NADIA

DOCUMENTATION OF GANGA FROM GAUMUKH TO GANGASAGAR

Report submitted by:

The Natural Heritage Division

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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

Chapter 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 compliance

verification 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

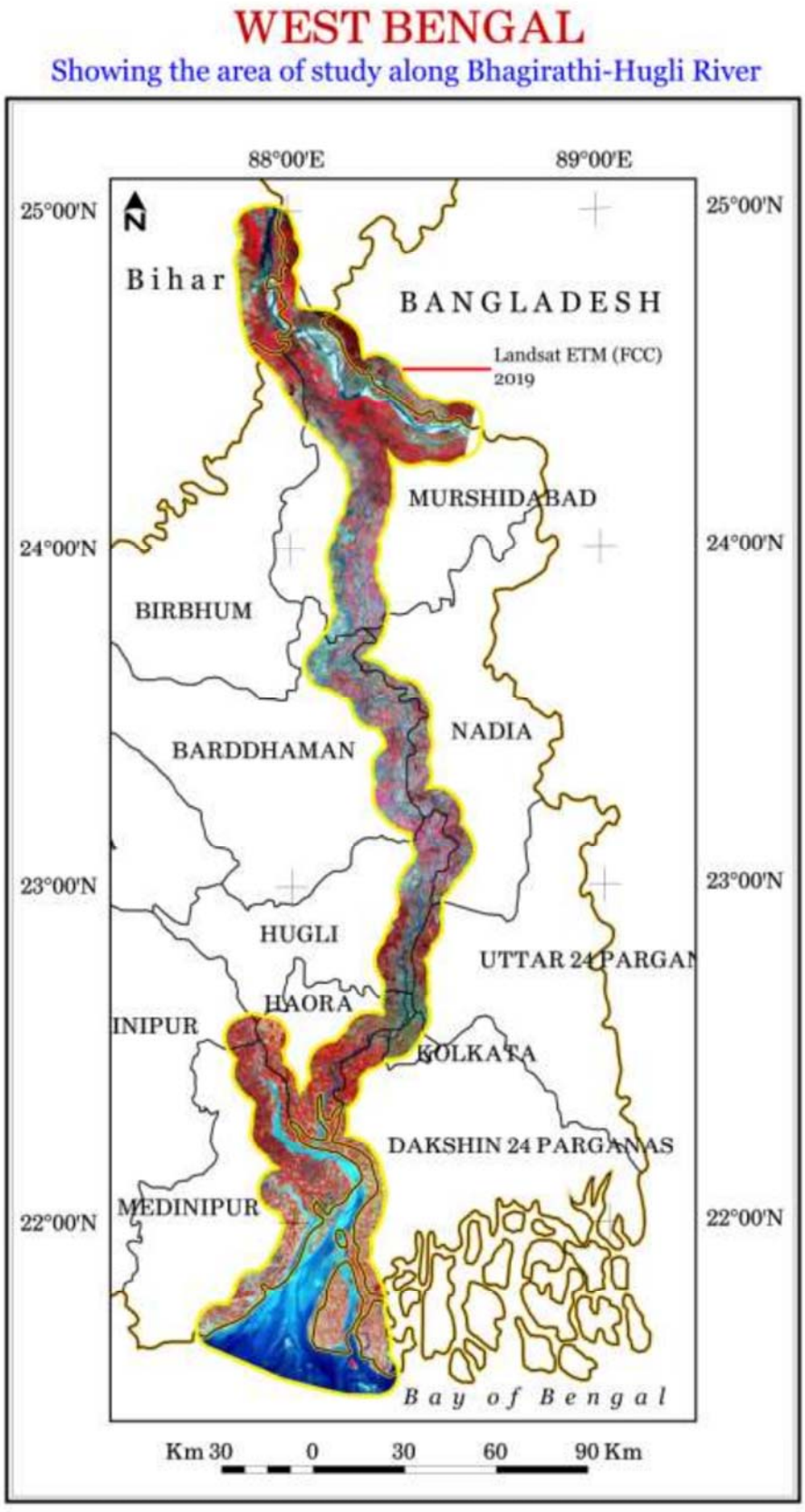
The aims and objectives of NMCG are to accomplish the mandate of National Ganga River Basin Authority (NGRBA) are:

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.

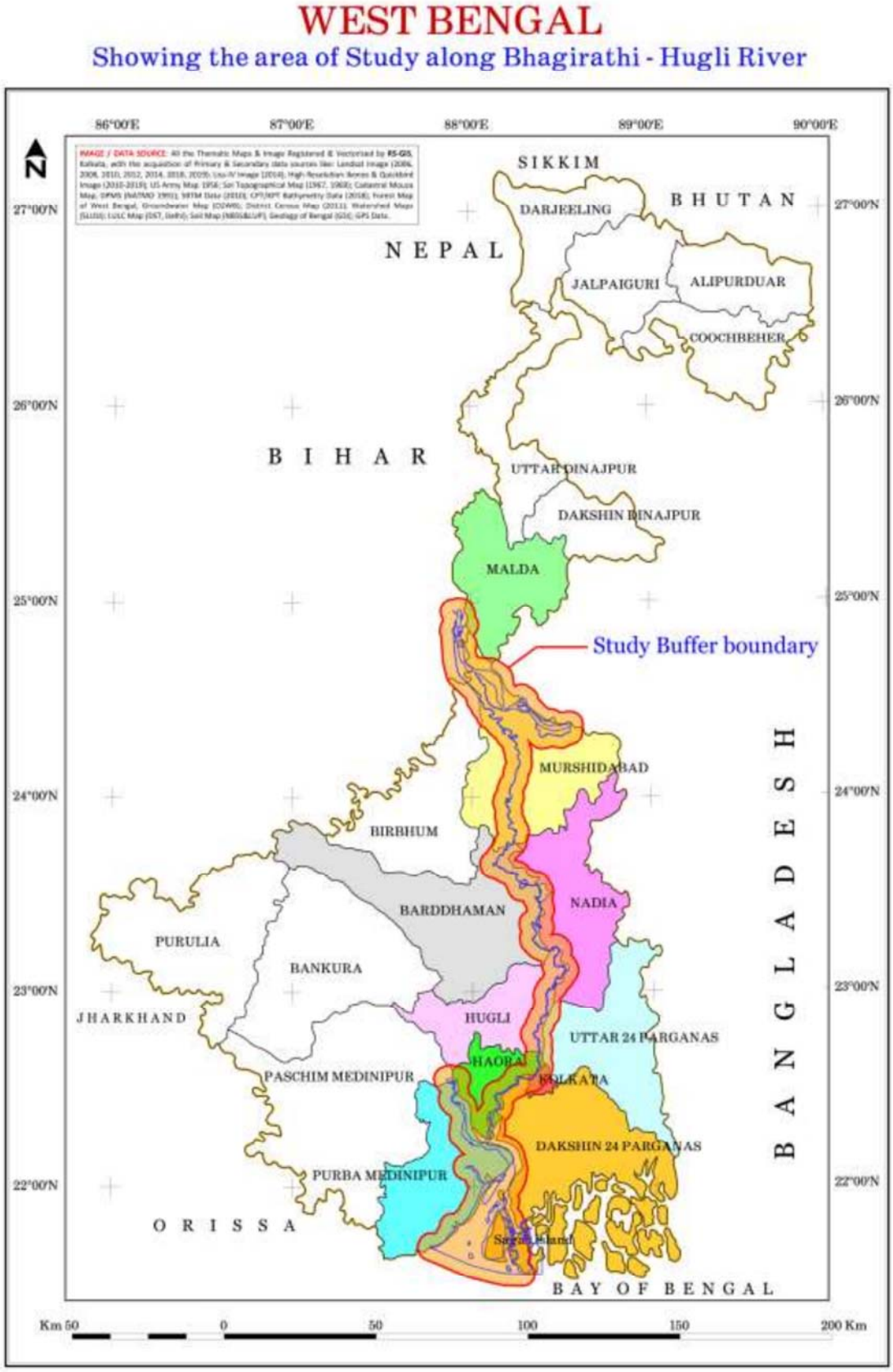
1.2. GANGA CULTURAL DOCUMENTATION

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 1 – Map of West Bengal showing the study area



Map 2 - Map of West Bengal showing the overall location of the Study area.

1.3. Documenting 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.

1.4. METHODOLOGY

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:** Following Gadgets/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

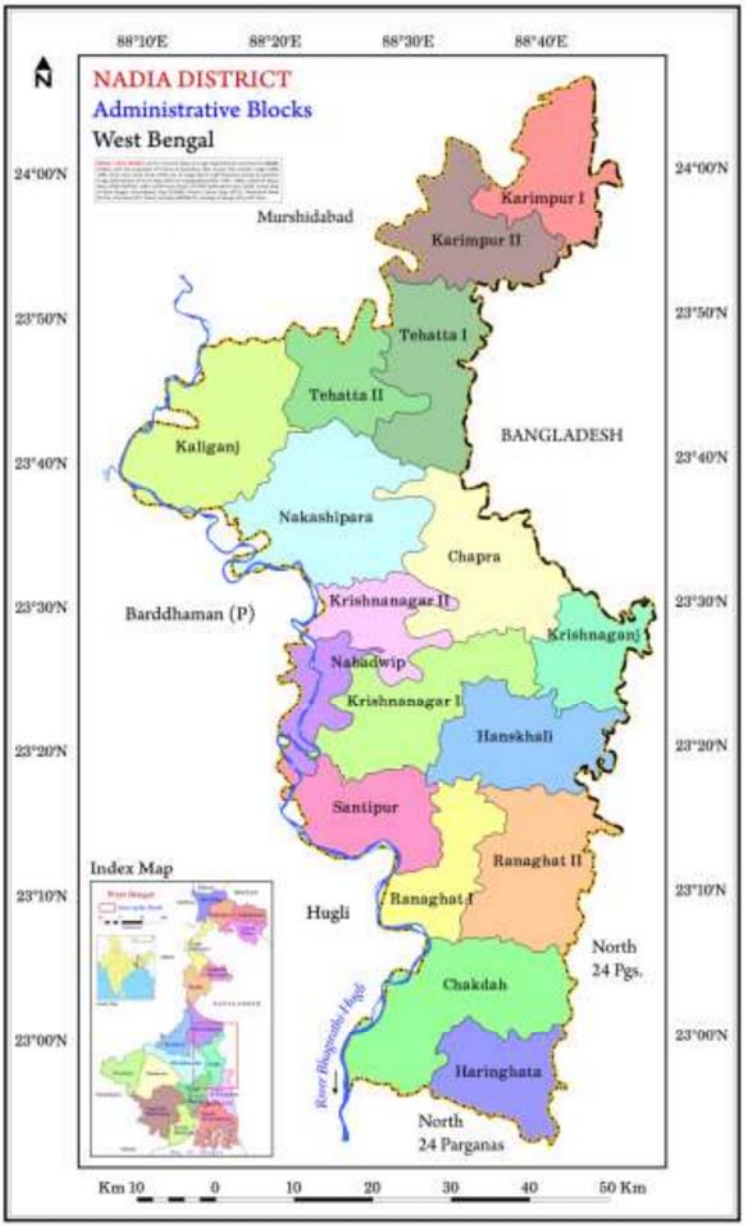
a. **Preparation of Draft Report:** Preliminary Draft Report in Soft & Hard copy mode (1 Colour Printed) of each District will be submitted to INTACH, Kolkata Convener for Verification / Correction

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.

CHAPTER 2 : LOCATIONAL SETTING

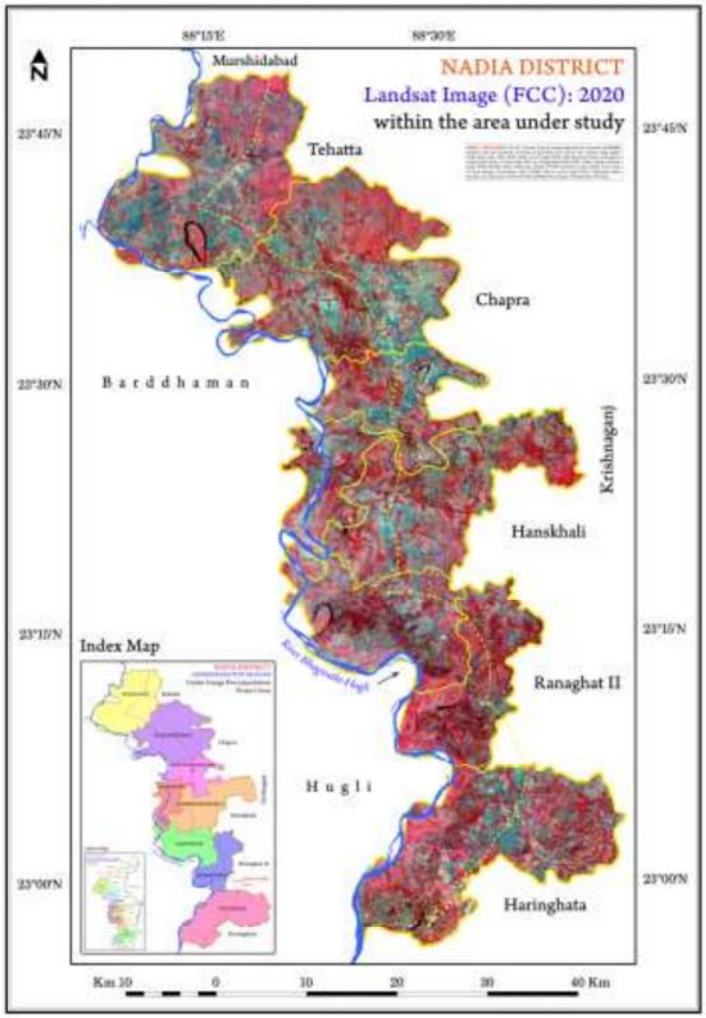
2.1. The district of Nadia *(Map 3)* is situated in the heart of the Bengal delta held within the arms of the Ganga, namely, the Bhagirathi on the West and Mathabhanga on the North. The entire district lies in the alluvial plain of the Ganga and its tributaries. Most districts in West Bengal take their name from the headquarters station of the district, but Nadia district takes its name not from Krishnanagar, the headquarter but from Nadia or Nabadwip hallowed by the memory of **Lord Shri Chaitanya Mahaprabhu** who was born here on 18th February, 1486. **2.2.** The British district of Nadia was formed in 1787. The present district of Nadia after partition was formed by Notification No.545-GA dated 23rd February, 1948. The district of Nadia is bounded on the north and north-west by the district of Murshidabad. On the south-east and east it is bounded by the Republic of Bangladesh. In the south and south-east the district is bounded by the district of North 24-Parganas.The shape of the district is irregular, lying North to South. The district is about 46ft. above



Map 3 – District Map with Blocks

the mean sea-level and the tropic of cancer divides the district into two parts.

2.3. The Nadia district *(Map 4)* is a large alluvial plain stretching southward from near the head of the delta formed by the successive rivers into which the Ganges has from time to time distributed itself. As to the formation of this delta, the following remarks of Dr. Thomas Oldham recorded in the proceedings of the Asiatic Society of Bengal, 1870, page 47, may be quoted



Map 4 : Landsat Image , FCC , Study area, Nadia

"I suppose no one will hesitate to acknowledge that the whole of the country, including the Sunderban proper, lying between the Hugli on the west and the Meghna on the east, is only the delta caused by the deposition of the debris carried down by the rivers Ganges and Brahmaputra, and their tributaries. It is also equally well known that in such flats the streams are constantly altering their courses, eating away on one bank and depositing on the other, until the channel in which they formerly flowed becomes choked up, and the water is compelled to seek another course. It is also certain that in this peculiar delta the general course of the main waters of the Ganges has gradually tracked from the west towards the east, until of late years the larger body of the waters of the Ganges have united with those of the Brahmapurta and have together proceeded to the sea as the Meghna. Every stream, whether large or small, flowing through such a flat, tends to raise its own bed or channel by the deposition of the silt and sand it holds suspended in its waters, and by this gradual deposition the channel bed of the streams is

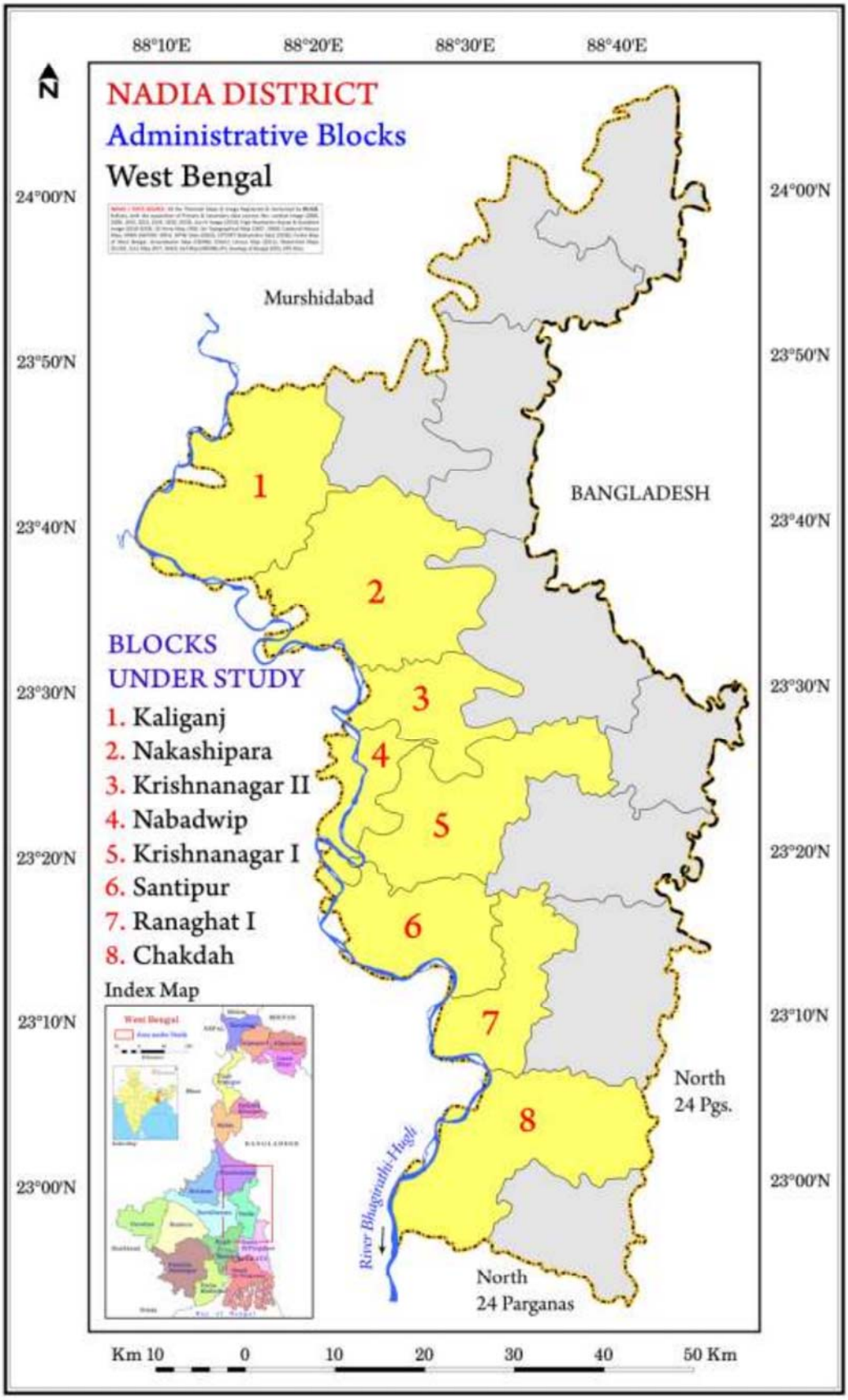
raised above the actual level of the adjoining flats. It is impossible to suppose a river continuing to flow along the top of a raised bank, if not compelled to do so by artificial means, and the consequence of this filling in and raising of its bed is that, at the first opportunity, the stream necessarily abandons its original course, and seeks a new channel in the lower ground adjoining, until after successive changes it has gradually wandered over the whole flat and raised the entire surface to the same general level. The same process is then repeated, new channels are cut out, and new deposits formed.

Plate 1– River Bhagirathi in Santipur Block of Nadia District

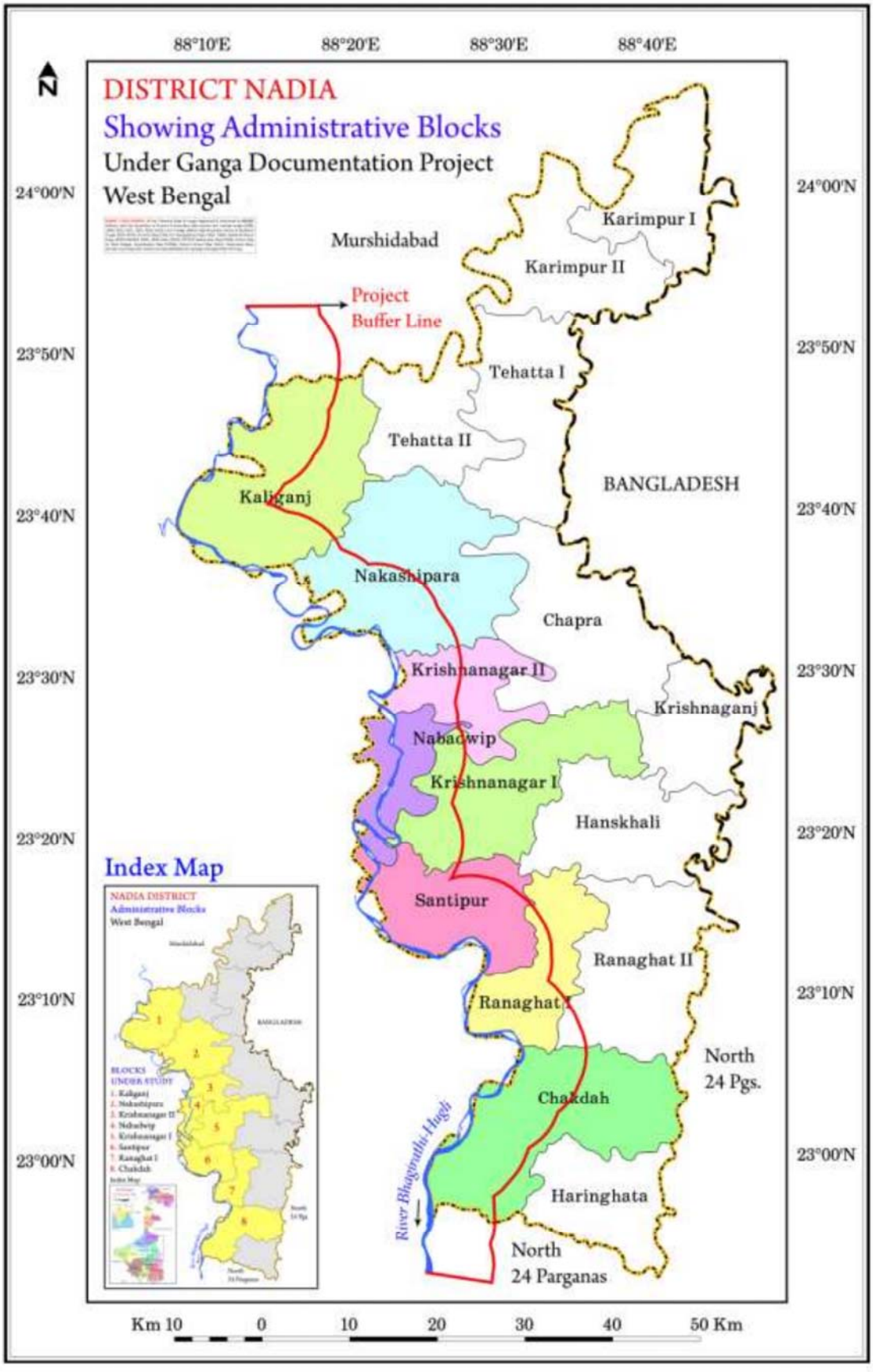
2.4. The name Nadia or **Navadwip** does not appear to be an ancient one. It's earliest mention of Nadia spelt as **Nudiya** is in *Minhaj_us_Siraj's Tabaqat-i-Nasiri* in connection with the raid on this city by Bakhtiyar Khilji in circa A.D 1200. The Tabaqat says that it was the capital of Lakshmansena. But none of the 8 copper plates grant inscriptions of the same king discoverd till now mentions this as his capital. The post-Chaitnya Vaishnava literature and popular traditions however identify Navadwip with Nadia.

2.5. Study Area: River Ganga in form of its most important distributary, Bhagirathi - Hugli covers about **112 km stretch** bordering this mighty district . For our Study area (7km along the bank of the river) we have 9 Blocks – 1.Kalyani- 329 sq.km (Municipality) 2.Chakdah-332.51 ha 3.Ranaghat-163.964.Santipur-196.96 sq.km 5.Nabadwip-108.02 sq.km 6.Krishnanagar 1- 271.66 sq.km 7. Krishnanagar II -143.19.sq.km 8.Nakashipara- 366.27 sq.km 9.Kaliganj1 -327.34 sq.km *(Map 5 , 6, 7)*

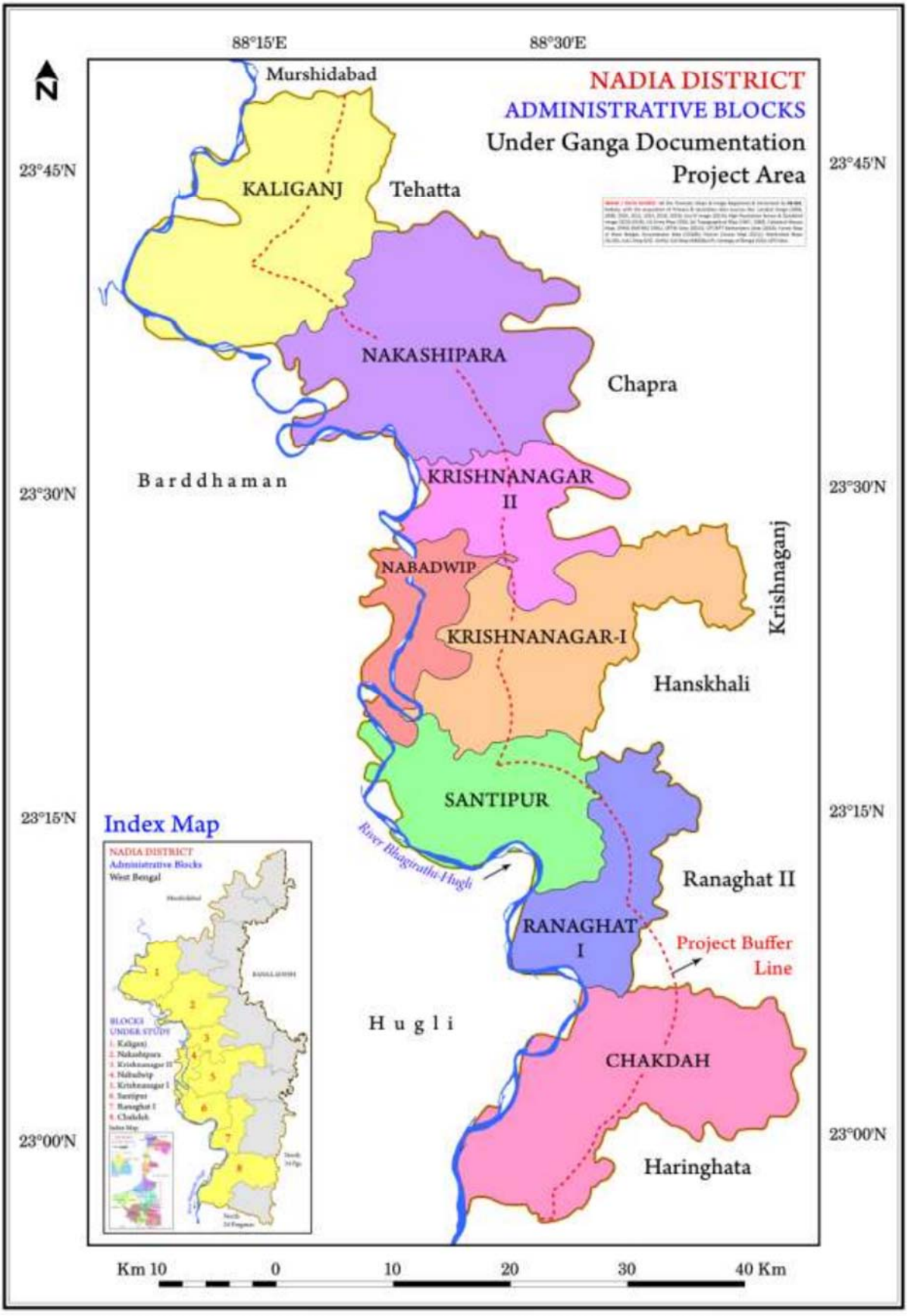
District	Block	Area (sq.km)
Nadia	Chakdah	**332.51**
	Ranaghat 1	**163.96**
	Santipur	**196.96**
	Nabadwip	**108.02**
	Krishnanagar 1	**271.66**
	Krishnanagar II	**143.19**
	Nakashipara	**366.27**
	Kaliganj1	**327.34**
	Total	**1910.91 sq.km**



Map 5 – The Study area blocks of Nadia District



Map 6 : The 7 km Buffer line showing the study area



Map 7 : The Study Area administrative blocks of the Nadia District

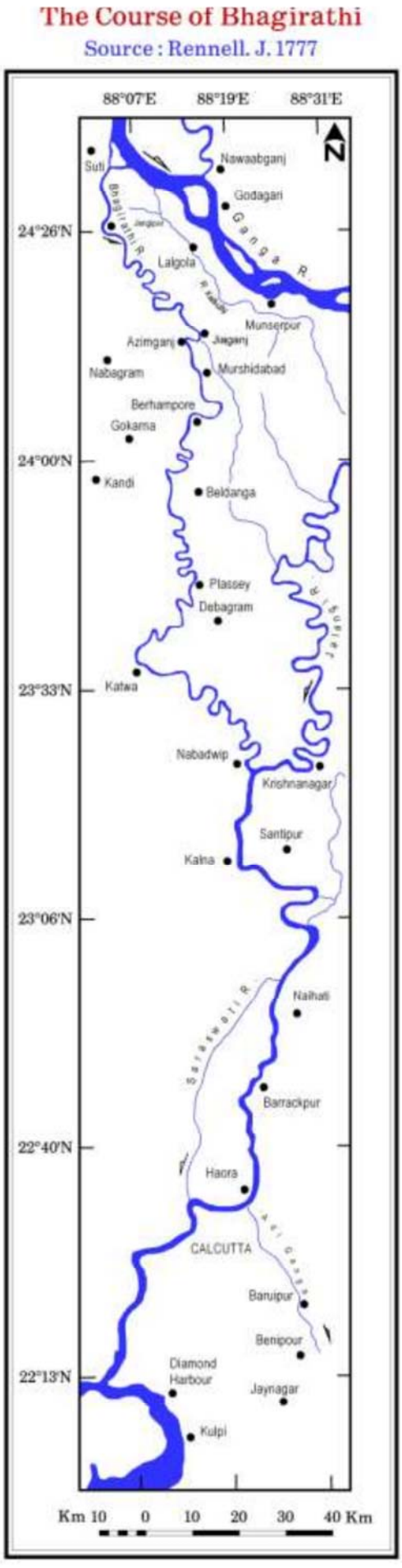
2.6. Ganga in Nadia : The Bhagirathi , the main distributary of Ganga in West Bengal , impinges upon the district near Plassey (Plate 3), and for some distance, forms its western boundary. It takes the name of the Hugli from its junction with the **Jalangi** opposite **Nabadwip** town (Plate 2). In its upper reaches it is a comparatively insignificant stream, but the surrounding country gives evidence of the vast size which it attained, when it formed the main bed of the Ganges, the name of which is still applied to it by the villagers along its banks. The river receives Churni near Ranaghat block of Nadia. The study area is in old stage of fluvial process. The old stage of river is characterized by the low elevation with very gentle slope of land. Meandering streams are one of the few morphological system for which an abundant historical record exists of changes of channel pattern and associated flood plain erosion and deposition (Panda and Bandyopadhyay, 2010). In this stage meander, abandoned channels oxbow lakes are developed. It's mostly flood plain area. *(Map 8 , 9)*

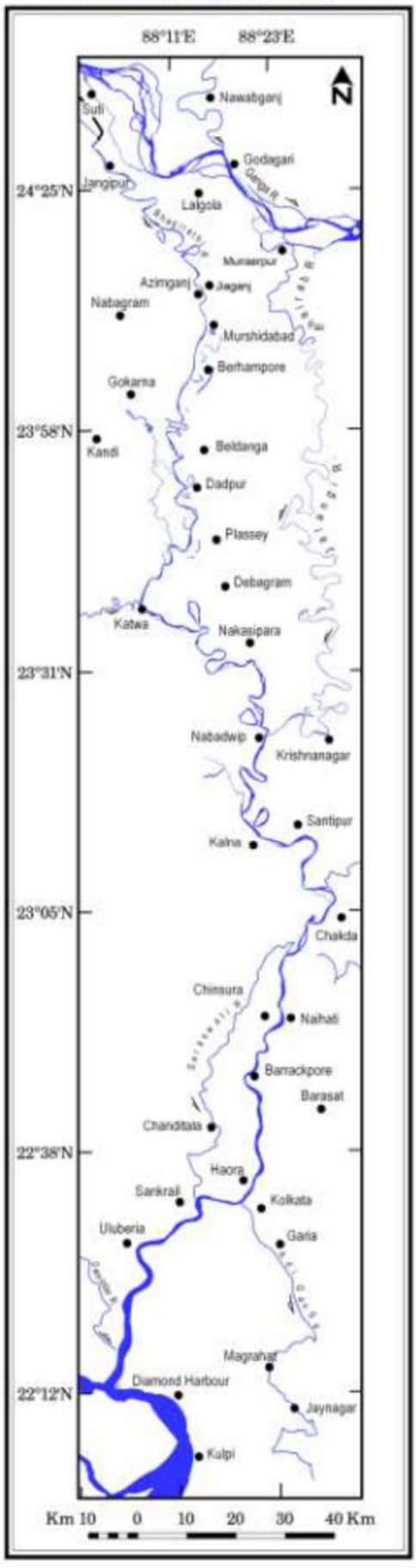
Plate 2 : River Bhagirathi-Hugli near Nabadwip Ghat , 23°24'46.95"N 88°22'44.28"E

Plate 3 - River Bhagirathi-Hugli near Plassey , Kaliganj1 , 23°46'0.51"N 88°13'49.35"E

Plate 4 : River Bhagirathi-Hugli near Ranaghat

Map 8 & 9 : The course of Bhagirathi- Hugli , 1777 & 2010 , Source , River Atlas of Bengal , Dr. Kalyan Rudra





CHAPTER III : PHYSICAL SETTING OF THE STUDY AREA

3.1. **Relief:** Geographically the district belongs to the moribund Delta Region of the state of West Bengal. The Nadia district is a large alluvial plain stretching southward from near the head of the delta formed by the successive rivers into which the Ganges has from time to time distributed itself. The country is flat and the general aspect is that of a vast level alluvial plain, dotted with villages and clusters of trees and intersected by numerous rivers, back-waters, minor streams and swamps. The highest elevation found is 30 m which is in the extreme northern part. *(Map 10 & 11)* On the top surface it appears to be formed of recent alluvium containing blue clay and sand, but below the top surface there is evidence of the existence of an underlying plinth of older alluvium formed of yellow material. The natural soil region of the district under different conditions forms three dissimilar soil associations, viz.

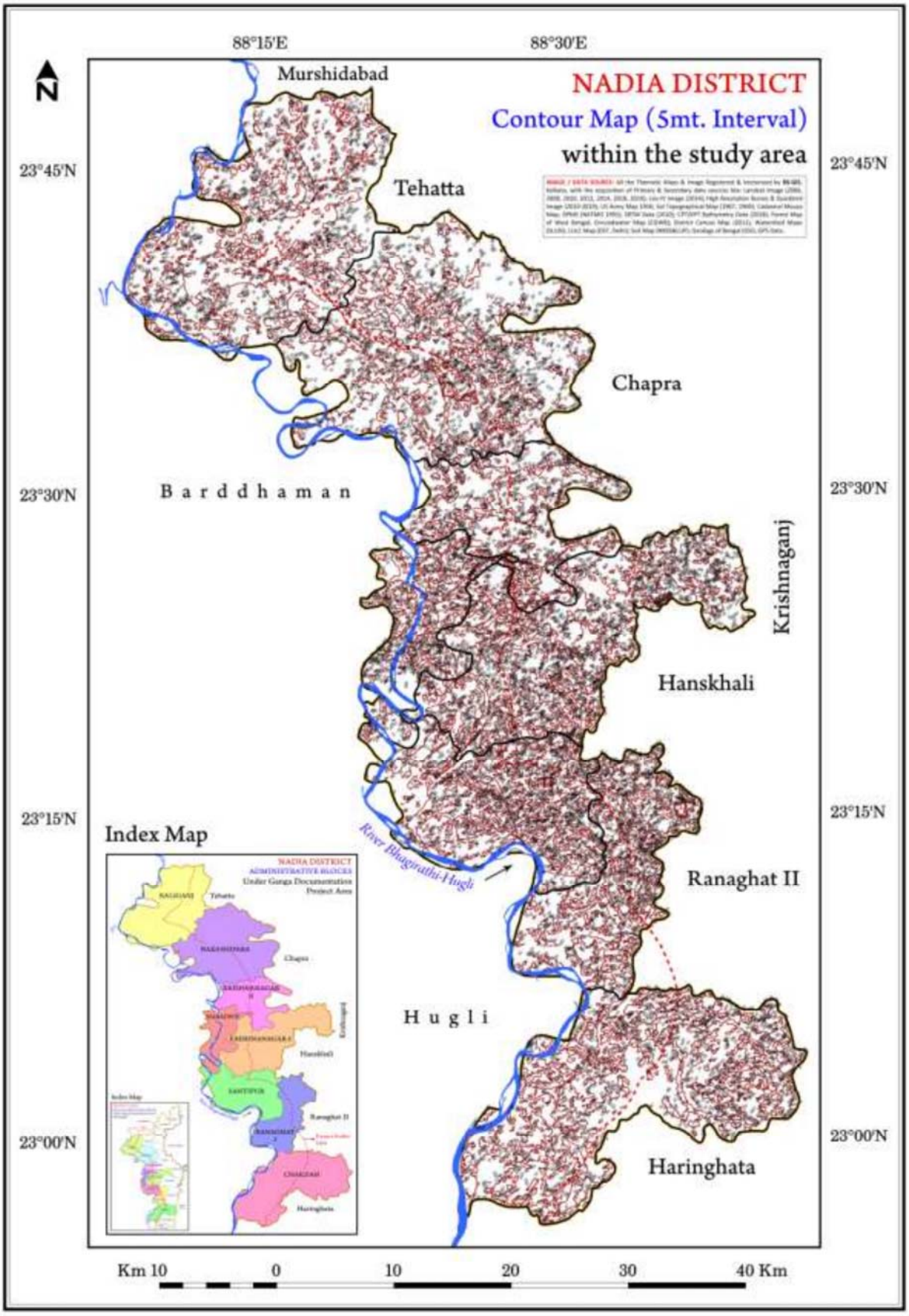
(i) Ganges riverine lands, (ii) Ganges flat-lands, and, (iii) Ganges low lands.

This large alluvial plain area is intersected by rivers, streams and swamps. A number of rivers namely the Bhagirathi, the Jalangi and the Churni drained this district flowing towards south. The low-lying tract of black clay soil, called 'Kalantar' lies in the western part of the district. The tract is stretching between the Bhagirathi and the Jalangi rivers. The Bhagirathi forms the western boundary with the Barddhaman district. But the eastern bank is lower and hence the southeastern slope adjacent to the river is marked by embankment. The district is divided into 5 sub-micro regions.

a. Bhagirathi plain : The region covers the whole stretch of the Bhagirathi river. It flows from north to south in the western side of the district and forms the district boundary with Barddhaman. The region is sloping towards south-east. In the region there are many depressions in the form of swamps caused by the oscillation of the Bhagirathi.

b. Jalangi-Bhagirathi Interfluve : The region extends between the Bhagirathi on the west and the Jalangi on the east. The area belongs to 'Kalantar' tract. This tract stretches southward from Murshidabad district in the north. There is no drainage and it forms a large shallow lake

during the rains. The region has a large number of dead (old) rivers running from north to south due to the oscillation of Bhagirathi on the west and the Jalangi on the east.



Map 10: Contour Map of the study area with the highest contour value of 30 m in the extreme northern part of the study area.

c. Nadia Plain North: The region covers the north-eastern part of the district bordering Bangladesh. The Jalangi river forms the western boundary of the region. The Bhairab and the Mathabhanga (the branch ofPadma river) traverse the area. Many depressions in this area are formed by the presence of old channels and meandering rivers. The general slope is towards the south-east.

d. Krishnanagar-Santipur Plain: The region occupies the central plain area of the district. The Jalangi and the Bhagirathi interfluve limits its boundary on the north-west and the Churni (branch of Mathabhanga) on the south-east. The region is sloping towards south-west and many dead river co~rses and swamps are found developing in this region.

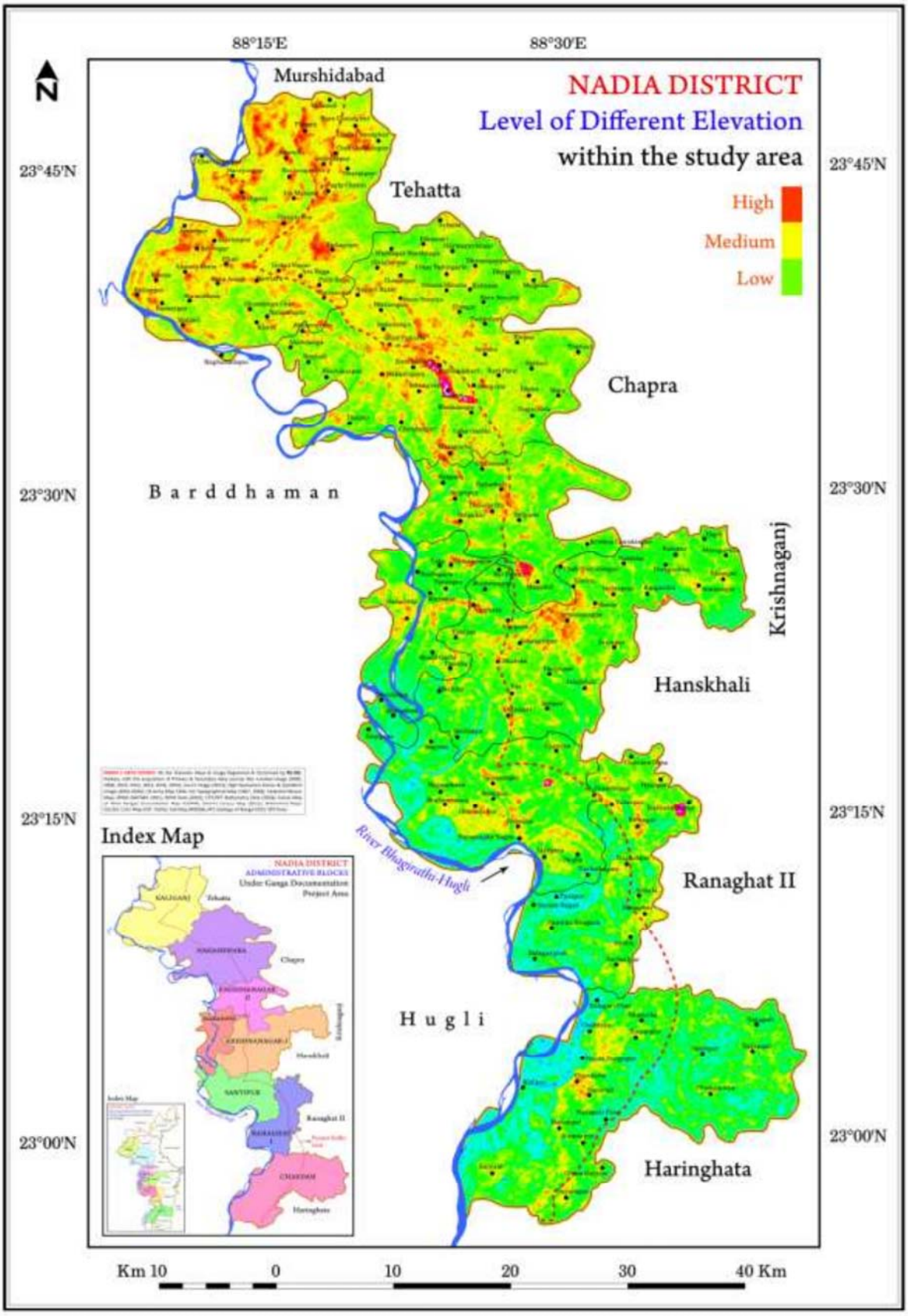
e. Ranaghat-Chakdah Plain: The region lies over the south-eastern part of the district. It is separated from the Krishnanagar-Santipur plain by the Churni river. The region is characterised as a low-lying area and sloping gradually towards south. The Ichhamati (once branch of the now dead Bhairab) forms the eastern boundary of the district till it enters the district of North 24 Paraganas. This region is also characterised by the presence of numerous depressions and swamps due to the frequent changes of the river courses. Elevation of the district from the mean sea level is 59 metres.

Plate 5 – Ranaghat-Chakdah Plain, 23° 1'16.53"N 88°26'54.69"E

Plate – Bhagirathi-Hugli River in Chakdah block.

Plate 6 - Bhagirathi –Hugli in Santipur area, 23° 3'41.80"N 88°29'3.19"E

Plate 7– Bhagirathi Hugli river near Dignagar railway station. 23°19'32.52"N 88°22'49.90"E



Map 11 : Relief Map of the study area , showing elevation level of the land

3.2. CLIMATE: The climate of this district is characterized by an oppressive hot summer, high humidity all the year round and well distributed rainfall during the southwest monsoon season. The cold season is from about the middle of November to the end of Februmy. The period from March to May is the summer season. The southwest monsoon commences about the begining of June and lasts till the end of September. October and the half of the November constitute the post monsoon season. The average rainfall of the district is 1,310.4 mm. (51.59"). The maximum temperature was recorded in 1960 which was 45.9° Celsius (114.8°F) and minimum temperature was 3.9° Celsius (39.0°F). Humidity is high through out the yem·. But in the summer months, March and April, the relative humidity is comparatively less. Winds are generally light with a slight increase in force in the summer and monsoon seasons. Winds blow mostly from directions between south mid east in May and in the south-west monsoon season. Krishnanagar is located at 23.4°N 88.5°E. The area of the municipality is around 16 km2. It is situated on the southern banks of the Jalangi River. It has an average elevation of 14 metres (46 ft). The Tropic of Cancer passes through the outskirts of Krishnanagar. The latitude of the Tropic of Cancer is 23° 26′ 5″ N. Average of the maximum and minimum temperature and rainfall of the district for the preceding ten years is as follows:

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average high °C (°F)	26.4 (79.5)	29.1 (84.4)	33.5 (92.3)	35.3 (95.5)	35.4 (95.7)	34 (93)	32.3 (90.1)	32.1 (89.8)	32.4 (90.3)	32.3 (90.1)	30.3 (86.5)	27 (81)	31.7 (89.0)
Average low °C (°F)	13.8 (56.8)	16.9 (62.4)	21.7 (71.1)	25.1 (77.2)	26 (79)	26.5 (79.7)	26.1 (79.0)	26.1 (79.0)	25.8 (78.4)	23.9 (75.0)	19.6 (67.3)	14.5 (58.1)	22.2 (71.9)
Average precipitation mm (inches)	1 (0.0)	2 (0.1)	3 (0.1)	4 (0.2)	89 (3.5)						8 (0.3)	0 (0)	
Average rainy days	4	3	4	6	12					11	3	1	125

Plate 8 & 9– Tropic of Cancer passes through the northern part of the district near Krishnannagar

3.3. Soil : According to AISLUS (All India Soil and Land-Use Survey) a total 16 nos. soil series have been mapped in Nadia district under fluvial landscape, out of which 78.35% under Alluvial plain, 9.64% under flood plain & 6.44% under marshy land. 76.50 % area of the district are cultivated followed by plantation (12.15%), open scrub (6.44%), waste land (0.30%) and forest land(0.15%).

Soils of the area are taxonomically classified into three orders i.e.Alfisol, Inceptisols and Entisols. All the sixteen soils series identified in the area are further classified into 5 sub-orders and great groups, 12 subgroups and 16 families. Soils are slightly acidic to neutral in reaction and low to medium in fertility needs recommended doses of balanced fertilizer in addition of organic manure. Soils of alluvial and flood plain have good potential of wide variety of crops. Soils of the district has almost none to slight(82.93%) erosion followed by moderate(12.30%)erosion and marginal area are moderate to severe erosion(0.31%). Soils of the districts fall in four slope classes a. Level to nearly level slope 122677ha 31.24% b. Nearly level to very gently slope 40604ha 10.34% c. Very gently slope 162513ha 41.38% d. Very gently to gently slope 49405ha 12.58%

Soils under different Land Capability classes II 135257 ha 34.44% II-III 165693ha 42.19% III 742249 ha 18.91%. Land capability class wise data reveals that the survey area has good potential for Agriculture and Horticulture.

Plate 10 – The new alluvial soil of the floodplain area is very much suitable for cultivation.

3.4. Ground Water : The area under study is underlain by Quaternary alluvium the aquifers are regionally extensive and interconnected forming a single potential aquifer system within about 200 mbgl. However, number of discontinuous clay partings exists within this top aquifer. From the exploration data of CGWB & other organisations, it has been found that this top aquifer is, in general, underlain by the thick clay layer down to the drilled depth of about 400 mbgl. The entire district lies in the rich alluvial zone of the Ganga and its tributaries. In the study area, ground water occurs under water table conditions down to a depth of about 180 mbgl . Wherever upper sandy or silty clay is present, aquifer impart a partially confined conditions. In some parts of Krishnanagar-II in Nadia district, ground water occurs under confined conditions between depth of 200 to 330 mbgl.

From the Hydrogeological Map of CGWB showing water table contours, it is observed that, ground water table ranges from more than 12m amsl (above mean sea level) to more than 6m bmsl (below mean sea level) during pre-monsoon period and, from more than 15 m amsl (above mean sea level) to more than 3 m bmsl (below mean sea level) during post-monsoon period of 2015. The regional ground water flow is in general, from north-west to south-east direction from Purbasthali-II of Bardhaman district to Habra-I block of 24 Parganas (N) district. In the study area, locally there are a number of ground water troughs and mounds, as observed.

Plate 11– In the Municipality areas, tube wells are the sources of water for domestic use.

a. Pre-monsoon & Post-monsoon long term trend analysis :

The long term trend analysis reveals that there are falling trends in all the Blocks both during Pre-monsoon and Post-monsoon periods except in Kalna-II and Ranaghat-I blocks where slight rising trends are observed during pre-monsoon period . The Pre-monsoon falling trend varies from 0.01 cm/year (in Krihnanagar-I Block) to 43.70 cm/year (in Singur Block). The Post-monsoon falling trend varies from 3.62 cm/year (in Bangaon Block) to 33.96 cm/year

(in Polba-Dadpur Block) Details of pre-monsoon and postmonsoon water level trend (from 1995 to 2011) in cm/year for individual Block is given in Table-III.

b. Quality of Shallow and Deeper Aquifer Water:

Ground water samples were collected during pre-monsoon period from the National Hydrograph Stations as well as the Key Observation Wells falling in the study area and those have been analysed in the departmental Chemical Laboratory. Chemical quality of ground water occurring in shallow and deeper aquifers does not vary significantly, except arsenic concentration. Using the data of chemical parameters, overall analyses for ground water quality were done separately for arsenic infested and non-arsenic infested areas in the study area. The ground water in both the cases, in general, is Ca-Mg- HCO_3 type and at few places, Ca-Mg-Cl-SO_4, Na-K-Cl-SO_4 and Na-K- HCO_3 types.

c.General range of chemical parameter in the area:

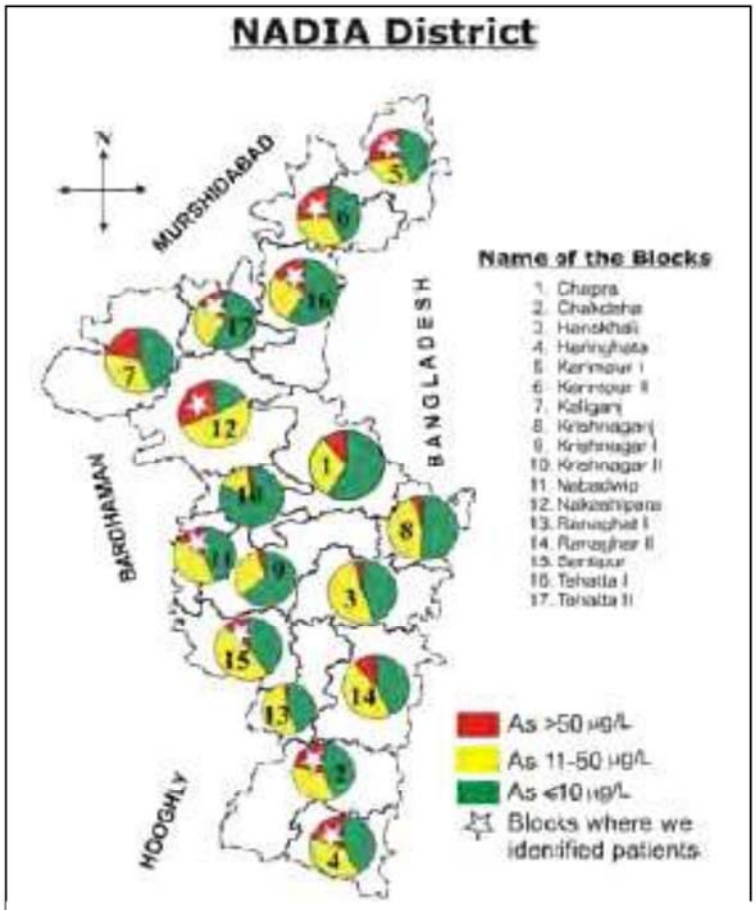
From the analytical results as available so far from the Laboratory, it is found that, pH of water, in general, varies between 6.5 and 8.8 and, EC between 251 and 4878 (µS/cm) Concentrations of Na and K ranges from 3 to 850 mg/1 and from 0.1 to 139 mg/1, respectively. Fe content is also available sporadically upto 7.8 mg/1 . CO3 is upto33 mg/l. HCO3 present in the range of 31-750 mg/1 and Cl is mostly in the range of 7-1099mg/1. F ranges from 0.0- 1.0 mg/1. SO4 concentrations are varying from 0 to 199 mg/l. Total hardness as per CaC03 ranges from 13 - 675 mg/1, whereas Ca varies from 4 to 227 mg/1. Nitrate concentration ranges from 0.0-108 mg/1 (in parts of Nadia districts)..

d.Groundwater utilization of Nadia district , has been emerging rapidly in the wake of increasing urbanization and production of agricultural commodities . The study area is basically under intensive irrigated agriculture by groundwater and also partly by surface water. Paddy and Rabi vegetables are the important corps cultivated by farmers in the region. In major part of the area farmers depend only on groundwater for cultivation of these crops during all seasons. Any reduction in the yield of the tube wells due to decline in groundwater shall adversely impact the production of the food grain. Though the study area has multilayer aquifer system in which Aquifer I (within depth of 200 m bgl) is highly potential in nature, holds fresh water and caters to the need of irrigation in, agriculture and industries. In some places arsenic contamination in ground water occurs (>0.01mg/l) in a sporadic manner in

Aquifer I and therefore it is not suitable for drinking purposes. Aquifer II (within depth of 160 to 390) occurs below the Aquifer I separated by thick clay bed and is in general arsenic free (arsenic content BDL to <0.01 mg/l). Aquifer II is not so much potential as Aquifer I. The urban agglomeration depends on aquifer II for their requirement. CGWB has constructed number of arsenic free wells tapping the Aquifer II using cement sealing techniques and handed over to PHED/ State Government departments for supply of arsenic free water. PHED. It is observed that ground water level is declining slowly in most of the area under irrigation and also in some of the wells in the urban areas. Therefore, there is need for efficient management of the aquifer systems for sustenance of the tube wells tapping Aquifer I as well as Aquifer II.

e. Arsenic Contamination in the study area – (*Map 12)*

Arsenic pollution in groundwater, used for drinking purposes, has been envisaged as a problem of global concern. Arsenic contamination in drinking water has been reported from many countries like Taiwan, China, Argentina, Chile, Mexico, Cambodia, Thailand, Myanmar, Nepal, USA, but the severity of this contamination in India and Bangladesh is unprecedented. The common symptoms of chronic arsenic toxicity due to prolonged drinking of arsenic contaminated water are pigmentation and keratosis and cancer of skin. In India, significant arsenic contamination in groundwater was detected in the year 1983 in West Bengal, when some villagers were diagnosed to be suffering from arsenicosis due to drinking of arsenic contaminated water. Today, in West Bengal, the arsenic contamination in ground water has been detected in 79 blocks in 8



Map 12 : All the blocks of the district are arsenic affected with Kaliganj , Nakashipara being maximum

districts of the state. Of these, the major affected districts are Malda, Murshidabad, Nadia, Burdwan and North and South 24 Parganas. It is suspected that 6 million people are exposed to arsenic contaminated ground water (>50μg/l).

As there has not been any authentic epidemiological study carried out in the state to estimate the disease burden of *arsenicosis*, a scientific epidemiological study by adopting stratified multistage design was carried out in Nadia district, one of the arsenic affected districts of West Bengal where all its 17 blocks are affected by ground water arsenic contamination.

Water samples were collected from all available current and previous private and public tubewells used for drinking and cooking purposes by each recruited household. Arsenic levels were measured by an atomic absorption spectrophotometer with flow-injection hydride generation system. Summary results of the study given- A total number of 2297 households of 37 arsenic affected villages in the 17 blocks, selected by statistically sampling method, were surveyed in the district of Nadia, West Bengal. Out of 10469 participants examined, 1,616 (15.43%) patients showed clinical features of *arsenicosis* (cases) characterized by arsenical skin lesion, while 8853 participants did not have any such lesion (controls). This showed a prevalence rate of *arsenicosis* to be 15.43%. The probable number of people affected with arsenical skin lesion in the district of Nadia appears to be 0.14 million as estimated by using the method of calculations described earlier. The incidence of this disease was found to be significantly high (57.8%) in males compared to females (42.2%), (P<0.001) .The mean age was 53.36 years among cases and 33.74 years among non-cases (controls). Majority of the population living in the arsenic affected villages were of low socio-economic condition and education status, lived in kuchcha houses and were engaged in agricultural farming or physical labor. Sanitary latrine was absent in about 33% of the participants

3.5. Natural Vegetation: a. Early Days - The forests in Nadia today had been the legacy of the zamindari forests and the Khasmahal jungles. After getting vested with the Government during the fifties, extensive plantations (mostly of Teak) were raised on those degraded forests. Hence trees older than fifty years are rare. Over the years, a fair amount of natural regeneration had come up and a more mixed type forest was evolved endowing them with the appearance of high forests. Large stretches of forests do not exist now, although old records vouch once Nadia formed a forest belt in continuation with the Sunderbans through Parmadan-Ranaghat -Hanskhali-Chapra-Karimpur (all in Nadia district) - the remnant of which are now seen as mere 'forest islets'. Even tigers had been reported from the forests off Chakdah (Stevorious, 1785) where no forest exists now. There are records of dense forests in Krishnaganj (no forest there at present) and along the Mathabhanga river (Bishop Heber, 1824). Also there was account of the existence of high forests in Betai during 1942. Rampant deforestation occurred with the advent of twentieth century especially during the post-partition - days when heavy influx of refugees took place. Many of those Khas forests gave way to agricultural lands and habitations. The steady population influx ever since would have nearly wiped out the forests, but for the highly successful social forestry project during the eighties when people were encouraged to plant trees on all available space with Government assistance.

b. Present Condition - In Nadia district, fruit orchards of Mango, Kathal, Litchi, Guava, Sapota and Lemons are available. These were raised as progeny orchards to supply high quality saplings to the villagers during' *Aranya Saptaha'* as this district is traditionally known for its fruit crop. Broadly three types of forests are found, viz. **(i) Moist deciduous type,** (ii) **Dry deciduous type,** and (iii) **Riverine type.** Forests in Nadia mostly belong to moist deciduous, type represented by species such as: Arjun, Sissoo, Jam, Teak, Behera, Hijli, Neem, Ghora neem, Chatim etc. The dry deciduous tracts are represented by (i) Mahua, (ii) Peasal, (iii) Sal, (iv) Teak, (v) Kendu etc. The Riverine forests have tree species intermixed with Thatch grasses, viz .. Sissoo, Simul etc. In addition to these, introduced species like Akashmoni, Subabul, Minijiri and to some extent Eucalyptus are found grown in varied soil types. The babla is found thriving well everywhere. Littoral species such as Sundari etc. are found sporadically near the clayey riverbanks due to the tidal currents that reach upto Nabadwip.

The stretches of low-lying land under rice cultivation afford a foothold for many marsh species, while the numerous ponds and ditches are filled with submerged and floating water plants. Remarkable among these for its rarity, and interesting on account of its distribution to Europe on the one hand, and to Australia on the other, is the floating *Drocera.* The edge of sluggish creeks is lined with large sedges and bulrushes, and the banks of rivers frequently have a hedge-like shrub jungle. The sides of embankments and village sites, where not occupied by human habitations, are densely covered with large growths of semi-spontaneous vegetation, often interspersed with clumps of planted bamboos, and groves of *Areca, Moringa, Mangifera,* and *Anona.* Waysides and waste places are filled with grasses and weeds, usually of little intrinsic interest, but sometimes striking because of their distribution. A large proportion of the species of this class to be met with in the district have been inadvertently introduced by human agency, and besides weeds that are indigenous in other parts of India, European, African and American species are sometimes found, which can not only hold their own vyith, but actually spread more plentifully than, similar weeds of truly Indian origin. In many places the soil does not seem to suit mango, jack and other indigenous fruit trees, and consequently the poorer classes are, in times 'of scarcity and famine, deprived of one resource which they can fall back upon in more favoured districts.

Plate 12 : Bethuaduari Wildlife Sanctuary , under Nadia-Murshidabad Forest Range.

d. Bethuaduuari Wildlife Sanctuary - Among the 14 wildlife sanctuary in West Bengal, **'Bethuadahari' wildlife sanctuary** is one of them. Nestled among the verdant farmlands and growing hamlets nearby **Bethuaduari Wildlife Sanctuary** is situated at Nakashipara Block under Police Station Nakashiapara in the District of Nadia. It came into existence once the afforestation activity was taken up on the degraded land which was a private property. It was handed over to the Forest Department, government of West Bengal during early 50's. It is 122 Km from state capital Kolkata and represents middle part of lower Gangetic basin. The tropic of cancer passes through this district. The sanctuary is very rich in biodiversity and famous for **spotted deer**. This sanctuary is 121 hectare man-made deer sanctuary, situated close to National Highway (NH) 34, linking state capital Kolkata with North Bengal and Bhutan. In recent years, widening of NH 34 accompanied by vehicle and rail transport and constructions of inhabitants in and around the forest has greatly impacted the forest ecosystem. The sanctuary has a deer park, a wetland inside and is an attractive destination of migratory birds during winter.

The present investigation reported that the major floral diversity of **'Bethuadahari Wildlife Sanctuary'** consists of sal *(Shorea robusta),* Teak (*Tectona grandis)* , Arjun (*Terminalia arjuna),* Indian rosewood (*Dalbergia sissoo),* and bamboo (*Bambusoideae).* The other species are –

Sl.No	Species *Scientific Names* (Native Name)
1	*Acacia nilotica* (Babla)
2	*Aegle marmelos* (Bael)
3	*Albizzia lebbek* (Kala Siris)
4	*Albizzia procera* (Sada Siris)
5	*Amoora wallichi* (Lali)
6	*Anona reticulate* (Atha)
7	*Artocarpus integrifolia* (Kathal)
8	*Azadirachta indica* (Neem)
9	*Baringtonia acutangula* (Hij ul)
10	*Bauhinia purpurea* (Kanj an)
11	*Bombax ceiba* (Siniul)
12	*Borassus flabellifer* (Palm)
13	*Cassia fistula* (Amalthas)
14	*Cassia siamea* (Minjiri)
15	*Cedrella toona* (Toon)
16	*Coccos nucifera* (Narkel)
17	*Cordia myxa*
18	*Dalbergia sisoo* (Sissoo)
19	*Dillenia indica* (Chalta)
20	*Emblica officinalis* (Amloki)
21	*Feronia elephantum* (Kathbael)

22	*Ficus hengalensis* (Bodh)
23	*Ficus glomerata*
24	*Ficus recemosa*
25	*Ficus religosa* (Pipul)
26	*Gmelina arborea* (Gamar)
27	*Holarrhena antidysentrica* (Kurchi)
28	*Holoptelia integrifolia* (Charla)
29	*Inca dulce* (Jelapi)
30	*Lagerstroemia hypoleuca* (Benteak)
31	*Lagerstroemia speciosa* (Jarul)
32	*Lannea indica* (Jeol)
33	*Leucaena lencocephala* (Subabul)
34	*Litsaea sp*
35	*Mangifera indica* (Am)
36	*Mitragyna parviflora* (Telekadam)
37	*Moringa oleifera* (Sajne)
38	*Oroxylem indicum* (Totola)
39	*Phoenix sytvestris* (Khajur)
40	*Polyalthea longifolia* (Ashok)
41	*Polyalthea suberosa* (Hamjam)
42	*Samanea saman* (Rain tree)
43	*Shorea robusta* (Sal)
44	*Spondias pinnato* (Amra)
45	*Streblus asper* (Sheora
46	*Syzigium cumlni* (Jamun)
47	*Tectona grandis* (Segun)
48	*Terminalia arjun* (Arjun)
49	*Trema orientalis* (Charcoal tree)
50	*Trewia nudiflora* (Pitali)
51	*Ziziphus spp*. (Kul)
52	*Abrus precatorius*
53	*Accacia concinna*
54	*Anamirta paniculata*
55	*Capparis horrid*
56	*Cryptolepis sp.*
57	*Mikanea sp.*
58	*Smilax sp.*
59	*Vitis sp.*
60	*Calotropis glgantea (Nishind)*
61	*Cassia tora*
62	*Clearodendron spp. (Vats)*
63	*Colocasia Spp. (Kochu)*
64	*Croton sparciflorus*
65	*Curcuma longa (Haldi)*

Sl No.	GRASSES
1	*Brachiaria Sp*
2	*Eleusine Sp.*
3	*Cynadon dactyl*
4	*Cynadon dactylon (doob)*
5	*Chrysopogan Sp.*
6	*Imperata Sp (Ullu ghas)*

7	*Panicum Sp*
8	*Paspalum Sp*
9	*Pennisetum Spp.*

Plate 13 – Mixed vegetation iInside Bethuaduari Wildlife Sanctuary , Nadia . Plate 10 – Riparian Grasses along Bhagirathi , near Nabadwip.

Plate 14 & 15 : Inside the Bethuaduari Wildlife Sanctuary . Nakashipara , Nadia & Murshidabad forest Range . Spotted Dears are the flagship species.

e. Medicinal Plants : From the wetlands of Nadia district as many as 42 species of angiosperms belonging to 26 families and 2 species of pteridophytes were observed which are locally used for various purposes. Of these plants, 30 species have excellent medicinal properties.

Plant Species	Vernacular Name	Uses	Abundances
Alternanthera sessilis (L) DC	Chanchi	Young shoots are nutritious. Plant galactagogue, chola-gogue, febrifuge and abortifacient. Cures indigestion.	Very common
Aponogeton natans (L.) Engleret Krause.		Tuberous rootstocks edible.	Common
Azolla pinnata R. Br.		Used as possible source of biofertilizers, rich in protein, minerals, chlorophyll and carotenoids; used as fresh green forage for cattle and poultry feed.	Very common
Centella asiatica (L.) Urb.	Thankuni	Used as an alterative, tonic and diuretic. Decoction useful in leprosy, diseases of nervous system and heart. Fried leaves used as green vegetable.	Common
Ceratophyllum demersum L.	Jhanji, Sheoyala	Used in scorpion sting and biliousness. Antipyretic, has cooling effect. Known as hyper accumulator of heavy metals.	Very common
Commelina bengalensis L.	Kanchira	Useful in leprosy, also as emollient, demulcent, refrigerant and laxative.	Very common
Commelina paludosa Bl.	Jata Kanclira	Young shoots eaten as vegetable.	Common
Cynodon dactylon (L.) Pers	Durba	Root decoction diuretic and used in secondary syphilis. Root infusion haemostatic. Plant juice astringent, useful in hysteria, epilepsy, insanity, chronic	Common
Cyperus articulatus L.		Stems woven into mats. Tubers used as tonic and stimulant and in perfumery.	Rare
Cyperus exaltatus Retz.		Stems woven into mats.	Common
Cyperus iria L.	Bara chucha	Stems used for making mats. Plants are tonic, stimulant, and stomachic, astringent.	Very common
Cyperus rotundus L.	Mutha	Rhizomes yield an essential oil which is used in perfumery, soaps and as insect repellents. Tubers diurectic, aphordisiac, astringent and stimulant.	Very common
Desmodium gangeticum (L.) DC.	Salpani	Roots and seeds febri- fuge and anticatarrhal, used in snake bite and scorpion sting and as expectorant, alterative and diuretic.	Common

Echinochloa colona (L.) Link.	Shama	Grains edible. Valued as a quickgrowing fodder grass	Common
Echinochloa crus-galli (L.) P.Beauv.	Bara shama	Grains edible. Plants used in diseases of spleen and in stopping haemorrhage.	Common
Eclipta alba (L.) Hassk.	Kesuti	Juice used along with hair oil as hair vitaliser; useul in catarrhal jaundice. Roots used externally for treating ulcers and wounds of cattle. Shoots used as a tonic and deobstruent in hepatic and spleen enlargements and in skin diseases.	Very common
Eichhornia crassipes (Mart.)Solms	Kachuripana	A scavenger of pollution by retaining heavy metals. It is a source of fish feed, compost and	Very common
Enydra fluctuans Lour	Hingcha	Leaves used as vegetable, liver tonic, laxative, anti bilious agent, demulcent and in diseases of skin and nerves.	Very common
Hydrilla verticillata (L.f.) Royle	Kaschra, Jhanji	A food for the fishes and a source of oxygen in waterbodies.	Common
Hygrophila schulli (Buch. Ham) M.R. and S.M. Almeida	Kanta kalia, Kulekhara	Leaves, seeds and roots diuretic, used in jaundice, dropsy, rheumatism and disease of the urinogenital tract; especially used in treating anaemia.	Very common
Ipomoea aquatica Forrsk.	Kalmi-lata	Young shoots used as vegetable. Juice emetic, purgative and antidote to opium and arsenic poisoning.	Very common
Ipomoea carnea Jacq. ssp. fistulosa (Mart. ex choisy) D. Austin	Dhol kalmi	Leaf juice has insecticidal properties	Very common
Limnophila indica (L.)	Karpur	Leaves eaten as vegetable; plants antiseptic and used in elephantiasis. Leaf juice used externally in fever and internally in dysentery.	Common
Marsilea minuta L.	Sushni sak	Leaves used as vegetable, sedative and in hypotensive	Very common
Merremia emarginata (Burm. f) Hallier.		Considered as diuretic and used in rheumatism and neuralgia.	Very common
Monochoria hastata (L.) Solms	Nilotpal	Leaves edible and juice used in boils. A tonic, alterative and used in insanity.	Very common
Monochoria vaginalis Pres		Root chewed in toothache, asthma, used in stomach and liver complaints. Leaves used in cough.	Common
Nelumbo nucifera Gaertn.	Padma	Leaves are used as food plates, seeds edible. Flowers are used in religious activities.	Common
Nymphaea nouchali Burm.f.	Rakto kamal	Rhizomes and seeds edible. Flowers used in worship.	Common
Nymphaea pubescens Willd	Saluk	Rhizome, stem, stalks and flowers eaten as vegetable.	Common

Nymphoides indica (L.) O.Kuntze	Panchuli, Chandmalla	Used as a substitute for chiretta, as febrifuge and in jaundice.	Very common
Ottelia alismoides (L.) Pers	Parmikalla	Leaves and petioles used as vegetable fruit edible. Plant used as a rubefacient	Very common
Pistia stratiotes L.	Khudipana	Plant used as manure, juice used in earache and ashes are applied to ringworm infection. Leaves used in eczema, leprosy, ulcer.	Very common
Polygonum barbatum L.	Bekh-unjubaz	Seeds relieve colic pain; roots act as astringent and cooling agent. Herb yields blue dye. Root-stocks used in piles, jaundice, debility and constipation.	Very common
Polygonum hydropiper L.	Pakurmul, Panimaricha	Herb decoction used as an oral contraceptive, and its infusion is used in uterine disorders. Herb gives a yellow dye and a fish poison.	Common
Polygonum orientale L.	Bara panimirich	Used as a tonic and vulnerary.	Very common
Polygonum plebeium R. Br	(Chemti sag, dubia sag)	Used in bowel disorders and in pneumonia.	Very common
Potamogeton crispus L.		Food for some water-fowls and ducks and provides shelter and Rare 38.Potamogeton crispus L. _ shade for fishes.	Rare
Ranunculus scleratus L.		Plant juice used in rheumatism, dysuria, asthma and pneumonia. Seeds used in kidney troubles	Common
Sagittaria guyanensis Kunth ssp. lappula (D. Don) Bogin.		Rhizomes eaten as vegetable.	
Sagittaria sagittifolia L.	Muyamuya, Chotokut	Rhizomes eaten as vegetable. Leaves useful in skin diseases.	Rare
Spirodela polyrrhiza (L.) Schleiden		Good source of compost. An important primary producer of water ecosystem.	Common
Trapa bispinosa Roxb.	Paniphal	Fruits edible. Kernels ground and used like cereal-flours.	Common
Typha domingensis Pers.	Hogla	Rootstock used as diuretic and astringent. Leaves used for thatching huts and fencing.	Common

Plate 16- *Typha domingensis Pers.* Hogla . 23° 8'0.56"N 88°30'8.85"E

Plate17 - *Saccharum spontaneum*
23° 0'41.45"N 88°26'22.03"E

Plate 18- *Cyperus rotundus L.*
23° 7'4.84"N 88°30'49.16"E

Plate 19- *Cyperus rotundus*
L.23°25'19.39"N 88°22'46.52"E

3.6. Fauna: At the beginning of the nineteenth century tigers were common in the more sparsely inhabited portions of the district near the Bhagirathi. A reference has been made to their depredations in the Gazetteer article on Chakdaha in the last chapter of this volume. It is, however, many years since the last of these animals disappeared, and none are now to be found nearer than in the Sundarbans.

Among lesser fauna are foxes, hares and porcupines. Monkeys (the black-faced Hanuman or langur) are numerous and destructive in the towns, especially Krishnanagar, where they cause much damage in gardens, and to the mango crop when it is ripening. Jackals are credited with carrying off about 100 infants yearly, and many cases of hydrophobia are caused by their bites. Crocodiles are fairly common, especially in the Garai and other rivers in the north of the district, and they occasionally kill human beings.

Of game-birds, the *florican* used to breed on the field of Plassey, but appears to have deserted the district during recent years. *Snipe* are very common in the south of the district during the latter part of the rains and the beginning of the cold weather. Various kinds of wild duck and other aquatic birds are found in large numbers in the east and north of the district during the cold weather, and wild geese are common in the ox-bow lakes of Bhagirathi-Hugli. A few partridge and quail are occasionally met with. Snakes are common, and account for some 400 deaths annually.

Fish abound in most of the rivers and *bil/beels/baors,* and very large catches of hilsa are made in the Bhagirathi Hugli during the rainy season, and are exported freely by rail from Damukdia, or Sara, on the opposite bank of the river.

a. Bethuadahari Wildlife Sanctuary - The WLS is situated in the Nakashipara , Nadia District, West Bengal,spread over an area of 67 hectares it was established in 1980, has a large population of Spotted deer, Jackal, Bengal fox, Porcupine, Common Langur. As per the 2011 census, it had 297 Chital (*Axis axis*) as the flagship species and has about fifty species of wildlife including Blacked napped hare (*Lepus nigricolis*) , Porcupine (*Hystrix indica*) Jackel(*Canis aureus*) Common mangoose(*Herprestris edwardsi)* Palm civet (*Paradoxorus hermaphrodites*) Jungle cat (*Felis chaus*) Common langur(*Presbytes entellus*) Monitor lizard (*Varanus bengalensis*) , Python (*Python molurus*), Krait(*Bangarus caeruleus*), Gharial (*Gavialis gangeticus*) Species of amphibians like Frogs, soft shell turtle and Cobra (*Naja naja*)

c. During our survey, we found the following birds. They are –

Sl.N	Name of the birds	Sl.N	Name of the birds
1	Barbet, Blue throated	30	Iora, Common
2	Barbet (Coppersmith)	31	Kingfisher, Br.headed, stork billed
3	Barbet, Green	32	Kingfisher, Pied.
4	Babbler, Jungle	33	Kingfisher, White - breast
5	Babbler, Common,	34	Kite, Black-winged
6	Bulbul, Red vented	35	Lapwing, Red wattled
7	Bulbul, Red whiskered	36	Magpie Robin
8	Chloropsis, Gold fronted	37	Minivet, Smal
9	Cormorant, Little	38	Myna, Common
10	Crow pheasant	39	Myna, Grey-headed
11	Cuckoo, Indian	40	Myna, Jungle
12	Dove, Emerald	41	Myna, Pied
13	Dove, Ringed	42	Nightjar, Long-tailed
14	Dove, Spotted	43	Oriole, Black-headed
15	Drongo, Bronze	44	Oriole, Golden
16	Drongo, Black	45	Owlet, Spotted
17	Egret, Large	46	Parakeet, Red-breasted
18	Egret, Small	47	Parakeet, Rose-ringed
19	Fantail, White browed	48	Pigeon, Green
20	Flycatcher, Paradise	49	Roller, Indian
21	Ground Thrush, Orange headed	50	Serpent-eagle, Crested
22	Grebe, little (Dabchick)	51	Sunbird, Purple
23	Hawk Cuckoo	52	Tailor Bird
24	Heron, Pond	53	Tit, Grey
25	Tree-pie	54	Woodpecker, Pied, Fulvous breasted,
26	Wood pecker, Lesser, golden backed	55	Coucal
27	Greater Coucal	56	Warbler
28	Open bill stork	57	Pond Heron
29	Night Heron	58	Sand Piper

Plate 20&21 : Spotted Dears and Gharial are common in the Sanctuary

Plate 22 – Bronze wing Jacana , Agrwadip Cut-Off , Nakashipara, 23°36'35.53"N 88°15'16.72"E

Plate 23 – Open Stork bill , Prachin Mayapur , along the palaeochannel of Bhagirathi 23°25'39.36"N 88°22'26.16"E

Plate 24– Pond Heron , Krishnadebpur , Nadia 23°15'16.91"N 88°21'23.42"E

Plate25 – Citrine Wagtail , Nabadwip Ghat 23°24'32.99"N 88°22'34.93"E

Plate 26 – Red Watt led lapwing , Maheshguange , Jalangi 23°25'13.31"N 88°23'59.99"E

Plate 27 – Purple Swamphen , Chakdah 23° 1'53.51"N 88°27'20.64"E

A SPECIAL REPORT ON NOACHAR

Noachar village is located in Kaliganj Tehsil of Nadia district in West Bengal, India. It is situated 20.7km away from sub-district headquarter Debagram and is in the right side of River Bhagirathi-Hugli adjoining Katwa of Purba Barddhaman District. It is named as Noachar since it is the new land which has emerged from the bed of Bhagirathi Hugli. Though it is now near to Katwa , Purnabardhaman (5 km) with the River Hugli flowing east , once it was the part of the Nadia district with the river in its west. Because of the shifting of the river, this piece of land is now located in the western bank of the river with the administrative jurisdiction under Kaliganj Block , Nadia.

Map 13 : High Resolution Image showing Noachar area

Noachar , has a huge range of wild lives starting from insects to aquatic animals. Ganesh Chowdhury , an young man is working relentlessly for saving the wildlife of the area . Being


Plate I: Smooth coated Otter, bank of the river.

a river island this area has about 1560 families mostly depending on fishing and agriculture. The fine alluvial soil is fit for any crops but the inundation of the land hampers the larger productivity. According to Ganesh Chowdhury , there are about 60 Golden Jackals in the island along with mongoose, wild cats, fishing cats etc . The reptiles consists of from monitor lizard to a varied species of snakes like Russet Viper, King Cobra etc to a larger reptiles like alligators . In the riparian zone one can find Smooth Coated Otter , Softshell Turtles , many migratory birds like little pranticoles , plovers etc. In this zone , where River Ajoy mixes up with River Ganga , a large numbers of Gangetic Dolphins congregate during breeding season . Noachar , is the wildlife hotspot and Ganesh Chowdhury is working very hard to conserve the biodiversity of this place. He has started eco tourism in his ancestral land of Noachar along the bank of River Bhagirathi Hugli , where one can enjoy the variety of wildlife.

Plate II : Noachar , adjoining a narrow creek along River Bhagirathi-Hugli

Plate III : Gangetic Dolphin , photo clicked by Ganesh Chowdhury.

When he was young, Ganesh recalls, many people revered the animal and some still do. Yet some people see those dolphins as a gold mine. River dolphins are mostly covered in blubber, which is a thick layer of fat, and the oil extracted from it is remarkably adept as bait for fish. This oil sells for anywhere between □ 150-□ 200 (£1.60 to £2.15) per litre with each dolphin carcass producing tens of litres of it. Locals also believe that the oil aids in treating inflammation and arthritis.

It is not just the oil, though. Every part of those dolphins can be sold, with the oil and marrow from its spine fetching the highest amount. Therefore, a dolphin carcass becomes an

important possession for a marginalised fisher who earns less than □ 500 (£5.40) a day. However, the Ganges river dolphin is protected under schedule 1 of the Wildlife Protection Act of India so anyone found in its violation is liable for punishment. Yet, an illegal market exists in the state because of several factors ranging from lack of awareness to economic volatility.

Plate IV : Co-existence of dolphins with the locals, Noachar. Picture Courtsey : Ganesh Chowdhury. The locals have accepted the presence of this beautiful animal in their daily chores.

Plate V: Softshell Turtle , Noachar , Nadia . Picture Credit – Ganesh Chowdhury

Plate VI: Paradise Flycatcher with babies , Noachar , Nadia. Picture credit : Ganesh Chowdhury

Noachar provides an open and natural habitat for all the beautiful birds and animals. They live freely in a protected area, uninterrupted by any external threat that might hamper their existence. Travel to Noachar to witness wildlife at its best.

Plate VII: Hoopoe is commonly found in the island.

Plate VIII : Golden Jackal of the island.

CHAPTER 4 – DOCUMENTING NATURE & PROPERTIES OF NATURAL HERITAGE

4.1. Nadia Rivers

The whole district is a net work of moribund rivers and streams, but the Bhagirathi, the Jalangi and the Matabhanga are the three which have been for more than a century, and still are distinctively known as the "Nadia Rivers." *(Map 17)* At present all the Nadia rivers may be described as offshoots of the Padma, or main channel of the Ganges, but it seems clear that at one time the Ganges found its way to the sea along the course of the Bhagirathi, and in those days, before the Padma broke its way to the eastward and intersected the drainage of the Darjeeling Himalayas, there must have been some earlier streams to carry that drainage to the sea, of which the Bhairab is said to have been one. Now-a-days, however, all the drainage of Northern Bengal is intercepted by the Padma before it reaches Nadia. In our study area we find Jalangi and Churni Rivers opening up in Bhagirathi Hugli River. So , the major tributaries of the river Bhagirathi Hugli are as follows :

A. JALANGI

The Jalangi leaves the Padma at the extreme north of the district, and after forming the greater part of the north-western boundary, passes within the district at a point some miles north of Tehata. Thence it pursues a tortuous course in a southerly direction until it reaches Krishnanagar, from which point it proceeds due west until it falls into the Bhagirathi opposite the town of Nabadwip.
(23°24'42.14"N 88°22'49.81"E)

Plate 28 – Confluence of Jalangi and Bhagirathi Hugli

Plate 29– River Jalangi confluences with River Bhagirathi Hugli near Nabadwip 23°24'42.14"N 88°22'49.81"E , Map 14 : Confluence of Jalangi River with Hugli

The Jalangi is emotionally referred to by the modern Bengali poet Jibanananda Das in his poem **abar asibo phire:**

"abar asibo ami banglar nodi math khet bhalobeshe
jalangir dheuey bheja banglar e shobuj korun dangaey"

(When again I come, smitten by Bengal's rivers and fields, to this
Green and kindly land, Bengal, moistened by the Jalangi river's waves.)

Lyricist Sagar Chattapadhyaya and folk singer Bablu Halder's song is well known regarding the Jalangi river as 'O Amar Jalangi Nadi, Tor Kolete Roilam Ami, Janamo Abodhi'

The river Jalangi is a vital part of the Ganga-Brahmaputra Delta (GBD) system. The original offtake of the river is located near a village called **Jalangi** in the eastern part of the Murshidabad district, West Bengal. The river owes its name to the village Jalangi (Rennell, 1781). The initiation of the Jalangi river could be sourced to the course of presently non-active Bhairab river, which once flowed from the Padma river (main distributary of Ganga) across the present beds of Jalangi and Mathabhanga rivers in the south easterly directions, and further eastwards towards Faridpur district of Bangladesh (Hirst, 1915). Since the main channel of Padma is shifting continuously, it might have affected the offtake of Bhairab in an adverse manner. Jalangi opened up long after the Bhairab ran as a strong stream. It is assumed that the Jalangi River opened .up at about the end o{17th century, flowing south-west into the Bhagirathi-Hugli river and cutting across the Bhairab river flowing south-east (Reaks, 1919), although there is no direct evidence of this. During the greater part of 19th century, the discharge in this river has considerably diminished due to siltation of its off take (Garrett, 1910). The original offtake of Jalangi, though presently non- functional, is found to be at the north of the Jalangi village (24°11'01"N, 88°43'15"E), where Padma river takes a perpendicular bend towards east to enter Bangladesh. After initiation, the course of the river followed south-westerly direction and formed the boundary between Murshidabad and Nadia districts. On the way, Jalangi converges with Sialmari and Bhairab (opened up during. early 20th century by capturing the upper course of-the Kalkali river} rivers. The discharge through the Bhairab course is continuous and therefore it maintains the flow of the Jalangi River after the confluence.' Jalangi, after meeting Bhairab, flows southward to enter Nadia district. It trailed in a tortuous manner towards south within Nadia until it reaches Ghurni near Krishnanagar town. From Ghurni, it proceeds due west up to Mayapur where it falls into the Bhagirathi-Hugli river (23°24'55"N, 88°23' 48"E).

Plate 30 – River Jalangi near Ghurni , 23°25'8.39"N 88°30'17.11"E

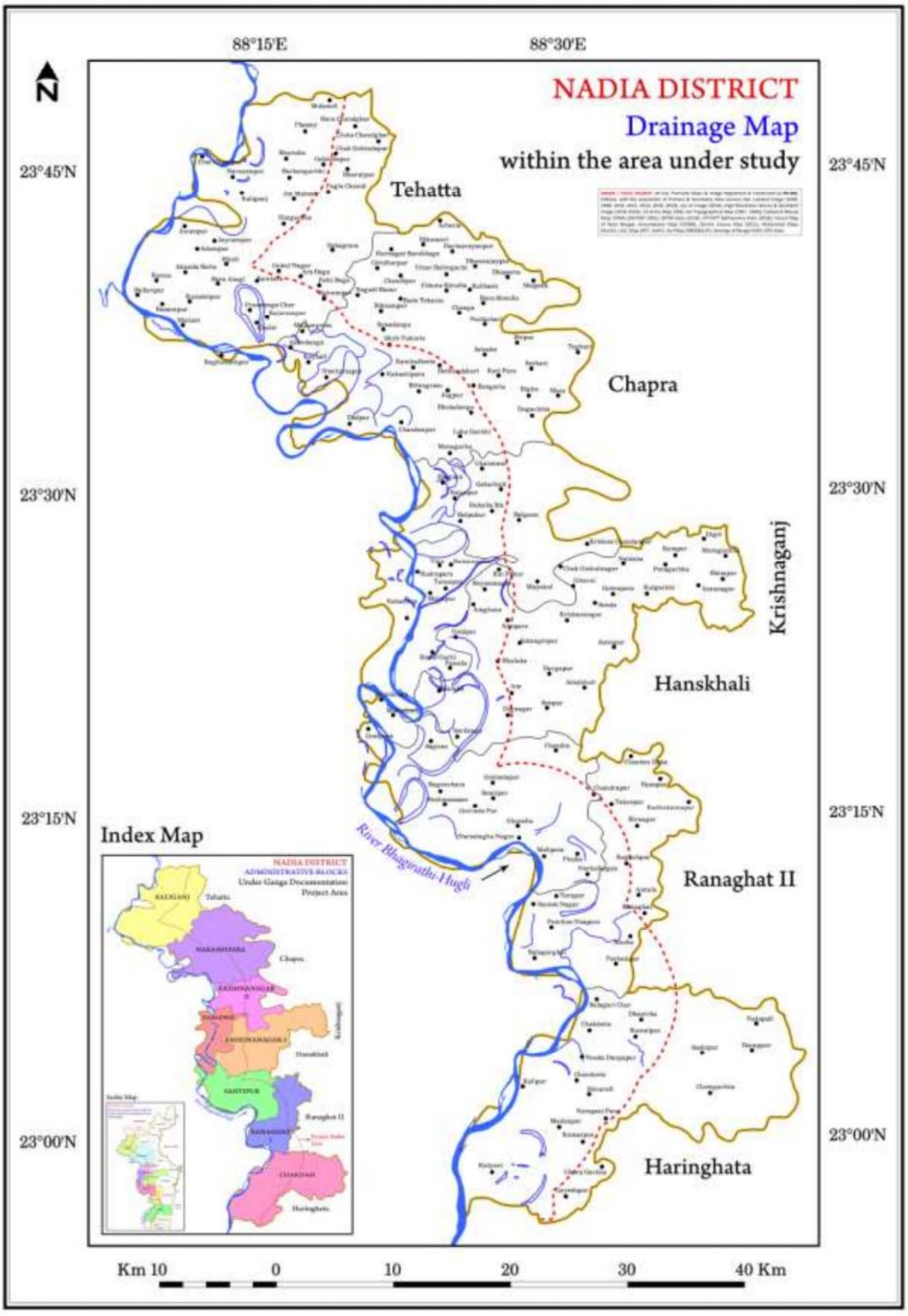
Map 15 : Satellite Image showing Ghurni near Jalangi River .

District of Bangladesh. The Mathabanga divides into two rivers, the Ichamati and the Churni near Majhdia in Nadia district .The Churni flows through Shibnivas, Hanskhali, Birnagar, Aranghata, and Ranaghat, and finally joins River Bhagirathi at Shivpur,Nadia-Hugli near Chakdaha. Its length is almost 56 kilometres (35 mi).

According to an article in the International Journal of Current Research, the river is in part the remnants of an artificial canal ordered dug by a 17th-century maharajah (king). Changes to a nearby distributary of the Jalangi River resulted partly from water diversion down the canal. Sedimentation eventually dried up the upper part of the distributary, called the Anjana, while the canal and the lower Anjana formed the **Churni**. Another name for the Churni is **Kata Khal** or "**dug river".**As recently as the 1930s, the river was an important route for water travel and trade. However, in the 21st century it has partly filled with silt, including many small islands, visible or submerged, and is no longer navigable.

Map 16– Churni River Off Take point , Ranaghat 23° 7'58.72"N 88°30'8.33"E

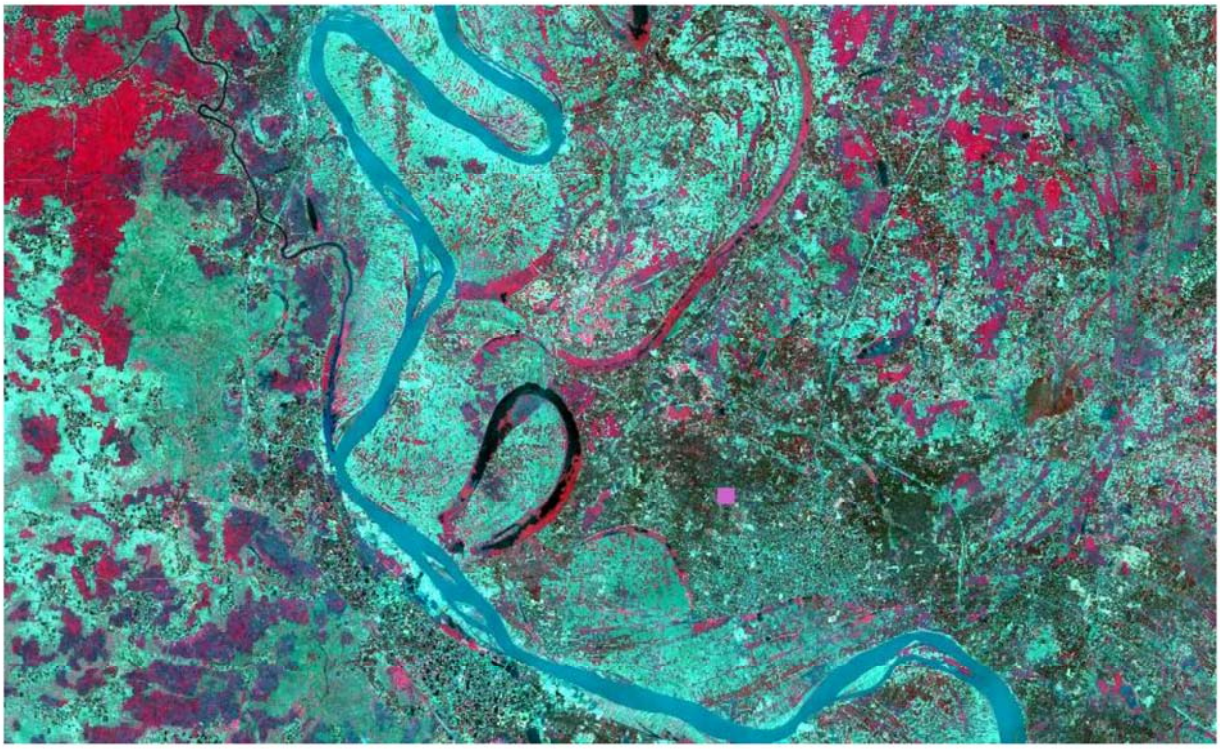
Plate 32 & 33- Churni River Off Take point , Ranaghat 23° 7'58.72"N 88°30'8.33"E



Map 17 : Drainage Map of Nadia District

4.2. FLOOD PLAIN CHARACTERISTICS: According to Leopold et al (1964), a typical floodplain will include the following: i) The river channel ii) Ox-bows or ox-bow lakes: they represent the cut-off portion of meander bends of a river. These are usually serpentine or horse-shoe shaped. iii) Point bars: These are loci of deposition on the convex side of curves in the channel. iv) Meander scrolls: Depressions and rises on the convex sides of bends formed as the channel migrates laterally down valley by the erosion of the concave bend. v) Sloughs: Area of dead water formed both in the meander scroll depressions and along the valley walls as flood flows more directly down valley scouring adjacent to the valley walls. vi) Natural levees: Raised berns or crests above the floodplain surface adjacent to the channel, usually containing coarser materials deposited as floods flow over the top of the channel banks. These are most frequently found at the concave bank and are submerged annually. They may be absent or imperceptible where most of the silt load in transit isfine grained. vii) Back swamp deposits: Over bank deposits of finer sediments deposited in slack water ponded between the natural levees and the wall or terrace riser. These are submerged for long periods of the year. viii) Sand splays: Deposits offload debris usually coarser sand particles in the form of splays or scattered debris:

Our Study Area is a classic example of floodplain having almost all the above geomorphic features. The entire stretch is characterised by Cut-offs and Meander Scrolls along with Sloughs , Natural Levees and back swamp deposits.



Map 18 : FCC Landsat , 2019 showing the scars of the PaleoChannels

A Paleochannels /Cut-offs *(Map 17*) **-** Moribund deltaic part of Nadia region possesses hydro-ecologically precious dynamic wetlands of different kinds. One of the major characteristics of this flood plain is the formation of Cut-off s and Ox bow lakes. There are 6 distinct ox bow lakes in the study area. They are as follows-

a. **Char Plassey, Kaliganj - 23°46'29.50"N 88°14'55.36"E to 23°45'24.16"N 88°14'25.38"E**. It is about 3.5 Km long and about 3 Km away from the main river. Agriculture is done along this Ox Bow Lake .

Map 19: Char Plassey

Plate 34 : Char Palashiused for cultivation and fishing

b. Chuadanga Char , Nakashipara from 23°37'13.15"N 88°14'41.51"E to 23°37'19.17"N 88°14'58.42"E. It is about 12 km loop 1 km away from the main river. This cut off is used for agriculture and fishing.

Map 20 : Chuadanga Char , Nakashipara

Plate 35 – Chuadanga Char, Nakashipara .

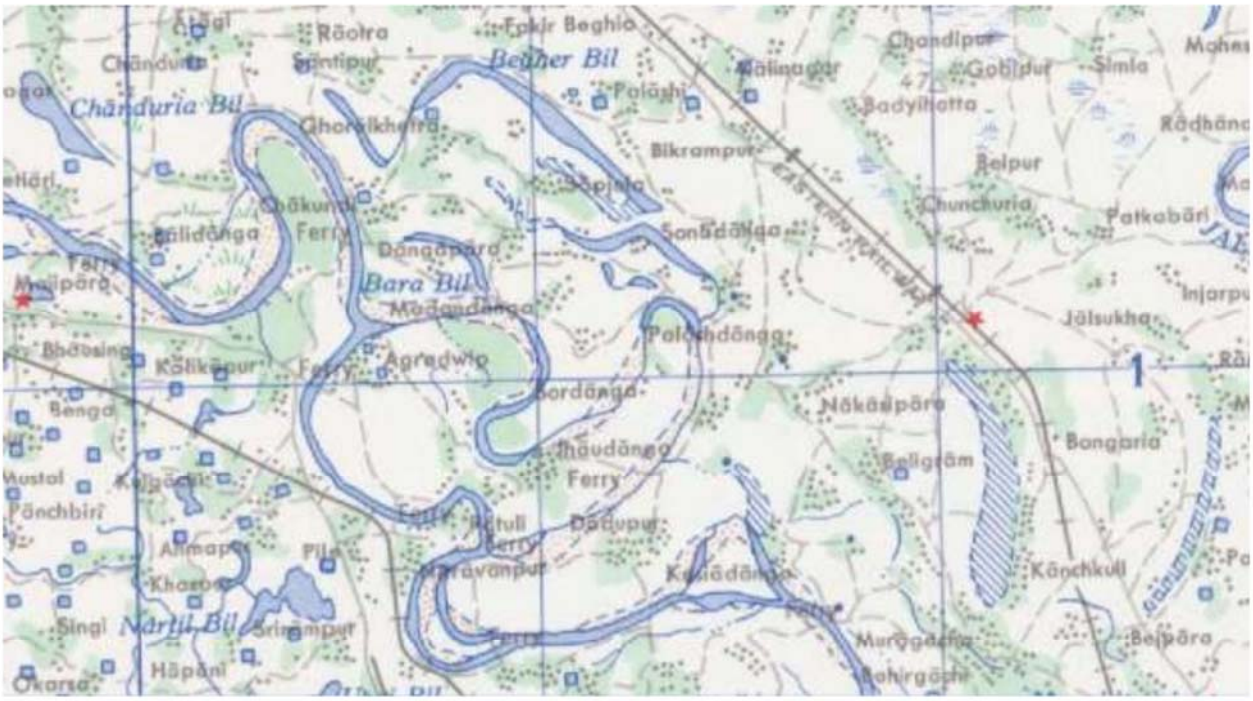
c. Agradwip Cut-off - 23°36'30.63"N 88°15'13.39"E to 23°36'6.40"N 88°15'29.28"E, Nakashipara . The loop is about 4 km and is a recent formation .Till 2016 this loop was attached with the main channel.This cut-off is used fishing and agriculture.

Map 21 A,B,C, D : Timeline series of Satellite Image showing the changing configuration of Agradwip

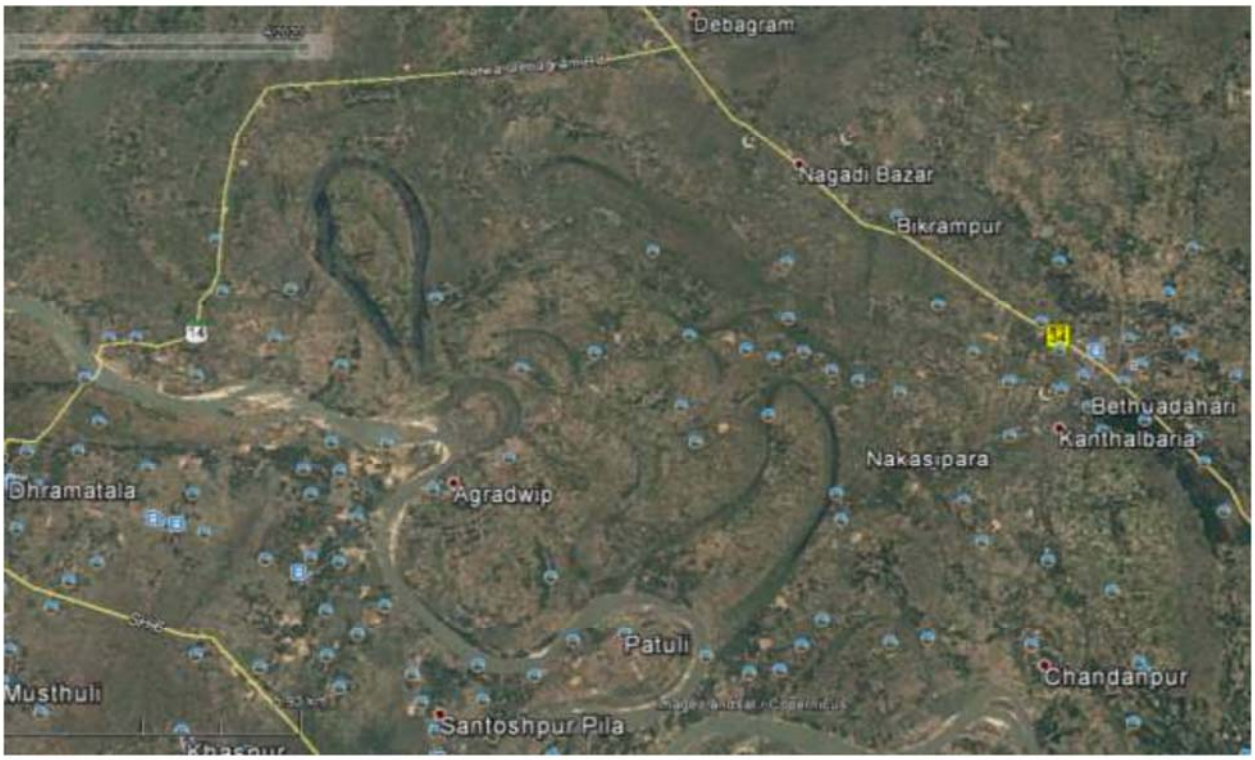
d. Nischintapur Cut-Off - 23°34'36.29"N 88°17'12.77"E to 23°34'0.53"N 88°18'34.46"E . near Bethuaduari, Nakashipara. It is about 12 km long scar of the old channel and is about 250 meters away from the main flow. The area is used for cultivation and the marsh is used for fishing.

Map 22 : Nischintapur Cut-Off

Plate 37 : Nischintapur Plains



Map 23 & 24 – US Army Map 1954 & High Resolution Image ,2020 , Flood Plain ,Nakashipara



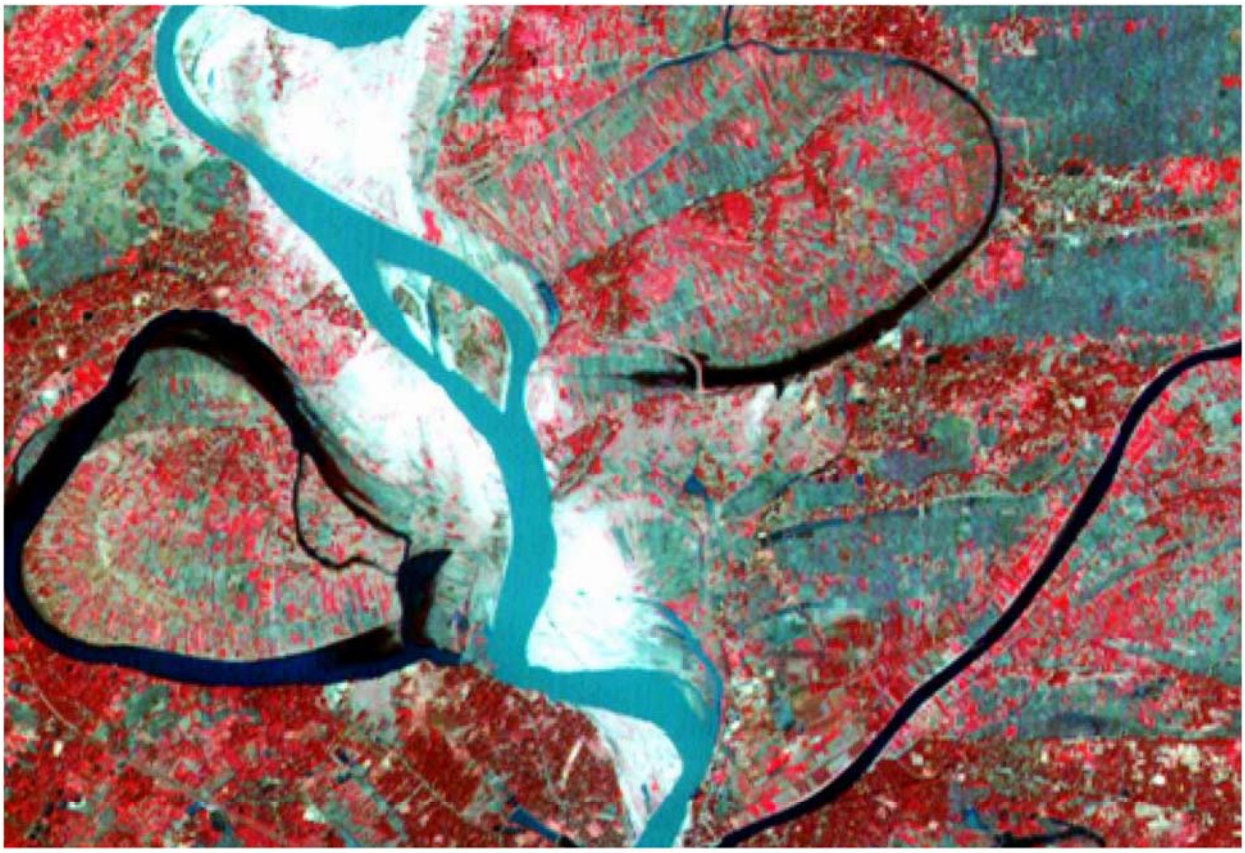
e. Krishnadebpur Cut-Off , Santipur - 23°15'12.45"N 88°21'19.62"E to 23°14'42.60"N 88°21'43.62"E . It is about 10 km in length and about 500 meter from the main river.

Map 25 & 26 : Krishnadebpur Cut-Off , Santipur , High Resolution Image , 2019 & US Army Map , 1957

Plate 38 – Krishnadevpur Cut-Off

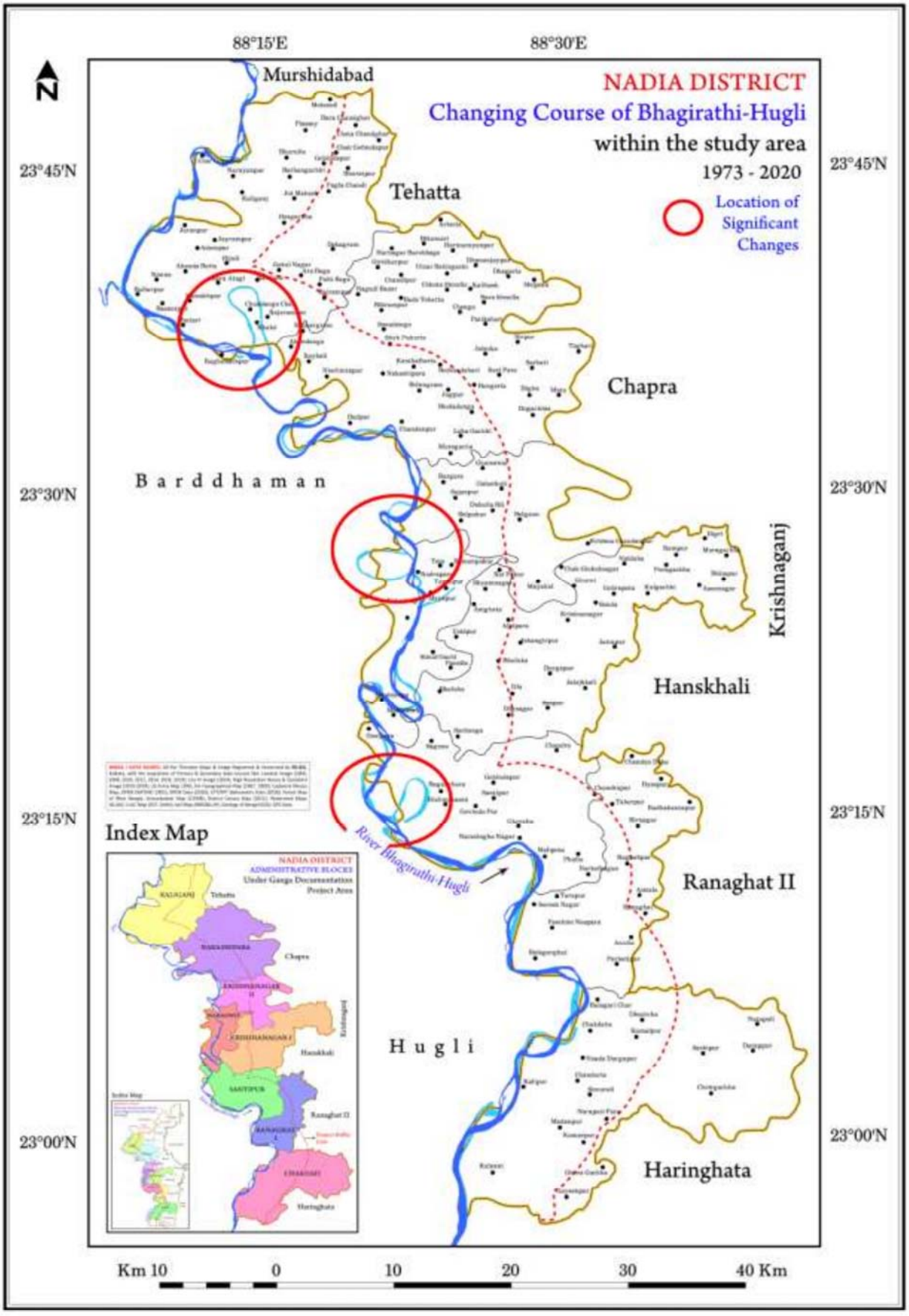
B. Shifting of the Bhagirathi river - The study area is in old stage of fluvial process. The old stage of river is characterized by the low elevation with very gentle slope of land. Meandering streams are one of the few morphological system for which an abundant historical record exists of changes of channel pattern and associated flood plain erosion and deposition (Panda and Bandyopadhyay, 2010). In this stage meander, abandoned channels oxbow lakes are developed. It's mostly flood plain area. *(Map-29)*

Map 27 : High Resolution Satellite Image showing river shifting



Map 28 – Satellite Image showing the Cut offs of Bhagirathi-Hugli River , near Nabadwip.

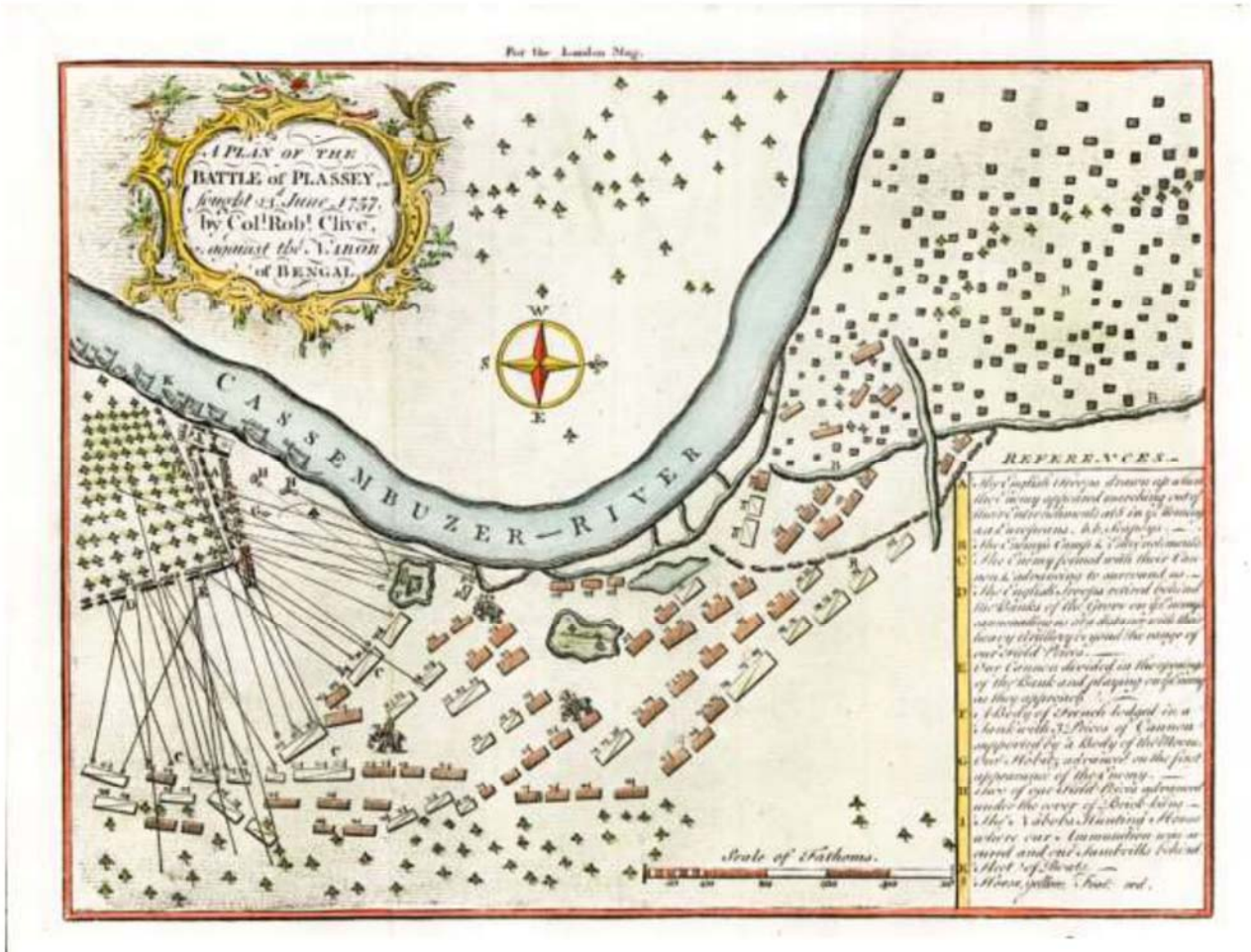
River channel migration is a natural phenomenon and related to lateral erosion across to flood plain. This process is mainly driven by combination of bank erosion and point bar deposition over time. At plain area, rivers tend to take the easiest way, the rout least resistant due to obstruction of river bed, the speed of flowing water between two banks becomes different. Now, the meandering process starts. Actually bank erosion starts the meandering formation of channel (Fridkin 1945). The low gradient, little discharge and very low stream power are main factors to transform the channel into a curvature pattern. If this curvature or sinuosity index number is more than 1.5, it's called a meandering channel (Yen, B. C.1965). Generally, due to changing course of river in different decades, the meandering loop is cut off from main channel. This cut off loop is called Ox-Bow-Lake. The channel migration and related phenomenon are very common at Hugli river basin. With the passage of time river channel migration, bank erosion, changing land-use landcovers are very common phenomenon and interconnected to each other at lower bank of Hugli River (Islam 2013). Highest sinuosity, acute meandering, paleo channel formation are also important characteristics of lower basin of River Hugli (Mallick 2016). Various changing features, different Morphometry, dissimilarity of lithology and dynamic nature and characteristics of different course of channel, are main evidences of channel shifting or channel migration. Various scholars, (Rennell 1781, Colebrooke 1779, Sherwill 1858, Hunter 1870, Hirst 1915, Mukhergee 1938, Sanyan 2008, Rudra 2010, Islam 2013, Laha 2015, Roy 2015, Mallick 2016) are associated with several Geo-morphological works related to Morph-dynamic characteristics of lower Hugli basin. Two types of avulsion are very significant in Hugli River, one is Channel shiftings mainly lateral erosion of channel and another is meandering cut-off (Schumm 1999, Sligerland and Smith 2004, Allen 1965). With the passage of time, heavy siltation occurred at Hugli's off take point. As a result in upland area, amount of discharge and carrying capacity have reduced. Movement of channel mainly depends on sediment composition, flow of water, discharge, which helps to identify proof on avulsed of channel or channel cutoff and related phenomenon (Anderson et al. 1996; Keen-Zebert et al. 2013). So, from upper to lower region of Hugli basin, channel courses has continuously changed over time since independence of India (James Rennell 1788, Fergusson 1863, Garret 1910, Hist 1915, Adams and Willams 1915).



Map 29 : Shifting of Bhagirathi Hugli , 1973-2020

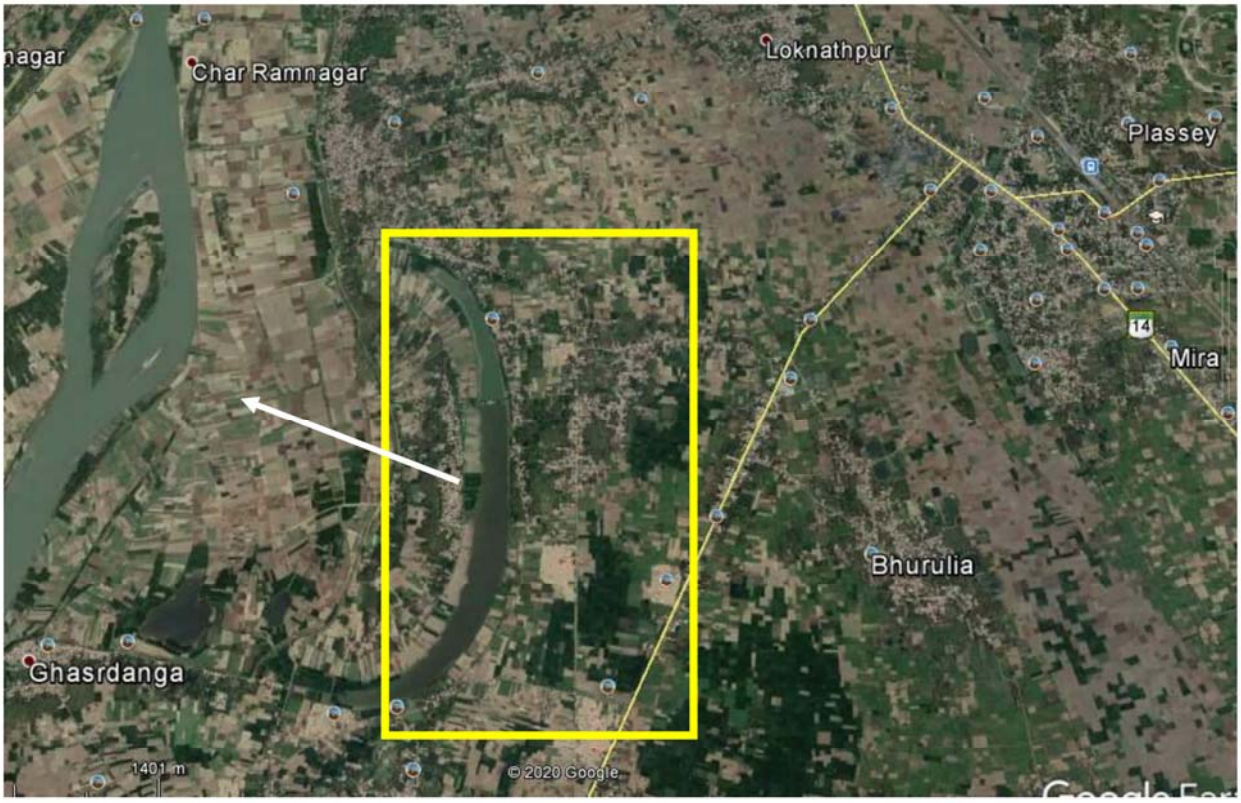
The Ganga river course shifted gradually towards east from 1977 to 2019. However in certain areas there is a significant westward shift also.Our study area starts from – Kaliganj Block (Char Ramnagar , 23°47'15.17"N 88°14'1.26"E) to Chakdah (Char Madhusudhanpur , 23° 0'19.17"N 88°25'3.71"E) covering 115 Km. Major changes in the river can be observed in – a. Plassey (23°45'23.09"N, 88°13'28.23"E) b.Nakashipara (23°34'14.71"N 88°17'50.87"E) c.Nabadwip-Krishnanagar (23°24'24.20"N 88°22'42.77"E) d.Santipur (23°14'55.45"N 88°21'1.61"E) e.Ranaghat (23° 9'33.50"N 88°27'2.06"E) and Chakdah (23° 5'0.06"N 88°29'45.21"E).

a. **Plassey** (23°45'23.09"N, 88°13'28.23"E) – Palashi or Plassey is a very significant historical place where "The Battle of Plassey" took place. It was a decisive victory of the British East India Company over a much larger force of the Nawab of Bengal and his French allies on 23 June 1757, under the leadership of Robert Clive. The battle helped the Company seize control of Bengal. Over the next hundred years, they seized control of most of the entire Indian subcontinent, Myanmar, and Afghanistan.

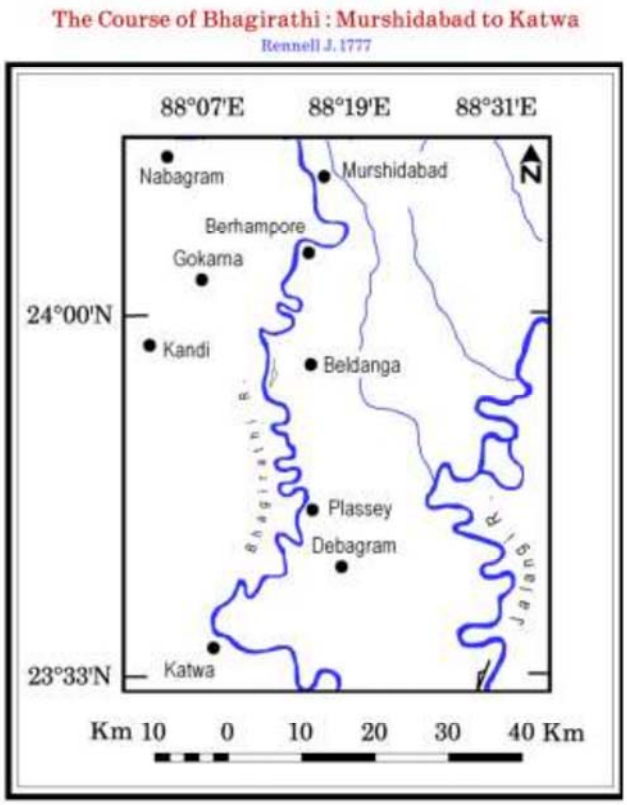


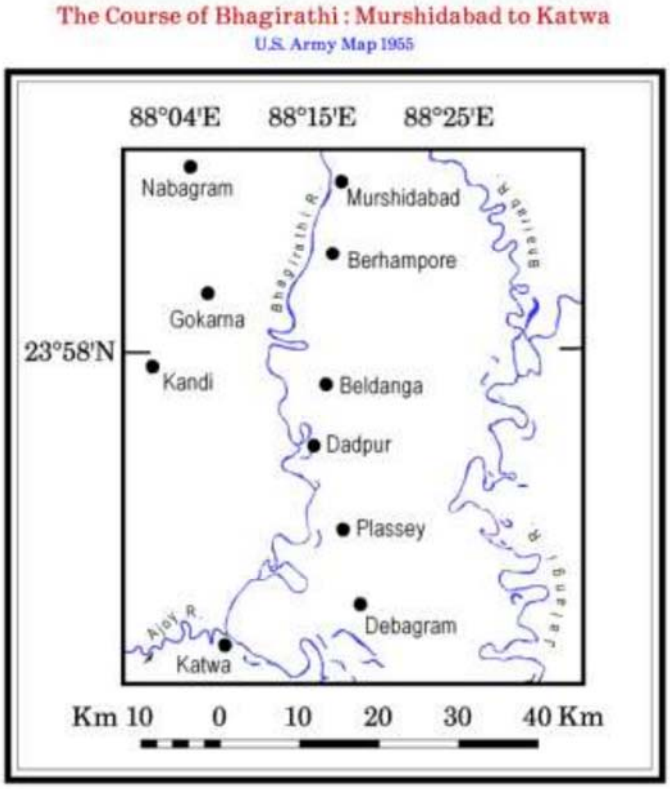
Map 30 : This battle plan was published in the London Magazine less than 3 years after the actual battle. The compass rose tells us that the map has a West orientation, meaning North is to the right. The Cossimbazar River is actually the Bhagirathi River a distributary of the Ganges. The arrow on the river shows its North-South flow. Murshidabad the capital of Bengal is about 30 miles (50km) upstream; Calcutta the English settlement is about 100 miles (160 km) downstream. The town of Plassey is immediately to the left.

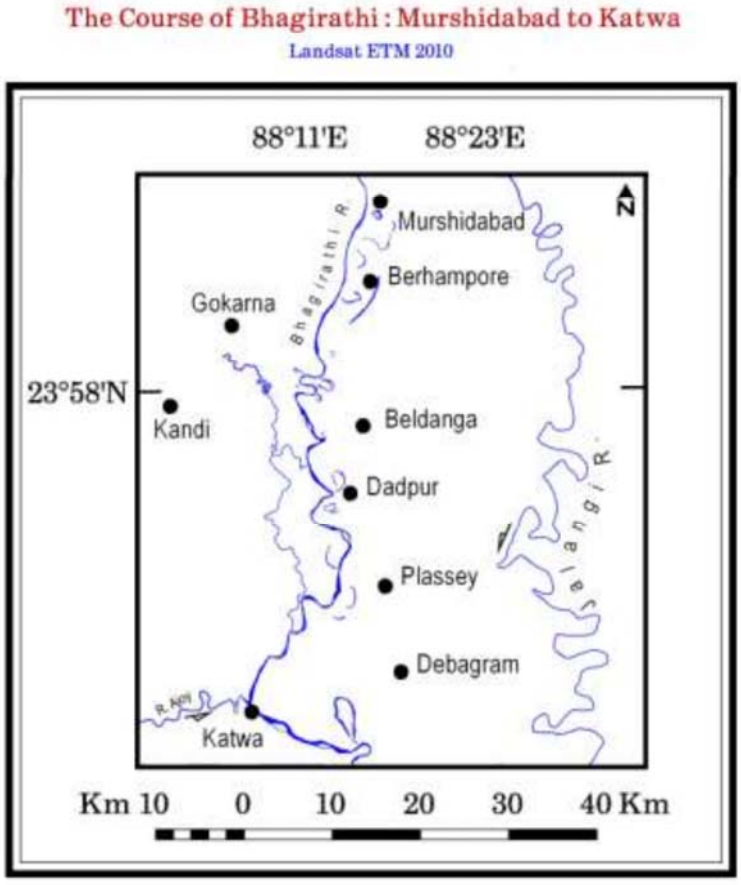
But at present the river has shifted atleast 4km from 1757. The original river side has been only a cut-off now. The present satellite imagery of the same place is shown here where the shifting is prominent.



Map 31 & Plate 39 – Battele of Plassey Ground 23°45'49.93"N 88°14'26.02"E





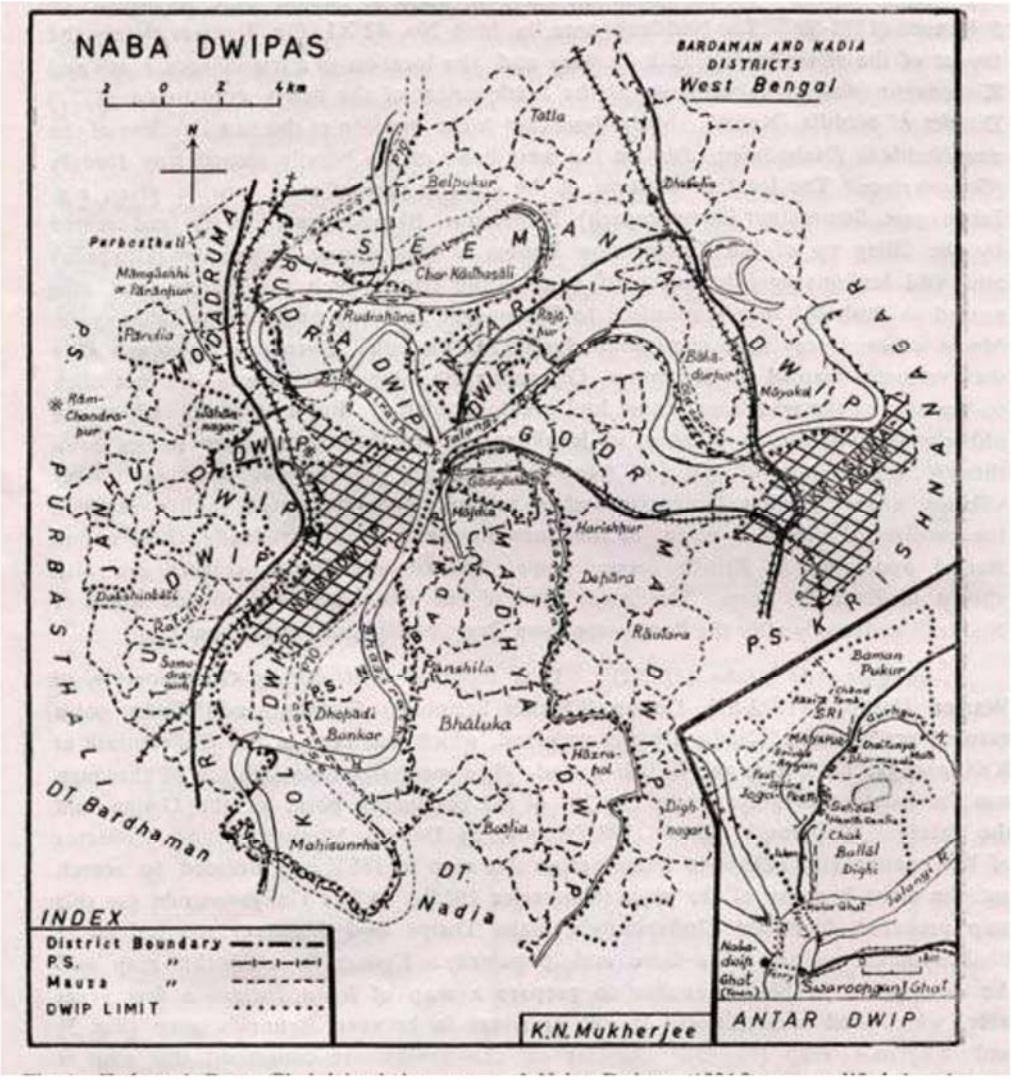


Map 32 , 33, 34 : Timeline showing course of Bhagirathi Hugli from Murshidabad to Katwa

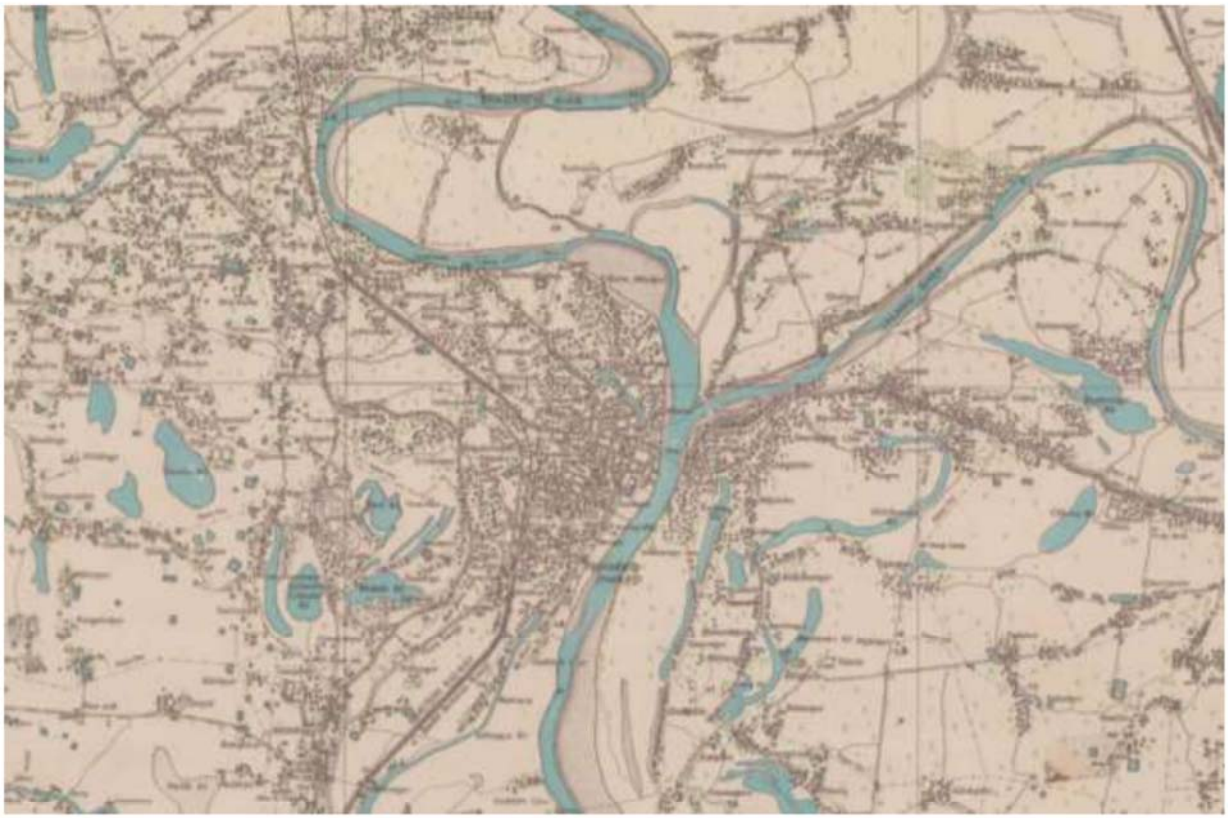
Plate40 & 41 : Portions of Bhagirathi Hugli from Nakashipara and Plassey

b. Major changes are observed near **Nabadwip- Krisnanagar**. Change of river width occurred due to shift of left bank towards east and right bank towards west direction.

According to Some Scholars, the meaning of Nabadwip is new island (dwip=island). In earlier days it was an island in the middle of Ganges surrounded by Ganges Jalangi Rivers. Later the river had changed its course and the island further. Gradually it changed into populated place that became the capital of kingdoms. The new village that was established upon the island was called 'Naba-dwip' .

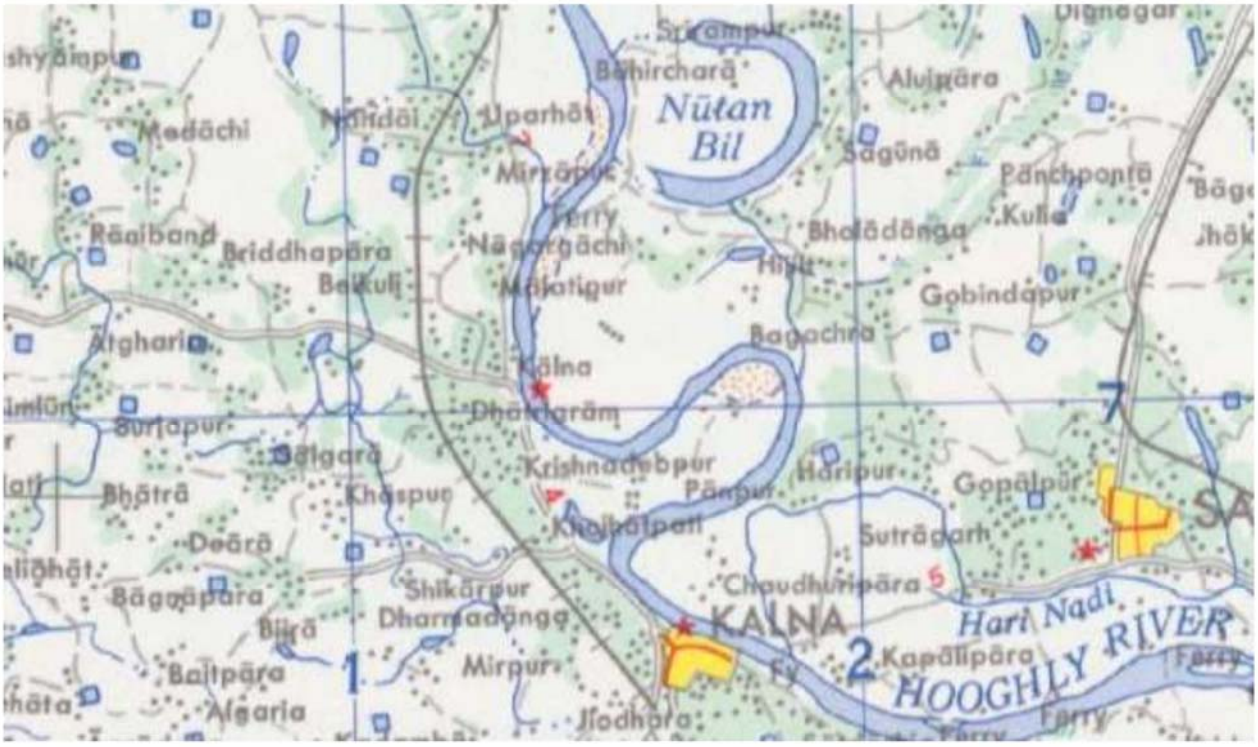


Map 35– Old Map of Nabadwip showing the confluence of Jalangi and Bhagirathi-Hugli



Map 36 & 37: SOI Map (1960)& High resolution Image (2010)showing confluence of Jalangi and Bhagirathi

c. Near **Ranaghat-Santipur**, river becomes wider near about 0.58km. The process of river course shifting and its subsequent erosion and deposition process causes simultaneously loss and newly formation of land.



Map 38 & 39 : US Army Map and High Resolution Image showing the changing river course in Ranaghat – Santipur area

The total amount of land loss is 38.88 km2 (29%) where total amount of deposition is 42.19 km2 (41%) and 6.48 km2 (5%) land is under channel bar. The channel morphology indices i.e. sinuosity index value ranges from 1.9 to 1.7 from 1977 to 2010 which actually indicates meandering stage in this area. The analysis of cut off ratio indicates near **Kaliganj,** river already cuts its course creating an ox bow lake. Near Nabadwip and Nakasipara there is high chance of river cut off. The rail way track between **Samudragarh to Kaliganj** which is parallel to the river become a high risk zone of river erosion. In this study it has been observed that the erosional and depositional process of river Bhagirathi-Hugli till continuing. It may cause severe problem in the future which can be prevented by taking proper planning and management activities in the recent years.

Map 40 – High Risk zone near Bhaluka , Ranaghat Block, 23°21'17.34"N 88°20'17.09"E

C. Bank Erosion - The erosion and deposition processes are active due to change in river course. At the bend of the river, the flowing water dashes straight into the outer bank and erodes it into a steep river cliff. The water piles up on the outside of the bend because of the centrifugal force. A bottom current is set up in a corkscrew motion and is hurled back into mid-stream and inner bank. Thus deposition occurs in the inner bank forming the very gentle slip-off slope (Morisawa, 1985). The change of areal extension occurs due to such simultaneous erosion and deposition processes.

The river Bhagirathi-Hugli, in West Bengal resorts to massive bank erosion at an alarming scale in Malda, Murshidabad, Nadia, Burdwan and Hugli and contributes to a dominant irreparable loss of farm lands of a very high quality each year. It has been estimated, that about 43% of the total geographical area of the state has been declared as flood prone. Form reports of West Bengal Irrigation Department, it has been seen that the average annual quantum of land, engulfed by the rivers in West Bengal is about 800 hectares.

Chakdah , Santipur , Nakashipara , Kaliganj Block in Nadia District is similarly hit by this environmental hazard and its associated problems of mass displacement of the poverty stricken rural population with their land, cattle, houses and other assets lost. Throughout our study area in Nadia district we find extreme cases of bank erosion as well as deposition in form of Point Bars (Chars) and Islands. Here is a documentation of the sites.

a. **Chakdah Block 23° 0'21.34"N 88°25'15.44"E (Plate 42) -** *Tarinipur, Umapur, Alaipur* and Sarati under Sarati gram panchayat, are the worst affected areas of Chakdah Block .

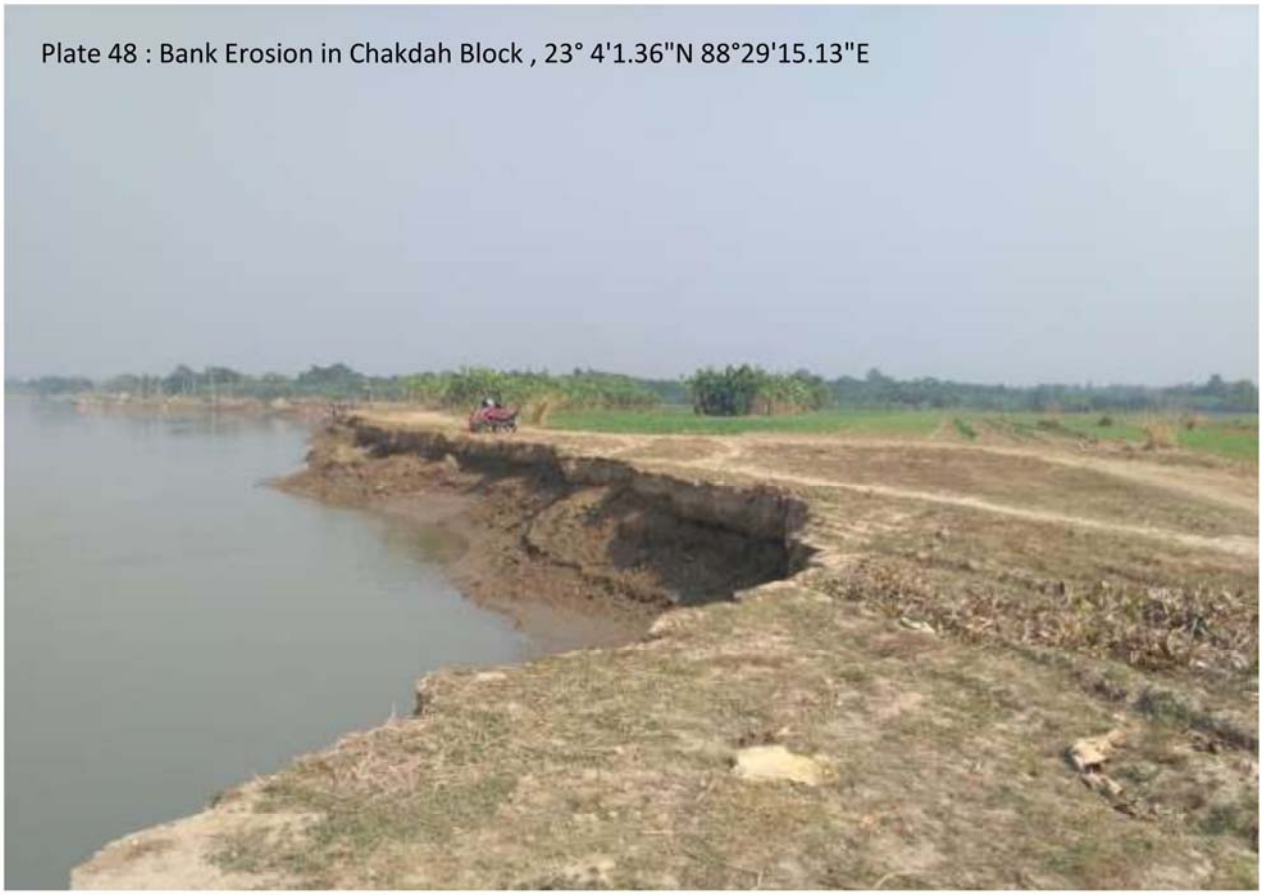
Plate 43 & 44 – Prominent bank erosion areas of Chakdah . 23° 3'9.44"N 88°27'28.23"E & 23° 3'33.89"N 88°27'28.56"E

Plate 45 : Prominent bank erosion areas of Chakdah . 23° 3'48.85"N 88°28'31.70"E

Plate 46 – Bank Erosion site in Chakdah , 23° 3'49.78"N 88°28'38.69"E

Plate 47 : Massive Bank erosion in Chakdah Block, 23° 3'46.60"N 88°28'13.95"E

Plate 48 : Bank Erosion in Chakdah Block , 23° 4'1.36"N 88°29'15.13"E



b. Santipur Block - Santipur Community Development Block, is in the Ranaghat Subdivision of Nadia District of West Bengal, India, more than 211kms downstream of Farakka Barrage, at the left bank of the river BhagirathiHugli.(The Gangs after Farakka is known as Hugli.). The river here resorts to massive bank erosion. Methidanga in Haripur Gram Panchayat and Kalna Ghat in Nrishinghapur, are the places which houses the people uprooted from their original places of residence. Since the Farakka barrage has been planted in Malda, vast parts of land downstream, gets affected by massive floods almost every year. Erosion occurs mainly through slumping and hydraulic action of the river water. While assessing the rate of bank erosion in the study area, we found that in the Kalna Ghat area, land loss is about 10 meters each year on an average and if this trend continues, then parts of Haripur constituting some 300 people will be lost within a few years, rendering them homeless. In the Gobarchar area, in the northern part, there has been an erosion of about 23.50 meters of land on an average, which if allowed to continue, shall eat up the whole Ghorolla region within just a few years. In the middle and the southern part, the rate of land loss were 44.83 meters and 21.525 meters respectively. Three villages have been submerged,

the most prominent being the Methidanga village, which can be found even in the Survey of India, topographical map of 1970. However, people have shifted themselves and named their new land Methidanga.

Plate 49 : Bank Erosion in Santipur
23°13'43.47"N 88°22'22.58"E

Plate 50– Eroded Banks near Krishndevpur , Santipur 23°13'16.44"N 88°27'57.73"E

Plate 51 : Massive Bank Erosion in 23°13'32.38"N 88°22'33.63"E

c. Palashi - 23°46'14.51"N 88°14'5.61"E , Char Palashiarea along River Bhagirathi Hugli.**(Plate -52 & 53)**

d. Nakashipara - 23°34'15.79"N, 88°17'44.78"E , near Jhaudanga Village. **(Plate -54)**

d. Nakashipara - 23°33'39.12"N 88°18'9.57"E, Patuli Ghat area . **(Plate 55)**

4.3. WATERBODIES

There are innumerable waterbodies in the entire study area, mostly comprised of Ox-Bow Lakes, remnants of PaleoChannels and some aquaculture and brick kiln ponds. The Waterbodies are mostly used for fishing, irrigating cultivated lands and domestic purposes. Block wise we have listed the following .

Sl. No	Block	Location		Type	Purpose	Condition
		Latitude	Longitude			
1	Chakdah Block	23° 0'59.50"N	88°27'1.32"E	Pond	Cultivation	Regular
2		23° 0'58.84"N	88°27'1.51"E			
3		23° 0'46.65"N	88°27'20.25"E			
4		23° 0'52.98"N	88°27'24.52"E			
5		23° 0'57.43"N	88°27'23.84"E			
6		23° 1'6.74"N	88°27'21.61"E	PaleoChannel	Fishing Cultivation	Congested
7		23° 1'10.75"N	88°27'20.43"E			
8		23° 1'19.46"N	88°27'19.72"E			
9		23° 1'26.19"N	88°27'20.37"E			
10		23° 1'35.27"N	88°27'20.20"E			
11		23° 1'42.64"N	88°27'19.62"E			
12		23° 1'32.67"N	88°27'26.36"E	Pond	Cultivation	Regular
13		23° 1'29.11"N	88°27'28.74"E			
14		23° 1'7.35"N	88°27'23.55"E			
15		23° 1'7.59"N	88°26'56.58"E			
16		23° 0'52.56"N	88°27'56.35"E			
17		23° 1'1.81"N	88°27'58.22"E			
18		23° 0'42.68"N	88°28'18.46"E			
19		23° 0'36.34"N	88°28'6.15"E			
20		23° 0'26.71"N	88°28'12.07"E			
21		23° 0'45.31"N	88°28'12.50"E			
22		23° 0'10.61"N	88°27'39.35"E			
23		22°59'28.48"	88°27'24.48"E			
24		22°59'8.35"	88°27'32.28"E			
25		22°59'38.57"	88°27'9.76"E			
26		22°59'41.95"	88°26'54.32"E			
27		22°59'57.61"	88°27'0.00"E			
28		22°59'59.21"	88°26'34.05"E			
29		23° 0'24.61"N	88°26'31.97"E			
30		23° 0'34.22"N	88°26'32.20"E			
31		23° 0'1.98"N	88°27'35.97"E			
32		23° 0'0.65"N	88°27'41.21"E			
33		23° 0'4.00"N	88°27'47.43"E			
34		22°59'53.06"	88°27'44.99"E			
35		22°59'56.78"	88°27'47.19"E			
36		22°59'50.30"	88°27'44.92"E			
37		23° 0'38.38"N	88°29'36.44"E		Cultivation & Fishing	Congested
38	Chakdah Block	23° 1'20.91"N	88°29'7.10"E	PaleoChannel		
39		23° 1'31.47"N	88°29'14.99"E			
40		23° 1'38.93"N	88°29'20.90"E			
41		23° 1'50.93"N	88°29'24.77"E	Pond	Cultivation	Regular
42		23° 2'1.02"N	88°29'23.97"E		Cultivation	Regular
43		23° 1'26.26"N	88°29'24.91"E		Cultivation	Regular
44		23° 1'13.77"N	88°29'15.92"E		Cultivation	Regular

45		23° 1'3.84"N	88°29'15.79"E		Cultivation	Regular
46		23° 0'53.20"N	88°29'16.57"E		Cultivation	Regular
47		23° 0'51.27"N	88°29'26.28"E		Cultivation	Regular
48		23° 0'34.15"N	88°29'19.86"E		Cultivation	Regular
49		23° 0'23.30"N	88°29'18.54"E		Cultivation	Regular
50		23° 0'17.70"N	88°29'30.78"E		Cultivation	Regular
51		23° 8'12.65"N	88°28'56.56"E		Cultivation	Regular
52		23° 8'7.52"N	88°29'15.15"E		Cultivation	Regular
53		23° 8'20.00"N	88°29'5.07"E		Cultivation	Regular
54		23° 8'17.61"N	88°28'58.39"E		Cultivation	Regular
55		23° 8'49.76"N	88°28'37.12"E		Cultivation	Regular
56		23° 8'39.58"N	88°30'2.46"E		Cultivation	Regular
57		23° 8'33.00"N	88°29'54.59"E		Cultivation	Regular
58		23° 8'44.90"N	88°29'50.13"E		Cultivation	Regular
59		23° 7'43.77"N to 23° 8'17.75"N	88°31'15.45"E to 88°30'59.41"E	PaleoChannel	Cultivation & Fishing	Congested
60					Cultivation & Fishing	
61		23° 8'18.93"N	88°31'14.79"E	PaleoChannel	Cultivation & Fishing	Congested
62		23° 7'44.14"N	88°30'45.30"E	PaleoChannel	Cultivation & Fishing	Congested
63		23° 7'49.64"N	88°30'48.77"E	PaleoChannel	Cultivation & Fishing	Congested
64		23° 7'40.09"N	88°30'58.73"E	PaleoChannel	Cultivation & Fishing	Congested
65	**Ranaghat Block**	23° 7'54.74"N To 23° 8'26.60"N	88°31'10.14"E To 88°30'26.77"E	PaleoChannel	Cultivation & Fishing	Congested
66				PaleoChannel	Cultivation & Fishing	Congested
67		23° 8'10.96"N	88°30'21.36"E		Cultivation	Regular
68		23° 8'18.24"N	88°30'19.77"E		Cultivation	Regular
69		23° 7'22.23"N	88°31'1.50"E		Cultivation	Regular
70		23° 7'20.26"N	88°30'56.30"E		Cultivation	Regular
71		23° 7'28.40"N	88°30'54.66"E		Cultivation	Regular
72		23° 7'42.26"N	88°30'58.81"E		Domestic	Regular
73		23° 8'43.06"N	88°30'49.13"E		Domestic	Regular
74		23° 9'11.01"N	88°30'27.49"E		Domestic	Regular
75		23° 9'16.22"N	88°30'16.01"E	Pond	Domestic	Regular
76		23° 8'59.93"N	88°30'26.08"E		Cultivation	Regular
77		23° 8'22.26"N	88°30'30.51"E		Cultivation	Regular
78		23° 8'12.89"N	88°30'42.21"E		Cultivation	Regular
79		23° 7'49.89"N	88°30'48.36"E		Cultivation	Regular
80		23° 7'30.96"N	88°31'18.25"E		Cultivation	Regular
81		23° 7'22.03"N	88°31'33.88"E		Cultivation	Regular
82		23° 6'43.57"N	88°31'42.62"E		Cultivation	Regular
83		23° 7'5.31"N	88°32'3.08"E		Cultivation	Regular
84		23° 7'51.06"N	88°32'43.20"E		Cultivation	Regular
85		23° 7'57.94"N	88°32'11.01"E		Cultivation	Regular
86		23° 7'49.13"N	88°32'25.96"E		Cultivation	Regular
87		23° 7'27.31"N	88°32'39.37"E		Cultivation	Regular
88		23° 7'19.41"N	88°32'45.40"E		Cultivation	Regular
89		23° 7'11.89"N	88°33'10.57"E	Pond	Cultivation	Regular
90		23° 9'15.92"N	88°29'56.25"E		Cultivation	Regular
91		23° 9'16.07"N	88°29'37.15"E		Cultivation	Regular
92		23° 9'28.81"N	88°29'36.62"E		Cultivation	Regular
93		23° 9'29.68"N	88°29'29.16"E		Cultivation	Regular
94		23° 9'52.93"N	88°29'22.61"E			Regular

95		23°10'24.58"N to 23°10'58.09"N	88°29'42.77"E to 88°31'24.33"E	PaleoChannel	Cultivation & Fishing	Regular
96					Cultivation & Fishing	Regular
97		23°11'10.20"N to 23°11'41.39"N	88°31'46.55"E to 88°29'31.35"E	PaleoChannel	Cultivation & Fishing	Regular
98	**Santipur Block**	23°11'34.19"N	88°28'52.65"E	PaleoChannel	Cultivation & Fishing	Congested
99		23°11'34.08"N	88°28'46.33"E	PaleoChannel	Cultivation & Fishing	Congested
100		23°11'32.24"N	88°28'38.04"E	PaleoChannel	Cultivation & Fishing	Congested
101		23°11'38.94"N	88°29'7.34"E	PaleoChannel	Cultivation & Fishing	Congested
102		23°13'10.41"N	88°29'6.77"E	Pond	Cultivation	Regular
103		23°13'45.27"N	88°29'23.39"E	Pond	Cultivation	Regular
104		23°14'23.79"N	88°27'39.10"E	Pond	Cultivation	Regular
105		23°14'27.13"N	88°27'26.50"E	Pond	Cultivation	Regular
106		23°14'23.44"N	88°27'12.66"E	Pond	Cultivation	Regular
107		23°14'13.55"N	88°26'56.67"E	Pond	Cultivation	Regular
108		23°14'29.18"N	88°26'54.37"E	Pond	Cultivation	Regular
109		23°14'1.95"N	88°26'23.75"E	Pond	Domestic	Regular
110		23°13'57.98"N	88°26'17.24"E	Pond	Domestic	Regular
111		23°13'27.89"N	88°26'8.63"E	Pond	Domestic	Regular
112		23°14'1.40"N	88°25'21.35"E	Pond	Cultivation	Regular
113		23°14'9.71"N	88°24'56.60"E	Pond	Cultivation	Regular
114		23°12'58.28"N to 23°13'31.16"N	88°24'33.30"E to 88°22'32.69"E	PaleoChannel	Cultivation & Fishing	Congested
115					Cultivation & Fishing	Congested
116		23°14'19.92"N to 23°13'37.43"N	88°22'8.25"E to 88°22'32.13"E	PaleoChannel	Cultivation & Fishing	Congested
117		23°14'44.92"N To 23°15'10.21"N	88°21'32.69"E to 88°21'14.76"E	PaleoChannel	Cultivation & Fishing	Congested
118		23°16'35.12"N	88°23'2.60"E	Pond	Cultivation	Regular
119		23°16'42.26"N	88°23'22.91"E	Pond	Cultivation	Regular
120		23°16'25.06"N	88°23'32.61"E	Pond	Cultivation	Regular
121		23°16'43.02"N	88°23'23.82"E	Pond	Cultivation	Regular
122		23°17'1.72"N	88°23'58.05"E	Pond	Cultivation	Regular
123		23°17'8.95"N	88°24'31.63"E	Pond	Cultivation	Regular
124		23°17'41.11"N	88°24'39.52"E	Pond	Cultivation	Regular
125		23°17'24.24"N to 23°17'17.21"N	88°22'13.37"E to 88°21'48.32"E	PaleoChannel	Cultivation & Fishing	Congested
126		23°17'7.87"N	88°21'27.81"E	Pond	Cultivation & Fishing	Congested
127		23°17'12.36"N	88°21'16.04"E	Pond	Cultivation & Fishing	Congested
128		23°17'36.43"N	88°21'29.67"E	Pond	Cultivation & Fishing	Congested
129		23°17'11.68"N	88°20'52.55"E	Pond	Cultivation & Fishing	Congested
130		23°15'33.82"N	88°21'2.03"E	Pond	Cultivation & Fishing	Congested
131		23°17'8.21"N	88°22'46.98"E	PaleoChannel	Cultivation &	Congested

		to 23°21'28.40"N	to 88°24'42.70"E		Fishing	
132		23°21'11.18"N	88°23'53.66"E	Pond	Drinking (Phed)	Congested
133		23°20'31.58"N	88°23'1.09"E	Pond	Drinking	Regular
134		23°20'51.79"N	88°23'50.78"E	Pond	Domestic	Regular
135		23°21'22.61"N	88°23'18.69"E	Pond	Domestic	Regular
136		23°22'15.71"N to 23°23'1.99"N	88°23'0.03"E to 88°23'31.67"E	PaleoChannel	Fishing	Congested
137		23°23'27.67"N	88°23'11.22"E	PaleoChannel	Fishing	Congested
138		23°23'40.08"N To 23°24'29.00"N	88°23'27.38"E to 88°25'2.92"E	PaleoChannel	Fishing	Congested
139		23°24'36.18"N	88°24'38.96"E	Reservoir	Domestic	Congested
140		23°24'34.08"N	88°24'27.86"E	Pond	Domestic	Congested
141		23°24'51.23"N	88°24'9.76"E	Pond	Domestic	Congested
142		23°25'5.11"N	88°24'13.25"E	Pond	Domestic	Congested
143		23°25'13.96"N	88°24'19.51"E	Pond	Domestic	Congested
144		23°25'9.00"N	88°24'3.06"E	Pond	Domestic	Congested
145		23°25'0.90"N	88°23'54.68"E	Pond	Domestic	Congested
146		23°24'57.14"N	88°23'41.74"E	Pond	Domestic	Regular
147		23°24'50.19"N	88°23'27.89"E	Pond	Domestic	Regular
148		23°24'51.08"N	88°23'21.83"E	Pond	Domestic	Regular
149		23°24'33.62"N	88°23'16.85"E	Pond	Domestic	Regular
150		23°24'34.92"N	88°23'12.96"E	Pond	Domestic	Regular
151		23°24'46.92"N	88°23'15.71"E	Pond	Cultivation	Regular
152		23°24'47.14"N	88°23'9.95"E	Pond	Cultivation	Regular
153		23°24'42.36"N	88°23'6.07"E	Pond	Cultivation	Regular
154		23°24'51.06"N	88°23'27.34"E	Pond	Cultivation	Regular
155		23°24'52.82"N	88°23'49.59"E	Pond	Cultivation	Regular
156		23°25'8.50"N	88°24'4.00"E	Pond	Cultivation	Regular
157		23°25'18.07"N	88°24'24.12"E	Pond	Cultivation	Regular
158		23°25'8.99"N	88°24'39.14"E	Pond	Cultivation	Regular
159		23°25'25.19"N	88°24'58.04"E	Pond	Cultivation	Regular
160		23°17'39.77"N	88°21'40.20"E	Pond	Cultivation	Regular
161		23°17'16.43"N	88°21'13.87"E	Pond	Cultivation	Regular
162		23°17'11.41"N	88°21'33.48"E	Pond	Cultivation	Regular
163		23°17'6.55"N	88°22'4.88"E	Pond	Cultivation	Regular
164		23°23'17.97"N to 23°23'45.36"N	88°21'40.76"E to 88°21'58.80"E	Pond	Cultivation	Regular
165		23°23'56.53"N	88°22'12.22"E	Aquaculture	Fishing	
166		23°24'1.16"N	88°22'19.05"E	Aquaculture	Fishing	Regular
167		23°24'10.76"N	88°22'17.60"E	Aquaculture	Fishing	Regular
168		23°24'1.38"N	88°22'23.73"E	Aquaculture	Fishing	Regular
169		23°24'11.92"N	88°22'17.74"E	Aquaculture	Fishing	Regular
170		23°23'57.31"N	88°22'8.36"E	Aquaculture	Fishing	Regular
171		23°23'45.65"N to 23°22'56.68"N	88°21'59.09"to E 88°21'21.90"E	PaleoChannel	Cultivation & Fishing	Congested
172		23°22'39.58"N	88°21'21.17"E	Pond	Cultivation & Fishing	Congested
173		23°22'18.50"N	88°21'3.73"E	Pond	Cultivation & Fishing	Congested
174		23°22'4.38"N	88°21'11.50"E	Pond	Cultivation & Fishing	Congested

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175		23°23'36.88"N	88°21'43.77"E	Pond	Cultivation & Fishing	Congested
176		23°24'41.88"N to 23°25'7.11"N	88°22'30.12"E to 88°22'1.42"E	PaleoChannel	Cultivation & Fishing	Congested
177		23°25'36.19"N	88°21'43.83"E	Pond	Cultivation	Regular
178		23°25'0.51"N	88°21'35.56"E	Pond	Cultivation	Regular
179		23°24'34.97"N	88°21'37.55"E	Pond	Cultivation	Regular
180		23°23'56.84"N	88°21'27.93"E	Pond	Cultivation	Regular
181		23°24'37.88"N	88°22'11.21"E	Pond	Cultivation	Regular
182		23°25'27.64"N	88°23'18.44"E	Pond	Cultivation	Regular
183		23°25'46.39"N	88°23'56.01"E	Pond	Cultivation	Regular
184		23°25'24.18"N	88°24'0.77"E	Pond	Cultivation	Regular
185		23°25'6.49"N	88°23'42.56"E	Pond	Cultivation	Regular
186		23°25'28.77"N	88°23'31.52"E	Pond	Cultivation	Regular
187		23°25'25.90"N	88°23'17.80"E	Pond	Cultivation	Regular
188		23°25'25.22"N	88°23'5.85"E	Pond	Cultivation	Regular
189		23°25'51.45"N	88°24'29.15"E	Pond	Cultivation	Regular
190		23°27'5.64"N to 23°28'38.56"N	88°23'37.78"E to 88°23'54.90"E	PaleoChannel	Cultivation & Fishing	Regular
191		23°28'11.90"N	88°22'6.92"E	Pond	Cultivation & Fishing	Regular
192	**Nakashi para**	23°29'0.02"N	88°22'44.65"E	Pond	Cultivation & Fishing	Congested
193		23°27'2.28"N to 23°28'34.90"N	88°23'33.58"E to 88°24'9.44"E	PaleoChannel	Cultivation & Fishing	Congested
194		23°28'55.81"N to 23°30'6.03"N	88°23'44.40"E to 88°25'12.51"E	PaleoChannel	Cultivation & Fishing	Congested
195		23°29'39.70"N to 23°30'34.72"N	88°23'28.99"E to 88°23'44.45"E	PaleoChannel	Cultivation & Fishing	Congested
196		23°29'32.97"N to 23°30'3.47"N	88°22'58.19"E to 88°23'2.26"E	PaleoChannel	Cultivation & Fishing	Congested
197		23°30'34.47"N to 23°31'52.41"N	88°23'15.25"E to 88°22'26.20"E	PaleoChannel	Cultivation & Fishing	Congested
198		23°33'9.14"N to 23°33'59.18"N	88°22'18.32"E to 88°21'47.35"E	PaleoChannel	Cultivation & Fishing	Congested
200		23°33'59.78"N to 23°34'21.71"N	88°22'18.98"E to 88°21'19.64"E	PaleoChannel	Cultivation & Fishing	Congested
201	**Nakashi para**	23°33'57.26"N to 23°35'7.76"N	88°20'46.00"E to 88°20'1.19"E	PaleoChannel	Cultivation & Fishing	Congested
202		23°34'24.89"N to 23°35'23.81"N	88°18'53.78"E to 88°18'44.36"E	PaleoChannel	Cultivation & Fishing	Congested
203		23°34'59.02"N To 23°35'34.45"N	88°17'50.37"E to 88°17'39.43"E	PaleoChannel	Cultivation & Fishing	Congested
204		23°36'45.75"N to 23°37'22.96"N	88°16'50.55"E to88°15'48.72"E	PaleoChannel	Cultivation & Fishing	Congested
205		23°36'30.33"N to 23°36'4.87"N	88°15'13.19"E 88°15'33.91"E	PaleoChannel	Cultivation & Fishing	Congested

206		23°37'0.08"N to 23°37'33.99"N	88°14'50.84"E to 88°14'57.75"E	PaleoChannel	Cultivation & Fishing	Congested
207		23°37'21.45"N to 23°36'41.53"N	88°15'47.83"E to 88°16'50.58"E	PaleoChannel	Cultivation & Fishing	Congested
208		23°37'11.74"N	88°17'46.83"E	Pond	Cultivation	Congested
209		23°37'47.25"N	88°17'33.85"E	Pond	Cultivation	Congested
210		23°38'2.47"N	88°17'37.62"E	Pond	Cultivation	Congested
211		23°38'0.83"N	88°18'0.11"E	Pond	Cultivation	Congested
212		23°38'7.01"N	88°17'36.13"E	Pond	Cultivation	Regular
213		23°39'8.21"N 23°39'9.83"N	88°17'34.07"E to 88°16'8.38"E	Pond	Cultivation	Regular
214		23°38'40.50"N	88°15'21.51"E	Pond	Cultivation	Regular
215		23°38'30.94"N	88°15'28.61"E	Pond	Cultivation	Regular
216		23°38'53.91"N	88°15'14.09"E	Pond	Cultivation	Regular
217		23°39'20.31"N	88°15'24.22"E	Pond	Cultivation	Regular
218		23°39'33.39"N	88°15'19.27"E	Pond	Cultivation	Regular
219		23°39'35.98"N	88°15'8.27"E	Pond	Cultivation	Regular
220	**Kaliganj1**	23°39'54.90"N	88°15'9.70"E	Pond	Cultivation	Regular
221		23°40'3.38"N	88°14'36.65"E	Pond	Cultivation	Regular
222		23°39'9.62"N	88° 8'41.07"E	Pond	Cultivation	Regular
223		23°39'2.53"N	88° 9'9.96"E	Pond	Cultivation	Regular
224		23°39'8.95"N	88° 9'13.80"E	Pond	Cultivation	Regular
25		23°39'21.71"N	88° 9'26.47"E	Pond	Cultivation	Regular
226		23°39'33.24"N	88° 9'23.89"E	Pond	Cultivation	Regular
227		23°39'30.96"N	88° 8'50.53"E	Pond	Cultivation	Regular
228		23°39'24.79"N	88° 8'38.76"E	Pond	Cultivation	Regular
229		23°39'10.18"N	88° 8'39.93"E	Pond	Cultivation	Regular
230		23°39'22.47"N	88° 8'22.03"E	Pond	Cultivation	Regular
231		23°39'43.61"N	88° 8'23.75"E	Pond	Cultivation	Regular
232		23°40'15.26"N	88° 9'38.77"E	Pond	Cultivation	Regular
233		23°40'8.03"N	88° 9'49.77"E	Pond	Cultivation	Regular
234		23°40'46.46"N	88° 9'43.51"E	Pond	Cultivation	Regular
235		23°40'41.68"N	88° 8'43.09"E	Pond	Cultivation	Regular
236		23°41'9.17"N	88° 8'51.51"E	Pond	Cultivation	Regular
237		23°41'16.31"N	88° 9'58.85"E	Pond	Cultivation	Regular
238		23°41'23.42"N	88°10'45.50"E	Pond	Cultivation	Regular
239		23°43'29.10"N	88°11'3.83"E	Pond	Cultivation	Regular
240		23°43'1.61"N to 23°43'2.63"N	88°11'0.83"E to 88°13'59.96"E	PaleoChannel	Cultivation & Fishing	Regular
241		23°43'30.24"N	88°13'25.11"E	Pond	Cultivation & Fishing	Regular
242		23°43'58.96"N	88°13'12.49"E	Pond	Cultivation & Fishing	Regular
243		23°44'39.33"N	88°13'3.66"E	Pond	Cultivation & Fishing	Regular
244		23°44'46.20"N	88°14'15.75"E	Pond	Cultivation & Fishing	Regular
245		23°45'24.61"N to 23°46'28.71"N	88°14'2.46"E to 88°14'56.66"E	PaleoChannel	Cultivation & Fishing	Regular
246					Cultivation & Fishing	Regular
247		23°46'16.43"N	88°15'40.68"E	Pond	Cultivation & Fishing	Regular
248		23°45'55.90"N	88°15'26.23"E	Pond	Cultivation & Fishing	Regular
249		23°45'29.98"N	88°14'6.74"E	Pond	Cultivation &	Regular

					Fishing	
250		23°45'21.41"N	88°13'51.49"E	Pond	Cultivation & Fishing	Regular
251		23°45'17.75"N	88°13'40.48"E	Pond	Cultivation & Fishing	Regular
252		23°44'44.94"N to 23°44'36.13"N	88°14'19.55"E to 88°13'47.18"E	PaleoChannel	Cultivation & Fishing	Regular
253		23°44'1.47"N	88°13'16.82"E	Pond	Cultivation & Fishing	Regular
254		23°43'46.15"N	88°13'26.07"E	Pond	Cultivation & Fishing	Regular
255		23°43'27.50"N	88°12'41.46"E	Pond	Cultivation & Fishing	Regular
256		23°43'25.08"N	88°15'27.57"E	Pond	Cultivation & Fishing	Regular
257		23°43'44.69"N	88°16'51.33"E	Pond	Cultivation & Fishing	Regular
258		23°44'0.70"N	88°16'23.12"E	Pond	Cultivation & Fishing	Regular
259		23°44'0.67"N	88°13'12.75"E	Pond	Cultivation & Fishing	Regular
260		23°44'30.92"N	88°13'5.62"E	Pond	Cultivation & Fishing	Regular
261		23°44'25.76"N	88°12'39.20"E	Pond	Cultivation & Fishing	Regular
262		23°44'38.13"N	88°13'18.19"E	Pond	Cultivation & Fishing	Regular
263		23°44'44.57"N	88°12'43.11"E	Pond	Cultivation & Fishing	Regular
264		23°44'49.57"N	88°12'14.27"E	Pond	Cultivation & Fishing	Regular

Plate 56 - Reservoir , Nabadwip township 23°24'36.18"N88°24'38.96"E

Plate 57 - 23°25'13.96"N88°24'19.51"E, a big pond inside Nabadwip Municipality

Plate 58 - 23° 45.521'N 88° 14.457'E , a big waterbody near Palassey, Kaliganj1

Plate 59 - 23° 25.158'N 88° 22.126'E, Ranir chara , Nabadwip Municipality

Plate 60– Waterbody near Ranaghat , 23° 12.993'N, 88°

Plate 61- 23° 12.583'N 88° 29.736'E , WHS near Phulia

Plate 62 - A WHS (Water Harvesting Structures) , Phulia, 23° 13.992'N ,88° 26.750'E

Plate 63 – An ox-bow-lake near Santipur , 23° 15.879'N, 88° 22.937'E

Plate 64 - 23° 10.733'N , 88° 31.117'E, Ox bow lake , Ranaghat.

Plate 65 - 23° 1.299'N 88° 28.991'E Shimurali

Plate 66– Santipur Horse Shoe lake , 23° 15.406'N 88° 22.651'E

Plate 67 – Water Project , Prachin Mayapur , 23° 25.306'N 88° 22.382'E

4.4. SACRED TREES -

Nabadwip is a city and a municipality in Nadia district is a holy place where Chaitanya Mahaprabhu was born. Located on the western bank of the Hugli River, it is considered to have been founded in 1063 CE, and served as the old capital of the Sena dynasty. A center of learning and philosophy in medieval India, the city is still noted for its traditional Sanskrit schools. The great Vaishnava saint, social reformer and an important figure of the Bhakti movement, Chaitanya Mahaprabhu (1486–1534) was born here. It was after Chaitanya Mahaprabhu's birth that Nabadwip became an important center of pilgrimage for the Vaishnavas worldwide as well as for Hindus in general. Many who follow Gaudiya Vaishnavism visit Nabadwip to celebrate the auspicious birthday day of Shri Mahaprabhu, which, as per lunal calculations, occurs on Phalguni Purnima (i.e. on the Full moon day of February–March). This day is commonly known as Gaura-purnima.

This holy place has number of sacred trees including the one under which Chaitnya Mahaprabhu was born.

Plate 68– a. Chaitnya Mahaprabhu's birthplace, known as the Yogapitha, 23°26'17.85"N 88°23'33.88"E is on the east bank of the holy Ganga and was discovered in 1887 by the 19th Century Vaisnava saint, Srila Bhaktivinoda Thakura. The Thakura built a beautiful temple here with the Deities of Mahaprabhu and His consorts Visnupriya and Laksmipriya, and Radha-Madhava. It is an ancient Neem Tree (*Azadirachta indica*) under which Mahaprabhu took birth. The name "Nimai" is also because of this Neem Tree.

However, there is another school of thought amongst Vaishnavites who all think that the original birthplace is in the west of Bhagirathi River , Prachin Mayapur located north of present Nabadwipa. There is also a sacred Neem Tree which is treated as the birth place of Nimai Mahaprabhu. Plate 69 : 23°25'22.98"N 88°22'16.97"E

Plate 70: Chand Kazi's Samdhi in Simanta. This stone samadhi with a huge champaka tree entwined around and towering about it is the samadhi of the Muslim ruler Chand Kazi, who was the magistrate of Navadvipa. This place is located just outside the boundary of Shri Antardwip. Nearby was his palace, and in the same general locale the father of Sacimata, Nilambara Cakravarti, resided.

Beside this holy tree there are many other ancient trees in both sides of Bhagirathi which are all worshipped. These trees are as follows -

b. Mahakaal Mandir , Banyan Tree, near Nabadwip Ghat 23°24'35.97"N 88°22'36.07"E (Plate 71)

Plate 72 – Prachin Mayapur Ghat , Banyan Tree with Shiva 23°25'28.79"N 88°22'40.43"E

Plate 73 & 74 - 23°23'40.57"N 88°22'13.07"E Banyan Tree , Manipur Ghat .

Plate 75 & 76– Jibon Krishna Das planted Banyan and Peepal Tree 23°24'24.49"N 88°22'28.35"E

Plate 77– Baba Pashupati Nath Temple , Phansitala , Nabadwipa , Nadia 23°24'18.90"N 88°22'15.23"E

Plate 78 –Shiva Linga associated with Peepal Tree , Ranichara , 23°24'47.62"N 88°22'36.09"E

Plate 79– Shiva Linga with Peepal Tree 23°24'52.26"N, 88°22'35.66"E

Plate 80– Banyan Tree with Kali Mata , Ranirchara , 23°24'49.52"N 88°22'35.57"E

Plate 81- 23°24'30.98"N 88°22'48.62"E, Peepal tree with Shiva Temple near Swarup ganj Ghat

Plate 82- 23°24'30.43"N 88°22'35.25"E Nabadwip Ghat , Chaitnya Mahaprabhu Temple , Peepal Tree

Plate 83– Nileswar Para , Nabadwip , 23°24'16.18"N 88°22'29.49"E

CHAPTER 5 – DOCUMENTING STRUCTURES INTHE RIVER

5.A. The National Waterway 1 or NW-1 or **Ganga-Bhagirathi-Hugli river system** is located in India and runs from Haldia (Sagar) to Prayagraj across the Ganges, Bhagirathi and Hugli river systems. It is 1,620 km (1,010 mi) long, making it the longest waterway in India. It is of prime importance amongst all the national waterways considering its locational advantages. The NW-1 passes through West Bengal, Jharkhand, Bihar and Uttar Pradesh and serves major cities and their industrial hinterlands like; In West Bengal there are 7 major terminals and amongst them Santipur in our study area is one of the most important one.

5.B. Ferry Service : Beside this , there are regular ferry services in the study area commuting passengers from Nadia to Hugli and Burdwan Districts. They are as follows –

a. Raninagar Ghat , Chakdah , 23° 4'50.81"N 88°29'49.40"E . This is a temporary Boat (Ferry Service connecting Raninagar near Chakdah to Char Khairamari , Hugli near Jirat. This area is extremely affected by bank erosion and thus ferry service is a very temporary option. (Plate 85)

b. Gour Nagar Ghat , 23° 6'8.24"N 88°30'48.63"E – Connecting Balagarhi Char (Chakdah) with that of Gour Nagar Char (Hugli) . This is also a temporary ferry service connecting the 2 districts. (Plate 86)

c. Shibpur Ferry Service , Churni River 23° 7'59.28"N 88°30'8.26"E, Shibpur to Gosaipur Char . Also plying to the new island of Ghola Nadia.(Plate 87)

d.Balgarhhat Ferry Service , Ranaghat - 23° 7'49.49"N 88°28'13.94"E Balagarh Ferry Service is a proper Ferry Service connecting Sripur , Hugli district with that of Chak Sripur of Nadia District. Balagarh is the largest boat making centre of Bengal.(Plate 88 & 89)

e.Krittibas Ghat - 23°13'3.41"N 88°28'38.70"E , Mahakavi Krittibas Ojha Bengali pronunciation: (1381–1461) was a medieval Bengali poet. His major contribution to Bengali literature and culture was Indian epic Rāmāyaṇa in Bengali. His work, the Śrīrām Pā̃cālī, is popularly known as the Krittivasi Ramayan. His work, edited by Jaygopal Tarkalamkar, was published by the Serampore Mission Press.

f. Guptipara Ghat - 23°12'39.30"N 88°25'17.27"E , connecting Santipur to the old heritage temple town of Guptipara , Hugli. At present Ferry service is closed as it got heavily affected by the bank erosion. Photo – Anandabazar archive.(Plate 89)

i. Nrisinghapur Kalna Ferry Service - 23°13'31.81"N 88°22'31.57"E connecting Nrisinghapur , Nadia to Kalna , Burdwan. Thousands of commuters avail this ferry service from 6 am to 9pm .(Plate 90)

j. **Nabadwip-Swarupganj Ghat - 23°24'30.26"N 88°22'47.72"E** From Jalangi River crossing Bhagirathi –Hugli , this ferry service connects Nabadwip Dham with Mayapur. Almost 25 thousand commuters generally uses these ferry services involving **4 ghats** (2 over Jalangi and 2 over Bhagirathi . The Hulur Ghat , Mayapur 23°24'50.76"N 88°22'58.11"E over Jalangi connects the Nabadwip Ghat of Nabwadwip Dham. This Ferry Service is maintained by Nabadwip Jalapath Paribahan . Because of lockdown the authority is facing huge loss .

Plate 94 &95 : Hulur Ghat , Jalangi River

Plate 96 & 97 : Nabadwip Ferry Ghat


SRMB TMT

l.Prachin Mayapur Ghat , 23°25'26.84"N 88°22'42.31"E – connecting Prachin Mayapur with Mayapur.(Plate 99)

a.Gouranga Bridge is a 588 m (1,929 ft) long Road bridge that crosses the Bhagirathi River in between Nabadwip and Krishnanager, Nadia in West Bengal. It is the part of State highway 8. In 1972, the then Minister of Public Works, Bhola Sen, laid the foundation stone of the Gouranga Bridge to connect Nabadwip and Krishnanagar. Gammon India Limited took the responsibility to construct the bridge. On 16 January 1973, Minister of Public Works of Left Front Government, Jatin Chakraborty inaugurated the bridge. The bridge is built in the Class-A stage in terms of carrying load according to the importance and demand of the connecting cities. (Plate 104 , 105, 106, 107)

CHAPTER 6 - DOCUMENTING LIVLELIHOOD PATTERN & ACTIVITIES IN AND AROUND THE RIVER HUGLI.

6.1. LANDUSE LANDCOVER STUDY IN THE STUDY AREA

Nadia district of West Bengal, India has very special characteristics in land use / land cover dynamics due to its long international boundary with Bangladesh and proximity to Kolkata city.

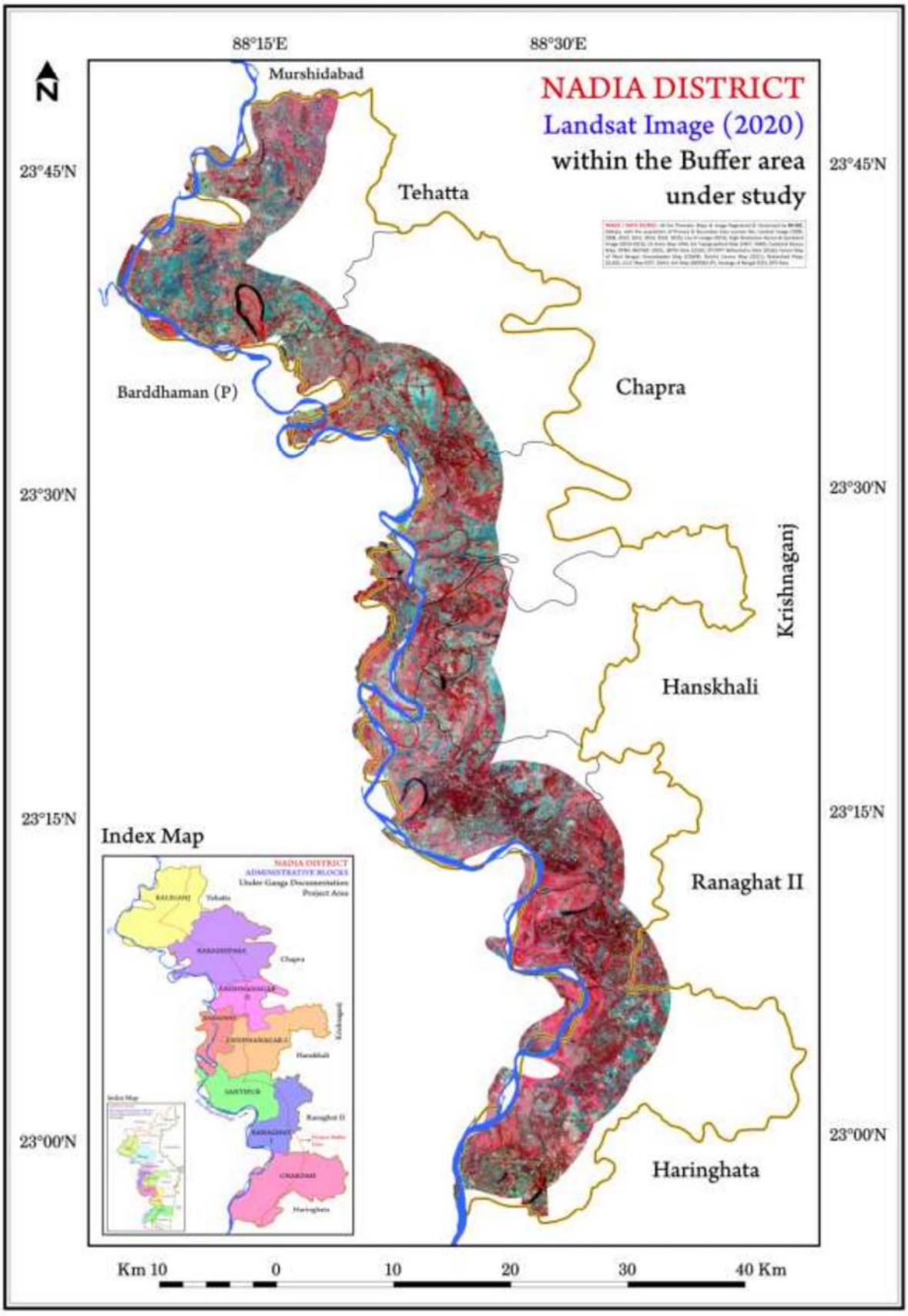
We have used Landsat Image of 2019 (21st January) for the analysis of the present Landuse Landcover study of our buffer area. For the change detection study we have used 2015 Landsat Image along with the latest one. Supervised Classification has been done for finding out different LULC categories. 5 classes were identified as – Waterbody including the rivers, ponds, paleo channels and cut-offs , Agricultural Land (Mono & Double) , Depressed Land (mostly used for cultivation , orchards or fishing purposes) , Settlements with homestead orchards. The total area under study is 1084.2 sq.km and amongst which 47% is under multiple cropping area. Agriculture forms the backbone of the district with Aman Paddy being the primary crop. In summers & winters, the vegetables or oilseeds are grown in the same area. The fertile soil of the area results in high cropping intensity. Mono crop pattern of agriculture is still in practice in the region due to drainage congestion. Nadia district has a huge area about 20% under the depressed land category . Here mostly jute is cultivated along with paddy. The entire stretch of land along the bank of river Hugli suffers bank erosion and inundation. The low-lying area is used for jute plantation and is bounded by banana orchards.

There are many areas in our study area where we do find river cut-offs. Cultivation and fishing is done in these abandoned channels. There are numerous brick kilns all along the channel occupying a considerable amount of landuse cover.

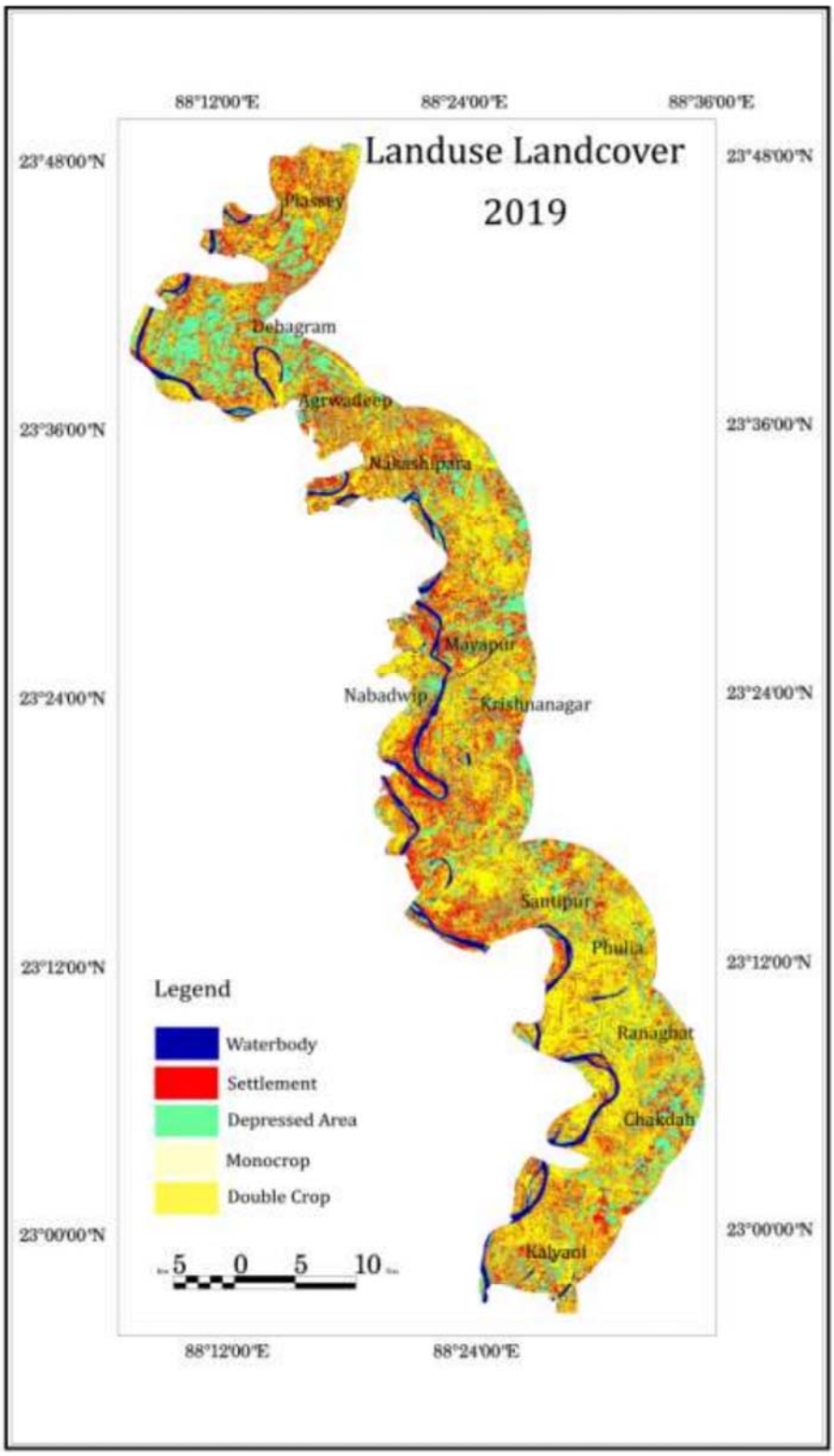
By using landsat image of 2015 & 1973 we have done change detection study of our study area and found that the area under settlement has increased rapidly. The water bodies , specially cut-off s are extensively dynamic in nature. River has changed it's course in several areas. New land formation has also resulted because of sedimentation. Like Noachar , in Kaliganj Block has emerged out from the river and has now 1600 households with primary occupation of cultivation and fishing.

During 1972-1989, there was a huge conversion of area under natural vegetation to settlement and also some amount to agricultural lands. There was also a mentionable amount of land cover change from agricultural land to settlement. The transition of LULC from agriculture to water body class may be due to misclassification of submerged rice fields as water body in satellite images. Least transformation occurred of settlement class. In the 1989-2006 time span also, high amount of area under natural vegetation and agricultural land was shifted to settlement class. Like the earlier, least change of LULC was from settlement class. However, in contrary to 1972 to 1989 duration, in 1989-2006 there was a remarkable change from all other LULC classes (mainly from natural vegetation) to water bodies. In the whole time span (1972-2006), shifts indicate the fast growth rate of population as well as urbanization. Some amount of LULC change from settlement to natural vegetation and agriculture instead of huge increase of total settlement probably indicated shift of people from rural to urban areas. On the other hand, shift lands under water body class to settlement class were an indicator of development of human habitat by damping water bodies.*(Map 41,42,43)*

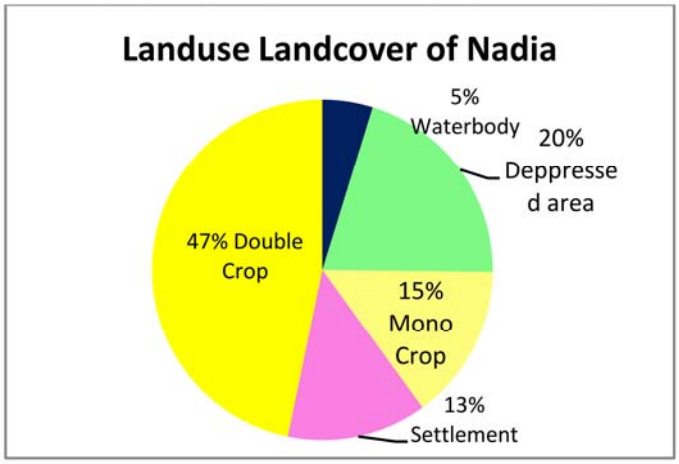
Sl. no.	LULC Category	1973 (sq.km)	2019(sq.km)	Remarks
1	Waterbody	78.1	54.21	Includes all cut-offs, scars etc
2	Depressed Land	320.1	216.84	The flood prone areas, suitable for orchards, jute plantation
3	Mono crop	266	162.63	Paddy is only grown here
4	Double Crop	300.01	509.574	Cropped twice or more. Very fertile.
5	Settlement	120	140.946	Urban and rural



Map 41 : Landsat FCC , 2019 used for Landuse Landcover classification

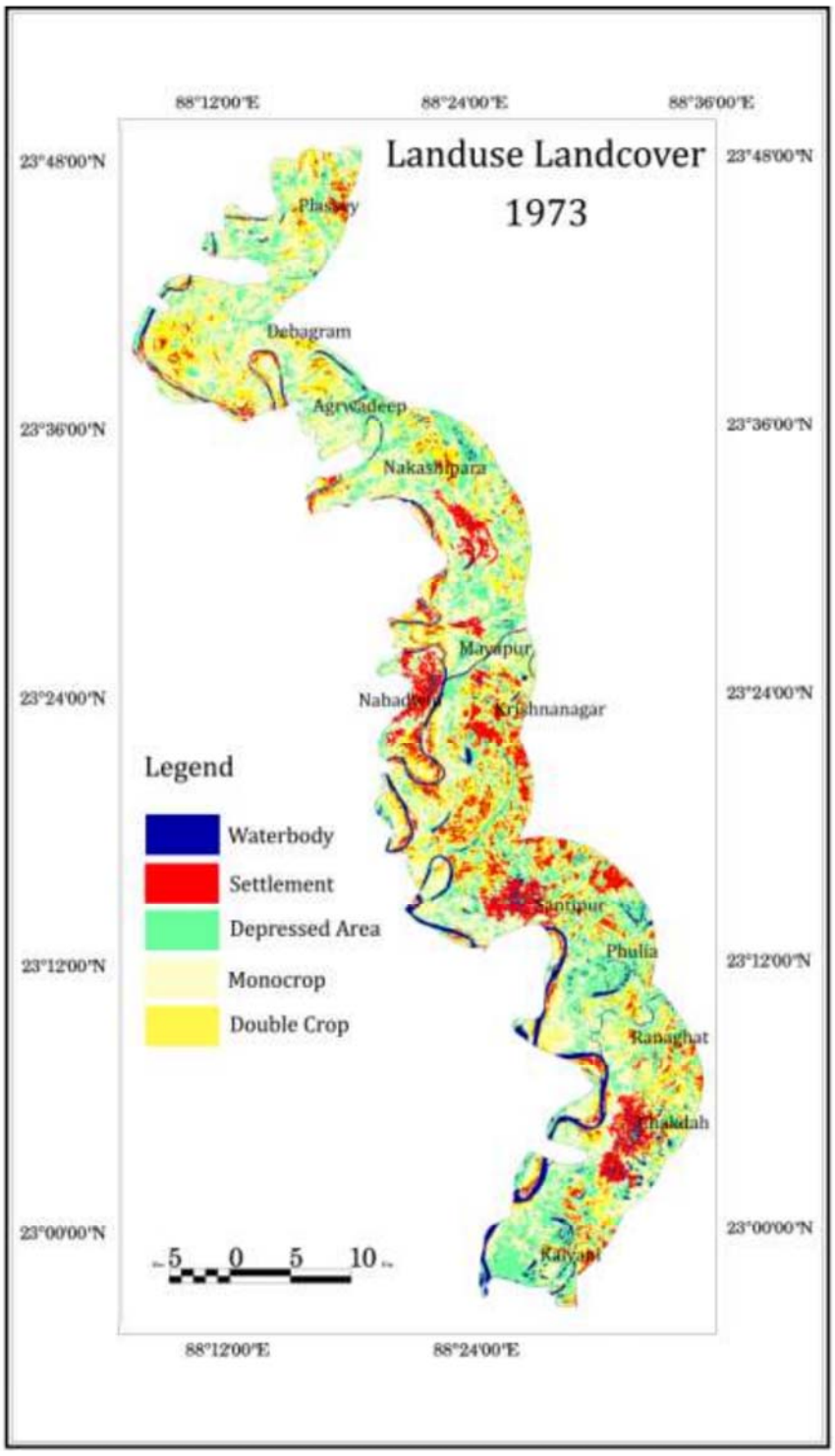


MAP 42– LANDUSE LANDCOVER , NADIA STUDY AREA , 2019



Pie Chart showing the percentage of areas under different LULC

Plate 87 : Nadia Farmers in a Paddy Field , Santipur, Source : Outlook India Photo Gallery



Map 43 : landuse Landcover Map , 1973

Plate 110 – Banana Orchards in the depressed area , 23°10'58.68"N 88°27'54.71"E

Plate 111– Mustard Fields , in the flood plains of Prachin Mayapur 23°25'15.04"N 88°22'46.21"E

6.2. River / Channel bank using for various Economic activities

6.2A. Agriculture

Nadia represents the biggest agro-climatic zone in West Bengal – the new Alluvium Zone. The alluvium zone spreads southward approximately from the head of the delta formed by the succession of rivers. This district has the highest cropping intensity and crop diversity. The district is about 10 m -15 m above MSL and criss-crossed by the Bhagirathi and its tributaries. Soil of this agro-climatic zone is deep, well drained, texturally fine, loamy, and neutral in reaction with high base saturation and medium to medium low NPK status. The area is humid and with high precipitation. Summer is hot and humid and winter is moderate which facilitates higher crop production and yield. The district has a tendency of high rainfall and also occurrence of flood.

a. PRINCIPAL CROPS

The **autumn rice or Aus**, is also known as ***bhadoi rice***, after the name of the month in which it is harvested. As already stated it is by far the most important crop which is grown in the district. It requires less water than the other varieties of rice, and in fact it cannot be grown on land which is liable to be flooded during the rains to a depth of more than two feet, as it does not grow to a height of more than three or three and-a-half feet, and it does not possess the power of accommodating its growth to the depth of the water surrounding it, as do the long stemmed varieties. Cultivation of the land for it commences as soon as the early showers permit of the ploughing and the seed is sown broadcast in April or May. As soon as the young plants have attained the height of 5 or 6 inches, the field is harrowed with a view to somewhat thin out the crop, and also to prepare way for the first weeding. During May and the first half of June it is most necessary to keep the fields clear of weeds, and it is the amount of labour required in this operation which makes the acs a more troublesome crop even than the transplanted arrioq. Under favourable conditions the crop is ready for the sickle in August or September. The rice yielded is of coarse quality, and difficult to digest ; it is used by the lower classes only. The outturn is less in weight, and fetches a lower price than that afforded by the aman crop, but it provides the raiyat with a foodgrain, and his cattle with fodder, at a time of the

year when both are scarce. Moreover it is off the ground early enough to permit of the preparation of the land for the rabi or winter crop, which gives it another advantage over the am an. The normal outturn of aus rice in Nadia is 12 maunds per acre, which compares favourably with the figures for other districts, notwithstanding the infertile nature of the soil ; but this result is only obtained by allowing the soil far more frequent and prolonged periods of rest than are necessary elsewhere. Aus paddy is one of the best cleaning crops for lands which have become badly infested with weeds ; and it is occasionally grown for this purpose. It is specially useful for ridding from ufu grass land on which it is desired to plant out an orchard.

b.WINTER RICE OR AMAN

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. In Nadia aman rice is nearly the sole crop in the *Kalantar*, and it is also grown fairly extensively in the Kushtia Subdivision. The normal yield is about 13 maunds of rice per acre, which is less than what is obtained in the other districts of the Presidency Division.

Plate 112 : Drying of Aus paddy taking place , Ranaghat , 23°14'39.72"N 88°23'44.04"E

Plate 113 : Aman Paddy Cultivation in the River Cut Off, Kalaiguange.

c. JUTE

The cultivation of jute has been steadily increasing of late years, and this crop now occupies 14 per cent. of the normal net cropped area. Generally speaking, it does well on lands which are suitable for ours rice. 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 Nadia 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 Nadia and other districts in the Presidency Division less care is taken in this respect ; a further explanation as regards Nadia itself lies in the inherent infertility of the soil. The best jute has its fibres in long thick clusters, soft and fine, yet strong, of a white glistening colour and free from particles of the bark or wood. The inferior qualities have a coarse red fibre. The length or shortness of the stem is said not to affect the price ; only its fineness, cleanness and silkiness are looked to.

Plate 114 & 115 : Dry Jute Sticks are stacked everywhere during October , November month all along Bhagirathi-Hugli channel

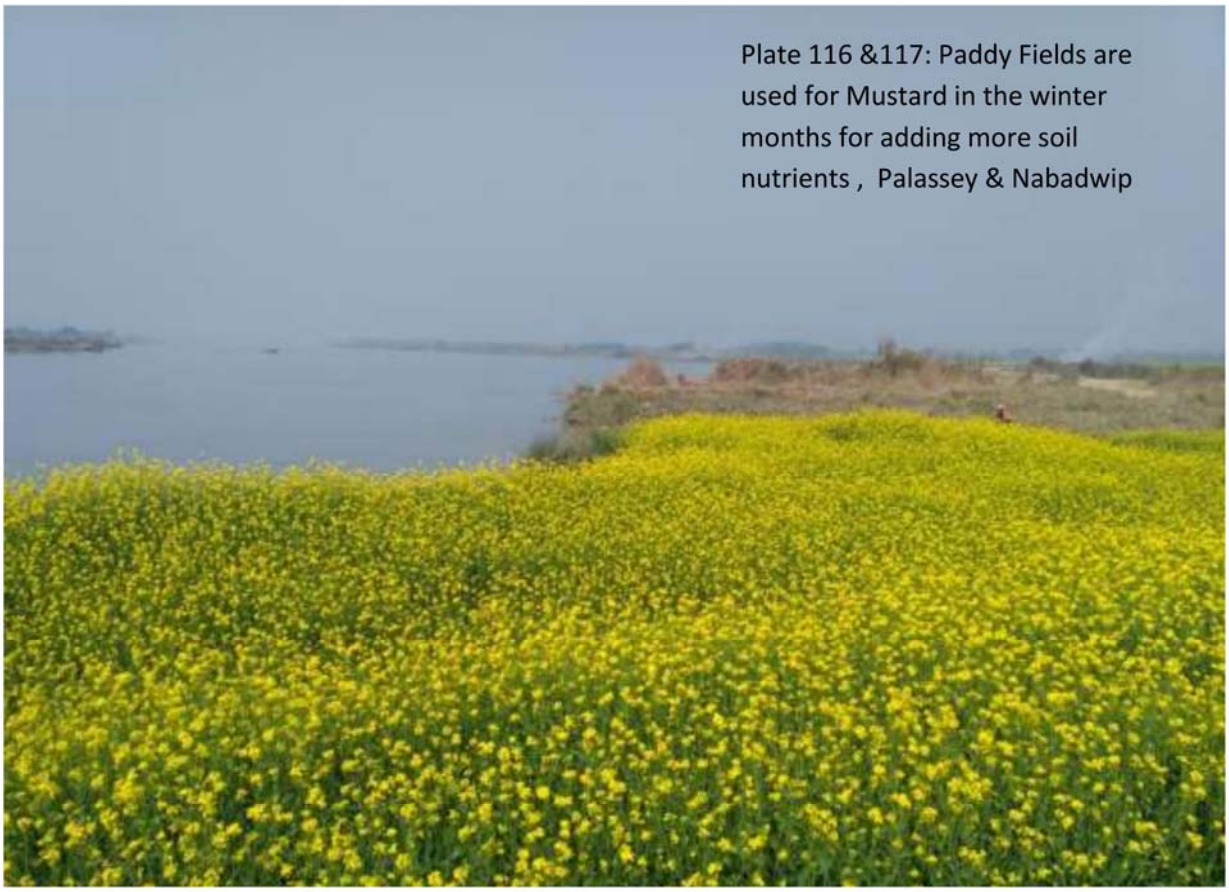


Plate 116 &117: Paddy Fields are used for Mustard in the winter months for adding more soil nutrients , Palassey & Nabadwip

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,fi00 acres are devoted to orchards and market-gardens. Generally speaking, the quality of the mangoes is not good, and in some parts of the district, especially in the Kalantar, even the yommon 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 Calcutta. Different vegetables like brinjal, pointed gourd, bitter gourd , leafy vegetables etc are cultivated.

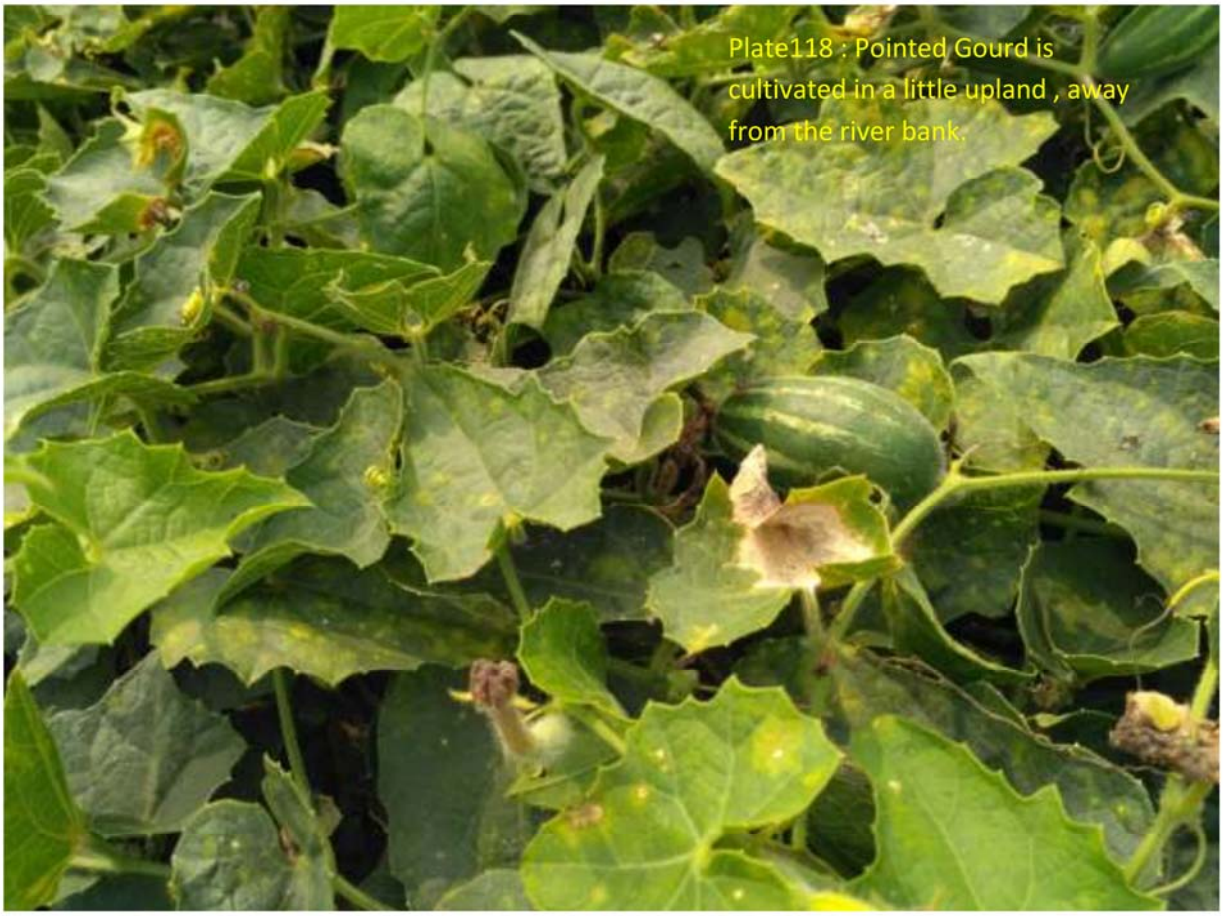


Plate118 : Pointed Gourd is cultivated in a little upland , away from the river bank.

Plate 119 & 120: Brinjal and gourd plantation all along the floodplain.

Plate 121 & 122 – Gourd and Maize cultivated in the upland area.

Plate 123 – Maize Cultivation in the upland area

6.2.B. Floriculture & Horticulture

Floriculture is an important aspect of modern agriculture, means the cultivation of flower and ornamental plants in intensive way within garden and arable land. In national level importance of floriculture is so much. Area of floriculture in all over Nadia district is increasing gradually in respect of crop calendar year 2001 to 2012. Some blocks are facing well development in this field and some blocks are facing low development .Due to some constraints like poor marketing system, poor transport system, lack of knowledge, training facilities, application of modern technology, poor irrigation system, in sufficient application of fertilizer and pesticides, etc are responsible for backwardness of some blocks of this district.

a. Banana Plantation - Banana (Musa sp.) is the second most important fruit crop in India next to mango. Its year round availability, affordability, varietal range, taste, nutritive and medicinal value makes it the favourite fruit among all classes of people. It has also good export potential. Nadia district is the largest producer of banana in West Bengal with Chakdah , Ranaghat being the largest area contributor under the plantation.

b.Mango Plantation - Mango (Mangiferaindica L.) is one of the most popular fruit crop in the tropics. It is universally considered as one of finest fruit in the world .Mango is called the king of fruits and it is also known as national fruit of India. India has about 1110 varieties and 20 varieties are now accepted as commercially well established. Mango is also an important fruit of west Bengal. In West Bengal mango occupies about 80.90 thousand hectares which is more than 41% of total area under fruits west Bengal is unique in having more than 200 varieties. Among the varieties Himsagar and Amrapali are commercially cultivated in the district of Nadia. Numerous number of mango orchards found in Nadia district nearlyPhuliaand Santipur area. there are mainly two type ofHimsagar are cultivated in nadia. oneis" kalahimsagar"anotherone"sadahimsagar". Sadahimsagar is more attractive foe its fine outer look but kalahimsagar is more delicious than sadahimsagar.other varieties like Amrapali contain 12% of total mongo production, Gulaabkhaas contain 6%, west Bengal langraoccupies 5%, Sindoori take 4%, chatterjee varieties contain 3% and some indigenous variety locally known as"" take 2% of the total production. As per ranking according to their production Himsagar rank 1 st , Amrapali rank 2nd , Gullabkhaas rank 3rd , west Bengal langra rank 4th , sindoori rank5th , Chatterjee variety rank 6th and Indigenous varieties rank 7th

Plate 124 & 125 : Banana Plantation in the vulnerable bank sides of Chakdah, Ranaghat.

Plate 126 & 127: Mango orchards

C. Bee Farming or Apiary in Nadia

Beekeeping is one of the oldest tradition in India for collecting the honey. Honey be farming is becoming popular due its market demand in national and international markets as well. Not only the farmers make a sweet dividends but beekeeping also help increase agriculture productivity through pollination. Honeybees also produce honey, bee wax and royal jelly thus giving additional benefits to the farmers. After successive losses in traditionally grown crops, farmers are inclining towards bee farming. In order to maximize agricultural production, honeybee can be used as an important input agent. About 80 % crop plants are cross-pollinated, as they need to receive pollen from other plants of the same species with the help of external agents. One of the most important external agents is the honeybee. Bee Keeping farmers faced a major loss in recent Amphan Cyclone . Most of the boxes are destroyed.

Plate 128 - Beekeeping done in Nakashipara near Bethuadahari

D. Fishing in Nadia -

Throughout our study area, fishing is done in the main river and also in the numerous Ox bow lakes formed along the main river course. Inland fishing has special importance in the study area. The major fishing zones are – Rivers like Bhagirathi, Jalangi and Churni and Natural Bills like – Amdaha (Ranaghat) , Bhluka (Krishnanagar) and Hasadanga Bill (Krishnanagar) . However in almost all the blocks sweet water river fishing is done. It has an important role to the development of the socio economic scenario of our district, Nadia. Inland fishing is an effective means which greatly influences local economy by alleviating poverty through employment generation of the people, especially among women and marginal farmers. Inland fishing also boost the development of rural infrastructure and helps creating ancillary industries i.e. fishing boat manufacture, net making etc. which, in turn, opens the opportunity of more employment. Notwithstanding those pros, it has also several cons like overfishing; fishing techniques fishing management etc. which causes adversely on environmental issues such as destruction of habitat; break down of lentic eco-system, extinction of some species of fish and reduction of fish population, pollution of water body and many more. The common fishes which are available in the inland water bodies of Nadia district are Rohu, Catla, Mrigale, Pungas, Grass Carp, Bighead Carp, Silver Carp, Common Carp, Tilapia, Nilotica, Bata, Koi, Shinghi, Magur etc.

As the other sector of economy, fishing also a sector where females are engaged in different activities. Though men are dominated in fish capture but post -harvest activities like fish processing, retailing and trading are often done by women. Uneducated and poor women of the fishing villages are involved in post harvest activities as high skill and large amount of capital is not required in this purpose. A large number of small scale fishers are women. They often supported their family by earning from fishing though men control a large of the households main cash generating activities. Vulnerable women are involved these activities which play a important role in our district, a large number of female are engaged in fish related activities in the fishing villages which represent a vital element of the day to day struggle for economic and social development.

The women of ‘Kalyani Shahid Palli’ a self-dependent community are the trend seaters in this respect. The women of Medermath apart from this approx. 200 women of Medermath village annex to the Hingnara Gram Panchyet, Chakdah Block have firmed 18 self-dependent communities through the S.G.S.Y. project and their prime activities is to work up the socio

economic progress through fish firming. From above mentioned 18 communities every single self-dependent community whose 70% of women are in BPL category.

a. Fishing near Gaur Nagar Ghat , Chakdah 23° 5'56.62"N 88°30'44.45"E (Plate 129 & 130)

b. Fishing is done near Raninagar Ghat , Chakdah , 23° 5'1.33"N 88°29'47.62"E (Plate 131&132)

c. Fishing in Shibpur , Ranaghat 23° 7'59.03"N 88°30'7.64"E (Plate 133)

d. Fishing in Churni River, Paschim Sambhupur , 23° 7'59.03"N 88°30'7.64"E . River Churni is one of the major sources of the surface water of the district and plays an important role as thousands of fishermen from the river side areas depend on the productivity of this river. (Plate 134)

e. Fishing in Narasinghanagar 23°13'48.94"N 88°27'37.54"E , Santipur (Plate 135)

Plate 137 & 138 – Fishing is done in

Plate 139 & 140: Fishing is done near Jaluidanga , Krishnanagar II

i. Inland Fishing - The beel or floodplain wetlands usually represent the Ienticcompouent of floodplains viz., ox-bow lakes, sloughs, meander scroll.depressions, residual channels and the back swamps and excludes the lotic component (the main river channels, the levee region and the flats). In addition, tectonic depressions located in river basins are also included under beels. Thus, all the. wetland formations located at the floodplains can be termed as beels. They are either shallow depressions or dead riverbeds generally connected to the principal rivers and/or receive backflow water from the rivers during floods or from the huge catchment area following monsoon rains.

Nadia has 42 Beels with 2.4 to 7m of depth. A rich variety of fishes has been recorded from the floodplain wetland ecosystem. Majority of the fishes are resident fauna of the system. Few fishes recorded from the beels are found to undertake local migration between beels and adjacent river. A clear distinction is discernible in case of fish fauna of open and closed types of beels. The open type of beels are found to harbour many riverine species in addition to fishes resident of such ecosystem. The closed type of beels has its own distinctive fauna. However, many of the riverine forms have gained entry into closed beels either through introduction or due to flooding. Seasonal fishery of a few species in closed beels is the testimony of migration of their brooders (for breeding) or migration of young ones for shelter or grazing. Commonly encountered exotic carps in beels are silver carp (Hypophthalmichthys molitrix) and common carp (Cyprinus carpio).The grass carp (Ctenopharyngodon idella) is not commonly encouraged to be stocked in beels as it can enter the adjacent agricultural fields during monsoon and cause damage to the tender paddy.

Plate 141 : Bhaluka Bill , Krishnannagar

E. Boat Making : While surveying we found in certain areas of Ranagahat and Santipur there are some boat making centres. They mostly prepares smaller boats and for bigger ones they buy from Balagarh Hugli District lying in just opposite bank. They areas are as follows-

Plate 142 – Haran Sardar , Sripur , Ranaghat , 23° 7'58.91"N 88°29'10.59"E

Plate 143– Shibpur , Ranaghat, 23° 7'57.85"N 88°30'12.13"E

Plate 144– Boat making is going on in 23°13'50.53"N 88°27'39.44"E Narasinghanagar

Plate 145– Boat Repairing centre , Balagarhi Char , Ranaghat 23° 6'32.26"N 88°31'0.86"E

Plate 146 – Boat preparation going on in Malipota , Santipur , 23°13'6.97"N 88°28'37.36"E

F. Pottery – Our study area includes one of the most ancient potters hub , Ghurni Krishnannagar. The most ancient industry in our country is the industry of the soil. Pottery in artwork is much more interesting. Pottery is considered as one of the earliest creative craft of Bengalis. Many years ago, people created this occupation as a means of livelihood. Of all the ancient artwork of the people, pottery is one of the oldest. The continuous flow of mixture of soil and water elements has inspired people to create the first pottery. Later on, the use of fire made it more suitable for the use of pottery made by it. As the artist's paint these potteries aesthetically it gives aesthetic look to the scene. The 'Kumar' also prepares the soil with his hand. Earthen craft emerged through the artistic insight of craftsmen well-versed in the color scheme and their imagination, realistic style and most importantly from the religious narrations and a deep observation of social practices considering demographic dividend.

A. Miniature clay dolls of Ghurni , Krishnanagar - Adjacent to river Jalangi is the picturesque village of Ghurni in Nadia, home to clay doll makers which are an integral part of Bengal's culture. The clay dolls have been adored worldwide for their impressive forms and features. The perfect detailing of forms, feature and stance, the meticulous realism of the clothes to the last fold and tuck and the marvellous expressions make each of the clay dolls a collector's item.

Ghurni is home to around 280 artists who are into clay doll making. Government of West Bengal's Department of Micro, Small and Medium Enterprises & Textiles, in association with UNESCO, has developed Rural Craft Hub in Ghurni. It is a perfect destination for visitors to witness doll making by the artists and collect few exquisite souvenir.

148 : Clay Modelling artist in Ghurni

Plate 149 : Miniature clay Figures , signature art of Ghurni

Plate 150 & 151 : Artists and their Clay Models , Ghurni , Krishnanagar

B. Other Clay items –

Plate 152 & 153 : Other clay products like pots and well rims

G. Weaving Industry - Handloom activities are spread up in many parts of the district. The Clustering Phenomena of Handlooms can be noted at Ranaghat I & II, Phulia, Santipur, Nabadeep & Nakshipara/ Rajapur. The loom position availability of weavers and the product profile of the places are as under:

l.	**Handloom clusters of Nadia**	**Product**	**Estimated Number of Looms**	**Present Trend**
1	Ranaghat I & II	Coarser Saree, Lungi, Gamcha, Furnishing, Fabric	2000	Decline
2	Phulia & Adjoining	Tangile Saree, Jamdani Saree, Dress Material, Exportable Fabrics	12000	Prospering
3	Santipur	Santipuri Saree, Exportable Fabrics	20000	Prospering
4	Nabadeep	Coarser Saree, Lungi, Gamcha, Jamdani, Shirting	2000	Decline
5	Nakshipara/ Rajapur	Jamdani Exportable Fabrics	1000	Decline

During survey , it is learnt that Phulia is the leader in production of weaves followed by Santipur is the follower. In Phulia, the workers are from the North Bengal, mainly labours, whereas in Santipur the weavers are locally settled.

In the annals of Indian handloom saree, Shantipur and Phulia are a name to reckon with. their fascinating story is also in a nutshell the story of Bengal handloom sarees. The geographical twins could not be more different. The first, a handloom weaving centre over 500 years old. The second came to flourish only after Partition. Yet, their destinies are linked together – the Shantipur andPhuliasaree swim or sink with the success or otherwise of Bengal handloom. There are records of handloom saree weaving activity in Shantipur, a centre of Vaishnavite culture and Bhakti movement, as early as the 15th century. Weaving flourished throughout the medieval era, and the famed indigo-dyed Neelambari made the Shantipur saree a household name.The demographics of Shantipur region went through a sea-change after Partition. Hindu weavers fleeing the erstwhile East Pakistan (now Bangladesh) settled down in large numbers in a concentrated area on either side of the Ganga in Nadia and Burdwan districts of South Bengal. A considerable number among them settled in Fulia, neighbouring Shantipur.Phulia is now uttered in the same breath as Shantipur. Weavers there trace their lineage to the great Bengal handloom saree weaving centre of Tangail near Dhaka (Bangladesh). They have evolved their own weaving style called PhuliaTangail.

Plate 154 & 155 : Saree weaving is done in every household of Phulia.

H. Brick Kilns – In our study area , Chakdah , Ranaghat , Kaliganj and Nakshipara blocks have number of brick kilns which are using river based silts for making bricks. This is one of the most important criteria for heavy bank erosion in these areas.

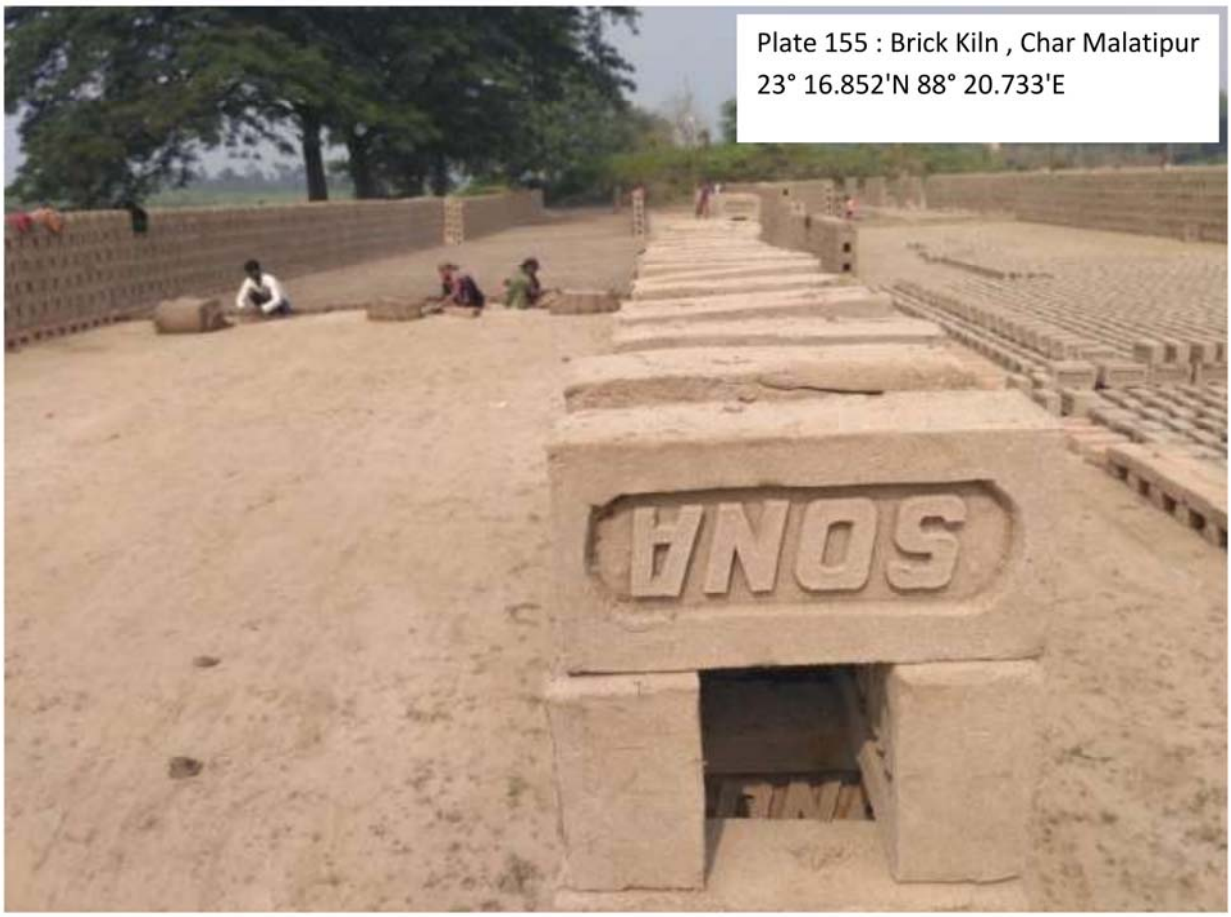


Plate 155 : Brick Kiln , Char Malatipur
23° 16.852'N 88° 20.733'E

Plate 156 : Brick Kiln ,
Gayeshpur, 23° 17.156'N,
88° 20.920'E

Plate 157 : Brick Kiln , 23° 12.971'N 88° 25.469'E

Plate 158 : Chak Sijaipur , 23° 19.705'N 88° 22.899'E

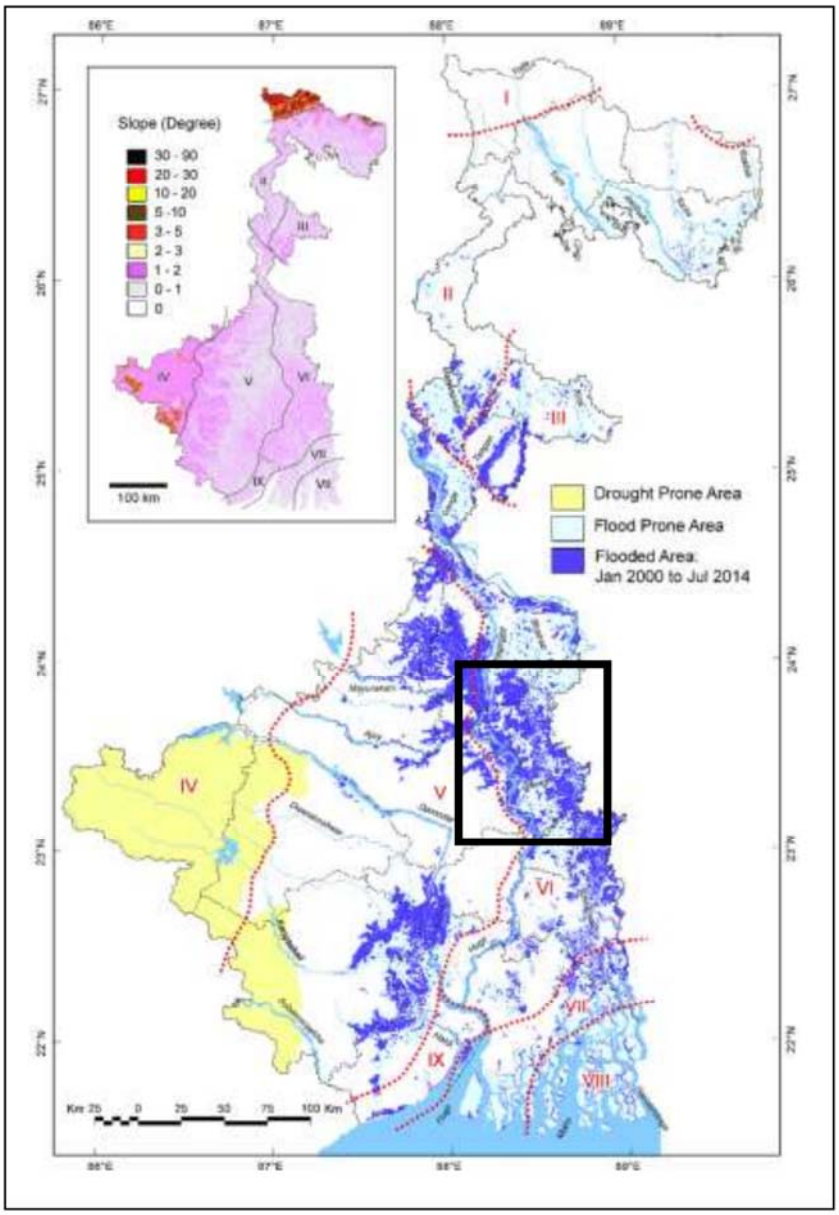
CHAPTER 7: DOCUMENTING ENVIRONMENTAL PROBLEMS

7.1. Flood - The Nadia district is one of the flood prone districts of West Bengal. Every year during the rainy season large areas have been inundated by flood water. The main rivers of the district are becoming very much shallower due to rapid siltation of its bed. Sometimes river water over flows its banks and inundated to its surrounding regions and water from one river bed enters at the other river. As a result many blocks and villages flooded by water. The **Nakashipara, Kaliganj** of our study area are most flood prone areas of the district. Flood hazard and vulnerability results in house collapse, damage to agricultural crops, buildings, roads and livelihood support system of the villagers.

Name of the Block	Type of Hazard	Year of Occurrence	Name of The GPs / Wards Affected	No. of People Affected	No. of Houses Damaged
Nakashipara	Rain with Hail	2015	Nakashipara	11000	800
			Majhergram	10000	950
			Dharmada	230000	1680
			Billwagram	4000	102
			Muragachha	1550	88
			Dhananjoypur	2000	120
Kaliguanj	Flood	2000	All GPs of the Block	200000	NA
	Flood Like Situation	2006,15,20	Matiary,Gobra,Faridpur, Kaliganj, Rajarampur, Ghoraikhetra	30000	20000. Fully 5000
	Flood and water logging	2015,20	Barachandghar, Debagram, Faridpur, Gobra, Hatgachha, Juranpur,Kaligan	99000	
	Flood and water logging	2015,16,19, 20	Matiary, Palitbeghia, Panighata, Plassey-I, Plassey-II, Rajarampur, Ghoraikshetra, Mira-I, Mira-II	68000	
Chakdah	Flood	2015,16,19, 20	Gangaprosadpur,Doardangapur,Poradanga,Gournagar,Mukundanagar,Jhowchar,	60000	

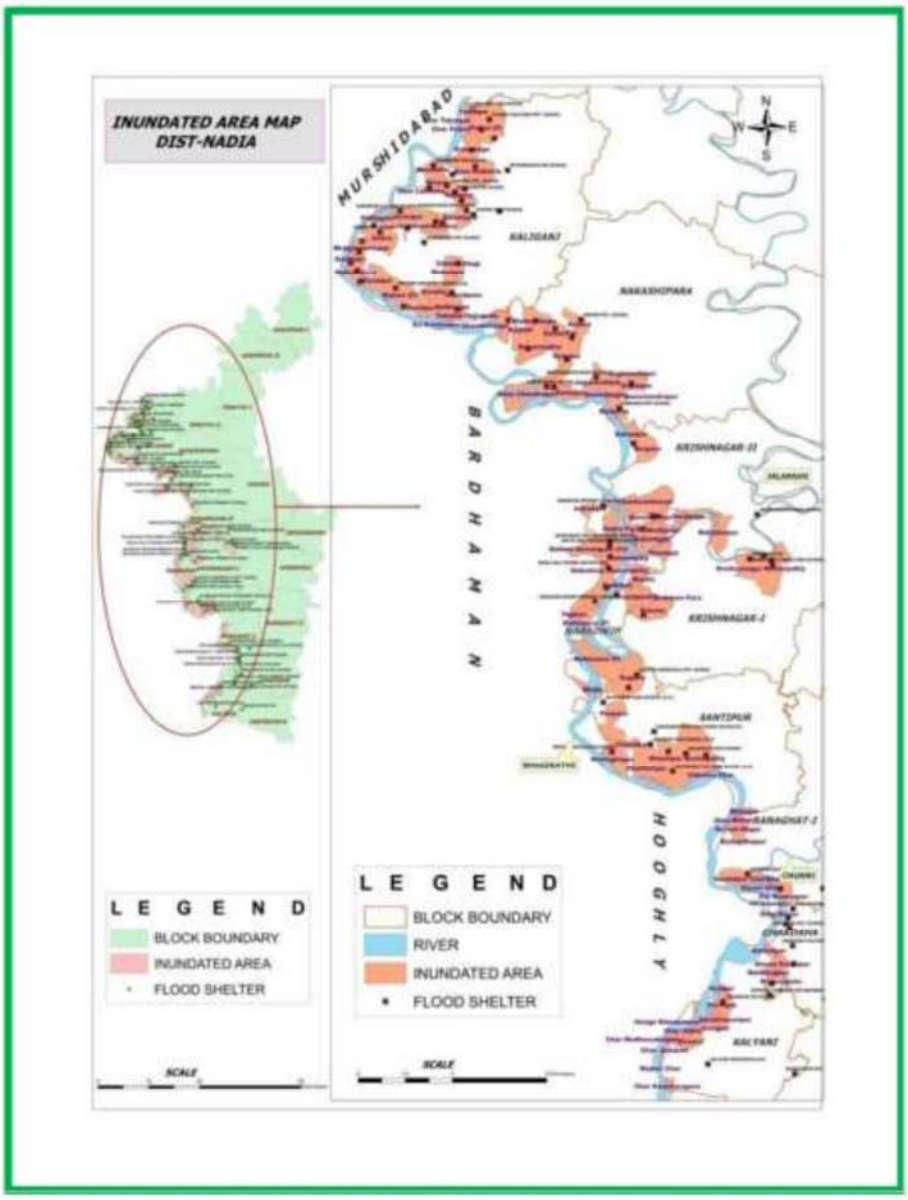
			Nowdadurgapur,Malichagarh,Balidapara,Monosapota		
Ranaghat	Flood	2015,16,19, 20	Dakshin Aranghat,Daspara,Nandibagan,Jugolpara,Kamdanga, Baranberia,Habaspur,Jugolpara,Salua,Malopara,Hossenpur,Shibpur	58000	

Source- District Disaster Management Plan, Government of West Bengal



Map 44 : West Bengal: Areas susceptible to flood and drought. Zones I-IX indicate physiographic divisions of (Source: Extent of floodprone areas from DoIW-GoWB, 2014; Actually flooded areas from DFO, 2014; Drought-prone areas from WBPCB, 2009; Slope map derived from Shuttle Radar Topography Mission data of 2000).

Due to increasing huge population pressure in the study area and increasing frequency of flood the local peoples who are living there are exposed to flood hazard. They are forced to take higher risks for collecting their livelihoods. To save the local people from flood hazard and vulnerability both government and non-government level immediate actions must be taken. The Bhagirathi and Jalangi these two rivers basin must be managed following the preservation of natural eco-system and bio-diversity. The flood plain zone and the low land must be kept safer by protecting flood hazard with the application of modern technology. In this way the people of the blocks can be saved.



Map 45 : Flood affected Mouzas of our study area

Regular dredging of the canals and river beds must be done. Embankment construction, its repair and maintenance must be done regularly. The land use pattern maintenance by the local people is scientifically essential. Flood emergency measures like flood warning and evacuation of the affected people are required. It is also necessary to build up flood awareness among the people. Flood hazard mapping and rescue shelter must be developed for taking the shelter during flood hazard. Lastly the integrated flood management approach must be adopted in the flood affected region.

7.2.Bank Erosion and it's impact- Channel instability and rhythmic fluctuation through erosion-deposition sequence are very familiar phenomena in the lower course of a river in monsoon climate. A river is found to be scouring in a place and deposit at others. A live channel, therefore, evolves through channel changes. The course of river Bhagirathi-Hooghly has undergone changes during last few centuries (Chatterjee, 1989). Descriptions by various scholars viz. Rennell (1788), Colebrooke (1801), Sherwill (1858), Hirst (1915), Mukherjee (1938), Bandyopadhyay (1996), Ray (1999), Bhattacharya (2000), and Rudra (2010) have outlined frequent shifting nature of Ganga. So channel shifting of Ganga or the Bhagirathi-Hooghly system has drawn attention from time immemorial.

The river Bhagirathi-Hooghly, in West Bengal resorts to massive bank erosion at an alarming scale in Nadia District along with Burdwan, Malda, Murshidabad and contributes to a dominant irreparable loss of farm lands of a very high quality each year. It has been estimated, that about 43% of the total geographical area of the state has been declared as flood prone. Form reports of West Bengal Irrigation Department, it has been seen that the average annual quantum of land, engulfed by the rivers in West Bengal is about 800 hectares. Shantipur, Chakdah, Ranghat,Krishnanagar II, Nabadwip ,Nakashipara,Kaliganj Block in Nadia District are similarly hit by this environmental hazard and its associated problems of mass displacement of the poverty stricken rural population with their land, cattle, houses and other assets lost.

Name of the Block	***Number of affected villages***	***Names of the villages***
Nabadewip	***8***	Indrapukur, Sankarpur, Rudrapara, Nabadwip Urban Area
Krishnagar II	***5***	Rukunpur, Bargora, Balainagar
Nakasipara	***12***	Kasiadanga, Karkaria, Kamalnagar
Kaliganj	***21***	Nasipur, Matiari, Noachar
Santipur	***8***	Methidanga,Nrisinghapur
Chakdah	***7***	*Tarinipur, Umapur, Alaipur* and Sarati
Ranaghat	***5***	

Plate 159 – River Bank Erosion , Nrisinghapur 23° 13.634'N 88° 28.013'E

Plate 160 : Severe bank Erosion near Chakdah 23° 3.853'N 88° 27.875'E

Causes - Since the Farakka Barrage has been planted in Malda, vast parts of land downstream, gets affected by massive floods almost every year. Erosion occurs mainly through slumping and hydraulic action of the river water. While assessing the rate of bank erosion in the study area, we found that in the Kalna Ghat area, land loss is about 10 meters each year on an average and if this trend continues, then parts of Haripur constituting some 300 people will be lost within a few years, rendering them homeless. In the Gobarchar area, in the northern part, there has been an erosion of about 23.50 meters of land on an average, which if allowed to continue, shall eat up the whole Ghorolla region within just a few years. In the middle and the southern part, the rate of land loss were 44.83 meters and 21.525 meters respectively. Three villages have been submerged, the most prominent being the **Methidanga** village, which can be found even in the Survey of India, topographical map of 1970. However, people have shifted themselves and named their new land Methidanga

Impact : a. Displacement of land - The people of the lost village of Methidanga were displaced four times in about 20 years. The village was gradually consumed by the river and people moved inland from the bank and were provided pattas (free land) by the government. Now the people are relocated to about 1.75 to 2.45 kms. east of the river. They have settled in a linear pattern along the Nrishingapur road, in temporary encampments, made of bamboo, and straw.

b. Displacement of property - The people in the Kalna Ghat area, either migrated once or did not migrate till now but are in a vulnerable position. A village in Purbasthali in Burdwan District, lying in the opposite bank of Shantipur, was submerged under water and the majority of its population shifted to Shantipur. The people here, did not get pattas. They had to buy lands at the rate of Rs.40, 000 per bigha.(1/6 acres)They have shifted parallel to the river bank in about 100 to 150 meters. from the bank line. Places of Panpara Bagachra, Harinadibhatsala are now in a better condition although they have suffered lots before, mainly when the river was in her way of straightening, throwing out a horse shoe lake.

c. Loss and change of livelihood - These poor sufferers are mostly small, marginal peasants and weavers. In Santipur area, mostly weavers reside. As they got affected Some continue with their job of weaving even in the worst conditions in their new settlements, some farmers now have resorted to either weaving or rickshaw pulling and some small and marginal jobs.

There are mainly handlooms, with a hand drawn small pit loom for weaving the world famous Shantipur "Tant Sarees". They get a wage varying from Rs. 70 to Rs.100 per day and work with all their proficiencies, energy and distress to weave one saree per day. They say that, their pit looms are all that they have and every time they are moved, they have to plant their looms in the new places, and in all these, their days of income slowly wanes. Moreover, their earnings from this industry is too low for them to build a good strong place of decent residence. Loss of enormous amount of multiple cropped land, has increased unemployment, and has created a continuous pressure on land and increased the number of surplus labour and resulted in a huge monetary loss.Many people, mostly from Hijuli, whoeir witness their properties to be gradually vanishing, have gone to Mumbai and Delhi to work as assistants to the jewelers. However, the MGNREGA scheme of the Goverment of India has created some jobs, but frequent flooding and slumping of bank and advancement of the river inland, has again left the people deprived of the benefits of this scheme. One of the main jobs in this scheme in the villages is guarding the advancement of the river by sand bags.

Plate 161 : Bank Protection Work with sand bags .

7.3. 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.

In our study area we found about 159 brickfields all along Bhagirathi Jalangi River.As per Govt.Records 159 brick fields cut 19835669cft soils per year . 71 brick fields cut 9559995 cft of soils per year out of which 2867999 cft (30%) soils are cut from banks or bed of the river .Most of the brick fields are on the higher concave bank of meander and owners make khadan to trap silt in these khadan during floods. But these khadans becomes further extended by attack of current on concave bank causing gradual shifting of the river.

Plate 162 : Soil cutting along the banks initiates bank erosion

Plate 163 : Illegal lifting of sand from river bed results in more erosion

Plate 164b.Ballavpur Ghat , Nakashipara , opposite Katwa, Barddhaman where River Ajoy confluences with River Hugli , Sand lifting is a huge illegal business.

7.4. EXCESSIVE FERRY SERVICE

The river Ganga has highly complex ecology and supports numerous flora and fauna interdependent on each other and on the quality of the fluvial aquatic environment. Frequent movement of barges along the waterways, although an economical proposition, may exert certain impact on the distribution as well as on well being of aquatic communities in the river stretch, which in turn might affect the fishers and other riparian population, depending directly or indirectly on the goods and services of the river for livelihoods. The Bhagirathi-Hooghly stretch of the river contains a sizable population of the endangered Gangetic dolphin (*Platanista gangetica gangetica*). The noise exposure behavior disturbance criteria for dolphins is 177 dB. However, the barge plying in NW-1 (1500-2000 DWT) with modern technology and regulated speed in the dolphin populated stretch generate noise of 110- 140 dB. Since, the noise generated from the barge is below the noise exposure behavior disturbance criteria for dolphins; no adverse impact on the organisms is anticipated. The critically erosion prone zones need to be protected through erection of retaining walls, putting gabions with stones, stone pitching, establishing vegetation, etc. However, IWAI reported that it has taken suggestive measures from the Haldia to Farakka stretch.

7.5 . 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.

Plate 165 : Absence of vegetal cover results in more erosion

Plate 166: Immense bank erosion near Agradwip , Nakashipari

Plate 167 : The recently formed Agradwip Cutoff

7.6. RIVER POLLUTION –

Handloom sector plays an important role in the socio-economic development of a locality where weaving is a very traditional part of it. Dyeing yarns is one of the most important auxiliary occupations in this weaving sector. Ranaghat, Fulia and Shantipur are three suburban towns, situated in our study area on the bank of the river Bhagirathi and Churni and are famous for the clusters of handloom textile factories operating in Nadia district and producing exquisite varieties of handloom clothes for many years. However, discharge of effluents from these textile factories into the river Churni as well as into many adjoining closed water bodies and its ecological hazards to local aquatic ecosystem remained largely unattended. Textile factory effluents are serious offenders of aquatic environment. Use of synthetic dye is a part of textile processing for adding color to the raw materials or to the products as well as to prevent putrefaction of organic matters contained in the raw textile materials. As a result, textile factory effluents discharged into the environment at various stages of operation contain dye, which is a serious threat to aquatic lives due to presence of many toxic heavy metals in modern dyes . Chromium (Cr) besides lead, cadmium and copper is widely used for the production of color pigments of textile dyes and is thus a common

Plate 168 : Discharge of effluents results in pollution of River Churni

contaminant in textile factory effluents [2–4]. Soil contaminated by textile factory effluents has also been found to contain high concentration of Cr [4,5].

In Shantipur, Fulia and Ranaghat hundreds of people are involved in the dyeing process in both organised (Govt. undertaking co-operatives) and unorganised (private) units of dye houses. The yarns dyeing process has different steps viz desizing, scouring, bleaching, mercerization, dyeing, washing and drying . Different type of chemicals for solublizing agent, reduction inhibitor, alkali, binding agent, wetting agent antifoaming agent, electrolyte, colours and bleaching, H2SO4 and a large volume of water are the ingredients of the dye factories. So the textile dyeing effluents contain several types of chemical, acids, alkaline, heavy metals and toxic colours and are directly discharged into the surrounding environment almost without any treatment. Due to excessive use of different chemical compositions, the textile industry effluent is considered as number one toxic polluter to the flora and fauna (Mezohegyi, 2009; Mathur and Kumar, 2013). Most of these textile dyeing factories are cottage based small units. Due to lack of knowledge, the untreated toxic effluent is directly discharged into the surrounding environment. Though several steps have been taken to improve the surface water quality, but waste water management practice should be mandatory for every dye factory (Sivakumar, 2011). Moreover Awareness campaign and regular monitoring of the factories may keep away the environmental stresses.

Plate 169 : Harmful chemicals are the number one toxic polluter to the adjoining flora and fauna

Other sources of Pollution - Rivers perform very important role in geo-morphological, environmental, sociological and economic status of the district. Studies have revealed that due to huge pollution load from diffused sources, ecological condition of the rivers like Churni and Bhagirathi are in critical state. The present investigation has found that anthropogenic interventions like disposal of industrial effluents and agricultural run-off from on-bed and off bed land use are the main drivers of the pollution. Furthermore, natural forcing in the form of neo-tectonic movements and monsoon regimes has intensified the problem. The dissolved organic load is likely cause for concern in the Churni river, which regularly receives untreated municipal and industrial sewage. The excess in phosphorus may trigger proliferation of nitrogen-fixing algae, thereby enhancing the state of eutrophication and biodiversity loss. As a result there is happening species loss and change in Fish Community Structure in the rivers.

The degrading ecological condition casts some adverse impacts upon socio-economic condition of the river-side villages. The river loses its natural productivity especially in its upstream. Rest of the part of the total stretch is facing serious threat of eco degradation. Some fishes have been found to be eliminated completely from the stretch. Huge variations in the limnological parameters and presence of only 33 fish species (mostly present in middle and lower stretch) in the river have been evident during the total stretch of the study. The fishermen from the said arena have compelled to quit their occupation owing to the aforesaid degrading condition of the river. In this study, seasonal variation of limnological parameters, present status of fish fauna and socio-economic structure of the riverside fishermen community have been beaconed to compare the previous and recent conditions. Comparing the result with the previous reports, about 61.35% fishermen are found to switch over their occupation since last 2 decades. About 72.73% in upstream, 65% in mid-stream and 25% in downstream have been recorded as elimination rate of fish since the period. Decreasing rate of dissolved oxygen (DO) and increasing Biochemical Oxygen Demand (BOD) indicate the deterioration of water quality. To cope up with this problem, suggestions have been discussed in several awareness programmes, seminars at grass root level in the river side areas, conducted by the research team. It is also found that the actual development of the riverine ecosystem and socio-economic condition of the riverside communities can be improved only by the proper interference of Governmental actions.

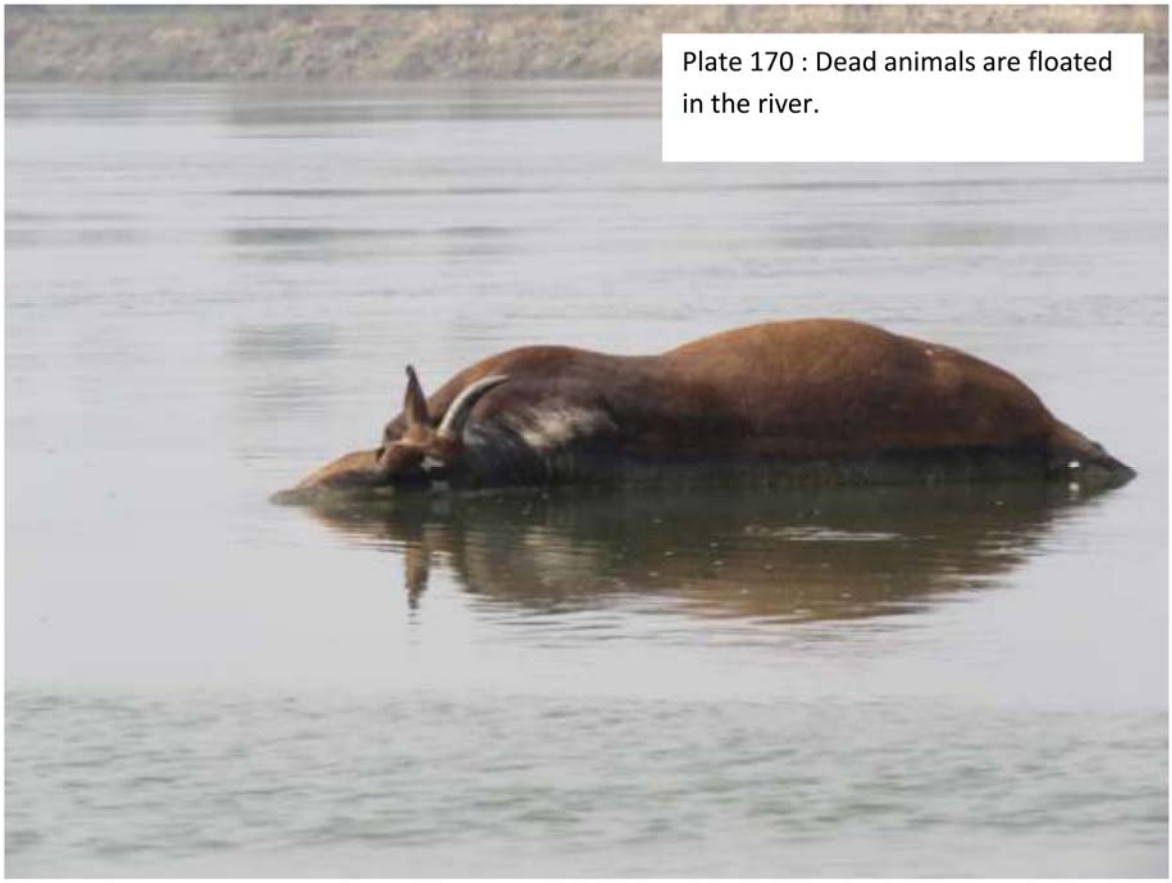


Plate 170 : Dead animals are floated in the river.

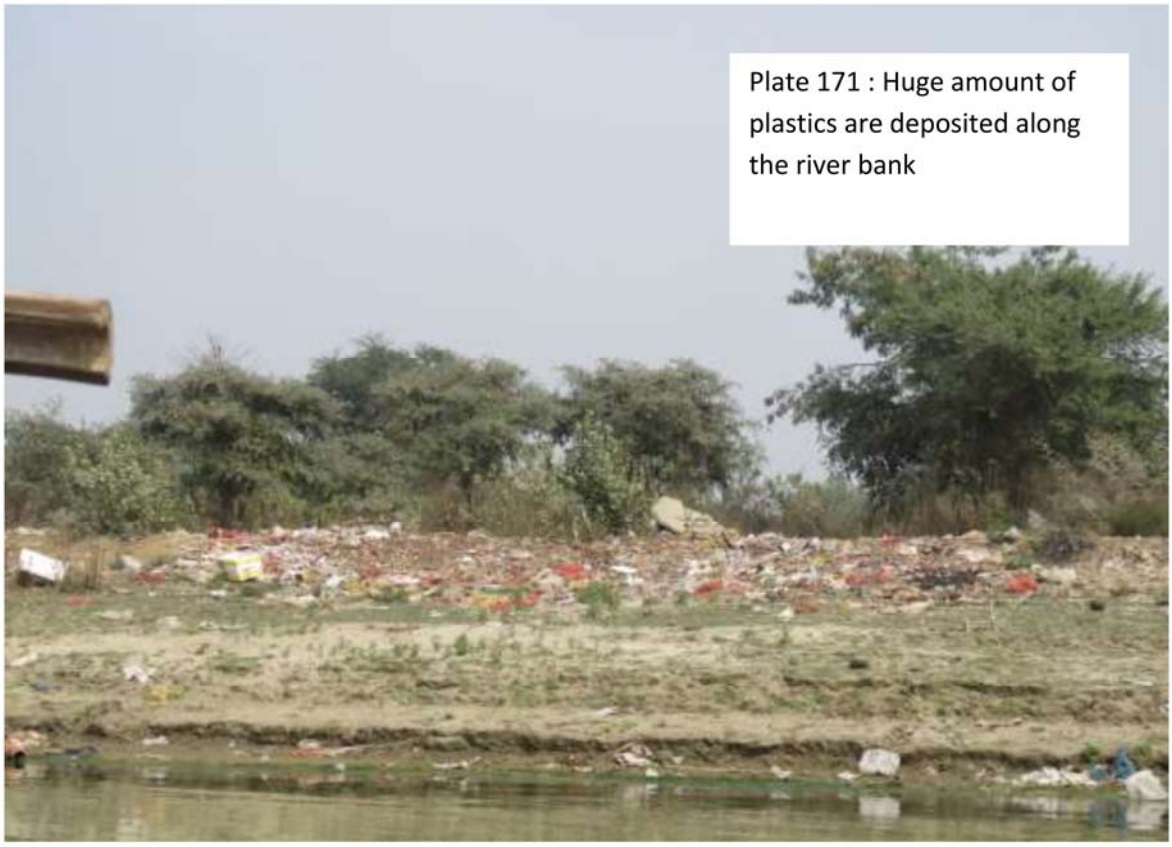
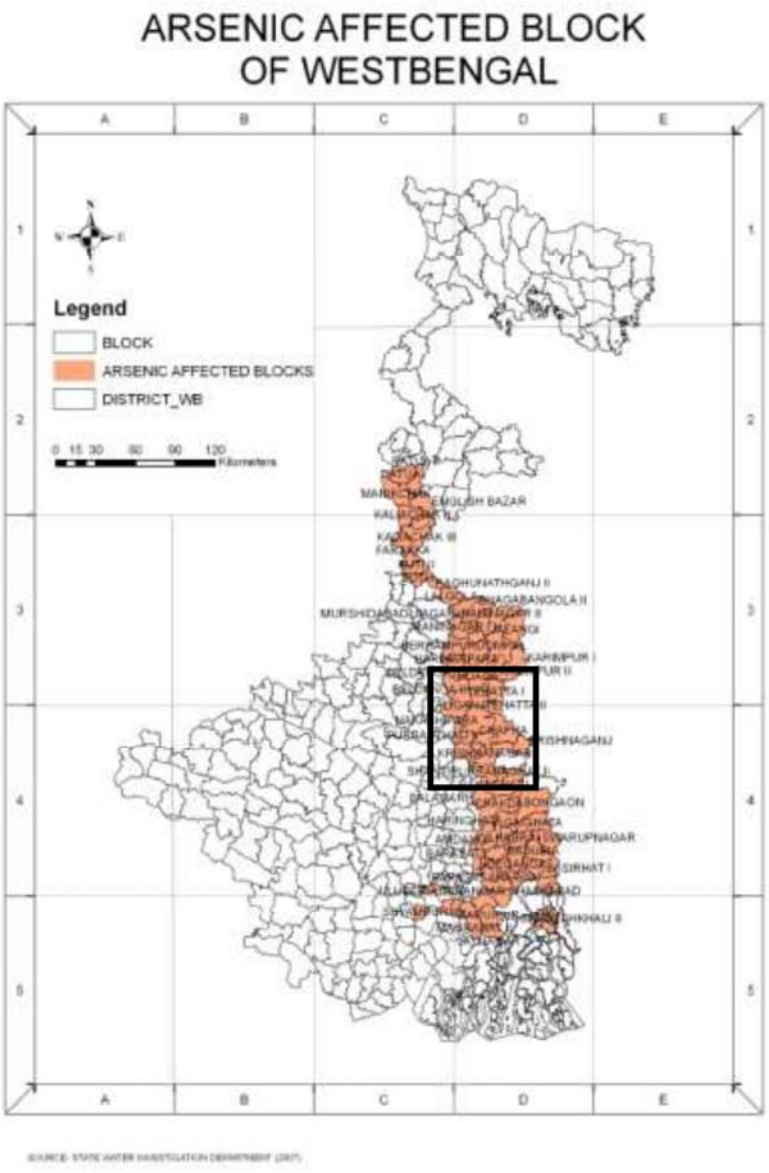


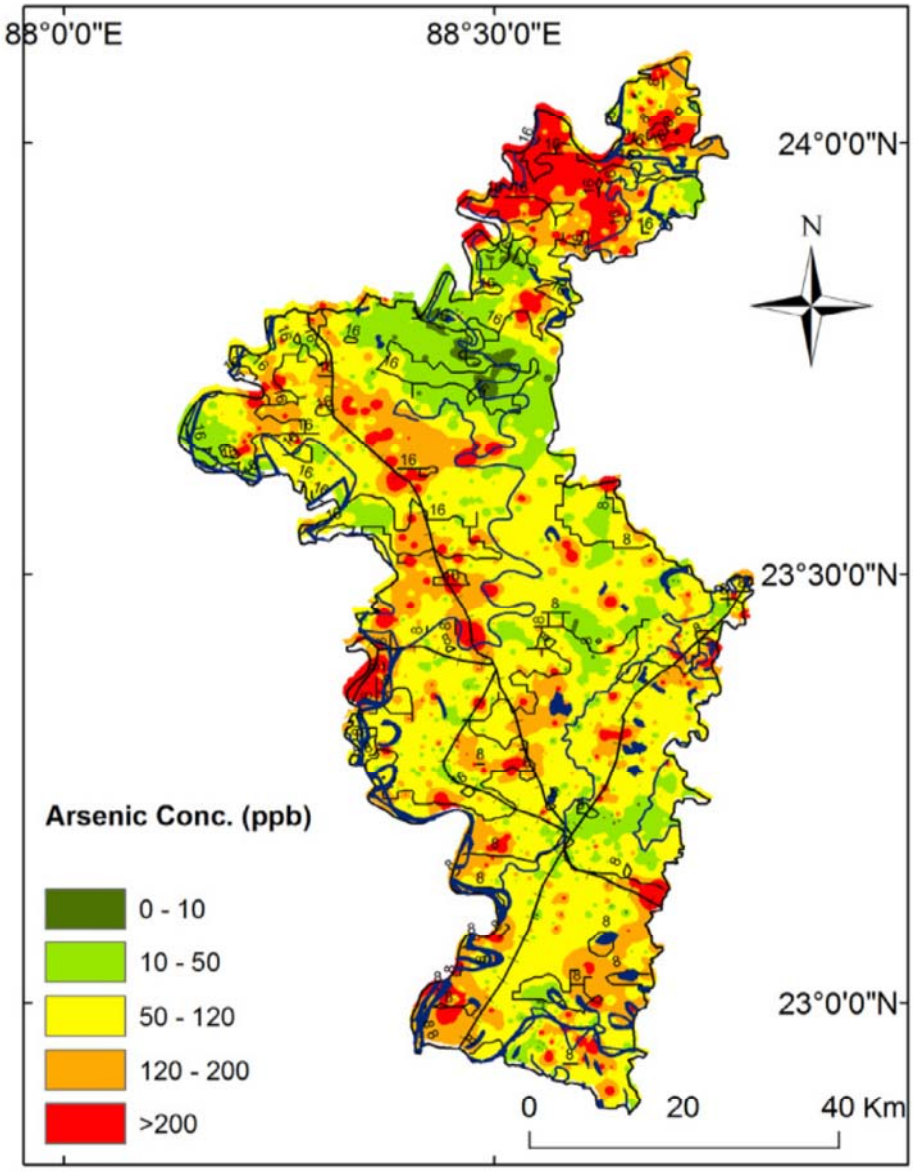
Plate 171 : Huge amount of plastics are deposited along the river bank

7.7. ARSENIC POLLUTION & GROUND WATER: The natural occurrence of **arsenic** in groundwater constitutes a major setback in the provision of safe drinking water to millions of people in Asia and worldwide (The World Bank, 2005). This issue makes a wide range of problems in terms of water quality as well as quantity and it is emerged during the past three decades. Arsenic is by far one of the most toxic elements in the environment (Cullen and Reimer, 1989; Dermatas et al., 2004; Hudson-Edwards et al., 2004) and is responsible for the highest risks of morbidity and mortality worldwide, both because of its toxicity and the number of people exposed (Hopenhayn, 2006). The World Health Organization (WHO, 2007) permissible limit for arsenic is 0.01 mg/l for drinking water and FAO permissible limit is 0.10 mg/l for irrigation water (Bhattacharya et al., 2009; Ahsan and Del Valls, 2011). Whereas the concentrations of As in non-contaminated soils range from 0.1 to 10 mg/Kg (Kabata-Pendias and Pendias, 1992). The immediate and long-term impact of using As contaminated water for irrigating paddy soils is a burning concern as arsenic can transfer from water to soil and several studies have proven this phenomenon.Each day groundwater is being withdrawn by the village people for the fulfillment of their basic needs and for agricultural purposes. With the groundwater along



Map 46 : Arsenic affected blocks of west Bengal

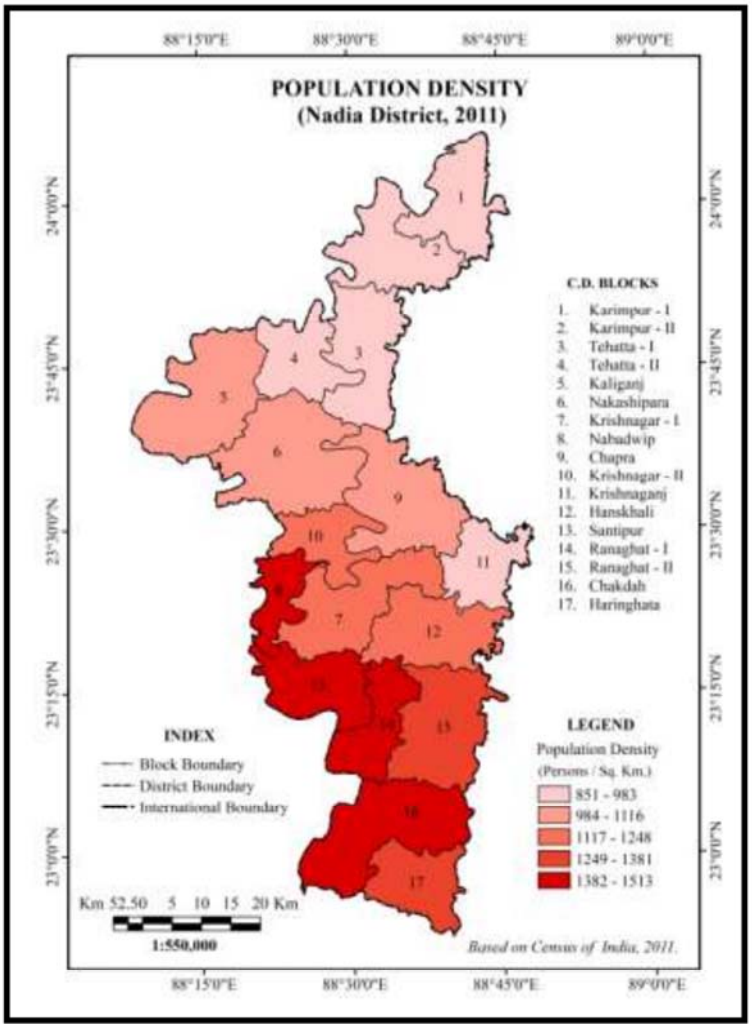
with high concentration of arsenic (As), many other heavy metals are also getting introduced in the environment. In the areas with a long history of use of such groundwater, the agricultural lands have been affected severely. The extent of contamination has increased to a level where the crops grown in those lands are becoming a major source for arsenic and other heavy metals poisoning and subsequently transfer to different trophic levels.



Map 47 : Varying Concentration of arsenic in Nadia district

7.8. HUGE POPULATION PRESSURE AND URBANISATION -

In the study area 27.84 per cent of the total population lives in urban areas which is much less than the national average (31.16 per cent) and the state average (31.87 per cent). The western plain formed by Hugli alluvium containing Nakashi para, Nabadwip, Krishnanagar I, Krishnanagar II, Shantipur, Ranaghat I is the most urbanised region of the district as its 21.57 per cent population leaves in towns, a percentage just below the district average of 27.84 per cent. It contains slightlyhigher than 1/5 of the total urban population. The high concentration of population in urban areas is mainly due to industrial, commercial, administrative, educational and other infrastructural facilities, which have played as a centripetal force in attracting rural mass to these areas. With a population of 5.17 million and an average density of 1316 persons per sq. km. in 2011, Nadia is a fairly densely populated deltaic plain country. The population is unevenly distributed in the four subdivisions, like, Tehatta, Krishnanagar, Ranaghat and Kalyani sub division. Tehatta sub division with 21.96 per cent of the total area supports 15.41 of the total population, while Krishnanagar sub-division, Ranaghat susb-division and Kalyani sub-division with the rest 78 per cent of the total area contain about 84.59 per cent of the total population. Regional variations in population distribution are closely related to terrain, climate, soil and accessibility. Kalyani sub-division in the south, with its rich agricultural and industrial resources and easy access, supports the highest density



Map 48 : Population density Map of Nadia District

of 1693 persons per sq. km. Towards the north, the density declines with increases with altitude, ruggedness of topography and the absence of urban environment.

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13. PROBLEM OF RIVER BANK FAILURE AND THE CONDITION OF THE EROSION VICTIMS: A CASE STUDY IN CHAKDAH, WEST BENGAL, INDIA

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