm Squirrel	*Funambulus pennantii*
4	Fruit Bat	*Pteropus sp.*
5	Gray Langur	*Semnopithecus sp.*
6	Indian Flying Fox	*Pteropus giganteus*
7	Indian Grey Mongoose	*Herpestes edwardsi*
	Birds	**Scientific Names**
1	Alexandrine Parakeet	*Psittacula eupatria*
2	Asian Koel	*Eudynamys scolopaceus*
3	Asian Openbill	*Anastomus oscitans*
4	Asian Palm Swift	*Cypsiurus balasiensis*
5	Asian Pied Starling	*Gracupica contra*
6	Black Drongo	*Dicrurus macrocercus*
7	Black Kite	*Milvus migrans*
8	Black-hooded Oriole	*Oriolus xanthornus*
9	Black-naped Monarch	*Hypothymis azurea*
10	Indian Pond Heron	
11	Jungle Babbler	*Turdoides striatus*
12	Jungle Myna	*Acridotheres fuscus*
13	Lesser Goldenback	*Dinopium benghalense*
14	Lineated Barbet	*Megalaima lineata*
15	Marsh Sandpiper	*Tringa stagnatilis*
16	. Oriental Magpie Robin	*Copsychus saularis*
17	Pale-billed Flowerpecker	*Dicaeum erythrorynchos*
18	Purple Heron	*Ardea purpurea*
19	Purple Sunbird	*Nectarinia asiatica*
20	Purple-rumped Sunbird	*Nectarinia zeylonica*
21	Indian Cormorant	*Phalacrocorax fuscicollis*
22	House Sparrow	*Passer domesticus*
23	House Crow	*Corvus splendens*
24	Green Bee-Eater	*Merops orientalis*
25	Fulvous-breasted Woodpecker	*Centropus sinensis*
26	Greater Coucal	*Dendrocopos macei*
27	Eurasian Collared Dove	*Streptopelia decaocto*
28	Eastern Jungle Crow	*Corvus levaillantii*
29	Coppersmith Barbet	*Megalaima haemacephala*
30	Common Tailorbird	*Orthotomus sutorius*
31	Common Sandpiper	*Actitis hypoleucos*
32	. Common Pigeon	*Columba livia*
33	Common Myna	*Acridotheres tristis*
34	Common Kingfisher	*Alcedo atthis*
35	Common Iora	*Aegithina tiphia*
36	. Common Hoopoe	*Upupa epops*
37	Common Hawk Cuckoo	*Hierococcyx varius*
38	Cattle Egret	*Bubulcus ibis*
39	Blue-throated Barbet	*Megalaima asiatica*
40	Black-naped Oriole	*Oriolus chinensis*

41	Red-vented Bulbul	*Pycnonotus cafer*
42	Red-whiskered Bulbul	*Pycnonotus jocosus*
43	Rose-ringed Parakeet	*Psittacula krameri*
44	Rufous Treepie	*Dendrocitta vagabunda*
45	Shikra	*Accipiter badius Accipitridae*
46	Spotted Dove	*Stigmatopelia chinensis*
47	Spotted Owlet	*Athene brama*
48	Stork-billed kingfisher	*Pelargopsis capensis*
49	White Wagtail	*Motacilla alba*
50	Taiga Flycatcher	*Ficedula albicilla*
51	White-breasted Waterhen	*Amaurornis phoenicurus*
52	White-throated Kingfisher	*Halcyon smyrnensis*
53	Yellow-footed Green Pigeon	*Treron phoenicoptera*
	Reptiles	***Scientific Names***
1	Bengal Monitor Lizard	*Varanus bengalensis*
2	Buff Striped Keelback	*Amphiesma stolatum*
3	. Checkered Keelback	*Xenochrophis piscator*
4	Common House Gecko	*Hemidactylus frenatus*
5	Oriental Garden Lizard	*Calotes versicolor*
6	Rat Snake	*Zamenis longissimus*
7	Russell's Viper	*Daboia russelii*
8	Skink	*Lampropholis sp.*
	Butterflies	***Scientific Names***
1	Angled Castor	*Ariadne ariadne*
2	Blue Mormon	*Papilio polymnestor*
3	Brown Awl	*Badamia exclamationis*
4	Blue Tiger	*Tirumala limniace*
5	Chestnut Palm	*Bob Iambrix salsala*
6	Chestnut-streaked	*Sailer Neptis jumbah*
7	Commander	*Moduza procris*
8	Common Banded Awl	*Hasora chromus*
9	Common Baron	*Euthalia aconthea*
10	Common Bushbrown	*. Mycalesis perseus*
11	Common Castor	*Ariadne merione*
12	. Common Cerulean	*Jamides celeno*
13	Common Crow	*Euploea core*
14	Common Evening Brown	*Melanitis leda*
15	Common Five-ring	*Ypthima baldus*
16	Common Four-ring	*Ypthima huebneri*
17	Common Grass Yellow	*Eurema hecabe*
18	Common Guava Blue	*Virachola isocrates*
19	Common Gull	*Cepora nerissa*
20	Common Jay	*Graphium doson*
21	Common Jezebel	*Delias eucharis*
22	Common Leopard	*Phalanta phalantha*
23	Common Lineblue	*Prosotas nora*
24	Common Mime	*Papilo clytia*
25	Common Mormon	*Papilo polytes*
26	Common Palmfly	*Elymnias hypermnestra*
27	Common Pierrot	*Castalius rosimon*
28	Common Quaker	*Neopithecops zalmora*

	Odonates	**Scientific Names**
1	Black Marsh Dart	*Onychargia atrocyana*
2	Black Marsh Trotter	*Tramea limbata*
3	. Common Picturewing	*Rhyothemis variegata*
4	Coral Tailed Cloud-wing	*Tholymis tillarga*
5	Coromandel Marsh Dart	*Ceriagrion coromandelianum*
6	. Crimson-tailed Marsh Hawk	*Orthetrum pruinosum*
7	Ditch Jewel	*Brachythemis contaminata*
8	Estuarine Skimmer	*Macrodiplax cora*
9	Fulvous Forest Skimmer	*Neurothemis fulvia*
10	Granite Ghost	*Bradinopyga geminata*

Image No31: Monitor Lizard found in Gadiara

Image No32:Kingfisher, Uluberia

Image No33:Cormorant, Santragachi Jheel

Image No 34.a: Bronze winged Jacana at Santragachi Jheel

Image No 34.b: Open stork bill atSantragachi Jheel, Haora

Image No35: Cattle Egrets &Image No36: Barn Swallow at Gadiara, Shyamnagar

4. Documenting Nature & Properties of Natural Heritage

4.1 Drainage

A. River Bhagirathi-Hugli: It is a notable distributary of the river Ganga, which rises from the snow-clad mountains of the mighty Himalayas. Hence a perennial supply of water is unfailing. This river is the main artery of the lower Bengal. The draining of water of Haora is primarily accomplished through this river. Starting from Bally Ghat 22°39'18.52"N 88°20'59.60"E in the north the journey of the river is towards south upto Gadiara , Shyampur 22°13'14.45"N 88° 2'55.29"E where it is joined by River Rupnarayan . This river, because of its tidal character and numerous meanders, resulting from negligible slope is sometimes unable to carry entirevolume of its water. This affects the drainage system very badly. (high tides and high level of river water coincide the affluents of Hugli river cannot discharge their waters into and inundate vast areas inland. In spring, the tides rise 5 m above the lowest tide-level at Kidderpore and 3.5 m in summer.During the periods of flood the rises of the mean high tides andthe mean low tides are 7 and 5 m respectively.

Image No37: Bally Ghat, 22°39'18.52"N 88°20'59.60"E

Map No13: Confluence of Rupnarayan River and Bhagirathi Hugli River

Image No 38: Confluence Point

B. RiverDamodar: The only large river that flows right across the district is the **River Damodar**. The Damodar entirely depends on precipitation.Therefore, it swells very rapidly during the rainy season and shrinks appreciably during the dry season. But, during rains, it cannot carry the entire volume of its water. This results inoverflowing of the river and causes devastating floods in the lower reaches destroying lives and properties of the people. Irisfor this reason that the river is often called, the *Sorrowof Bengal *.Deforestation in the upstream area has aggravated soilerosion which is adversely affecting the Hugli river by formingshoals. In order to prevent the destructive floods caused by the Damodar, a complete basin developme ntal scheme has been undertaken by the DVC in the form of a multipurpose project.*T*he total length of the river in Haora is about 70 kms.

The river enters the district near the village Akna at Dihibhursut,and on receiving the **Madaria khal** on its left bank itfollows a southerly course upto Amta. Further south, the Damodardiverts some of its water to the Rupnarayan through the **Gaighata khal,** Thence it flows through Bagnan with a serpentine coursewhere it is traversed by the **Uluberia khal.** Finally, the riverpursues a south-easterly course to empty its waters into theHugli, opposite Falta. This river is an effective means of drainage,but the problem is that it carries huge quantities of waterfrom its upper reaches and causes flood during the rainy season.

Map No14: The Mouth of Damodar River (oldcourse)22°17'4.94"N 88° 4'42.46"E, Shyampur Block

Image No39: The old Damodar Channel at Dinga Khola, Shyampur Block 22°17'4.94"N 88°

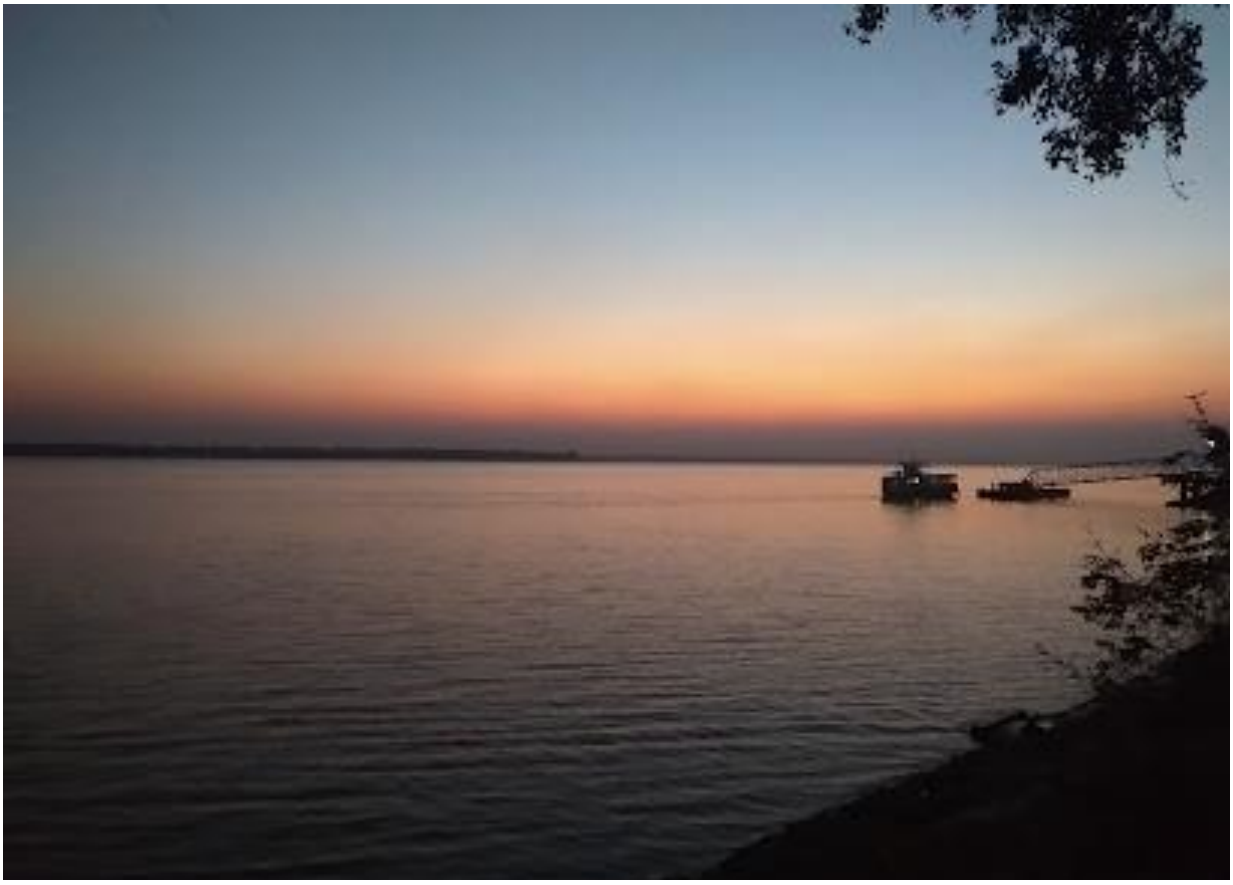
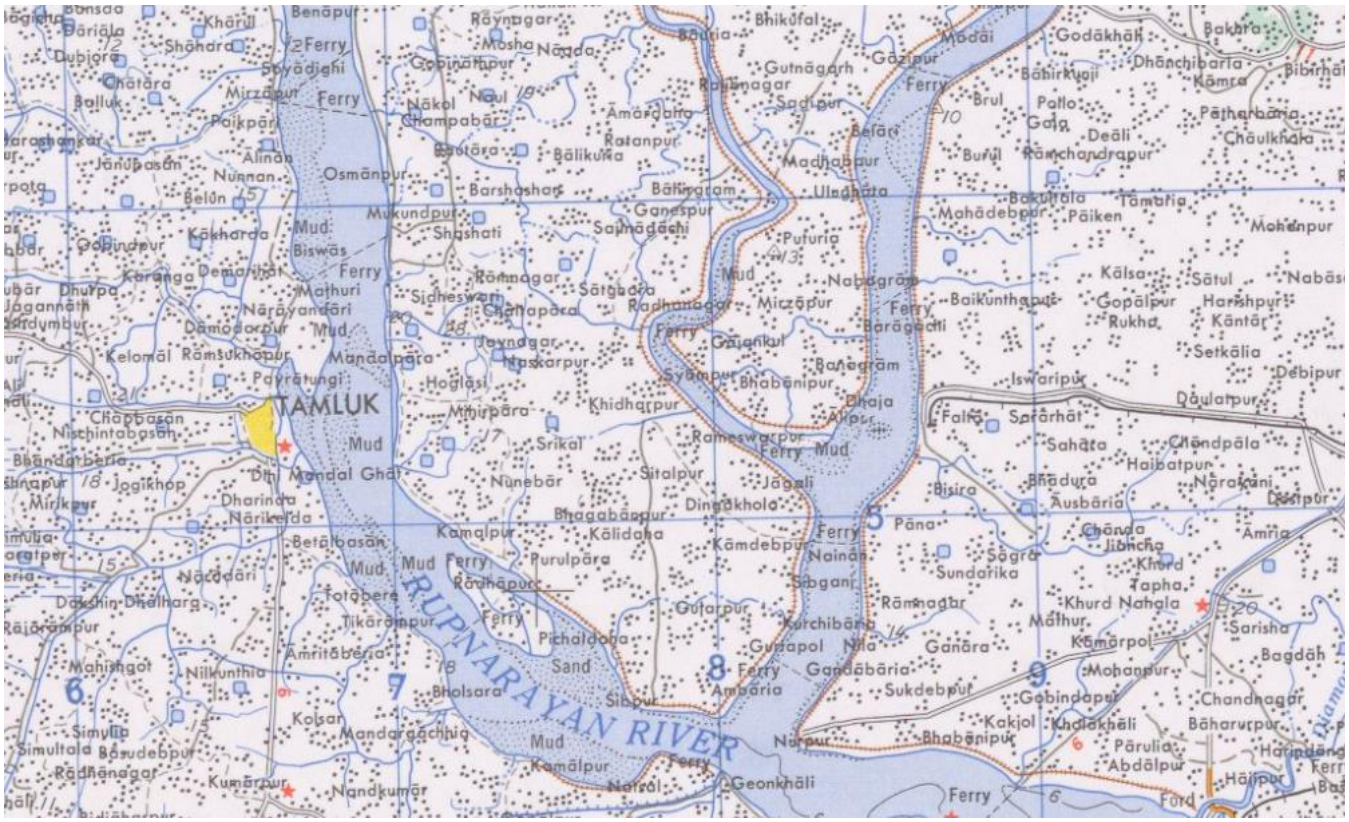


Image No40: Sunset near the old Damodar Channel

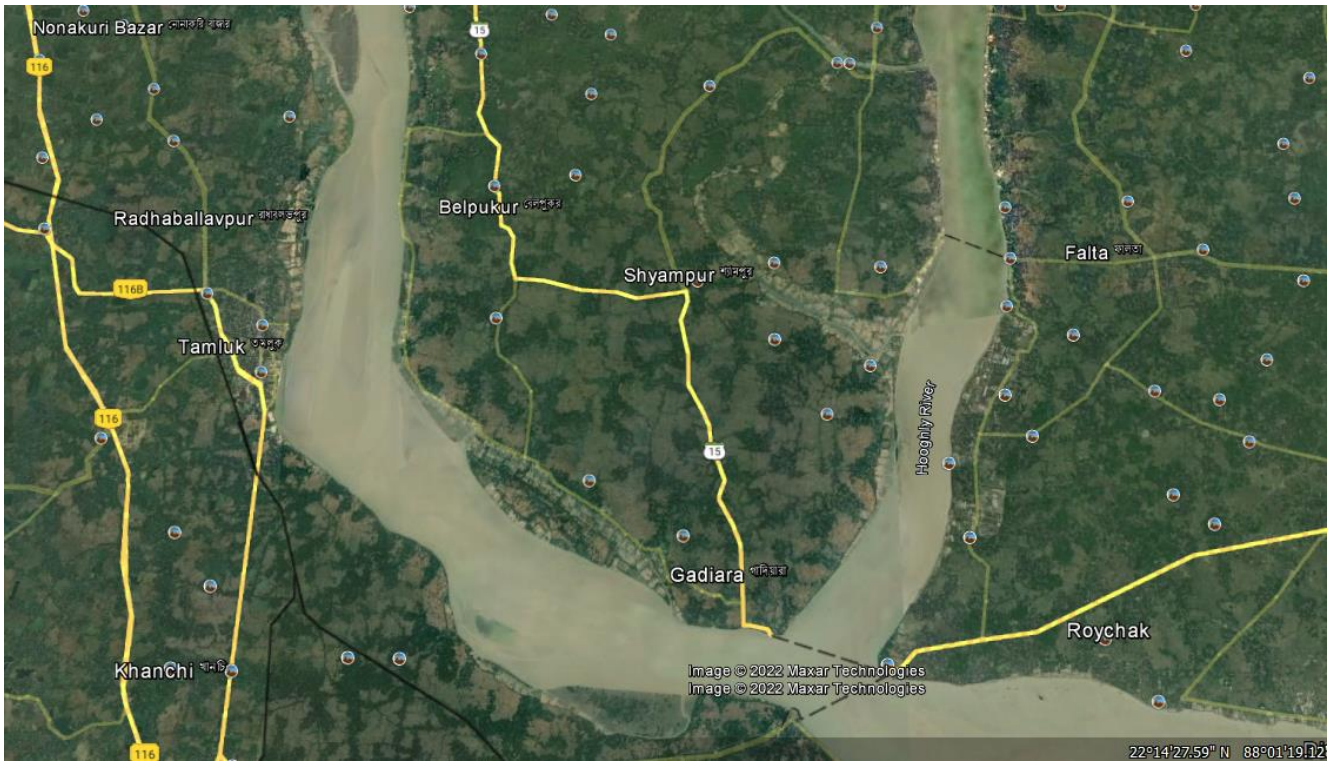
The river is tidal and the bores are experienced as far north asAmta during summer.Several chars have been built along its bank, most ofwhich being mantled with grass and few are utilised for agriculture.To protect the agricultural fields and the human habitationsfrom the devastating floods of the Damodar, embankmentswere constructed on both the banks before 1857. The embankmenton the right bank of the river was however, destroyed subsequentlybecause with the rise of the river bed by excessive siltdeposition it may aggravate the possibility of flood throughbreaches on the embankments. Elimination of the embankment on theright bank has solved the problem to some extent. The embankmenton the left is now being maintained by the Govt, to prevent theeastern railways, roads and above all the industrial region east of Damodar from the danger of being deluged.

The changes in the courses of the Damodar were considerable; formerly, the Damodar joined the Hugli at Nayasarai, some 64 kms north of the Haora city. Even it is presumed that, *the Damodar river had an independent delta of its own which wasbuilt-up in this area long before the deposition and development of Bhagirathi delta" (Das Gupta, 1953)* The prosperity or poorness in agriculture is very much related with the changing course of the river. Damodar, Madaria khal, Banaspati khal and a number of others are thought to be the old branches of Damodar.

Image No41: Damodar Riveroutfall,Garchumuk,22°21'0.01"N 88° 5'17.40"E



Map No15: US Army Map (1957-58) showing the old route of Damodar River Confluence with River Bhagirathi-Hugli



Map No16: Google Earth Image showing the dried-up course of Damodar River

C. The Rupnarayan: like the Damodar descends from the uplandof the Chotanagpur plateau. Its behaviour is somewhat likethat of the Damodar, as it is fed by rain-water.

The river touches the district south-west of UttarBhatora Village (Jl Ho,78, PS Amta), where the Mundeswaririver and the Par.suli khal join it. It debouches its water intothe Hugli. The length of the river bordering the district isabout 56 kms and with the approach of the mouth, it widens considerably.The lower reaches of the river is tidal. This riveris important from the point of view of navigation. However, theriver Rupnarayan is not so notorious for flood.

Image No 42: River Rupnarayan confluence with Bhagirathi Hugli,22°13'12.10"N 88° 2'52.53"E

D. The Saraswati starts its journey from the Hugli at Tribeni, a few kms above the town of Hugli and enters the Haora district at Baluhati (Baluti) as a very insignificant shallow meandering stream. The river falls into the River Hugli just near Sankrail 22°33'32.14"N 88°13'58.83"E. Its high banks and the old remains of large boats occasionally dug up from its bed show that once it was a much larger river.

Image No43: Outfall of Saraswati River, Sankrail22°33'31.30"N 88°13'58.13"E

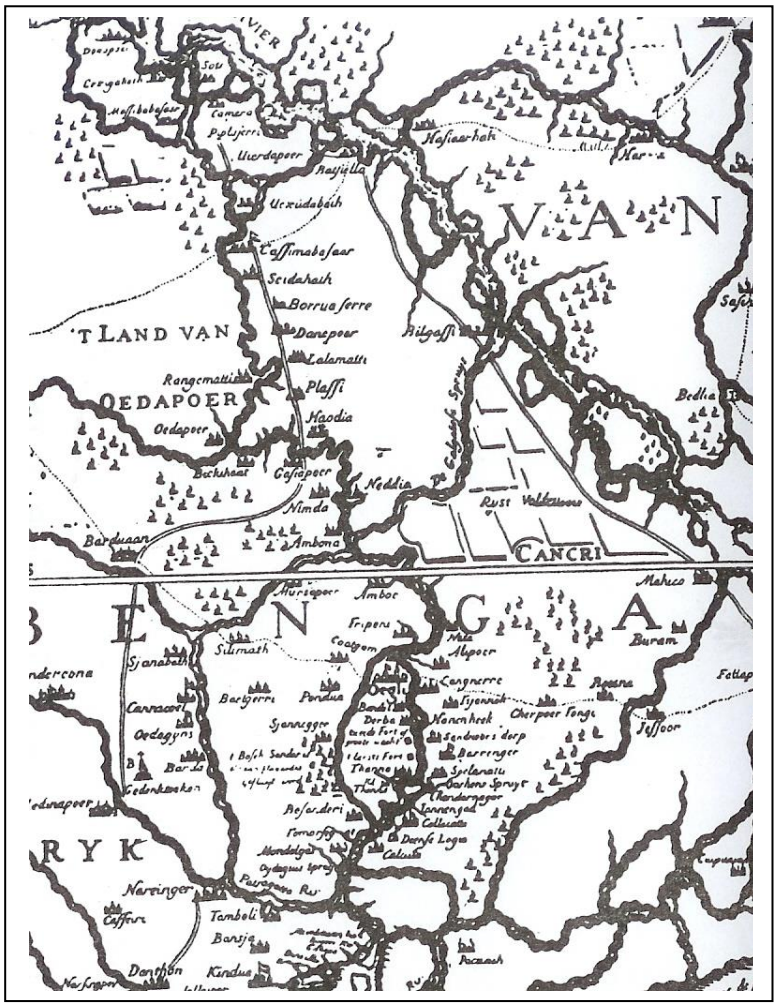
Image No44: Saraswati River passing through Andul, 22°36'1.51"N 88°13'54.60"E

From the historical perspective, it is evident that Saraswati was once a large river. Reference has been made of the flourishing part of Saptagram. Large barges as well as sail boats pile along the Saraswati. Thus, this river sustained the economy of the region by facility trade. It was responsible for the prosperity of the region. Iban Batuta came to Bengal through this part. The Portuguese controlled this part for some time. Commodities like rice, cotton goods, sugar, dry fruits etc. we're being exported through this part. Different trading classes and fisherman lived along this river as the Saraswati was a source of their livelihood. According to the local people, even fifty to sixty years ago it was very salient locally. The water of this river sustained cultivation and fishing. Small boats carried out local trade. But at present the Saraswati is a defunct, narrow silted up channel. Even locally, it has lost its importance particularly on fishing and agriculture. By detail study we discovered that the depth, width, water level has been decreasing exceedingly. As a consequence problems like flood, pollution and silting up are also increasing.

Image No45: River Saraswati, Andul

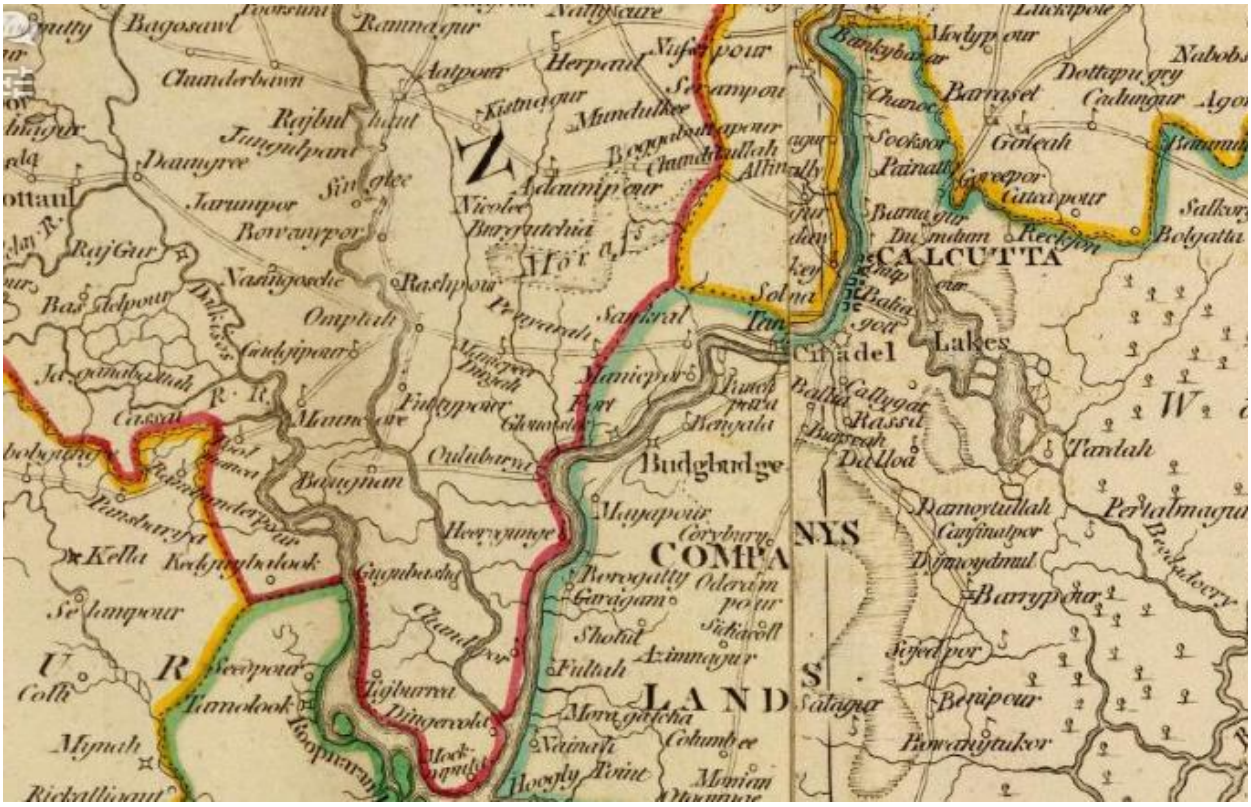
The History of Evolution of The Saraswati River Basin: the old Saraswati River has gone through a number to stage of drainage evolution e.g. **1. Pre Renell 2. Rennell 3. Pre DVC 4. Present or Post DVC , Map 17 :** Van Den Brouke

Stage I (PRE-RENELL PERIOD): From the sketch of the Jao-de-barros (1550AD) it is evident that Saraswati was somehow lined with the Damodar. Most probably it has more than one branch in the medieval period. One was probably towards Damodar and the other having received a branch of the then Bhagirathi River just a little below Batore certainly flowed towards the sea. The latter course has been prominent in the Sketch of Van Den Brouke (1600 AD). A few centuries back Saraswati and Bhagirathi ran almost parallel to each other. The lowest segment of the Bhagirathi was known as old Ganga and the Saraswati (Mkherjee, 1996) which is at presentin estuarine stage referred to as Hugli. Although Saraswati is a distributor of Bhagirathi, the river had a tell link with the Bhagirathi through a Sundarban creek at about the Sankrail town. From the navigation point of view the Saraswati was more convenient channel than Bhagirathi channel (Ganga) because of the stronger tidal flow. The upper reaches of the Saraswati and the Yamuna at Tribeni were originally Feebler than the upper sketch of Bhagirathi as those were mere distributaries of the main Bhagirathi. In course of time the upper sketch of Bhagirathi was silted up so much that it was letter completely detached from the main Ganga channel. It resulted in gradual decay of not only the Bhagirathi but also its continuation further south.



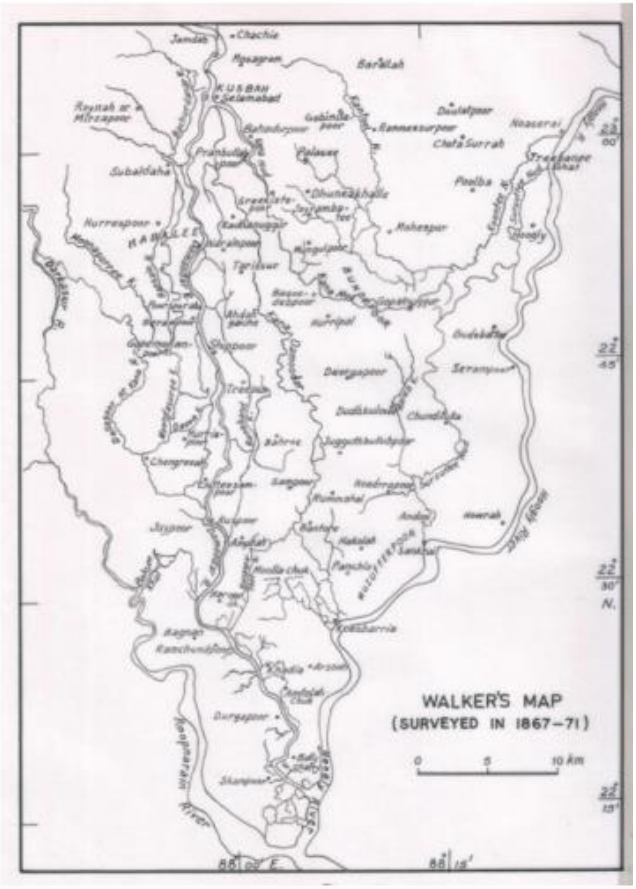
Map No 17:

Stage II (RENNELL PERIOD): Renell in his volume " Memoir of a map of Hindoostan" showed that in early 18th century the Bhagirathi continuity (the old Ganga segment) was deteriorating faster than the old Saraswati segment so much that an alternative channel for navigation for the foreign centers on the Bhagirathi was felt a dire necessaryWith the permission of the then ruler Nabab Alibardi Khan the Dutch traders of Oegli (Hugli) dredged and widened partly the link channel from Khidderpore to Sankrail, manually during low tides resulting in the main flow of the Bhagirathi from its decaying lower segment of to lower Saraswati naming this channel as Kaliganga (Mukhopadhyay ,1915/91,vide, Mukherjee 1996). From that time the entire course of this rejuvenated channel from Khidderpore to Bay of Bengal came to be known as Hugli River. This is a glaring example of human aided river capture. Although the Saraswati river channel remained unnamed in Rennell's map, he has also shown the full length of the river Kunti, its northern tributary and the third segment of the three pigtails (The Ymuna) but also not named.



Map No18: James Rennel's map of Bengal Basin showing the course of Saraswati & Damodar

Stage III (PRE-DVC PERIOD): J & C Walker in his map (Surveyed in 1867-71), Map 19 shows the detail Pre-DVC condition of the Damodar-Bhagirathi region where we find amaze of minor streams were interlinking the Rupnarayana, the Damodar, the Saraswati and Bhagirathi. All these streams and the main rivers were carrying down the monsoon deluge along with huge quantities of sediments from their upper catchments region causing massive floods in DamodarBhagirathi section. The flood havoc was so devastating mainly coming along the Damodar River that this river itself was nicknamed as "Sorrow of West Bengal". To partially save this sector the old Damodar stream was dredged in sections and extended beyond the Sarawati River through to the Bhagirathi. This was at that time known as Eden Canal. Although a number of channels interlinking the Damodar and the Saraswati / Hugli as marked in the post DVC period was either delinked from the Damodar or turned into Kana Nadi but in Walker's map they are still being shown as fully interlinking channel.



Map No 19:

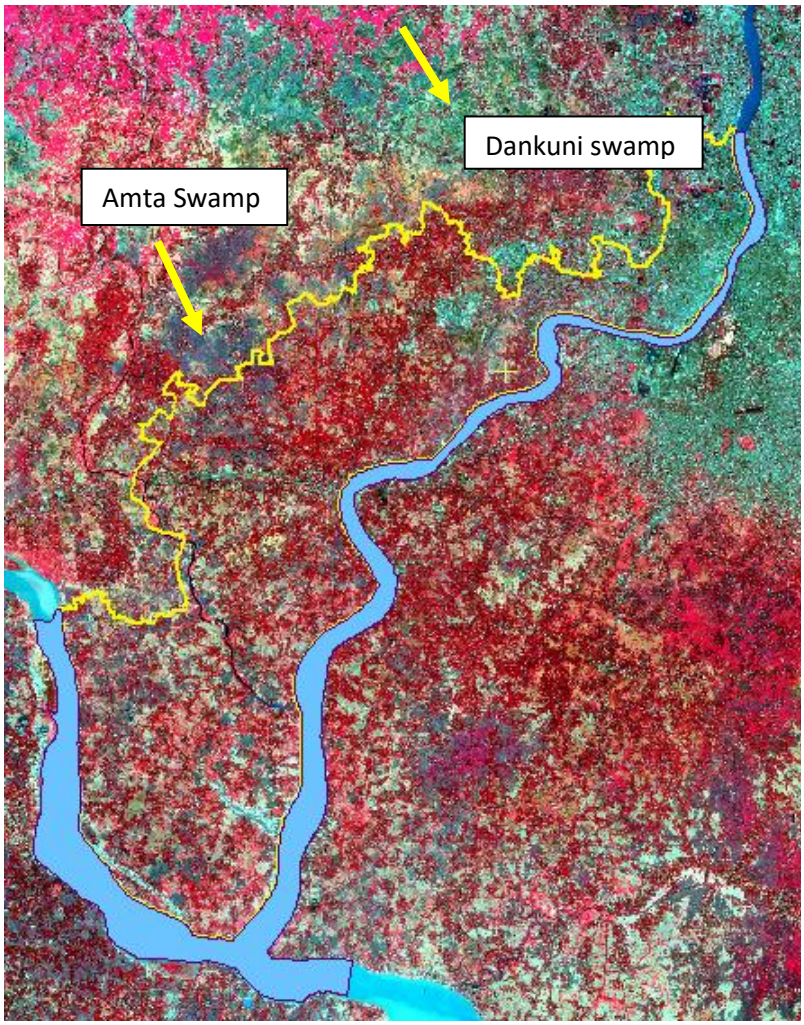
STAGE IV (POST DVC PERIOD): After independence, to make a radical cure of the Damodar flood problem, a Damodar valley Corporation (DVC) was created. This took up a multipurpose river valley project. The diversion of the major flow of the Damodar into diversion canals constructed from Durgapur Barrage to turn into a very lean flowing channel depriving almost all its distributaries became delinked from the Damodar and turned into non continuous inland drainage channels or KanaNadi. This is because of human interference and normal south easterly ground slopes some of the Damodar delinked channels in this heavy rainfall region, converted into tributaries of the Saraswati River e.g. Beulah, Kantul, Ghia, Julki etc. These are excellent examples of human aided river capture.

E. Kana Damodar: The western part of the Hugli and Serampore subdivisionsDamodar.It is drained by several streams, apparently old offshoots of the Damodar.'One of these, the Kana Damodar, was apparentlyonce a large channel. It branched off from the Damodar a fewmiles below Salimabad in the Burdwan district, but its mouth isnow more or less silted up. It is flushed yearly, however, fromthe Eden Canal. Flowing south, it is joined south-east of Kristanagarby the Kausiki, the reclamation of which has recently beentaken up by Giovemment nith the help of private cool ributions.The combined stream then passes into the Haora district pastJagatballabhpur, and falls into the Hugli at Sijberia, a mileabove Uluberia. In this portion of its course the stream, which isknown as the Kalsapa or Kansona Khal, has been converted intothe outfall of the **Rajapur Drainage Channel.**

F. The **Madaria Khal** rises north of Champadanga and passinginto the Haora district falls into the Damodar above Amtatown. In its course through Hugli it is called the Eanabanda. Recently, its overflow having caused much damage to crops nearAmta, the embankment along it has been raised and strengthened.Originally this stream appears to have debouched fromthe Damodar, but its intake has been closed by the embankmentalong its western bank..

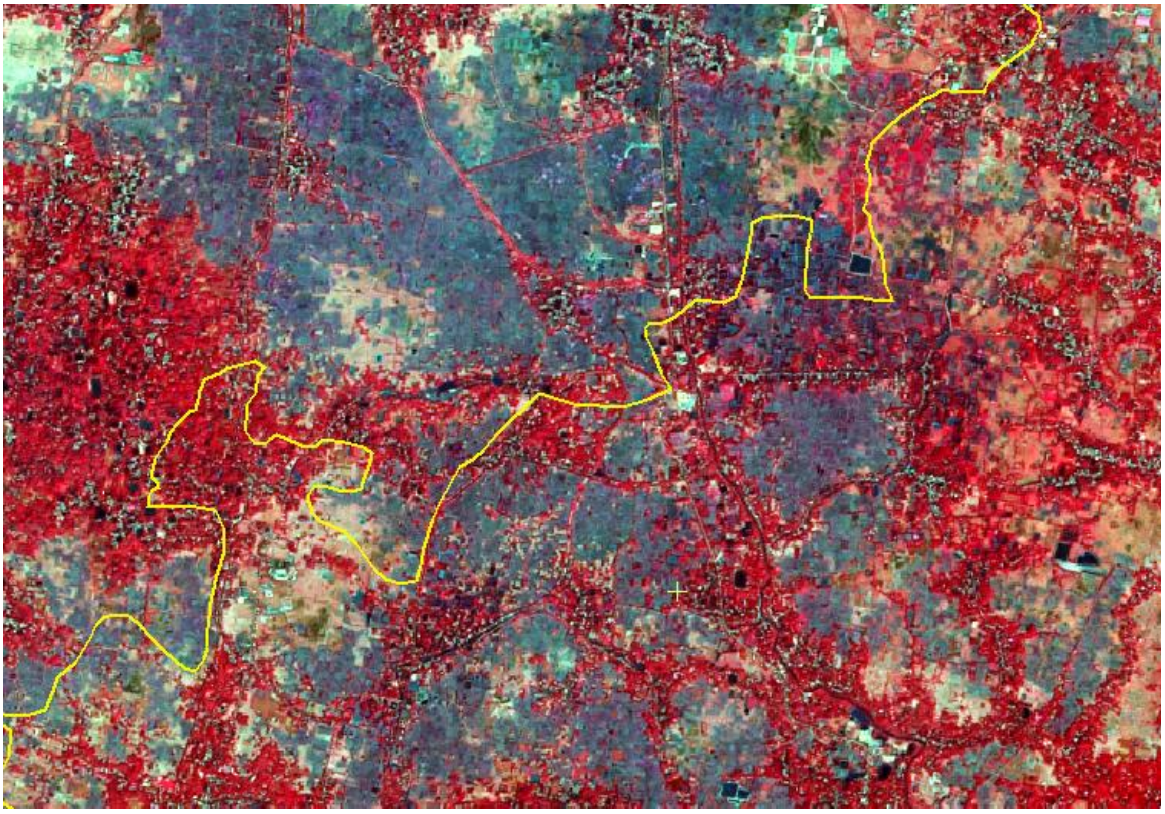
Image No 46: The Madaria Khal, Amta 22°26'45.36"N 87°53'35.22"E

4.2 The Flood Plain Characterestics: Hemmed in between the Hughli (Bhagirathi) on the east and Rupnarayana on the west and intersected by the Damodar, the Howrah district consists of a flat alluvial plain, with a gradual, almost imperceptible, rise towards the north and the north west, the general flow of drainage being consequently to the south and the south east. The product of these rivers and their branches, it compromises two main divisions, viz, the raised riverbanks and the large marshes or lowlands that separate them. In this way ,three districts tracts are formed each with a depression in the center bounded by their high banks in the rivers.viz, an eastern tract stretching away from the Hughli(Bhagirathi); and in the interveningcountry and numerous watercourses' or creeks,called "Khaals" which run dry or very shallow in the hot weather . The characteristic feature of this riverine landscape is the levee formations along all the rivers in between which there are extensive swamps (jheels) or depression (jalas) forming vast sheets of water during the rains. The eastern parts of Haora city, for instance is situated on the levee formed by the Bhagirathi while its western part occupies a portion of the **Dankuni and Haora** swamps extending from north and south between the Bhagirathi and Swaraswati. The Rajapur lies between the Saraswati and the Kana Damodar and while the **Amta Swamp** stretches between the Kana Damodar and Damodar. The average height of the riverside areas for which Bench Marks are available, varies from 15 to 20 feet above sea level, while the Botanic Gardens



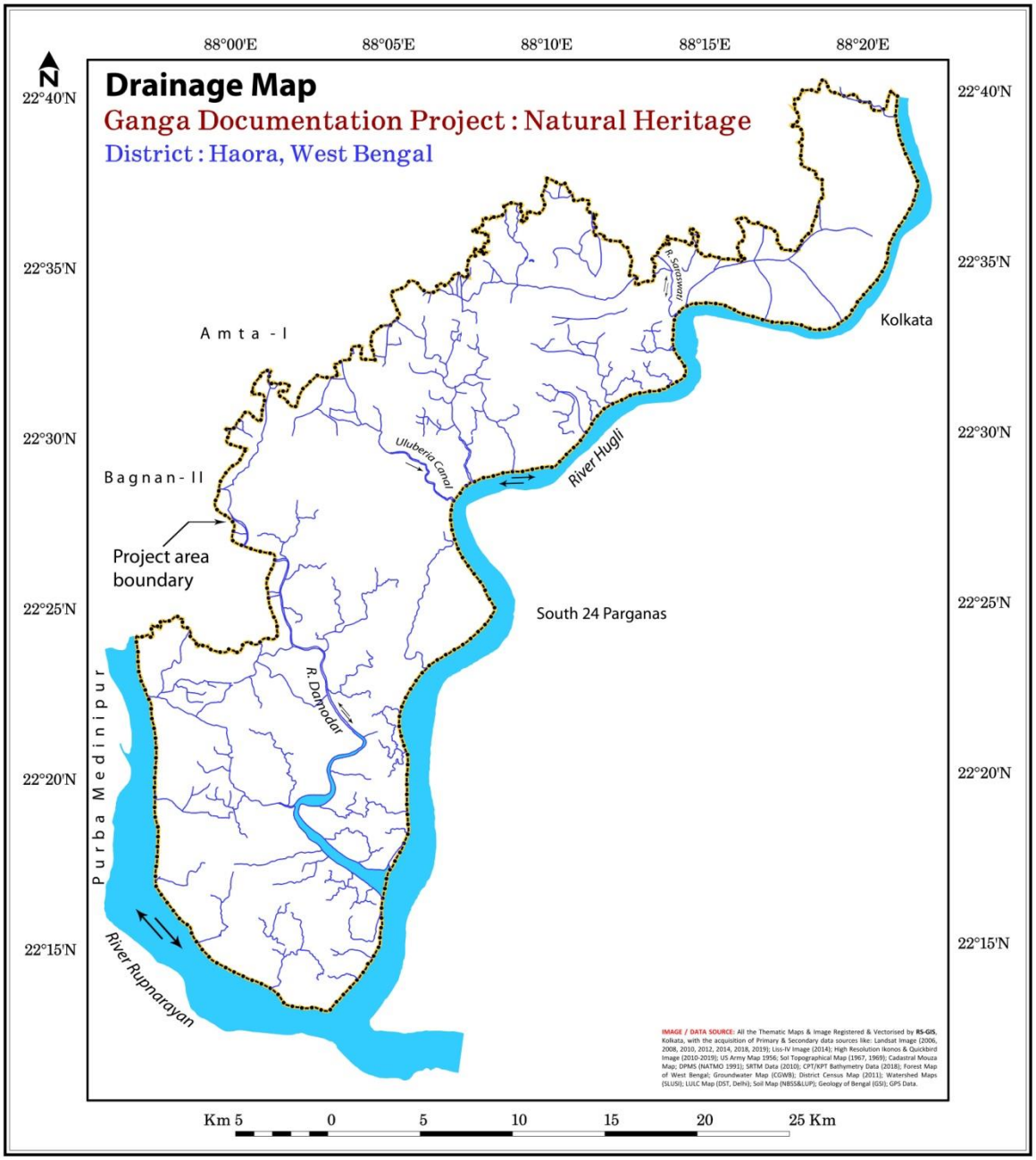
Map No20: Landsat Image, 2020 showing the swamp areas of the Haora district

area with an elevation of about 15 feet in the lowest. The drainage of the riverside areas flow into the low lying marshes, which drained into the river partly through the channel further west. A larger amount, however, remains stagnant due to unplanned construction of railways, roads and buildings and forms a conspicuous feature of the city's landscape.



Map No 21: Amta Wetlands as depicted in the Landsat Image, 2020

Image No47: Dadkhali Daha, Amta



Map No. 21 b : Drainage Map of the study area .

4.3 Wetlands and Marshes: Both Haora and Hugli districts entirely fall .under the physiographic subdivision known as 'mature delta' in the lower Ganga Plain. The vast plain of these two districts is endowed with fertile alluvial soils, 70 per cent of which is used for cultivation of paddy and kharif crops. These two districts, Haora and- Hugli, have a total area of 1467 sq. km. and 3149 sq. km. with a population of 37.91 lakhs and 43.52 lakhs (as per 1991 census) i.e., having 2967 persons and 2311 persons per sq. km. respectively .They are located between the latitudes 22° 13' ~nd 23°0 I' North and longitudes 87°30' and 88°30' East. They are hemmed in between Hugli (Bhagirathi) river on the east and Rupnarayan river on the south-west and· intersected by Damodar river. These rivers provide a network of waterways, notably the Damodar group with two branches viz., the Kana Damodar or Kausiki and the old Damodar ; and the Bhagirathi group with its branch, the Saraswati. Numerous tributaries of the main rivers and creeks. called khals which run dry or very shallow in summer months serve as the natural drainage system of the Damodar-Bhagirathi inter-riverine floodplain and Darakeswar-Damodar inter riverine floodplain areas of these two districts.

It may be mentioned that the very name of **Haora district** is derived from *'haor'* (swampy area) which was earlier known to be present in countless number in this district. However, at present, this district is dominated by industrial establishments in the north-eastern sector. The wetlands of both Haora and Hugli districts are mainly small freshwater wetlands. Low salinity can only be encountered in wetlands adjacent to Hugli and Rupnarayan rivers for having tidal influence in some of them. The wetland units of these two districts. vary in shape, size, origin and in vegetation type. There are both temporary and permanent wetlands as well as' natural and man-made wetlands. The ponds, big or small, are locally known as *pukurs, dobas, dighies and jheels.* While *haors, beels, jotas* and *dahas* are natural wetlands.. There is no lake or ox-bows as such in these districts. However, for convenience, these local wetland units are defined in addition to the common one . The definitions are :

a.Haor - A combination of floodplain and beel. *b.Jola* -A freshwater marsh. *c.Daha*- Natural pool of fresh standing water formed by sudden rushing outgress of river water due to spating of the river al)d break down of the embankment.*d. Beel* -Large, natural and shallow saucer-like depression often combining freshwater marsh, lake and/or floodplain. *E.Dighi* -Large, deep pond usually excavated by the Zamindars (feudal landlords) for religious and/or drinking purposes

4.2.1. We have plotted some of these waterbodies in the following paragraphs. Here is a table showing the Blockwise list of waterbodies in the district of Haora.

SL.NO	BLOCK	LATITUDE	LONGITUDE	TYPE/ CONDITION
1	SHYAMPUR	22°13'14.40"N	88° 2'41.24"E	MARSHES (HAORS,BILLS,DAHA) (CLOGGED)
2		22°13'18.04"N	88° 2'49.09"E	
3		22°13'17.18"N	88° 2'55.18"E	
4		22°13'18.66"N	88° 2'55.55"E	
5		22°13'29.31"N	88° 3'5.07"E	
6		22°13'33.99"N	88° 3'0.92"E	
7		22°13'39.22"N	88° 3'0.77"E	
8		22°13'57.92"N	88° 2'56.01"E	
9		22°14'6.79"N	88° 3'23.61"E	
10		22°14'15.72"N	88° 3'41.94"E	
11		22°14'19.51"N	88° 3'49.81"E	
12		22°14'40.11"N	88° 3'53.27"E	
13		22°14'49.68"N	88° 4'1.80"E	PONDS
14		22°14'44.13"N	88° 4'6.31"E	PONDS
15		22°14'39.57"N	88° 4'7.58"E	PONDS
16		22°14'49.56"N	88° 3'48.06"E	PONDS
17		22°15'3.12"N	88° 3'45.00"E	PONDS
18		22°15'18.70"N	88° 4'0.20"E	PONDS
19		22°15'21.94"N	88° 4'2.38"E	PONDS
20		22°15'31.39"N	88° 4'9.38"E	PONDS
21		22°15'30.56"N	88° 4'9.99"E	PONDS
22		22°15'56.80"N	88° 4'19.57"E	PONDS
23		22°16'36.82"N	88° 4'27.26"E	PONDS
24		22°16'35.13"N	88° 4'13.09"E	PONDS
25		22°16'29.35"N	88° 4'30.99"E	PONDS
26		22°16'26.96"N	88° 3'54.68"E	PONDS
27		22°16'22.30"N	88° 4'10.30"E	PONDS
28		22°16'35.03"N	88° 3'58.50"E	MARSHES

29		22°16'31.11"N	88° 4'2.04"E	MARSHES
30		22°16'33.17"N	88° 3'57.50"E	MARSHES
31		22°16'30.06"N	88° 4'14.24"E	MARSHES
32		22°16'34.58"N	88° 3'59.86"E	MARSHES
33		22°16'44.57"N	88° 3'59.82"E	MARSHES
34		22°16'49.26"N	88° 4'2.99"E	MARSHES
35		22°16'48.34"N	88° 4'3.31"E	PONDS
36		22°13'14.70"N	88° 2'41.48"E	PONDS
37		22°13'23.48"N	88° 2'28.10"E	PONDS
38		22°13'22.17"N	88° 2'25.46"E	PONDS
39		22°13'35.44"N	88° 2'39.34"E	PONDS
40		22°13'49.03"N	88° 2'8.67"E	PONDS
41		22°13'43.60"N	88° 2'5.02"E	PONDS
42		22°13'41.31"N	88° 1'48.72"E	MARSHES
43		22°13'35.33"N	88° 1'46.50"E	MARSHES
44		22°13'35.44"N	88° 1'41.68"E	MARSHES
45		23° 4.104'N	88° 28.391'E	MARSHES
46		23° 3.491'N	88° 27.086'E	MARSHES
47		23° 3.524'N	88° 26.941'E	MARSHES
48		23° 3.224'N	88° 26.914'E	MARSHES
49		23° 3.148'N	88° 27.072'E	MARSHES
50		23° 3.059'N	88° 26.866'E	MARSHES
51		23° 2.811'N	88° 26.814'E	PONDS
52		23° 2.721'N	88° 26.716'E	PONDS
53		23° 2.626'N	88° 26.530'E	PONDS
54		23° 2.626'N	88° 26.530'E	PONDS
55		23° 2.098'N	88° 26.125'E	PONDS
56		23° 2.567'N	88° 25.629'E	PONDS
57		23° 2.385'N	88° 25.781'E	PONDS
58		23° 2.161'N	88° 25.845'E	PONDS
59		23° 2.231'N	88° 25.716'E	PONDS
60		23° 1.946'N	88° 25.432'E	PONDS

61		23° 1.845'N	88° 25.380'E	PONDS
62	ULUBERIA	23° 1.493'N	88° 24.704'E	PONDS
63		23° 1.345'N	88° 24.708'E	PONDS
64		23° 0.970'N	88° 24.496'E	PONDS
65		23° 0.541'N	88° 24.467'E	PONDS
66		23° 0.311'N	88° 24.430'E	PONDS
67		23° 0.183'N	88° 24.396'E	PONDS
68		23° 0.149'N	88° 24.265'E	PONDS
69		23° 0.264'N	88° 24.215'E	PONDS
70		23° 0.145'N	88° 24.049'E	PONDS
71		22° 59.958'N	88° 24.014'E	PONDS
72		22° 59.692'N	88° 23.870'E	PONDS
73		22° 59.601'N	88° 23.824'E	PONDS
74		22° 59.615'N	88° 23.604'E	PONDS
75		22° 59.418'N	88° 23.530'E	PONDS
76		22° 59.312'N	88° 23.373'E	PONDS
77		22° 59.198'N	88° 23.356'E	PONDS
78		22° 59.151'N	88° 23.350'E	PONDS
79		22° 59.004'N	88° 23.231'E	PONDS
80		22° 58.916'N	88° 23.171'E	PONDS
81		22° 58.645'N	88° 23.045'E	PONDS
82		22° 58.623'N	88° 22.903'E	PONDS
83		22° 58.625'N	88° 22.797'E	PONDS
84		22° 58.487'N	88° 22.752'E	PONDS
85		22° 58.421'N	88° 22.700'E	PONDS
86		22° 58.372'N	88° 22.566'E	PONDS
87		22° 58.346'N	88° 22.406'E	PONDS
88		22° 58.050'N	88° 22.354'E	PONDS
89		22° 57.819'N	88° 22.776'E	PONDS
90		22° 57.834'N	88° 22.920'E	PONDS
91		22° 57.968'N	88° 22.853'E	PONDS
92		22° 57.997'N	88° 22.606'E	PONDS

93		22° 57.737'N	88° 22.358'E	
94		22° 57.323'N	88° 22.255'E	PONDS
95		22° 55.297'N	88° 22.425'E	PONDS
96		22° 55.197'N	88° 22.406'E	PONDS
97		22° 55.737'N	88° 22.918'E	PONDS
98		22° 55.439'N	88° 23.201'E	PONDS
99		22° 55.712'N	88° 23.426'E	PONDS
100		22° 55.872'N	88° 23.532'E	PONDS
101		22° 55.702'N	88° 23.603'E	PONDS
102		22° 55.389'N	88° 23.615'E	PONDS
103		22° 55.256'N	88° 23.823'E	PONDS
104		22° 55.229'N	88° 23.629'E	PONDS
105		22° 55.021'N	88° 23.706'E	PONDS
106		22° 54.860'N	88° 23.790'E	PONDS
107		22° 54.799'N	88° 23.867'E	PONDS
108		22° 54.661'N	88° 23.858'E	BRICK KILNS
109		22° 54.659'N	88° 23.730'E	BRICK KILNS
110		22° 54.601'N	88° 23.692'E	BRICK KILNS
111		22° 54.500'N	88° 23.579'E	BRICK KILNS
112		22° 54.403'N	88° 23.531'E	BRICK KILNS
113		22° 54.349'N	88° 23.511'E	BRICK KILNS
114		22° 54.279'N	88° 23.384'E	BRICK KILNS
115		22° 54.212'N	88° 23.277'E	BRICK KILNS
116		22° 54.233'N	88° 23.163'E	BRICK KILNS
117		22° 54.137'N	88° 23.073'E	BRICK KILNS
118		22° 54.122'N	88° 22.984'E	BRICK KILNS
119		22° 53.900'N	88° 23.002'E	BRICK KILNS
120		22° 53.879'N	88° 22.845'E	BRICK KILNS
121		22° 57.251'N	88° 22.305'E	BRICK KILNS
122		22° 56.900'N	88° 22.029'E	BRICK KILNS
123		22° 56.554'N	88° 22.088'E	BRICK KILNS

124		22° 56.167'N	88° 22.024'E	BRICK KILNS
125		22° 57.329'N	88° 22.455'E	PONDS
126	SANKRAIL	22°33'19.27"N	88°12'49.50"E	PONDS
127		22°33'16.19"N	88°12'49.09"E	PONDS
128		22°33'17.69"N	88°12'42.71"E	PONDS
12		22°33'16.14"N	88°12'37.53"E	PONDS
130		22°33'23.21"N	88°12'36.45"E	PONDS
131		22°33'3.45"N	88°12'30.77"E	PONDS
132		22°32'44.32"N	88°12'22.58"E	PONDS
133		22°32'36.66"N	88°12'15.89"E	PONDS
134		22°32'30.60"N	88°12'16.32"E	PONDS
135		22°32'13.27"N	88°12'1.14"E	PONDS
136		22°31'36.01"N	88°12'13.86"E	PONDS
137		22°31'1.85"N	88°11'48.44"E	PONDS
138		22°30'25.28"N	88°11'4.37"E	PONDS
139		22°32'30.53"N	88°11'34.45"E	PONDS
140		22°32'48.52"N	88°11'59.51"E	PONDS
141		22° 52.921'N	88° 23.096'E	BRICK KILNS
142		22° 52.865'N	88° 22.980'E	BRICK KILNS
143		22° 52.828'N	88° 22.987'E	BRICK KILNS
144		22° 52.686'N	88° 22.929'E	BRICK KILNS
145		22° 52.679'N	88° 23.130'E	BRICK KILNS
146		22° 52.713'N	88° 23.188'E	BRICK KILNS
147		22° 52.743'N	88° 23.259'E	PONDS
148		22° 52.828'N	88° 23.344'E	PONDS
149		22° 52.843'N	88° 23.475'E	PONDS
150		22° 52.709'N	88° 23.521'E	PONDS
151		22° 52.533'N	88° 23.322'E	PONDS
152		22° 52.440'N	88° 23.015'E	PONDS
153		22° 52.377'N	88° 22.737'E	PONDS
154		22° 52.167'N	88° 22.562'E	PONDS
155		22° 52.133'N	88° 22.549'E	PONDS

156		22° 52.044'N	88° 22.436'E	PONDS
157	HAORA	22°34'53.71"N	88°16'57.25"E	PONDS
158		22°34'52.34"N	88°16'43.40"E	PONDS
159		22°34'55.20"N	88°16'17.48"E	PONDS
160		22°34'31.10"N	88°16'31.64"E	PONDS
161		22°34'46.23"N	88°16'10.77"E	PONDS
162		22°34'17.25"N	88° 21.634'E	PONDS
163		22° 51.278'N	88° 21.550'E	PONDS
164		22° 51.233'N	88° 21.648'E	PONDS
165		22° 51.068'N	88° 21.383'E	PONDS
166		22° 51.016'N	88° 21.444'E	PONDS
167		22° 51.084'N	88° 21.347'E	PONDS
168		22° 51.332'N	88° 21.092'E	PONDS
169		22° 51.633'N	88° 20.947'E	PONDS
170		22° 51.549'N	88° 21.018'E	PONDS
171		22° 51.750'N	88° 20.823'E	PONDS
172		22° 51.223'N	88° 20.559'E	PONDS
173		22°35'31.71"N	88°16'55.35"E	PONDS
174		22°35'35.06"N	88°16'15.99"E	PONDS
175		22°35'54.71"N	88°17'30.15"E	PONDS
176		22°36'9.13"N	88°16'39.72"E	PONDS
177	HAORA	22° 50.172'N	88° 21.403'E	PONDS
178		22°36'36.45"N	88° 21.310'E	PONDS
179		22° 50.231'N	88°17'10.75"E	PONDS
180		22°36'44.56"N	88°17'45.41"E	PONDS
181		22°37'13.09"N	88°17'20.54"E	PONDS
182		22°37'30.04"N	88°16'59.25"E	PONDS
183		22°38'0.74"N	88°17'20.40"E	PONDS
184		22°36'41.94"N	88°17'46.61"E	PONDS
185		22°38'9.01"N	88°16'27.02"E	PONDS
186		22°37'29.12"N	88°18'10.05"E	PONDS
187		22° 49.521'N	88° 20.907'E	PONDS

188		22°37'43.24"N	88°18'28.15"E	BRICK KILNS
189		22°37'22.18"N	88°18'58.31"E	BRICK KILNS
190		22°37'52.46"N	88°19'30.07"E	BRICK KILNS
191		22°37'23.81"N	88°20'30.99"E	BRICK KILNS
192		22°37'18.45"N	88°21'5.20"E	BRICK KILNS
193	BELUR- BALLY	22°37'16.86"N	88°21'4.28"E	PONDS
194		22°37'16.64"N	88°21'5.68"E	PONDS
195		22°37'49.64"N	88° 20.758'E	PONDS
196		22°37'4.22"N	88°21'15.80"E	PONDS
197		22°38'16.20"N	88°21'10.36"E	PONDS
198		22°38'32.92"N	88°20'56.41"E	PONDS
199		22°38'57.45"N	88°20'40.10"E	PONDS
200		22°39'30.79"N	88°20'46.00"E	PONDS
201		22°39'43.86"N	88°20'39.80"E	PONDS
202		22°40'20.74"N	88°20'50.29"E	PONDS
203		22°41'13.51"N	88°20'39.74"E	PONDS
204		22°41'36.52"N	88°20'47.28"E	PONDS
205		22°42'11.00"N	88°20'47.32"E	PONDS
206		22°42'19.81"N	88°21'12.20"E	PONDS
207		22°42'45.96"N	88°21'15.08"E	PONDS
208		22°43'28.59"N	88°21'6.48"E	PONDS
209		22°44'0.84"N	88°21'13.27"E	PONDS
210		22°43'14.16"N	88°21'12.59"E	PONDS
211	BELUR -BALLY	22°39'0.13"N	88°20'42.65"E	BRICK KILNS
212		22° 47.694'N	88° 19.592'E	BRICK KILNS
213		22° 47.550'N	88° 19.239'E	BRICK KILNS
214		22° 47.359'N	88° 19.202'E	BRICK KILNS
215		22° 47.625'N	88° 19.171'E	PONDS
216		22° 47.400'N	88° 18.929'E	PONDS
217		22° 47.238'N	88° 18.752'E	PONDS
218		22° 47.086'N	22° 47.086'N	PONDS
219		22° 47.177'N	88° 18.289'E	PONDS

220		22° 47.294'N	88° 17.965'E	PONDS
221		22° 47.381'N	88° 17.726'E	PONDS

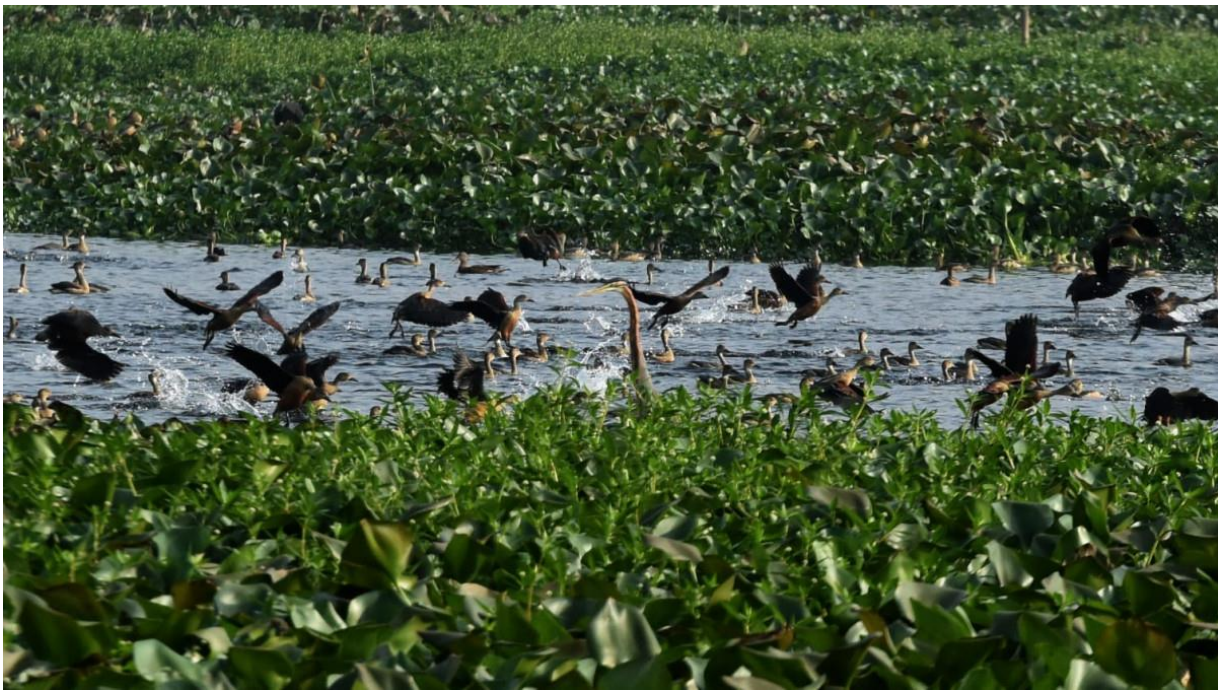


Image No 48: Paddapukur Jola, Haora

4.2.2. Some of the important natural wetlands of the study area are as follows:

Sl.no	Name	GPS Coordinate	Nearest Town	Area
1	**Santragachi**	22°34'55.23"N 88°16'59.06"E	**Haora**	**87 ha**
2	**Paddapukur Jola**	22°34'19.20"N 88°17'40.96"E	**Haora**	**0.8 ha**
3	**Phuleswar Jheel**	22°28'2.65"N 88° 6'41.32"E	**Uluberia**	**0.9 ha**
4	**Natibpur Jheel**	22°28'8.51"N 88° 6'26.53"E	**Uluberia**	**0.35 ha**
5	**Bagnan Jheel**	22°28'8.67"N 87°57'55.51"E	**Bagnan**	**0.6 ha**
6	**Gadiara pond**	22°13'17.00"N 88° 2'53.51"E	**Gadiara**	**0.1 ha**
7	**Amta**	22°35'8.69"N 88° 0'35.91"E	**Amta**	**0.3 ha**
8	**Siva Daha**	22°35'8.22"N 88° 0'26.37"E	**Amta**	**4.2 ha**
9	**Dadkhali Daha**	22°35'41.13"N 88° 0'41.47"E	**Amta**	**5.4 ha**

4.4Tides and Bore:

The Hugli is regularly affected by the tides, which riseat Kidderpore 4.7 m above the lowest tide-level in springand 3.2 m in neap tides. During floods the mean springs rise as high as 5.9 meter and the mean neaps 4.41 meter. The tidetravels to Calcutta from the Sagar Roads in 4 hours and 9minutes, and from Diamond Harbour in a little more than twohours, running at the rate of 27 km an hour at DiamondHarbour, 35 km at Mayapur and 28 kilometers an hour at FortWilliam, in addition to tides, the Hugli waters are affectedby several other factors, such as the seasonable low readings ofthe barometer between March and September, the forcing ofwater into the river by strong southerly winds from Marchto August and out of it by northerly winds from Novemberto February, and, lastly, by the floods which bring down alarge body of fresh water from July to October. The difference due to these causes is about 1.2 meters , the highest level being inAugust and September, and the lowest in February and March.

Bores of more or less violence occur at perigee springs,especially in February, March and April. The bore is not feltmuch until it enters the more tortuous and contracted reachesabove Hugli Point, where it not only capsizes and swampsboats that have not been hauled off into deep water in time, butalso affects vessels at anchor, forcing them to run upstream of their anchors with straightened cables, more especially if there is astrong southerly breeze. The following graphic description of theboro is given by a wriUr in the CakiiUa Review of 1859 “Uponthe approach of this wave a distant murmur is heard, which turnsinto the cry ban \ bdn\ ban ! from the mouths of thousands ofpeople, boatmen, saih^rs and others, who are always on the lookout for this much dreaded wave. This (Ty is the signal for allsorts of craft to push out into the centre of the river, the onlyspot where the wave does not curl over and break. Should anyboat or larger craft be caught in that portion of wave that breaks,instant destruction is inevitable. Numerous boats from theupcountry provinces are lost every year from the crews beingignorant either of the existence of the bore, or from not knowing the oorreot position to take up so as to meet it. Ships at anchorin Calcutta, though not exposed to the breaking portion of thewave, frequently part their cables when struck with the wave.

Standing on the shore during the rapid rushing passage of thebore, it is a curious sight to see the lower portion of the river, orthat nearest to the sea, six or eight feet higher than the upper

portion of the river, the tide rising that number of feet in aninstant. The height of the boro in the Hugli varies from fiveto twelve feet ; it is exceedingly dangerous in some parts of the river, but more moderate in others ; it never breaks on both sides ofthe river at the same time. Deep water destroys its force, butshallow water, or a sand bank, brings out all its power and fury.

Accretions [chars have been formed at various places on theHowrah side of the river, e.g,^ at Ghusuri, Ramkrishnapur, Sibpur(near the Engineering College), Sarenga and Uluberia. Thesechars are very valuable, especially those at Ramkrishnapur, which been the source of a considerable income to the PortCommissioners. Elsewhere the bank is sloping and is largelyutilized, outside municipal limits, for brick-making, A retiredline of embankments runs along it up to the mouth of theDamodar, but, being under the charge of a number of co-sharingzammdars, is more or less in decay with many unrepaired breachescaused by Hoods. In 1906/07 a part of the line near Uluberiahad to be repaired by Government, at the cost of the landlords,to prevent floods causing serious damage to crops in the interior.

The embankment between the mouths of the Damodar andthe Rupnarayan is kept up by the Public Works Department.

Image No49: Tidal Bore near Shibpur, Haora

4.5 Sacred Trees & their historical importance

Kalpavriksha and Chaityavriksha scriptures mention that worshipping trees have been an ancient Indian practice. Considering trees as sacred entities, dates back to the era of the Aryans who worshiped nature. Plants and trees are associated with several Indian rituals and tree worshiping continues to be an aspect of modern Indian traditions. These trees are an important storehouse of biodiversity, having remained largely undisturbed by human interference and these are the last remnants of natural forests which should be preserved for conserve the local biodiversity.

With this background the present study was undertaken along the bank of Bhagirathi-Hugli . The plants of these sacred groves are Ficus religiosa (Aswatha), Ficus bengalensis (Bot), Opuntia dillevii (Fani Manosa), Murraya paniculata (Kamini), Ocimum sp. (Tulsi) and Catharanthus roseaus (Nayantara). Some of the major sacred places are documented below.

Image No50:Azadirachta indica (Neem) near Bali with the Shiva Temple, 22°39'6.70"N° 88°21'1.46"E

Image No 51 & 52: Ficus bengalensis (Bot) Ramkrishnapur Ghat, Haora Municipality, 22°34'20.70"N, 88°20'10.17"E

Image No53:The Banyan tree is associated with Yama; the god of death and the tree is often planted outside the village near crematoriums. Panchla, Haora.

Image No54: Ficus benghalensis, the Banyan belongs to the Fig family. There are various types of fig trees all over the world, some of these are sacred.

Image No 55: Uluberia Kaali Bari Ghat, 22°28'5.38"N 88° 6'53.07"E

Image No 56: Uluberia kalibari Ferry Ghat is beautiful creation. On the opposite of the river is Burul the Baro Mandir in Konnagar has its own brand of unique charm.

Image No57:The Great Banyan Tree near Fort Gloster is worshipped by the local bathers,Bauria,Haora

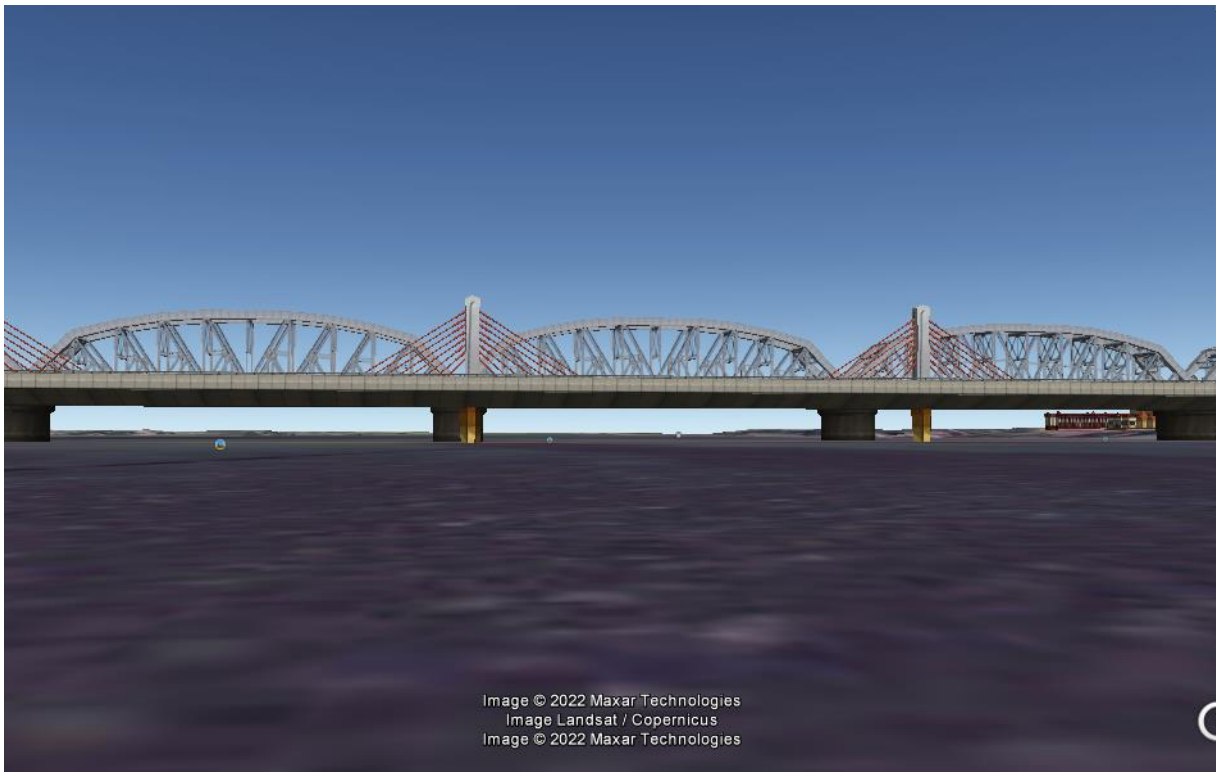
Image No58: The sacred Neem Tree of Jagatballavpur is worshipped as Gumo God, the local deity

Image No59: Worshipping of Tree is a custom of the village dwellers. Bakul Tree is being offered Uluberia, Haora

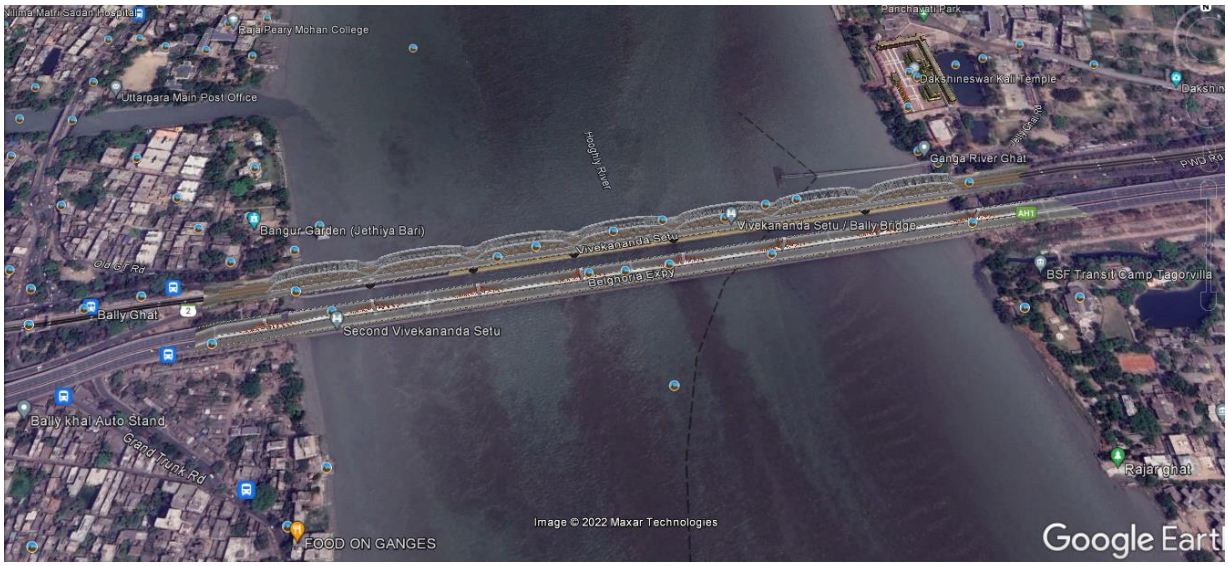
5. Documenting Major Structures in The River Bank

5.1 Major Bridges: There are 3 major bridges on River Bhagirathi-Hugli in this stretch. They are –**A. Vivekananda Setu** (also called Willingdon Bridge and Bally Bridge) is a bridge over the Hugli River in West Bengal, India. It links the city of Howrah, at Bally, to Kolkata, at Dakshineswar. Completed on 1931, it is a multispan truss bridge and was built to primarily to provide direct road and rail connectivity between the Calcutta Port and the major railhead at Howrah railway station on the West bank of the Hugli River. It is 2,887 feet (880 m) long having 9 spans in total. The famous Dakshineswar Kali Temple is situated on the banks of the Hugli River near the bridge. The bridge is one of the four bridges linking Howrah and Kolkata. A new road bridge, the Nivedita Setu, was constructed 50 m (160 ft) downstream in 2007 due to weakening of the Vivekanada Setu caused by its ageing. The bridge was originally named Willingdon Bridge after Viceroy of India, Freeman Freeman-Thomas, 1st Marquess of Willingdon. It was eventually renamed as Bally Bridge, before officially renamed as Vivekananda Setu. The erection and caissoning of the bridge was done by the noted Kutchi-Mestri railway contractor and industrialist Rai Bahadur Jagmal .Raja. His nameplate can still be seen on each girder of the bridge. Bridge near Kushtia in Bangladesh. He was a son of the American painter Charles Robert Leslie, ultimately Professor of Painting at the Royal Academy in London. The Jubilee Bridge is noteworthy in that it is a cantilever truss bridge, constructed entirely by riveting, without any nuts or bolts used in the construction.

Image No 60: The Jubilee Bridge, Hugli



Map No 22: Location of Vivekananda Setu 22°39'11.30"N 88°21'27.51"E



Map No 23: Connecting 2 Districts, Vivekananda Setu and Nibedita Setu

B. Nibedita Setu (22°39'10.36"N, 88°21'27.83"E) Nivedita Setu (also called Second Vivekananda Setu) is a multi-span extradosed bridge completed 2007 over Hugli River connecting Howrah with Kolkata, in West Bengal. It runs parallel to and about 50 m downstream of the old Vivekananda Setu opened in 1932. The bridge is named after Sister Nivedita, the social worker-disciple of Swami Vivekananda. Belghoria Expressway that connects the meeting point of NH 16 with NH 19 at Dankuni to NH 12, NH 112, Dumdum/Kolkata Airport and northern parts of Kolkata passes over the bridge. The bridge is designed to carry 48,000 vehicles per day. The 1932 Vivekananda Setu had become weak as a result of ageing and with heavy traffic even repairs became difficult. There was need for a second bridge.

The main challenge was to design and construct a new bridge that did not mar the view of the old Vivekananda Setu, did not dwarf the historically important Dakshineswar Kali Temple which is located well within visible distance, and carry substantially higher levels of fast traffic for around half a century. The bridge rests on deep-well foundations going down to the river bed level. It carries six lanes for high speed traffic. The carriageway is supported by 254 pre-stressed concrete girders. Cables from 14m high pylons extend additional support.

Nivedita Setu is the first bridge in the country that is a single profile cable-stayed bridge. By design, the height of the columns are lower than the tip of the Dakshineswar temple.

Image No 61: Nibedita Setu on River Hugli. 22°39'7.75"N 88°20'59.58"E

This bridge is estimated to cost approximately Rs. 6,50 crore. The construction of the bridge started in April 2004, by the construction giant Larsen and Toubro and was opened to traffic in a record time in July 2007.

The bridge is the India's first multi-span, single-plane cable-supported extradosed bridge; with short pylons and seven continuous spans of 110 m, totaling a length of 880 m (2,887 feet). It is 29 m wide and supports 6 lanes of traffic

C. Rabindra Setu : Rabindra Setu or the Howrah Bridge is a balanced cantilever bridge over the Hugli River in West Bengal, India. Commissioned in 1943, the bridge was originally named the New Howrah Bridge, because it replaced a pontoon bridge at the same location linking the two cities of Howrah and Kolkata (Calcutta). On 14 June 1965, it was renamed Rabindra Setu after the great Bengali poet Rabindranath Tagore, who was the first Indian and Asian Nobel laureate. It is still popularly known as the Howrah Bridge.

The bridge is one of four on the Hugli River and is a famous symbol of Kolkata and West Bengal. The other bridges are the Vidyasagar Setu (popularly called the Second Hugli Bridge), the Vivekananda Setu and the relatively new Nivedita Setu. It weathers the storms of the Bay of Bengal region, carrying a daily traffic of approximately 100,000 vehicles and possibly more than 150,000 pedestrians, easily making it the busiest cantilever bridge in the world. The third-longest cantilever bridge at the time of its construction, the Howrah Bridge is currently the sixth-longest bridge of its type in the world. The bridge serves as the gateway to Kolkata, connecting it to the Howrah Station, which is one of the five intercity train terminus stations serving Howrah and Kolkata. As such, it carries the near entirety of the traffic to and from the station, taking its average daily traffic close to nearly 150,000 pedestrians and 100,000 vehicles. In 1946, a census of the daily traffic was taken, which counted 27,400 vehicles, 121,100 pedestrians and 2,997 cattle. The bulk of the vehicular traffic comes from buses and cars. Prior to 1993, the bridge also carried trams. Trams departed from the terminus at Howrah station towards Sealdah, Rajabazar, Shyambazar, High Court, Dalhousie Square, Park Circus, Ballygunge, Tollygunge etc. In 1993, tram service on the bridge was discontinued due to the increasing load on the structure. However, the bridge still continues to carry much more than the expected load. A 2007 report revealed that nearly 90,000 vehicles were plying on the bridge daily (15,000 of which were goods-carrying), though its load-bearing capacity is only 60,000. One of the main reasons for the overloading

was that, although vehicles carrying up to 15 tonnes are allowed on the structure, vehicles with 12-18 wheels and carrying loads up to 25 tonnes often plied on it. From 31 May 2007 onwards, overloaded trucks were banned from crossing the bridge and were redirected to the Vidyasagar Setu instead. The road is flanked by footpaths 15 feet (4.6 m) wide, which are thronged with pedestrians.

Image No 62: Rabindra Setu, 22°34'19.04"N 88°20'8.85"E

5.2 Ghats of Haora Districts in Our Study Area

As almost the entire stretch of our study area has paved river bank there are many significant Ghats mostly used for ferry service and other domestic purposes. Here is a list of the ghats along with their purpose.

Sl.No.	Name of the Block /Municipality	Name of the Ghat	Latitude	Longitude	Purpose
1	**Bally Municipality**	Bally Nimtala Ghat	22°39'2.76"N	88°21'3.25"E	Ferry Service (occasional)
2		Kedarnath Ghat	22°38'54.76"N	88°21'4.02"E	Domestic
3		Pathak Ghat	22°38'51.69"N	88°21'4.32"E	Domestic
4		Bally Rabindra Bhavan	22°38'45.57"N	88°21'6.21"E	Domestic
5		Bally Deshbandhu Ghat	22°38'41.74"N	88°21'7.47"E	Ferry Service
6		Dewangazi Ghat	22°38'35.36"N	88°21'8.96"E	Domestic
7		Rashbari Heritage Ghat	22°38'13.53"N	88°21'18.09"E	Crematorium
8		Lal Baba Ashram Ghat	22°38'11.50"N	22°38'11.50"N	Domestic
9		Pal Ghat	22°38'9.73"N	88°21'19.65"E	Domestic
10		Ramkrishna Mission Belur	22°38'6.77"N	88°21'21.41"E	Ferry Service
11		Belur Math Maayer Ghat	22°37'59.17"N	88°21'25.23"E	
12		Belur Math Ferry Service	22°37'48.46" N	88°21'29.87"E	
13		Jagannath Mandir Ghat	22°37'43.31" N	88°21'31.63"E	
14		Moraghat Burning Ghat	22°37'32.22"N	88°21'37.18"E	Ferry Service
15		Jaganath Ferry Ghat	22°37'17.97"N	88°21'40.53"E	Domestic
16		Panchanantala	22°37'11.45"N	88°21'39.33"E	Domestic

		Jagannath Ghat			
17		Shimultala Ghat	22°37'11.02"N	88°21'39.02"E	Ferry Service
18		Gossain Ghat	22°36'47.41"N	88°21'31.08"E	Ferry Service
19	**Haora Municipality**	Shantinagar Ghat	22°36'26.33"N	88°21'18.76"E	
20		Om Prakash Ghat	22°36'22.37"N	88°21'17.30"E	
21		Pandit Ghat	22°36'12.58"N	88°21'9.06"E	Domestic
22		Bandhaghat Ferry Ghat	22°36'2.84"N	88°21'2.42"E	Ferry Service
23		Bandhaghat Burning Ghat	22°35'57.13"N	88°20'58.20"E	Domestic
24		Chatu Babu Ghat	22°35'48.54"N	88°20'53.45"E	Ferry Service
25		Golabari Ghat	22°35'33.56"N	88°20'47.13"E	Domestic
26		Namak Gola Ghat	22°35'17.75"N	88°20'42.50"E	Ferry Service
27		Setu Ghat	22°35'6.54"N	88°20'41.41"E	Domestic
28		Haora Station Ferry Ghat	22°34'58.70"N	88°20'39.33"E	Domestic
29		Bapu udyan	22°34'44.63"N	88°20'31.69"E	Domestic
30		Telkal Ghat	22°34'36.20"N	88°20'24.35"E	Domestic
31		Ramkrishnapur Ghat	22° 45.324'N	88° 20.907'E	Domestic
32		Ramkrishnapur Ferry Ghat	22°34'18.12" N	88°20'8.83"E	Crematorium
33		Shibpur Burning Ghat	22°33'37.88"N	88°19'32.47"E	Ferry Service
34		Shalimar Point	22°33'7.62"N	88°18'56.23"E	Crematorium
35		Balu Ghat	22°33'5.57"N	88°18'37.67"E	Ferry Service
36		Botanical Garden	22°33'11.18"N	88°18'2.76"E	Ferry Service

34		Nazafgarh Ferry Ghat	22° 46.652'N	88° 19.789'E	Ferry Service
35		Podrah Kheya Ghat	22°33'33.45"N	88°16'13.46"E	Ferry Service
36		Rajganj Ganga Ghat	22°33'46.03"N	88°14'15.09"E	Ferry Service
37	**Sankrail**	Sankrail Ghat	22°33'29.67"N	22°33'29.67"N	Domestic
38		Sankrail Manikpur Kanthaltala Burning Ghat	22°32'21.56"N	22°32'21.56"N	Ferry Service
39		Manikpur Ghat	22° 49.807'N	88° 21.843'E	Domestic
40		Manikpur Ferry Ghat	22°31'47.75"N	88°14'16.57"E	Domestic
41		Sarenga Ferry Ghat	22°31'16.72"N	88°12'47.58"E	Ferry Service
42	**Uluberia**	Palpara Ghat	22°31'10.23"N	88°12'27.90"E	Ferry Service
43		Panchanandatala Ghat	22°30'56.72"N	22°30'56.72"N	Domestic
44		Bowreah Jute Mill Ghat	22°30'25.12"N	88°11'19.31"E	Domestic
45		Bowreah Shiv Ghat	22°29'54.41"N	88°10'57.33"E	Domestic
46		Gloster Jute Mill Ghat	22°29'40.57"N	88°10'44.46"E	Domestic
47		Bowreah Thana Ferry Ghat	22°29'17.72"N	88°10'17.00"E	Domestic
48		Chengail Nepai ferry Ghat	22°28'54.99"N	88° 8'21.69"E	Ferry Service
49		Sejberia	22°28'40.42"N	88° 7'28.87"E	Domestic
50		Uluberia Ghat	22°28'6.91"N	88° 6'54.30"E	Ferry Service
51		Uluberia Jetty Ghat	22°27'49.09"N	88° 6'49.99"E	Ferry Service
52		Kalinagar Vedanta Ashram	22°26'30.42"N	88° 7'10.99"E	Ferry Service

54		Rangamati Ferry Ghat	22°25'42.50"N	88° 7'47.49"E	Domestic
55	**Shyampur**	Kantakali Kheya Ghat	22°24'13.07"N	88° 7'35.72"E	Ferry Service
56		Purba Basudevpur	22°21'3.51"N	88° 5'15.61"E	
57		Garchumuk River side	22°20'56.14"N	88° 5'18.59"E	Ferry Service
58		Boragachi Bazaar	22°19'23.70"N	88° 5'21.39"E	Ferry Service
59		Ramchandrapur -Falta	22°18'26.67"N	88° 5'25.10"E	Domestic
60		Dingakhala Burning Ghat	22°16'57.55"N	88° 4'43.62"E	Crematorium
61		Shibganj Ghat	22°15'39.87"N	88° 4'33.00"E	Domestic
62		Gurpole River Side	22°14'9.59"N	88° 3'49.67"E	Crematorium
63		Gadiara Riverside	22° 56.690'N	88° 24.335'E	Domestic
		Gadiara Ferry Service	22°13'19.29"N	88° 2'25.37"E	Domestic
64		Shibpur River Side	22°13'20.70"N	88° 1'40.47"E	Ferry Service

Image No 63: Bally Nimtala Ghat , 22°39'3.58"N 88°21'2.97"E

Image No 64: Dewanjee Ghat, Bally, 22°38'58.69"N 88°21'3.80"E

Image No 65: Kedarnath Ghat 22°38'57.55"N 88°21'3.54"E

Image No 66: Pathakghat Burning Ghat, 22°38'51.32"N 88°21'4.51"E

Image No 67: Poonam Chand Bageria Ghat 22°38'45.83"N 88°21'6.21"E

Image No 68 & 69: Barendrapara Ghat, 22°38'20.85"N 88°21'15.03"E

Image No 70: Paul Ghat, 22°38'2.19"N 88°21'24.26"E

Image No 71: Tribeni Burning Ghat 22°38'11.01"N 88°21'20.21"E

Image No72 & 73: Ramkrishna Mission Ghat

Image No 74: A.C Roy Marine & Mechanical Engineers Fabrication

Image No 75: Bandhaghat Ferry Ghat 22°36'2.01"N 88°21'2.83"E

Image No76 & 77: Chote Lal ghat 22°35'46.68"N 88°20'51.80"E

Image No 79: Namak Gola Ghat, 22°35'17.83"N 88°20'42.62"E

Image No 80 & 81: Ramkrishnapur Ghat, 22°34'20.68"N 88°20'10.77"E

Image No 82 & 83: Geonkhali & Gadiara Ghat, 22°13'18.43"N 88° 2'58.27"E

6. Documenting Livelihood Pattern & Activities in And Around the River Hugli

6.1 Landuse Landcover Study in the Study Area

Haora district of West Bengal is another very fertile stretch of land. However, our study area includes the heavily urban sector of the district mostly covering the municipalities starting from Bally , Liluah , Belur , Haora , Sankrail , Uluberia. The southern portion of the study area that includes Shyampur & Uluberia (parts) exhibits the rural traits where agriculture predominates. The rainfall is regular and copious, the soil is fertile, and it is periodically enriched by fresh deposits of silt from the overflow of the rivers. The latter are constantly carrying on the work of erosion and accretion, of soil denudation and formation, but the process of soil formation is the more active of the two. Being renovated annually by deposits of silt, they require no-manure, and they grow splendid rabi crops of pulses, mustard, tobacco or - vegetables. The lands along the river are similarly raised by accretion, and are also made to yield rabi crops, if high, and rice, if low-lying ; but a large proportion, not receiving fresh silt deposits, remains waste, and are covered either with coarse grass or wild undergrowth.
The major part of the Haora tract is protected from river floods by high banks or artificial embankments, but is liable to be submerged by excessive rain. The lands, whether high or low, are extremely fertile. The uplands yield fine crops of vegetables, and land at a slightly lower level Aus rice or jute alternating with rabi. The lowlands enriched by the drainage and refuse of the villages, are eminently adapted for the cultivation of winter rice. Southwards, in the Shyampur Block, the lowest lands receive the drainage from the whole of the northern tract, which is unable to find an outlet into the rivers. They are consequently converted into extensive marshes covered with reeds, sedges and coarse grasses, but winter rice grows well on their borders.

On an average in our study area about 38 percent of the total population belongs to the agricultural population while the non-agricultural sector accounts for the remaining 62 percent. The eastern, northern, southern and central areas of the district are extensively cultivated. Rice is the staple food of the district. Paddy covers maximum of the gross cropped area. Generally, three crops of paddy are taken as Aus, Aman and Boro in a year if irrigation water is available covering about 85 per cent of the total gross cropped area. Among

commercial crops, jute, sugarcane, potato and oilseeds are major crops. Vegetables are also grown abundantly.

Our Study area comprises of 649.80 sq.km with about 364.24 sq.km under agriculture. Out of this area almost 264.01 sq.km area is under double or multiple crops. Rest of the 100.23 sq.km area remains clogged during monsoon while some vegetables are grown in the winters. Heavy urbanisation can be observed along the banks of Hugli River with very ancient agglomeration of British along Shibpur , Bauria , Uluberia etc. The settlement area occupies about 200.67 sq.km covering 35% of land.

Potato is a very important vegetable produced and cultivated all along the river banks with oilseeds like mustard. As regard crop diversification it has been observed that the southern part is comparatively less diversified than the north-western part because of the variation in

A general landuse and cropping pattern map is prepared with the help of Landsat FCC Image , 2019 shows spatial distribution of Mono Crop Land (low lying areas), Double Crop Land , Settlement Areas , Water body & Homestead orchards . The major crop is rice, while the minor crop is pulse and vegetables growing areas in the district including rural-urban settlements, forest, orchard and plantation. Swamp area which is presently used as commercial fish production is also delineated in the map.

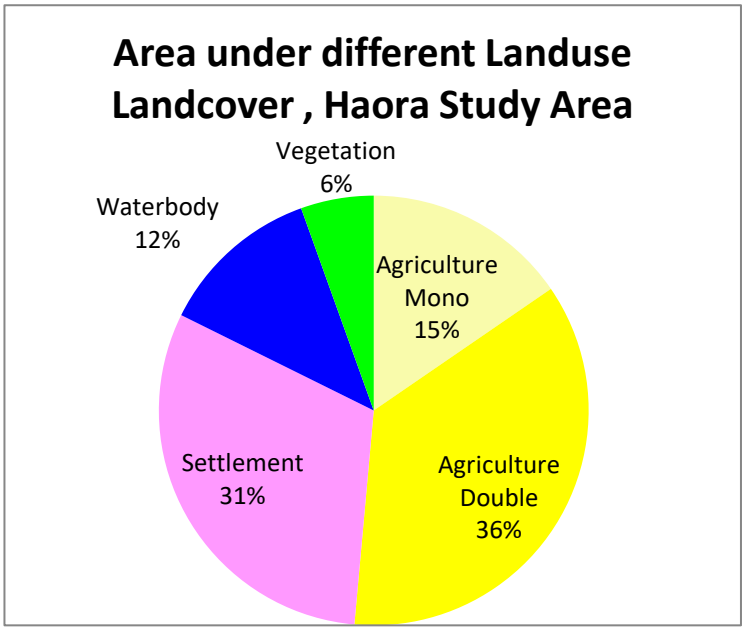
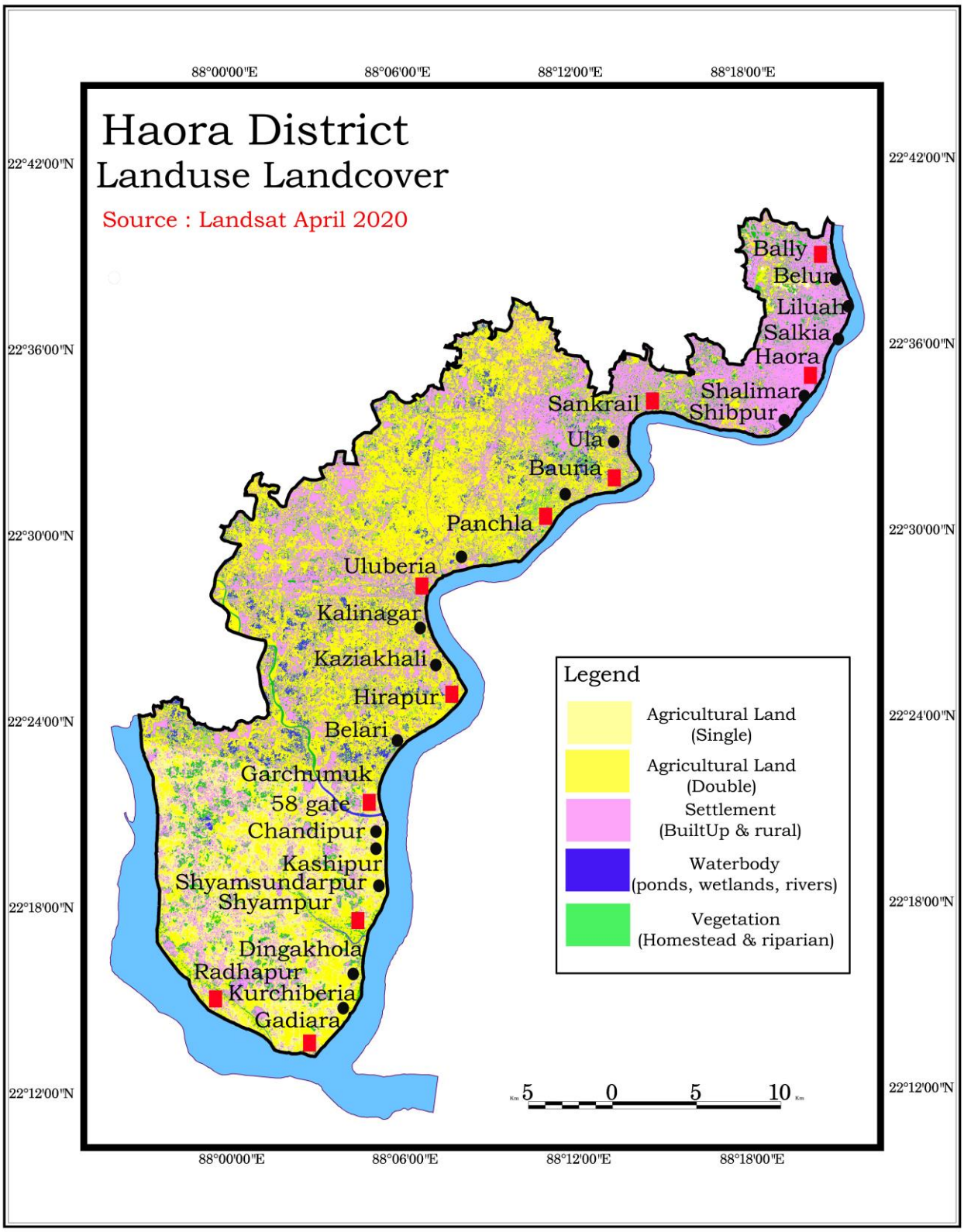
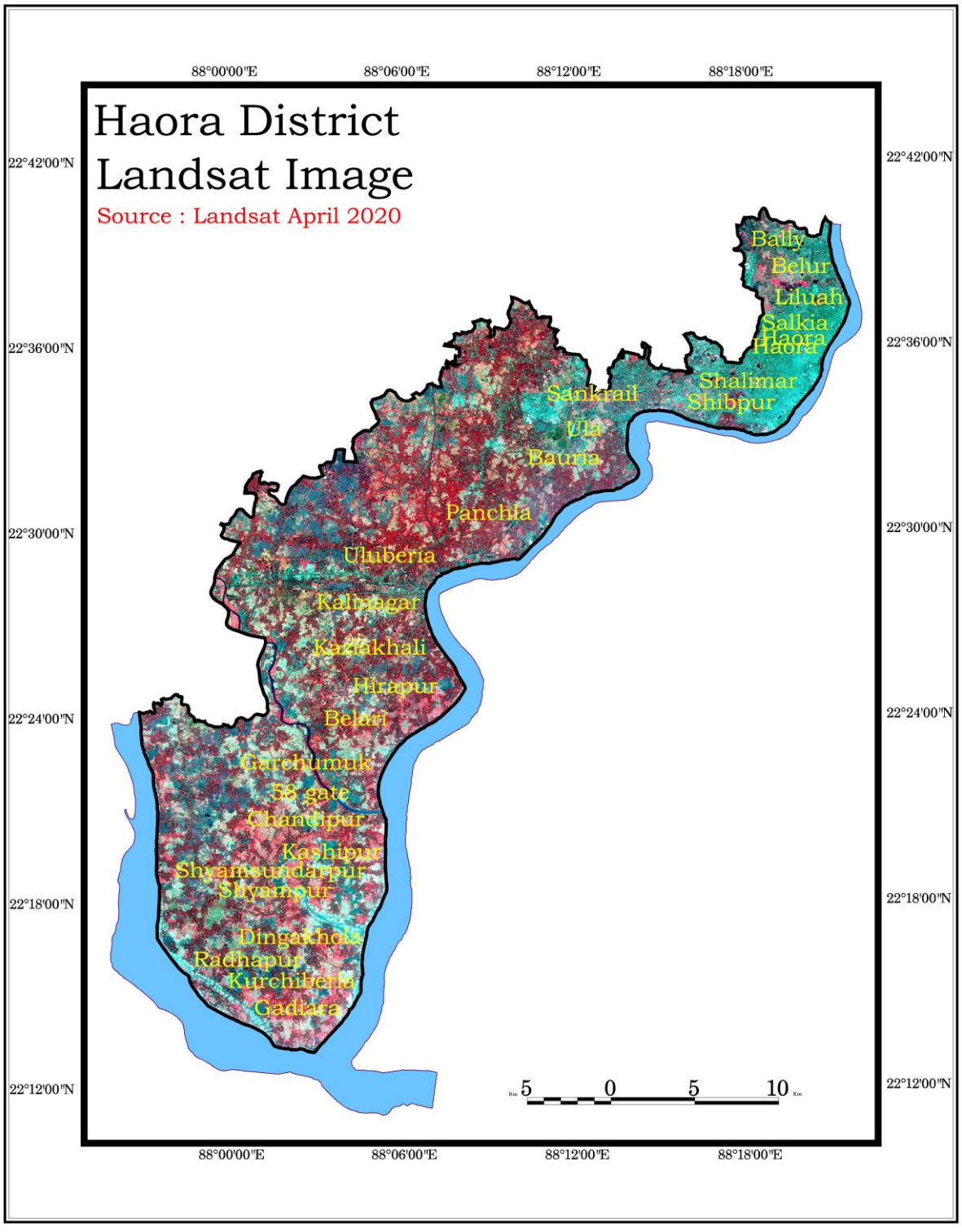


Image No 84: Paddy is the major agricultural crop of the study area, Uluberia 22°16'6.81"N 88° 3'34.41"E

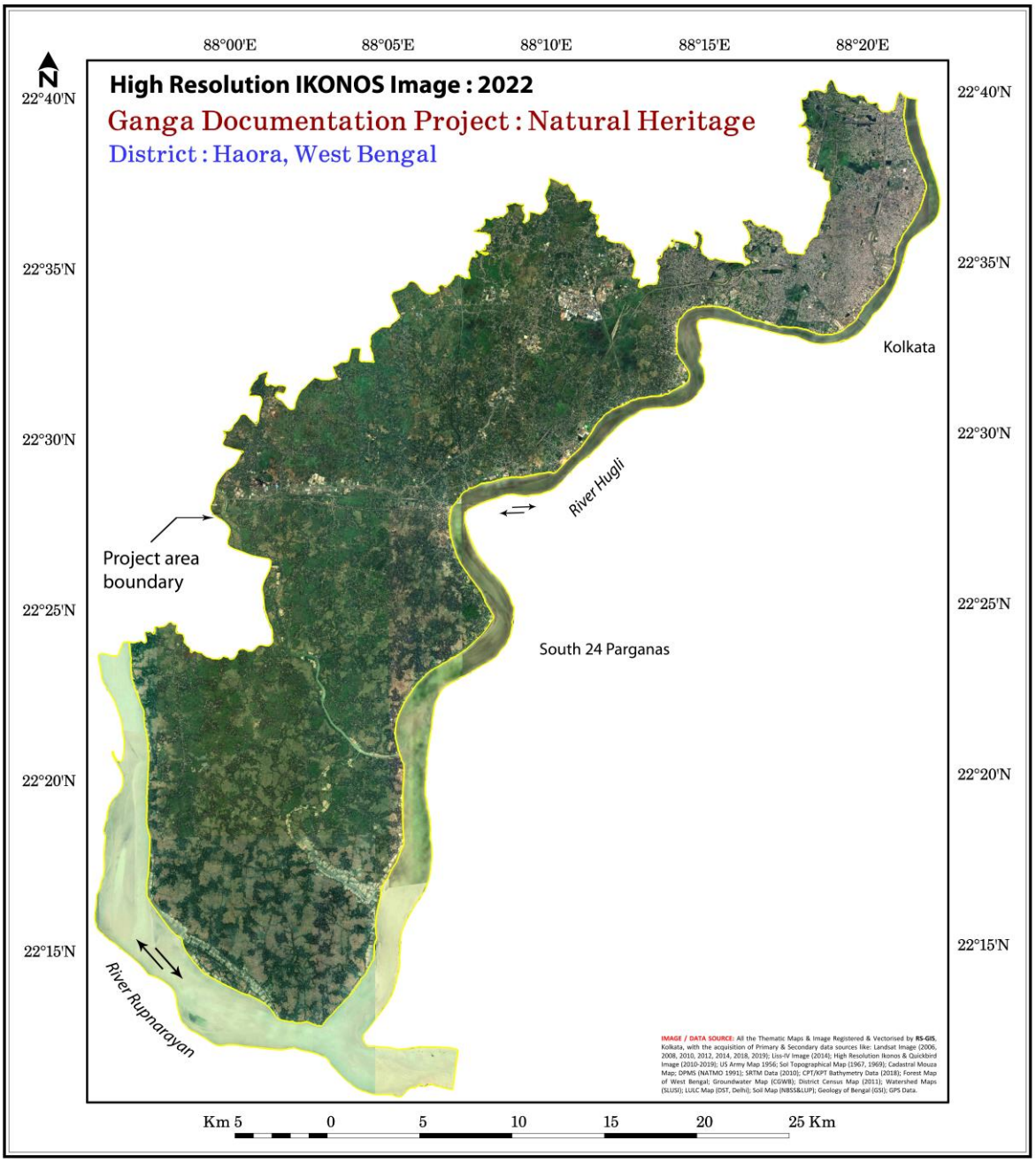
Image No 85: Rice Farming, Uluberia Block ,22°28'6.47"N 88° 6'52.51"E



Map No 24: LULC Map of the Study area, Source: Landsat Image, 2020



Map No 25: Landsat Image, 2020 used as source for Landuse landcover Classification



Map No 26: High Resolution Image showing the study area. Source: Land Use Landcover map

6.2. River / Channel bank using for various Economic activities

A. Agriculture

Of all the districts in Bengal, Haora is the least dependent on agriculture for the support of its population. It is practically, a metropolitan district, a large proportion of its inhabitants obtaining employment in the adjoining city of Kolkata and in the numerous industrial concerns along the Hugli river . These concerns are situated in the long riparian strip of high land which stretches from the Bally Khal on the north to the mouth of the Damodar on the south. It contains the populous city of Haora and the town of Bally, and below them are numerous mills, brick-fields and scattered homesteads. Even in the interior the villages are tending to be semi-urban in character, and the villagers contribute largely to the artisan class.

It is situated in the hot moist sub-humid agro-ecological situation having annual rainfall between 1100 to 1500 mm of which 75-80 % received during June to September. The mean annual maximum and minimum temperature fluctuates from 40.2° to 10.8° C and relative humidity ranges between 66 to 85 %. The soils of this district have been formed from the alluvium deposited by Ganga and its tributaries and sub tributaries viz. Ajoy, Damodar, Kansabati, Bhagirathi, Haldi, Rupnarayan etc. Topographically, there are three land situations namely up, medium and low and different farming systems are adopted accordingly. Frequent inundation of low lying areas result in stagnation of water for certain times of the year affecting some parts of the district. The soils of this sub-region have high nutrient content and mineral resource with a high potential for a large variety of agricultural and horticultural crops. Paddy (Aus, Aman and Boro), jute and potato are the major crops while pulses like gram, lentil etc., oilseeds like mustard, sesame, groundnut etc. and various kinds of vegetables are grown under varying physiographic situations of the district. Water chest nut, madur kathi, water lilly and lotus are also cultivated in some low lying marshy land areas of the district. Besides different agricultural enterprises there is ample presence of different industrial enterprises along with some homestead small scale industries scattered over different parts of this district.

Conditions are, on the whole, favourable to cultivation, as there is a rich alluvial soil which receives periodical deposits of fertilizing silt from the overflow of the Damodar and Rupnarayan. In the south, the land between those rivers lies very low and has to be protected

from Hoods by embankments. In the north the country is cut up by numerous khal or creeks, and there are many jhils or swamps, so that a large area lies waste and uncultivable.

Elsewhere there are wide stretches of low rice lands with rice or jute, sugarcane or orchards on lands of a slightly higher level. On a part of the latter pulses are grown after the reaping of dus or jute, and along the spring rice crops are raised. In the south the land is almost exclusively sown with winter rice, which is followed by pulse on some of the higher lands. On the alluvial accretions called c/tars, which form in the rivers, vegetables, oil-seeds, and, occasionally, tobacco are grown after the rains are over.

a. Principal Crops

Rice forms the staple crop of district, and is particularly well suited to the low damp lands, receiving an abundant rainfall. Many varieties are grown, but the crops may be grouped under three main heads according to the harvest seasons, viz., boro or spring rice, aus or autumn rice, and aman or winter rice.

Boro rice is ordinarily transplanted along the banks of Boro marshes, or in very low lands which remain wet till well into summer. Ploughing is not required if the ground is of soft mud otherwise one or two ploughings are given. It is sown in the nursery in November, transplanted in December, and reaped in April and May. This class of rice includes only coarse varieties and the area of land which can be profitably reserved for its

Image No 86: Aman Paddy cultivation, Uluberia, 22°27'44.93"N 88° 6'12.88"E

cultivation is small, Only newly threshed grain will germinate properly, and the grain has to be prepared carefully before sowing in the nursery.

The crop of next importance to the district is the winter rice or *Aman*. It is in this class that the most varieties occur, and it furnishes all the finest qualities of rice. The preparation of the land for this crop begins early in the year. In April or May the seed is sown very thick in a nursery, and when the seedlings make their appearance another field is prepared into which to transplant them. For this purpose it is necessary to repair the embankments round the field so that it shall retain all the rain which it receives. It is then repeatedly ploughed up until the surface is reduced to thick mud. The seedlings are then taken out of the nursery and transplanted into rows about nine inches apart, where they are left to mature, the only subsequent operation being one or two weedings in the latter part of August. The crop is harvested in November or December. The most critical period for this crop is when it begins to blossom in the latter part of October. If there is not sufficient moisture at this time, no grain will form in the ear. The soil most suited to the aman crop is one that contains a large admixture of clay.

b. Pulses: After rice, pulses are the most important of the food-grains. Gram is not grown, but other pulses, like Khesari , Mung , Peas and Masuri are the favourite second crop. Khesari or teora is sown on low rice lands when the *aman* is damaged by floods or has a podr outturn. It is sown broadcast in October, grows slowly until the winter rice is harvested, then shoots up rapidly, and is gathered in February and March. It costs little to cultivate, but the yield is not large if the rice crop is good. It is a grain which the well- to- do eschew, but owing to its cheapness, is much uted in the form of dal by the poorer classes. The other pulses form the main cold-weather crops on anna lands. They are sown in October and November after ploughing and are reaped in February and March. The ploughing is more carefully done, the seeds cost more, and the outturn is more valuable. They furnish the dal eaten by the higher classes.

Oil-seeds, such as linseed, A7, rape and mustard, are cold- Oil-seeds. weather crops grown only in small plots on high lands round the village sites and on the river chars which are periodically fertilized by new silt.

c. Jute: The cultivation of jute has been steadily increasing of late years, and this crop now occupies 9 per cent. of the normal net cropped area. Generally speaking, it does well on lands which are suitable for Aus rice. But still the inundated areas of adjoining districts of Nadia and Murshidabad has more land under jute cultivation. The preparation of the land for this crop begins as soon as sufficient rain to moisten it has fallen. It is first ploughed twice or thrice and then allowed to rest for a time, while the cultivator manures it with cow-dung and any other fertilizing agent upon which he can lay his hands. It is ploughed again in May, and the surface rendered' as fine as possible, after which the seed is sown. then the seedlings are five or six inches in height, a harrow is passed over the field with a view to thinning out the plants where they are too thick, and also to assist in the absorption of moisture by breaking up the surface of the ground. The first weeding does not take place until the plants are about a foot high ; every effort is then made to entirely eliminate the weeds, and if the work is well done no further weeding is required. The crop matures in August or September, and it is then cut and tied up in bundles about 15 inches in diameter, which are steeped in the nearest stagnant water for about a fortnight until the stalks have become sufficiently decomposed to admit of the extraction of the fibre from them. In performing this operation the stem is broken near the root, and the broken portion drawn off ; the protruding end of the fibre is then grasped, and, by gradual pulling and shaking, the rest of the fibre is extracted from the stalk. It is then well rinsed in water, and hung up on bamboos in the sun to dry. Jute is an exhausting crop to the land, and cannot be grown on the same plot for two years in succession. Some of the loss to the land is made up by scattering on the surface the leaves of the plant which are stripped from the stalks before they are steeped.

The quality of the jute grown in the Hugli district is inferior to that grown in the districts north of the Ganges. One reason for this is that in the latter districts the best lands are devoted to the crop, whereas in Hugli and other districts in the Presidency Division less care is taken in this respect .

Image No 87 & 88: Jute Farms are found in the depressed areas. 22°27'29.28"N 88° 5'55.62"E

Vegetables are grown extensively round the villagers home Vegbsteads, in private gardens, and along the f(^rtile banks of the numerous khdls and streams. Excellent patah [Tricomnitm dioica) come via Amta from the Lamodar chars, and arums {ol) from Sautr&g&chhi and Jagatballabhpiir. Amta also supplies large soft brinjals, fairly big water-melons and good radishes.

Several kinds of pot herbs, gourds, beans, yams, cucumbers, potatoes {deshi or Naini TaP, sweet potatoes and onions are raised for sale ; while near the towns cauliflowers, cabbages, peas, beet, and other European vegetables are grown.

d. Other Crops

Crops producing oilseeds occupy, between the different varieties, about 22 per cent. of the normal net cropped area. In some parts, especially in the Chuadanga Subdivision, the cultivation of chillies *{capsicum frutescens)* and turmeric forms an important feature of the rural industry, and the peasant relies upon it to pay his rent. Indigo, the manufacture of which was once the most important industry in the district, now occupies only about J,000 acres. About 20,000 acres are devoted to orchards and market-gardens. Generally

Image No89: Potatoes are very important crop of the region

speaking, the quality of the mangoes is not good, and in some parts of the district, especially in the Kalantar, even the common mango does not do well. The cultivation of potatoes is extending especially in the south of the district near the railway line, in which parts other garden produce is freely grown (where the conditions of the soil permit) and exported to Kolkata. Different vegetables like brinjal, pointed gourd, bitter gourd, leafy vegetables etc are cultivated.

Castes involved in cultivation : Among the castes engaged in agriculture the Kaibarttas predominate a thrifty industrious class, who have migrated largely climbs into the southern *thanas*, probably from the east of Midnapore. The other principal agricultural castes are Pods, originally a fishing caste, who came to the Uluberia subdivision, probably from the other side of the river Hugli ; Sadgops, a characteristic caste of West Bengal ; Chandals, probably emigrants from Eastern Bengal ; Baruis or hereditary betel-leaf growers ; and among the Musalmans that heterogeneous class, the Sheikhs.

From various causes, (chiefly economic, recruits have been received from other important classes, such as the weaving classes (Tantis, Suklis and Jolahas), the fishing castes (Tiyars and Bagdis), and other castes, such as Tolls, Chhutars and others. At present, owing to the high price of food-grains, there is a tendency for many persons in the rural tracts, who previously had no connection with cultivation, to take up land in order that they may have a stock of rice to fall back upon. Consequently, there is no important class or caste of which a certain proportion does not hold some land.

B. Manufacturing Industries: The west bank of river Hugli has played a significant role in the growth of industries in Eastern India. A layering of all data sources in form of maps and documents highlights a linear belt of industries running south to north all along the western banks of river Hugli. One of the major factors for this pattern of industrial growth is the ease of accessibility of the west bank of Hugli to the rest of India. The other factor is the that it became the serving bank for the Imperial capital in the 19th century. Each of these industries and the commodities associated with them have served as driving forces to develop a particular social structure, shaping the urban morphology.
During the end of eighteenth-century Haora became an industrial hub and trade centre and was called the 'Sheffield of India'. Many dock yards, ship building companies, iron foundries and engineering works were established and they were followed by cotton mills, jute mills, oil mills etc.
The industrial expansion of Haora was linked with commercial importance of the imperial capital at Calcutta (now Kolkata). As per travel records, most of the areas in Haora were covered by stacks of timber and bricks or tile kilns.
From literature sources and first-hand visits , the author attempts to categorize and understand the trends of rise and fall of industries at the Haora river-bank which is provided as follows:

C. Trade and Transportation Industry:

I. DOCKS: The first dock yard was opened in 1796 at Salkia. At the same place a ship building dock yard was first established in 1840. In 1872, there were eight large docks along the river Hugli between Haora and Ghusuri.

ii. RAILWAYS: After selection of Haora as a railway terminus of Eastern India Railway (E.I.R.), two railway workshops were established. The former was at Haora and the later was at Shalimar for repairing and construction of rolling stock. During the colonial period there were four railway workshops in Haora named as E.I.R. Carriage and Wagon Department at Liluah, other two were at Haora i.e. E.I.R. Engineering Works, and Loco and Carriage Workshop at Haora along with Shalimar Loco Engineering Workshop at Shibpur.

Among the Indian railroad stations, Howrah Junction railway station is considered as the oldest station and the largest railway complex in India. It was actually owned by EIR (East Indian Railway) which was founded in January, 1847 by merging the East India Railway Company and the Great Western Bengal Railway Company (GWBRC) into one. An initial survey was undertaken on 7 May, 1850 from Howrah (across the River Hooghly from Calcutta) to Burdwan on the route to the Raniganj coalfields by the EIR under its MD Macdonald Stephenson, George Turnbull, the company's Chief Engineer, and the engineer Slater. The first train of EIR was flagged off in August, 1854 to its full capacity from Howrah railway station to Hooghly a distance of 24 miles. It was an historic event. The train had first, second and third class compartments with break van. The first classes on the trains in those days were meant for the Europeans and so were the Deluxe waiting rooms at the railway stations.

iii. MASS PRODUCTION AND MANUFACTURING:

ROPERIES AND JUTE MILLS: Jute Roperies were an important industry that probably fare older than the dockyards. The major roperies were Ghusuri Rope Works at Ghusuri, Shalimar Rope Works at Shibpur and Ganges Rope Works at Ramkristapur.

IRON WORKS: In the beginning of the nineteenth century the iron works and engineering units were emerged to meet the demand of machineries for dock yards. The Shibpur Iron Works was established in 1811. These units had great advantages for their river front which helped them to get involved in ship building production as well as for taking in and dispatching goods through inland navigation routes and railways. Besides these, there were also large storages not only of materials for construction, but also the goods were sold by the Company as dealers.

iv. CONSTRUCTION ENGINEERING:

In the second half of the nineteenth century the British rulers emphasized on efficient transport system for which construction of bridge and roofs were necessary. Most of the engineering units were involved with such an attempt for constructional purposes.

Haora: trends of de-industrialisation

The industrial status of what was once known as 'Shefield of India' is declining consistently.

There are multiple internal and external factors resulting in generation of derelict industries. A concept of 'industrial sickness' emerged at the end of the 19th century. The reason for decline of the industrial typologies in the demarcated industrial heritage belt varies.

TRADE AND TRANSPORTATION INDUSTRY DOCKS: Many docks closed their operation and in 1908 only four dock yards were in working condition. Recently it has been noticed that most of the dock yards have closed their operation due to reduction of depth and the vessels were unable to enter into the present dock yards.

MASS PRODUCTION AND MANUFACTURING:

ROPERIES AND JUTE MILLS: Now the roperies are not in working condition and most of the units produce multiple varieties of products. But after independence most of the jute mills became weak due to paucity of raw material which posed as a major problem after partition. Consequently, these units have reduced their production and many units are suffering from lack of investment and consequent coupled with financial trouble labour unrest.

CONSTRUCTION ENGINEERING:

After independence many units have emerged with their great prosperity and previous trend but after 1990s most of the units became sick and weak due to huge financial loss along with implementation of some policies like freight equalization policy, lack of up gradation in machineries and plants, low marketing opportunities etc

Haora: towards re-industrialisation?

What is to be seen is that whether the process of de-industrialisation and re-industrialisation comes to a full cycle.

A shifting trend from traditional knowledge-based industry to mechanical skill-based industry has been observed. We find an equal concentration of both labour-intensive industries, resource-intensive and capital-intensive industries in Haora. The responsible and sustainable intervention trend should be a way to revert back to the traditional knowledge-based industry.

Image No 90 & 91: Hugli Dock & Port Engineers Limited (HDPEL) is a shipyard at Howrah, India.

Image No 92: Shri Hanuman Jute Mills, Manufacturer and exporter of jute bags, jute products and

Image No 93: Burn & Company came into existence in 1781 at Howrah, WB. Burn Standard Company Ltd., is one of the oldest and a leading wagon builder in India.

Image No 94: 28/1, Salkia School Road, Howrah – 711106, is one of the leading chemical dealers of Bengal

Image No 95: Eastern railway has one Mechanical Signal Workshop situated on the west bank of river Hooghly at Howrah

Image No 96: On the western banks of the Hooghly River, seven kilometres west of Calcutta, stands a fiery red brick building. It is the 200-year-old Salt Golah of Howrah — dilapidated, abandoned, a prisoner of aerial roots and creepers.

Salt *golah* means salt godown. This structure, however, is a collection of godowns — 206 in all. The location is no accident. Proximity to the waterways facilitated transport of salt to other parts of the country. The Salt Golah is all that remains of Bengal's once-flourishing salt industry; today, Gujarat is known as India's salt hub.

In 1765, Robert Clive, the then governor of Bengal, formed the Society of Trade through which the East India Company established monopoly on salt, betel nut and tobacco. The committee comprised senior officials of the Company. Two years later, however, the society was abolished. Thereafter, the old zamindari system was revived and simple salt farming was followed for a while. At the end of the 18th century, the Company had divided the salt-producing areas of Bengal into six agencies — Hijli, Tamluk, the 24-Parganas, Raimangal, Bhulua and Chittagong — which were to run under salt agents.

The Howrah Salt Golah was constructed in 1835. G.M. Kapur, convenor of the Calcutta chapter of Intach, tells **The Telegraph** that Intach, along with the Eastern Railways, had been planning to restore the 58 buildings that make up the place. "There are 206 compartments with a combined storage capacity of 42,93,700 maunds or 1,59,000 tonnes," he says.

Chakraborty says salt was most likely stored in jute sacks. The *golah* faces away from the river to avoid direct contact with the moist air and the buildings are at a level at which there would be no risk from the rising waters during high tide.

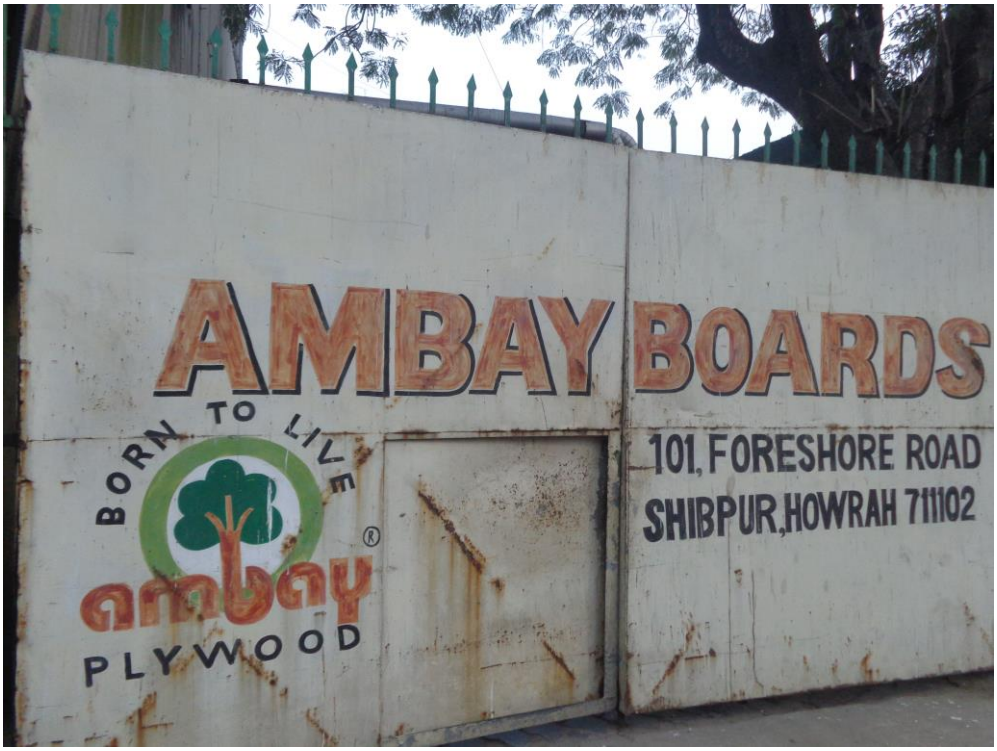


Image No 97: It deals with plywood, timbers and sun mica and various other types of wooden materials at reasonable rates. We also deal in bulk orders.

Image No 98: M/s Madheshiya Marines established in 1999 is situated in Kolkata, West Bengal, India and our yard is situated at Sarenga, Sankrail, Howrah. Since 2000 company is working in repairing of Mechanized Boat, fabrication of Pontoon, Barge, Gangway and supply of all sorts of marine equipments.

Image No 99: The Company is engaged in manufacturing and exporting of all types of Jute & Jute allied products, Woven & Non-Woven Jute Geotextiles, Treated Fabric-Rot Proof, Fire Retardant, jute products for Interior Decoration and Packaging of Industrial and Agricultural produce.

Image No 100: Shree Hanuman Jute Mills, one of the oldest Jute Mills in India was established in the year 1927 at Ghusure, 5 Kms from Kolkata on the bank of river Hooghly. The registered office of the mill is at 70, Nalani Seth Road

Image No 101: Ghusuri is situated on the west bank of Hugli River. It lies on the east of Liluah, between Salkia and Belur. The first cotton mill of India was set up in Ghusuri.

C. Potteries and other clay items

With the availability of riverine clay , many people are involved in making potteries and other useful items like Well Rims . During the time of religious festivals many of them start preparing idols also.

D. Brick Kilns: Brick production falls within one of the traditional industries in the Indian state of West Bengal. Most of the brickfields in Bengal had been set up more than two centuries back. Since the beginning of the colonial period in Bengal, many significant structures including the structure of Fort Williams represent the prevalence of brick under the construction industry in Bengal (Roy, 2012). A wide range of activities is involved in it. Due to the advent of industrialization and recent developments, the construction industry is taking a pivotal role for the construction of buildings, roads, bridges, and so forth (Bagchi, 2014). In West Bengal, around 3500 brick manufacturing units provide employment (officially) to more than 0.7 million people. The silted topography of West Bengal is uniquely suited for making bricks. In the past, the riverine delta region of South Bengal provided quality-soil as a cheap source of raw material and the in-land canals functioned as the mode of low-cost and easily accessible local transport. As the city Kolkata grew in size, the hinterland of the city became suitable locations for brickfields which include the districts of Haora, Hugli, South and North 24 Parganas. The brick industry has been highly concentrated on the sides of the river Bhagirathi-Hugli of the study area. Most of the brickfield has been developed over the year 2000 in the agricultural land of the riversides. It is a significant economic activity that is one of the principal operators of topsoil loss and environmental degradation. These activities are decimating enormous areas of agricultural land every year. It has some evil effects on the geo - environment. Indiscriminate cutting of topsoil from the fertile agricultural land, river banks and lifting of sand from the river bed by brickfields lead to a severe impact on geo-environmental such as loss of soil fertility, riverbank erosion, changes in the river channel, degradation of water quality, deterioration of land and the adverse effects on the health of the brickfield workers.

The entire stretch of our study area specially Shyampur and Uluberia blocks are full of Brick fields . The southern part of our study area especially along River Damodar in Shyampur Block we find innumerable active brick kilns.

Sl.no	Block/Municipality	Name of the BF	Latitude	Longitude	Condition
1	Bally Municipality	Dewangazi BF	22°38'33.79"N	88°21'8.64"E	Active
2.	Shibpur Municipality	Shibpur Brick Works	22°33'59.24"N	88°15'7.70"E	Active
3.	Shibpur	N.C Paul Bricks PVT. LTD	22°33'55.35"N	88°14'52.95"E	Active
4	Sankrail	Munna Brickworks	22°32'55.58"N	88°13'54.09"E	Dormant
5	Sankrail Sarenga	K.B.M	22°32'41.74"N	88°13'51.75"E	Active
6	Sankrail Sarenga	Sarenga Purba Para	22°31'25.90"N	88°13'41.15"E	Active
7	Sankrail Sarenga	Hirapur Brick Works	22°16'6.81"N	88° 3'34.41"E	Active
8	Shyampur ,Gurpole	Kurchiberia Brick works	22°14'39.67"N	88° 4'7.27"E	Active
9	Shyampur ,Gurpole	Gurpole River side Brick works	22°14'10.52"N	88° 3'48.01"E	Active

Image No 102:

Image No103: New Tribeni Bricks, Bally

Image No 104: Shyamnagar, MGM Bricks

Image No 105: Mahabir Brick Kiln, Shyamnagar

Image No 106: Manikpur, Sankrail, Howrah

7. Documenting Environmental Problems

7.1 Flood: In view of its geographical location, presence of various rivers and streams vulnerable to major natural hazards, such as Floods. Haora District is surrounded on three sides by three major rivers, namely Hugli River, Mundeswari River and Rupnarayan River. There is also one important arterial river named Damodar significant both with respect to irrigation as well as flood. In addition there are so many khals and channel like, Haora Drainage Channel, Mahishdhara khal, Barjola khal, Rajapur khal, Medinipur Main khal, Champa khal, Rampur Khal, Gaighata Khal etc. which play very important role in respect of flood and irrigation purpose. Besides the above, other small rivers like Saraswati, Maza Damodar, Kana Damodar etc. serves drainage purpose in the district. Total length of embankment/channel under Haora Irrigation Division in Haora District is 826 km. This makes Udaynaraynpur , Amta-I & Amta-II Dev. Block prevalently flood prone. Flood generally occurs during the month of late August to early part of the month of October. Besides flooding water logging is a major hazard in the other Blocks and Municipal / Corporation areas. Congestion in drainage channels and unplanned growth has exacerbated the problems to a great extent. Floods during the year 1978, 2000, 2015 played havoc on the lives and properties.

Vulnerability concerns towards flooding: Udaynaraynpur ,Amta-I, Amta-II blocks under this district are mainly vulnerable to flood hazard. Some major point of concerns is as follows;

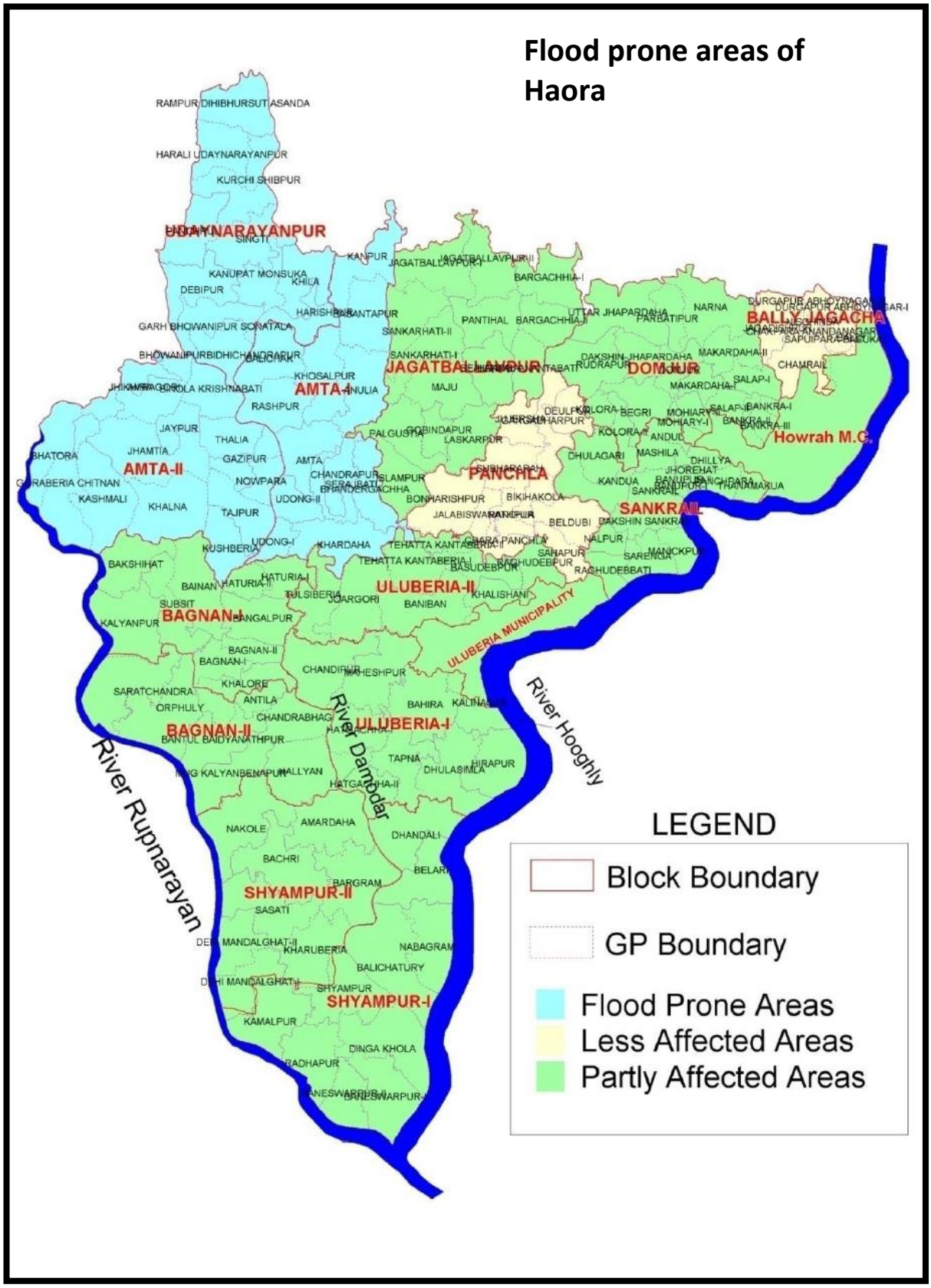
Sl.No	Name of the River	Block/G.P	Critical Point	Remarks
1	Hugly Right Embankment	Haora Municipal Corp.	Shalimar, Ghusuri	-
		Sankrail	near Sankrail Thana office, Dauka Sluice at Hirapur, near Delta Jute Mill and Goalberia	-
		Uluberia Municipality	Bauria near Depot para,	-
		Shyampur-I	Belari, Gadiara	-

2	River Rupnarayan [Left Embankment]	Shyampur-I	Keoratala	-
		Bagnan-I	Paschim Mankur	-
		Amta-II	Ghatpara, Dharapara, Khasmoli, Chitnan, Khalna, Bhatora	-
3	River Damodar [Right (dwarf) Embankment]	U.N Pur	Kultikuri, Barda, Hanidhara Ferry ghat, Ghola, Masjidtala, Hodal, Hariharpur, Jangalpara, Kumarchak, Shibanipur, Akna, Thakurani Chak, Monsuka, Shimultala	Absence of any embankment at the right side result in repeated spilling of bank leading to inundation in Unpur & Amta-II during passage of high discharge thru. DVC system.
4	River Damodar [Left Embankment]	U.N.Pur	Paliara, Gouranga Chak, Khila, Mallik Chak, and Narikelberi	-
5	River Damodar [Right Embankment]	Amta-I	Dayarmansatala, Rashpur, Bhojan Ferry ghat, Deora	-
6	Maja Damodar	U.N.Pur	Bhabanipur Bazar	-
7	Left Bank of Short Cut Channel	Bagnan-I	U/s and D/s of Bakshi Bridge	-

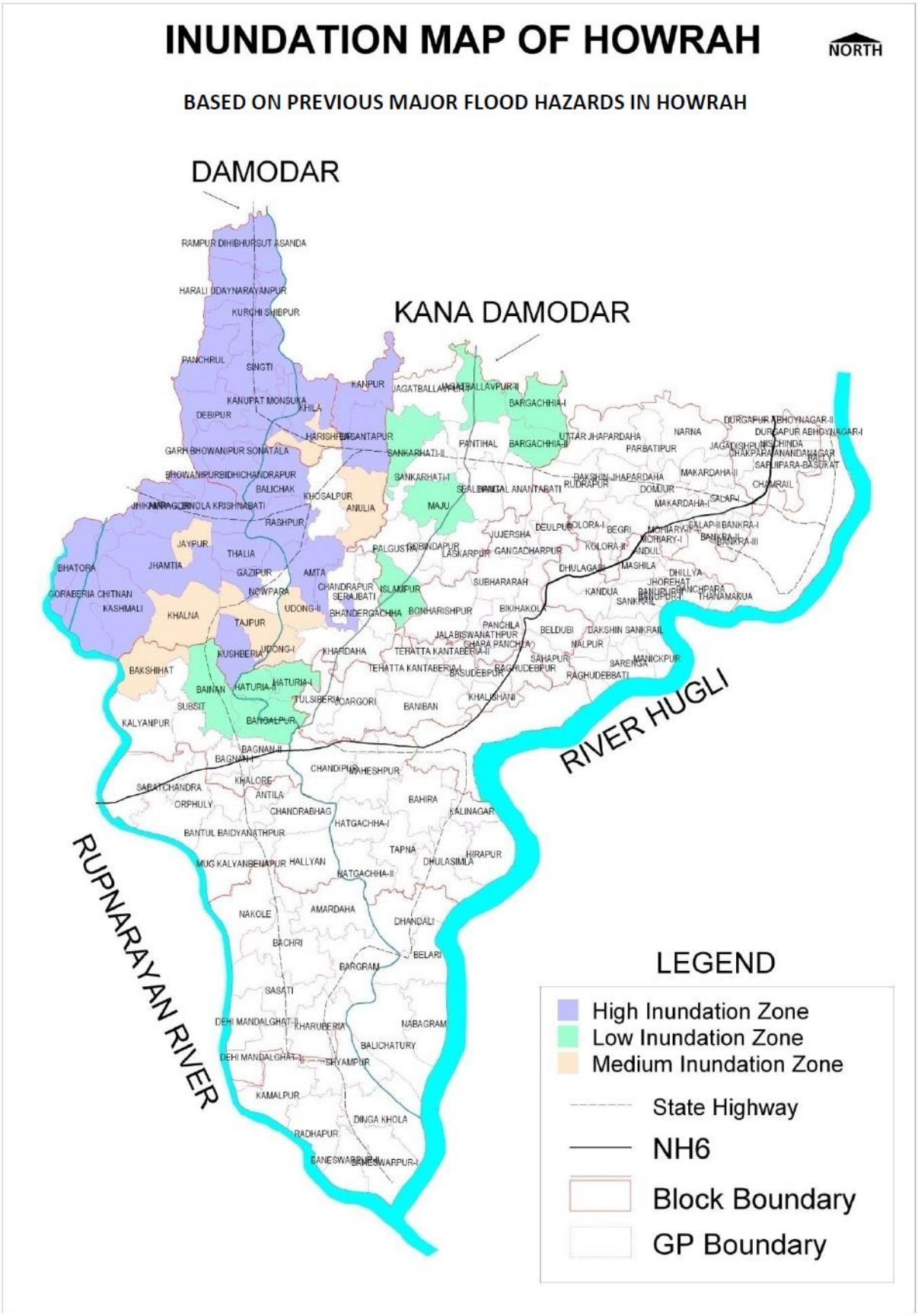
List of Vulnerable Areas To Flooding (Villagewise)

Sl.no	Block	G.P	Vulnerable Areas
1	Uluberia	RDA G.P	1. Rampur 2.Dehi Bhursut 3.Asanda 4.Ghola 5.Harali 6.D.Rampur 7.Baria Kurchi 8.Sitapur 9.Pratapchak 10.Sultanpur
2		Kurchi Shibpur G.P	11. Harishpur 12. Kurchi Binodbati 13. Jangalpara 14.Gangapart 15.Shibpur Part 16.Jangalpara Belgram
3		Singti	17. Rajapur 18.Jonka 19.Akna 20.Kumiramora 21.Jagaldaha 22.Abhirampur
4		Debipur	23.Debipur 24.Raichak 25.D.Singh 26.Uttar Manasree 27.D.Manasree
5	Sankrail	Sarenga	28.Sonimandir, 29.Banstala
		Manikpur	30.Kantaltola
		Kandua	31.Mohisgot
		Dhulagori	32.Shibtala
		Panchpara	33.Mohisdara
		Raghudevbati	34.Chak-Sreekrishna
		Nalpur	35.Full G.P
		D.Sankrail	36.Partly
		Jorehat	37.Bisco Bandh
6	Panchla	Banharishpur	38. Banaharishpur 39.Nayachak 40.Shyamchak
		Jalabiswanathpur	41.Dhunki 42. Jalabiswanathpur
		Juresha	43.Juresha
			44.Suvararah

			45.Deulpur
			46.Joyrampur
		Gangadharpur	47.Gangadharpur
			48.Joynagar
			49.Gandalpara
			50.Khasjajalsi
		Bikihakola	51.Bikihakola
			52.Ranihati
			53.Sankhali
		Panchla	54.Panchla
			55.Gabberia
		Char panchla	56.Dakhin Panchla
			57.Paschim panchla
		Beldubi	58.Beldubi
			59.Paniara
			60.Kulai
			61.Jala Kandua
		Sahapur	62.Shahapur
			63.Dhamsia
			64.Khajijapur
			65.Satgharia



Map No 27: Flood Prone areas of Haora District, Source: Disaster Management Cell



Map No 28: Inundation Map **of Haora District, Source: disaster Management Cell**

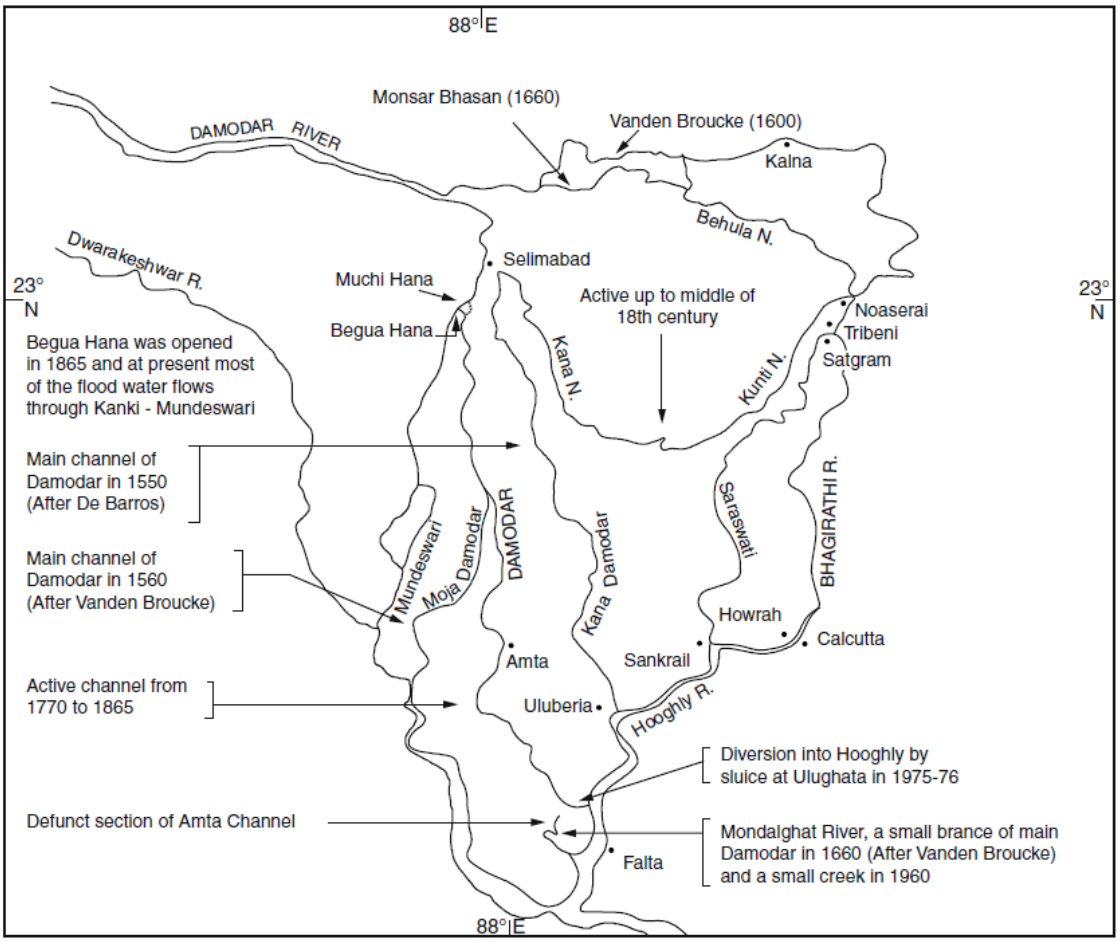
2. Dams, Riparian Settlement and the Threat of Climate Change in a Dynamic Fluvial Environment – Case Study – Damodar River.

The Damodar River, a subsystem of the Ganga, has always been flood prone. People as well as governments throughout the centuries have dealt with the caprices of this vital water resource, using structures such as embankments, weirs, barrages and dams. Post-independence the Damodar Valley Corporation (DVC) constructed four multipurpose dams to facilitate regional development and reduce flood hazards. Post-dam hydrographs show decreased monsoon discharges, reduced peak flow and a shifting of peak flow from July to August to September. Despite the DVC dams, the lower valley is still vulnerable to flooding, because the transport capacity of the river has also been reduced. As a result, the frequency of bank full events today is again similar to that observed in the pre-dam period. Because of the control structures once mobile channel char lands have been stabilised and permanently settled by Bangladeshi refugees. These new riparian communities are threatened by the fluvial environment. Changing patterns in riparian land use, fostered by alterations in flow regime, coupled with the long-term prospect of increased rain variability due to climate change, appear to be increasing the risk of rare but devastating floods in the Lower Damodar in the district of Haora .

In old records the Damodar has always been referred to as a river of sorrow. Flood propensity of the river is reflected in the construction of extensive embankments over 4,000 years ago as referred by hydraulic engineer Kapil Bhattacharyya (1959) and in sixteenth- to seventeenth-century maps (Fig. 5.2, Sen 1962; Bhattacharyya 1998, 2011). The first recorded flood occurred in 1730 (Voorduin 1947). Floods with a peak flow of 8,496 m3/s or more occurred 37 times between the years 1823 and 2007.

The floods of 1823, 1840, 1913, 1935, 1941, 1958, 1959 and 1978 had peaks of more than 16,992 m3/s. A peak flow of about 18,678 m3/s was recorded in August 1913, August 1935 and again in October 1941 (DVC 1995; Bhattacharyya 2011). In an early report on flooding and embankments in this area by Sage et al. (1846), 13 severe inundations took place over a time span of 115 years, with seven inundations occurring in the first 85 years and six in the last 30 years. This increase in flooding may be attributed to the fact that, in the earlier period, overflow irrigation from the Damodar was considered beneficial for agriculture, and people built and maintained canals to carry floodwater to their fields. From 1815 onwards, however, landlords and tenants of central Bengal started to neglect the irrigation canal systems, presumably beginning during the Maratha-Afghans war (1803–1818). The British thought these waterways were for navigation only and left them as they were. As these deteriorating waterways or canals took in lower amounts of water, more water remained in the Damodarmain channel, and it grew to be a menace to the riparian tract. Eventually the entire riverine

regime of Bengal, Bihar and Orissa was transformed from a flood enriched agrarian area into a landscape vulnerable to devastation by floods.



Map No 29: Changing course of Damodar River

The flood-prone Damodar River has encouraged the construction of control structures from very ancient times; however, most traces have been destroyed completely due to the shifting of rivers . The current embankments along the Damodar River were most probably constructed by local landlords to protect their land and property from floodsand certainly date from a period before British rule. The report of the embankment committee formed in 1846 states that these embankments were irregular and elevations were uncertain. The maintenance of embankments was inefficient and neglected (O'Malley and Chakravarti 1912), and breaching of embankments was a regular phenomenon. Several subcommittees were formed to investigate these issues (Bhattacharyya 1998, 2011). It was finally concluded that the removal of the right embankment for about 32.2 km would provide complete security to the left bank, which included the town of Barddhaman, the East India railway line and the populous districts of Hooghly and Barddhaman. In 1889 another 16.1 km of the right bank embankments was removed (Voorduin 1947). The left bank embankments were made continuous for a length of 176.87 km and were provided with many sluices. Attempts were also made to transfer excess water from the Damodar River to some of the decaying distributaries through the Eden canal in 1881. In 1933, the Damodar Canal system was opened. Water from the main river was admitted into the canal with the help of a weir at Rhondia near Panagarh of the district of Barddhaman.

Despite all of these measures, the river was flooding the lower sector throughout the British period (1908–1946). Concern about the devastation wreaked by the Damodar reached its peak in 1943, after one of the severest floods. Finally, after India won independence, the Damodar Valley Corporation (DVC) was founded on July 7, 1948. The project had originally envisaged the construction of eight dams and the planner estimated a design flood of 28,321 m3/s with a 100-year frequency. To protect the lower valley, it was estimated that the design flood be moderated to 7,080 m3/s, which was the total capacity of the Lower Damodar. However, due tofinancial and other constraints, the participating governments ofWest Bengal, Bihar (present Jharkhand) and the central government approved the construction of only four multipurpose dams

a. Downstream Impact of Dams on the Hydrologic Regime

The retention of water behind a dam and its gradual release downstream result in the reduction of peak storm flows and an alteration of the entire flow and sediment regimes. As the hydrologic conditions in the Damodar catchment have been modified through the development of control structures, the lower river channel system itself has been radically changed. Morphological changes along the Damodar River post DVC dam construction include both severe aggradation and narrowing of the channel through lateral accretion. Since the construction of the dam, the Damodar channel has undergone a general narrowing due to decreases in the flow and reductions in dominant dischargeThe channel bed has been aggraded at an alarming rate in some places, whereas the volume of sediment and rate of sedimentation have grown in other areas. Although sediment is trapped in the reservoirs, the river still receives a million tons of sediment from the uncontrolled sectors below the dams in the Raniganj coalfield region. The declining capacity of the river to transport this sediment has made the channel bed a sediment sink with a downstream series of growing sandbars (locally known as *char* lands or *mana*).

This effect is further enhanced by the coarsening of bed material. In some sections the Damodar channel has been reduced due to excessive sediment deposition following the flood of 1978. Channel reduction appears to have been achieved by the accumulation of sediment as shoals that are now vegetated and stabilised with agricultural fields and human settlements. Today, between the Maithon and Panchet reservoirs and the Falta outfall 250 km downstream, there are 23 larger occupied sandbars or char lands and a series of point bars. These char lands are now used as a resource base mostly by refugees who have matched land use at fine scales to flood experiences, applying their own concept of flood zoning to the riverbed and effectively assessing short-term and long-term risks.

7.2 Impact of In-Bed and On-Bank Soil Cutting by Brick Fields on Moribund Deltaic Rivers

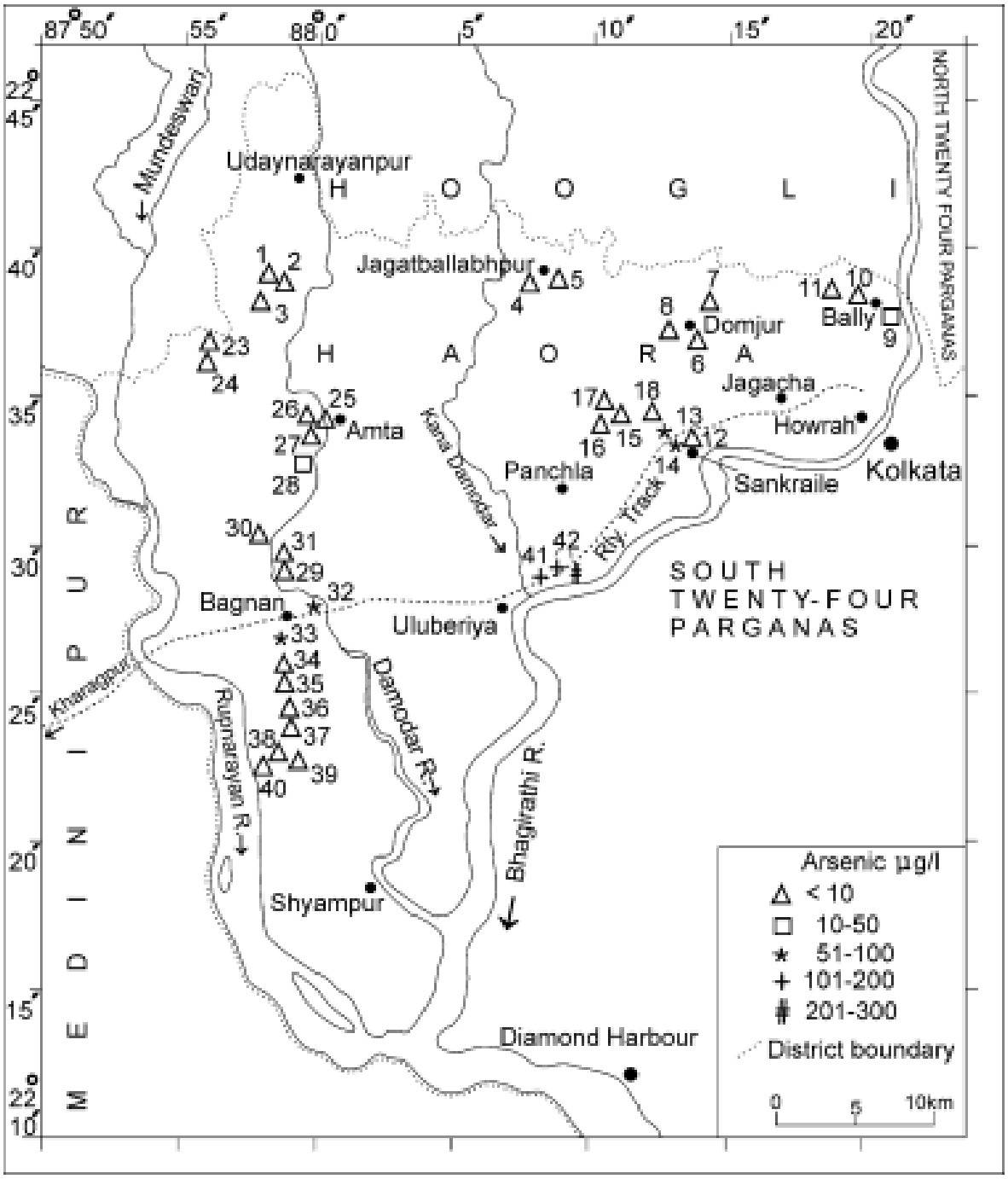
Soil Cutting from bank and bed for brick fields is one of the most triggering human activities affecting the river. This illegal practice causes bank erosion leading to loss of property and life. It also multiplies silt charge (Moscrip and Montogomery, 1997) and consequently the river becomes shallow and deteriorates rapidly (Collier et al, 1996). Given the context, we seek to focus on reckless soil and sand cutting from banks and beds of River Bhagirathi and Jalangi and assess the impact of those soil and sand cutting from banks and beds on the channel morphology and inhabitants on the banks of the river. The traditional brick manufacturing needs considerable land area and top soil. The land used for top soil loses its fertility and the land erosion is accelerated. The land area near the kiln is subjected to high temperature making it unfit for uses in agricultural activities after being abandoned. The brick manufacturing uses thousands of tonnes of coal and biomass fuel (The energy use is 30-35 % of production cost). The possible pollutants from brick kilns are: 1. Carbon dioxide (CO2). 2. Carbon monoxide (CO). 3. Sulpher dioxide (SO2). 4. Nitrogen Oxides (NOx). 5. Suspended Particulate Matter (SPM). Along with these there is a problem of high volume of bottom ash as residue. It affects the agricultural productivity of the surrounding fertile tracts. The other possible environmental threat may be disturbance of flow path of natural stream, nullah, river due to establishment of the brick kiln in the vicinity in the path leading to obstruction in downstream as well as for distribution on flow of water during rainy season. The waste produced from the brick kilns of the area falls in the nearby river thus creating pollution.

7.3 Absence of Vegetal cover: Soil erosion potential is increased if the soil has no or very little vegetative cover of plants and/or crop residues. Plant and residue cover protects the soil from raindrop impact and splash, tends to slow down the movement of surface runoff and allows excess surface water to infilt rate. The erosion- reducing effectiveness of plant and/or residue covers depends on the type, extent and quantity of cover. Vegetation and residue combinations that completely cover the soil, and which intercept all falling raindrops at and close to the surface and the most efficient in controlling soil (e.g. forests, permanent grass. Partially incorporated residues and residual roots are also important as these provide channels that allow surface water to move into the soil. As we travelled by the side of the Ganges, we could see a number of deciduous trees. These trees shed their leaves in winter. Plants of low height also dominate the area. Shrubs and grasses with hard knify leaves are found scattered.

Though the soil is sandy, it has a good percentage of silt and loam in it. The ground has grass but is not covered by it. The height of the shrub layer is seen to increase towards the river but as erosion proceeds, it engulfs the land areas. We heard a date palm tree falling in the river just the day before our 4th day of survey. Al these processes have a joint action on the bank materials and thus cause a substantial part of land to get detached and flow away with the running water.

7.4 Arsenic Pollution & Ground Water

Arsenic contamination in groundwater affecting West Bengal (India) and Bangladesh is a serious environmental problem. Contamination is extensive in the low-lying areas of Bhagirathi–Ganga delta, located mainly to the east of the Bhagirathi River. A few isolated As-contaminated areas occur west of the Bhagirathi River and over the lower parts of the Damodar river fan-delta. The Damodar being a Peninsular Indian river, the arsenic problem is not restricted to Himalayan rivers alone. Arsenic contamination in the Bengal Delta is confined to the Holocene Younger Delta Plain and the alluvium that was deposited around 10,000–7,000years bp, under combined influence of the Holocene sea-level rise and rapid erosion in the Himalaya. Further, contaminated areas are often located close to distribution of abandoned or existing channels, swamps, which are areas of surface water and biomass accumulation. Extensive extraction of groundwater mainly from shallow aquifers cause recharge from nearby surface water bodies. Infiltration of recharge water enriched in dissolved organic matter derived either from recently accumulated biomass and/or from sediment organic matter enhanced reductive dissolution of hydrated iron oxide that are present mainly as sediment grain coatings in the aquifers enhancing release of sorbed arsenic to groundwater. Overuse of groundwater and consequent depletion of groundwater level has unfortunately invited arsenic pollution in groundwater through oxidation of arseno-pyrites. Arsenic occurs at 15m-60m depth and is often found along the existing or abandoned river course, bils etc. Long continued consumption of arsenic-contaminated drinking water gives rise to arsenicosis, a health hazard which may cause skin lesions to cancer. Victims are mainly undernourished, poor people of remote villages in Balagarh & Mogra Chisurah blocks deprived of minimum transport, education, medical and marketing facilities.



Map No 30 of Haora area showing high arsenic level at Demur, Bally, Jagacha and the entire Damodar bank, Source: Subhrangshu Acharya & Babar A. Shah, Arsenic-contaminated groundwater from parts of Damodar fan-delta and west of Bhagirathi River, West Bengal, India: Influence of fluvial geomorphology and Quaternary morpho stratigraphy

Major Findings: i) Arsenic concentration is high in meander scars, oxbow lakes, linear lakes etc, left out by meandering Bhagirathi and Damodar. So, presence of arsenic may be related to the flood behaviour of the Bhagirathi, though the hypothesis is yet to be tested by scientists. ii) Arsenic concentration is mainly conined to a specific layer between 15m to 60m and sometimes at greater depth (100m). iii) Arsenic concentration changes over a very short distance. So, some of the tubewells are affected and some are not within a few 10s of metres. iv) People with poor nutrition are affected more. v) To the women arsenic related health hazard becomes a social hazard. vi) Arsenic is a silent killer for its longer lag period vii) Poor access to health facilities owing to poor transport system or low economic standard make the people vulnerable to this disease. ix) Measures taken to fight with arsenic pollution is still inadequate though the issue is often politicized. x) Arsenic pollution may create environmental refugees in future if the problem is not addressed with proper attention.

Impact of barge movement on fish catch and livelihood issues of fishers:

River plays an important role in supporting the livelihood of millions of impoverished communities. In the Bhagirathi-Hugli stretch of the Ganga river, a sizeable population of fishers depend on fishing for their livelihood and daily sustenance. Any disturbance including movement of vessels in the river will have direct bearing on fishing operations which may result into obstruction of the fishing activities and thereby affecting the daily livelihood of the fishermen.

7.5 Pollution: Our study area mostly covers municipality areas where Pollution is the major environmental hazard in this zone. Over 7 billion litres of raw sewerage are dumped into the Ganga every day from hundreds of towns along the river and its tributaries, and almost half comes from West Bengal, says Kalyan Rudra, chairman of the West Bengal Pollution Control Board and a hydrologist who has been tracking the state of the river for many years.

The state contributes 48% of wastewater produced in the Ganga basin and only treats 42% of this – leaving 1,779 MLD (million litres a day) of untreated waste flowing from the 54 drains throughout the state. Uttarpara – Kotrung , Serampur, Chandannagar , Chinsurah are the worst polluted areas of the study zone.

Water quality of the Bhagirathi-Hugli river at different sampling stations (State of environment report West Bengal, 2016) shows the following result .

Sample points	**DO (mg/l)**		**BOD (mg/l)**		**TCC (MPN/100ml)**		**FCC (MPN/100ml)**	
	Apr. 2015	Oct. 2015	Apr. 2015	Oct. 2015	Apr. 2015	Oct. 2015	Apr. 2015	Oct. 2015
Tribeni	7.1	6.0	1.88	4.3	140000	110000	70000	80000
Serampore	6.5	5.6	2.68	1.15	140000	80000	110000	70000

In our survey , what we find that almost all the outlets like canals , drains and rivers in the study area adds considerable amount of municipal wastes to the main river.

Image No 107: An outlet at Bally Municipality, 22°38'34.61"N 88°21'8.82"Ewith lots of municipal sewage.

Image No 108: Drain line of Haora Municipality 22°37'27.46"N 88°21'38.64"E

Image No 109: Polluted banks of River Bhagirathi Hugli, Haora Municipality 22°37'0.77"N 88°21'36.30"E

Image No 110: Idols are immersed near Ramkrishnapur Ghat, Haora Municipality

Image No 111: Sewage water discharge, Sankrail Municipality, 22°33'8.06"N 88°18'24.16"E

Image No 112: Polluted Bank of Hugli River, Bally Municipality

Image No 113: A portion of fully choked Bally Khal, one of the most polluted canals of the entire West Bengal (Source – West Bengal Pollution Control Board, 2020)

7.6 Urbanisation: Developing countries of the world encounter urbanisation and infrastructural development in or around the fertile tracts and the absence of any landuse plan for desired landuse change has led to conversion of farmlands, which is detrimental to future food security and environmental quality. Hugli district is traditionally well known as one of the most prosperous agricultural regions of West Bengal, but the district is experiencing rapid urban extension and infrastructural development towards productive agricultural land since 1991. This has caused decline in the amount of agricultural production, which may be treated as an indicator of increasing threat to the long run sustainable livelihood security of the people of the whole of West Bengal.

Blocks	**% of Urban population to total population**		**Urban area in km2**		**No. Of CT (Census towns)**	
	2001	**2011**	**2001**	**2011**	**2001**	**2011**
Balagarh	2.2	12.31	1	9.4	1	4
Chinsurah Mogra	46.83	64.87	19.9	24.43	9	15

Data- Census of India

The above mentioned data shows that in our study area there are 2 major blocks along Hugli River which shows rapid urbanisation which leads to broad-based rural to urban transformation relating population, landuse, economic activity, culture, or indeed any one of these (McGranahan et al., 2014:6). The study area has experienced rapid pace of urbanisation and infrastructural development within a span of 10 years from 2001 to 2011. Consequently, the net sown area of the selected blocks has declined and non agricultural landuse has increased simultaneously. Future projection of landuse change, loss of soil fertility, productivity decrease, and rise of population are some of the facts, which are directly consequent upon the future food security of the area.

An important consequence of urbanisation can be establishment of a new balance with the agricultural processes. This new balance necessitates direct attention to a number of problems that must include both formal and informal planning (Winfield, 1973: 73). Lower yield rate, constant increase of population, contraction of cropland by built up area and infrastructural development are the major problems in the study area. To deal with these problems, modern agricultural system becomes important. Modern agricultural process is solely dependent upon several formal and informal planning in agriculture, which requires access to resources, technology, management, investment, markets and supportive government policies. There

must be proper supply of nutrients to maintain soil fertility. Plant growth must be promoted without soil loss by new technologies and machineries. Effective irrigation system along with the use of improved genetics for crops and livestock to enhance yields and use of modern genetic and other techniques to protect plants and livestock from losses to competing plants, diseases, drought insects and other threats are necessary actions to be given attention. There must be a highly productive and efficient system that simultaneously protects the environment by means of sensitive and efficient use of natural resources (Motes, 2010: 13). Moreover, balanced urbanisation is a good sustainable urbanisation example where attainment of sustainable food security is must, which involves issues like conserving land, water, and economic growth through food production (Chambers, 1987; Jain et al., 2010 and Liu et al., 2017).

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