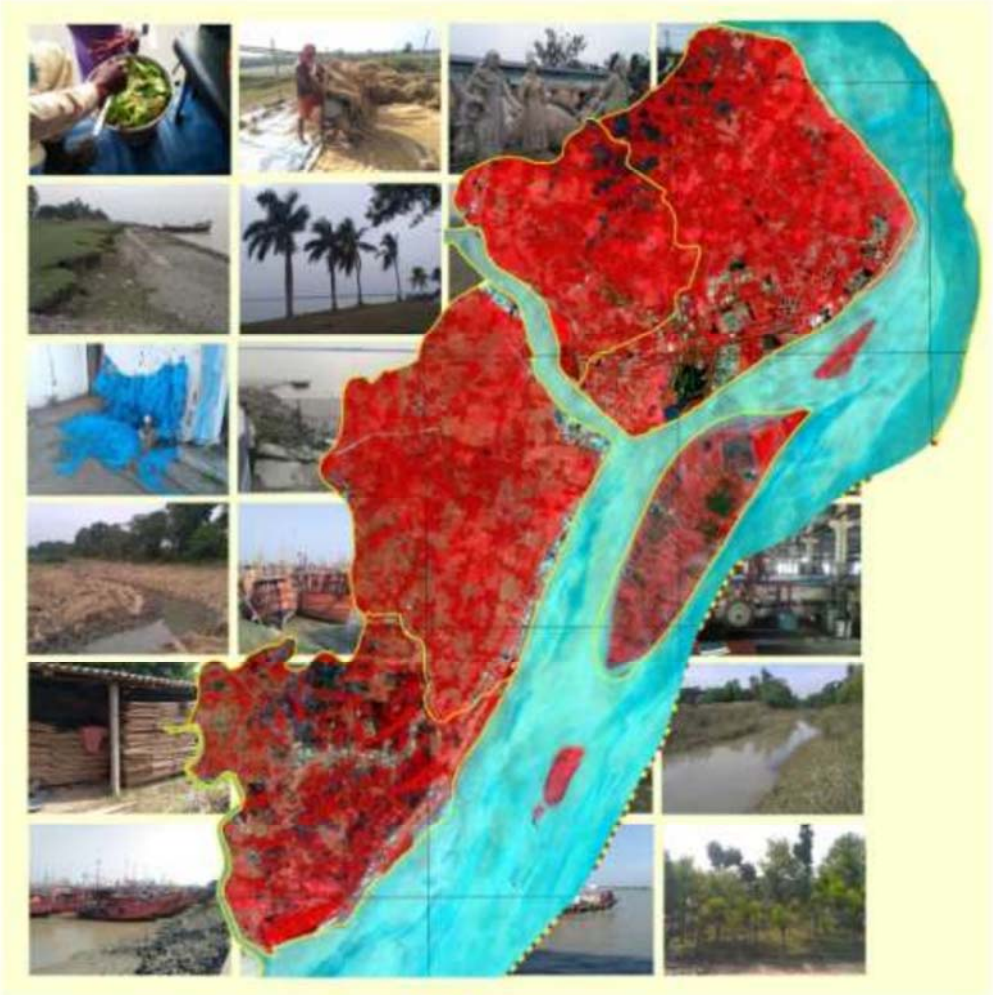
PURBA MEDINIPUR

DOCUMENTATION OF GANGA FROM GOMUKH TO GANGASAGAR



NAMAMI GANGE

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

UNDP	United Nations Development Programme
USGS	United Nations Geological Survey
WBPCB	West Bengal Pollution Control Board
WF	Wetland Fauna

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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

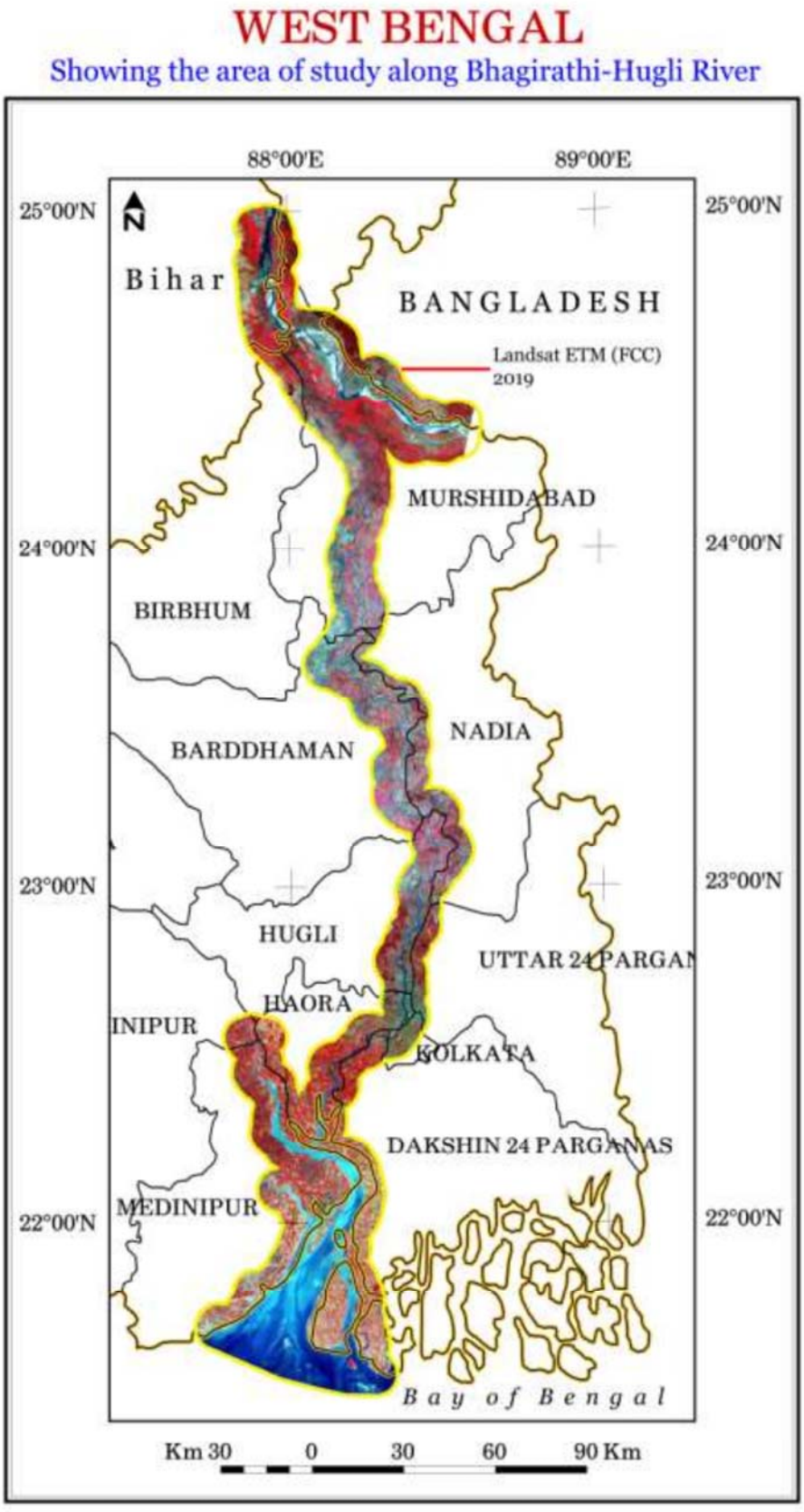
The aims and objectives of NMCG are to accomplish the mandate of National Ganga River Basin Authority (NGRBA) are:

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.

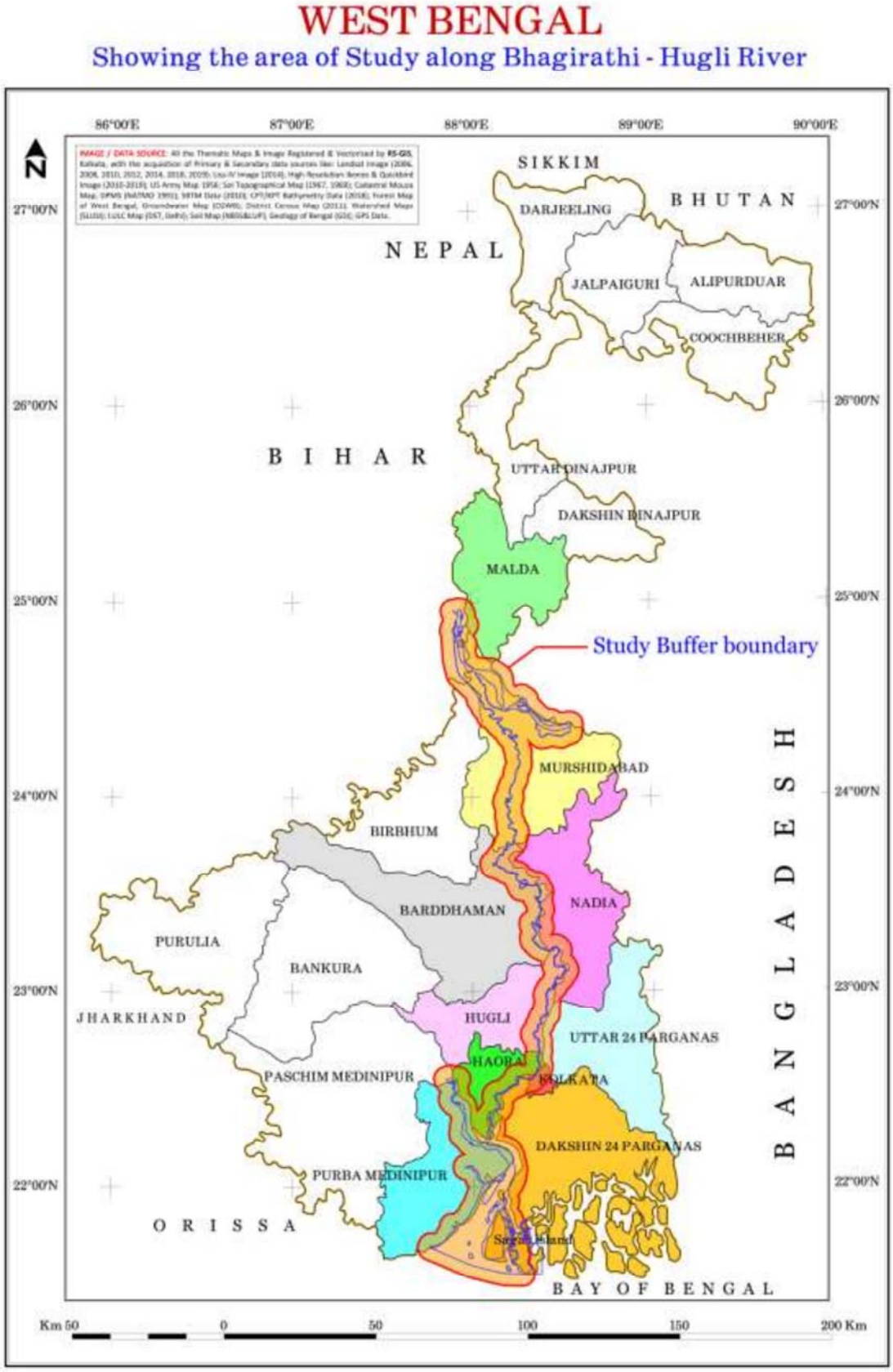
1.2. GANGA CULTURAL DOCUMENTATION

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	Uttar 24 Parganas	09	42 Km	
		H	Dakshin 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:

I. **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.

II. **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.

III. **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:

I. **Literature review:** Library work, Study of published and unpublished reports, News paper articles, Journals and Research papers.

II. **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.

III. **Satellite Data Acquisition (Real-time):** NRSA Hyderabad, University of Calcutta (Deptt. of Geography), USGS Earth Explorer.

IV. **Base-Map Preparation** (for whole Project area)**:** Consulting Topographical maps, Census maps, DPMS & Recent Multi spectral Satellite Image.

1.4C. Field Survey:

I. **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.

II. **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:

I. **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.

II. **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

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

IV. **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:

I. **Landuse Land cover units:** Physical & Cultural units on land surface to be verified after revisit the area with recent Satellite Image.

II. **GPS locations:** After Overlaying the data on Satellite Image (Google Earth Image) Cross-checking will be done

III. **Water Sample analysis data:** COD, BOD, pH, EC, DO, Turbidity analysis of Water samples.

IV. **Flora/Fauna:** Riparian, Sacred Species with their environment.

1.4E. Preparation & Submission of Report

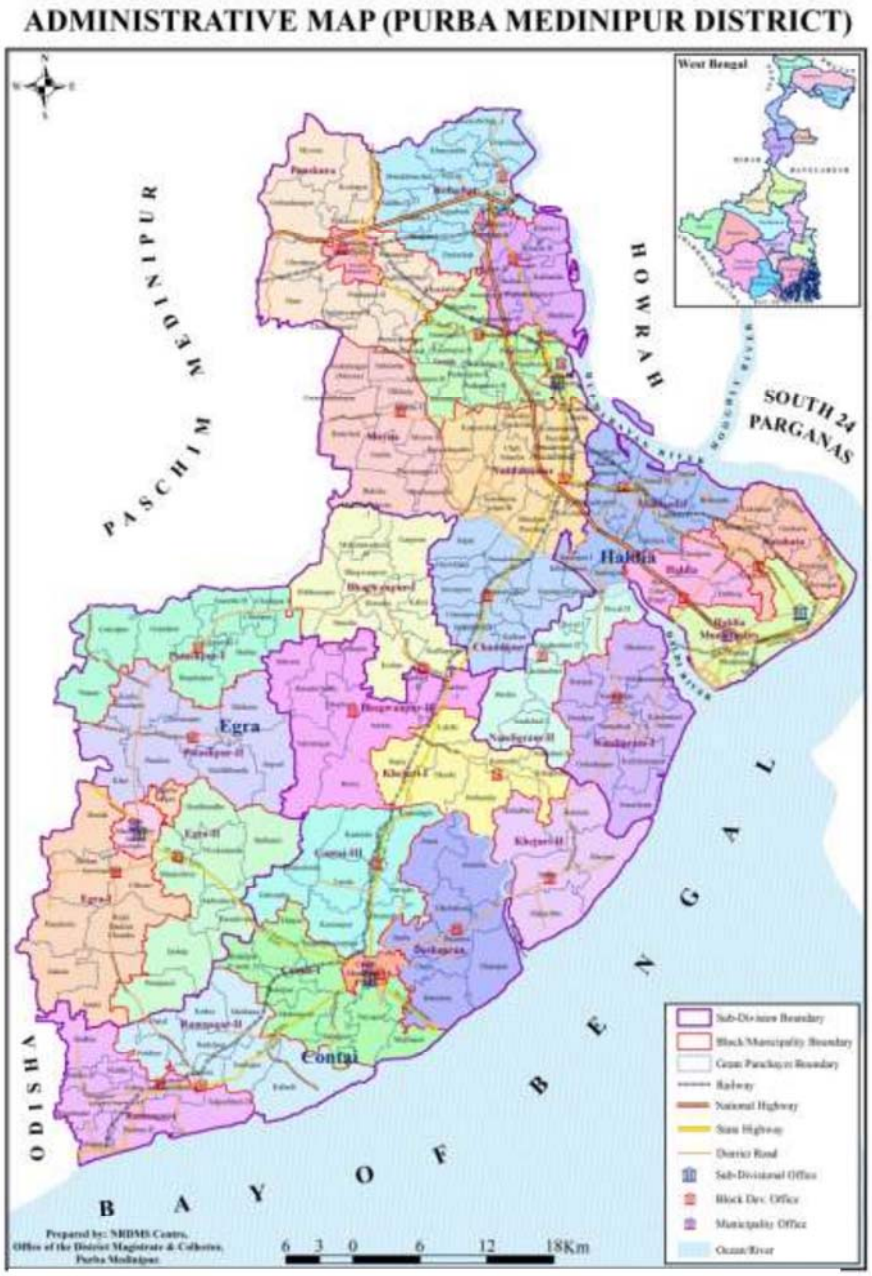
I. **Preparation of Draft Report:** Preliminary Draft Report in Soft & Hard copy mode (1 Colour Printed) of each District will be submitted to INTACH, Kolkata Convener for Verification / Correction

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

III. **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. Covering an area of **4736 sq.km,** Purba Medinipur (East Medinipur) is one of the southernmost districts of West Bengal, bounded by Hugli River and South 24 Parganas in east, Paschim Medinipur in west, Haora in north Odisha in South west and Bay of Bengal in South. The District is divided into 4 Sub-Divisions – Tamluk , Haldia , Egra & Contai which is further subdivided into 25 Blocks namely – Nandakumar, Moyna, Tamluk, Sahid Matangini, Panskura 1 & Panskura 2 , Chandipur, Mahisadal, Nandigram 1 &2 ,Sutahata Haldia, Bhagawanpur–I,Egra–I, Egra–II, Pataspur–I , Pataspur–II. Kanthi–I, Deshpran, Kanthi–III, Khejuri–I, Khejuri–II, Ramnagar–I and Ramnagar–II & Bhagawanpur–II.



Map 3– Administrative Map of Purba Medinipur

2.2. Our Study area includes - Mahisadal, Nandigram 1 ,Sutahata Haldia in Haldia Sub Division , Khejuri II in Contai Subdivision.

2.3. It was formed on 1 January 2002 after the partition of Medinipur District Purba Medinipur and Paschim Medinipur which lies at the northern and western border of it.

In our Study area , we will be

covering the following blocks –

Sl	Name of the Blocks	Police Station	Area to be covered
1	Mahisadal	Mahisadal	32 Km, Littoral Tract
2	Sutahata	Sutahata , Durgachak	
3	Haldia	Haldia	
4.	Nandigram-1	Nandigram	
5.	Khejuri II	Talpatighat Coastal P.S /Khejuri P.S	

2.4. Tamralipta, the port in ancient India, is believed by scholars to have been around modern-day Tamluk. It is mentioned in the writings of Ptolemy (150 AD), the Greco-Egyptian writer, as well as Faxian and Xuanzang, Chinese monks and travellers. It was the main port used by Ashoka, the Mauryan emperor. With too much siltation the port lost its importance around 8th century A.D

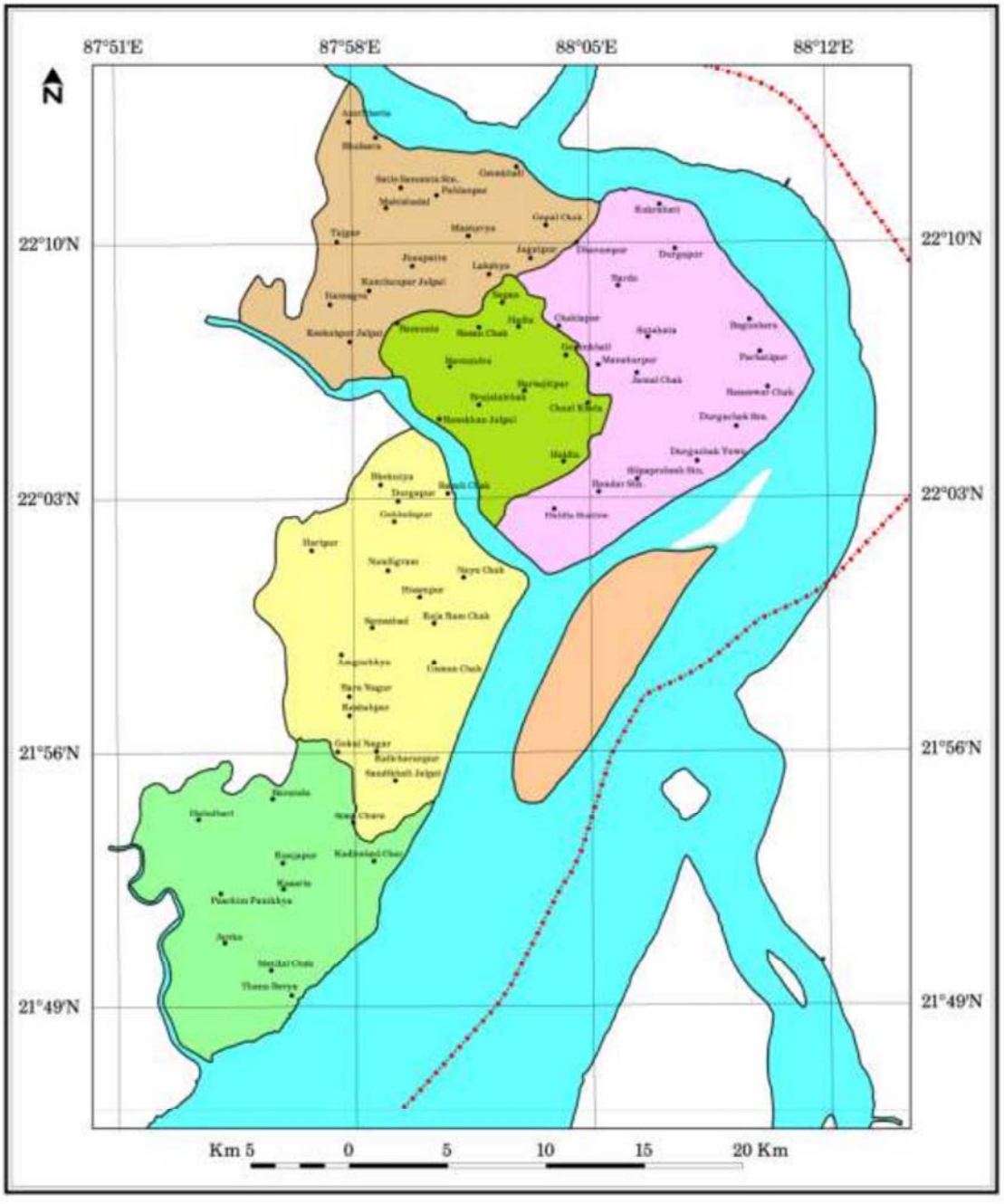
2.5. Purba Medinipur district is part of the lower Indo-Gangetic Plain and Eastern coastal plains. The vast expanse of land is formed of alluvium and is composed of younger and coastal alluvial. The elevation of the district is within 10 meters above the mean sea level. The district has a long coastline of 65.5 km along its southern and south eastern boundary.

2.6. At Geokhali , at Mahisadal Block , River Hugli receives one of its largest tributaries – River Rupnarayan after which the combined stream meets up with Bay of Bengal.

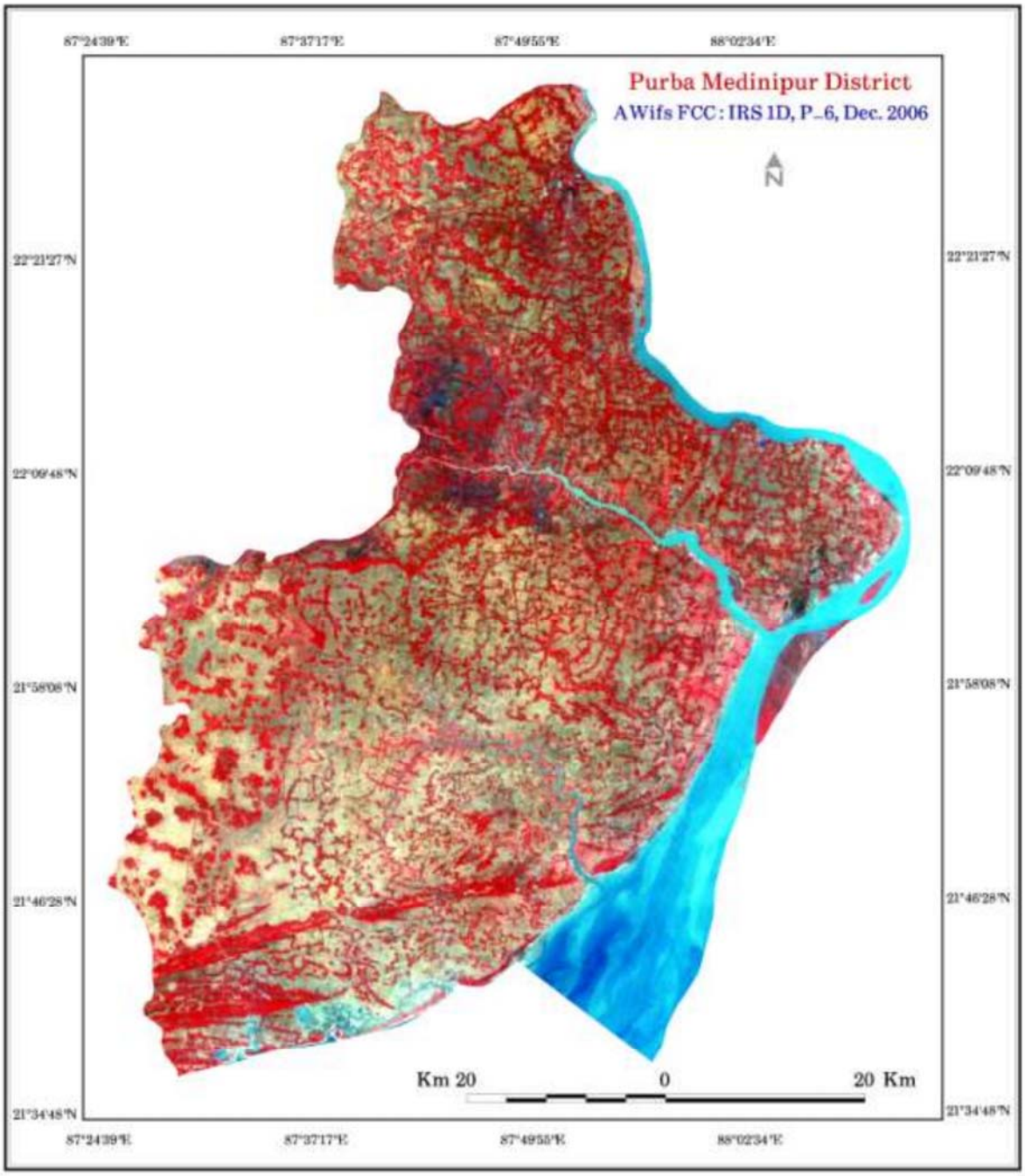
2.7..At the confluence of the river Bhagirathi-Hugli and the Bay of Bengal, Hijili Island emerged from the estuarine surroundings approximately within 1400-1500 A.D. Later the island was covered with natural mangroves. Gradually it became the abode of fishermen. Through many geomorphological, social, economic, political and historical phases it had come to the present state. Characteristically, Khejuri-Hijli is formed with ordinary alluvium of the Gangetic delta. The area is inclined to the South East direction with gentle undulating surface created by the waving rolls of the Bay of Bengal. In the early age of the formation of this tract it rose slightly above sea level and was intercepted by a number of tidal creeks. This area was then occupied by some tribal communities of fishermen, boatmen and sailors. Since long past it had a great locational importance because it was situated between the great historical port Kolkata and Piplipattanam (A port near Subarnarekha river mouth). At the time of emergence of this land, it was intersected by Cowcolly River, a tidal creek, and the two islands namely Khejuri and Hijili were formed. After the decaying of Cowcolly River the said islands were merged and the total area is called Khejuri.

2.8. Khejuri was a famous port till 18th century. Till the first half of the 19th century it was known to the British as **Kedgeree**. The British established their control over the area in 1765 and by 1780 had established a port and factory there. A light-house was built in 1810 at Dariapur, a village about five miles south of Khejuri. It is near the mouth of the Rasulpur River. People from various parts of India come to visit this historical place. It's also here where Bankim Chandra Chatterjee's novel's Kapalkundala temple is situated. Sagar Light House is located 13 miles away across the river on Sagar Island. Kaukhali light-house was abandoned in 1925. Raja Rammohon Roy left for England from this port. The first Telegraph line (1851-52) of India was established here between Calcutta and Khejuri. 5 miles south from Kaokhali is Kasba Hijli village, it was Taj-Kha's capital. Job Charnak established his first camp here.you can see Hijli Nabab family's founder Taj-Kha Masnad-E-Als's Tomb (1555) here. The mosque here is very famous.

2.9. Purba Medinipur saw many political movements during the British Raj. A parallel government named the **Tamralipta Jatiya Sarkar** was formed during the Quit India Movement in Tamluk. In 2007, Purba Medinipur witnessed the Nandigram violence, an incident of police firing that killed 14 farmers.



Map 4– Study Area , Purba Medinipur District



Map 5 – Satellite Image showing Purba Medinipur District

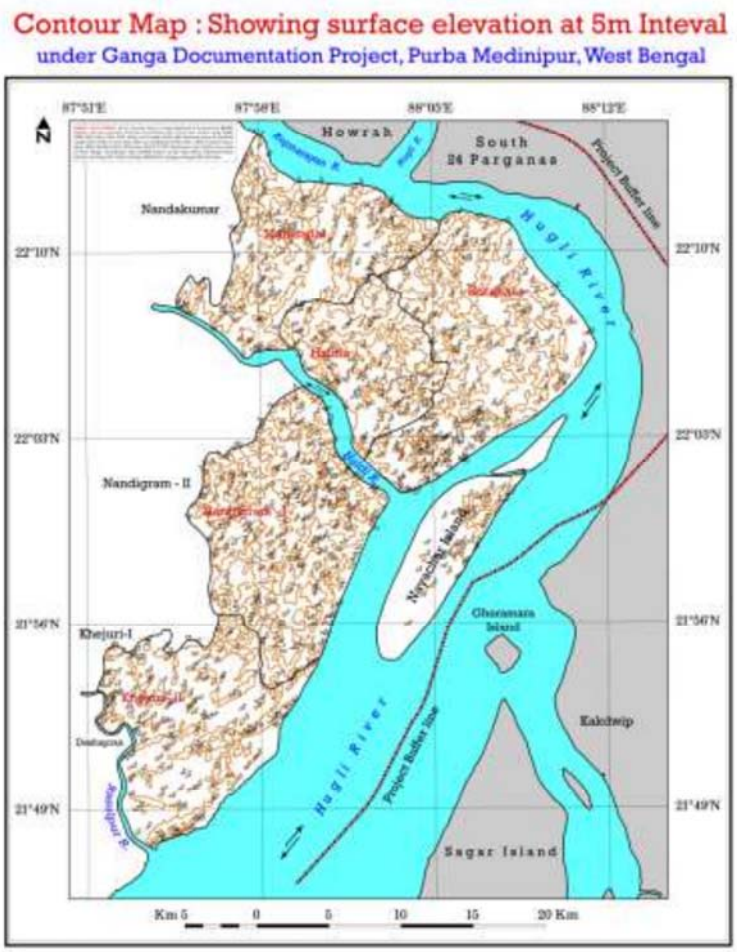
2.8. Ganga in Purba Medinipur : This is by far one of the most significant part of our study since here in this portion River Ganga opens up into the Bay of Bengal thorough its main distributary channel Bhagirathi Hugli. The rivers of the district were formerly distributaries of the Ganges, *ie.,* they were the channels by which its waters were distributed and ultimately discharged into the sea ; but the main current of that river has long since been deflected to the east, and their connection with its channel has been closed or silted up, so that they have ceased to be effective effluents. **The Hugli**, which is the most westerly of the channels by which the waters of the Ganges enter the Bay of Bengal, it marks the eastern boundary of the district. In our study area , 3 major rivers open up in Hugli River adding water to the drainage system. They area – **Rupnarayan river , forming the northern boundary , Haldi river and Roosulpur River.** Rupnarayan River confluences with Hugli at **Geokhali** , Mahisadal Block of Purba Medinipur.

Map 6- Landsat Image , FCC showing the study area -7km Buffer line

Plate 1 – The wide Rupnarayan River before joining with Hugli River. Plate 2–River Bhagirathi Hugli , near Haldia.

Chapter -3 : Physical Environment

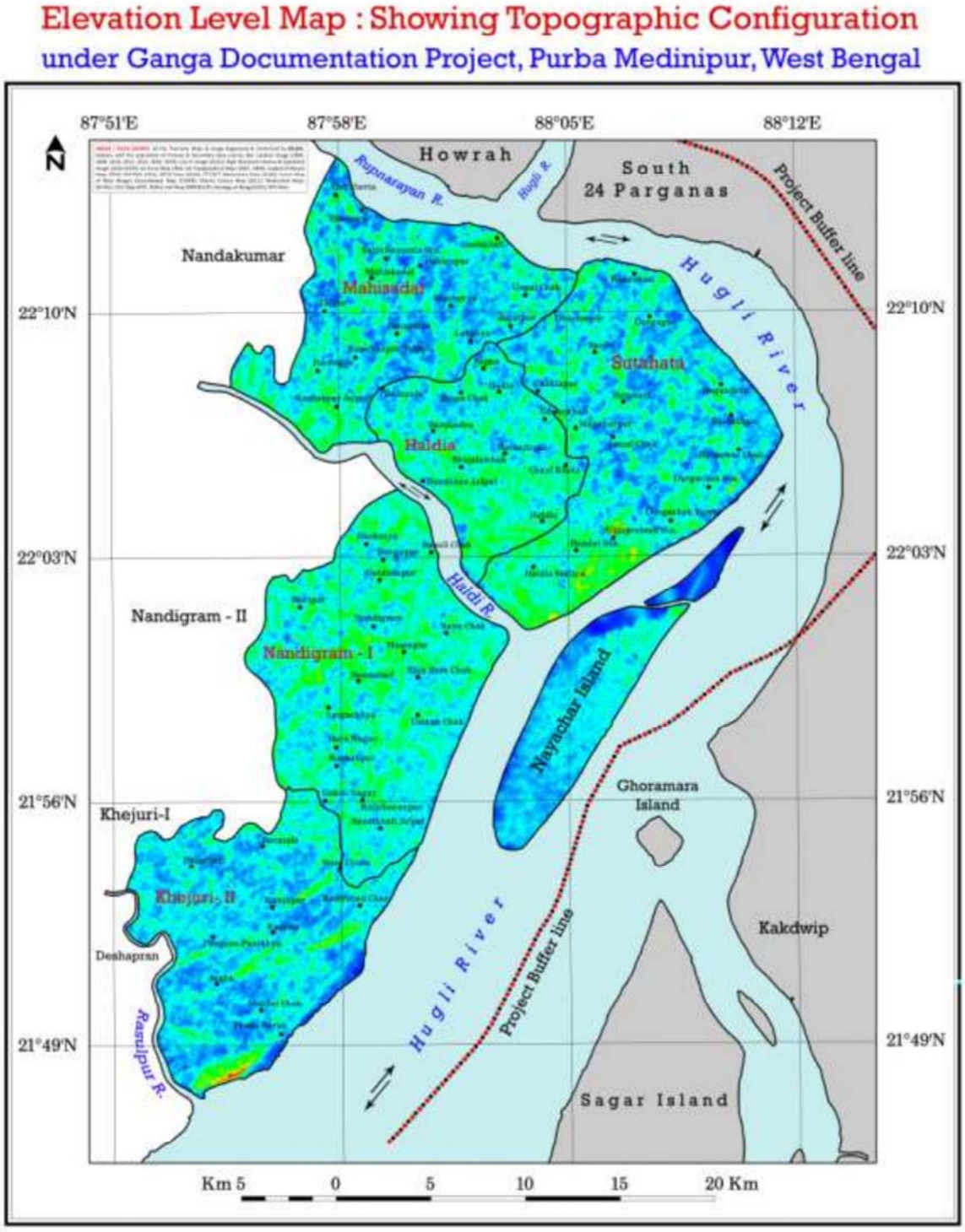
3.1. **Relief:** Most of the southern districts of West Bengal are characterized by flat gentle and large plains. Purba Medinipur is not an exception. Owing to its geographical position, undivided Midnapore was one of the most varied (in respect of physical aspects) district in West Bengal. The north-western part embraces a portion of eastern fringe of Chotanagpur Plateau and consists of hard laterites.The eastern part of the former undivided district is formed ofpure alluvial deposits borne by the river Hugli (Fig. 2) and its tributaries from the Great Gangetic System of Upper India. This eastern part emerged as the newly formed Purba Medinipur district in January, 2002. Topographically the district of Purba Medinipur may be divided into two parts –



Map 7 – Relief Map of the study area

(a) Almost entirely flat plains on the east, north and west. This flat plain owes its origin to the alluvial deposits of river Hugli, Rupnarayan, Haldi and Kangsabati. (b) The Contai coastal plain in the south of the district bordering the Bay of Bengal.

The general elevation of the whole study area is between 1 meter to 10 meter above mean sea level. The entire district is a level plain broken only by the sand hills which line the sea coast and stretch for some miles inland. The general slope of the whole district is towards the south east.



Map 8 : Elevation Map of the study area

3.2. Geology: The district of Purba Medinipur is underlined with unconsolidated sedimentary rocks of uniform height which gives the country a monotonous relief feature. In general the district lacks any kind of minerals of economic importance. Salt is plentiful in the southern portion of the district bordering the sea. Gold has been found in small quantities in the river sands.

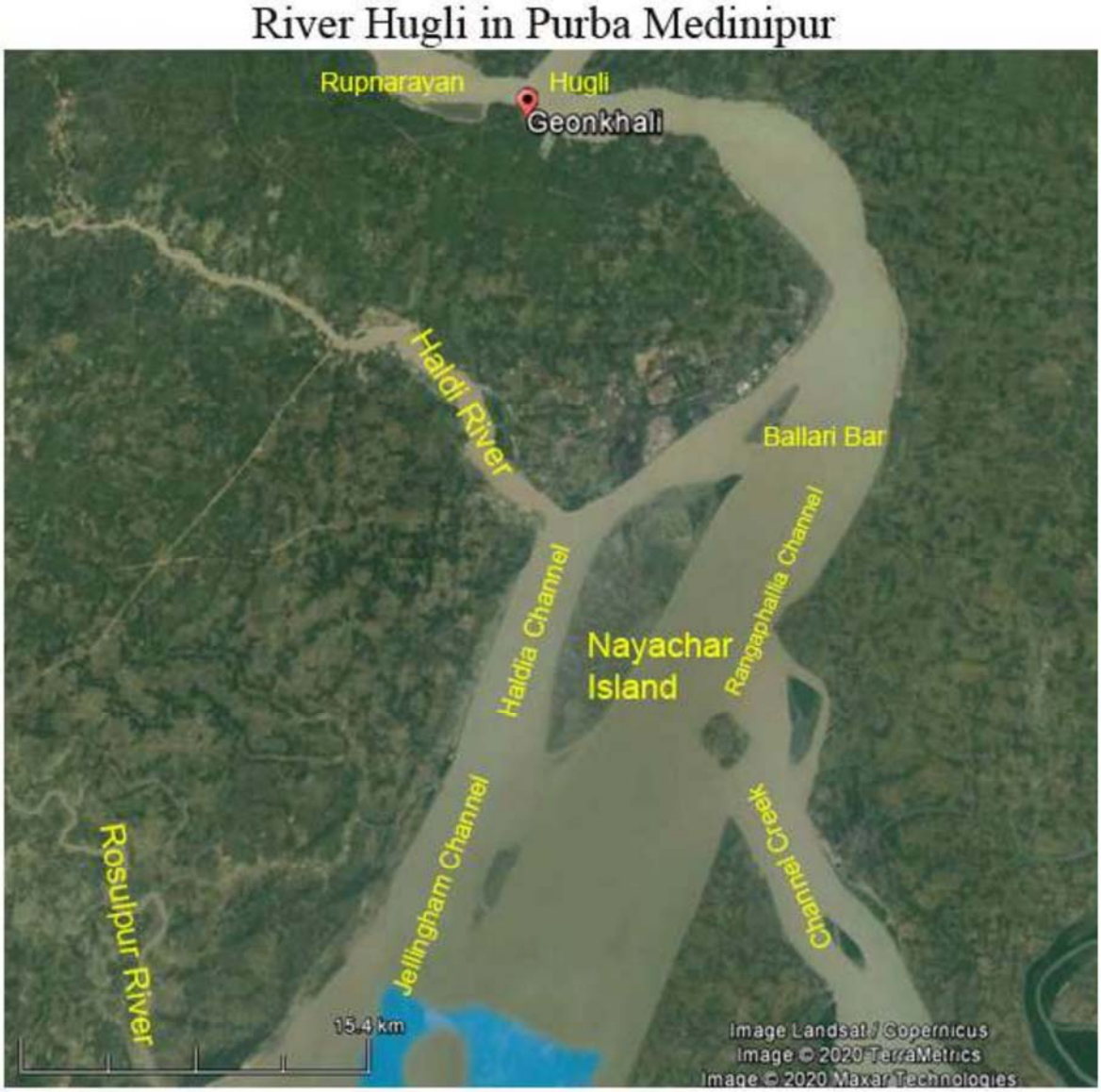
3.3. Drainage Network: The river system of Purba Medinipur district consists of the Hugli as the main river and its tributaries - the **Rupnarayan, Haldi, and Rasoolpur etc.**

Description of Hugli River Course (Medinipur Section) from the Bengal District Gazetteers Midnapor,1911, L. S. S. O'malley

The main channel first runs along the Midnapore side of the river down the Hugli Bight, which extends from Geonkhali Point on the right bank of the Rupnarayan for a distance of 3.5 miles to Luff Point, passing by the indentation called Puppies' Parlour.

Jt then swings other side along the Kukrahati Reach, which extends for a distance of 1.5 miles from Luff Point to Buffalo Point and is so called from the village of Kukrahati lying midway between them on the right bank. After this, it follows the left bank along the Diamond Harbour Reach, which turns to the south along Kantabaria Reach, where the Chingri Khal debouches into it. The channel then passes into the Kalpi Roads, which stretch from Diamond Point to Jigar Khal. The remaining channels between the Kalpi Roads and Mud Point on the north of Saugor Island are the Outer and Inner Rangafulla, Bellary and Haldia channels ; but from Kalpi to Saugor the channels constantly shift as the sands alter their shape and position. They form or wash away more or less rapidly, and do not, like the sands in the upper parts of the river, alter with the seasons with such regularity. Then, in order, come the Jellingham, Mud Point, Dredge and Auckland Channels, and then the Eden Channel, along which are the Kaukhali (Cowcolly) Roads, which used to be a general anchorage and main ohannel for vessels as late as 1861-62. The most interesting places in this latter portion of the course of the Hugli are Khejri (Kedgeree) which was formerly a reporting station for vessels, the Cowcolly lighthouse, the Hijlii flat, which stretches out from the shore below the Cowcolly lighthouse, and the Hijili temple, which stands 3.5 miles south-west of it on a point between the mouth of the Rasulpur river and the shore line. From Khejri to this point, and also below it, is a line of white sand hillocks interspersed here and there with a little brushwood and grass.

After receiving River Rupnarayan at Geokhali , 22°12'13.66"N ,88° 2'52.72"E at Mahisadal Block of Purba Medinipur , River Hugli moves towards east upto Kukrahati Ferry Terminal 22°11'17.21"N, 88° 7'12.81"E of Sutahata Block of Purba Medinipur . After moving 10 km south east upto Baneswar Chak , the river takes a sharp bend towards south 22° 6'33.78"N 88°11'38.12"E to join with Bay of Bengal. At Haldia , the river is joined by another important tributary , River Haldi , 22° 0'56.67"N 88° 3'22.54"E . River Hugli is bifurcated into Haldia Channel and Rangaphallia Channel by 2 major riverine islands – **Ballari Bar** and **Nayachar** in this location at 22° 3'48.44"N 88°10'27.99"E. River Hugli receives another important tributary called Rasulpur, 21°47'30.29"N 87°53'22.83"E after moving down south for 30 km near the boundary of Khehuri II (erstwhile Hijli) and Deshpran Block of Contai subdivision.



Map 9 - Major Channels in Purba Medinipur

Plate 3 - The Confluence Point of Hugli River and Rupnarayan river at Geonkhali 22°12'13.66"N ,88° 2'52.72"E

Plate 5– River Hugli takes a bend in the south from Kukrahati , 22°11'17.21"N, 88° 7'12.81"E of Sutahata Block

Plate 6 – Patikhali Jetty Ghat , Durgachak , Haldia near the mouth of Haldi River , 22° 0'56.67"N 88° 3'22.54"E

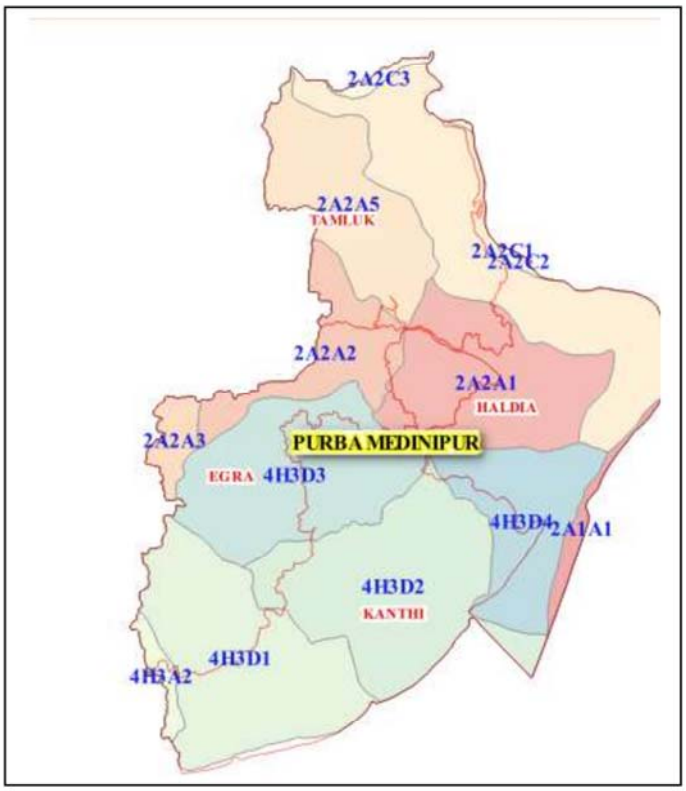
Plate 7 – Haldi River , opening up in Bhagirathi Hugli River , near Haldia 22° 1'1.93"N 88° 3'27.92"E

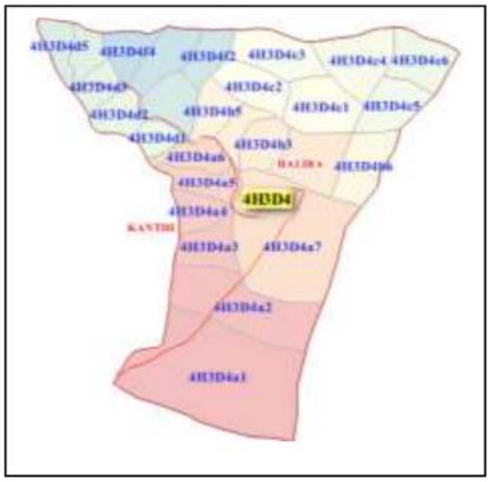
Plate 8– Rosoolpur River near Pratappur , Hijli , Purba Medinipur 21°47'47.31"N 87°52'58.50"E

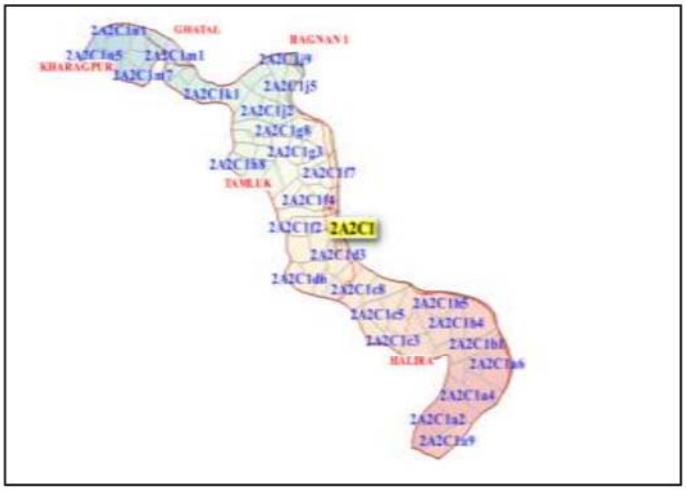
Plate 9 : West Bengal Fisheries Nayachar Island , 22° 0'41.27"N 88° 6'24.89"E

3.4. Watersheds of the Study area – Our Study area falls under 4H3D2,4H3D4, 2A1A1,2A2C2 sub-watersheds covering the portions of Tamluk, Haldia and Kanthi area of Purba Medinipur.

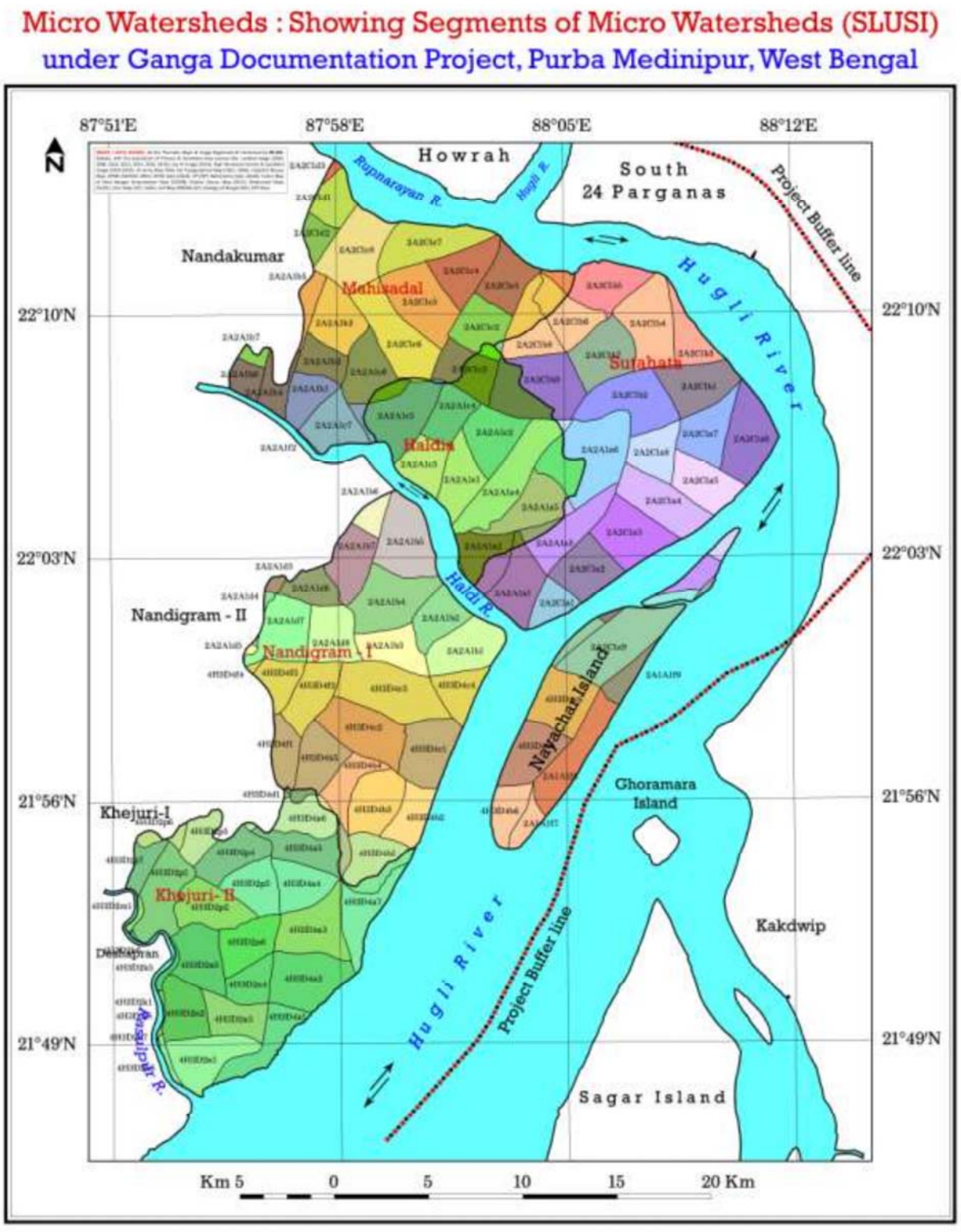
These sub watersheds are again further divided into micro watersheds







Map 10– Sub Watersheds of Purba Medinipur , Map 11 – Micro Watersheds of our study area. Source- SLUSI .



Map 12 : Micro watersheds of the study area

3.5.Climate

Climate of Purba Medinipur district is of monsoon type with hot and humid summers and dry winters - a common phenomenon of monsoon climate.

i.***Temperature***

The general temperature of Purba Medinipur district remains more or less hot throughout the year like other districts of southern part of West Bengal. High day temperature is a feature in the hot summer months. The year 2003 received highest maximum temperature of 39°c in the month of May. The temperature remains high during the months from March to September. The winters are generally soothing. The minimum winter temperature ranges between 15°c and 22°c. The average annual temperature of the district is about 26.5°c. The following table (Table-1) shows the month wise temperature and rainfall for the district of Purba Medinipur for 2003.

ii. Rainfall

Due to the northward movements of cyclonic storm from the south of the Bay of Bengal a very meager amount of rainfall occurs in the cold months of November, December, January and February. During this time cloudy weather and light rainfall occurs due to the passage of northerly trade winds. Heavy rainfall occurs owing to the occasional incursions of cyclonic storms during the period from May to October. During the southwest monsoon season the weather conditions in Purba Medinipur district resembles to that of southern Bengal. The monsoonal precipitation is mainly associated with cyclonic storms and inland depressions. The annual rainfall varies from 1400 millimetre to 1600millimetre. The Contai littoral tract receives the highest amount of rainfall in comparison to the other parts of the district. The monsoonal rain tends to decrease from the coastal part towards the north-west. During the year 2003 the month of October has received the maximum rainfall of 584 millimetre in comparison to the occasional monsoonal months of June-July etc. This is due to the occurrence of strong depression at Bay of Bengal which generated cyclonic storms and heavy downpour. There is a strong relationship between these two variables; more the number of rainy days, much is the amount of rainfall. During the occasional monsoonal months of June July etc heavy downpour occurs within fewer days in comparison to other months. Purba Medinipur district received 315 millimetres of rainfall in 2004 only within 9 days in the month of June and 584 millimetres within 15 days of October in 2003. Annual heavy downpour has become

a menace of flood in the district of Purba Medinipur.

iii. Winds

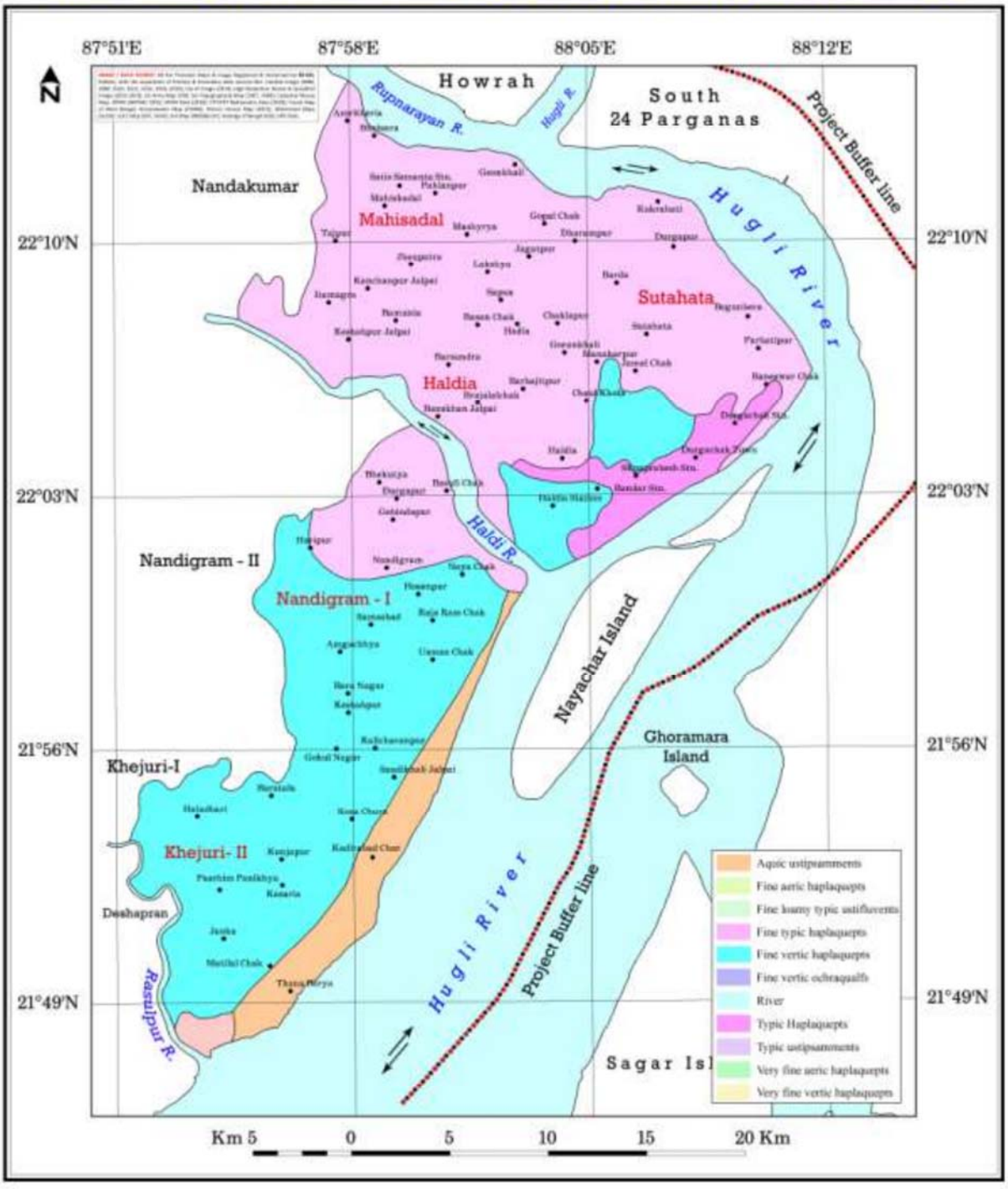
Local breeze begins to blow during the month of March. This hot and dry breeze is known as loo which is a very typical summer feature of southern Bengal. From the beginning of June this wind is replaced by south-west monsoonal breezes and continues till the month of October. Cyclonic winds are frequent in the district during summer months and this causes the monsoonal downpour.

3.6. Soil : The district of Purba Medinipur has vast expanse of alluvial soil and is composed of younger alluvium or *Entisols* . In our study area , we mostly find 2 categories of soil types . They area – a. Younger Alluvium or *Entisols* Group and b. Saline and saline-alkali soils of *Aridisol group*

The Entisols are mostly found in the strip of purely deltaic land bordering Rupnarayan and Hugli rivers. The second division consists of the coastal alluvium of *Aridisol* group. Much of the tract is salifereous and has been protected from the incursions of the sea by a long embankment. There is a long, narrow, and elongated strip of saline and saline-alkali soils of Aridisol group, stretching from Digha to the eastern portion of the Haldi river. Peculiar range of sand hills is found in this portion. It can be said probably these sand ridges at one time formed the coastal line.

The third division consists of the alluvial tract of the remaining small portion of the district. This alluvium is older in nature and can be grouped under *Alfisols* group. Along

the river beds are constantly rising due to enormous siltation and therefore the surrounding area is protected by embankments. These embankments obstruct the natural drainage with the result that the soil being deprived of its increment of deposit and therefore is permanently depressed resulting in frequent water logging during the monsoons.



Map 13 : Soil Map of the study area

3.7. Ground Water :

Water level below the ground surface in the Purba Midnapur district varies from 3-15 m during pre-monsoon to 4-12 m in the post-monsoon period. Generally, brackish water is found in all the aquifers below sand dunes up to the depth of 120-300 m towards south east region to as high as 450 m around Contai.

Our study area falls under the semi confined to confined condition in both the litho systems and receives recharge from a distant area, the exact amount of recharge is difficult to determine .

Status of Ground Water Development Block – (Blockwise)

Block	Tentative Aquifer Zones in bgl	Aquifer Potentiality & Chemical Quality
Mahisadal	55-62,137-143,150-156,183-189,2130,222,240-252,257-263,330-346	Upper aquifer within 120mbgl is brackish/saline. Potential fresh aquifer is below 120 mbgl Aquifer is under Confined condition . HDTW tapping granular zone of 30-40m within depth 300mbgl yield 100-200m3/hr. T values range 400-2000 m2/day S values range 1.4x10-4 to 9.0x10-4 Ground Water is Na-Ca-Cl-HCO3 Type
Nandigram 1		
Haldia	55-64,102-108,116-121,130-136,155-160,164-170,177-183,203-225	
Sutahata		
Khejuri II	50-60,226-228,236-254,265-280	

According to CGWB , the coastal block s of Mahisadal -1 , Sutahata-1 shows a declining trend in Pre Monsoon and Post Monsoon . This indicates that ground water draft in these blocks have exceeded the subsurface outflow of groundwater through the deeper acquifers. Another major problem of in groundwater development in East Midnapur district is the occurrence of saline water in the near surface shallow aquifer in the coastal zone. The existence of a thick clay bed at the top of the sedimentary sequence and the saline water in the near surface aquifers has restricted the development in the ground water in the shallow aquifers in the coastal area. Haldia Industrial Complex area falling under our study area has ground water in confined condition. In the last 3 decades the demand of ground water in this heavily industrial belt has increased manifolds . Annual withdrawal of fresh ground water in the area is 24.63MCM and the annual ground water flow through the confined aquifer is 5.348MCM leaving an annual deficit of 18.282MCM.

Plate 10– Deep Tube Well at Nayachar is the main source of drinking water. Plate 11– Submersible pump in Sutahata , Purba Medinipur (Worshipping is done by the women folk since it is the primary source of irrigation)

3.8. Natural Vegetation: The Coastal belt of Midnapore District represents 27% of West Bengal of coastal tract (60 Km) extending along the West Bank of Hugli estuary from New Digha and then curving around Junput, Dadanpatrabar, Khejuri and Haldia on the east to the further north east up to Tamluk or even on the bank of Rupnarayan . This beach-dune-mudflat system presents different kind of management challenges including prevention of coastal erosion and development of sustainable tourism with effective control of pollution of the coastal region. Thus this vunerable zone is under Integrated Coastal Zone Management Project which along with Forest Directorate , ZSI ,PHED looks after the environmental health condition. The coastal tract of our study area – Nandigram 1, Khejuri II & Mahisadal is under the protection of ICZM.

The low lying swampy land laid out in rice fields consists of flora corresponding to that of southern West Bengal. Towards the south-east and near the river Hugli the flora resembles to that of savannah swamps of the Sundarbans. **Hogla** (*Typha elephantina Roxb*) **Kans** (*Saccharum spontaneum)* , and **Nal grass** (*Phragmites karka*) are the dominant species found in the riparian tract of the study area . Both the grasses are used for making the roofs of rural area. Our entire study area was once part of the Kingdom called Hijli. This name has been derived from the tree called " Hijal Tree/Indian Silk Oak (*Barringtonia acutangula)* " which grows in the moist low lying area. Hijal Tree bears beautiful red coloured flowers.

List of Trees found during Survey -

Sl No	Name of the Plant species	Scientific Name	Remarks
1	Arjun	*Terminalia arjuna*	widely as wood of commerce even for fuel wood purpose
2	Amra	*Spondias pinnata*	
3	Kalo Jam	*Syzygium cumuni*	
4	Khiris	*Samania saman*	
5	Gab	*Diospyros malabarica*	
6	White teak , Pitali	*Trewia nodiflora*,	
7	Indian tulip tree	*Thespesia populnea*	
8	Jhau	*Casuarina equisetifolia*	
9	Gulmohar)	*Delonix regia*	
10	Cadam),	*Anthocephalus cadamba*	
11	Babla	*Acacia nilotica*	
12	Sonajhuri	*Acacia auriculoformis*	
13	Kankul	*Zizyphus oenoplea*	Fruits are used for commercial purpose
14	Topa kul	*Z. jujube*	
15	Sajne/Sanna	*Moringa oleifera*	
16	Piyara	*Psidium guajava*	
17	Kitchmich	*Pithecellobium dulce*	
18	Aam	*Mangifera indica*	

19	Narkel	*Cocos nucifera*	
20	Tal	*Borassus flabellifer*	
21	Khejur	*Phoenix sylvestris*	
22	Caesarweed	*Urena lobata*	Medicinal Purpose
23	Nishinda / Chinese chaste tree	*Vitex negundo*	
24	black creeper	*Ichnocarpus frutescens*	
25	Devil's cotton	*Ambroma augusta*	
26	Helonchi,Helchi bodo	*Enhydra fluctuans*	
		Wedelia calandulacea	
28	Orangeberry	*Glycosmis pentaphylla*	
29	Chaff-flower	*Achyranthes aspera*	
30	Basak	*Adhatoda vasica*	
31	Bagan Bilas	*Bougainvellia spectabilis*	Ornamental purpose
32	Tree Tulip	*Spathodia campanulata*	
33	Kalke	*Thevetia peruviana*	
34	Kadam	*Anthocephalus cadamba*	
35	Hijal	*Barringtonia acutangula*	

Plate 12 : Bamboo Cluster adjoining a canal in Khejuri II. 21°57'15.86"N 88° 0'55.20"E

Plate – Casurina Plantation in Khejuri II coastal area under Integrated Coastal Zonal Mnagement

Plate 13– Hogla Grasses in the Flood Plain region of Hugli river (Near Kukrahati)

Plate 14– Mat stick Grasses along the Haldi River , Haldia .

Plate 15– Kans Grass in the swampy zone adjoining Rupnarayan River

Plate 16 – Mat Stick Grass in the bank of Hugli , Haldia

Plate 17- Mangrove Vegetation mostly *Baine* along the creeks . Nayachar Island , Plate 18- Riparian Grasses (Hogla) along the creeks in Nayachar

Plate 19 – Khejuri Block got its name from Khejur or Date Palm Trees

Plate 20 – All along the Haldia Coastal area , coconut trees are found

Forest Nurseries - Habitats for medicinal plants available along the coast of Purba Medinipur are very interesting. This is due to high and low tide round the year. Here, people use medicinal plants dawn to dusk for their own purpose as these are ready remedies for curing ailments. Knowing the theme in mind, private and governmental nurseries prepare seedlings in nurseries and distribute among people. Governmental nurseries in Purba Medinipur found in areas like Khejuri, Hijli, Nandigram or Jellingham and Sankarpur under Tamluk forest Division. Here staff members in the nursery; prepare stocks on various plants under the category namely medicinal, economic, ornamental, halophytes and some extent wood producers.

Result revealed that, Nandigram forest nursery develops seedlings and or stocks of 9 plant species. Among them, *Bruguiera gymnorrhiza* (Beng.-Kankra, Eng.-Black mangrove) and *Sonneratia apetala* (Beng.- Keora, Eng.- Mangrove apple) are true halophytes. Along the shore line all halophytes are planted and kept in nursery for further readymade use if required . Here, *Portulaca grandiflora* and *Mirabilis jalapa* are ornamentals though large scale use of *Polyalthia longifolia* and *Casuarina equisetifolia* have been used by people to decorate landscape.

Similarly, Khejuri shows 9 important plants which are raised in nursery by forest department. Here, we see *Bruguiera gymnorhiza* an important halophytic plant . *Casuarina equisetifolia* and *Bruguiera gymnorhizai* are used for degraded land restoration. Here, medicinal plants like *Abroma augusta*, *Alstonia scholaris* and *Azadirachta indica* are used for medicinal purpose. Wood producing species like *Acacia auriculofirmis*, *Dalbergia sissoo* and *Tectona grandis* are used widely by the people for commercial purpose.

Nursery of Nijkasba, Hijli area shows 21 important plants which are raised in nursery by forest department. Here, we see Avicennia officinalis and Bruguiera gymnorhiza as important halophytic plants . *Casuarina equisetifolia* and *Bruguiera gymnorhizai* are used broadly to fill the ground cover and make vegetation in low lying areas. Other plant species found in nursery are *Acacia auriculiformis*, *Alstonia scholaris*, *Anthocephalus cadamba*, *Artocarpus heterophyllus*, *Azadirachta indica*, *Dalbergia sissoo*, *Ficus benghalensis*, *Milletia pinnata*, *Phyllanthus emblica*, *Pterocarpus marsupium*, *Pterocarpus santalinus*, *Santalum album* and *Tectona grandis*. Mdicinal plants raised in nursery are *Alstonia scholaris*, *Azadirachta indica*, *Terminalia arjuana* and *Pterocarpus santalinus. Citrus aurantifolia* is used in orchard area and the demand is high as commercial plant **.**

Some of the Medicinal Plants of the Study area are -

Sl.no	Species Name	Family	Importance	Habitat
1	*Adhatoda vasica Nees*	Acanthaceae	Leaves	Hedge and Garden
2	*Aloe vera Tourn. ex L.*	Liliaceae	Leaves	Garden
3	*Ambroma augusta L.f*	Sterculiaceae	Flowers and seeds	Hedge
4	*Andrographis paniculata (Burm.f.) Wall ex Nees*	Acnthaceae	Leaves	Shrubberies
5	*Azadirachta indica A. Juss*	Meliaceae	Fruits, bark and leaves	Pond side
6	*Bryophyllum calycinum Salisb.*	Crassulaceae	Leaves	Garden and waste land
7	*Catharanthus roseus (L.) G. Don.*	Apocynaceae	Leaves	Wasteland
8	*Centella asiatica (L.) Urban.*	Apiaceae	Leaves	Pond and wetland even in rice field
9	*Cissus quadrangularis L.*	Vitaceae	Stem	Jungle
10	*Clerodendrum serratum Spreng.*	Verbenaceae	Roots	Shrubberies
11	*Costus speciosus Koen. Ex Retz*	Costaceae	Rhizome	Shrubberies
12	*Emblica officinalis Gaertn*	Euphorbiaceae	Fruits	Garden
13	*Enhydra fluctuans Lour.*	Asteracea c	Twigs	Pond side and in water of wet land
14	*Euphorbia antiquorum L.*	Euphorbiaceae	Roots	Shrubberies
15	*Euphorbia nerifolia L.*	Euphorbiaceae	Leaves	Sacred place of home garden
16	*Gloriosa superb L.*	Liliaceae	Tuber, roots, Leaves and Flowers	Shrubberies and road side waste land.
17	*Ichnocarpus frutescens R. Br.*	Apocynaceae	Roots	Shrubberies
18	*Jatropha gossypifolia L*	Euphorbiaceae	Twigs, stems	Road side
19	*Marselia quadrifolia L.*	Marseliaceae	Leaves	Aquatic body
20	*Ocimum sanctum L.*	Lamiaceae	Leaves	Home Garden, Burning place
21	*Plumbago zeylanica L*	Plumbaginaceae	Roots	Jungle
22	*Smilax ovalifolia Roxb.*	Smilacaceae	Roots	Shrubberies
23	*Stephania japonica (Thumb.) Miers.*	Menispermaceae	Leaves	Jungle and waste land
24	*Swietenia macrophylla King*	Meliaceae	Seed/Fruit	Plantation site
25	*Swietenia mahagony L.*			Plantation site
26	*Tylophora tenuis Bl.*	Asclepiadaceae	Roots	Highland of Coastal strip.
27	*Vitex negundo L*	Verbenaceae	Leaves	Shrubberies
28	*Wedelia calandulacea Less. Non Rich*	Asteraceae	Leaves	Wetland site

Mangrove associates in the Study area.

Sl.No	Name	Family	Habit	Habitat
1	*Barringtonia racemosa Roxb*	Baringtoniaceae	Small tree	Near bank of river and pond
2	*Cannavelia rosea (Sw.) DC.*	Fabaceae	Twiner	Near bank of river
3	*Caesalpinia bonduc (L.) Roxb.*	Caesalpiniaceae	Bushy shrub	Shrubberies, Coastal bund
4	*Clerodendrum inerme Gaertn.*	Verbenaceae	Shrub	Wasteland, Degraded land
5	*Fimbrystylis ferruginea (L.) vahl*	Cyperaceae	Small shrub	Coastal canalside.
6	*Ipomoea tuba (Schl.) G. Don*	Convolvulaceae	Creeper	Coastal dyke
7	*Merope angulata (Willd.) Swingle*	Rutaceae	Herb	Coastal canal side
8	*Pandanus odoratissimus L. f.*	Pandanaceae	Bushy Shrub	Coastal area and in rice field
9	*Pluchea alba Less.*	Asteraceae	Shrub	Garden side
10	*Salacia chinensis L.*	Hypocrataceae	Herb	Near river bank
11	*Stenochlaena palustre (Burm.) Bedd*	Polypodiaceae	Under shrub	Underneath of Canal shrubberies
12	*Stictocardia tillifolia (Desr.) Hall.f*	Convolvulaceae	Twiner	Cnal shrubberies
13	*Thespesia populnea (L.) Sol. Ex Correa*	Malvaceae	Tree	Planted as in garden and bank of Pond
14	*Tylophora tenuis Bl*	Asclepiadaceae	Twiner	Coastal dyke and in jungle.
15	*Avicennia*	Verbenaceae	Tree	Creeks

Plate 21– Baine , Indian Mangroves , Nayachar


I.C.Z.M.P
MANGROVE PLANTATION-2012
Beat- NANDIGRAM
Range- BAJKUL

3.9. Fauna of the Study area

Biodiversity is important in functioning of an ecosystem. Each species plays a unique role within an ecosystem and each species is dependent on other for food, shelter or other resources. The Purba Medinipur district in West Bengal is rich in diverse water bodies of brackish water resources. Thus, it has great potentiality of the fin fish and also shell fish culture.

3.9.1. The Instream Fauna - Ichthyofaunal Diversity of rivers or canals represents the actual fact of fish diversity and their abundance. The canals and rivers of the study area is generally flooded with three types of water, namely; freshwater, brackish water and marine water owing to the strong connection with Bay of Bengal.

The major fish species like-*Scatophagus argus, Sillago sihama, Terapon jarbua, Lates calcarifer, Pomadasys argenteus, Oreochromis niloticus, Channa punctata, Channa striata, Sardinella albella, Coilia dussumieri, Setipinna taty, Mugil cephalus, Mystus gulio, Catla catla, Labeo rohita , Cirrhinus mrigala, Systomus sarana, Pethia ticto, Hypophthalmicthys molitrix* etc. were predominant.

In addition to that, some economically important shell fishes are also found in the canal like-*Penaeus monodon, Fenneropenaeus indicus, Metapenaeus monoceros, Scylla serrata* etc. During the survey by West Bengal Fisheries Department in 2015-16, a total 37 ichthyofauna, belonging to 9 order, 22 family and 36 genera were found. Beside that 9 species of shell fish, belonging to 4 order, 5 family and 9 genera were also found in the canal. The fish and shell fish species are enlisted in the table.

Sl. No	Order name	Family and Scientific name	Vernacular name/ Local name	Season of collection	Conservational status
1	**Anguilliformes**	***Muraenesocidae***			
		Muraenesox bagio (Hamilton, 1822)	Common pike conger/ Turd mach	Monsoon and Summer	Not Evaluated
	Beloniformes	***Belonidae***			
		Xenentodon cancila (Hamilton, 1822)	Freshwater garfish	Monsoon and Winter	Least Concern
2	**Clupeiformes**	***Clupeidae***			
3		*Corica soborna Hamilton, 1822*	Ganges river sprat/ Kagja mach	Winter	Least Concern
4		*Anodontostoma chacunda (Hamilton, 1822)*	Chacunda gizzard shad/ Khayera mach	Winter and Summer	Not Evaluated
5		*Sardinella albella (Valenciennes, 1847)*	Sardine	Winter and Summer	Least Concern
		Engraulidae			
6		*Coilia dussumieri Valenciennes, 1848*	Gold spotted grenadier anchovy/ Ruli mach	Winter and Summer	Not Evaluated
7		*Setipinna taty (Valenciennes, 1848)*	Scaly hair fin anchovy	Winter and Summer	Not Evaluated
	Cypriniformes	***Cyprinidae***			
8		*Catla catla (Hamilton, 1822)*	Major Carp/ Catla	Monsoon	Least Concern
9		*Labeo rohita (Hamilton, 1822) M*	Major Carp/ Rohu	Monsoon	Least Concern
10		*Cirrhinus mrigala (Hamilton, 1822)*	Major Carp/ Mrigal	Monsoon	Least Concern
11		*Labeo bata (Hamilton, 1822)*	Minor Carp/ Bata	Monsoon	Least Concern
12		*Systomus sarana (Hamilton, 1822)*	Olive barb / Saral Punti	Monsoon	Least Concern
13		*Pethia ticto (Hamilton, 1822)*	Ticto barb/ Punti	Monsoon	Least Concern
14		*Hypophthalmicthys molitrix (Valenciennes, 1844)*	Silver carp	Monsoon	Near Threatened
15		*Salmostoma bacaila (Hamilton, 1822)*	Large razor belly minnow/ Chela	Monsoon and Winter	Least Concern
	Mugiliformes	***Mugilidae***			
16		*Mugil cephalus*	Flathead grey	Monsoon	Least Concern

		Linnaeus, 1758	mullet/Parse mach	and Winter	
	Perciformes	***Apogonidae***			
17		*Apogon nitidus (Smith, 1961)*	Blue spot cardinal fish	Winter and summer	Not Evaluated
		Channidae			
18		*Channa punctata (Bloch, 1793)*	Spotted snakehead/ lata mach	Monsoon	Least Concern
19		*Channa striata (Bloch, 1793)*	Striped snakehead/ sole mach	Monsoon	Least Concern
		Cichlidae			
20		*Oreochromis niloticus* (Linnaeus, 1758)	Nile tilapia/ Nylontica	Monsoon and Winter	Least Concern
		Eleotridae			
21		*Gobiomorus dormitor* Lacepède, 1800	Giant goby/ Balkiri mach	Monsoon and Winter	Least Concern
		Gerreidae			
22		*Gerres oyena* (Forsskål, 1775)	Common Silver-biddy	Monsoon and winter	Least Concern
		Gobiidae			
23		*Gobiosoma hildebrandi* (Ginsburg, 1939)	Balkiri mach	Monsoon	Not Evaluated
24		*Glossogobius giuris* (Hamilton, 1822)	Tank goby/ Balkiri mach	Monsoon	Not Evaluated
25		*Periophthalmus modestus* Cantor, 1842	Shuttles hopp fish/ Danphar mach	Winter	Not Evaluated
		Haemulidae			
26		*Pomadasys argenteus* (Forsskål, 1775)	Silver grunt/ Khurunda mach	Monsoon and Winter	Least Concern
		Latidae			
27		*Lates calcarifer* (Bloch, 1790)	Giant perch/ Vetki mach	Monsoon and Winter	Least Concern
		Leiognathidae			
28		*Eubleekeria splendens* (Cuvier, 1829)	Splendid pony fish/ Tekathi mach	Winter	Least Concern
29		*Leiognathus lineolatus* (Valenciennes, 1835)	Ornate pony fish	Winter	Least Concern
		Scatophagidae			
30		*Scatophagus argus* (Linnaeus, 1766)	**S**potted scat/Vajachauli	Monsoon and	Least Concern

				Summer	
		Sciaenidae			
31		*Johinus sp*	Croaker	Winter and summer	Least Concern
		Sillaginidae			
32		*Sillago sihama* (Forsskål, 1775)	Silver sillago/ Sila mach	Monsoon and Winter	Not Evaluated
		Terapontidae			
33		*Terapon jarbua* (Forsskål, 1775)	Tiger perch/ Kunkuni mach	Summer and Winter	Least Concern
	Pleuronectiformes	**Soleidae**			
34		*Solea elongata* Day, 1877	Elongate sole/ Pata mach	Monsoon and Winter	Least Concern
	Siluriformes	**Ariidae**			
35		*Arius maculates* (Thunberg, 1792)	Spotted catfish/Kandhia mach	Monsoon and Winter	Least Concern
36		*Mystus gulio* (Hamilton, 1822)	Long whiskers catfish/Tengra mach	Monsoon and Winter	Least Concern
	Tetraodontiformes	**Triacanthidae**			
37		*Triacanthus biaculeatus* (Bloch, 1786)	Short-nosed tripod fish	Monsoon and Winter	Least Concern

Shell fish species recorded

Sl	Order	Family & scientific name	Vernacular Name	Season of Collection	Status
	Decapoda	**Portunidae**			
1		*Penaeus monodon* Fabricius, 1798	Giant tiger prawn/ Bagda chingri	Monsoon and winter	Not Evaluated
2		*Fenneropenaeus indicus* (Milne-Edwards, 1837)	Indian white shrimp/ Toni chingri	Monsoon and winter	Not Evaluated
3		*Metapenaeus monoceros* (Fabricius, 1798)	Brown shrimp and pink shrimp/ Pamra chingri	Monsoon and winter	Not Evaluated
4		*Scylla serrata* (Forsskål, 1775)	Giant Mud Crab/Kaliya kankra	Monsoon and winter	Not Evaluated
5		*Portunus pelagicus* (Linnaeus, 1758)	Blue Swimming Crab/Jahajiya kankra	Monsoon and winter	Not Evaluated
		Matutidae			
6		*Matuta planipes* Fabricius, 1798	Flower Moon Crab	Winter	Not Evaluated
	Stomatopoda	**Squillidae**			
7		*Squilla mantis* (Linnaeus, 1758)	Spot tail mantis	Monsoon and winter	Not Evaluated
	Sepiida	**Sepiidae**			

Plate 22 - This favourite of Kerala, Karimeen Fish are cultivated in Haldia and now in Nayachar Island , with the help of the Fisheries Department.The fishes are cultivated by fisherwomen of Haldia block, in Purba Medinipur district. The Fisheries Department has trained about 50 fisherwomen for one-and-a-half months at one of its farms.

Though cultivated in sweet water in Kerala, this fish also thrives in brackish water. Hence are cultivated in farms in the coastal regions of Haldia block.

Plate 23 : Marine fish drying , Khejuri Block . It is very common in the entire coastal zones of West Bengal and this practice is restricted to 24 Parganas and Purba Medinipur. These dried fishes have demand both in domestic and international market and plays an important role in employment generation of coastal poor people (Goswami et al., 2002). In this dry fish marketing channel people involved early in the production chain (fishing and drying) add relatively more value and make little profit due to small scale production, poor product quality, lack of market access and high transportation cost/toll/taxation etc

Plate 24– Mud skippers and Gule Fish in Nayachar Island. The Island dwellers use this fish for their own consumption. Plate 25- Asian Sea Bass, or Bhetki fish is one of the major white fish available in this zone.Plate- Black cat fish or Tyngra fish are also cultivated in the local bheris of Charkendamari.

3.9.2. Mammels - During our survey , we have not found much of the mammels but from the local interview we got the names of the following residing animals .

Sl.No	Name	Scientific Name	Conservation Status
1.	Marsh Mongoose	*Atilax paludinosus*	Threatened
2	Crab Eating Mongoose	*Herpestes urva*	Threatened
3	Indian Grey Mongoose	*Herpestes edwardsi*	Least Concerned
4	Smooth-coated otter	*Lutrogale perspicillata*	Threatened
5	Fox	*Vulpes vulpes*	Threatened
6	Indian Wolf	*Canis lupus pallipes*	Threatened
7	Fishing Cat	*Prionailurus viverrinus*	Threatened
8	Jungle Cat	*Felis chaus*	Threatened
9	Giant squirrels	*Ratufa indica*	Threatened
10	Stripped Squirrels	*Funambulus palmarum*	Least Concerned
11	Indian Pangolin	*Manis crassicaudata*	Threatened
12	Langaur	*Semnopithecus*	Least Concerned
13	Monkeys	*Rhesus macaque*	Least Concerned

Plate 26– Languars found in the adjoining areas of Rupnarayan, Mahisadal

3.9.2. Avifauna of the Study area- Avifaunal diversity of a given area or region, act as significant indicator for the evaluation of habitat quality of that particular area or region. Moreover, avifaunal documentation helps us to understand the distribution of particular species in a particular area and time (Peterson et al., 2000; Colin et al., 2000). Through their immense role in ecosystem as pollinators, seed dispersal agents, pest control agents, predators and scavengers, birds provide us inestimable ecosystem functioning services.

During the recent survey conducted by **Arajush Payra , for Cauernos de Biodiversidad** , a total of 178 species of birds under 16 orders and 57 families were recorded from estuary region . With the compilation of previously published papers (Patra and Chakrabarti, 2014; Payra et al. 2017) and records of eBird (eBird, 2020), the number of total recorded birds of the Coastal areas of Purba Medinipur goes to **225 species** under 17 orders and 61 families .

As we have surveyed we have found that -

Passeriformes represent highest number of species in the coast of Purba Medinipur, followed by **Waders or shorebirds** (48 species), **Waterbirds** (22 species), **Colourful birds** (11 species), **arboreal birds** (10 species), **Birds of prey** (9 species) . Some winter visitors are also found.

Some of the birds found during our survey are as follows-

Lesser Whistling Ducks , Ruddy Shelduck , Grey Heron , Gray-bellied Cuckoo , Black-winged Cuckooshrike , Common Moorhen , Watercock , Lesser Adjutant , Painted Stork , Striated Heron , Black-headed Ibis , Egret, Great Cormorant , Oriental Darter, Indian Cormorant and Little Cormorant, Grey Plover , Black-winged Stilt, Little Stint, Common Redshank, Oriental Pratincole , River Tern , Greater Crested Tern , Common Terns and Lesser Crested Terns, Osprey , Crested Serpent Eagle , Western Marsh Harrier , Bee Eaters , Lesser Flameback, Rose Ringed Parakeets , Drongos , Crows, Black-naped Oriole , Grey-backed Shrike , Blyth's Pipit , Yellow-bellied Prinia , Wire-tailed Swallow , Red-rumped Swallow , White Breasted Kingfisher , Cuckoo , Common Kingfisher at the periphery of fishery land near estuary area, Common Starling , Rosy Starling Pastor Roseus , Brown-breasted Flycatcher , Tickell's Thrush , Brahminy Starling Sturnia , Raven etc

Plate 27 – Lesser Flameback , Nayachar Island

Plate 28 - Green Headed Bee Eaters , Hijli Canal

Plate 29- Oriental Pratincole in the muddy bank of Haldi River

Plate 30 – Open Stork Bill in the open rice field, Sutahata.

Plate 31 – Red Wattle Lapwing , Nayachar Island

Plate 32– Brown Shrike , Nayachar Island

Plate 33 &34: Migratory Birds , Ruddy Shelduck & Grey Heron , Nayachar Island ,

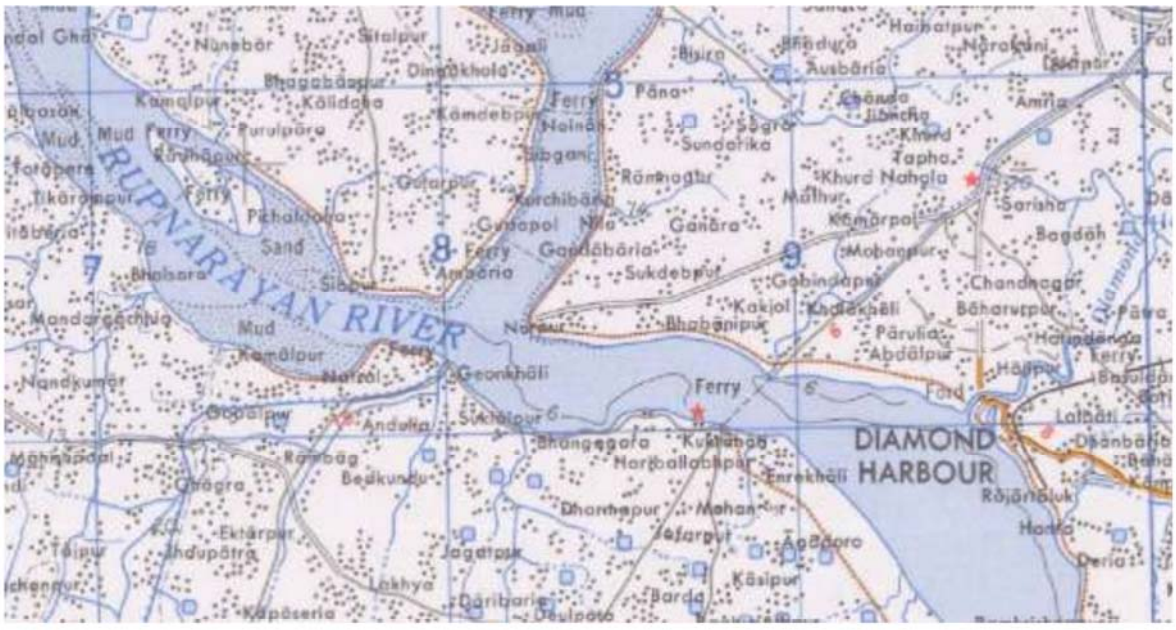
CHAPTER 4 – DOCUMENTING NATURE & PROPERTIES OF NATURAL HERITAGE

4.1. River System in the Lower Reach.

The river system of our Study area in Purba Midnapore consists of the Hugli, of its tidal tributaries, the Rupnarayan, Haldi and Roosulpur, and of their sub-tributaries.

4.1. a. Rupnarayan:

The Rupnarayan River is about 80 km long river begins as the Dhaleswari (Dhalkisor) in the Chhota Nagpur plateau foothills northeast of the town of Purulia . The Rupnarayan River with the catchment area of 1226 sq.km enters the district from Haora and flows along the eastern boundary. It then follows a southerly course to Tamluk. Here it takes an easterly bend and finally empties itself into the Hugli River at ***Geonkhali*** 22°12'7.66"N/ 88° 2'53.26"E opposite Hugli Point.



Map 14 : US ARMY Map showing the confluence zone of Bhagirathi Hugli with Rupnarayan

Within historic times great changes have taken place in the course of Rupnarayan River (Lower Reach) . This river was known to Europeans up to the eighteenth century by a number of different names. It is called Ganga in the maps of Gastaldi (1561) and De Barros (1553-1613), Guenga in Blaev's map (1650), Tamalee in Bowrey's chart of the river Hugli (1687), Tomberlie in the pilot chart of 1703, Patraghatta in Yalentyn's map (1670), and finally the Eupnarayan by Eennell, who refers to it as falsely called the " Old Ganges." Similarly, in the

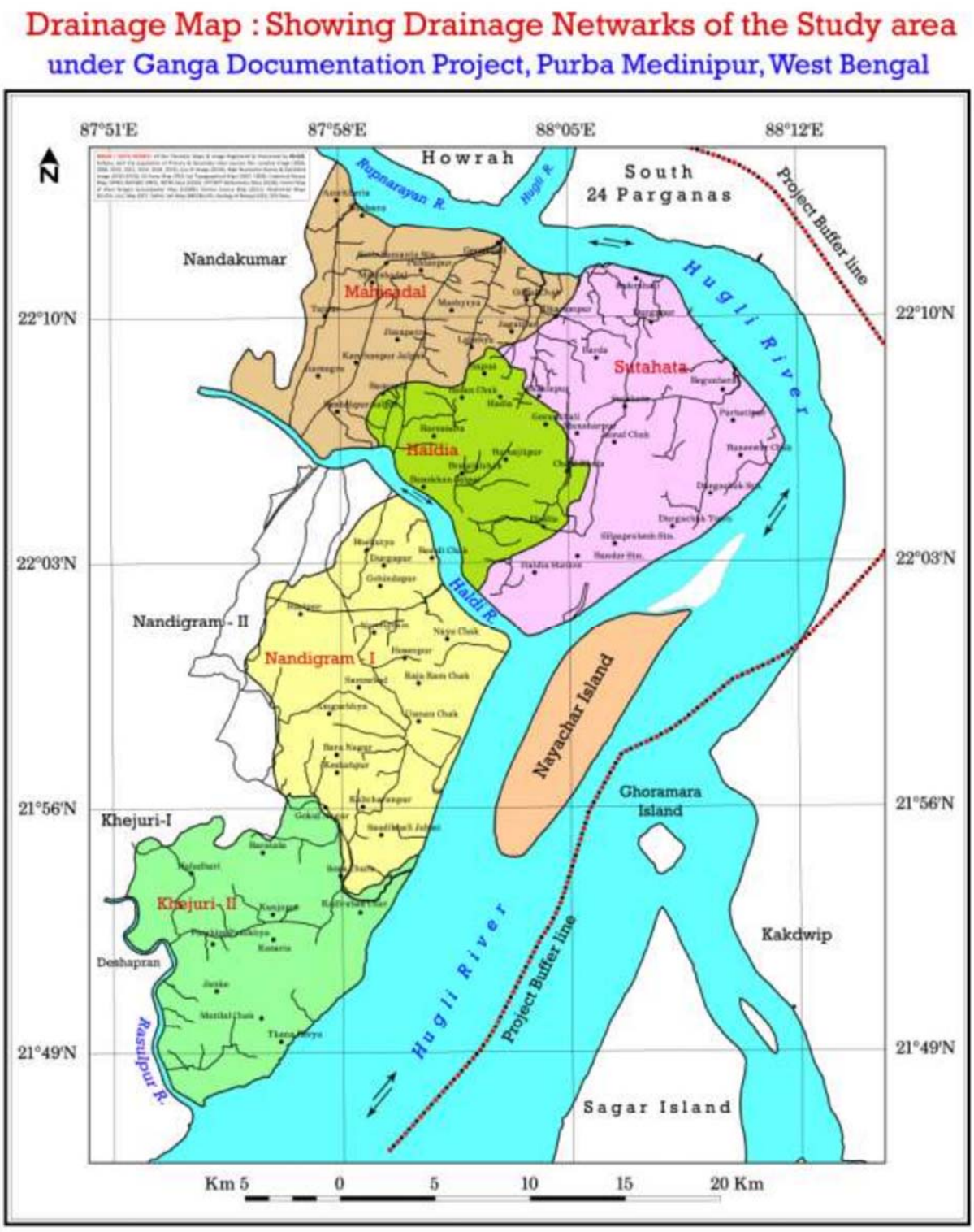
older accounts, such as the " Da Asia " of De Barros, it went under the name of Ganga and in the later accounts of the seventeenth century as Tumbolee (Hedges), Tumberleen (Master) and Tombolee (Bowrey). Prom Yalentyn's map it appears that a large branch of the Damodar fell south into the Rupnarayan above Tamluk, while another branch running east fell into the Bhagirathi (Hugli) near Kalna. The main channel of the Damodar is still connected with the Rupnarayan by the Kana Dwarakeswar, and it is not unlikely that, as shown in Yalentyn's map, a large stream flowing past Arambagh and Khanakul (in the Hugli district) joined the Rupnarayan somewhere near Ghatal. By these two branches, boats could have passed without much difficulty from the Bhagirathi to the Rupnarayan, and this connection probably led to the idea of its being a branch of the Ganges.

The next noticeable fact is that the Rupnarayan is shown in the older maps (Gastaldi, De Barros Blaev) as discharging itself by two channels enclosing a large island at its mouth. The south-easterly channel disappears in Valentyn's map, Bowrey's chart and the pilot map of 1703 ; and it may be presumed that .the island became more or less joined to the mainland in Midnapore. The Tingercoolly river of Bennell (Plate YXI)', which was joined at Tingercoolly by a stream from Tamluk may be identified (with the modern Haldi; and thana Sutahita and part of thana Tamluk are apparently comprised in the island shown in the old maps. Other effects of this change were the ruin of Tamluk as a sea-port and the gradual formation of the James and Mary Sands.

Map 15 : Confluence Zone of Rupnarayan & Hugli River, High Resolution Image

Plate 35 – Rupnarayan River , Mahisadal, 22°15'56.71"N 87°55'56.77"E

Plate 36 – Rupnarayan River in Geonkhali , 22°12'5.76"N , 88° 3'8.73"E



Map 16 - Drainage Map of the Study Area

4.1.A.i. Bed Profile Survey on Rupnarayan river near the ancient port town Tamluk-

Tamluk is a town in India. It is the district headquarters of *Purba Medinipur* district of West Bengal, India. Though there is some controversy, scholars have generally agreed that present day Tamluk is the site of the ancient city variously known as Tamralipta or Tamralipti. The present town is located on the banks of the Rupnarayan river close to the Bay of Bengal.

Our Study area lies about 3 Km away from Tamluk Municipality on Rupnarayan River starting from Narayanpur (22°15'57.00"N, 87°55'56.23"E) in Nandakumar Block under Tamluk Subdivision upto Amritberia Ferry Ghat (22°13'24.72"N, 87°58'27.15"E).

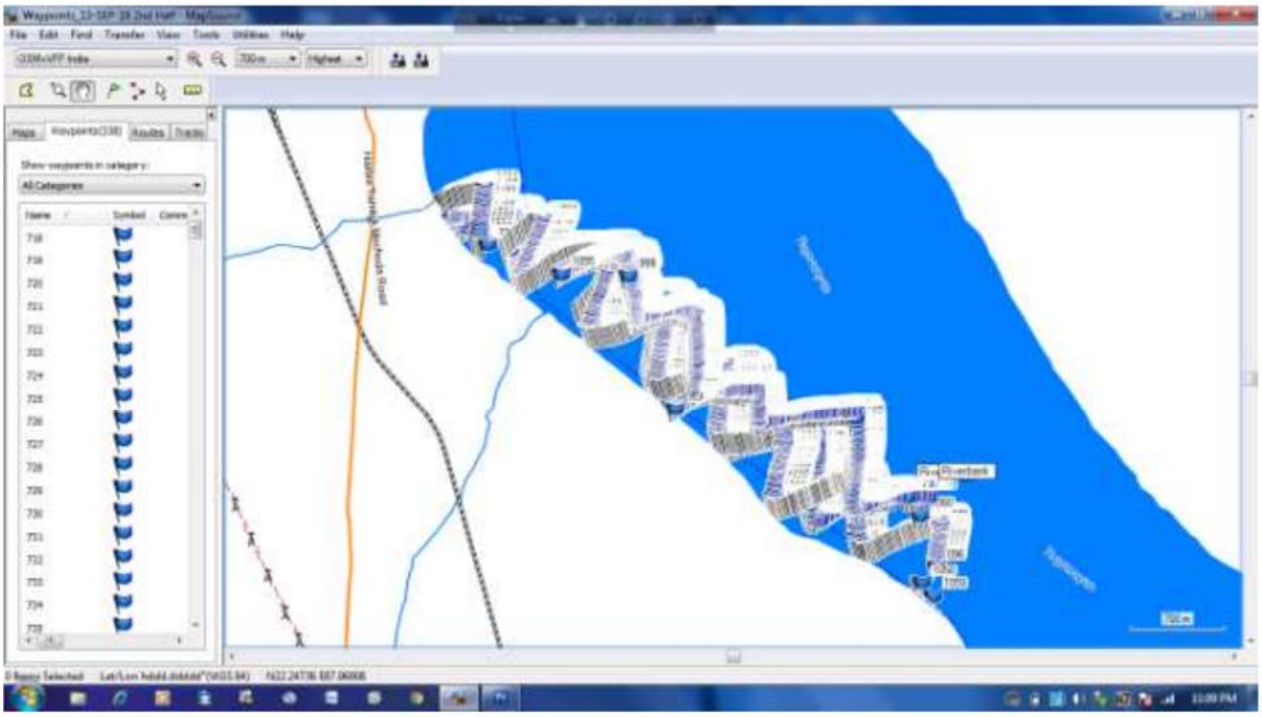
The Rupnarayan River is a river in India. It begins as the Dhaleswari (Dhalkisor) in the Chhota Nagpur plateau foothills northeast of the town of Purulia. It then follows a tortuous south-easterly course past the town of Bankura, where it is known as the Dwarakeswar river. Near the town of Ghatal it is joined by the Shilabati river, where it takes the name Rupnarayan. Finally, it joins the Hoogly River after crossing Tamluk, Nandakumar and Mahisadal Block of Purba Medinipur.

We have surveyed **4.52 sq km** area of the River from its Right Bank to assess the bed profile of the Rupnarayan River before meeting with Hugli River.

Detail Mapping Methodology under Remote Sensing & GIS Platform:

Reconnaissance: As every project require a start-up plan to complete it effectively and economically, reconnaissance has to be undergone. A complete reconnaissance of whole survey area to choose the best possible site was undertaken. This would facilitate satisfactory completion of the survey in accordance with the requirements and specifications governing such work.

In line with the working plan the following Methodology is adopted for the Bed Level Survey and the preparation of Thematic Maps under Remote Sensing & GIS environment:



A. Collection of source / Base maps / information:

1. **Police Station Map** containing Block / Police Station & Mouza boundaries with JL. Numbers from DLLRO/BLLRO, GoWB.
2. **CD Block map** from Census of India (2011) containing Block / Police Station & Mouza boundaries with Census Code.
3. **Topographical Map** consulted from Survey of India (SoI).
4. Acquisition of **SRTM** (Shuttle Radar Topographic Mission, 2014) data from USGS.
5. Acquisition of **High Resolution Ikonos Image** (2016 - 2018) from USGS & NRSC.
6. Acquisition **Landsat Image** (2016 – 2018; MSS & PAN) from USGS.
7. Field Survey by using GPS, Auto Level and Echo Sounder instruments.

B. Remote Sensing, GIS & GPS Softwares used:

1. **ArcGis:** Version 10.2 for Mapping under GIS environment.
2. **Geomatica 2012:** Version 10.0.for Mapping under Remote Sensing environment.
3. **Erdas Imagine:** Version 9.2 for Mapping under Remote Sensing environment.
4. **Map Source:** Version 6.0.for Mapping with GPS Data.
5. **Google Earth Pro:** for GPS data monitoring & verification on High Resolution Ikonos Image.

C. Projection system & Datum:

1. All secondary image sources are **Geo-rectified / Georeferenced / Geo-coded** under **UTM Projection system** with **WGS 84 Datum** (i.e. UTM, Zone 45, Row Q, E012).
2. **Reprojection** has done with Survey of India (SoI) **Topographical Map** (Polyconic, Everest ellipsoid), **Police Station Map** (following SoI Topographical Map Co-ordinates), **SRTM data**, **Landsat Image** & High Resolution **Ikonos Image**.
3. The **GPS device** is configured under WGS 84 Datum during field data collection.

D. Specifications of Prepared Maps under RS-GIS Platform

Sl. No.	Theme Map under IWMP	Image / Data Source	Methods / Procedure under RSGIS Platform	Utility & Outcome
1	India with location of West Bengal	Atlas of India: Oxford	Georeferenced under Polyconic Projection on Indian Datum.	Preparation of Location & Index Map of the Study area
2	West Bengal with location of the respective District	Administrative Plate Map from NATMO & Survey of India (SoI)	Georeferenced under UTM Projection on WGS 84 Datum under Remote Sensing & Vectorisation of Districts under GIS platform.	
3	Purba Medinipur with the location of Blocks	Administrative Plate Map from NATMO & Survey of India (SoI)	Georeferenced under UTM Projection on WGS 84 Datum under Remote Sensing & Vectorisation of Districts under GIS platform.	
4	Rupnarayan River	High Resolution Image	Georeferenced under UTM Projection on WGS 84 Datum under Remote Sensing & Vectorisation of Districts under GIS platform.	

Sl. No.	Theme Map under IWMP	Image / Data Source	Methods / Procedure under RSGIS Platform	Utility & Outcome
5	Location of the Study area on the high resolution satellite image	High Resolution Satellite Image with the GCP taken by GPS	Georeferenced under UTM Projection on WGS 84 Datum under Remote Sensing & Vectorisation of Districts under GIS platform.	
6	Depth of the Water	GPS, Auto-Level and the Echo Sounder Survey of the Study Area	Satellite Imageries were studied along with the SRTM Data to get the feel of the area. The method started by locating special control points along the bank line. Locate Horizontal Control: The horizontal control is necessary to locate all features of the land and marine in true relative positions. Hence a series of lines whose lengths and azimuths are determined by using Auto level in the adjoining bank line. The depth taken is analogous to the leveling. The sounding method is employed to determine the depth at various points by means of stationary boats. Sounding locations can be either made from boat to the control points or by fixing a point in the boat and taking sounding from the control point.	Bathymetry Map Isobath Map
7	Bed Level Height	GPS, Auto-Level and the Echo-Sounder Survey of the Study Area.	Keeping the Bench Mark near the bank line and considering the depth of the spots at a regular interval the Bed Level Height Data was processed	Bed Level Height Map

Bottom Configuration:

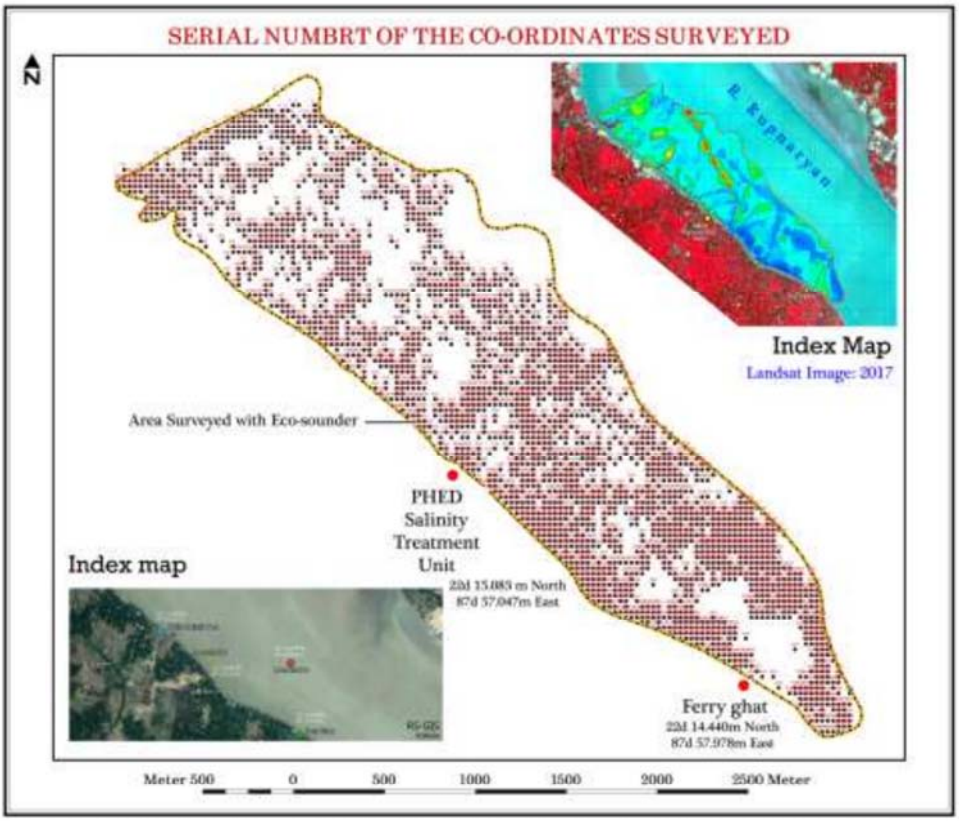
Since the study area is located in the proximity of the mouth of Rupnarayan River it is characterised by 3.5 to 4 km width and number of mid channel bars which attains almost 3m of average height. There is a heavy influence of tide in this location which results in exposing about 50 % of the mid channel bars during the Mean Tidal Situation.

Data analysis:

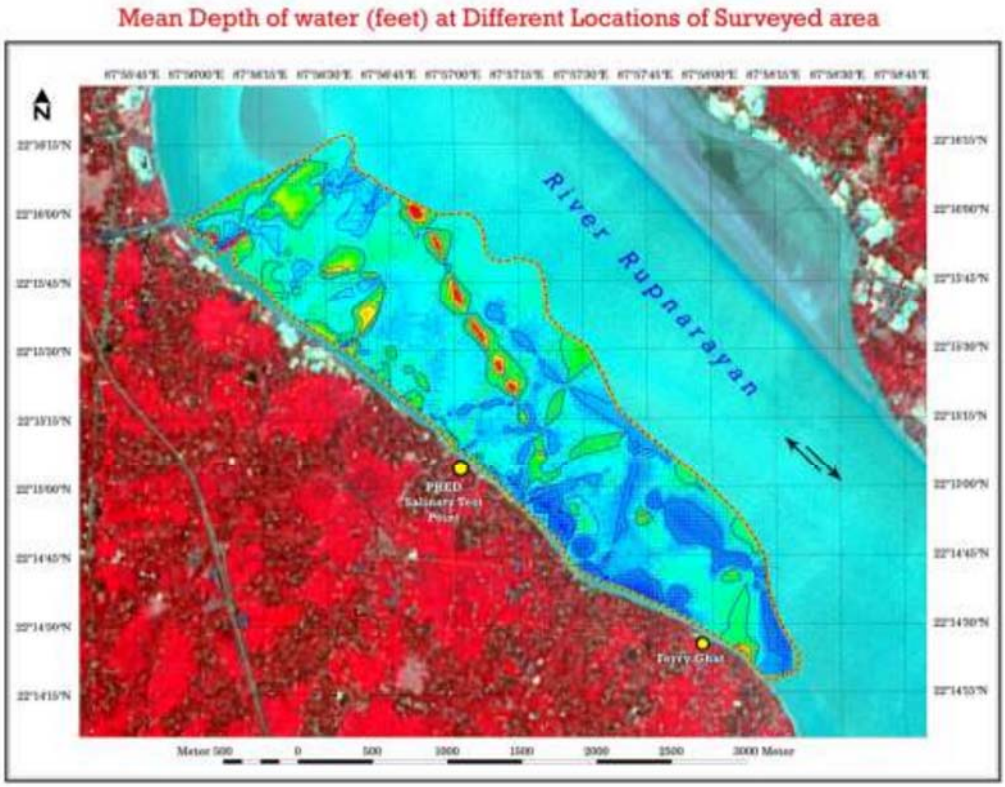
About **3107 Ground Control Points** and **Depth data** were collected from an approximate area of **4.54 sq km** with the help of Global Positioning System (WGS 84 Co-ordinate system and UTM Projection) and **Echo Sounder** (Garmin Echo 150)**.** The biggest challenge was however the tidal nature of the river where there is a daily fluctuation of water level following the High Tide and Low Tide. The Bench mark was set at **8 m /26 ft**. The Highest High Water Level was **7.79 m / 25 ft** and the Lowest Low Water Level was recorded at about **3.44m. /11.3 ft**. The Tidal Fluctuation was observed as **4.35m. /14 ft. The Mean Water Level is 5.62m/ 18.52 ft from Mean Sea Level. (MSL).**

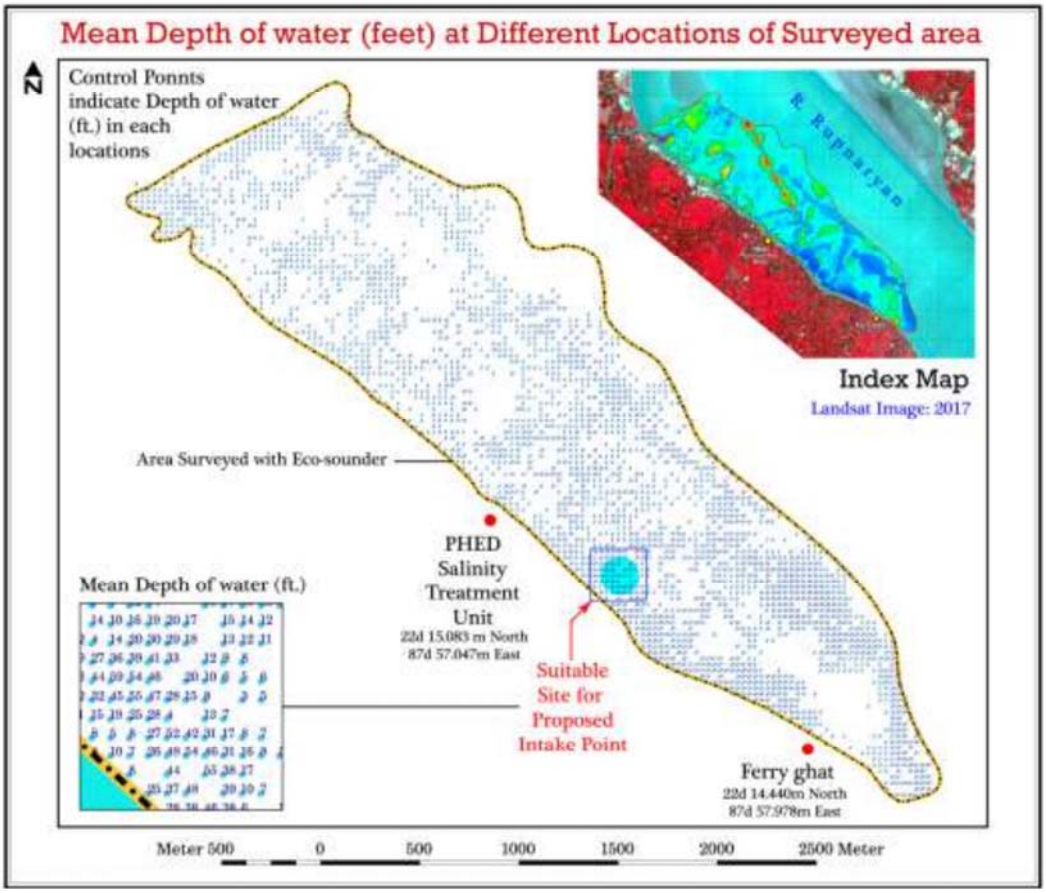
Plate 37 &38 : Bench Mark was set at Amritberia Ferry Ghat

It is a norm that as the region is situated in the Tropical Belt, that there is a simultaneous High Tide and Low Tide occurring 4 times within a time frame of 24 hrs 52 minutes, each effecting about 6 hrs 13 minutes.

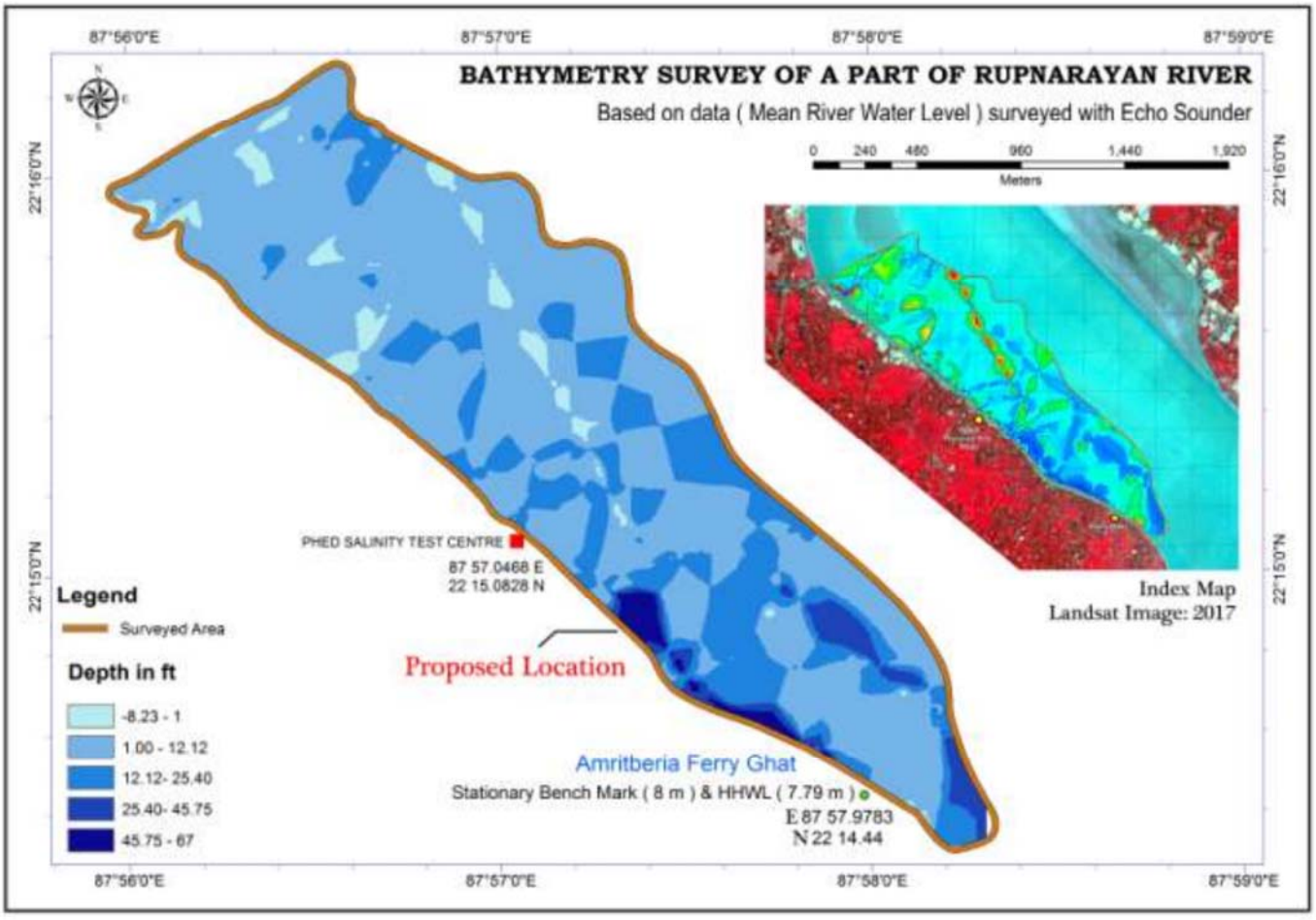


Map 17 : GCPs of the Surveyed Area

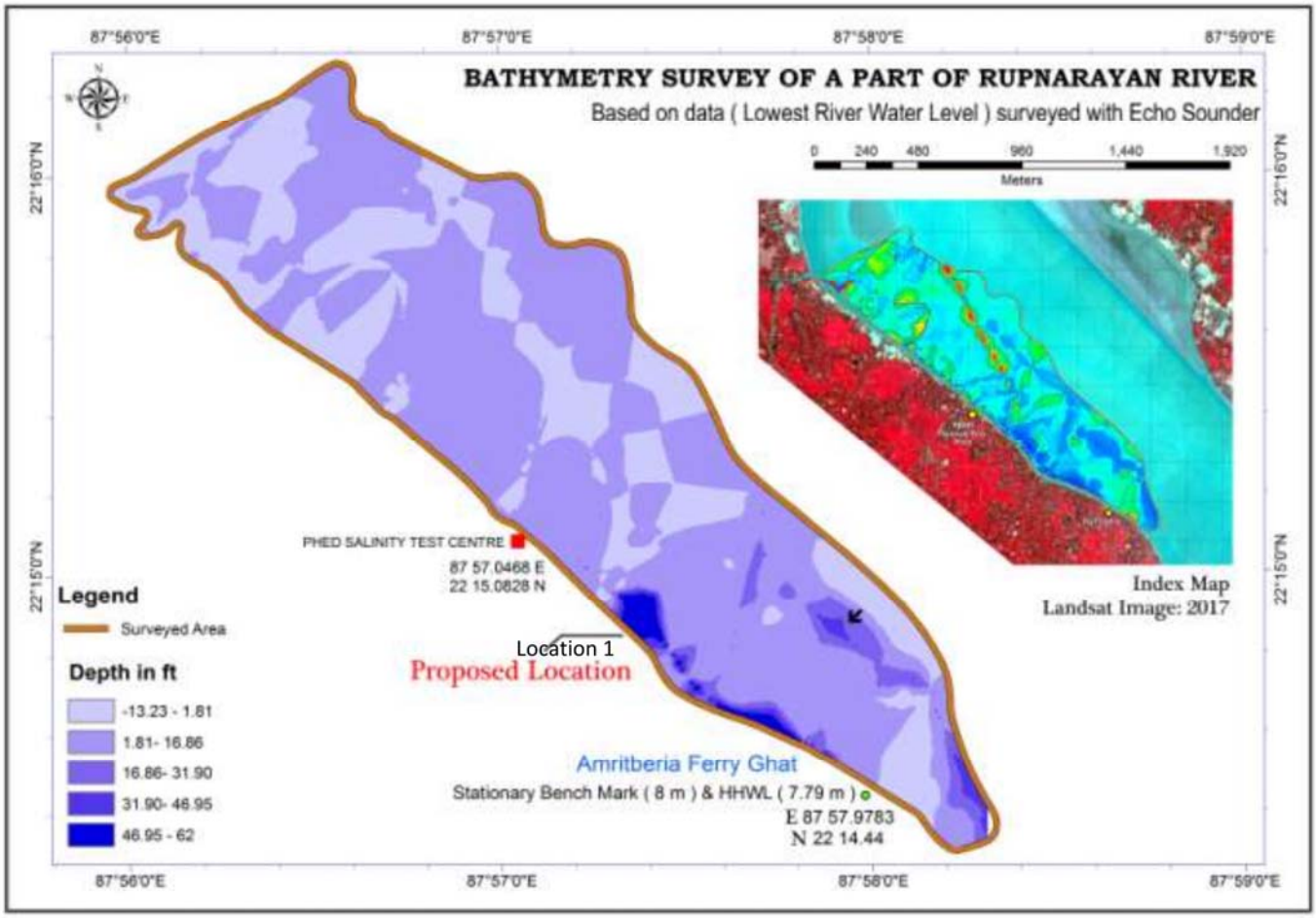




Map 18 & 19 : GCPs and Depth data on Landsat Image, 2018.



Map 20: Colour Code used to signify the different levels of the river depth. The depth of the surveyed area varied between (-) 8.23 ft to about 67 ft following a Mean Water Level.



Map 21: Colour Code used to signify the different levels of the river depth. The depth of the surveyed area varied between -13.23 ft to 62 ft following the Lowest Low Water level

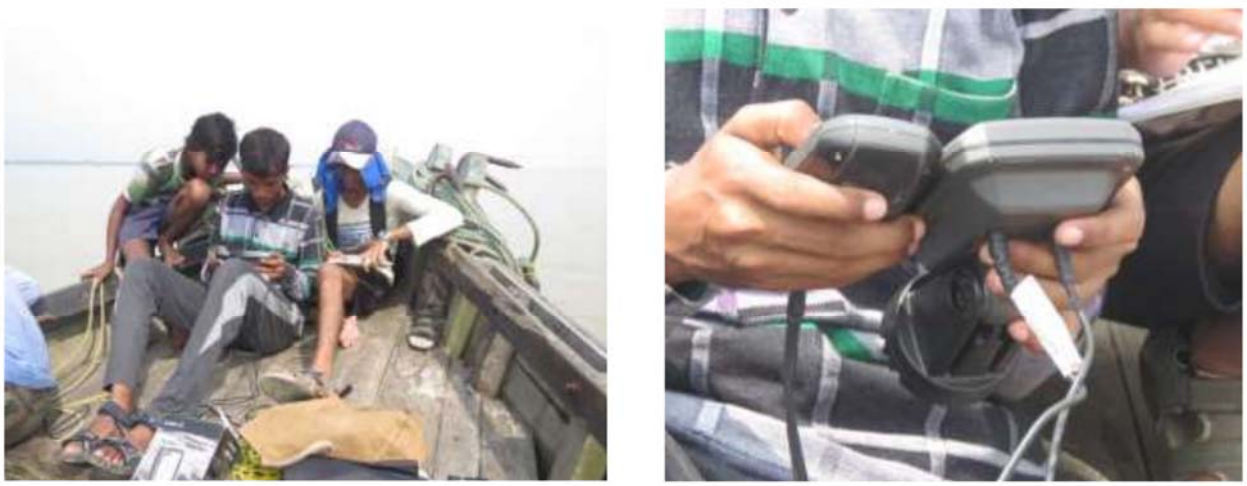
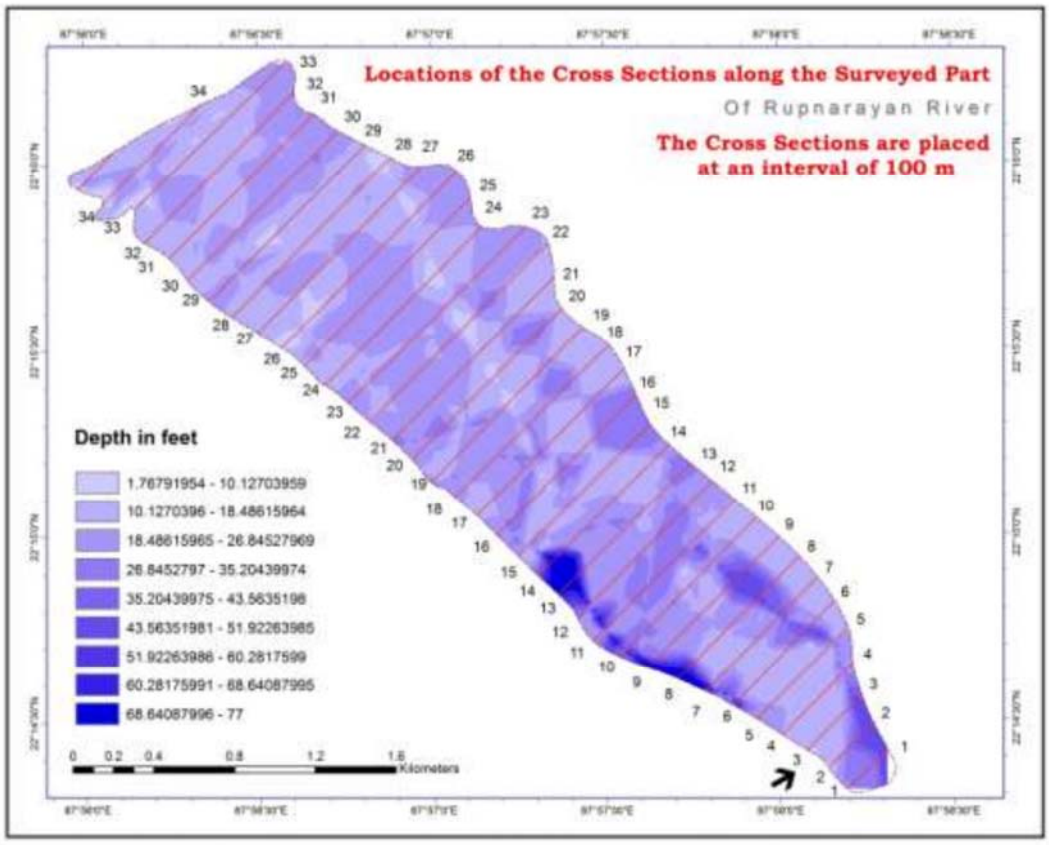
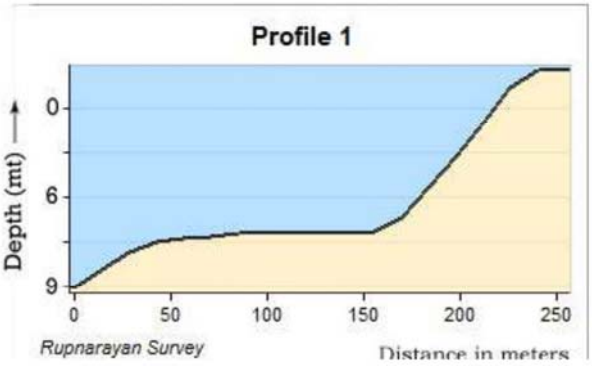
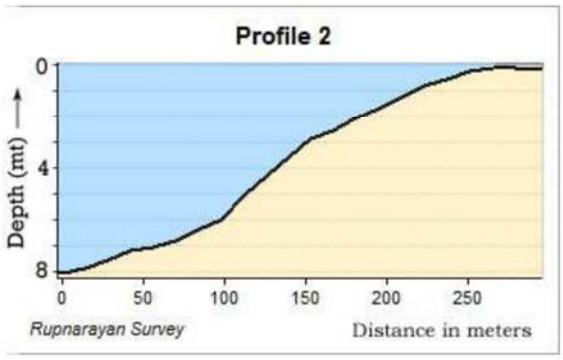


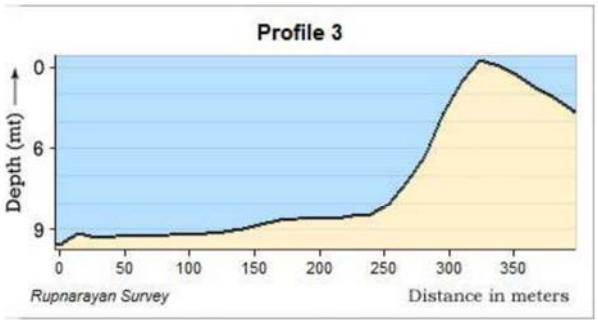
Figure 39: On Going Survey Work with GPS and Echo Sounder

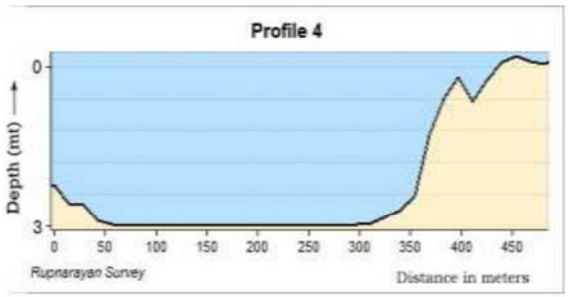
As we have surveyed the entire stretch we have generated the Cross sections in an interval of 100 meters all along the and thus attaching all for further consideration.

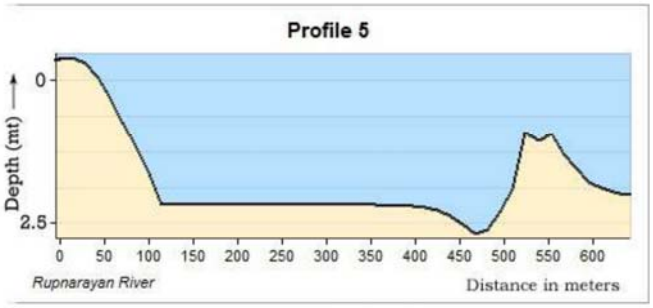








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2.5
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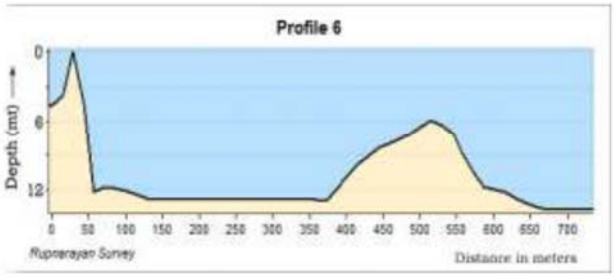
Rupnarayan River
Distance in meters


Profile 6
Depth (mt)
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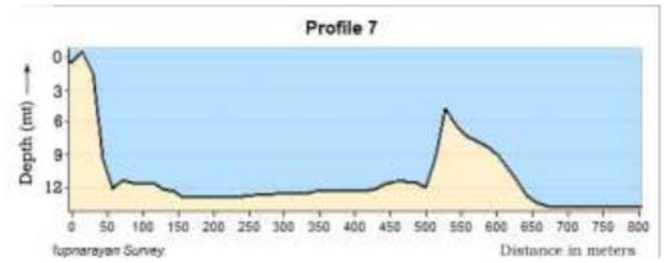
6
12
Rupnarayan Survey
Distance in meters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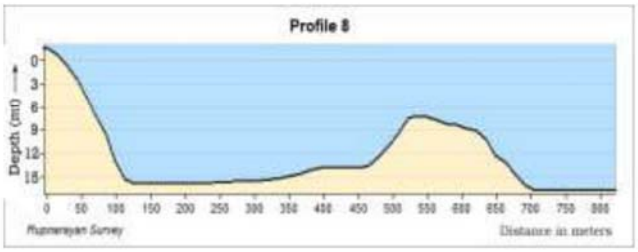
0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800
Rupnarayan Survey
Distance in meters


Profile 8
Depth (mt)
0 3 6 9 12 15
Rupnarayan Survey
Distance in meters


Profile 9
Depth (mt)
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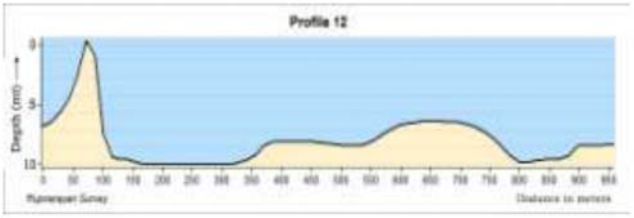
0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900
Rupnarayan Survey
Distance in meters


Profile 10
Depth (mt)
Rupnarayan Survey
Distance in meters


Profile 11
Depth (mt)
Rupnarayan Survey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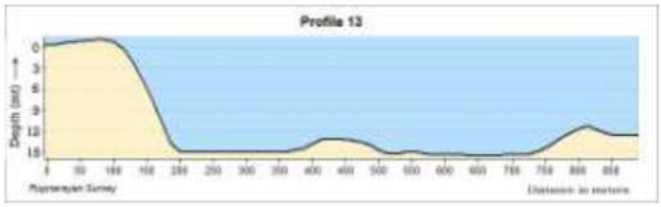
Depth (mt)
Rupnarayan Survey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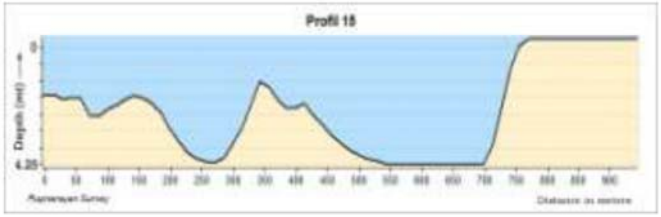
Depth (mt)
Rupnarayan Survey


Profile 14
Depth (mt)
Rupnarayan Survey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Depth (mt)
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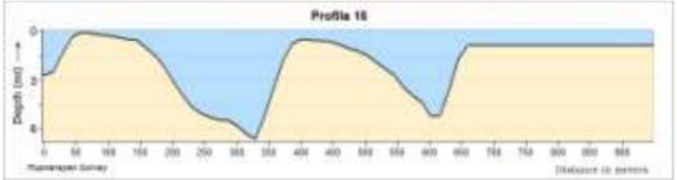
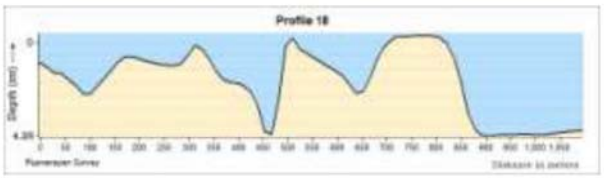

Profile 16
Depth (mt)
Rupnarayan Survey

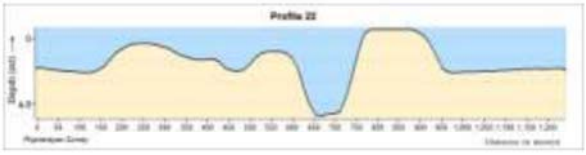

Profile 17


Profile 18


Profile 19

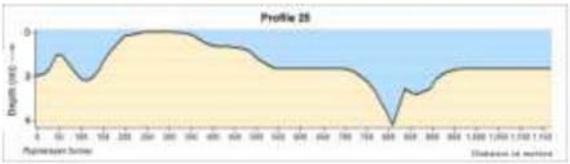

Profile 20


Profile 21


Profile 22


Profile 23


Profile 24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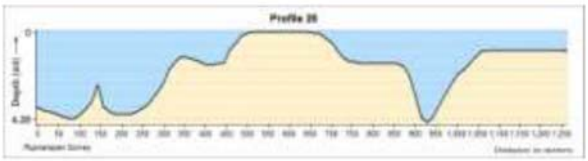
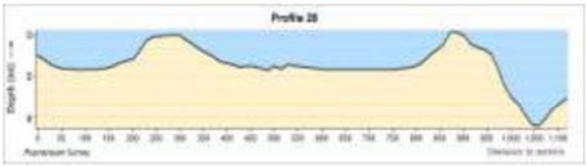

Profile 26


Profile 27


Profile 28


Profile 29
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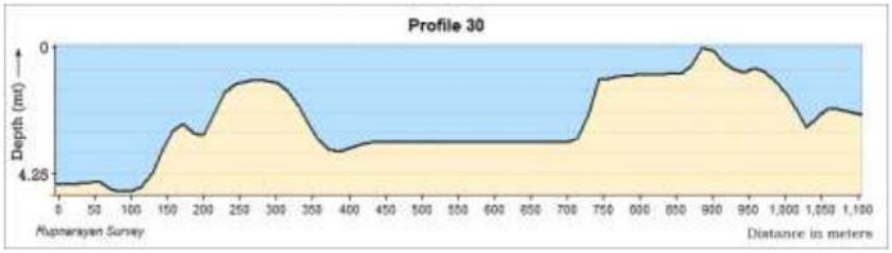
Rupnarayan Survey
Distance in meters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Depth (mt)
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4.25
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Rupnarayan Survey
Distance in meters


Profile 31
Depth (mt)
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2.5
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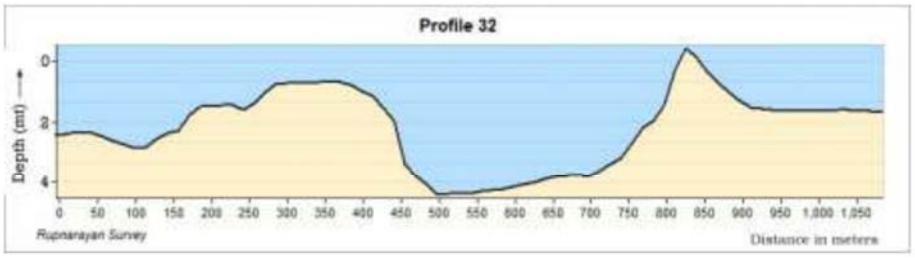
Rupnarayan Survey
Distance in meters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Depth (mt)
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2
4
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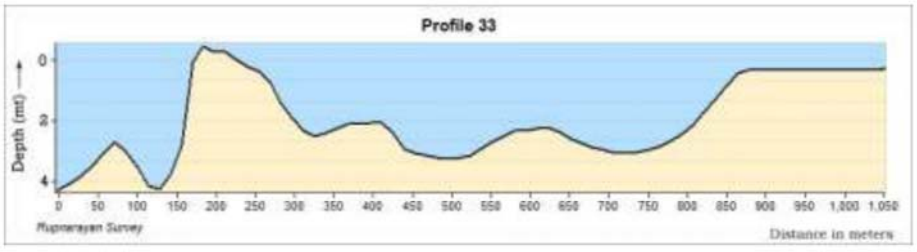
Rupnarayan Survey
Distance in meters


Profile 33
Depth (mt)
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2
4
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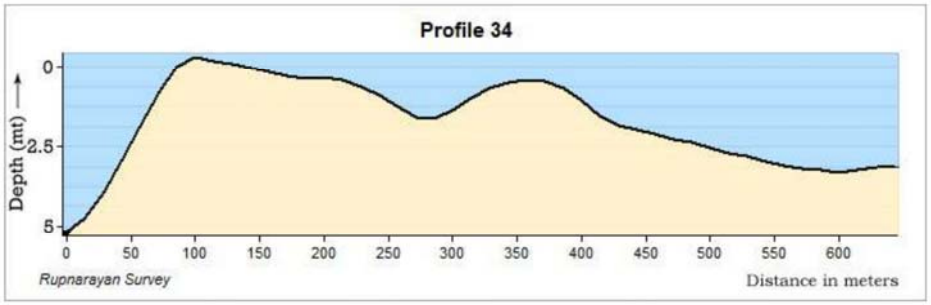
Rupnarayan Survey
Distance in meters


Profile 34
Depth (mt)
0
2.5
5
0 50 100 150 200 250 300 350 400 450 500 550 600
Rupnarayan Survey
Distance in meters

4.1.B. Haldi River

The river Haldi is a 42 km long tributary of the Hugli occupying 614 sq.km of catchment area , flowing south of river Rupnarayan. This river takes its rise in Purba Medinipur district only. It is formed by the confluence of river Kangsabati or Kasai and Kaliaghai opposite Tengrakhali of Nandigram III Community Development Block. It follows a south-eastern course till it debouches into the river Hugli 22° 1'0.94"N 88° 3'12.03"E. It is a large river at its mouth and throughout the year it is navigable. Rapid rate of siltation is going on its bed. The Haldi River has several minor feeders and offshoots especially near the mouth. **Tangua Khal** joins with Haldi River near Brindabanpur , 22° 2'30.54"N, 88° 1'2.73"E. Haldia Dock is located near the mouth of Haldi river.

Map 22 - Origin of Haldi River , 22° 9'52.08"N 87°49'34.41"E

Map 23– Confluence of River Haldi and Hugli River 22° 1'0.94"N 88° 3'12.03"E

Plate 40 –Haldi River , 22° 2'26.31"N, 88° 1'57.22"E near Indian Oil Township Cluster

Plate 41–Haldi River confluence with Bhagirathi Hugli 22° 0'53.20"N 88° 3'20.59"E

4.1.c. Roosulpur River

The River Roosulpur is the 19 km long tributary of the Hugli in Purba Medinipur district. It takes its rise in the south-west of the district under the name of **Bagda river**. It flows first towards the east and then towards the south till it debouches into the Hugli below the **Kaukhali (Cowcolly) lighthouse**. This river furnishes a large area with water communication. The Roosulpur itself is of little length, only it has several large feeders. The general direction of the drainage system is to the south and east, which is evident from the course of the large rivers Rupnarayan and Haldi. Its tributaries are **Itaberia Khal, Mugberia Khal, Palabani Khal, Padurbheri Khal and Alipur Khal.** It joins the Bay of Bengal shortly after **Petua Ghat**, a Fishing Harbor just before the estuary of the river, opposite Sagar Island.

Map 24 – Roosulpur River joining with Hugli River

Map 25 : Roosulpur River Mouth, US Army Map ,1956

Plate 42 - Roosulpur River near Petua Ghat 21°47'39.92"N 87°53'12.17"E

Feeders of Roosulpur River –

Sl. no	Name of the Canal	GCP (Off Take Point)	Remarks
1.	Mirzapur Canal	21°49'15.20"N 87°52'9.49"E	**Right Bank**
2	Amirabad Canal	21°50'35.97"N 87°52'10.96"E	**Right Bank**
3.	Bagda Canal	21°54'52.36"N 87°46'25.26"E	**Both of them joined together near Kanaidighi to form Roosulpur River**
4	Barju Nadi	21°54'58.64"N 87°46'37.11"E	
5	Haria Khal	21°54'33.24"N 87°48'57.63"E	**Left Bank**
6	Kasaria Khal	21°52'13.27"N 87°52'38.49"E	**Left Bank**

Plate 43– Roosulpur River joining with Bhagirathi Hugli , 21°47'24.25"N 87°53'29.16"E

4.2. OTHER CANALS OF THE STUDY AREA

4.2.A. Hijli Canal – **Hijli Canal** is a part of Orissa Coast Canal which was formed in 1880-81.In 1866 Orissa was visited by a most devastating famine in her colonial history. It was so terrible that one third of its population were perished . The Famine Commission of 1866 directed the attention to the state of communication of Orissa and measures were taken thereafter to prevent the recurrence of similar disaster by improving the communication.

In our study area , we find Hijli Canal in Geonkhali Area 22°12'16.08"N, 88° 2'55.70"E connecting Hugli River to Haldi River 22° 6'43.22"N 87°56'42.75"E. Further, another branch of the canal joins Roosulpur River at 21°55'7.17"N, 87°46'34.28"E . From Roosulpur River , the canal branches out to join Subarnarekha River in Odisha .

Map 26 – Opening point of Hijli Canal to Hugli River near Geonkhali , Mahisadal 22°12'15.58"N 88° 2'56.54"E

Plate 44– Hijli Canal near Mahisadal Rajbari 22°10'56.75"N 87°59'2.69"E

Plate 45–Hijli Khal , Mahisadal near Geonkhali 22°11'0.47"N 87°58'59.26"E

Plate 46 & 47 – Off Take Hijli Khal to Rupnarayan River 22°12'17.17"N 88° 2'56.03"E

4.2.B Other Canals of the Study area-

Beside the major rivers like Rupnarayan , Haldi and Roosulpur and major canal like Hijli Canal , there are many minor canal outlets to both the Rupnarayan River and Hugli River. They are as follows ;

Sl No	Name of the Canal	Location	GCP
1	Tentulberiya Khal	Mahisadal Block	22°11'20.85"N 88° 4'2.91"E
2	Horokhali Khal	Sutahat Block	22° 8'14.09"N 88°10'19.39"E
3	Haldia Khal	Haldia Municipality	22° 1'1.37"N 88° 3'32.60"E
3	Kendramari Khal	Nandigram I	22° 2'31.49"N 88° 1'3.47"E
4	Tilabati Khal	Khejuri	21°54'23.28"N 88° 0'9.43"E

Plate 48 - Kendramari Khal, Nandigram 1

Plate 49– Haldia Khal , Haldia Municipality 22° 1'1.37"N 88° 3'32.60"E

Plate 50 – Durgachak Canal outlet near Patikhali Ferry Ghat , Haldia Block , 22° 3'23.44"N 88° 8'25.49"E

Plate 51– Horokhali Khal, Sutahata , 22° 8'13.12"N 88°10'18.30"E

Plate 52- Tilabati Khal, Khejuri , 21°50'27.99"N 87°56'24.25"E

4.3. ISLANDS OF THE STUDY AREA –

Leonard (1865) while writing a report on the river Hugli stated that the sand bars are constantly changing their shape and location with the changing form of channel. According to him the extreme mobility of the materials forming the sides of all the channels which they occupy is responsible for this redressing and reshaping of the bars and islands (O'Malley, 1911).

Causes of island formation **-** In Hugli estuary sediments are derived from the rivers and carried as colloids or small charged particles that repel each other. This situation is changed by the electrolyte salts present in the sea water and the grains as they enter into an estuary start to agglomerate together in a process known as *flocculation*. It generally occurs at the fresh water-salt water interface where a number of physical changes in density, temperature, turbulence, fluid shear, pH, organisms and organic matter occur.

During a tidal cycle, in the still water period around the high water level, individual or groups of flocks settle on the bed of a stream or mud-flat and get slowly consolidated during the subsequent slack water period. During the next high tide, the mid-tide currents may not be sufficient enough to erode all the materials deposited previously. In the continuous cycles of tidal deposition and erosion, accretion only occurs if a net edge of deposition exists over erosion (Dyer, 1979).

There is a great natural depression called **"Swatch of No Ground"** in the Bay of Bengal, south of the Raimangal estuary between 21° 00′ to 21°22′ N latitudes. The surrounding water depth, which is around 20 metre, changes suddenly to 500 metre abruptly. Fergusson's theory (1863) stated that the sediments are carried away from the spot, and deposition is prevented by strong currents produced by a meeting of tides from the east and west coasts of Bay of Bengal. The silts thus carried away are either diverted to the south of Sundarban or are being pushed forward further eastward to form new islands. With the formation of shoals by tidal deposition they start to emerge above the low tide line and pioneer mangrove species like *Porteresia coarctata* and *Aeluropus lagopoides* soon start to colonise on the muddy tidal flats and the bio-tidal accretion processes take over.

According to "the classical succession view of mangrove dynamics" (Sneadaker, 1982), plant communities such as these literally "prepare the ground" for the next community as they raise the level of the shoal by inducing sedimentation and thereby changing tidal environment of a particular locality. At climax stage non-mangrove vegetation communityevolves as the land is raised sufficiently above the tidal limits (Thom, 1984). Mangroves can induce an increased level of tidal accretion by various processes. The stems of such plants often cause eddies that trap sediments. The sticky algal mats that develop under the plant cover can also do the same.

Apart from these, the entire surface of the colonising mangrove species becomes an area for sediment deposition during their tidal inundation. This sediment is contributed to the accreting land surface when the veneer gets dry and then flecks off during their subsequent low tide exposition (Pethick, 1984).

The Islands of Hugli Estuary **-** Our Study area has 2 major Islands within Hugli Estuary. They are – a. Nayachar & b. Ballari Bar .

4.3.A. Nayachar Island :

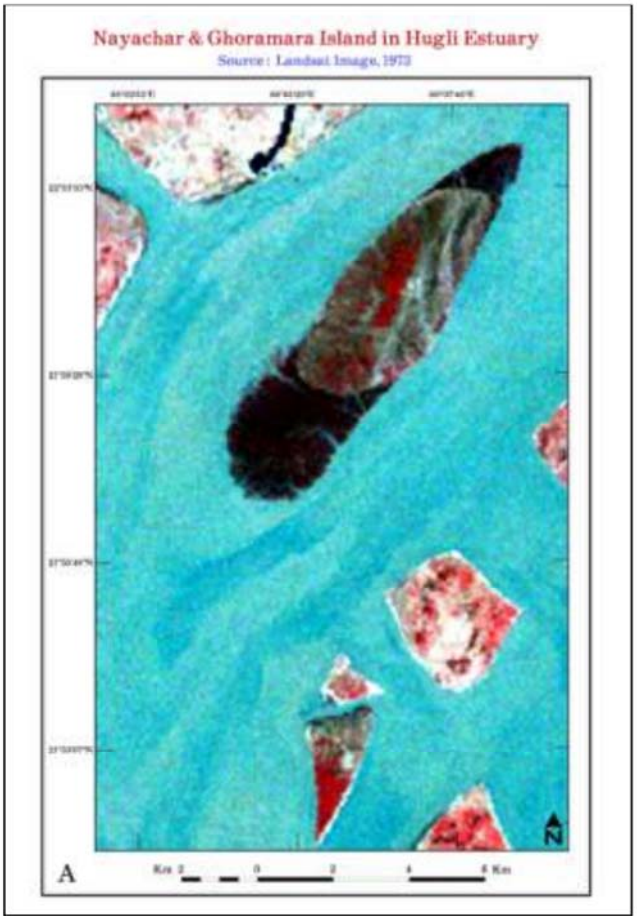
i. Location & Evolution – Nayachar Island (22° 1 ′ to 21° 54′ N and 880 3′ to 88° 8′ E) is the second largest island of the Hugli estuary is currently passing through the accretion phase of island evolution.

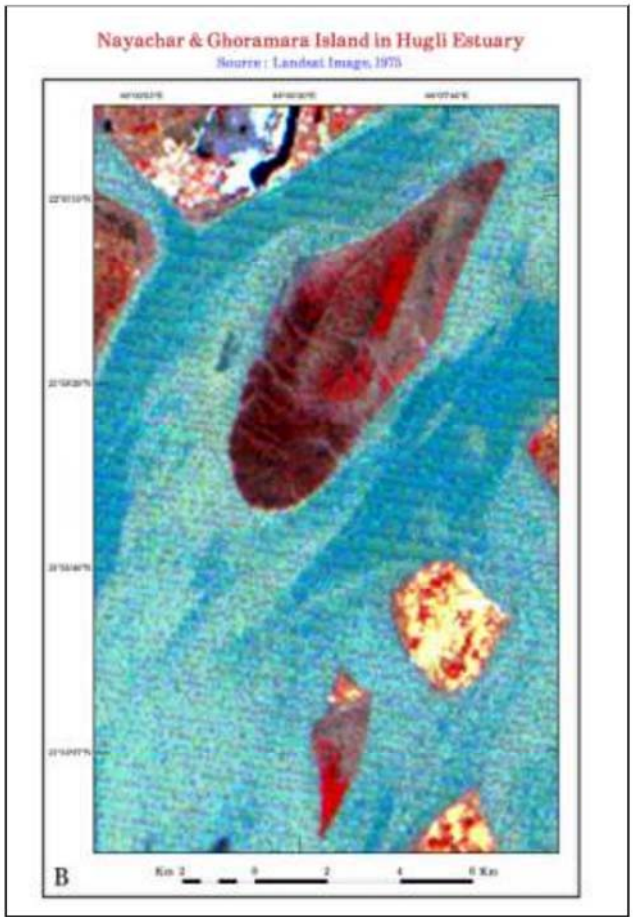
During 1904-05 this estuarine island on the Haldia tidal sand ridge had only 0.24 km2 area. It started accreting from 1945. During 1967-68 it had 16.08 km2 area, during 1986-88 it enlarged to 39.79 km2 area and in 2009 the island progressively enlarged to50.8 km2 areas .Most of this accretion took place on the south-western part of Nayachar, giving it a highly elongated appearance (length: 15.85 km2 , maximum width: 4.52 km2), characteristic of macro tidal conditions. The island was previously known as **'Agnimari Char'** because light of fire (agni) from the numerous brick fields could be visible from the mainland.

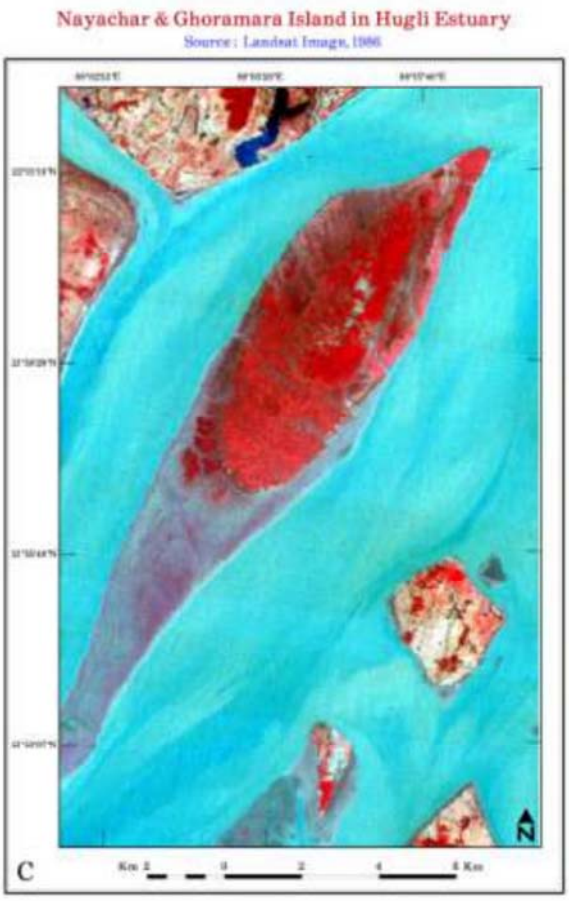
The buffalo grazing community of 24 Pargans used this no man's land indiscriminately for grazing for 6 months every year (Paul, 1993). Forests have also been destroyed considerably for the opening up of fish ponds where shrimps, prawns and other types of fishes are being cultured. In addition to all these human interventions into the natural setting of Nayachar, this island is also exposed to possible impacts of storms, erosion, high amplitude tide phase inundation etc. (Paul, 2007).

Thus the physically dominated ecosystems of the island are gradually being brought under the anthropogenic control off setting its natural set up.The hydrodynamic setting and depositional environment of the Hugli estuary have dominantly guided the geomorphology of Nayachar Island. Furthermore, variations in nature and functions of geomorphological processes operative on different morphogenetic zones have strongly influenced plant succession and variability in the spatial pattern of species associations over the island surface. The important geomophological and bio geomoprphological components of the area are as follows-

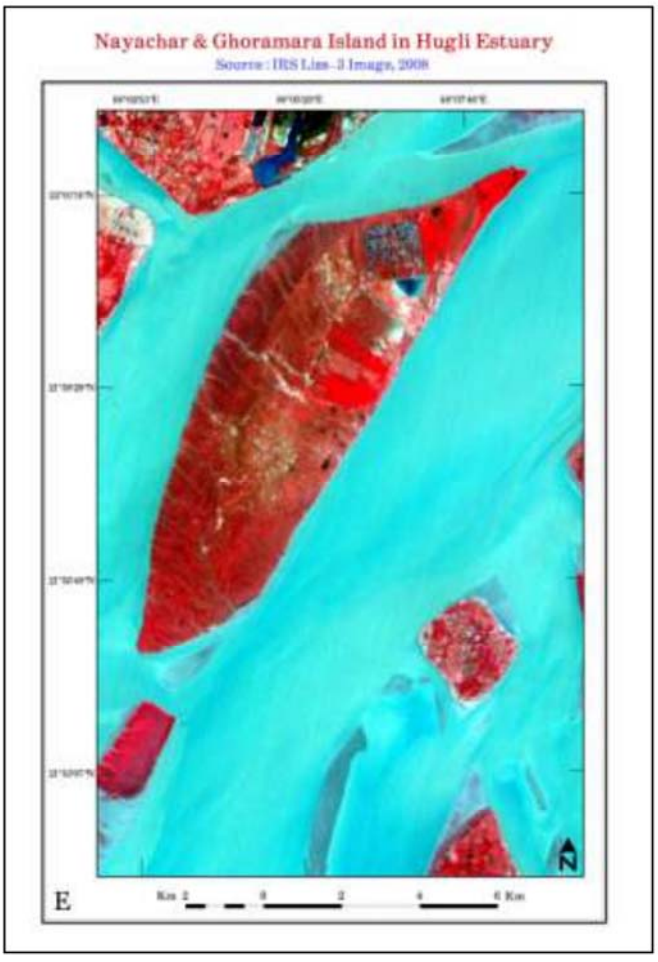
Map 27- US ARMY MAP – 1955-57 showing the early impression of Nayachar Island

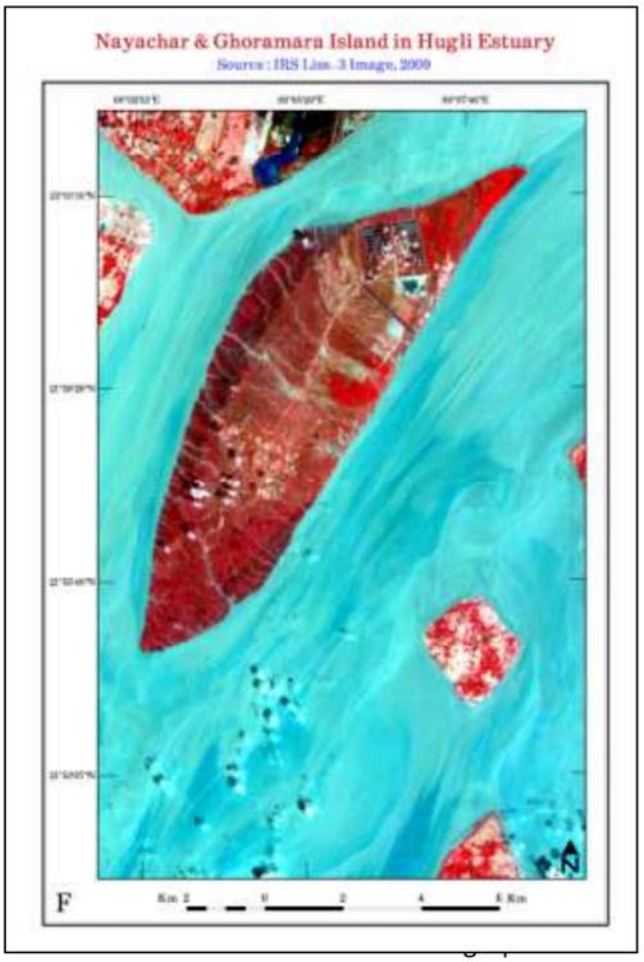


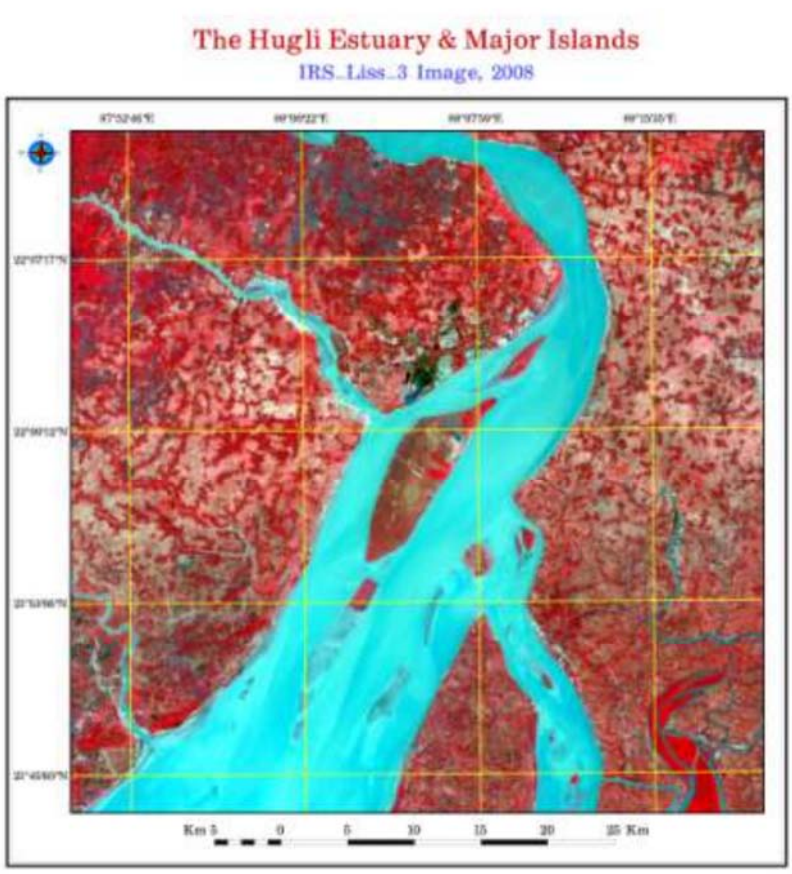



Nayachar & Ghoramara Island in Hugli Estuary
Source : Landsat Image, 1986
C
N


Nayachar & Ghoramara Island in Hugli Estuary
Source : IRS PAN Image, 2001
D
N


Nayachar & Ghoramara Island in Hugli Estuary
Source : IRS Liss-3 Image, 2008
E
N


Nayachar & Ghoramara Island in Hugli Estuary
Source : IRS Liss-3 Image, 2009
F
N



Map 28 – Present Configuration of Nayachar Island

Geomorphology of Nayachar Island

Geomorphic Surface	Altitude	Geomorphology	Sediment Composition	Vegetation	Hydrology	Age
Low Tide Platform with tidal mudflats and creek mouth sediment	1-2 meter	Gently to moderately slopping mudflat usually emerged at Low Tide	Unconsolidated silt clay surface with the basement of compact sand	A thin film algae mat	Regular tidal inundation and short term exposure to sub aerial condition	Youngest
Island Rim Platform with active tidal channels	2.5-3.5 meter	Significant marsh cliffs on the island margins, and inter tidal flats separated with channels and valley flats	Wash over silt at ebbing tides and fresh silts at the flooding tides	Dense halophytic grassland	Flooding through creeks	Younger
Middle Marsh Platform with vertical creek bank walls,sand flats,and primary salt pans	4-5 meter	Relatively higher flats separated with swampy terrain and fresh water wetlands	Peaty soils, sodium clays and loamy soils	Heath land Vegetation with short grass	Over bank discharge of tidal creek	older
High Marsh Platform with open swamp surface and rain water storage tanks	6-7 meter	Supra tidal flats with swampy terrain and fresh water wetlands	Muddy and saturated with water.	Dense mangrove	Salt water encroachment through tidal creeks	oldest

-

Plate 53– Active Tidal Channels of Nayachar Island

Plate 54- **Low Tide Platform with tidal mudflats and creek mouth sediment**

Plate 55 - **Island Rim Platform with active tidal channels**

Plate 56 - Middle Marsh Platform with vertical creek bank walls,sand flats,and primary salt pans.

Plate 57: High Marsh Platform with open swamp surface and rain water

Plate 58 : Extensive sedimentation , Low Water Tide Level

Plate 59 – Tidal Creek , Nayachar Island

iii. Survey by ZSI on Nayachar Island

The Zoological Survey of India (ZSI) started working on the project since 1989, which aimed at understanding soil stabilisation in an emerging island and the succession of living organisms in a new habitat. First Survey: In 1989, when ZSI first surveyed the island, it found only three invertebrate soil fauna (organisms living under the soil).Till 1990, it was completely barren, with hardly any plant or animal species. After a couple of years, the number doubled and, by the late Nineties, it recorded 76 invertebrate fauna, both underground and terrestrial. Recent report: In October 2017, ZSI published its report as 'Studies on the Succession and Faunal Diversity and Ecosystem Dynamics in Nayachar Island Indian Sundarban Delta'.As per the data, the number of animal species increased to 151 on the island, making it a rare case in ecology. The publication is unique in nature as it reveals how an emerging landmass can gradually provide habitats for diverse groups of organisms.

Ecology of Nayachar Island

Nayachar is a mangrove ecosystem and the species succession we have observed here is unique.The natural succession of species on the island has been aided by the inundation of water during tides, and the soil brought from other places by fishermen. As per ZSI survey, soon after the emergence of protista (single-celled organisms) on the island, scientists could record salt-tolerant micro fauna from the *Acarina* and *Collembola* groups living under the soil. The island has not only recorded a growth in species of fauna but also increased in size from 17.99 sq. km. to 46.29 sq. km. to 62 sq.km.

Plate 60 – Existing Mangrove patch, Nayachar Island

Plate 61 – Grasses along the side of Tidal Creeks Plate 62 –Hogla Grasses along the Khals

Ecological Succession:

Nayachar has provided that rare opportunity for researchers to study species succession from a very nascent stage. Researchers point out that soil formation and subsequent changes including evolution of species followed the classic textbook pattern soil formation. First, Microfauna organic material is released by the soil, which in turn releases energy and CO2. Macrofauna reported on the island is found both in the soil and in the emerging habitation cover. The stepped process centres around microfauna like *collembolans* and *mites*, and leads to increased nitrification and formation of humus. Insects and fish are attracted to the food available in the aquatic habitat and soil vegetation. This also leads to an increased number of avian species. It is important to monitor its physical and biological changes with a continuous surveillance system, without allowing any major economic activity on the island.

Plate 63– Mud Skippers , in the fresh tidal mud deposits .

Plate 64 – Red Watteled Lapwing , Nayachar Island

Plate 65– Wild Buffaloes of Nayachar Island

iv. The Commercial Ventures in Nayachar Island - In December 1987, then land and land reforms minister Benoy Chowdhury had ordered the island handed over to the fisheries department. The order was carried out in March 1988. **Benfish**, the official agency of the fisheries department, undertook its development. The island was renamed **Meendwip**, meaning fish island, but nothing much seems to have happened.

a. Fisheries - In government files, the island is "uninhabited" although there are around 2,500 people living on the island, mostly as "encroachers". In the year 2000 13 fishery cooperatives were set up, 315 ponds were dug and many of the 400 families on the island work in these. The rest catch fish on their own, either in the river or in small ditches that fill up with small fish during high tide. The government or fisheries department never gave them any right to the land or ponds. They were only allowed to fish around. Some 200 fishermen arrive every morning on the ferry service, work in the co-operatives and leave in the evening. In 2007, the fisheries department has even ended the contracts with the cooperatives.

Plate 66-- In March 1988, **Benfish**, the official agency of the fisheries department, undertook the development of Nayachar. The island was renamed **Meendwip**, meaning fish island, but nothing much seems to have happened. However , it did not matured. The remains are still there in the island

Map – High Resolution Image shows -Aquaculture Ponds, Nayachar

Plate 67 – Near the huge aquaculture tank, Nayachar Island

Plate 68 - Fishing is done by Bagdi (Fishermen communities) in Nayachar

Plate 69 –Aquaculture ponds of Nayachar

Plate 70 – Prawns and Bhetki are the regular fishes found in the Island

Plate 71: The existing huge Fishing Unit of Benfish in Nayachar (at present non functional)

***b. Chemical hub* -** The Government of India introduced the concept of chemical hubs, calling them Mega-Chemical Industrial Estates (MCIES) in 2005, but a year later enlarged it and introduced the concept of Petroleum, Chemicals ad Petrochemicals Investment region (PCPIRs). A PCPIR was defined as a specifically delineated investment region with an area of around 250 km² planned for the establishment of manufacturing facilities for domestic and export led production in petroleum, chemicals. Out of this around 40 percent of the total region was expected to have the hub. It is expected Haldia-Nayachar would attract total investment of Rs. 440 billion . The proposal of the **Salim Group for chemical hub** was cleared in principle by the board of approvals of the Union Commerce Ministry, Government of India, in October 2006. Other places where similar chemical hubs are being set up in India are: Mangalore in Karnataka, Panipat in Haryana, and Achutapuram in Andhra Pradesh .

***c.Haldia-Nayachar complex* -** Indian Oil Corporation, Haldia Petrochemicals and Mitsubishi Chemicals, all petrochemical companies, are operating in Haldia. However, for setting up a chemical hub there under the ambit of the Petroleum, Chemical, Petrochemical Investment Region policy of the Government of India, the West Bengal State Government would need to acquire an additional 10,000 acres (40 km2) of land, in addition to the existing 15,000 acres (61 km2) in Haldia, Nayachar has emerged as the most logical option for a major chemical hub as the land belongs to the state government and the area being largely uninhabited. It will neither entail land acquisition nor require population displacement.
The chemical hub would be set up as a joint venture project of West Bengal Industrial Development Corporation Ltd and New Kolkata International Development. Indian Oil Corporation would be the anchor investor there. The NKID comprises three companies including the Salim Group of Indonesia.

However, Nayachar comes under the coastal regulation zone where industries are not permitted under the existing environment rules.

4.3.B. Balari Island - i. Location & Evolution – (22° 2'18.76"N 88° 9'6.37"E): Situated in the northern part of the Nayachar Island is the Balari Bar which started developing from 1950. But the surface expression came from 1990 onwards. The systematic study of charts and maps indicates that Balari Bar is increasing rapidly from a mere 0.29 sq.km in 1997 to 5.48 sq.km in 2020.

Anticipating the growth of the Balari Bar, a comprehensive river training work was planned in the early 1980s. The main aim was to divert a significant amount of ebb flow into the Haldia Channel. The highlights of the project were to construct a 2.8-kmlong guide wall at the northern tip of the Nayachar island and an 8-km long guide wall at the southern tip of the island, both to guide the ebb and the flood tides into the Haldia Channel.

Of these, only the construction of the northern guide wall was taken up and was completed in June, 1992.Contemporaneously, according to an agreement reached in 1990, the recessional dredging project was handed over to a Dutch company, specialised in riverbed bulk shore disposal dredging. Shore disposal of dredged material technique was important here because channel disposal, which is practiced by the Indian dredgers, could return the sediments to their place of origin. The project failed as the strong tides dismantled the pipelines connected with the dredger for the shore disposal of the dredged materials. Since then, any attempt of capital dredging has not been done in this reach and the Jiggerkhali Flat and Balari Bar have remained untouched except for some maintenance dredging.

As a consequence, the gradual deterioration of the Haldia Channel restricted the movement of ships from HDC to KDS through it. By 1994, the Balari Bar had become stable and its area and height started to increase. Every year an additional 4 million m3 of dredged material (bed sediments) is lifted from around the HDC to keep it open to traffic.With time, the Balari Bar expanded vertically as well as longitudinally choking up the northern most oil jetty of HDC (Oil Jetty 1) where the draft falls to 5 m or less becoming virtually impossible to accommodate Suezmax vessels. It also becomes difficult to accommodate Panamax vessels during post-freshet months. Tangible effect of the deterioration of the Haldia Channel due to southward extension of the Balari Bar is noticed from drop in the cargo handling of the HDC since 2009 .

EVOLUTION OF BALARI BAR, From 2001-2020

2001 , High Resolution Image , 0.63 sq.km

2005 , High Resolution Image , 3.46 sq.km

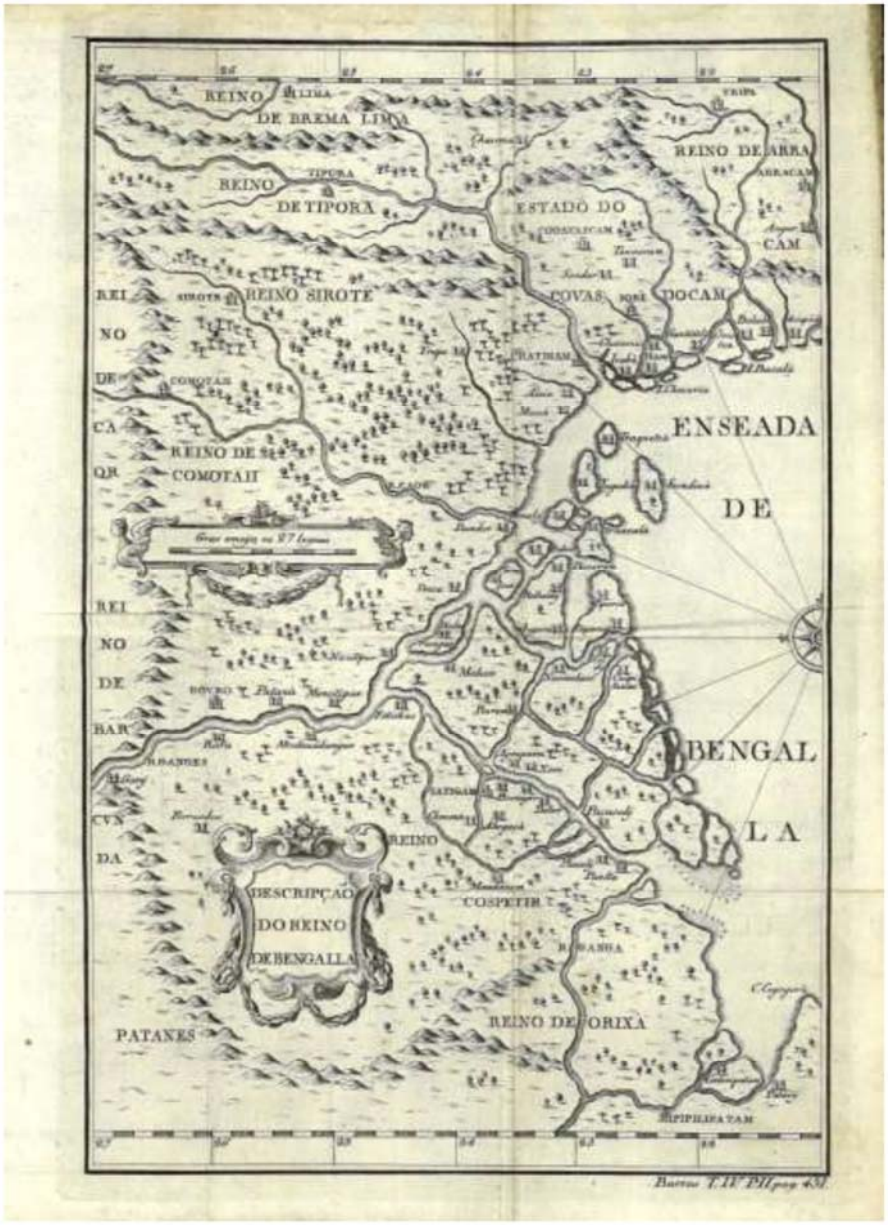
2010, High Resolution Image , 3.60 sq.km

2015, HighResolution Image , 3.89 sq.km

2020, High Resolution Image , 5.54 sq.km

Changing shoreline of the Study area, Purba Medinipur –

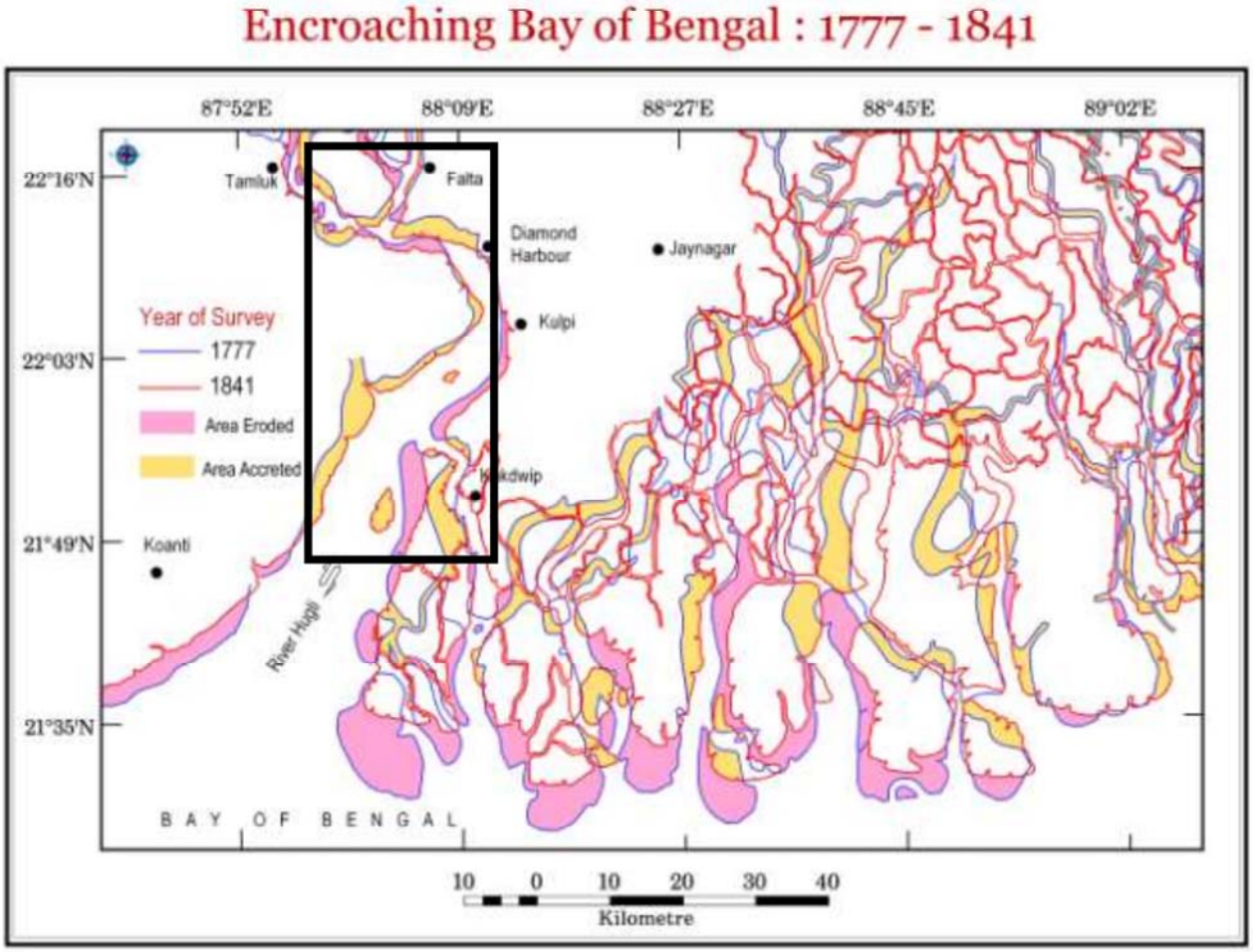
In the maps of De Barros and Blaev sand banks are shown on the coast, indicating the formation of an island. In Valentyn's map and Bowrey's chart two islands are shown distinctly, one above the other the upper one being the island of Khejri and the lower one the island of Hijili. They are mentioned also in contemporaneous accounts, such as the factory records and the diaries of the East India Company's Agents. In 1687, when the English made war against the Nawab of Bengal, Job Charnok seized the island of Hijil! and, after fortifying it, held it for months against the Nawab's army. Both the islands appear in the pilot chart of 1703, and they continued to bo shown in the maps down to a later date, e.g., in Bolt's map of Bengal {circa 1770) and Whitchurch's map (1769). In Rennell's Atlas (Plates VII and XIX) the islands no longer appear, presumably because they had been joined to the mainland in the same way as the Kukrahati-Tamluk island above mentioned.



Mattheus van den Broucke was Director of the Dutch East India Company (Vereenigde Oost-Indische Compagnie or VOC) in Bengal during 1658-1663. Van den Broucke authorized a survey of Bengal, which was carried out by Commander Johan van Leenen in 1666-1667.

Major James Rennell, FRS FRSE FRGS (3 December 1742 – 29 March 1830) was an English geographer, historian and a pioneer of oceanography. Rennell produced some of the first accurate maps of Bengal at one inch to five miles as well as accurate outlines of India and served as Surveyor General of Bengal. He first authentic Map of Hugli Estuary however shows absence of any islands in the Purba Medinipur coast.

"Carte du Bengale," by W. Bolts, from 'Etat civil, politique et commerçant, du Bengale...', Paris, 1775;



Map –River Atlas of Bengal , K. Rudra

Based on the earlier Maps it is found that there is more accretion in our study area than erosion. Specially near the mouth of Haldi River there is considerable amount of deposition.

4.5. Waterbodies of the Study area –

There is innumerable number of Waterbodies in the study area where mostly fish farming is done. The entire river bank of Hugli River is dotted with Aquaculture Farms. Over the last decade, Indian shrimp farming industry has transformed from a traditional agriculture system to a highly profitable semi-intensive system because of its increasing consumer demand, continuous foreign export and stagnation in the wild catch. In our entire stretch of study area we find that the Nandigram I and Khejuri II blocks have their entire river bank strewn with aquaculture ponds. In fact nowadays, because of easy return from shrimp culture, maximum cultivated lands are also getting converted to aquaculture ponds.

Plate 72– Charkendamari , Nandigram I block along Bhagirathi Hugli River. 22° 0'45.30"N 88° 2'24.72"E

Plate – Aquaculture ponds in Charkendamari , Nandigram I, 22° 0'45.30"N 88° 2'24.72"E

Plate 73 - Aquaculture ponds in Charkendamari , Nandigram I, 22° 0'21.63"N 88° 2'55.52"E

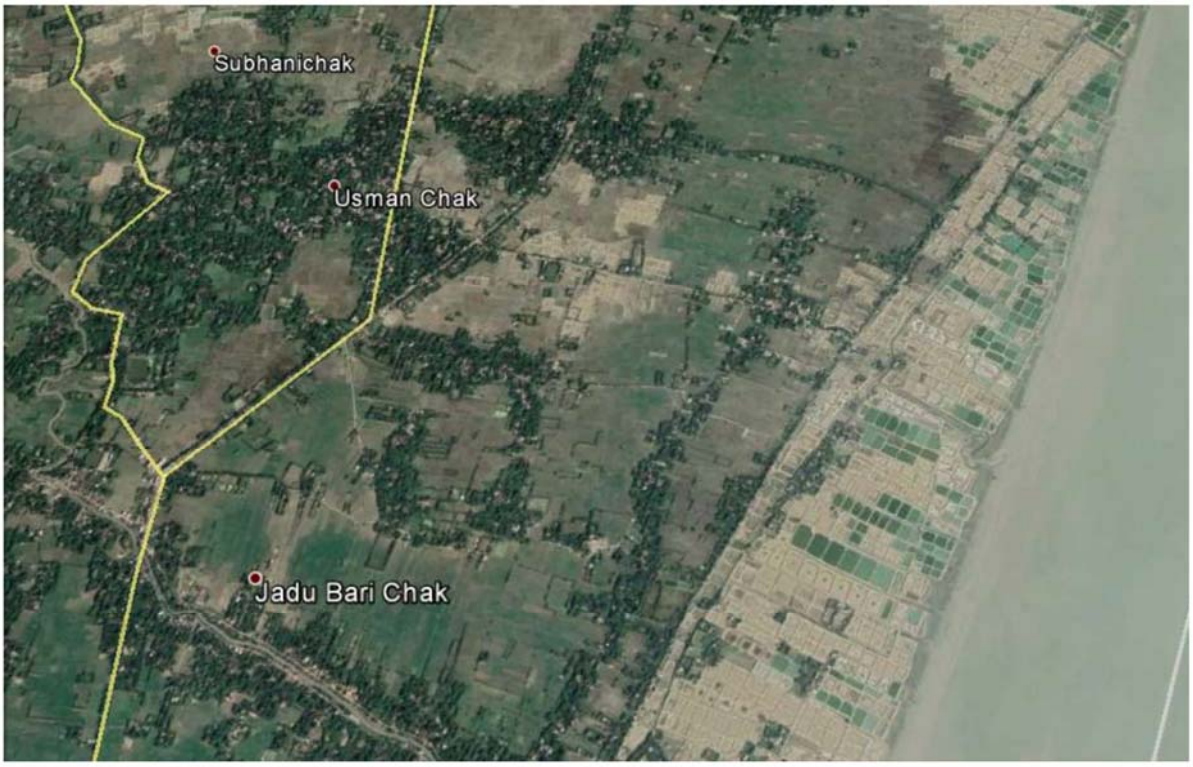


Plate – Aquaculture farms all along the Bhagirathi Hugli river , Khejuri BlocK, 21°56'40.83"N 88° 1'4.95"E

Plate 74- Aquaculture farms all along the Bhagirathi Hugli river , Khejuri BlocK, 21°56'34.73" 88° 1'3.24"E

Plate – Aquaculture farms along Roosulpur Khal , near Pratappur, 21°48'2.53"N 87°52'57.50"E

Plate 75– Aquaculture ponds near Roosulpur River 21°48'2.53"N 87°52'57.50"E

Plate 76 & 77 : Fishing is done by all the households of Nayachar Island .

Beside these major Aquaculture Farms there are also many waterbodies inside the villages used for domestic and irrigation purpose. The entire study area in Purba Medinapure District falls under the coastal zone and thereby salinity is a major issue with Groundwater. Thus the rain water is very important for cultivation. Rain water harvesting structures are found in the near by villages which are used for irrigating the fields. Some of them are -

Sl no	Location	GCP
1.	Mahisadal Block	22°10'47.54"N 88° 7'38.85"E
2	Mahisadal Block	22°10'47.38"N 88° 7'41.94"E
3	Mahisadal Block	22°10'40.92"N 88° 7'53.13"E
4	Mahisadal Block	22°10'39.18"N 88° 7'51.10"E
5	Mahisadal Block	22°10'37.68"N 88° 7'58.77"E
6	Mahisadal Block	22°10'28.42"N 88° 8'0.91"E
7	Mahisadal Block	22°10'18.31"N 88° 7'52.45"E
8	Mahisadal Block	22°10'8.13"N 88° 7'56.43"E
9	Mahisadal Block	22° 9'33.57"N 88° 7'58.44"E
10	Mahisadal Block	22° 9'33.13"N 88° 8'7.58"E
11	Mahisadal Block	22° 9'8.27"N 88° 7'43.24"E
12	Mahisadal Block	22° 9'3.48"N 88° 7'50.62"E
13	Mahisadal Block	22° 8'46.16"N 88° 8'6.16"E
14	Mahisadal Block	22° 8'36.90"N 88° 8'5.72"E
15	Mahisadal Block	22° 8'34.69"N 88° 8'8.21"E
16	Mahisadal Block	22° 8'33.40"N 88° 8'4.27"E
17	Mahisadal Block	22° 8'26.28"N 88° 8'7.50"E
18	Mahisadal Block	22° 8'29.22"N 88° 8'15.84"E
19	Mahisadal Block	22° 8'9.17"N 88° 8'10.90"E
20	Mahisadal Block	22° 8'1.09"N 88° 8'11.81"E
21	Mahisadal Block	22° 8'32.71"N 88° 8'8.35"E
22	Mahisadal Block	22° 8'20.63"N 88° 8'38.10"E
23	Mahisadal Block	22° 7'52.45"N 88° 8'42.04"E
24	Sutahata Block	22° 7'18.35"N 88° 8'21.28"E
25	Sutahata Block	22° 7'7.65"N 88° 8'34.28"E
26	Sutahata Block	22° 6'43.05"N 88° 8'35.08"E
27	Sutahata Block	22° 6'20.05"N 88° 9'5.20"E
28	Sutahata Block	22° 6'11.80"N 88° 9'14.07"E
29	Sutahata Block	22° 6'9.85"N 88° 9'28.98"E
30	Sutahata Block	22° 5'58.83"N 88° 9'26.36"E
31	Sutahata Block	22° 5'54.30"N 88° 9'42.92"E
32	Sutahata Block	22° 5'56.51"N 88° 9'23.41"E
33	Sutahata Block	22° 5'45.18"N 88° 9'33.60"E
34	Sutahata Block	22° 5'30.56"N 88° 9'33.39"E
35	Sutahata Block	22° 5'7.17"N 88° 9'39.50"E
36	Sutahata Block	22° 4'43.27"N 88° 9'23.83"E
37	Sutahata Block	22° 4'39.82"N 88° 9'42.30"E
38	Sutahata Block	22° 4'25.68"N 88° 9'27.24"E
39	Sutahata Block	22° 4'36.61"N 88° 9'4.35"E
40	Sutahata Block	22° 4'58.73"N 88° 9'3.40"E

41	Sutahata Block	22° 4'58.73"N 88° 8'56.85"E
42	Sutahata Block	22° 4'34.37"N 88° 8'48.14"E
43	Sutahata Block	22° 4'28.77"N 88° 8'57.83"E
44	Sutahata Block	22° 4'7.14"N 88° 8'43.62"E
45	Sutahata Block	22° 4'1.15"N 88° 8'39.06"E
46	Sutahata Block	22° 4'1.57"N 88° 8'26.18"E
47	Sutahata Block	22° 4'3.90"N 88° 8'6.98"E
48	Sutahata Block	22° 4'10.32"N 88° 8'6.55"E
49	Nandigram I	22° 4'3.51"N 88° 7'1.66"E
50	Nandigram I	22° 0'59.68"N 88° 0'31.31"E
51	Nandigram I	22° 1'14.81"N 88° 0'26.94"E
52	Nandigram I	22° 1'21.62"N 88° 0'5.71"E
53	Nandigram I	22° 1'26.86"N 87°59'59.07"E
54	Nandigram I	22° 0'51.64"N 87°59'39.09"E
55	Nandigram I	22° 0'33.83"N 87°59'23.63"E
56	Nandigram I	22° 0'39.48"N 87°59'2.10"E
57	Nandigram I	22° 0'27.87"N 87°59'37.66"E
58	Nandigram I	22° 0'19.92"N 87°59'40.03"E
59	Nandigram I	22° 0'19.92"N 87°59'40.03"E
60	Nandigram I	22° 3'39.09"N 88° 5'59.36"E
61	Nandigram I	22° 2'56.06"N 88° 4'45.09"E
63	Nandigram I	22° 2'51.33"N 88° 4'10.02"E
64	Nandigram I	22° 2'49.61"N 88° 2'42.57"E
65	Nandigram I	22° 3'39.69"N 88° 2'8.62"E
66	Nandigram I	22° 5'2.06"N 88° 2'24.39"E
67	Nandigram I	22° 5'52.29"N 88° 3'15.83"E
68	Nandigram I	22° 6'12.19"N 88° 2'7.38"E
69	Nandigram I	22° 4'30.86"N 88° 1'40.32"E
70	Nandigram I	22° 0'18.55"N 88° 2'26.23"E
71	Nandigram I	21°59'59.72"N 88° 1'39.37"E
72	Nandigram I	21°59'49.70"N 88° 1'36.26"E
73	Nandigram I	21°59'10.32"N 88° 1'11.01"E
74	Nandigram I	21°58'52.01"N 88° 1'16.85"E
75	Nandigram I	21°58'33.91"N 88° 0'56.61"E
76	Nandigram I	21°58'11.59"N 88° 1'14.66"E
77	Nandigram I	21°57'55.80"N 88° 1'4.04"E
78	Nandigram I	21°57'51.48"N 88° 0'30.00"E
79	Nandigram I	21°57'31.34"N 88° 0'24.39"E
80	Nandigram I	21°57'26.02"N 88° 0'19.24"E
81	Nandigram I	21°56'46.11"N 87°59'46.11"E
82	Nandigram I	21°56'43.97"N 87°59'51.94"E
83	Nandigram I	21°56'10.27"N 88° 0'21.29"E
84	Nandigram I	21°55'54.92"N 88° 0'11.11"E
85	Nandigram I	21°55'48.67"N 87°59'31.32"E
86	Nandigram I	21°55'40.03"N 87°59'20.09"E
87	Khejuri II	21°53'1.92"N 87°58'29.38"E
88	Khejuri II	21°52'46.44"N 87°58'25.57"E
89	Khejuri II	21°52'23.04"N 87°58'19.59"E

90	Khejuri II	21°51'58.55"N 87°57'46.26"E
91	Khejuri II	21°51'51.11"N 87°57'27.71"E
92	Khejuri II	21°51'53.95"N 87°57'14.30"E
93	Khejuri II	21°51'47.36"N 87°57'15.25"E
94	Khejuri II	21°51'41.15"N 87°57'0.03"E
95	Khejuri II	21°51'28.79"N 87°57'2.06"E
96	Khejuri II	21°51'1.51"N 87°56'51.72"E
97	Khejuri II	21°51'15.23"N 87°56'41.02"E
98	Khejuri II	21°51'15.96"N 87°56'34.11"E
99	Khejuri II	21°50'17.34"N 87°56'26.53"E
100	Khejuri II	21°50'6.67"N 87°56'15.01"E
101	Khejuri II	21°50'5.69"N 87°56'11.40"E
102	Khejuri II	21°50'22.49"N 87°56'12.22"E
103	Khejuri II	21°50'6.21"N 87°56'8.35"E
104	Khejuri II	21°49'57.35"N 87°56'2.16"E
105	Khejuri II	21°49'49.53"N 87°56'1.35"E
106	Khejuri II	21°49'44.48"N 87°55'57.34"E
107	Khejuri II	21°49'49.91"N 87°56'8.27"E
108	Khejuri II	21°49'45.86"N 87°55'58.13"E
109	Khejuri II	21°49'26.69"N 87°55'59.73"E
110	Khejuri II	21°49'14.90"N 87°55'52.15"E
111	Khejuri II	21°50'53.85"N 87°56'40.91"E
112	Khejuri II	21°50'39.14"N 87°56'35.37"E
113	Khejuri II	21°50'27.12"N 87°56'36.75"E
114	Khejuri II	21°49'19.70"N 87°55'53.72"E
115	Khejuri II	21°49'17.46"N 87°55'45.54"E
116	Khejuri II	21°49'5.86"N 87°55'35.46"E
117	Khejuri II	21°49'1.00"N 87°55'18.34"E
118	Khejuri II	21°49'1.64"N 87°55'3.72"E
119	Khejuri II	21°49'1.56"N 87°54'38.64"E
120	Khejuri II	21°48'47.03"N 87°54'34.27"E
121	Khejuri II	21°48'38.63"N 87°54'27.58"E
122	Khejuri II	21°48'26.06"N 87°54'10.71"E
123	Khejuri II	21°48'15.40"N 87°53'57.73"E
124	Khejuri II	21°48'13.98"N 87°53'41.17"E
125	Khejuri II	21°47'59.17"N 87°53'37.91"E
126	Khejuri II	21°47'51.30"N87°53'34.54"E
127	Khejuri II	21°49'22.48"N 87°53'2.76"E
128	Khejuri II	21°49'16.83"N 87°54'28.62"E
129	Khejuri II	21°48'23.72"N 87°54'43.14"E
130	Khejuri II	21°48'14.93"N 87°54'45.31"E
131	Khejuri II	21°48'20.16"N 87°54'46.86"E
132	Khejuri II	21°48'26.60"N 87°54'17.97"E
133	Khejuri II	21°48'25.48"N 87°53'52.97"E
134	Khejuri II	21°48'18.95"N 87°53'45.18"E
135	Khejuri II	21°48'14.31"N 87°53'37.02"E
136	Khejuri II	21°48'22.08"N 87°52'50.80"E
137	Khejuri II	21°48'54.04"N 87°52'51.06"E

138	Khejuri II	21°49'18.49"N 87°52'41.62"E
139	Khejuri II	21°49'30.22"N 87°52'46.13"E
140	Khejuri II	21°49'35.23"N 87°52'41.56"E
141	Khejuri II	21°49'30.68"N 87°52'56.83"E
142	Khejuri II	21°49'20.84"N 87°53'19.23"E
143	Khejuri II	21°49'28.02"N 87°53'24.72"E
144	Khejuri II	21°49'19.89"N 87°53'24.56"E
145	Khejuri II	21°49'17.50"N 87°53'28.83"E
146	Khejuri II	21°49'12.24"N 87°53'40.29"E

Plate 78– WHS construction in Sutahata, 22° 7'28.13"N 88° 9'34.75"E, Purba Medinipur

Plate 79– Water harvesting Structure , Sutahata , 22° 5'28.72"N 88° 8'17.93"E

Plate 80– A Village pond , Mahisadal 22°11'1.57"N 88° 6'0.30"E,

Chapter 5: Documenting major Structures in the River bank

5.1. HALDIA PORT

Haldia port or Haldia Dock Complex has been built at the meeting place of the Haldi River and Hugli river 22° 1'19.15"N 88° 4'48.65"E. It is 8 meter above canal. Kolkata Port Trust has been created in this port as the port's partner. So it is not a port. It is an official dock complex. It has a vast hinterland comprising the entire north east of India including West Bengal, Bihar, Jharkhand, Uttar Pradesh, Madhya Pradesh, Assam, North East Hill States and two landlocked neighbouring countries namely, Nepal and Bhutan and also the Autonomous Region of Tibet (China).

The port consists of:

- Impounded dock; system with 12 berths
- 3 oil jetties in the river
- 3 barge jetties in the river for handling oil carried by barges
- Haldia anchorage for lash vessels
- The docks are impounded dock systems with locks from river.

Plate 81 : Haldia Port , Source – Website . Restricted Area

5.2. PETUAGHAT FISHING HARBOUR –

Petuaghat Fishing Harbour is a fishing harbour established near the mouth of the Rasoolpur river at Petuaaghat in Purba Medinipur district. 21°47'45.16"N , 87°52'52.03"E. The port originated in 2010 in the then West Bengal's then-fashioned MK Narayanan. The port has been developed in 11.8 hectares of land. The port is one of India's 7th largest fishing ports. The port has 400 deep sea fishing trawlers and 200 traditional trawlers. One ice mill, ice house, fake fabric centre and trailer oil sales centre at the port. It has also been proposed to build a trailer repair centre here.

Plate 82– Petuaghat Fishing Trawlers in the fishing port of Rosoolpur River.

Plate 83 – Ice Factory , Petua Ghat Fishing Harbour , Plate 84 – Loading and unloading of fish done in boxes.

Plate 85 & 86 – Fishes are transported to the major fishing markets of Bengal

5.3. INLAND NAVIGATION –

The National Waterway 1 or NW-1 or Ganga-Bhagirathi-Hugli river system is located in India and runs from Haldia (Purba Medinipur) to Prayagraj across the Ganges, Bhagirathi and Hugli river systems. This stretch of our study falls under the primary phase of National Waterway 1. It starts from "The Haldia Multi-Modal Terminal " . It is a barge set up in Port City Haldia in Purba Midnapore district and a small barrier set for small ships. The terminal is built near the Haldia Port.

In our study area of Purba Medinipur District we find 3 major Rivers apart from Bhagirathi Hugli River. They are – Rupnarayan River , Haldi River and Roosulpur River . All these rivers are navigable and ferry services are there in all the rivers. Beside these rivers , Bhagirathi Hugli is also navigable in this stretch of the study. South 24 Parganas & Haora are connected with the ferry service.

Plate 87– Geonkhali Jetty Ghat . 22°12'11.77"N 88° 2'55.94"E on Rupnarayan River .

Ferry Service – 1. To Noorpur (South 24 Parganas) , Crossing confluence of Bhagirathi Hugli & Rupnarayan River. 2. To Gadiara (Haora) , Crossing Crossing confluence of Bhagirathi Hugli &

Plate 88 – Kukrahati Ferry ghat on River Bhagirathi Hugli . 22°11'18.16"N , 88° 7'13.20"E Ferry Service – 1. To Raichak , South 24 Parganas 2. To Diamond Harbour , South 24 parganas.

Plate 89 – Patnikhali Ferry Ghat , Haldia . 22° 3'24.33"N 88° 8'23.13"E, Ferry Service – To Nayachar Island. Once every day . Timing depends on tide.

Plate 90– Haldia Ferry Service connecting Haldia Municipality with Charkendamari , NandiGram 1 Block , along Haldia River. 22° 1'19.19"N 88° 3'13.64"E. Plate 91– Fishing Trawlers crossing point from Haldia to Charkendamari

Plate 92– Petuaghat-Hijli Ferry Service on Rosoolpur River , 21°47'51.45"N 87°53'0.98"E connecting Khejuri II with that of Deshpran Block , Plate 93– Petua Ghat main jetty on Rosoolpur River connecting Maya Goalini Ghat , Sagar Block , South 24 Parganas 21°47'38.55"N 87°52'59.56"E

Plate 94 & 95 – Patikhali to Nayachar Ferry Service , once in a day. Because of tides and sedimentation the existing Jetty is becoming useless

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

6.1. LANDUSE LANDCOVER STUDY IN THE STUDY AREA

The study area of Purba Medinipur, is situated in the proper delta of lower Ganga plain. It is little higher above the flood level and the physical features are similar to deltaic land of the country. Agriculture and fishing comprise the most important economic activities in rural landscape. However the huge hub of Haldia Port and Chemical Hub attracts huge number of people from all over the world.

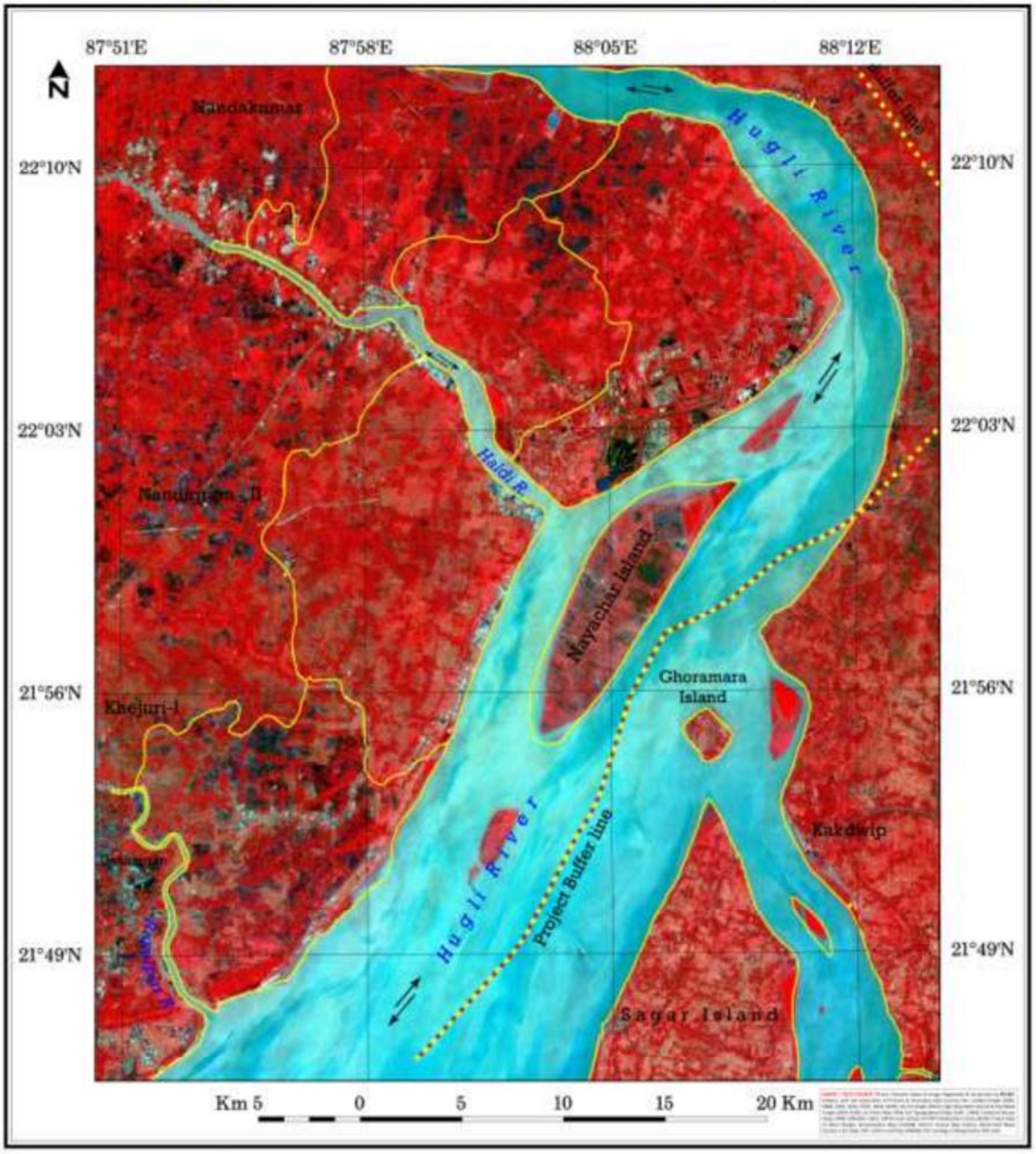
Though Agriculture forms the backbone of the district , our study area has a considerable amount of land devoted to aquaculture. Actually this part suffers a lot due to pronounce presence of saline water in estuarine tidal rivers and creeks which sometimes creates havoc through ingression of brackish water lets the land unsuitable at least next three to four years. Lack of waters for irrigation causes crop failure and reduction of area under multiple cropping. Therefore now farmers have shifted their occupation to fish farming in brackish water.

A general landuse and landcover is prepared with the help of Landsat FCC Image , 2019 . It shows spatial distribution of Mono Crop Land , Double Crop Land , Settlement Areas , Waterbody , Mangroves , Other Vegetation and Mud flat . This image also depicts that there is a huge sedimentation in the bed of Bhagirathi Hugli river making it shallow. The difference is so acute that we have kept 2 classes on the River Water.

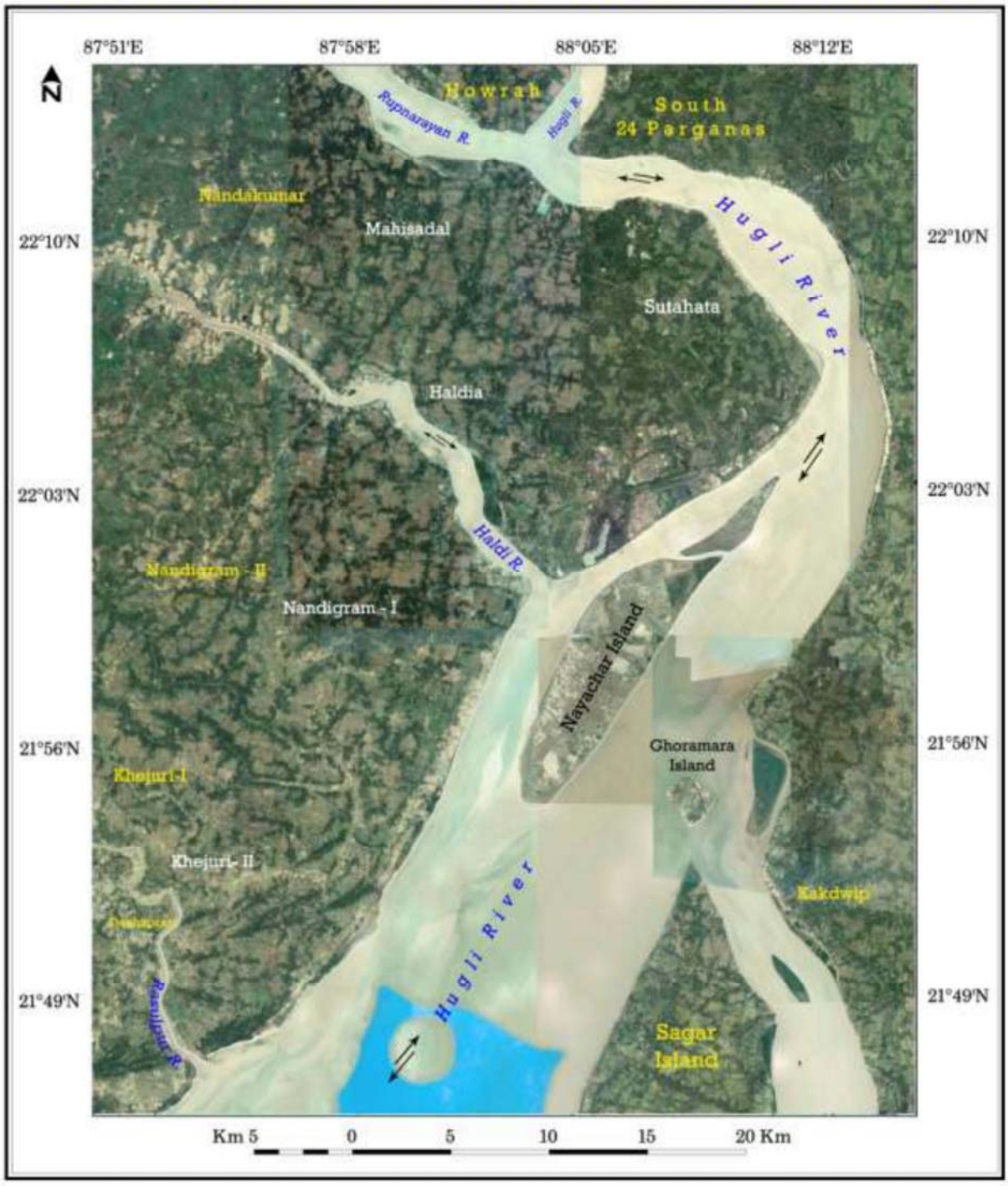
The major crop is rice, while the minor crop is pulse and vegetables growing areas in the district including rural-urban settlements, forest, orchard and plantation. Swamp area which is presently used as commercial fish production is also delineated in the map and are categorised under aquaculture.

Sl no	Categories	Percentage of land under each LULC (%)
1	Industrial Centre including Port	2
2	Settlement	12
3	Waterbody – River (Deep)	14
4	Waterbody – River (Shallow)	7
5	Aquaculture	21
6	Double Crop/Multiple Crop	18
7	Mono Crop	18
8	Vegetation	8
9.	Mud Flat	4

Satellite Image : False Colour Composite (15th February 2019)
under Ganga Documentation Project, Purba Medinipur, West Bengal

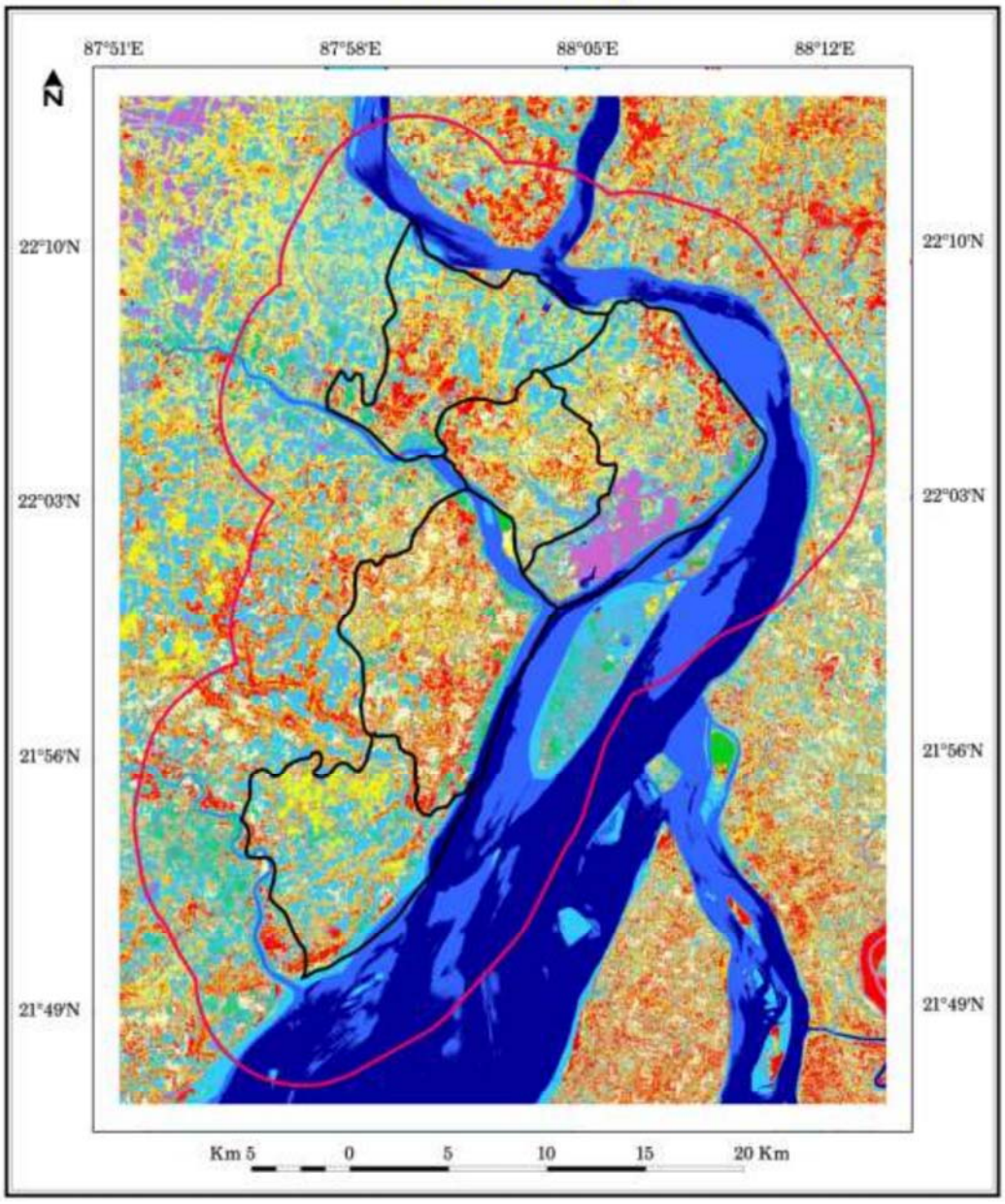


High Resolution Ikonos Image : December 2020, Showing the Study Area under Ganga Documentation Project, Purba Medinipur, West Bengal



LANDUSE LANDCOVER MAP

Purba Medinipur



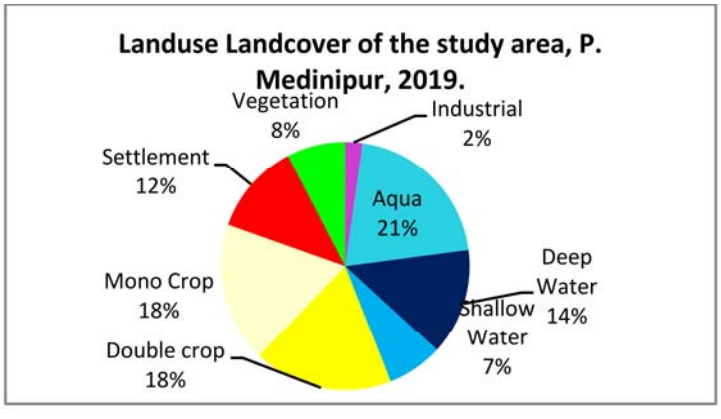


Plate – Fresh Tidal Mud Flat , Nayachar Island

Plate 97 – Haldi River , Haldia Municipality Area

Plate 98– Aquaculture Ponds , Khejuri , Plate 99– Forested Tract of Khejuri Coastal area

6.2. River / Channel bank using for various Economic activities

6.2A. Agriculture

Purba Medinipur district is mainly a land of agriculture and more than 80% of the total population is residing in the villages and the rural economy is based on Agriculture and Agro-based small industries. The district Purba Medinipur falls under two agro climatic zones namely, i) Bindhiya 4 alluvium zone covering 6 blocks ii) Coastal saline zone covering 19 blocks. Our study area lies in the second category.

Only few years before traditional agriculture were the mainstay of the economy. But now fish farming specially shrimp farming has taken over the river bank economy. Paddy (Aus, Aman & Boro) is the main crop in the low lying areas along with, Wheat, Potato, Oilseeds, Vegetables, Pulses, Jute, Betel vine, Mat stick, etc. Aman paddy, during monsoon season is quite uncertain owing to excessive rainfall, submergence of agricultural field and very poor drainage facilities, especially in the coastal blocks. A considerable area of the district is inundated during rainy seasons. Even during normal rainfall water logging in the low land areas is a major problem. As a result farmers are now compelled to transform their land into aquaculture farms.

Plate 100 : Straws and Hays in the paddy field . Nandigram II , 21°59'54.83"N 88° 2'27.90"E

Plate 101: Mustard Field , Mahisadal , 22° 1'51.51"N 88° 0'31.43"E

Plate 102 : Paddy Field , Sutahata 22° 0'36.44"N 88° 1'39.91"E

Bettle Vine Plantation – Purba Medinipur is the largest producer of the best quality of Beetle leaves in west Bengal with the Tamluk Subdivision being the largest contributor in the district. In our study area we find that in **Sutahata** and **Mahisadal** , a considerable amount of land is devoted under beetle leaf cultivation. The betel leaf creeper called pan was grown up in garden known as *baraj*. It is to be further mentioned that directly and indirectly a remarkable section of people depended on betel-vine for their livelihood. Around 30 varieties of *paan* are found in Bengal, including Bangla, Sanchi, Mitha, Kali Bangla and Simurali Bangla. Betel leaves are grown for local consumption and also exported to countries like Sri Lanka, United Kingdom, Bangladesh and Malaysia. The two districts, of Purba Medinipur and South 24 Parganas , aided by their climatic characteristics, happen to be a very important source for the famous and pricey **'mitha (sweet) patta'** variety. However the going for the betel leaf farmers had already become tough in the lockdown phase when, with the normal marketing channels becoming practically inactive, the farmers had to witness the stacked leaves losing flavour and rotting. There was some elbow room with the unplucked leaves, but with marketing outlets not available, the middlemen, who are a key factor in the betel leaf

Plate 103 : Beetle vine Tard , Nandigram II. Source : Assistant Director of Agriculture

trade, had their chance of hammering down the prices. As they were trying to figure out ways of minimising their loss, super cyclone Amphan dealt the final blow on May 20-21. Almost 100% of the betel leaf farms were ravaged in Amphan's fury. Out of 25 blocks in Purba

Medinipur, 10 blocks have intensive 'paan' farming. These blocks are Nandakumar, Tamluk, Sahid Matangini, Moyna, Mahishadal, Ramnagar I and II, Egra and Nandigram.

Jute : Jute is an important cash crop. It covers only about 0.5 per cent of TCA. It generally grows well on loamy soil. Some amount of jute is also grown in Budge Budge, Kulpi, Magrahat blocks. The jute mills in Budge Budge, Maheshtala and adjoining areas provide the main market for raw jute.

Oilseeds : Mustard is the principal variety of oilseed grown in this District. Recently sunflower, til (sesamum), groundnut, soyabean, linseed etc. are being cultivated due to expanding market of oil extracted from them. Special incentives are also being given to the farmers from the government for cultivating oilseeds. The loamy soil with medium salinity, as is found in the southern part of the District, is quite suitable for growing **sunflower.** Groundnut and Cashew Nuts can also be grown on the coastal sandy soil. Improved varieties of seeds are being distributed from time to time for growing sunflower by the State Government. The result is quite encouraging.

Plate 104 – Mustard Plantation , Mahisadal 22°10'9.05"N, 88° 0'59.07"E

Madursedge / Madur Kathi – They are the rhizome plant found abundantly in the alluvial tracks of East and West Medinipur districts. The climate and land in the two districts are suitable for the reeds that grow between April and July as well as between September and November. The plant is capable of tolerating extremities such as prolonged submergence in water and extended drought conditions. The swampy and marshy lands are used to cultivate mat-sedges. In our study area , marshy swamps of Mahisadal and interior of Nandigram , Khejuri Block produces Mat sticks. Then this sticks are transported to adjoining blocks of Bhagawanpur , Ramnagar , Deshpran for Mat making.

Plate 105 – Madur Kathi Grass along Haldi River , Haldia.

Hogla (Typha elephantina) grows naturally in the marshy lands of the state and the biggest concentration is in and around Uluberia, like Amta and Kulgachhia etc. of Howrah district and to some extent in the adjoining East Medinipur district. Mahisadal and Sutahat in our study area along Rupnarayan and Hugli river produces a good amount of Hogla . The plant grows to a height of around 20 ft. The same is harvested around the month of September by cutting at a point 2 to 3 ft above their root and is bundled for transportation. Such bundle is called 'Galda' and usually weighs around 70 to 80 kg. The Hogla leaves are dried and used to prepare Chhai by stitching the leaves with rope, which is used mostly for temporary roofing of make shift houses. There are around 100 big traders and around 1,000 labourers are engaged in stitching and handling of Chhai. Price of one Chhai varies from Rs 80/ to Rs 200/ depending on the quality. Around 5 lakh Chhai are traded every year and a substantial part of the same is used for Gangasagar mela. Total value of Chhai traded is around Rs. 8 crore a year.

Plate 106 – Hogla Grasses are found all along the banks of rivers, khals and marshy areas

Plates 107– These Hogla Grasses are dried and stacked for making shelters

Plates 108 – After Processing the Dried Hogla Grasses are transported to different areas for making products Plate 109 : Men and women are engaged in making different products out of dried Hogla

Plate 110 : The Patti (individual blades of grasses are stitched together to make the pati which are used for making temporary shelters for boats , houses etc Plate 111 : These have high demand in Sagar Mela for making temporary huts.

Plate 112 ,113 , 114,115,116– Straws and Hays are used for making different objects

Plates 117 – Date Palm leaves are dried and used for different product making

B.Aquaculture - In these large, rain-fed, perennial, low-lying fish farming areas, paddy farming was done traditionally but the fields have been converted into fish farming regions since 2011 for better profits. Peripheral areas on four sides are deepened and embankments constructed with excavated earth. Here, farmers are either doing grow-out culture of Asian seabass, Indian major carps or a combination of both, on their own. Professional fi sh farmers in nearby regions have taken tracts on long-term lease to undertake Asian seabass culture in freshwater on large scale. In such mithen gheri, tidal infl uence does not persist and water from the brackish rivers of the Indian Sundarbans region does not enter. Fishery (fishing and aquaculture) is treated as the backbone of Purba Medinipur economy. Our study area is ecologically and economically important and is a representative aquatic region for the present investigation as it is one of the shrimp farming hot spots along the east coast of India. **Nandigram 1** and **Khejuri II** blocks of our study area due to their potential riverine system and marginally saline soil which provides considerable scope for brackish water shrimp culture. Most of the Shrimp farming activity particularly for water supply in the study area depends on coastal creeks, Roosulpur River and Haldi River. The coastal line is about 50 km in length. This area is nearly a flat surface with average elevation of 5m to 7m above mean sea level. Sand dunes are sometime noticed because of fluvial and tidal activities.

Plate 119– Aquaculture Ponds along Bhagirathi - Hugli River , mainly Tiger Prawn Farming , Khejuri II Block 21°55'39.86"N 88° 0'36.73"E

Shrimp becomes an important item in the world aquaculture scenario. Presently Now-a-days Taiwan, Indonesia, Thailand and India are known as global leaders in shrimp production. **West Bengal** in India again secures a major position in shrimp production. The bulk of the culture of *peneaid shrimp* is mainly centered in three coastal districts in West Bengal, i.e. North 24 Parganas, South 24 Parganas, and Purba Medinipur. Among these districts Purba Medinipur holds a renouned position in the shrimp production (MPEDA/NACA, 2016). The farms are capable of producing 1-1.5 ton/ha/crop with proper water management, selective stocking of quality shrimps seeds, use of pellatized feed and use of artificial aeration system .Purba Medinipur district which has 5618.22 ha of culturable brackish water area and this type of extensive system and semi intensive farming systems are mainly done here. Among this 3342 ha of potential areas are suitable for shrimp farming (Upadhyaya, A.S., 2001; Abraham et al 2004). Shrimp culture is now considered as one of the leading economic activities in this districts. Shrimp farming judiciously utilises the fallow, unproductive and marginally productive lands and also generates employment in rural areas. It is also responsible for increasing production to strengthen nutritional security and for increasing foreign exchange earnings.

Plate 120 : Regular maintenance is required for aquaculture ponds, Nandigram II

Types of Fishing On the basis of locational aspect, the fisheries of Purba Medinipur District may be broadly classified into the following categories: **I) Marine and offshore fisheries ii) Estuarine fisheries iii) Inland fisheries**

Offshore and Marine Fishing - In Purba Medinipur District, deep sea fishing or rather say fishing in the offshore zone of the Bay of Bengal is done in Digha , Mandarmani, Sankarpur zone of the coastal blocks . In our study area we have not included these blocks.

Estuarine Fishing - Potentiality of estuarine fishing is very high in this region due to the existence of mangrove forest. The litters of mangrove forest play an important positive role in the production of huge amount of fish food like phyto-plankton, zoo-plankton etc. which in turn attract great varieties of brackish water fishes. In the estuarine part of South 24-Parganas, particularly in Sundarban region, more than 120 euryhaline fish species are caught in commercial amount (Naskar, Guha Bakshi, 1982). Amongst these, Hilsa (Hilsa ilisha) is the most important and favourite. The next important are Bombay duck (Harpodon nehereus), Parse (Mugil parsia), Bhetki (Lates calcarifer), Cat-fishes etc. Tiger shrimp (Penaeus mondon), however, draws the attention of most fish traders for its high export potentiality. Varieties of crab belonging to different genera and species are also available . But amongst these the economically important edible ones are Scylla serrats (*Forskaal*) and Neptunus pelagicus (L). Various types of brackish water fishes like bhetki, parse, pomfret etc. have high demand in domestic market, while the tiger prawn is exclusively harvested for international market. Brackish water fish farming is mainly practised extensively in the southern and eastern parts of this District over an area of about 2,500 ha covering large areas of Nandigram 1, Khejuri II , Sutahata etc. Such brackish water fisheries are locally known as 1 bhasa-bada', 'nona-bheri' or 'nona gheri' fisheries. In this region paddy-cum fish culture is another popular form .of brackish water fish culture in which both paddy and fish are grown side by side. This system has developed from the long standing experience of the local people. A considerable portion of this deltaic region has been reclaimed for agriculture with the help of a series of earthern embankments, with sluices encircling the banks of rivers and creeks. In this system, the shallower plots are kept for fish farms and the higher plots are used for paddy culture. Three types of brackish water fisheries are common in this region, viz.,

i) Nona-gheri fish farm ii) Nona-gheri paddy-cum-fish farm iii) Nona-gheri fish-cum-paddy farm.

There are innumerable blind creeks and canals in Sundarban area which may be converted to nona-gheries by constructing cross-embankments and sluices for letting tidal water in and out to trap the fish. Thus extensive areas which otherwise would remain unproductive may be utilised for fish production. Some common indigenous varieties of fish found in the paddy fields and nearby bils, jheels and canals during monsoon are Punti (*Barbus spp*.), Chela (*Qxygaster spp*.), Chanda (*Ambassis spp*.}, Mangur (*Carius batrachus*), Singi (*Heteropneuster fossilis*), Tangra (*Mystus spp*.), Pabda (*Ompok spp*.), Koi (*Anabas testudineus*), Bele (*Glossogobius giuris*), Bhetki (*Lates calcarifer*), Lata (*Channa punctatus*) etc. But due to their slow growth rate and high feeding habit, these --varieties are considered less economic. So they are not usually cultured due to low out-turn.

Tiger Prawn Culture - The estuarine tract of West Bengal is fortunate enough having good supply of large quantities of seeds of tiger prawn during April-August. However, surveys carried out by CIFRI shows that tiger prawn seeds are available throughout the year though in varying quantities in some tidal rivers of this estuarine tract. Prawn seed banks have been set up to reduce the mortality of seeds and keep them in sound condition. But presently the seed banks are not in a position to assume the continued supply of prawn seed for prolonged period.' It is found that, in general, the bigger and better quality of shrimps are found in the first crop of the season, while the second crop is poorer in quality and yield is also lower. An assured supply of the required quantity of good seed is needed to increase its overall yield per hectare. For that purpose, it is necessary to have prawn seed hatcheries. India has now two modern commercial hatcheries for tiger prawn, established by Marine Products Export Development Authority. Prawns require specific types of feed for different larval and post-larval stages for optimum growth. Some of the feeds are biological. One such zoo-plankton is rotifers. But the feed for post-larval period are to be prepared by the farmers in their ponds. Research and experiments are going on for the preparation of feed with high feed conversion ratio. But the entrepreneurs prefer imported feed than to face risks in raising them in hatcheries.

Inland Fishing Inland fresh water pisciculture is practised in Purba Medinipur District not only in the local rivers but also in numerous tanks or ponds and other water bodies. These fresh water fishes have a very good market in Calcutta and adjoining areas. Often it is found

that the supply of such fresh water fishes fails to meet the growing demand. So there is much potentiality for the development of this resource.

Fishing in Rivers - Fishing in the rivers, particularly in the Hugli river is gradually losing importance, due to various natural and man made hazards. Amongst the rivers in the estuarine tract, Rupnarayan, Rooosulpur and Haldi carry most of their fresh water from upstream region. All the rivers in the southern part of the District are tidal in nature, thereby during high tides they are subjected to ingression of saline water rich in fish juveniles or fingerlings of Tiger shrimp (Penaeus monodon), Penaeus indicus, etc. Supply of various other brackish water varieties like Liza parsia, L. tade, Mugil cephalus etc. is sufficient. The catch of hilsa **(Hilsa ilisha)**, one of the most favoured deep sea variety, which forms various mouth-watering dishes of typical Bengalees, is gradually declining with the passing of years owing to enviromental hazards. Choking up of the rivers due to higher rate of sedimentation, occasional drought condition leading to lesser supply of fresh water, construction of dams and barrages in the upstream zones, water pollution due to industrial waste are some of the causes leading to decline in fish production in these rivers.

i. Fishing in Rupnarayan River -

Plate 121– Fishing in Rupnarayan River, Geonkhali
22°12'16.91"N 88° 3'4.04"E

ii. Plate 122 : Fishing in Haldi River - 22° 4'36.01"N 88° 1'3.79"E

iii. Plate 123 : Fishing in Roosulpur River - 21°48'8.64"N 87°52'37.62"E

Commercial Aquaculture Various technologies are available for extensive, intensive and industrial aquaculture. The production levels recommended for extensive culture are two tonnes of fish and one tonne of prawn/hectare, for intensive culture, five tonnes of fish and four tonnes of prawn/ha and for industrial hi-tech aquaculture 25-50 tonnes of fish/ha/year and 8-10 tonnes of prawn/ha/year. But these levels have been achieved at research and demonstration levels. Industrial aquaculture, however, requires trained manpower, raw materials, inputs and finance and a well organised effort for product development and marketing. High-tech aquaculture, controlled systems, culture of feed, formulated feeds and cage culture have opened up new vistas in such enterprises. The major consideration is that aquaculture uses water as a medium and consumes oxygen and nutrients for growth. These wet-land reservoirs and other water bodies have been created for agriculture and irrigation system, flood control and other uses. These are also used for aquaculture. Therefore aquaculture is a byproduct of agriculture and irrigation systems. But due to good economic returns it can support rural development and self employment programmes. It is interesting to note that the total income from fisheries is comparable to that of forests and further increase in income from this sector is expected.

Plate 124 : Fishing Port – Petuaghat , Roosulpur 21°47'44.85"N 87°52'52.38"E

In December 1987, the island of Nayachar was handed over to the fisheries department. The order was carried out in March 1988. Benfish, the official agency of the fisheries department, undertook its development. The island was renamed Meendwip, meaning fish island, but nothing much seems to have happened.

In government files, the island is "uninhabited" although there are around 2,500 people living on the island, mostly as "encroachers". Seven years ago 13 fishery cooperatives were set up, 315 ponds were dug and many of the 400 families on the island work in these. The rest catch fish on their own, either in the river or in small ditches that fill up with small fish during high tide. The government or fisheries department never gave them any right to the land or ponds. They were only allowed to fish around.

Plate 125 : Fishing in Nayachar Island, 22° 0'47.73"N 88° 6'14.99"E

Plate 126 : Major Fish Catch in Nayachar Island

6.2C. Industry

Haldia Industrial Hub- Established in the '90s as a symbol of industrial resurgence in West Bengal, Haldia Petrochemicals Ltd. or HPL was the first integrated petrochemicals complex situated in Haldia, 125 kms from Kolkata in West Bengal.

With a state-of-the-art naphtha cracker complex constructed in a record time of 36 months, HPL started production in the year 2000, during the turn of the millennium. Continuous drive for improvement and optimisation led to rapid growth of the company's capacity, reaching 700 KTA from 420 KTA in a short time. Haldia has several major factories, including South Asian Petrochemicals Ltd, Indian Oil Corporation Limited (IOCL), Haldia Energy Limited, Exide, Shaw Wallace, Tata Chemicals, Haldia Petrochemicals, India Power Corporation Ltd., Hindustan Lever, Mitsubishi Chemical Corporations, S.J.Constructions and LTC&Co. Other major logistical companies are JAY ROAD CARRIERS which provide affordable logistics across India.

Plate 127 : Haldia Refinery , Haldia Petrochemical Area

6.2.D. Brick Kilns

Brick Kilns of the river bank – Brick Industry is one of the informal/unorganized industries in India. This industry is booming with the expansion of real estate business. Rupnarayan River and Hugli River Bank is dotted with Brick Kilns up to Sutahata area. But from Haldia Industrial Development area upto down south till Hijli , we do not find any more brick fields . Based on our survey there are about 50 Brick Kilns amongst which 20 are at present out of service. Few years back also Khejuri Block was full of brick Kilns . But now from 2016/17 onwards, the kiln areas have been transformed into aquaculture ponds. Brick Kiln industries are labor intensive industry. It employs huge number of labours at cheaper rates. The workers in these Kilns were mostly found from Bihar and Uttar Pradesh. Though local workers are also engaged, but their numbers are low. Women and Child labours are seen widely in this industry.

a. Plate 128 : Brick Kiln at Kukrahati , Sutahata- Near Maniruddin Char , 22° 9'3.32"N , 88°9'27.48"E

Plate 129 - Brick Kiln near Begunbere , 22° 8'23.91"N, 88°10'4.77"E

Plate 130- 22° 4'37.73"N 88°10'5.44"E , near Durgachak , Haldia Municipality

Plate 131 - 22° 7'53.74"N, 88°10'33.84"E , Sutahata Block

Plate 132 - 22°10'37.80"N, 88° 8'22.66"E, Baishnab Chak

Plate 133 – Matiramchak , Mahisadal 22°11'25.88"N 88° 6'23.49"E

Plate 134 - 22°11'10.56"N 88° 4'55.41"E, Hariballabhpur , Mahisadal

Plate - Brick Kiln at Sutahata , 22° 4'19.13"N 88° 9'42.30"E

CHAPTER 7 : ENVIRONMENTAL PROBLEMS

Where the Ganga ends up her more than a 2,500 km long journey embraces Sagar Dwip with two outspread arms and then plunges into the sea, the coastal tract of our study area stands on the western bank of the western arm of Ganga, alias Bhagirathi, allies Hugli. Geomorphologically, this region is situated over the „geomorphic triple junction" of River Hugli, River Roosulpur and Bay of Bengal, i. e., it shows the well convergence of closing journeys of River Roosulpur and Hugli and happy beginning of Bay of Bengal. In fact, it has been featured by fluvio-coastal characteriscis in the combination of fluvial and coastal actions. In our study area, the northern blocks like Mahisadal , Sutahata along with Haldia Municipality till Haldi River has slight different environmental problems than the southern blocks of Nandigram I and Khejuri II till Roosulpur River. The major problems are categorized under 3 heads . A. Natural Hazards B. Geomorphological Hazard C. Anthropogenic Hazards

A. Natural Hazards : Based on the data of the Disaster management cell , the common Natural disasters of the zone are – Cyclone, flood, drought, earthquake and hailstorm while the Man made disasters are Chemical Hazards, Fire, Communal Riot, Accidents. In the last 8 years the major disasters faced by the districts area-

1. 2009 – Aila (Tropical Cyclone)
2. 2010-Flood Water logging
3. 2013- Flood
4. 2014-Water logging
5. 2015_Flood like situation
6. 2019-Bulbul(Tropical Cyclone)
7. 2020-Amphan(Tropical Cyclone)

As Haldia Petrochemicals Ltd (HPL) is located in this zone , high degree safety measures were taken during this recent Amphan Cyclone.

So , as we can see that it is the tropical cyclones and water logging or flood like situation are the major problems of the study area.

a. Tropical Cyclones -

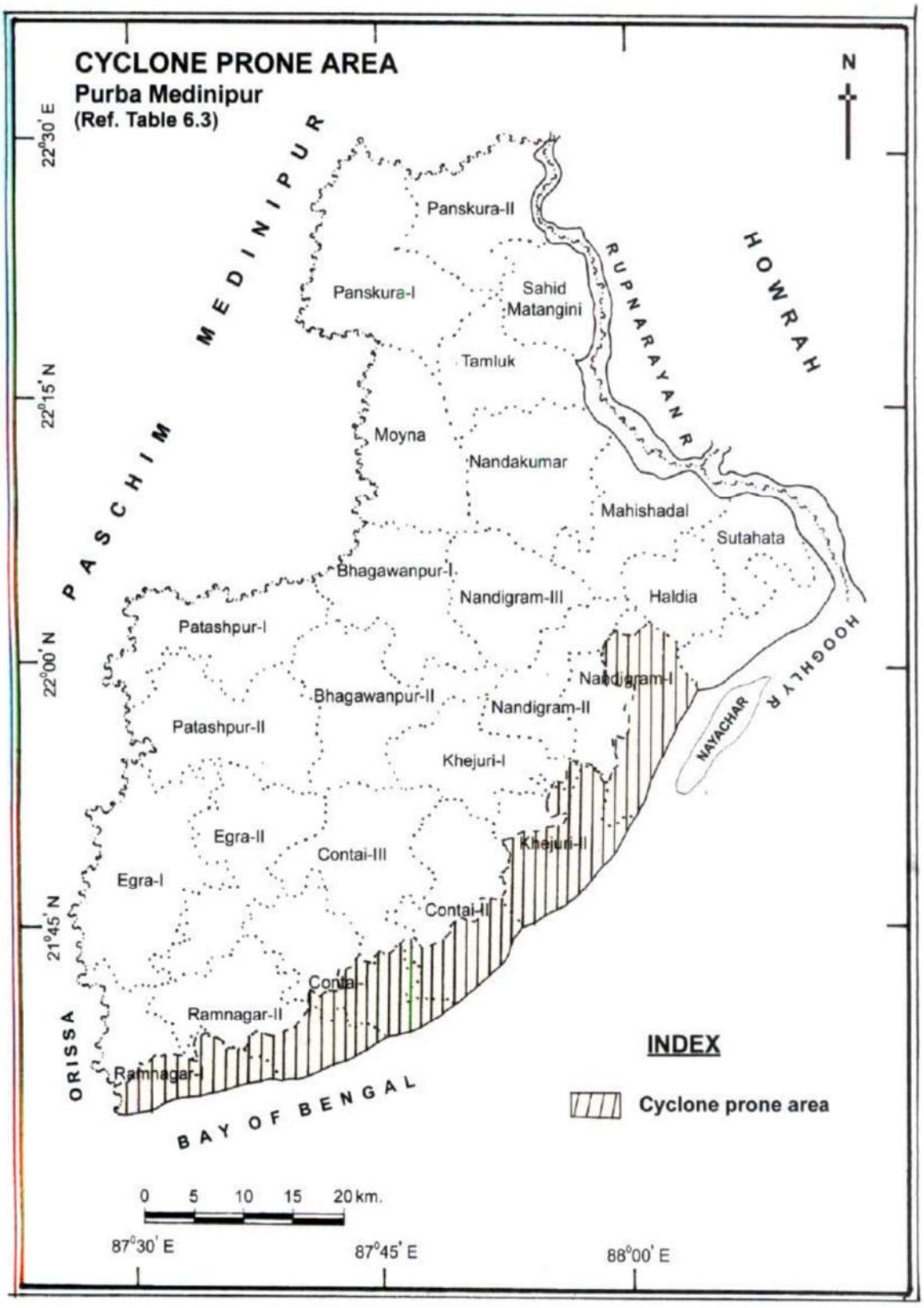
The destructive action of a tropical cyclone is mostly felt on the right of its track (northern hemisphere) and on the shores that face an advancing system perpendicularly (Coch,1994). It is an adverse combination of factors like lowest pressure attained by a storm, local sea level and tidal conditions at the time of its landfall that determines the surge level at a particular locality (Flather & Khandker, 1993).Thus, while the storm frequency diagrams and recurrence intervals do provide an approximate guide for frequency of the events, they do not necessarily mean recurrence of similar levels of destruction.

CASE REPORTS: The estuarine islands have faced severe cyclonic storms during the last three hundred years.

The event 1680: In 1680 a cyclone passed over the Sundarban including the Sagar island. It affected tremendously the whole island which was inundated by wave flows and great loss of life occurred.

The event 1737: Gentleman's Magazine of 1738 explained a graphic account of this calamity: "On the 30th September last happened a furious hurricane in the Bay of Bengal, attended with a very heavy rain which rained 15 inches of water in 5 hours, and a violent earthquake which threw down abundance of houses; as the storm reached 60 leagues up the river, it is computed that 20,000 ships, barks, sloops, boats, canoes etc., have been cast away. A prodigious quantity of cattle of all shorts, a great many tigers, and several rhinoceroses were drowned; even a great many caymans were stifled by the furious agitation of the waters. Two English ships of 500 tons were thrown into a village about 200 fathoms from the bed of the river Ganges, broke into pieces and the people drowned pell-mell amongst the inhabitants and cattle. Barks of 60 tons were blown two leagues up the land over the tops of high trees. The water rose, in all, 40 feet higher than usual. A french ship was drove on shore and bulged. After the wind and water abated, they opened the hatches and took out several bales of merchandize, etc., but the man who was in the hold to sling the bales suddenly ceased working, nor by calling him could they get any reply. On which, they sent down another, but heard nothing of him, which very much added to their fear, so that for some time no one would venture down. At length, one hardier than the rest went down and became silent and inactive as the two former to the astonishment of all. They then agreed by lights to look down into the hold, which had a great quantity of water in it, and to their great surprise they saw a great alligator starting as expecting more prey. It had come in through a hole in the ship's

side, and it was with difficulty that they killed it, when they found the three men in the creature's belly".



The event 1833: Blanford (1877) stated that the cyclone had crossed Sagar island on 21st May. The island was submerged to a depth of 10 feet, and the whole population of 3,000 to 4,000 was said to have perished. On this occasion an East India man, the Duke of York, was carried into the rice fields at Falta and left there high and dry.

The 1864 event: It was the most disastrous one. The height of the 1864 surge was greater than the 1833.The storm had been travelling up the Bay of Bengal in the day time of 4th October. It made itself felt at the sand heads on the afternoon and attained its full fury in the night. On 5th October the cyclone (originated in the north west of Andaman) and the associated storm surge "swept across the island with great force and wrought great havoc" (Pargiter, 1934).

The 1977 event: On 11th September a severe cyclonic storm had passed over Sagar. The maximum wind velocity reached 130-148 km hr-1 (Pant et al., 1978). The cyclone had caused devastating disasters in coastal parts of West Bengal and Orissa. Pant et al. (1978) have 12 reported that about 40 persons (might be more the actual figure) and 4,000 cattle died due to this disaster.

The 1988 event: The cyclonic storm of 29th November brought widespread damage to the coastal Sundarban including Sagar island (De and Bose, 1991) killing some 30 persons in the coastal areas of South 24-Parganas and Medinipur districts.

The 2009 event: The severe cyclone Aila has crossed Sundarban on 25th May, 2009. The wind velocity was 110 km hr-1. The heavy rainfall, strong wind and storm surge are the disastrous weather associated with cyclone. It continued to move in a northerly direction across West Bengal .According to media report, the state chief secretary has put the number of storm affected people at 2.2 million. More than 61,000 houses collapsed, more than 1, 32,000 houses were partially damaged and 100 people lost lives due to Aila. The entire Sundarban biosphere reserve area of 9,600 km2 has suffered extensive damage under the impact of AILA (Severe Cyclonic Storm, AILA: A Preliminary Report, IMD, 2009). Sibpur and Dhablat areas of Sagar island were severely affected due to Aila.

November , 2019 - Very Severe Cyclonic **Storm Bulbul** was a strong and very damaging tropical cyclone which struck the Indian state of West Bengal as well as Bangladesh in November 2019, causing storm surge, heavy rains, and flash floods across the areas.. After crossing the Indochinese Peninsula, Severe Tropical Storm Matmo's remnants entered the Andaman Sea. It began to organize over the southern Bay of Bengal in the beginning of November, then it slowly intensified into a cyclonic storm as it moved north. In addition, it is only the second to make it to hurricane strength, the first being in 1960 and also the first severe cyclone that struck West Bengal after 1891.

March 20, 2020 – One of the most deadliest cyclone, **Amphan** hit the Bengal Coast with a speed of more than 190km/hour . Super Cyclonic Storm Amphan (/ˈɑːmpɑːn/) was a powerful and deadly tropical cyclone that caused widespread damage in Eastern India, specifically West Bengal, and also Bangladesh in May 2020. It was the strongest tropical cyclone to strike the Ganges Delta since Sidr of the 2007 season and the first super cyclonic storm to have formed in the Bay of Bengal since the 1999 Odisha cyclone. It was also the third super cyclone that hit West Bengal since 1582, after 1737 and 1833, as well as being the strongest storm to impact the area. Causing over US$13 billion of damage, Amphan is also the costliest cyclone ever recorded in the North Indian Ocean, surpassing the record held by Cyclone Nargis of 2008.

Cyclone Amphan made landfall in the Sagar Island , Shibpur Dhablat Mouza **(other coast of Roosulpur River , Khejuri Block, Purba Medinipur)** at 2:30 p.m. IST on 20 May, buffeting the region with strong winds and heavy rains . Although the extent of fatalities was less than initially feared, the cyclone's effects were nonetheless widespread and deadly. South Bengal , the epicenter of the cyclone's landfall, saw the most widespread damage from ***Amphan***. The storm was considered the strongest to hit the region in over a decade. The state government estimated that the storm caused at least □1 trillion (US$13.2 billion) in damage and directly affected 70 percent of the state's population. Chief Minister Mamata Banerjee described the storm's effects there as worse than that of COVID-19. An estimated storm surge of 5 m (16 ft) inundated a wide swath of coastal communities and communications were severed. The greatest inundations were expected in the Sundarbans, where flooding could extend 15 km (9.3 mi) inland. Embankments in the region were overtaken by the surge, leading to inundation of the islands in the Sundarbans. Bridges

linking islands to the Indian mainland were swept away. The cyclone produced sustained winds of 112 km/h (70 mph) and gusts to 190 km/h (120 mph), which were recorded by the Alipore observatory, Kolkata, West Bengal, damaging homes and uprooting trees and electric poles. Wind speed along coastal areas of both the banks of Hugli River were measured up to 150–160 km/h (93–99 mph). In Nandigram I the wind speed of 157 km/h (98 mph) with gusting up to 185 km/h (115 mph) was recorded, while nearby Nimpith and Sagar Island observed 155 km/h (96 mph) and 111 km/h (69 mph) wind speed. TheNetaji Subhas Chandra Bose International Airport recorded wind speeds up to 133 km/h (83 mph) .This overturned vehicles and snapped approximately 10,000 trees. The Calcutta Municipal Corporation stated that Amphan toppled over 4,000 electric poles, leaving much of the city without power for over 14 hours. At least 19 people were killed in Kolkata. The storm also triggered widespread flooding around the city. 236 mm of rain was recorded in Kolkata.

Downed power lines caused power outages across West Bengal, prompting CM Banerjee to order power supplies to be cut in the two states of 24 Parganas as a precautionary measure. Thousands of mud homes were damaged in the entire strtch. A million homes were damaged in Sagar Island , Namkhana , Kakdwip , Diamond Harbour blocks and breached embankments led to the flooding of villages and swaths of cropland. Saltwater inundation affected surrounding areas following damage to 19 km (12 mi) of nearby embankments. Across West Bengal, 88,000 hectares (217,000 acres) of rice paddies and 200,000 hectares (500,000 acres) of vegetable and sesame crops were damaged.

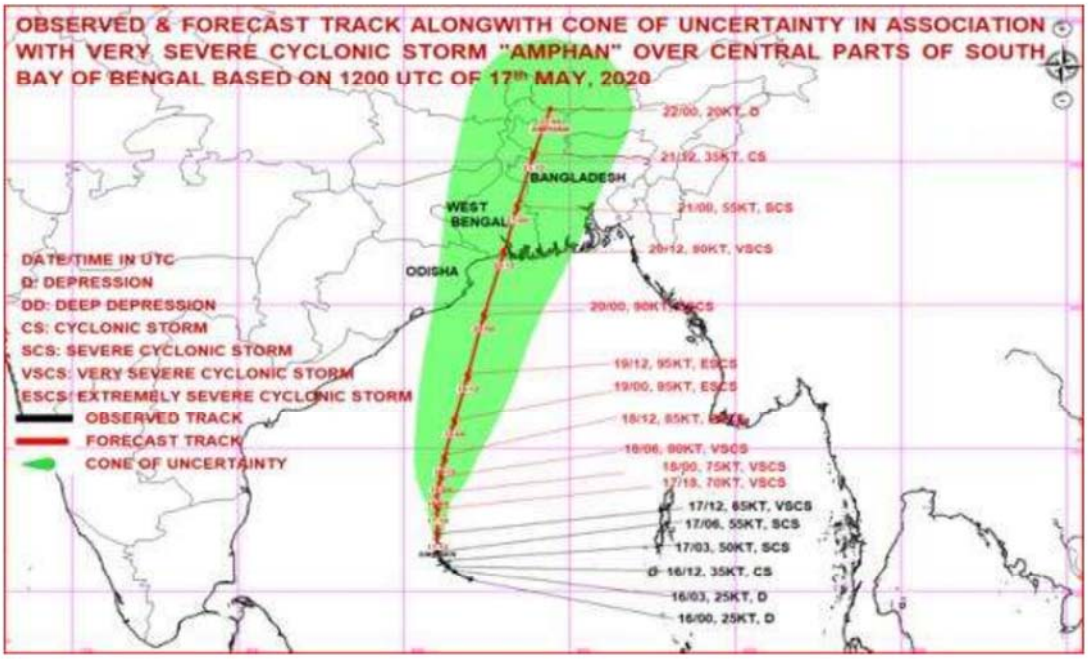
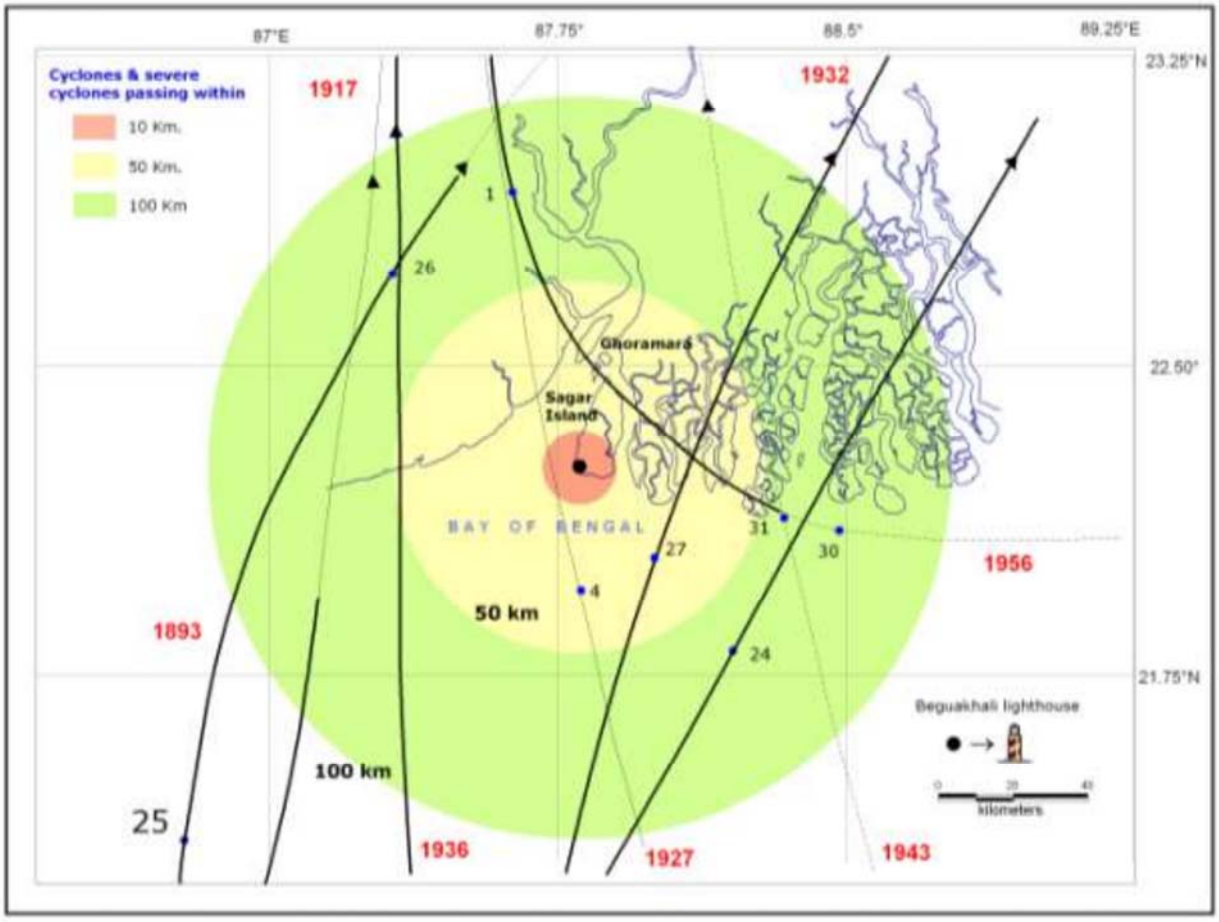
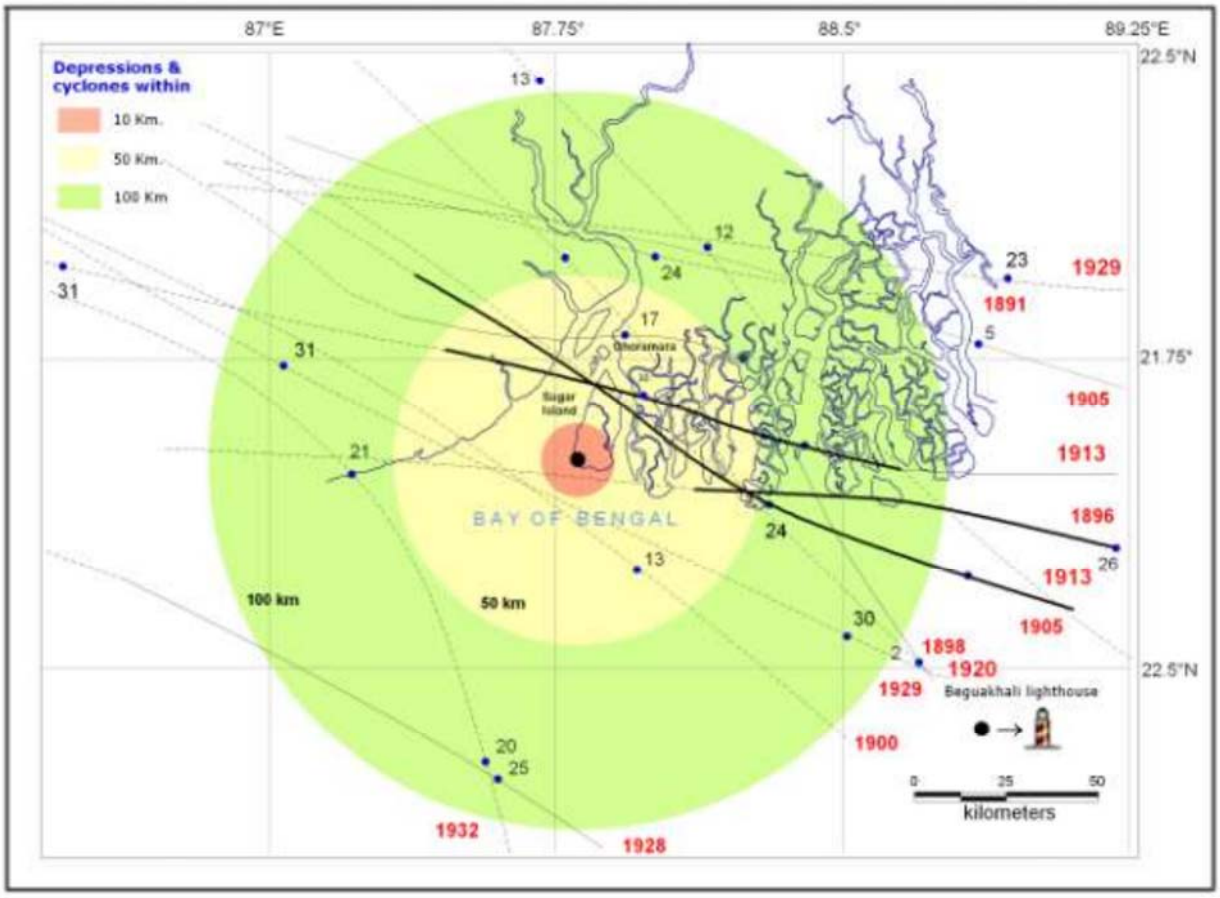


Plate 135,136,137 – Destroyed Coastline of Purba Medinipur


87°E
87.75°
88.5°
89.25°E
23.25°N
22.50°
21.75°N
Cyclones & severe cyclones passing within
10 Km.
50 Km.
100 Km
1917
1932
1956
1893
1936
1927
1943
25
Ghoramara
Sagar Island
BAY OF BENGAL
50 km
100 km
Beguakhali lighthouse
kilometers


87°E
87.75°
88.5°
89.25°E
22.5°N
21.75°
22.5°N
Depressions & cyclones within
10 Km.
50 Km.
100 Km
1929
1891
1905
1913
1896
1913
1905
1898
1920
1929
1900
1932
1928
Ghoramara
Sagar Island
BAY OF BENGAL
100 km
50 km
Beguakhali lighthouse
kilometers

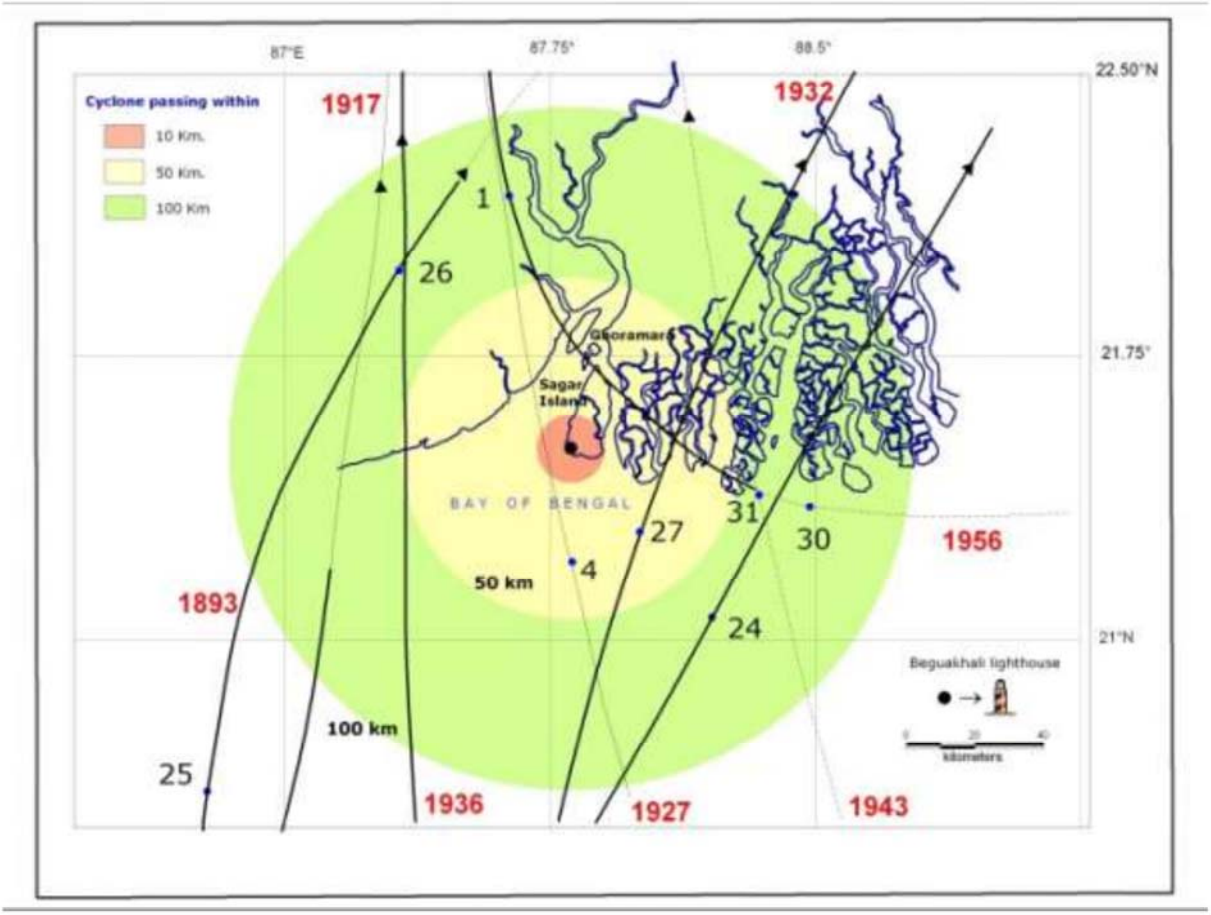
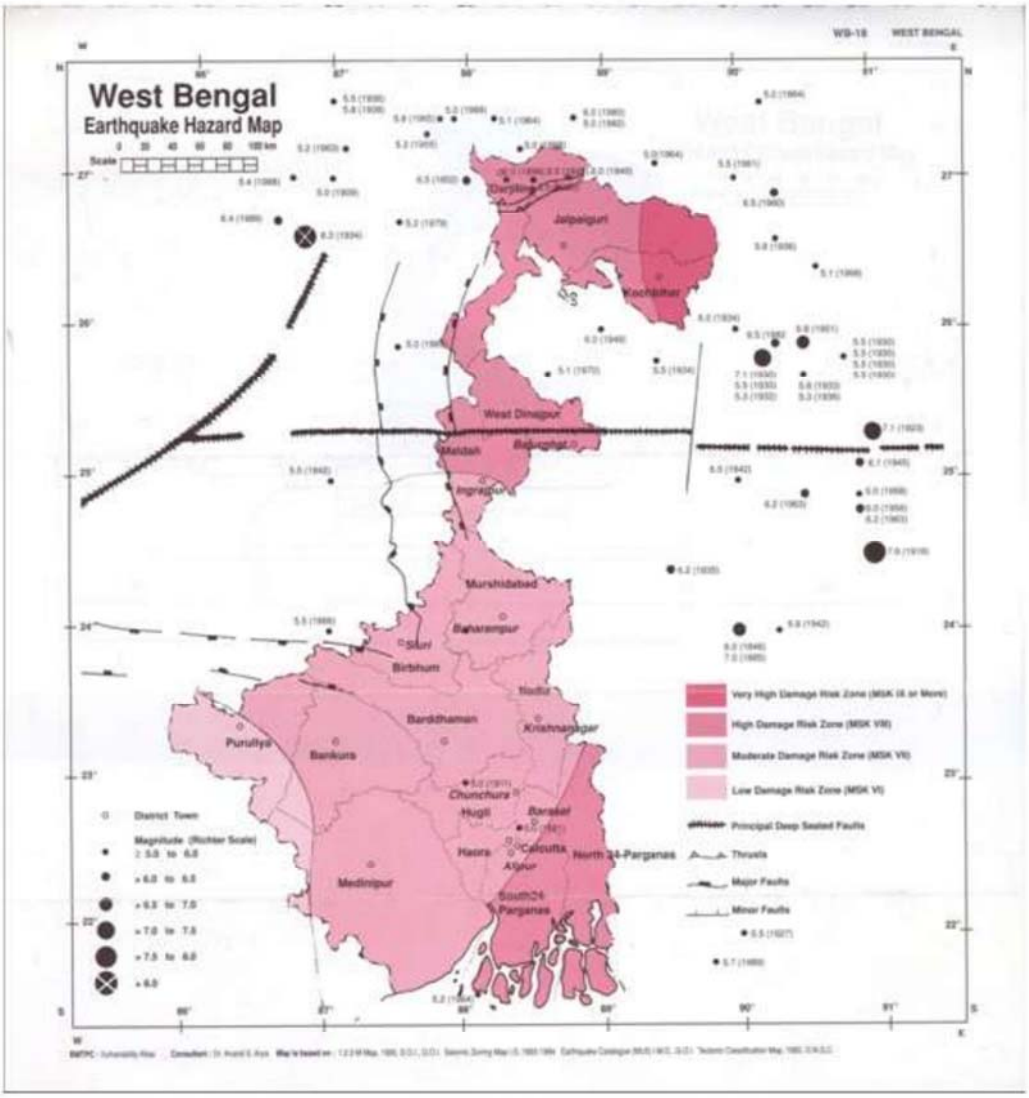


Plate 138 : Devastated shoreline , Khejuri II Block after Amphan , 2020

b. Tectonic Hazards

1. Being located very near to Sagar island and Sundarbans , our study area in Purba Medinipur falls under the Moderately Damaged Risk Zone. Though there is no record of tectonic activities , but it also lies in the vulnerable zone.

2. Tsunami- Tsunamis are unlikely to pose a significant hazard in the islands of the Hugli estuary. As such, there is no report of damage in the region due to the catastrophic tsunami of 26th December 2004. However, any future offshore developments in the islands may be affected by tsunamis.



Map 70 – Earthquake Zones of West Bengal

c. Flood (Water Logging) -Among all natural hazards flooding and water logging have a huge influence on land use pattern. In the study area about 43%of the total area is under flood prone . The prominent flood prone blocks of the district are Moyna , Egra, Mahisadal , Sutahata . Floods in the district deserve critical attention because of its extent, severity and frequency. Floods in the district are wider in extent, devastating in severity and regular in frequency. As the district is surrounded by a number of rivers, canals and interconnected khals this natural phenomena affect almost every block of the study area and control economic activities of the concerned blocks in a varied manner. Floods in the study area are recurring problems. As the district comprises of two important low depressed basins and several other basins, the district is subjected to severe water logging even during normal rainfall. Long period of incessant rainfall in the catchment areas of the river Keleghai, Rupnarayan, and Roosulpur increases large volume of water in the down stream resulting into overtopping and sometimes resulting into *ghai* (breaching)of river banks. In our study area , 8 out of 11 number of Mouzas in Mahisadal ,3 out of 7 number of Mouzas in Nandigram I,3 out of Sutahata and 2 in Haldia are prone to flood. Construction of Zamindary embankments along the margins of the rivers and tidal estuaries to protect individual holdings and to acquire Jalpai lands from the tidal ingression has further aggravated the drainage problem.
Being obstructed by these embankments the silt laden rivers and to a greater cegree the action of the influx and efflux of silt bearing tidal water the beds of the channels are gradually and steadily raised resulting into reductior of carrying capacity of water and drainage arteries overtop their banks and spills flood plains. On the other hand being deprived of the silt deposition (lack of incremental silt) the land of the inner side of these embankments remain depressed and waterlogged during rainy seasons while waterways become choked with silt resulting into gradual raising of beds of these drainage arteries. To add insult to injury is the poor condition of the embankments. All the rivers and canals are bordered with long man made embankments . Together with Ex-Zamindary embankments these bunds protect agricultural land from huge volume of water during peak discharge period. Proper maintenance of these embankments is long pending resulting into breaching and slumping regularly.

B. GEOMORPHIC HAZARDS –

A. Sedimentation Silt deposits at the mouth of the Hugli river have rendered Haldia port nearly unnavigable, raising fears that India's second largest container port might soon be shut down. The formation of sandbars, largely due to inadequate dredging, has raised the riverbed, making the shipping channel shallow. At two locations in the channel the depth is less than the minimum required for loaded cargo ships to navigate their way to the port in West Bengal from the Bay of Bengal. The ideal navigable depths at these two locations, named after sandbars Jellingham and Auckland, are 6.1 metres and 6.3 m respectively at zero tide, the average low-tide height there. In October, a Kolkata Port Trust survey found that the depths at the two locations had decreased to 3.9 m and 4.3 m respectively. With this the approach to the port from the south is in danger of getting blocked. The approach from the north was blocked in 1986 due to the formation of sandbars or shoaling. In 1986, nine years after Haldia port was commissioned, the shortest channel to Kolkata dock called the Balari channel, that goes past Haldia dock, got blocked by shoaling. This channel was west of Nayachar island and Balari bar. Ships bound for Kolkata dock now take the channel east of Nayachar and Balari bar.

Plate 139 – Sedimentation in the mouth of Hijli Khal

Several measures were planned to open up the Balari channel but were left half-done. This has largely contributed to the situation today. Measures included a guide wall at the northern tip of Nayachar and a deflecting spur a little upstream on the channel. Deflecting spurs are constructed transverse to the river flow and projected from the bank into the river to deflect the current towards the opposite bank. The idea was that water would hit the spur and move through the northern guide wall into the Balari channel, thereby building enough momentum to wash away the silt towards the sea, aided by dredging.

The guide wall was built in 1986 but the spur is yet to come up. Consequently, there has been heavy shoaling at the guide wall and the northern tip of Nayachar has nearly merged with the southern tip of Balari bar. Another guide wall was to come up at the southern tip of Nayachar to prevent it from extending further into the channel. That did not materialize. Now Nayachar's southern tip is growing towards a smaller land bar called Mizzen Sands, nearly blocking the channel between the two land bars through which ships make their way to Haldia.

Plate 140 – Heavy Sedimentation in the River Bed

The district is characterized with a complex system of drainage network. Floods in Purba Medinipur District are often associated with alluvial rivers draining extensive alluvial flood plains. The huge amount of sedimentation in the drainage system reduces the carrying capacity of excess water of the rainy seasons. Due to delay in periodical removal of silt to increase drainage co-efficient a considerable area gets submerged in the rainy seasons. Even after desiltation materials are heaped on the banks of the canals and khals . This lacklustre attitude from the officials helped siting process immediately in the very next rainy season. Flooding as well as drainage congestion in the district pose a serious threat to land use pattern.

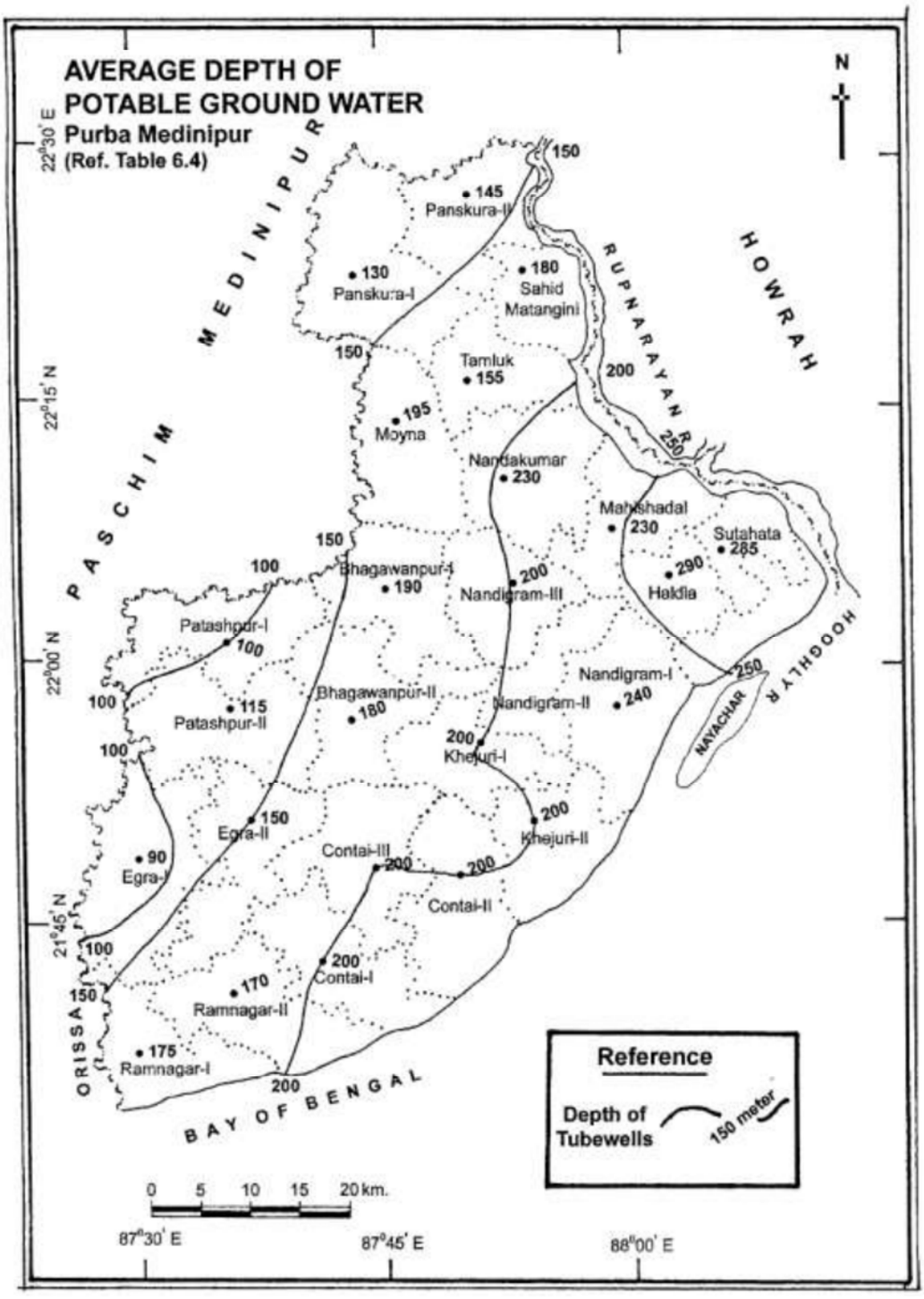
Plate 141 : Haldi River Bank , Haldia

Plate 142 & 143 : Heavily silted bank line , Kukrahati Ferry Ghat

b. Salinity - The entire southern part of Khejuri belt adjoining the Hugli and Roosulpur River was known as "JALPAI" which means an area from where huge fuel-wood was collected for making salt from brine . Once one a time Khejuri was noted for making this type of salt. So it paved the way for massive deforestation causing enormous soil erosion in this area. Naturally this erosion helped silting in the river bed. The density of population here demands varieties of trees and plants in place of mangrove swamps seemingly less valuable in the eyes of the people of this place. But its saline environment, only suitable for mangrove swamps, cannot stand the indiscriminate felling of these trees and so it causes quick erosion of soil and silting. These Blocks also faces saline or degraded alkaline soil. Thus in the major part of the study area , with the problem of water logging in the 'basin like islands 'of degraged or saline soil coupled with poor irrigation facilities only mono cropping is generally practised by the farmers. Tidal ingression through estuaries and creeks along the coast has aggravated the salinity problem of the district and damage the fragile wetland ecosystem. In the study area high content of saline water occurs mostly along the coastal areas. This saline water is underlain by fresh ground water down to the average depth of 200-250 meter . The low to medium saline ground water is generally found in the blocks like Ramnagar-I and II, Contai-I and II, Khejuri-I and II, Nandigram-I and II, Sutahata, Haldia, Nandakumar and Mahishadal. As sodium chloride, the important constituent of ground water is not absorbed to any great extent by either organisms or sediments of estuaries it acts as a conservation tracer of sea water. Due to the influx of brackish water from the areas adjacent to the tidal impact the blocks of the coastal areas are subjected to acute saline problems (S.W.I.D-2005). The upper aquifer in the coastal areas (with in depth of 120 meter) contain saline water and the chloride value ranges between 2000-6000mg/l (C.G .W.D.2003-04).

Another important drawback regarding ground water potentiality of the district is yield rate of tube wells. In the alluvial areas the yield rate from tube wells varies between 10-200m3/hr. for a draw down ranging from 5-20 meter. But in coastal areas it is very poor. Due to these complex geohydrological problems availability of irrigable water in the coastal areas is restricted. Table-7.4 depicts the block wise intensity of irrigation from 2001- 04. From the table it is found that very low intensity of irrigation is found in the blocks like Haldia (36.8%), Nandigram-I (17,8%) and ll(32.3%), Contai-1(23.4%), Contai-I I (18.9%) and III (37.7%), Khejuri-I (21.8%) and Khejuri-ll (20%). From the table 7.4 it is reflected that due

to presence of saline ground water, intensity of irrigation is very poor in these blocks specially in Nandigram-I and II, Khejuri-I and II, Haldia, and Contai-I and II. The potable ground water is achievable below 200-250 meter which is not only feasible but also costly. In spite of the presence of tidal affected khals, canals and rivers irrigation through any type of wells is poorly developed here. All theabove mentioned blocks are heavily dependent on tanks, bills, dighis and other sources of irrigation.



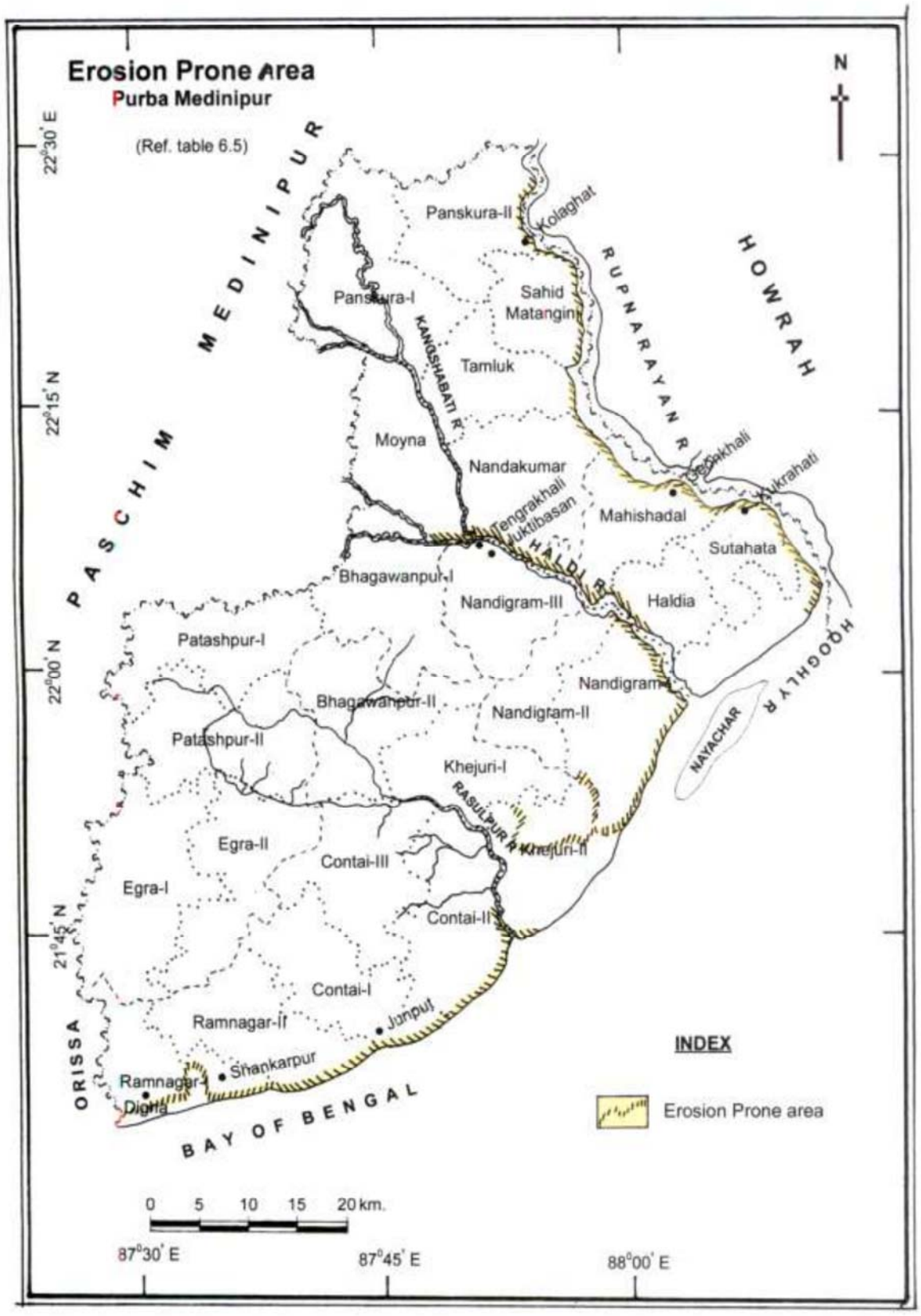
c.Bank Erosion - Both coastal and river bank erosion has been major problem of the land use pattern of the district during last few years . In the last ten years 50 acres of land at a rate of 3.50 meter per year(I.W.D.-2005) has been eroded on the right bank *o~* the river Hooghly in down stream from the nodal (Geonkhali) point to Haldia. There is also a constant thrust on the existing embankment almost in each high tide period and is further aggravated during monsoon as the river Hooghly caters a huge discharge from the upstream catchments area resulting abnormal surge in water level . During powerful cyclonic storms and high kotals the wave of sea water rises above 5.50mt. G.T.S. resulting into formation of vertical slips due to sea erosion, rain cuts with erosion through out its length from Umapatibar to Kanaichatta (8 km), To reduce the severity of erosion problems, several methods have been adopted in erosion prone locations. These methods include boulder pitching, placing of sand bags, construction of wooden barrier and placing of geo tubes along coastal lines.

Plate 144 – Bank Erosion , Haldi River , Haldia22° 1'1.93"N 88° 3'30.71"E

MAJOR EROSION PRONE AREAS ALONG THE RIVER HOOGHLI

1 Mahishadal Geonkhali Near Gauge Station 100
2 Mahishadal Geonkhall Down Stream of Launch Ghat 200
3 Sutahata Tentulberia Near Regulator gate at u/s 100
4 Sutahata Tentulberia Near Regulator gate at d/s 150
5 Sutahata Tentulberia Near Regulator gate at d/s 100
6 Sutahata Tentulberia Near Regulator gate at d/s 10
7 Sutahata Badur Near Regulator gate at d/s 20
8 Sutahata Badur Near Regulator gate at d/s 200
9 Sutahata Badur Near Regulator gate at d/s 200
10 Sutahata Lotpotia Near Regulator gate at d/s 450
1' Sutahata Kukrahati Near Regulator gate at d/s 100
TOTAL AFFECTED LENGTH 19006.

Plate 145 : Mud Flats , Bank of Hugli River , Kukrahati


Erosion Prone Area
Purba Medinipur
(Ref. table 6.5)
N
22°30' E
22°15' N
22°00' N
21°45' N
PASCHIM MEDINIPUR
HOWRAH
HOOGHLY R
ORISSA
BAY OF BENGAL
Panskura-II
Kolaghat
Panskura-I
Sahid Matangini
Tamluk
KANGSHABATI R
RUPNARAYAN R
Moyna
Nandakumar
Debkhali
Mukrahati
Mahishadal
Sutahata
Bhagawanpur-I
Nandigram-III
Haldia
HALDI R
Patashpur-I
Nandigram-I
Bhagawanpur-II
Nandigram-II
Patashpur-II
Khejuri-I
NAYACHAR
RASULPUR R
Khejuri-II
Egra-II
Contai-III
Egra-I
Contai-II
Contai-I
Ramnagar-II
Junput
Shankarpur
Ramnagar-I
Digha
INDEX
Erosion Prone area
0 5 10 15 20 km.
87°30' E
87°45' E
88°00' E

C. ANTHROPOGENIC FACTORS

a. High Population pressure - Due to high population growth rate people have put themselves at risk by developing floodplains for agriculture, settlements, building roads, railway lines in floodable positions (Plate 6.4). Creation of boro bunds, fishing traps exclusively for commercial and vested interests over some river and channel beds is also responsible for this flood problem. Channel and culverts that cope with floods for years have failed miserably as people flytip rubbish in them since its construction. Moreover, erections of shops onembankments, fishing pattas in canals and brick fields on river embankments are also complicating the drainage problem (Plate 6.5, 6.6 & 6.7). The hazard like flood becomes disaster due to the existence of vulnerabilities like weak embankments, breached embankments, shallow river beds, encroached embankments and a few low lying depressed areas in the district (Plate 6.8). Excess water of the Subamarekha from Orissa is over flown and becomes stagnant during the rainy seasons causing flood in Ramnagar-I block.

b. Aquaculture and the changing LULC pattern-Only few years back also , aquaculture was not so developed in this part of the Purba Medinipur. But now , Khejuri II and Namdigram 1 along with Nayachar have emerged out to become one of the major pisciculture centre. Explosive population growth, haphazard settlement expansion, illegal and capricious human activities and recent development and planning process have compelled to change and modify this coastal landscape . Squeezing behavior of agricultural lands due to changing anthropogenic mind setting towards more beneficial economic activities influences the decline in natural lowland or wetland for different aquatic fresh water living forms. Not only that, establishment and development of brick manufacturing and recent trend towards fish and shrimp farming have encroached the large habitat existence of freshwater fish species along with other aquatic lives. Thus, the changing land use image depicts the turn down look up of natural feeding and breeding field of indigenous fresh water fish species in the study area, Khejuri & Nandigram.. The quality of soil is also changing because of saline water

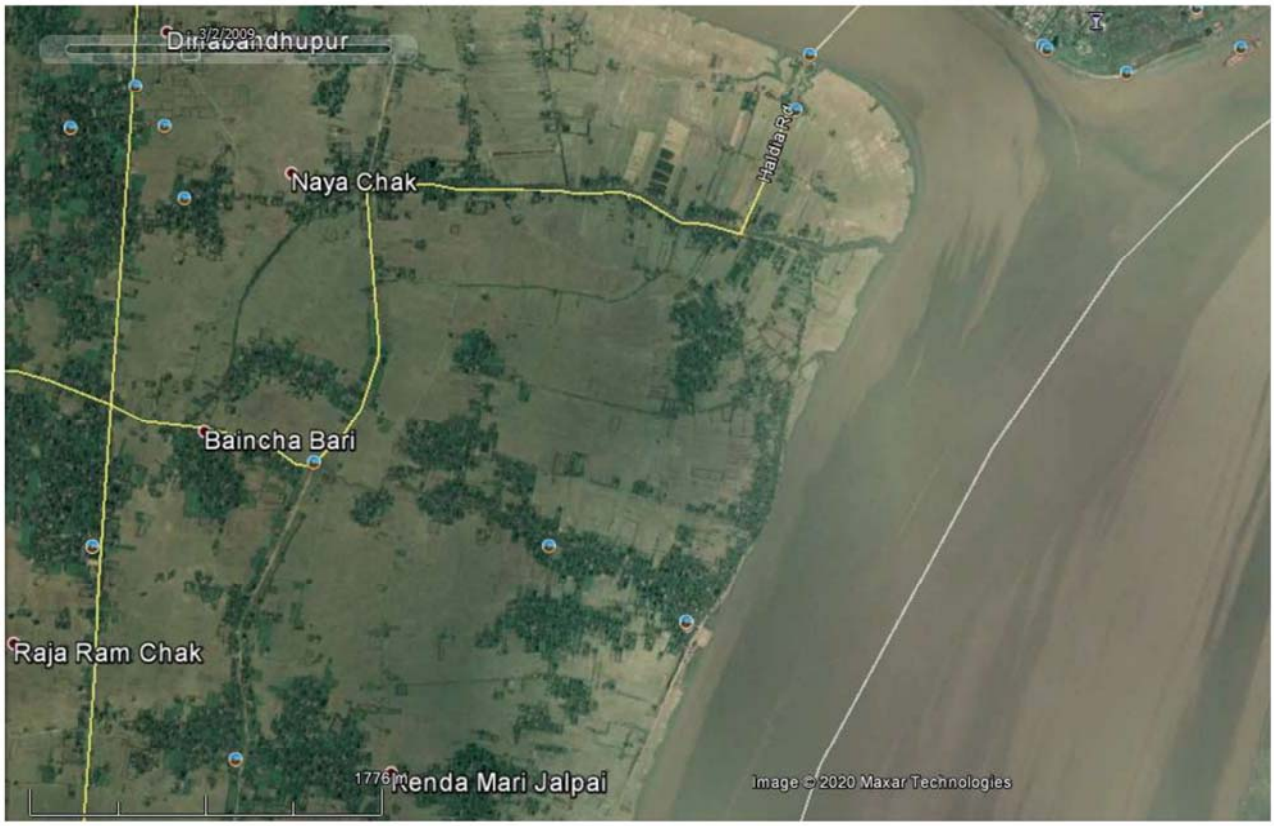


Plate – Aquaculture has developed within few years . Image 1 – 2012 , Charkenadamari , Nandi Gram i, Image 2 – 2019 , Charkendamari , Nandi Gram i

Change in LULC in Nayachar Island .

Change in LULC cover , Khejuri

c. Pollution -Multifarious industries situated on the mouth of Haldi river namely Indian Oil Corporation, Haldia Petrochemical Pvt. Ltd., Tata Chemicals, Pesticide unit, Vegetable Oil, Exide Industries Ltd., Mitsubishi Chemical Pvt. Ltd. etc. A tolerable quantity of toxic and hazardous substances is released to this important aquatic system through these industrial effluents along with huge organic load flow from agricultural and several non point resource. The water characteristics fully depended on the seasonal changes and tidal fluctuation of water from the Bay of Bengal. The mouth of Haldi river divided into three separate sites based on their released effluents, which included; Site 1 (major industrial effluent out fall at Patikhali in Hooghly river), Site 2 (5 km down stretch from Site 2) and Site 3 (5 km above confluence on river Haldi).

Plate 146: Bharat Petroleum , Patinala , Haldia

A study was conducted by WBPCCB in 2017 to assess the pollutants particularly metal traces in the study area. During this study period trace metal content in soil (Cd, Zn, Cu,Mn,Pb) and water (Cd, Cr, Cu, Ni, Pb, Zn) the possible impact due to anthropogenic activities in this site were also evaluated. 23 fish species and different plankton, and heavy metal effect on the fish muscle were identified. Therefore, owing to the tidal inflow the experimental site salinity

increased which diluted the heavy metal concentration and sustained the various life forms like plankton, fishes. The dominating plankton found in the site are *Spirogyra sp*, *Volvox sp*, *Anabaena sp*, *Nostoc sp*, *Stigeoclonium sp*, *Brachionus sp*, *Keratella sp*, *Cyclops sp*, *Daphnia sp*, *Mysid Shrimps*, *Nauplius stage* etc. Moreover, phytoplankton has been found more in terms of their density and diversity as compared to the zooplankton. Due to the abundance of various types of natural food in water body the fish production moderately. Therefore, the Govt. agencies either central government and state government or any other NGO's should take proper initiative to conserve the fish faunal diversity for a long term benefit of the local people in particular and commercial exploitation in future.

Plate 147 - Effluents from Haldia Petrochemicals get released in Bhagirathi –Hugli