KOLKATA

DOCUMENTATION OF GANGA FROM GOMUKH TO GANGASAGAR

NAMAMI GANGE

Report submitted by:

The Natural Heritage Division

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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

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:

I. **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.

II. **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.

III. **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.

IV. **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 centers' at Dehradun, Narora, Allahabad, Varanasi and Barrackpore has been developed for restoration of identified priority species.

V. **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.

VI. **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, and YouTube etc.

VII. **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.

VIII. **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:

- River Ganga has significant economic, environmental and cultural value in India.
- 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.
- The Ganga basin - which also extends into parts of Nepal, China and Bangladesh - accounts for 26 per cent of India's landmass.
- 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:

I. 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
II. 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 6,24,235.73 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	E	
				N	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**	Map:1
		J	Purba Medinipur	06	92 Km	
7.	Total Length of the Bhagirathi-Hugli River in the Lower Part			1282 Km.		

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

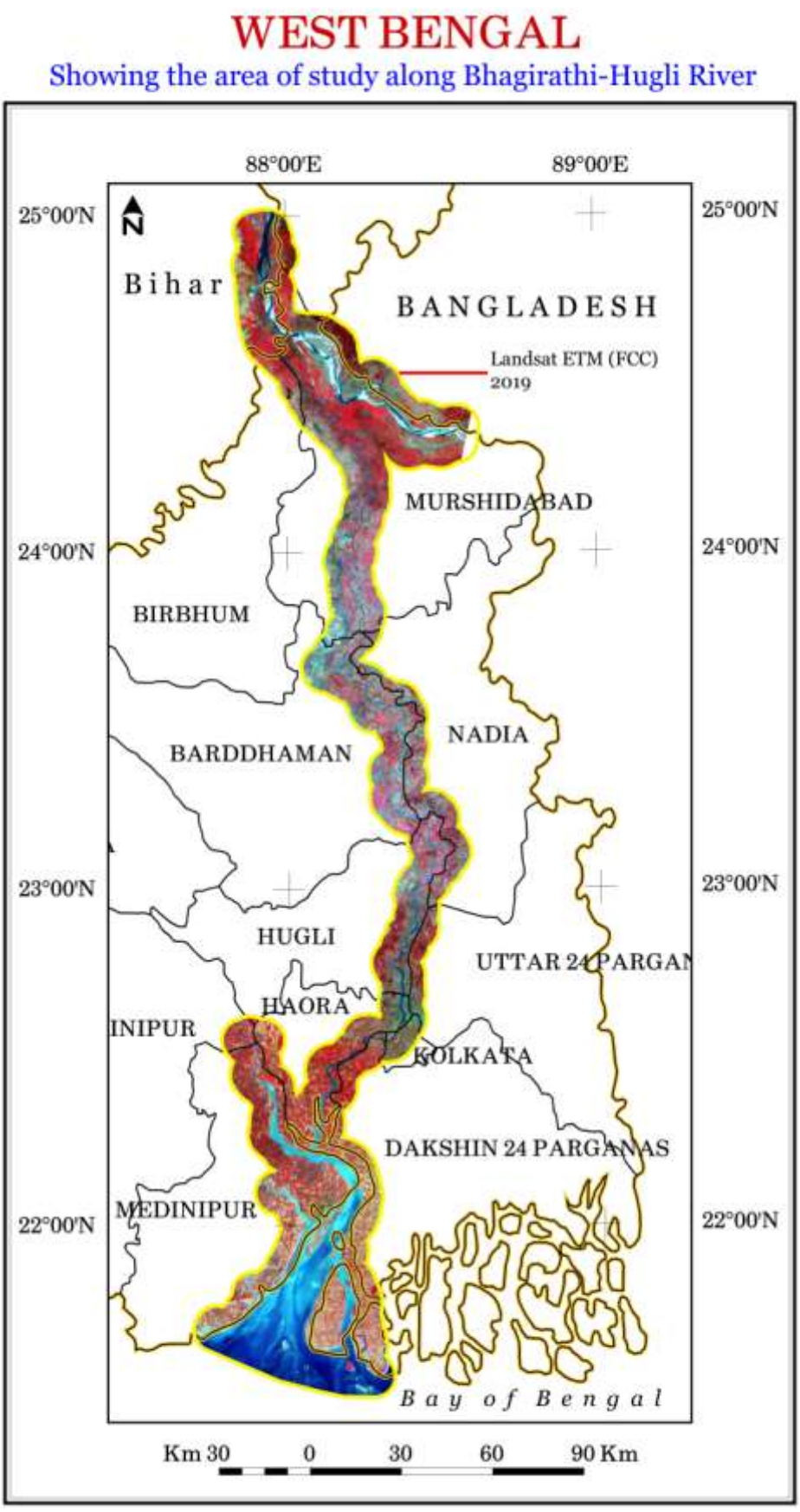
1.3D. Sacred Groves: Landscapes that have both ecological and religious significance, where religion has ensured conservation of natural landscapes shall be noted

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.



Map 1 – Location Map of the Study area

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: Location of the Study Area

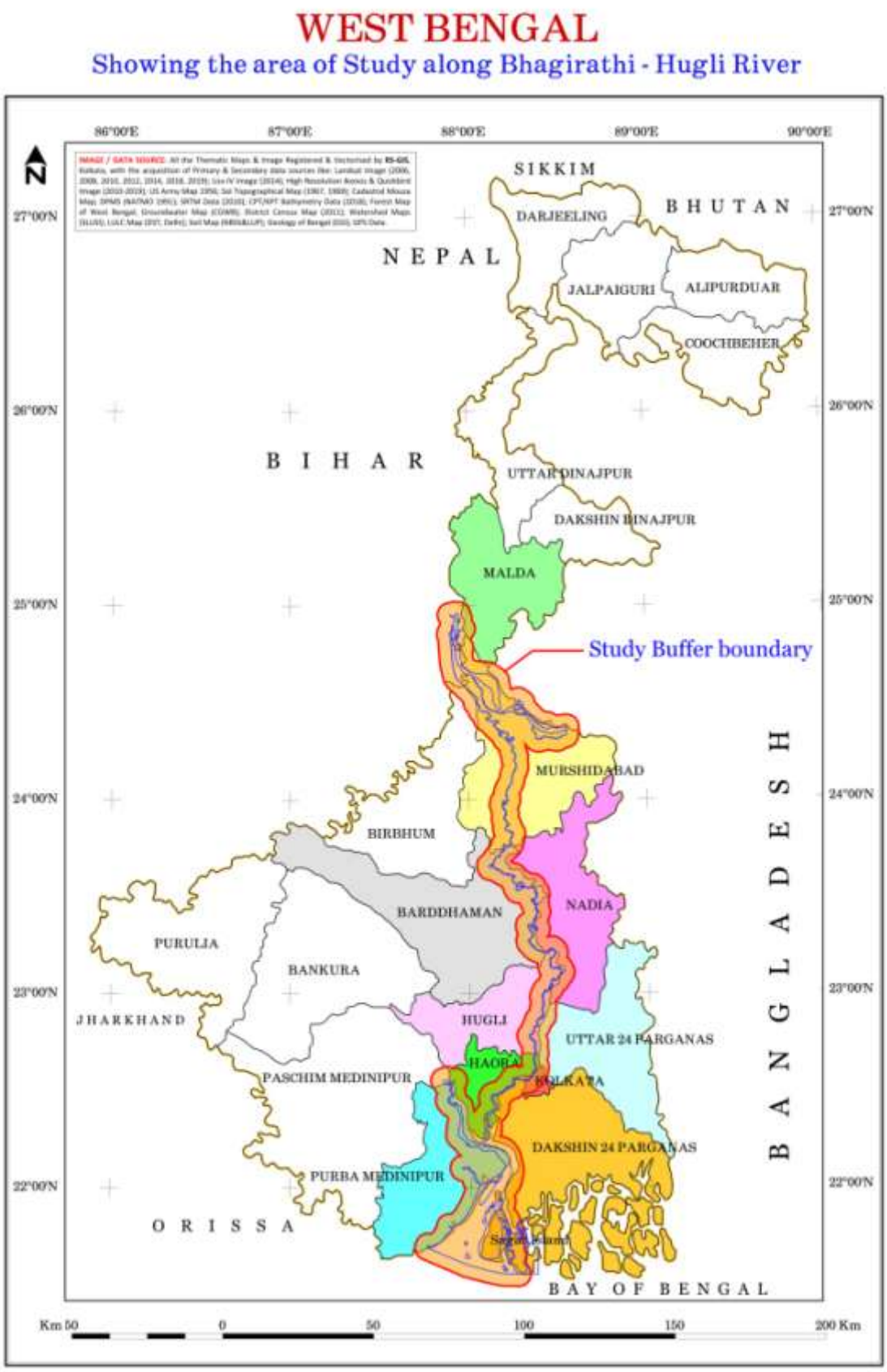
2.1. River Hugli in Kolkata District

Hugli River - Hugli also spelled Hooghly, is a river in West Bengal state, north-eastern India. An arm of the Ganges (Ganga) River, it provides access to Kolkata (Calcutta) from the Bay of Bengal. It is formed by the junction of the Bhagirathi and Jalangi rivers at Nabadwip. From there the Hugli flows generally south for about 160 miles (about 260 km) to the Bay of Bengal, through a heavily industrialized area with more than half of West Bengal's population. The river's lower reaches are fed by the tributaries like Ajay, Damodar, Rupnarayan, and Haldi rivers, which all rise to the northwest on the Chota Nagpur plateau area. From Kolkata the Hugli flows west and south to the Rupnarayan estuary, then twists south and southwest, entering the Bay of Bengal through an estuary 3 to 20 miles (5 to 32 km) wide. It is spanned by a cantilever bridge between Haora and Kolkata and by the Bally Bridge between Bally and Baranagar.

Our study area starts from Paramanick Ghat , Kashipur , Ward No 1 , KMC (22°37'53.65"N 88°21'51.18"E) to Adi Shoshan Kali Ghat , Badartala , Ward No. 141 , KMC a stretch of about 20 kms along River Hugli with a 7 km buffer area towards east . As this zone almost coincides with the KMC administrative boundary we have taken the entire Kolkata and even East Kolkata Wetlands located beyond KMC boundary as our Study area. *(Refer Map 2& 3)*

Like all the great cities of the world having history of originating beside Rivers, Kolkata also developed based on River Hugli. From time immemorial, Kolkata's heart and soul remained in the flow of Hugli River.

Plate 1: The Calcutta city along River Hugli, 1885, Bourne & Shepherd collection

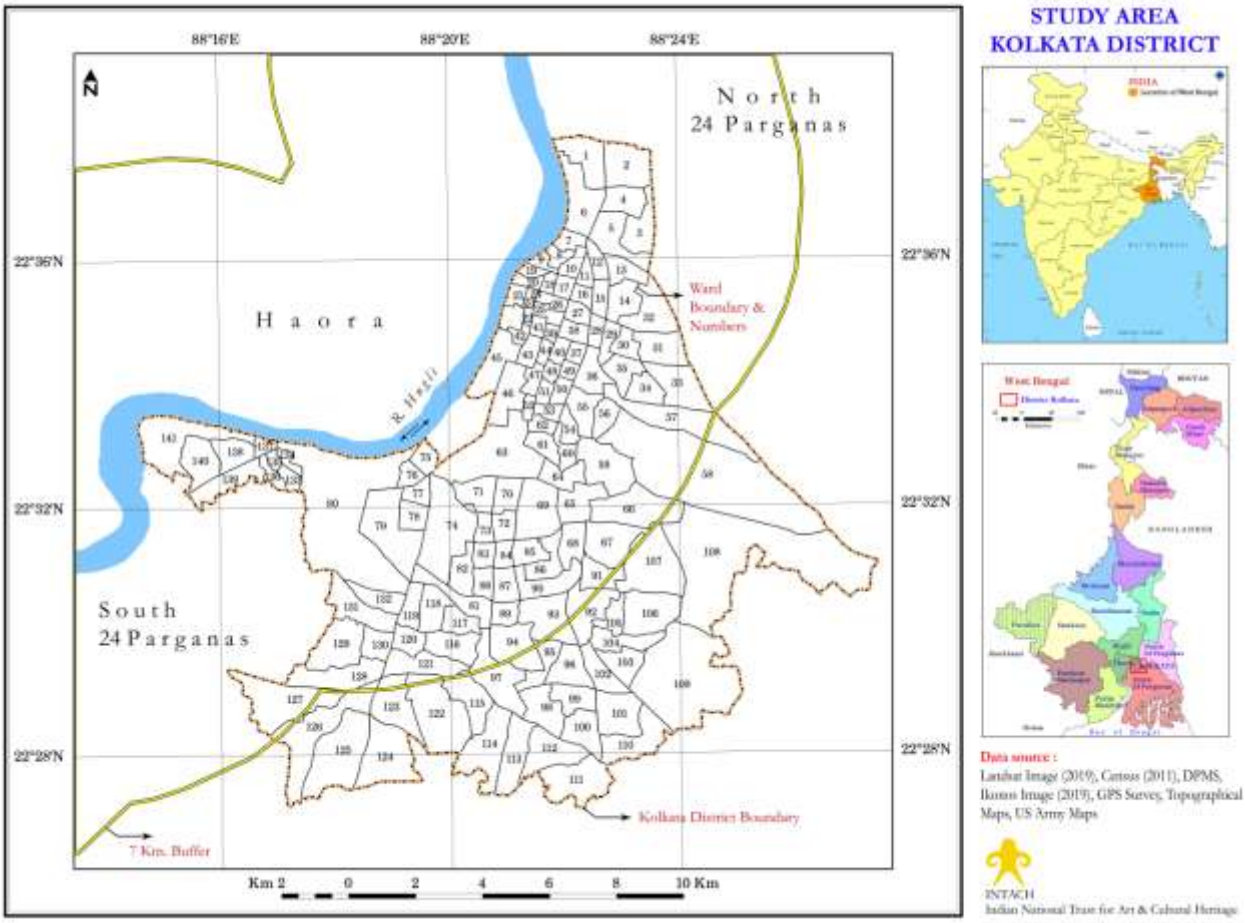


Map 2 – Study area along Bhagirathi-Hugli river

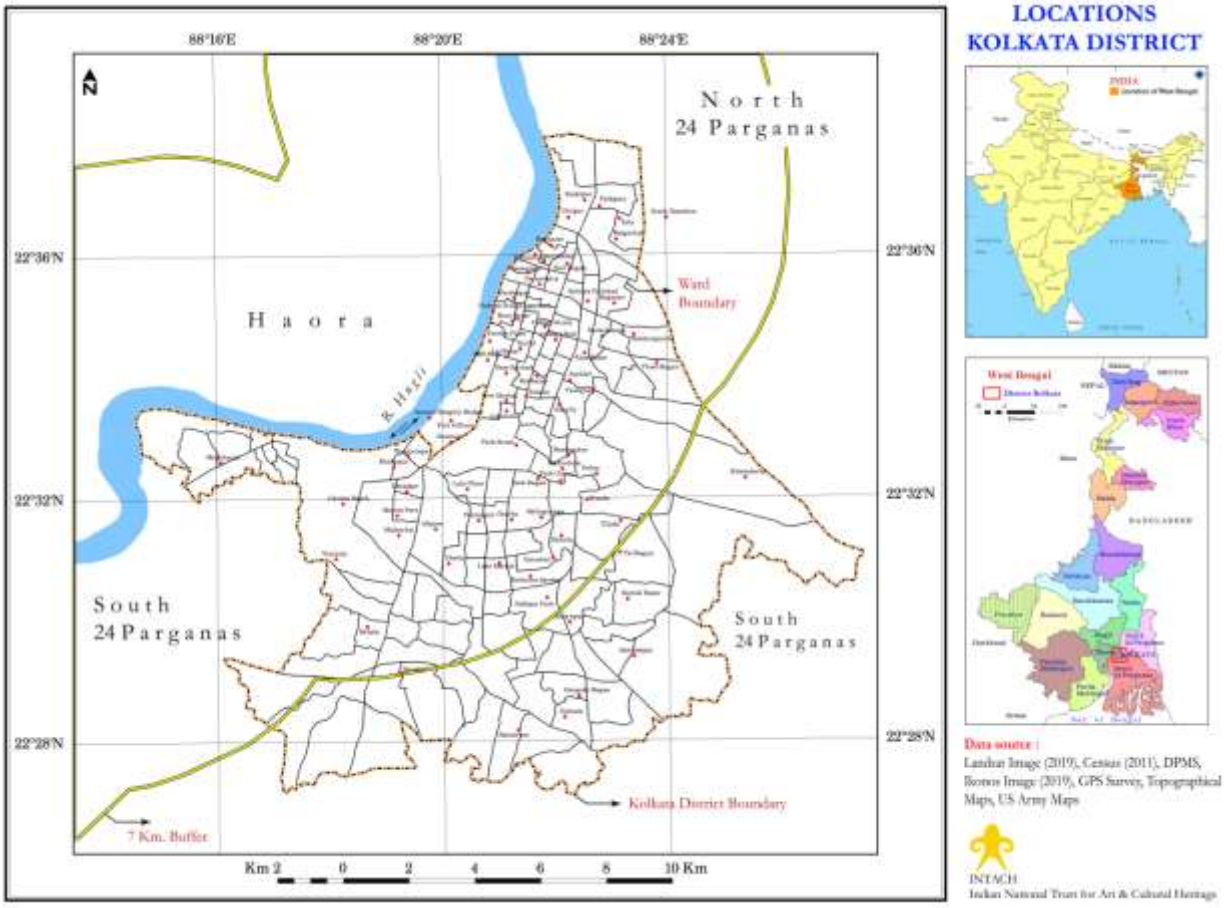
Plate 2 – High Resolution Satellite Image showing the location of urban agglomeration of Haora & Kolkata along River Hugli ,2020

Plate 3 – The urban landscape of Kolkata , High Court , Eden Gardens area , Source – Kolkata Police

Plate 4 – River Hugli with Haora Bridge, Source –Kolkata Police, Brainwing.in



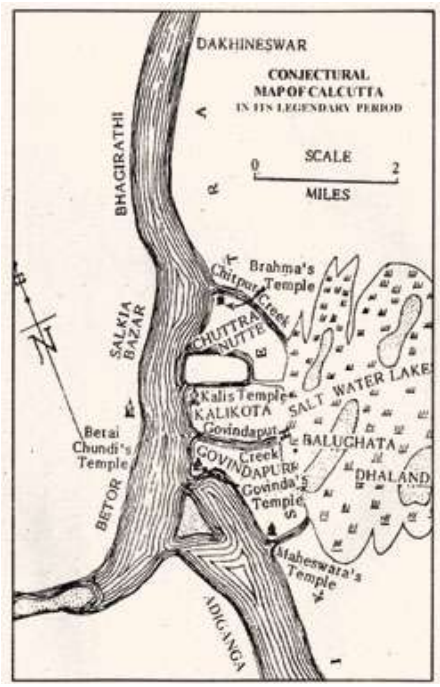
Map 3 & 4 – The Location of the Study area with the Buffer area of 7kms



2.2. THE NAME KOLKATA

The name Kolkata was mentioned in the rent roll of the Mughal Emperor Akbar (1556-1605) and also in the *Manasa Mangal* of the Bengali poet Bipradas as early as 1495. "Calcutta" later "Kolkata", is most commonly derived from the name of the goddess *Kali* of Kalighat. It would be simplistic to derive it directly from *Kalighat*, as the two names occur side by side in early texts. But many variants have been suggested, such as *Kali-Kata* (the home or abode of *Kali*); *Kalighatta*, a North Indian distortion of *Kalighat*; and the most Sanskritic, *Kalikshetra*, the field or terrain of Kali.

Since early 17th Century, three local villages- Sutanuti, Kalikata and Gobindapur (*Map 5*) - had been chosen as a place to settle by Indian merchants who had migrated from the silted up port of Satgaon, further upstream of Bhagirathi-Hugli. Ironically, Kalikata or Calcutta was much less important than Sutanuti or Gobindapur, the two other villages which formed the nucleus of today's city.



Map 5– Conjectural Map of Kolkata

2.3. GEOGRAPHICAL LOCATION

Kolkata is located in the eastern part of India, which falls between North latitudes 22°28′00″ and 22°37′30″ and East longitudes 88°17′30″ and 88°25′00″. It is the capital of the State of West Bengal. It is situated on the eastern bank of Hugli River (also called Bhagirathi-Hugli or Ganga). River Bhagirathi-Hugli, in fact is a distributary of river Ganga. The city is about 130 km north of the Bay of Bengal. The city is running administratively by Kolkata Municipal Corporation (KMC) that provides different environmental and social amenities to the citizens of Kolkata. (*Map 3&4*)

2.4. GEOGRAPHICAL BOUNDARY

Kolkata is a part of Kolkata Metropolitan Area (KMA) often termed as a Greater Kolkata. The city Kolkata is bounded by River Hugli in the Western and South-western part, South 24 Parganas District in the Southern Part, North 24 Parganas District in the Eastern and Northern part. The city is the gateway to eastern and northern India.

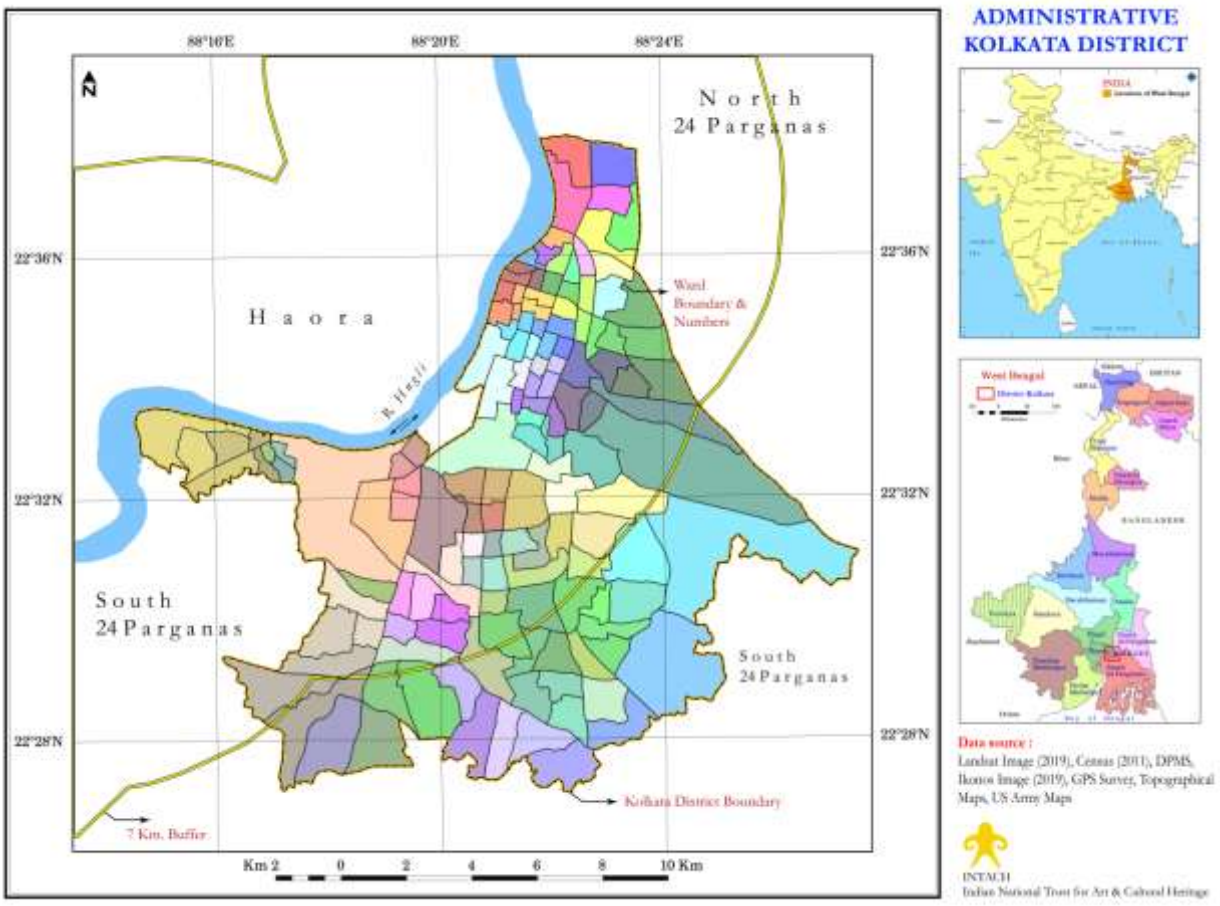
Plate 5 – The present view of Hugli River with the Iconic Howrah Bridge

Plate 6 – The Launch Service jetty (Babughat) in Hugli River

2.5. GEOGRAPHICAL AREA

The city boundary of Kolkata has changed many a time, the last taking place in 2018-2019. The original area covering three villages namely Sutanuti, Gobindapur, Kolkata granted for British settlement was only 6.8 sq. Km. by the end of 20th Century (1984) the total area under KMC was 185 sq. km. by the middle of the 18th century additional villages were included ant total area was increased to 20sq. Km. The town was then divided into 18 wards. In the nineteenth century there was further expansion and the total area became 53 sq. km. The area of Kolkata Municipal Corporation (KMC) increased to 73 sq. km. through addition of North Suburban Municipality and East Suburban Municipality in 1923, and to 104 sq.km by the addition of South Suburban Municipality in 1953. The number of Wards grew up to 100. Municipalities of South Sub-urban, Garden Reach and Jadavpur along with some municipal areas were added to the jurisdiction of Kolkata Municipal Corporation in 1984. The area then further increased to 185 sq. km. the number of Wards went up to 141. During 2018, again the geographical area of Kolkata has increased, which presently measured as 206.33 sq. km. and the wards are grouped into 16 Boroughs.

Kolkata is the seventh biggest city of India in area. The total area under KMC is 206.20 km^2.

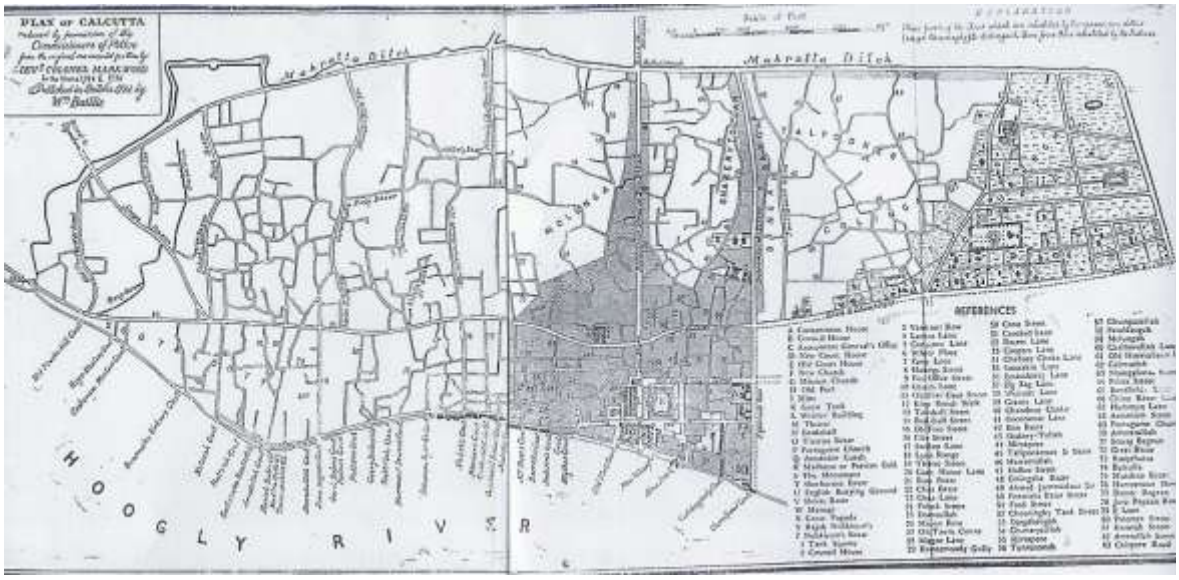


Map 6: Administrative Divisions (Ward map) of KMC with Buffer Area

2.6. GROWTH OF THE KOLKATA CITY

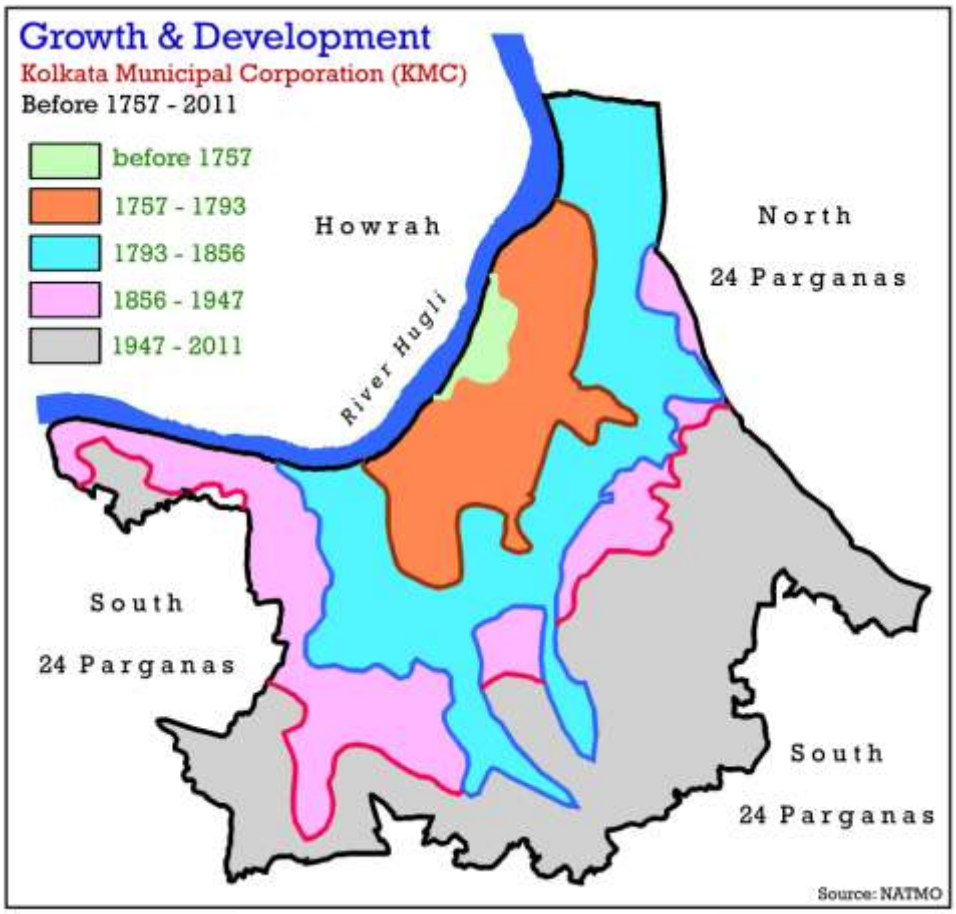
In the sixteenth century, port of *Satgaon* or Saptagram on the western side of Hugli River bank, the centre of old Bengal went into decline due to caprices of the river. The *Seths*, *Basaks*, *Sheels* and *Dattas*, the pioneers of trade of Bengal moved towards the downstream of Hugli and settled at the east bank of Hugli River. In the late seventeenth century East India Company, the British Trading Organization, acquired the three villages namely Sutanuti, Kalikata and Gobindapur on the Eastern bank of Hugli River, which became the original British holdings, formed the city of Kolkata, formerly Calcutta .

Job Charnock an agent of East India Company established an English yarn factory at Sutanuti on 24th August, 1690. This date is considered as the foundation day of Kolkata for study of its growth and expansion through the atlas of different times and also other contributions of Kolkata These three villages were part of an imperial Jagir, i.e., an estate of the Mughal Emperor, whose Zamindari rights were held by the Sabarna Roy Choudhury100 family of Barisa-Behala, in the southern suburbs of modern Kolkata. In 1698, East India Company acquired the Zamindari rights from Sabarna Choudhury at Rs.1, 300 for 5,076 bighas and 18.75 cottahs and paid regular rent to the Mughals for these three villages till 1757. When the British formed their headquarters, the new Fort William in Gobindapur with loot from the Battle of Plassey in 1757, they displaced the native traders from Gobindapur and they were compensated with more lands in Sutanuti, northward of Gobindapur. Job Charnock was convinced of the commercial and tactical advantages and potential importance of this area. Kolkata was 130 Kms. away from the Bay of Bengal. Job Charnock chose Kolkata as a trading centre to get the advantage of its suitable location for a safe and commodious harbor for the large sea-going vessels of those days. What Job Charnock once made Kolkata as a trading centre, has now become an enormous market town.

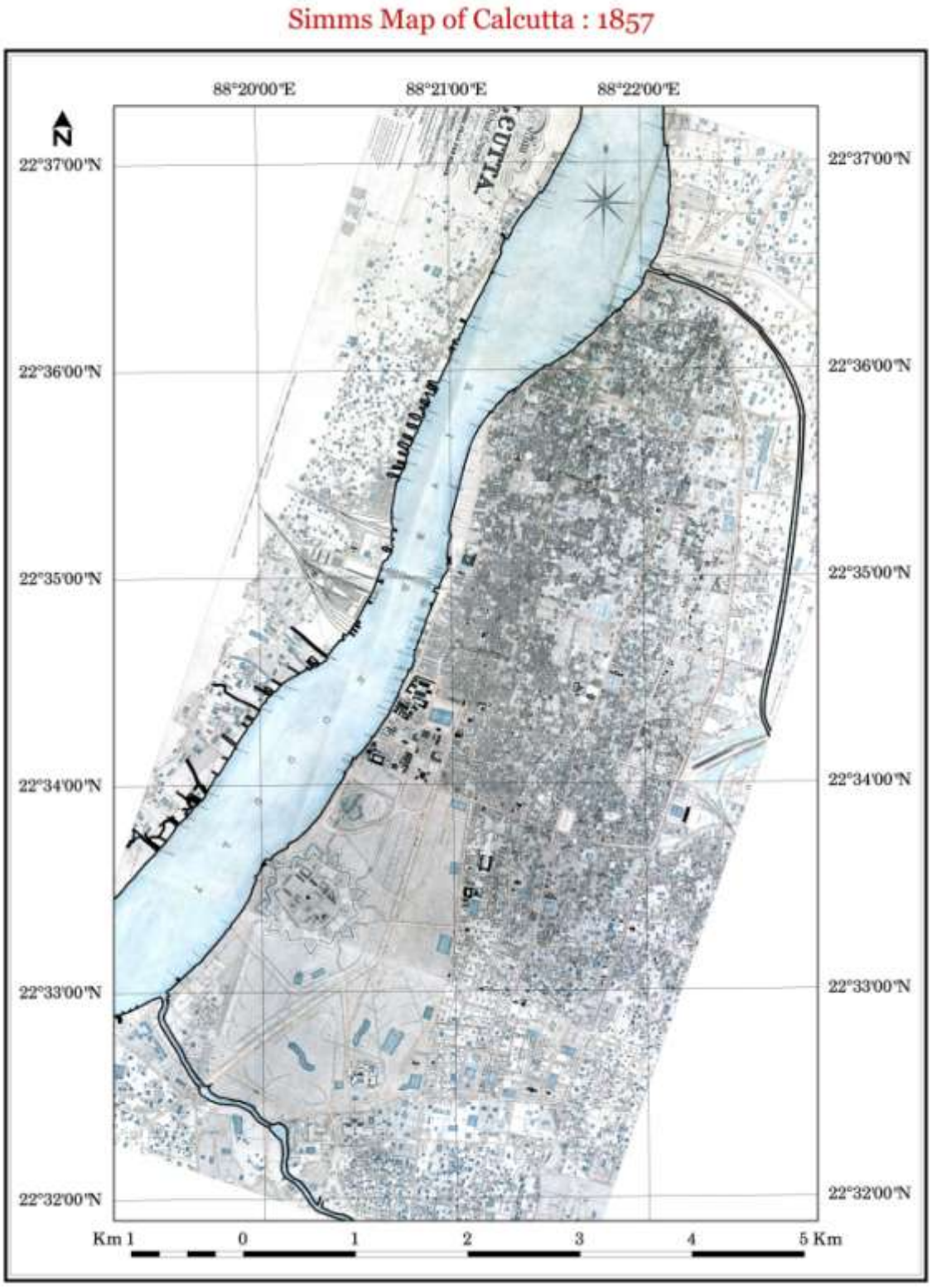


Map 7 – The Plan of Calcutta, reduced by permission of the Commissioners of Police from the original one executed for them by Lieu ant Colonel Markwood in 1784 & 1785. Published in October 1792, by William Baillie.

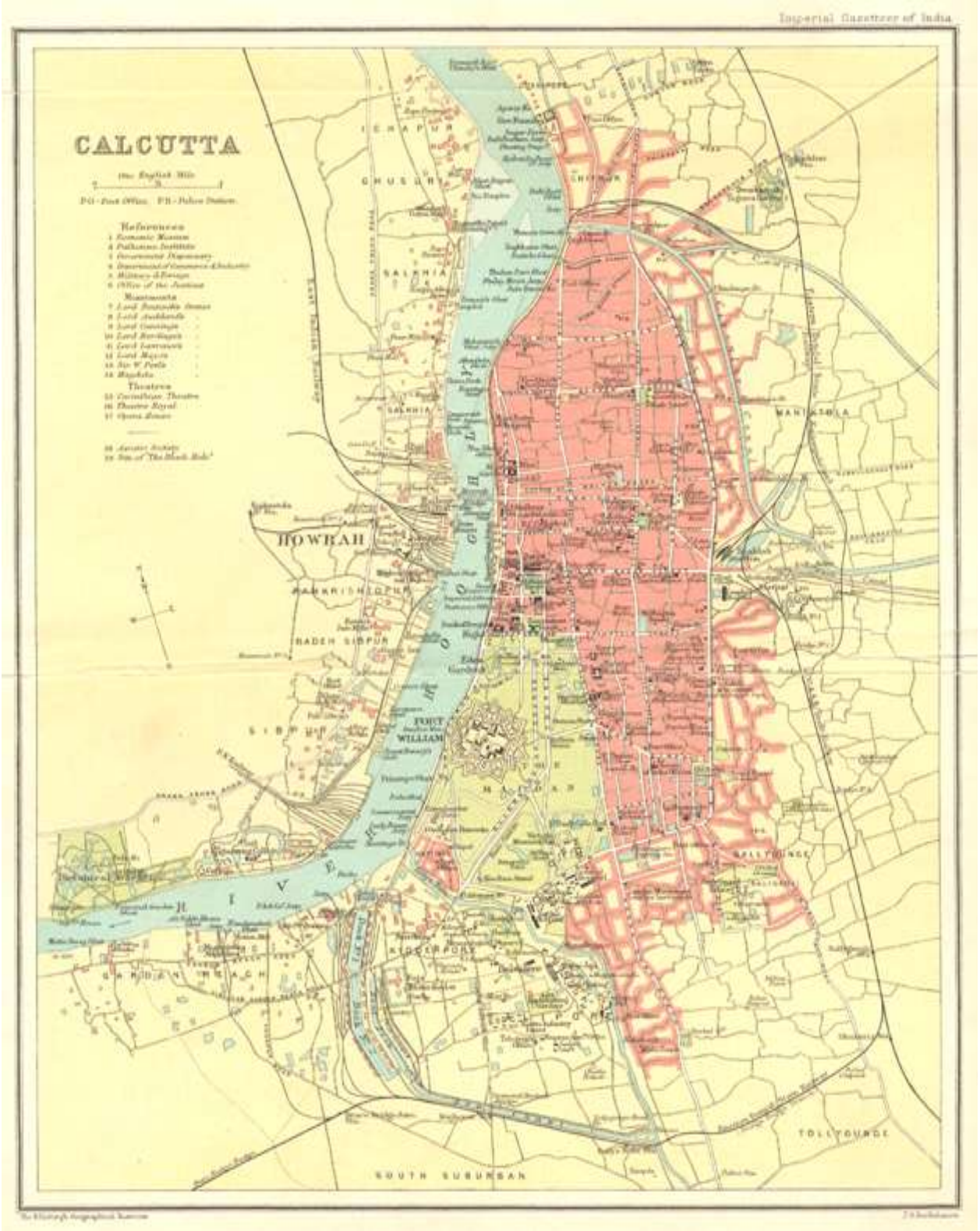
The basic structure of Kolkata's land use was laid out during imperial rule when Kolkata became a major port city of the British Empire passing through various phases of trading, administrative and military roles. In 1794, the boundaries of Kolkata were defined and underwent revision till 1889. Kolkata city was defined in the early days as the area under the "original jurisdiction" of Kolkata High Court bounded by the Hugli river on the west, the Bagbazar canal on the north and Maratha ditch (Circular Road) to east and on south Lower Circular Road (now known as Acharya Prafulla Chandra Road) to Khidderpore bridge and Adiganga (Tolly Nulla) to the river Hugli including the Fort and Colly Bazar (Hastings). (*Map -7&9*) In 1889, the boundaries were redefined leading to an extension of the area from 2,022 hectares to 4,836 hectares, adding in that process parts of Entally, Ballygunge, Bhawanipur and Tollygunge to the city. In, 1924 the municipal township was extended to 7887 hectares to include Kashipur-Chitpur, Manicktala, Garden Reach and New Dock Extension areas in the city. The next extension occurred in 1953 when the Tollygunge municipal area was added to Kolkata and thus Kolkata became 9560 hectares excluding the fort, port and canals. As horizontal land space was so limited, vertical growth soon followed increasing the density of population. In 1984 three municipalities—Jadavpur (formed in 1981), South Suburban (Behala) and Garden Reach were added to Kolkata and the Kolkata municipal area was divided into 141 wards. At present, the number of wards of Kolkata Municipal Corporation is 144 after the wards 142, 143 and 144 (Joka 1 and Joka 2) being added to it.(*Map-8*)



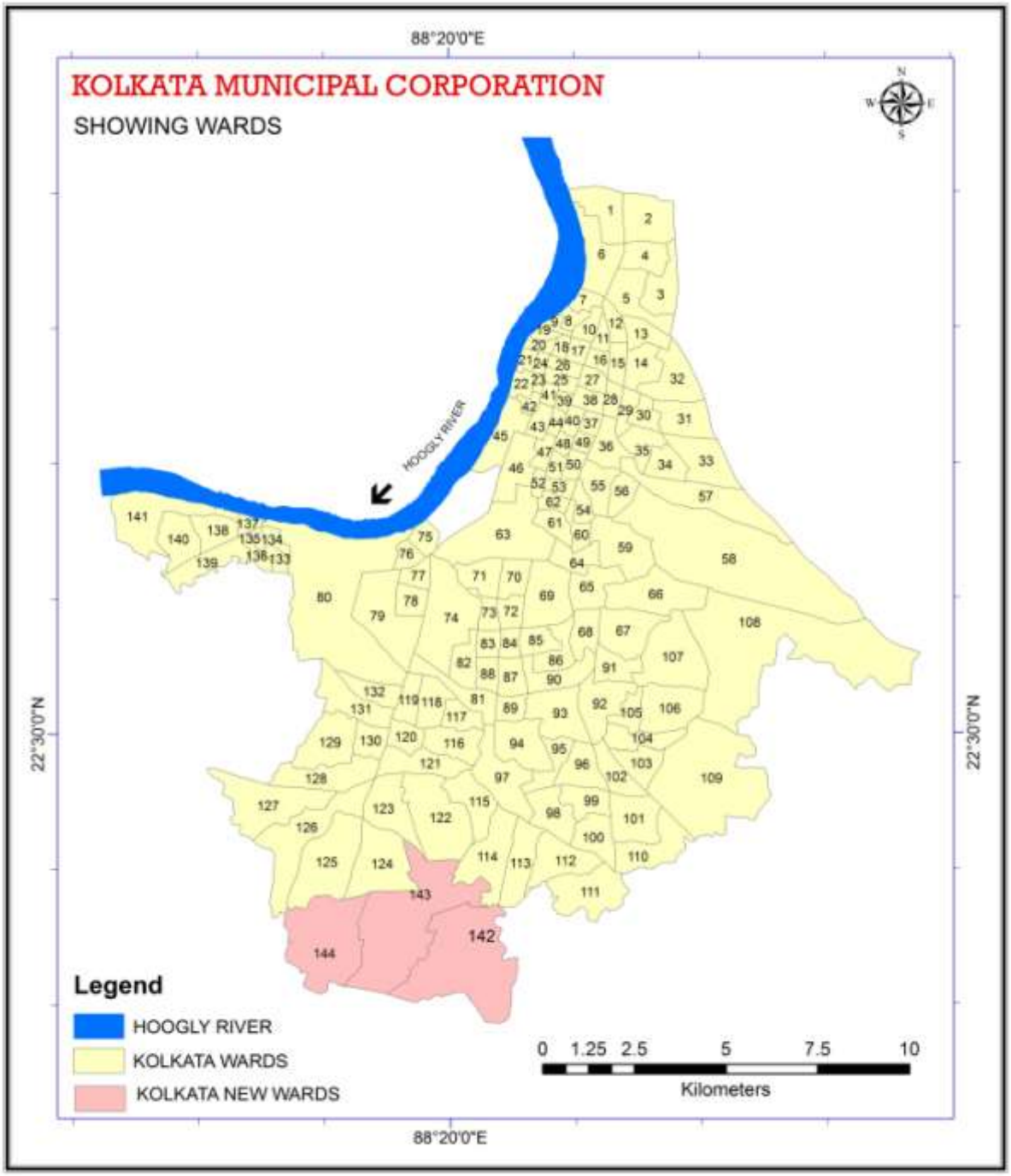
Map 8 – Growth of the city, NATMO



Map 9– Simms Map of Calcutta, 1857, Source – David Rumsay Historic Map Collection, British Library



Map 9 – The boundary of KMC, 1907. Source – Imperial Gazetteer



Map 10 – The present KMC Boundary with 144 wards

Plate 7 – VIEWS OF CALCUTTA AND ITS ENVIRONS - James Baillie Fraser - C 1826 Vintage Orientalist (Paintings of India - Art Prints)

Plate 8 – The Old Court House Street, 1930 Bourne & Shepherd

2.7 ADMINISTRATIVE DIVISIONS

The civic administration of Kolkata (the metropolitan city and the capital of the West Bengal state of India) is executed by several government agencies, and consists of overlapping structural divisions. At least four administrative definitions of the city are available; listed in ascending order of area, those are:

I. Kolkata District and the Kolkata Municipal Corporation area ("Kolkata City")*(Map-10)*
II. The Kolkata Police area,(*Map-13*)
III. Greater Kolkata, which adds to the KMC area and some areas just adjacent to it,(*Map-11*)

The Kolkata Metropolitan Area

The area within which the Kolkata Municipal Corporation (KMC) functions also has the following authorities involved in administration: the KMC itself, the Kolkata Collector (see Kolkata District), the Kolkata Police and the District Magistrate (DM) of South 24 Parganas District.

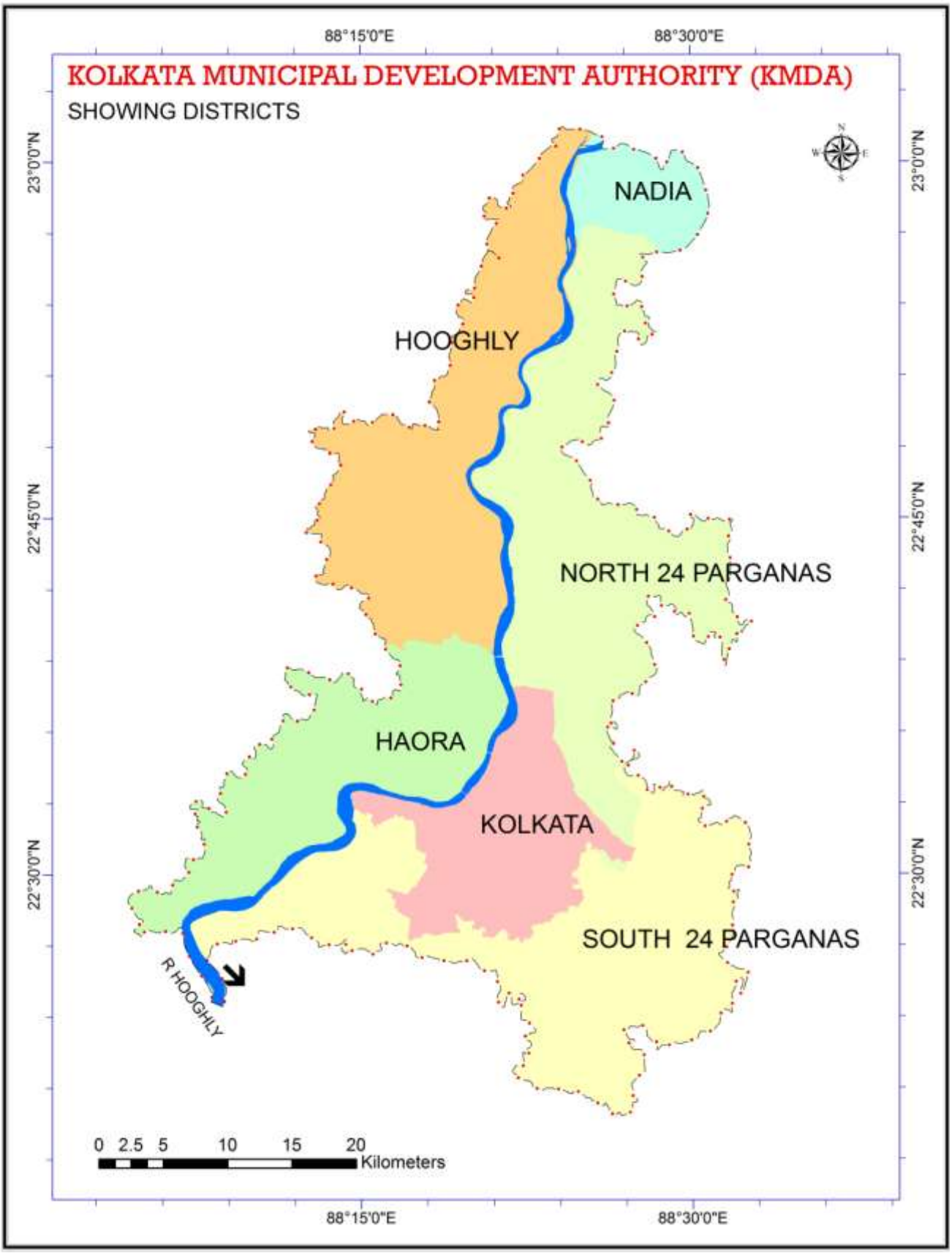
The Kolkata Collector collects land revenues in Kolkata district, the area which is administered by the KMC. In 2011, Kolkata Police underwent restructuring and as of 2012, the Kolkata Police area is slightly bigger than Kolkata Municipal Area.

Kolkata District and the Kolkata Municipal Corporation area ("Kolkata City")-The Kolkata Municipal Corporation, or KMC, oversees and manages the civic infrastructure of the city's 16 boroughs, which together encompass 144 wards. Each ward elects a councillor to the KMC. Each borough has a committee of councillors, each of whom is elected to represent a ward. By means of the borough committees, the corporation undertakes urban planning and maintains roads, government-aided schools, hospitals, and municipal markets. As Kolkata's apex body, the corporation discharges its functions through the mayor-in-council, which comprises a mayor, a deputy mayor, and ten other elected members of the KMC. The functions of the KMC include water supply, drainage and sewerage, sanitation, solid waste management, street lighting, and building regulation.

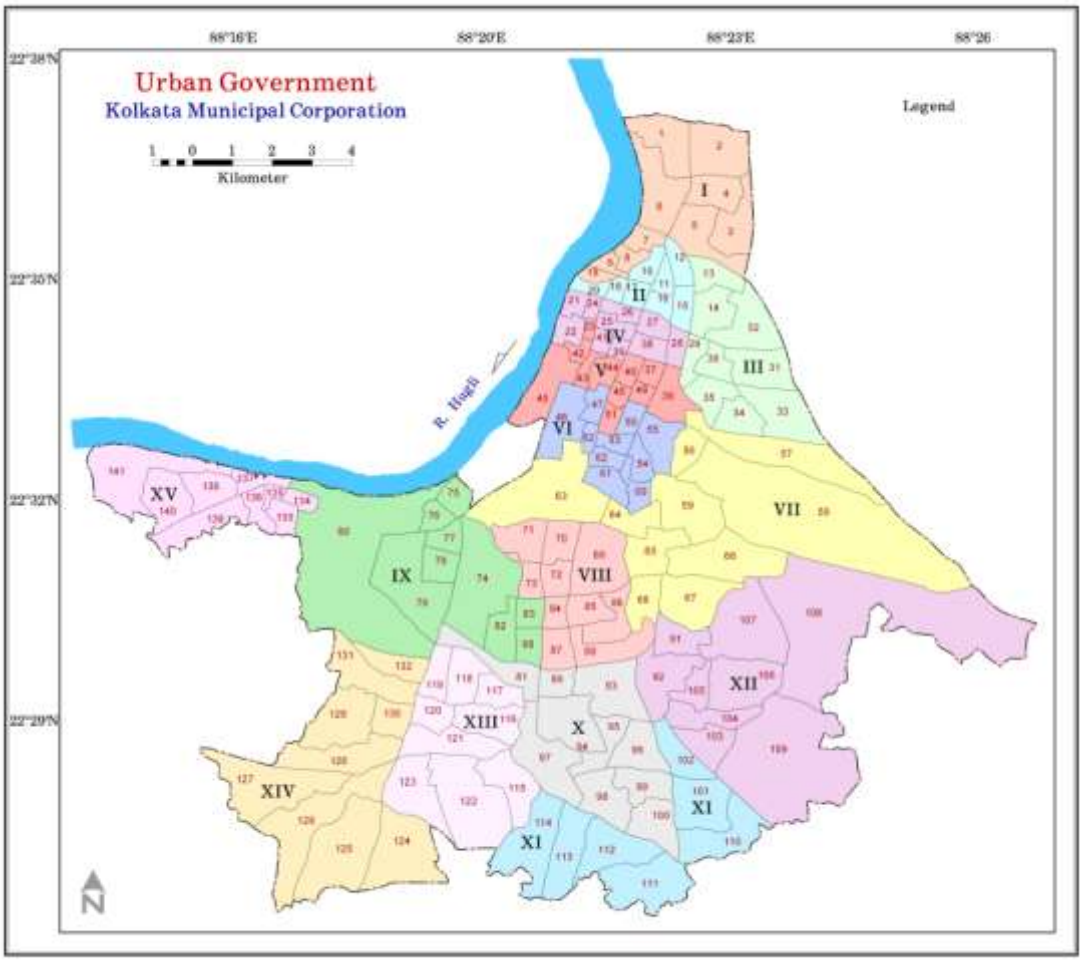
The city also has an apolitical titular post, that of the Sheriff of Kolkata. The Sheriff presides over various city-related functions and conferences.

In 2011, it was announced that Kolkata Police and Kolkata Municipal Corporation area will be almost coterminous. In 2012, erstwhile Joka-I & Joka-II Gram Panchayats were added to municipal limits. This addition increases the area of KMC to 205 square kilometres (79 sq mi) Table 1: **Administrative Divisions of Kolkata**

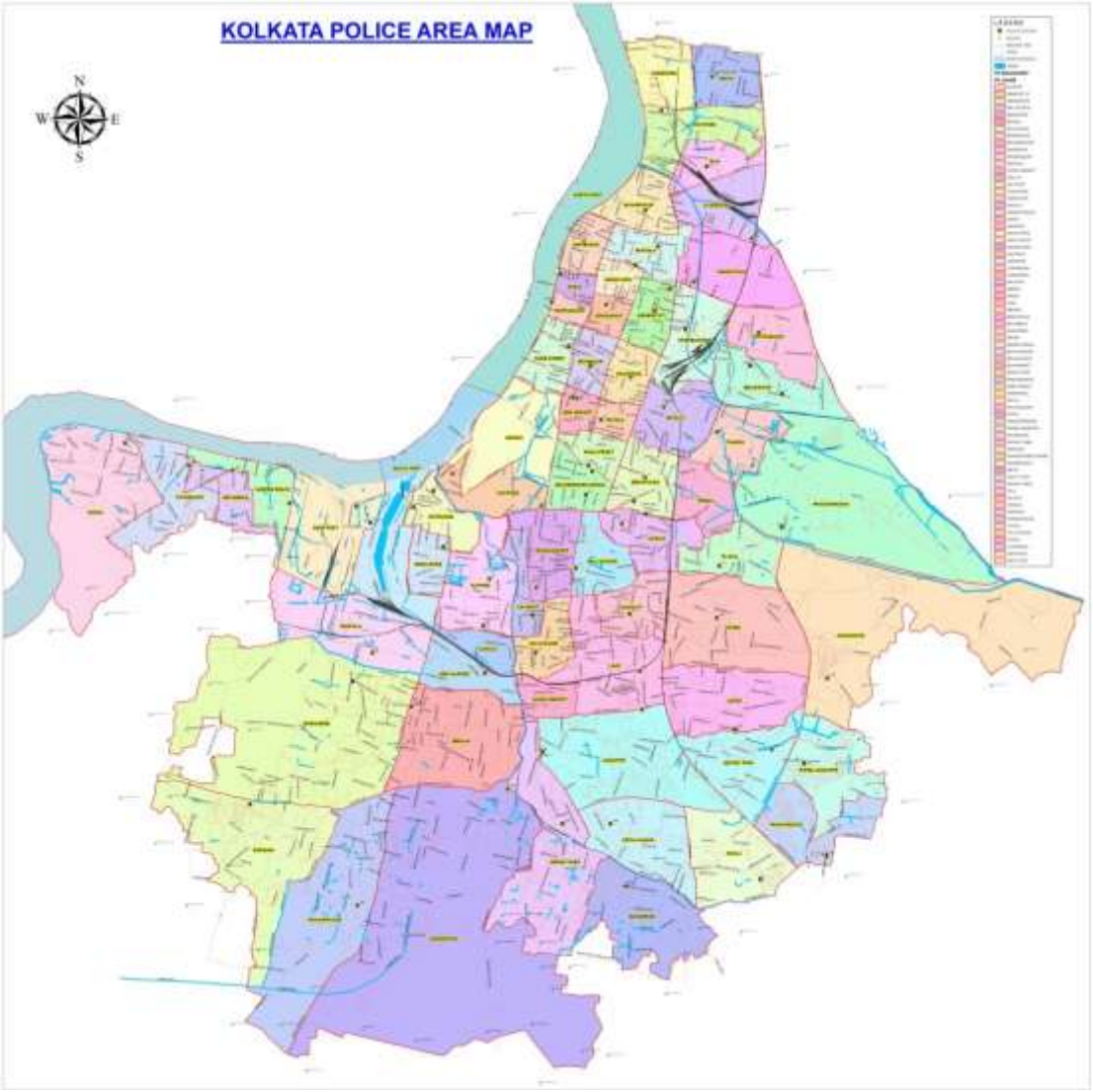
Sl.	Borough No	Total no of KMC Wards	Sl.	Borough No	Total no of KMC Wards
1	**I**	09	9	**IX**	10
2	**II**	09	10	**X**	12
3	**III**	09	11	**XI**	07
4	**IV**	10	12	**XII**	07
5	**V**	11	13	**XIII**	07
6	**VI**	10	14	**XIV**	07
7	**VII**	09	15	**XV**	09
8	**VIII**	11	16	**XVI**	07



Map 11 – Kolkata Municipal Corporation within Kolkata Metropolitan Area



Map 12 – Borough Map of Kolkata

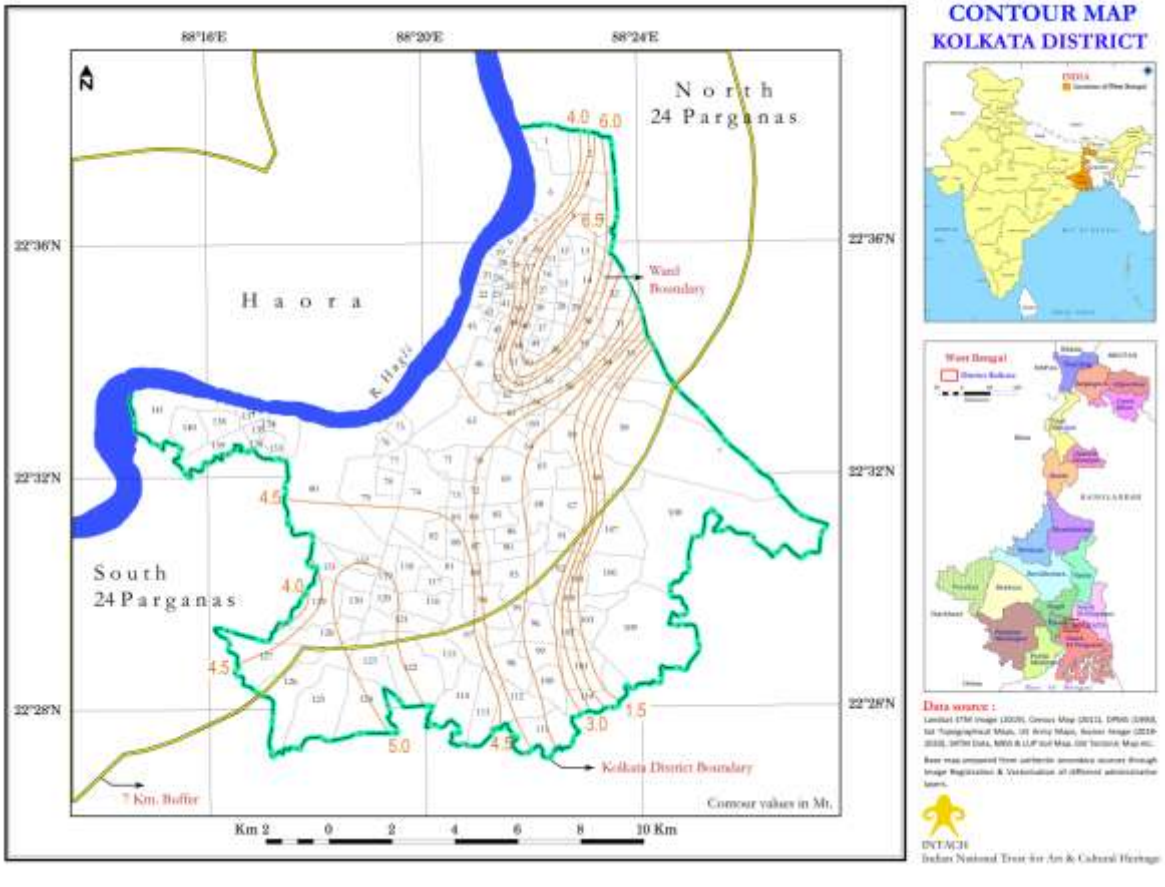


Map 13 – Kolkata Police Area Map

Chapter 3: Natural / Physical Background of the Study Area

3.1. RELIEF /PHYSIOGRAPHY

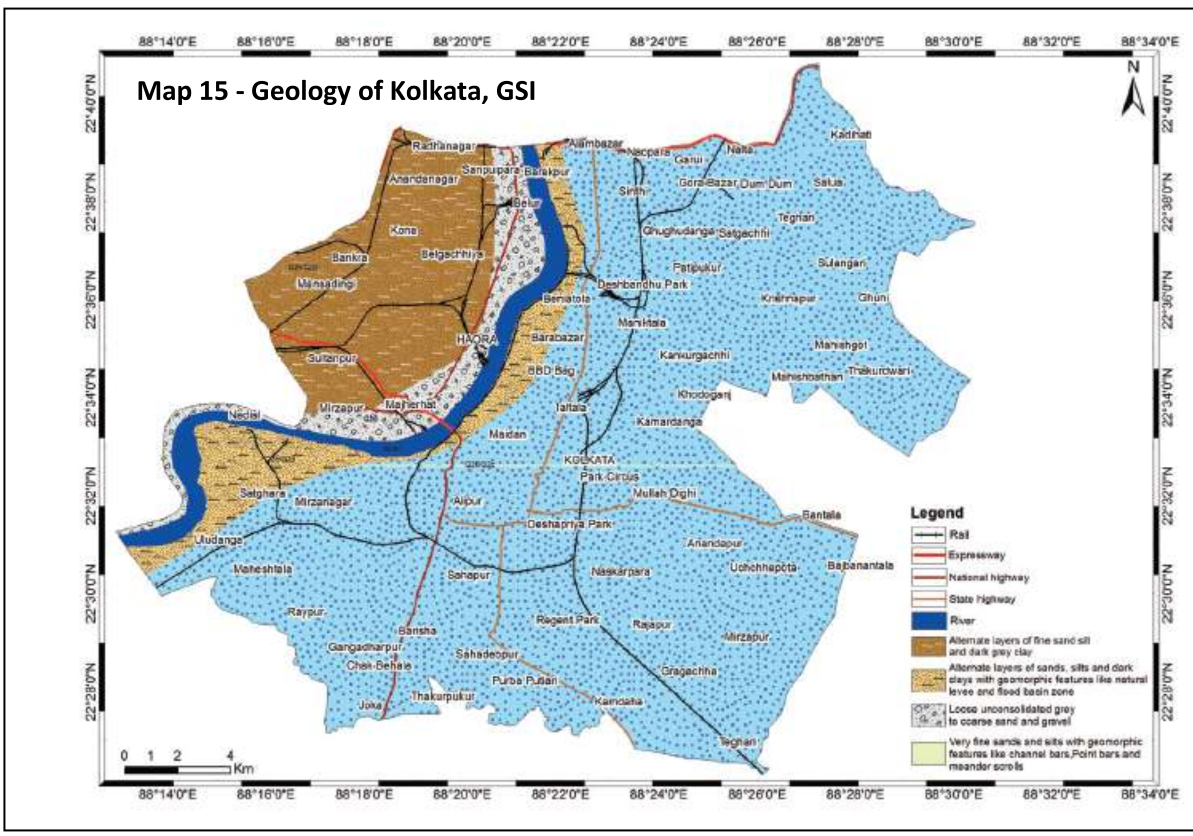
Kolkata is mostly flat and slopes in general from north to south and from west to east. A digital elevation model (DEM) prepared under KEIP from satellite data brings out the elevation distribution in the city. Elevation ranging from less than 3m and more than 10m but less than 20m above mean sea level (MSL) has been mapped. The high grounds are confined to linear stretches along the Hugli river and along the abandoned Adi Ganga river. Low lying areas are to be found to the eastern and south western part of the city. The high grounds within the low-lying areas of the east are man-made features and comprise solid waste dumping grounds (old and active), the P C Chandra Nature Park and the Swabhumi hillock by the side of Subhas Sarobar.(Map14)



Map 14-Contour Map of Kolkata

3.2. GEOLOGICAL SETTING OF THE AREA

Kolkata is located over a tiny part of the huge pericratonic Bengal Basin with an enormous thickness of fluvio-marine sediments. The sediment thickness and facies are significantly varied from the shelf area in the west and the deep basinal region in the east. The total sedimentary thickness below Kolkata is in the order of 7500 m above crystalline basement, out of which the top 350-450 m is Quaternary sediment followed by 4500-5500 m of Tertiary sediments, 500-700 m of Cretaceous Trap/Trap wash and 600-800 m of Permo-Carboniferous Gondwana rocks (Das



and Chattopadhyay, 2009; Nandy, 2007). The lowest parts of the Bengal Alluvium began at the onset of the Pleistocene glacial maximum, with sea level (i.e., regional base level) at least 100 m below present MSL. Thus, the rivers draining the plain during that The geology in and around Kolkata is rather uniform, characterized by the presence of 30-60m thick grey sticky clay followed by relatively coarser sediments consisting of either silt/fine to medium sand or coarse sand with or without pebbles/cobbles (Chatterjee *et al*., 1964). The recent geological formations, poorly consolidated/unconsolidated water charged sediments and man-made landfills posed favorable conditions for liquefaction in the City. More than half of the study area, *i.e.* nearly 330

km2, extending from northeast to southeast of the region is covered with very fine sand and silt in channel bars, point bars as well as meander scrolls. The northwest region of the study area is nearly 57 km2 characterized by unconsolidated sediments, alternate layers of fine sand, silt, and dark clay, which belongs to the Panskura formation or equivalent to the Chinskura formation as shown in Figure 2.25. Alternate bands of sands, silts and dark clays from the Panskura/Chinskura formation equivalent to the Arambag formation are exhibited to the eastern part of the River Hugli on natural levees and flood zone. Loose unconsolidated grey to coarse sand and gravel from Hugli formation of the Late Holocene age covered the minimum areal extent in the west of the Hugli River. The spatial extent of these geological units is represented in (Map -15).

3.3. GEOMORPHOLOGY

The Kolkata city falls under the vicinity of Eocene Hinge Zone. The sediments on both the sides of the Eocene Hinge Zone are very distinct in the characteristics. Subsurface mapping of the Kolkata city revealed that the base of the City is built up with marine as well as the river sediments and carbonaceous shale with organic matter as peat layer indicates the swampy and deltaic environment. Physiography and Geomorphology of a region define the lithological characteristics.

It is very difficult to identify the different geomorphological units in Kolkata due to the urbanization and absence of exposure of surface materials in many areas. Satellite data do not reveal the detail geomorphic features apart from the pattern of settlements. Study of old maps (1817) published by the NATMO reveals that the settlement of Kolkata at that time was along the Hugli river extending upto 2 to 3 km towards the east. As old settlements generally develop on the levee of a river-side it is assumed that the Hugli river levee extends from the Hugli river bank to the east and level data generated from reduced level survey of the monitoring wells have been used to generate a contour map of Kolkata with 0.2 meter interval. This map reveals the surface features of Kolkata. From the contour map and traverse survey along Adi Ganga the reconstruction geomorphology of Kolkata is attempted. These maps show high land near the Hugli River and also along the channel of Adi Ganga. The surface is gently sloping towards the east and south east and formed low lying areas in the east which transgresses into the saline lakes or east Kolkata wetlands.

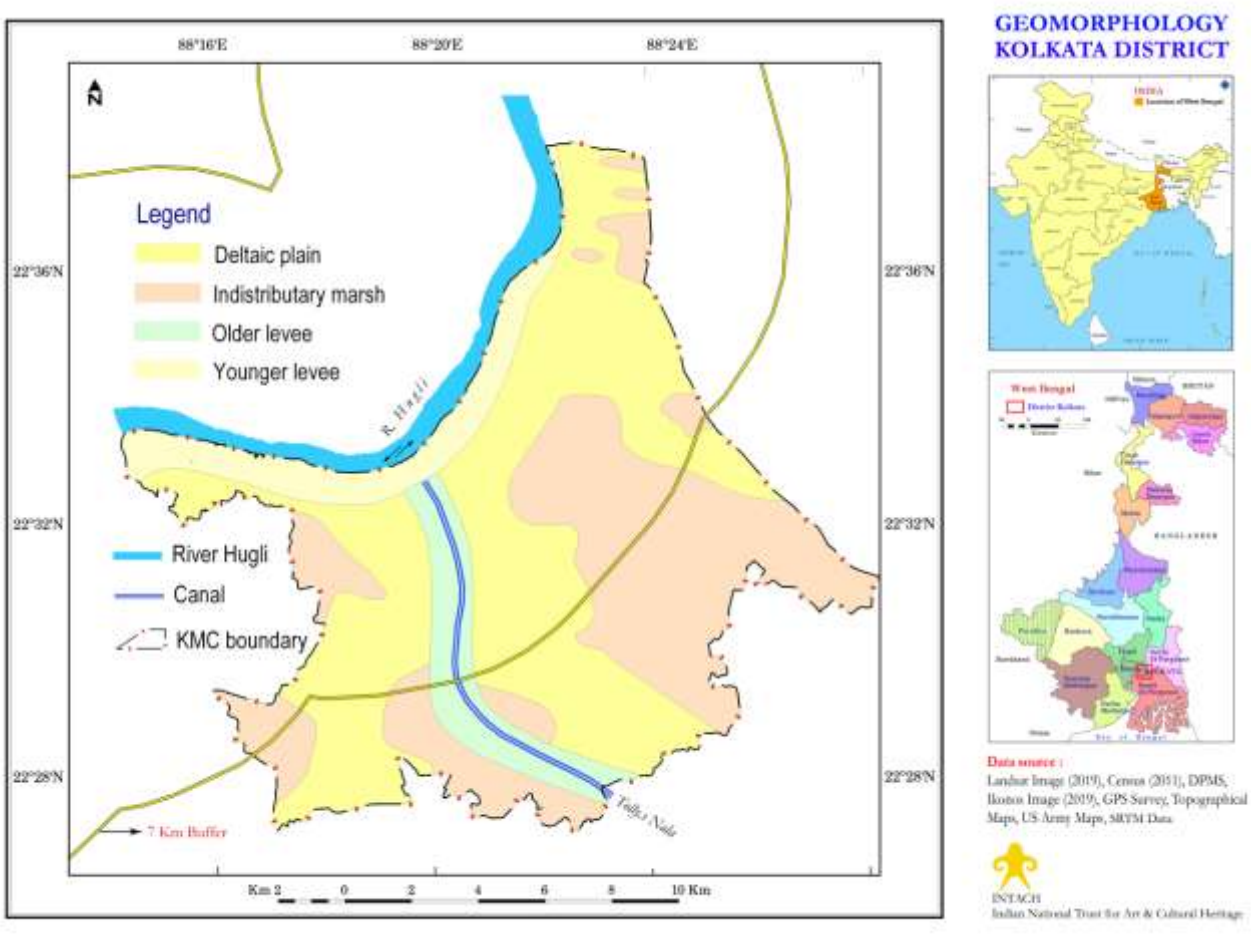
Another attempt was made to determine the depositional features using spatial distribution pattern mapping of the thickness of surface clay of Kolkata. The map is given in Figure.5. This map shows that along the Hugli River the thickness of clay is more than 40 metres whereas along

Adi Ganga channel the thickness is moderate. In the eastern part and in the south western part the thickness is less than 20 metres.

During this study attempt has made to understand whether there is any relation between geomorphology or the sedimentation pattern and the chemical quality of groundwater. The study shows some distinctive patterns compatible with both surface contour and clay thickness. Along the Adi Ganga channel both specific conductivity and chloride concentration is low. On the other hand both chloride concentration and specific conductivity is high near the Hugli river and also at the eastern low lands.

Geomorphologically Kolkata may be divided into four major features.

1. Hugli levee deposit: Extends upto 2-3 km from the Hugli river bank
2. Adi Ganga levee deposit: Extends from north to south covering a large area from Khiddirpur, Alipur, Tollygunge, Bansdroni, Naktala and Garia
3. Adi Ganga channel deposit : Covers a small strip along the river in Naktala and Garia
4. East Kolkata Marshland deposit: Covers a large area in the eastern part starting from, Ultadanga, Park Circus, Santoshpur and Garia in the east and extends towards the east(Map-16)



Map 16 – Geomorphology Map of Kolkata

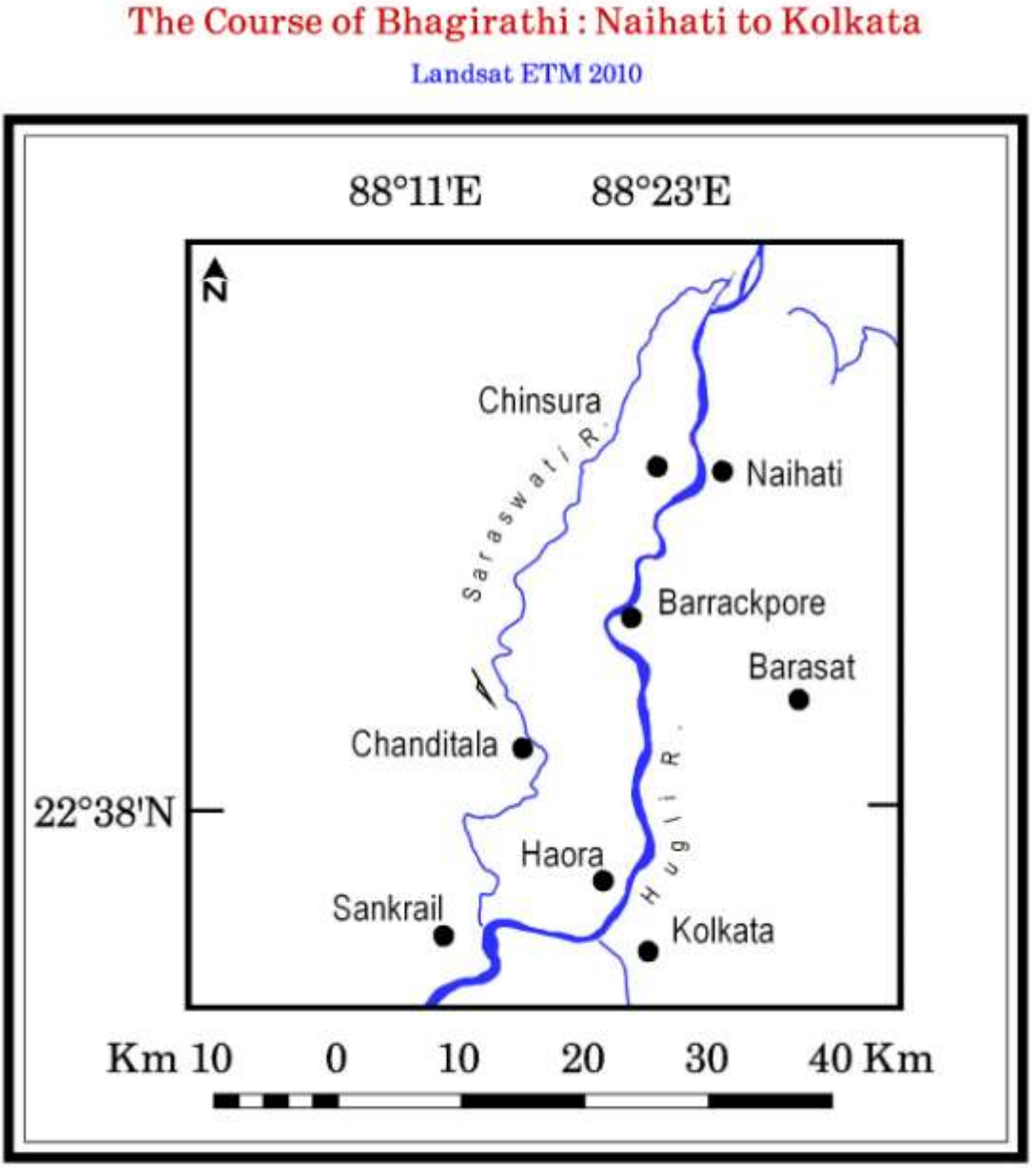
3.4. DRAINAGE

The area is drained by major Hugli river along its North-western boundary and by several canals like Bagjola Khal in the north and Beliaghata and Circular Khal in the central part and Adi-Ganga (a paleo channel), and Tolly nala in the southern part, which flows in the NNW-SSE direction. These *Khals* and *Nalas* cover a large area of the city. At present all the khals and nalas have been silted. They need proper desiltation as they are the main surface water sources inside the city and they can be used for inland water transport. (Details in Chapter 4).

Hugli River – The Hugli river is formed by the confluence of three rivers, the Bhagirathi, Jalangi and Mathabhanga-Churni, of which the Bhagirathi which takes off from the river Ganga at Biswanathpur , is the most important since it is the main channel bringing fresh water

Map 17 – Course of Bhagirathi-Hugli with the tributaries and distributaries, Source – Changing River Courses of Bengal, Sea Explorer's Institute.

discharge into the Hugli. All rivers in the Gangetic delta change their courses. Bhattacharya (1973) mentioned that Ganga is continually favouring preferred slope to the east. The source of fresh water supply into sub delta of the Bhagirathi-Hugli is from its western tributaries and the Ganga but such water is received for only 70 to 80 days in a year. With the commissioning of the Farakka Barrage, during the non monsoon months of the year perennial discharge of varying quantam up to a maximum of 40,000 (about 1200 cumec) cusec is available. During the Monsoon the freshet discharge varies from 50,000 cusecs (about 1400 cumec) to 300,000 cusecs (8400 cumec).



Map 18 – Course of Hugli from Nalhati to Kolkata

3.4a. Depth of the River Hugli, Kolkata Stretch: Kolkata Port Trust regularly generates Depth Map based on bathymetric survey of River Hugli. We have ourselves also conducted Echo Sounder Survey to get the depth of River Hugli. Like all the major rivers at their lower course, River Hugli also confronts a huge problem of sedimentation.

I. Some observations

a. **Kashipur to Ahiritola:** – The depth of water is maximum near Bagbazar Ghat and minimum in Chitpur area. The highest depth recorded is (-14 m) near Bagbazar Ferry Ghat. In this stretch River Hugli in Kolkata side has better depth than that of Haora side.

b. **Ahiritola to Rabindra Setu:** The entire stretch of this part has lower depth of water than the Haora section. The flow of water is towards Howrah side. The highest depth observed is(-17m) while a long stretch of the river in Kolkata side is less than (-3 m).(Map 19)

c. **Rabindra Setu to Gwalior Monument:** From Fairley jetty to Chandpaul Jetty, the flow of the water is again towards Kolkata side . But the overall stretch has a lower depth than the upper reach.

d. **Gwalior Monument to Khiddirpur Dock:** Again this stretch of river has very less depth with an average depth of (-8 to -10 meter). In the lower reach near Khiddirpur area the depth observed is more than -14m.

e. **Khiddirpur Dock and B.N R Guest House**: This stretch has quiet a good depth of river in the Kolkata stretch. The average depth of the entire stretch is -14 to -15mt with some areas having more than -17m .

f. **From IWAI Jetty to Metiabruz Jetty:** Again the depth in the Kolkata side of the river Bank reduces and in Metiabruz it is less than -3mt. The flow of the water is again towards the Haora side.

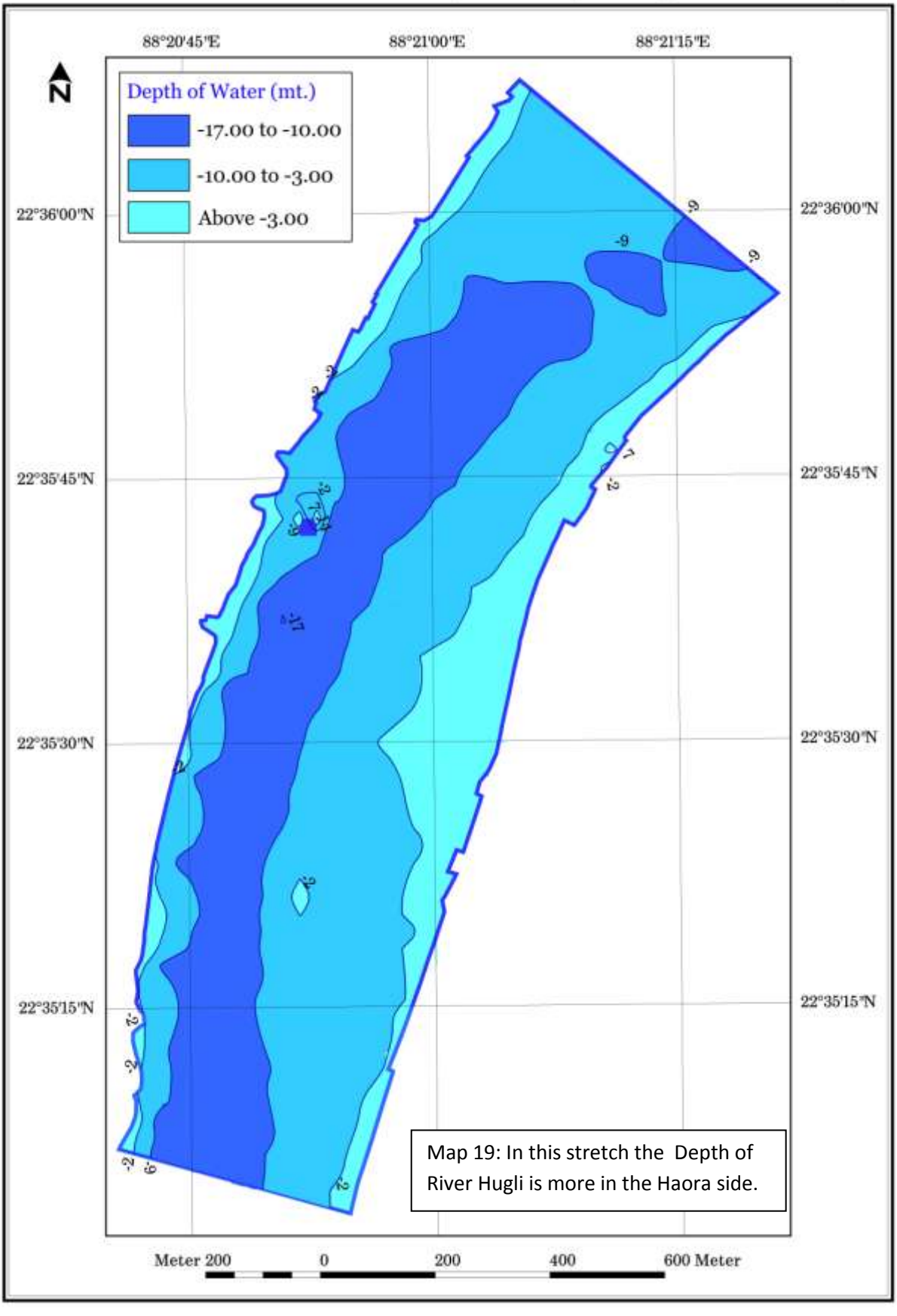
The overall observation is that the stretch of river from Kashipur to Metiabruz is more or less shallow except the Bagbazaar Side and Kolkata Port area near Khiddirpur. We have categorised the depth level in 3 zones. 1. -17m to -10m 2. -10m to -3m and 3. -3 m and above.

Plate 10: With the help of the Echo Sounder instrument we have done the Bathymetry survey in the Bagbazaar area. However the above observations are based on KOPT Marine Department data acquired from the office.

Based on our survey and KOPT data we have managed to prepare a Bathymetry Map of River Hugli from Ahiritola to Rabindra setu .

Bathymetry of River Hugli

Ahireetola Ghat to Rabindra Setu (Date of Survey: 18th - 19th December 2018)



Map 19: In this stretch the Depth of River Hugli is more in the Haora side.

3.4B. Hugli River Ghats: Kolkata is fortunate to have a long river front that is its life line. The length of the River in Kolkata is almost 20km stretching from Kashipur to Badarpur. The ornamental facade of the Ghats with their wide flight of stairs to the river water level is its treasured cultural resources used by people for various activities. Within the KMC area there are 56 Ghats along Hugli River and 28 Ghats along Adi Ganga. (GPS FIELD SURVEY,2020). The Ghats are used as places for religious rituals, spots for people to relax, rest and recreation and access to bathing / swimming in the river.

Plate 14-A very common sight of Ghat activities in Kolkata, Ahiritola Ghat, 22°35'45.71"N 88°21'10.96"E

3.4C. Tidal Bore: The Hugli River is subject to varying tidal action due to tides emanating from the Bay of Bengal (maximum range at the mouth 5.7m).The tides in the estuary are semi diurnal with spring ranges in the order of 4.27m-4.57m. A notable feature in the Hugli is the formation of "bore tides" or "high tides" characterized by a sudden and vertical rise of water level. Bore Tide now occur practically on every spring tide. The maximum bore height is of the order of 2.5 m and speed of travel about 30-32 kilometres per hour.

Plate 15 – Bore Tide in Hugli River, Kashipur (Source: The Telegraph)

3.4D. Salinity: Hugli Estuary has been classified as well mixed type. For spring tide range of 5.0m, the high water surface salinity is the order of 21.24 ppt. the mid-depth salinity of 22.50 ppt. while the near-bed salinity of the order of 23.40 ppt. Similarly at the low water stage, the respective figures are 10.62 ppt, 11.07 ppt. and 12.60 ppt. For a neap tide range 3.0 m and fresh water flow about 2500 cusecs, the vertical variation at the same location during the high water stage are as follows:

Depth below the surface (m.)	Approximate salinity (ppt.)
0.00	8.82
0.25	9.18
Mid-depth	9.36
0.75	9.36
Near Bed	9.54

The landward salinity intrusion has now come down to 35 km below Kolkata while the salinity at Sagar has come down to 18.00 ppt. The suspended sediment concentration varies from 1gm/lit to 32 gm/lit. The estuary exhibits a coarse bed sediment at upper reaches (D_{50}=0.12 mm) to a finer one at the lower (D_{50} =0.09 mm).

3.4E. Water quality of Bhagirathi-Hugli at Garden Reach

CPCB/WBPCB maintains a water quality monitoring station at Garden Reach in Kolkata stretch of Hugli river. Two more locations immediately upstream of Garden Reach are at Dakshineswar and Palta. Raw water for treatment and supply of potable water for the city of Kolkata is drawn from Hugli river near Palta and Garden Reach. Analysis of monthly monitored data of Hugli river in the Garden Reach stretch during 2011 brings out the Dissolve Oxygen (DO) concentrations vary considerably from around 4 to a maximum of 12 mg /l with high values recorded during winter months. BOD varies from a low of under 2 to as high as 6 mg/l with post-monsoon /early winter seems to be the worst months. Total coliform counts vary widely in different months (11 x 10^3 to 4x10^5 MPN/100ml.) and no definite pattern could be seen. Suspended solids (50 to 196 mg/l) and dissolved solids (148 to 340 mg/l) showed high concentration during rainy months. Water quality therefore does not even meet the bathing quality standard.

Yearly average data for the last decade based on monthly monitoring in respect of temperature, pH, Conductivity, BOD, DO, Nitrate, Faecal Coliform and Total Coliform are given in

Table -2 :

YEAR	Parameters							
	Temperature (^{0}C)	pH	B.O.D (mg/l)	D.O (mg/l)	Faecal coliform (MPN/100ml)	Total coliform (MPN/100)	Conductivity(µmhos/cm)	Nitrate (mg/l)
2002	-	-	3.0	5.9	101250	-	-	-
2006	-	8.0	4.1	6.2	406667	661667	-	-
2011	26.2	7.8	4.0	6.7	163077	243000	304	0.32

Source-WBPCB

Compliance with national standard and trend in concentration of three critical parameters at Garden Reach (BOD, DO and faecal coliform) show that DO is compliant and no define trend could be seen. Faecal coliform is totally non-compliant and trend is not satisfactory. BOD concentration is compliant with respect to national standard but has an increasing trend.

As part of preparation of IEE of KEIP Phase 2, one time monitoring of water quality of intake raw water during high and low tide stage and treated supply water from Garden Reach treatment plant was carried out. The supply water shows considerable reduction in turbidity, total

suspended solid, total volatile solid, BOD, COD, iron and nitrogen and complete elimination of total coliform making it compliant with drinking water standard.

Plate 20-River Hugli in Garden reach, 22°32'52.38"N 88°19'5.18"E

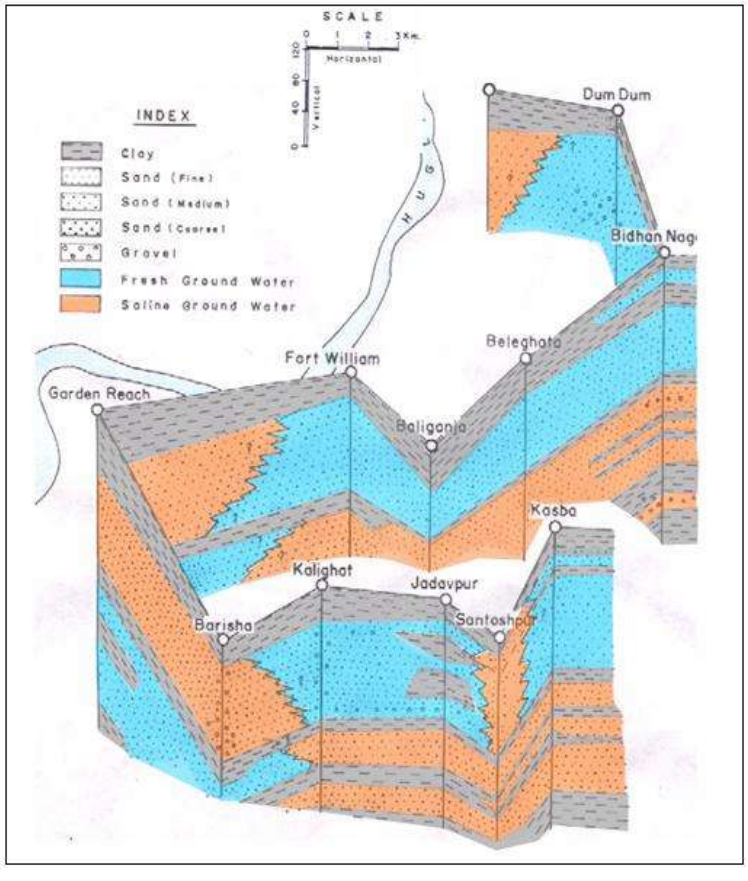
3.5. GROUNDWATER FLOW

3.5A. Occurrence of Ground Water: In general ground water in KMC area occurs under confined to semi confined condition. A typical hydro-chemical situation exists in KMC area. In the major part of KMC area fresh ground water overlies the brackish ground water except in the western part starting from Fort William in the central part on the bank of river Hugli and Kalighat in the south and in a localized body around Kashipur, west of Dumdum in the north, where brackish ground water overlies the fresh ground water. In the levee deposit on the bank of Hugli river thin lens of shallow aquifer occur within 12m bgl, where ground water occurs under water table condition. Ground water also occurs under unconfined condition within 17m below ground level in the marshy/swampy lands around *Ballygunge, Tollygunge, Tiljala, Dhakuria, Kasba, Santoshpur, Garia, Behala, Barisha* and *Thakurpukur.*

3.5B. Nature and depth of aquifer system:

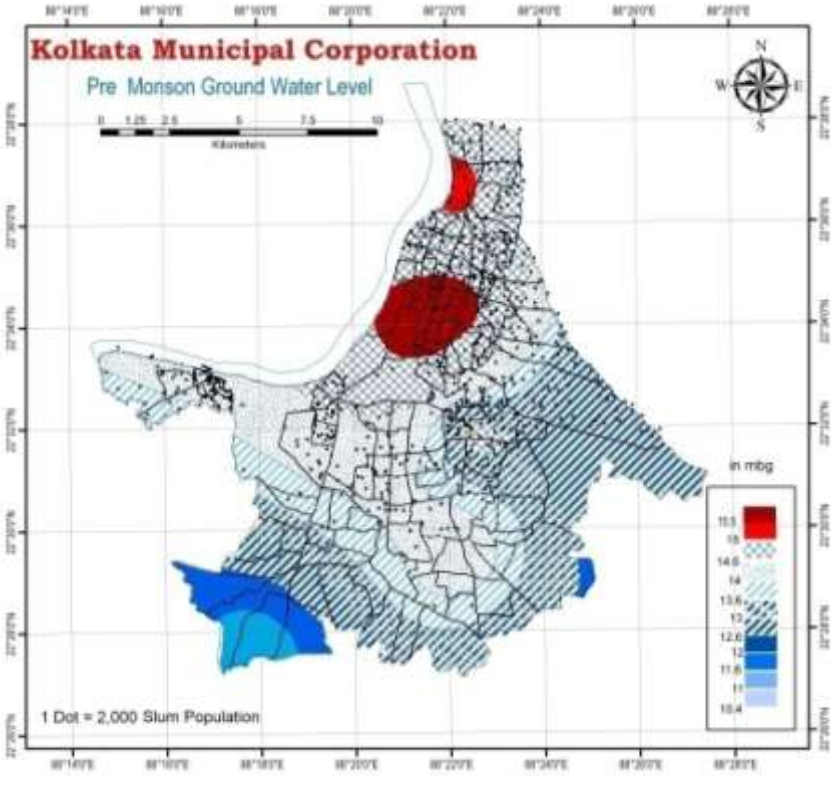
The sub-surface disposition of the aquifers indicates that the blanket of clay (10 to 60m thick) at the top of the sedimentary sequence imparts confined to semi confined nature to the groundwater occurring in the aquifers below this clay blanket. The aquifers below this clay bed consist of fine to coarse sand, which are occasionally mixed with gravel. The sediments show facies variation at a few places, which is characteristic of typical deltaic deposition and the top clay-bed shows a transition from aquiclude to aquitard. The thickness of the individual aquifer varies from place to place with the frequent occurrence of clay lens within them. The principal productive fresh water aquifer occurs within the depth span of 60-180m below ground level in the major part of the area except in the western part as discussed above. In the western part in Garden Reach-Barisha Sector and around Kashipur, west of Dumdum brackish water aquifers occur down to depth of 160m bgl and 200 m bgl respectively from the surface. These brackish water aquifers are underlain by fresh water aquifers. In Santoshpur area in the extreme south all the aquifers within 300 m bgl. are brackish.

SUB-SURFACE DISPOSITION OF AQUIFERS IN KOLKATA MUNICIPAL CORPORATION AREA

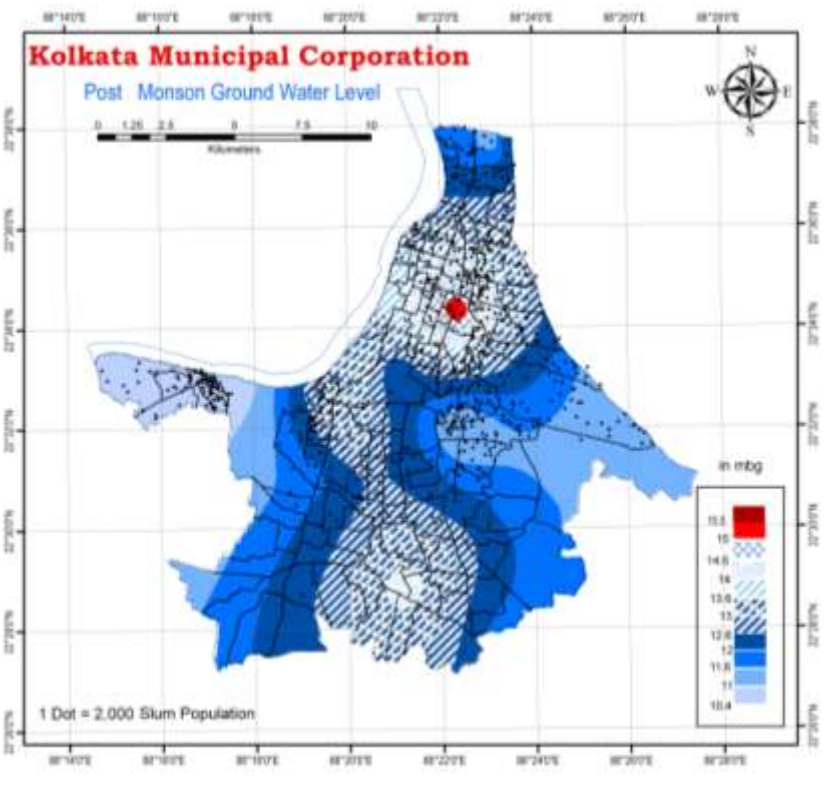


3.5.3. Depth to Ground water level:

Pre-monsoon 2018: Depth to ground water level in confined aquifer in use varies from 12.09 to 19.59 mbgl (Map-20). ***Post-monsoon 2018:*** Depth to ground water level in confined aquifer in use varies from 10.72 to 15.42 mbgl (Map - 21).



Map 20 – Pre Monsoon Ground water Level



Map 21 – Post Monsoon Ground Water Level

Table 3. Ground Water Potential, Borough Wise Report (Source – KMC)

Borough No	Depth of fresh ground water aquifer	Ground Water quality.	Depth to ground water level.		Trend of ground water level.	Scope for ground water development.
			Pre-monsoon 2016	Post monsoon 2016		
I	Within 170 mbgl except at Kasipur where ground water within 200mbgl is brackish	Ca-Mg-Chloride type	15 to 17 mbgl		11 to13 mbgl	Declining trend @ 0.11m/yr.
II	Within 160 mbgl	Ca-Mg-Chloride type	16 to 16.5m bgl		13 to 13.5 mbgl.	Declining trend @ 0.11 to 0.12 m/yr.
III	Within 160 mbgl	Ca-Mg-Chloride type	14-16.5 mbgl		12-14.5mbgl	Declining trend @ 0.11 to 0.15 m/yr.
IV	Within 160 mbgl	Ca-Mg-Chloride type	16.5 to >17mbgl.		13.5- >15 mbgl	Declining trend @ 0.11 to 0.15 m/yr.
V	Within 160 mbgl	Ca-Mg-Chloride type	16.5 to >17mbgl.		14->15 mbgl	Declining trend @ 0.11 to 0.15 m/yr.
VI	Within 160 mbgl	Ca-Mg-Chloride type	16 to >17mbgl.		12-13.75 mbgl	Declining trend @ 0.13 to 0.18 m/yr.
VII	Within 160 mbgl	Ca-Mg-Chloride type	13-16.8 mbgl		11-13.5 mbgl	Declining trend @ >0.30 m/yr.
VIII	Within 160 mbgl	Ca-Mg-Chloride type	14.5-15mbgl		12-13mbgl	Declining trend @ 0.20 m/yr.
IX	Below 160mbgl and within 160mbgl in the eastern part near Fort William.	Ca-Mg-HCO_3 type	14-15.5mbgl		11-12.5mbgl	Declining trend @ 0.13-0.16 m/yr.
X	Within 160 mbgl	Na-HCO_3 type	14.5-15mbgl		12.5-14mbgl	Declining trend @ 0.13-0.16 m/yr.
XI	Within 150 mbgl	Ca-Mg-HCO_3 type	13.5-14.5mbgl		12.5-14 mbgl	Declining trend @ 0.11-0.13 m/yr.
XII	Within 150 mbgl	in the east, Ca-Mg-HCO_3 type in the west and Na-HCO_3 type in the south with patches of Na-Cl type in the south-east except in Santoshpur area where all the aquifers within 300mbgl	13-14 m bgl		11-12mbgl	Declining trend @ 0.11-0.13
XIII	Below 160mbgl	Ca-Mg-HCO_3 type	13.5-14.5 mbgl		12-13mbgl	Declining trend @ 0.11-0.13 m/yr.
XIV	Below 160mbgl	Ca-Mg-HCO_3 type	12.5-13.5mbgl		11.5-12mbgl	Declining trend @ 0.11 m/yr.
XV	Below 150mbgl	Ca-Mg-HCO_3 type	14.5-15mbgl		10.5-11mbgl	Declining trend @ 0.11 m/yr.

3.5D. Ground Water Quality:

A typical hydro-chemical situation exists in KMC area. Ground water in KMC area may be classified under two principal types viz. **a)** Bicarbonate type and **b)** Chloride type. The anionic types may further be subdivided into two types on the basis of predominance of cation concentration. These are **i)** Calcium- Magnesium bicarbonate, **ii)** Sodium bicarbonate and **iii)** Calcium- Magnesium chloride and **iv)** Sodium chloride. Ground water in the area west of a line connecting BBD Bag, Park Street and Jadavpur is of Bicarbonate type whereas in the area east of this line ground water is of Chloride type .

Arsenic Contamination in Ground Water in Kolkata

Kolkata is one of the most populated metropolitan cities of India. For the last 300 years this city has experienced a huge population growth. Due to huge development and increase in population demand of water for domestic purpose mainly has increased by many folds. Domestic water supply is done mainly from the Hugli River through the *Tala* pumping stations and the Garden Reach pumping stations. In spite of this surface water sources a huge amount of water is drawn from the groundwater aquifers below Kolkata. This exploitation is so huge that permanent depletion of water level has occurred in the groundwater of Kolkata. The state government and the Central Groundwater board conduct regular monitoring of water level and water quality of Kolkata. The studies have revealed that water quality in Kolkata has deteriorated and arsenic contamination in ground water has been observed in some parts of Kolkata.

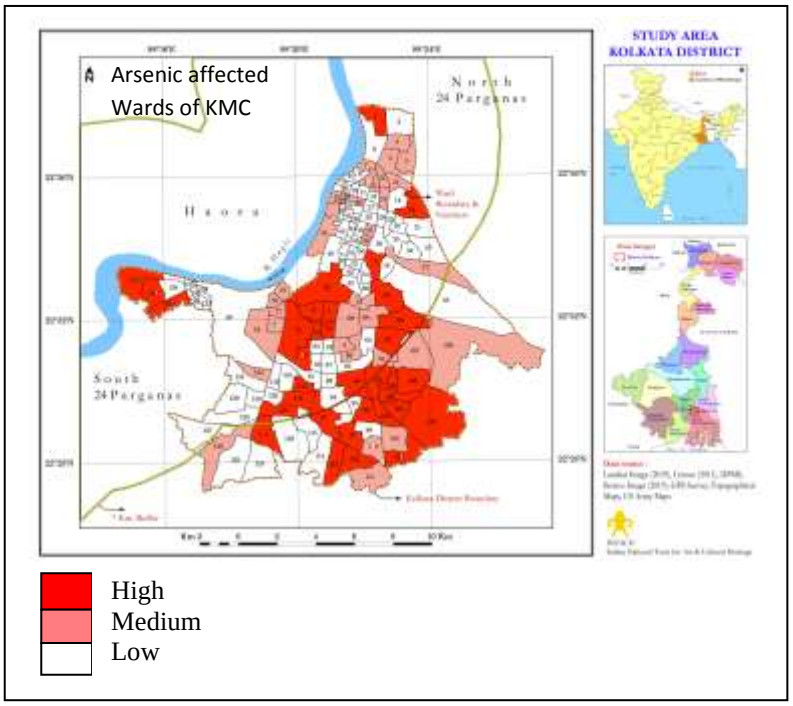
<table>
<tr><th>No of Wards surveyed</th><th colspan="2">No of Sample analysed</th><th colspan="5">No of Wards where some tub wells showed as >10µg/lit</th><th>No of Wards where some tube wells showed as >50µg/lit</th></tr>
<tr><td>100</td><td colspan="2">3626</td><td colspan="5">65</td><td>30</td></tr>
<tr><td colspan="7">Distribution of total samples in different Arsenic concentration (µg/lit) ranges</td><td rowspan="2">Maximum Arsenic concentration (µg/lit)</td></tr>
<tr><td>≤3</td><td>4 – 10</td><td>11 – 50</td><td>51 – 100</td><td>101 – 200</td><td>201 – 300</td><td>301-500</td><td>501-1000</td></tr>
<tr><td>2224</td><td>855</td><td>343</td><td>85</td><td>75</td><td>27</td><td>10</td><td>5</td><td rowspan="2">800</td></tr>
<tr><td>61%</td><td>23.5%</td><td>9.5%</td><td>2.3%</td><td>2.1%</td><td>0.8%</td><td>0.3%</td><td>0.1%</td></tr>
</table>

Table 4: Arsenic Contaminated Wards

There are reports to occurrence of Arsenic in tube well water of Kolkata Municipal Corporation area. Sengupta (2009) produced a map of Kolkata where isolated patches with elevated levels of Arsenic in ground water were depicted. A somewhat detailed account was provided by Chakraborty et al (2009) from their analysis of water from 3626 tube wells located in 100 wards of KMC. The analytical data was summarised as follows (Table 4):

About 84.5% of the sample showed Arsenic contamination from =3 to 10µg/lit out of which about 61% of the samples analysed Arsenic contamination below =3µg/lit. only about 15% of the samples analysed Arsenic contamination above 10µg/lit. the distribution pattern of Arsenic affected wells shows that southern part of Kolkata is more contaminated than the northern and central part. Only 20.8% of the water samples from tube wells deeper than 100mt showed Arsenic concentration above 10 µg/lit.

Arsenic in ground water was found beyond permissible limit (0.01mg/l) is one water sample in Ward number 93 (Borough X0 and five samples in Ward number 94 (Borough X) in south central Kolkata Municipal Corporation area. (Prince Anwar Shah Road and Prince GM Shah Road) and also in one sample in Ward number 108 (Borough XII) in south eastern KMC area (Chowbaga). Chloride concentration in groundwater in all KMC area, except in Boroughs VIII, X, XIII and XIV is higher than the desirable limit (250mg/l).



Map 22 – Arsenic Concentration in different wards of KMC

Iron concentration in groundwater under Boroughs XII, IX, X, XII, XIII and XIV is within the permissible limit. But groundwater under Boroughs I, II, III, IV, V, VI, VII and XI has iron concentration above permissible limit (1mg/l). Groundwater in Borough III (Beliaghata and EM Bypass) has abnormally high concentration (Rajib Chatterjee, 2011).

3.6. SOIL

The Kolkata Municipal Corporation (KMC) area is characterised by the presence of two distinct of soil: Entisols and Alfisols. The Entisols are present at the western part of the area and the rest represented by Alfisols. These soils are typically deltaic alluvial soils. The agro-climatic zone characterization of the area is Gangetic alluvium group of soils rich in calcium. Free calcium carbonate occurs in surface soils and the soil profile shows low to medium levels of organic matter and medium levels of a available phosphate and potash. Kolkata and the neighbouring areas are represented predominantly by clayey soils. Under KEIP II DPR preparation, physical and chemical characterization of soil from five boroughs (XI, XII, XIII, XIV AND XV) of KMC in the southern part of the city revealed that the soil contains detectable amount of pb, Ni, Cr^{3+}, Cu and Zn although the concentrations are well below the tolerance limits of hazardous wastes. Iron per cent in the soil was however on the high side.

3.7. CLIMATE

Climatologically Kolkata has four distinct seasons which are summer, monsoon, post monsoon and winter. The main seasonal influence upon the climate is the rain brought in by the Bay of Bengal branch of south-west monsoon which arrives in the first week of June. September to November is the transition period between monsoon and winter and is considered as post monsoon season during which time days are mostly clear and nights are comfortable. However, post monsoon season also experience severe cyclonic storm over Bay of Bengal that gives heavy rainfall in Kolkata up to October. In the present study, March-May was considered as summer, June-August as monsoon, September-November as post-monsoon and December-February as winter.

Several climatological features recorded during a four year period from January, 2018 to December, 2019 are summarized below.

Table 5 – Average Temperature / Rainfall of Kolkata (Source – Alipur Met Dept)

Input	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Avg. Temperature (°C)	19.5	22	27	29.9	30.4	29.7	28.7	28.6	28.9	27.4	23.3	19.5
Min. Temperature (°C)	12.6	15.1	20.4	24	25.4	26.1	25.9	25.6	25.7	23.4	17.7	12.9
Max. Temperature (°C)	26.5	28.9	33.7	35.9	35.4	33.4	31.6	31.7	32.1	31.5	28.9	26.2
Precipitation / Rainfall (mm)	14	22	28	51	126	301	375	339	305	141	26	7

3.8. AGRO-CLIMATIC ZONES

West Bengal is broadly divided into six Agro-climatic Zones, which fall within three Agro-climatic Regions (Eastern Himalayan Region, Lower Gangetic Plain Region, Eastern Plateau & Hill Region) out of total 15 regions in India, as classified by the planning commission, Govt. of India.

Table 6 – Agro climatic Zones of West Bengal

Sl no.	Zone Class	Districts	Soil type	Rainfall (mm)		Temperature ^{0}C	
				Max	Min	Max	Min
1	**Costal Saline Zone**	South Parganas	Coastal Saline	1600	1800	34	16
2	**Gangetic Alluvial Zone**	Barddhaman Hugli Howrah Murshidabad Nadia North Parganas **Kolkata**	Ganga Alluvial	1350	1650	35	15.6
3	**Northern Hill Zone**	Darjeeling	Brown Forest & Tarai	2500	3500	19.5	4.8
4	**Terai-Teesta Alluvial Zone**	Coochbehar Jalpaiguri Uttar Dinajpur	Tarai Soil	2000	3000	32.3	12.8
5	**Undulating Red and Laterite Zone**	Bankura Birbhum Purulia West Medinipur	Red Soil	1100	1400	37	14.8
6	**Vindhyan Alluvial Zone**	Dakshin Dinajpur Malda	Vindhyan Alluvial	1500	2000	35.5	15.1

3.9. NATURAL VEGETATION

The species of trees and shrubs seen in Kolkata today have come through a succession of elimination and addition. Earlier reports indicate that Kolkata along with other contiguous marshy areas sheltered a host of mangrove species along with some estuarine sedges and grasses. Benthall (1946) in his "Trees of Calcutta and its neighbourhood" provided an excellent account of as many as 276 species of flowering trees that were found till 1944.However , at present only 5% of Kolkata's LULC is dedicated to Urban Greenary. Because of huge land pressure and pollution there is a constant threat on the flora and fauna of the city.

3.9A: Common Trees planted along the roads, avenues, parks and gardens of Kolkata (Table 7: Source – Ground Survey):

Sl No	Name of the Trees	
	Common	**Scientific**
1	Babla	*Acacia nilotica*
2	Scholar tree – chhatim	*Alstonia scholaris*
3	Margosa tree – neem	*Azadirachta indica*
4	Palmyra palm – taal	*Borassus flabellife*
5	Flame of the forest – palas	*Butea monosperma*
6	Indian laburnum – amaltas	*Cassia fistula*
7	White silk cotton tree – schwetsimul),	*Ceiba pentandra*
8	Red silk cotton tree – simul	*Bombyx ceiba*
9	Casuarina – bilati jhau	*Casuarina equisetifolia*
10	Coconut palm – narikel	*Cocos nucifera*
11	Eucalyptus	*Eucalyptus citriodora*
12	Banyan tree – bot	*Ficus benghalensis*
13	Cluster fig – jagya dumur	*Ficus racemosa*
14	Peepal tree – aswatha	*Ficus religiosa*
15	Bola	*Kleinhovia hospita*
16	Mahwa tree – mohua	*Madhuca indica*
17	Mango tree – aam	*Mangifera indica*
18	Jasmine – akasnim	*Millingtonia hortensis*
19	Indian medlar tree – bakul	*Mimusops elengi*
20	Wild date palm – khejur	*Phoenix sylvestris*
21	Mast tree – debdaru	*Polyalthia longifolia*
22	Maple twist tree – kanakchampa	*Pterospermum acerifolium*
23	Jiaputa	*Drypetes roxburghii*
24	Brazilian mahogany tree – baropatar mahogani	*Swietenia macrophylla*
25	Mahogany tree – mahogani	*Swietenia mahagoni*
26	Indian blackberry tree – jam	*Syzygium cumini*
27	Tamarind tree – tetul	*Tamarindus indica*
28	Teak tree – segun	*Tectona grandis*
29	Arjun	*Terminalia arjuna*
30	Bahera	*Terminalia bellirica*
31	Indian almond tree – Budam	*Terminalia catappa*
32	Siris	*Albizia lebbek*
33	kadamda tree – kadam	*Anthocephalus chinensis*
34	Flame tree – gulmohor	*Delonix regia*
35	Indian coral tree – palitemandar	*Erythrina variegate*
36	Madre tree – bilati siris	*Gliricidia sepium*
37	Ivory tree – kurchi	*Holarrhena pubescens*
38	Green ebony tree – Neel gulmohor	*Jacaranda mimosifolia*
39	Queen of flowers – jarul	*Lagerstroemia speciosa*
40	Moulmein rosewood – tuma	*Millettia peguensis*
41	Copperpod tree – arunjyoti	*Peltophorum pterocarpum*
42	Rain tree – biliti Siris	*Samanea saman*
43	African tulip tree – tulip	*Spathodea campanulata*
44	Tulip tree – palas pipul	*Thespesia populnea*

Sl No	Name of the Trees	
	Common	**Scientific**
45	Silver oak tree – rupasi	*Grevillea robusta*
46	Yellow champa tree – champa	*Michelia champaca*
47	White champa tree – gulancha	*Plumeria alba*
48	Crimson temple tree – lal gulancha	*Plumeria rubra*
49	Asoka tree – asoke	*Saraca asoca*
50	Variegated bauhinia tree – raktakanchan	*Bauhinia variegata*
51	Peacock flower tree – krishnachura	*Caesalpinia pulcherrima*

Beside these common trees, according to Chakraverty and Jain's survey under KMC (2014) there are also some 667 different species of plants in Kolkata including,

- 96 medicinal plants
- 161 species of herbs
- 205 species of shrubs
- 229 flowering species
- 68 climbers

Plate 14: Trees along the banks of River Hugli , Kashipur , North of Kolkata
22°36'50.75"N 88°22'7.63"E

Plate 15 & 16 – Trees in Maidan,

Plate 17 – Trees along Hugli River, Prinsep Ghat

Plate 18 – Trees in St. John's Church, Dalhousie

3.9B: Flowering Plants recorded in different sites of Kolkata (Table 7: based on Ground Survey)

Site		No. of species recorded	Common flowering plant species recorded in different sites of Kolkata
1	Subhas Sarobar	208	Siris(*Albizia lebbeck*) , Kadam (*Neolamarckia cadamba*), Jarul (*Lagerstroemia speciosa*), Mahogany(*Swietenia),* Arjun(*Terminalia arjuna*), Rudrapalash(*Spathodea campanulata)* etc.
2	Tala Park	102	Chatim(*Alstonia scholaris),* Simul (*Bombax),* Krishnachura (*Delonix regia*), Radhachura(*Caesalpinia pulcherrima),* Hibiscus (*Hibiscus rosa-sinensis),* Jarul (*Lagerstroemia speciosa)*etc.
3	Maidan	132	Chatim (*Alstonia scholaris),*, Kadam (*Neolamarckia cadamba*), Kanak Champa (*Pterospermum acerifolium),* Sondal (*Santalum album),* Swarna Champa (*Magnolia champaca)* etc.
4	Eden Gardens	87	Chatim, Kadam, Sondal/sonali, Bakul(*Mimusops elengi),* Radhachura, Banyan (*Ficus benghalensis*) etc.
5	Brace bridge Wetlands	54	Radhachura,Krishnachura,Gamar(*Gmelina arborea),*Banyan,Subabul etc.
6	Tollygunge Club	62	Radhachura,Kurchi(*Holarrhena pubescens*),Kool,Rasna (*Pluchea lanceolata),*Subabul etc.
7	Agri-horticultural Society	210	Mango,Tree(*Mangifera indica),* Bread fruit tree*(Artocarpus altilis),* Chalta (*Dillenia indica)*etc.
8	Zoological Garden	105	Kunch Siris (*Albizia lebbeck*), Chatim, Jackfruit (*Artocarpus heterophyllus),* Dephal(*Artocarpus lakoocha Roxb),* Margosa(*Azadirachta indica)* etc.
9	Esplanade	118	Akashmoni (*Acacia auriculiformis),* Acalypha, Kunch Siris, Bel, Siris etc.
10	Raj Bhavan	284	Akasmoni, Kunch Siris, Bel, Chatim, Kadam etc.
11	Rabindra Sarobar	142	Akasmoni, Pakur(*Ficus infectoria*), Saranga, Jarul, Subabul etc.

Plate – A typical spring bloom at Kashipur Ghat adjacent to Hugli River. *Delonix regia*

3.9C. Avenue trees along stretches of Kolkata roads (Table 8: Based on Ground Survey)

James Long Sarani		**Diamond Harbour Road**		**Taratala More to Santoshpur Road Crossing**		**Behala to Begore Khal**	
Name of plant	**Percent (%)**	**Name of plant**	**Percent (%)**	**Name of plant**	**Percent (%)**	**Name of plant**	**Percent (%)**
Krishnachura	17.34	Krishnachura	14.60	Krishnachura	22.60	Krishnachura	16.08
Kadam	15.15	Bot	14.60	Debdaru	11.78	Kadam	10.49
Chatim	10.91	Kadam	11.45	Kadam	10.82	Bilati Babul	9.79
Debdaru	8.27	Chatim	8.68	Radhachura	10.34	Radhachura	9.09
Bot	6.77	Aswatha	8.49	Bot	9.62	Kath badam	4.20
Radhachura	5.51	Sirish	5.53	Bilaiti Babul	6.01	Guava	3.50
Aswatha	5.40	Bokul	5.34	Arjun	4.81	Arjun	2.80
Bokul	4.36	Radhachura	5.25	Ashwatha	4.33	Bot	2.80
Sirish	3.67	Mahogani	4.19	Sirish	3.37	Chatim	2.80
Neem	2.76	Kathbadam	4.10	Akashmani	2.88	Mayna	2.80
Kathbadam	2.07	Debdaru	3.91	Chatim	1.92	Sirish	2.80
Mango	1.72	Neem	3.15	Coconut	1.92	Debdaru	2.38
Mahogani	1.61	Subabul	1.53	Eucalyptus	1.68	Mango	2.10
Sajne	1.61	Mayna	1.05	Bottle Palm	1.44	Jum	2.10
Jum	1.49	Arjuna	1.05	Mahogany	1.44	Date	1.40
				Jarul	1.44		
				Dumur	1.20		

3.9.2. Trees found along various Drainage canals of Kolkata Municipal Corporation area (Table 9)

I. Kestopur Canal

Sl.	Plant Name	Percentage(%)	Sl.	Plant Name	Percentage(%)
1	Kadam	20.20	14	Kathabadam	10.53
2	Sirish	13.13	15	Pithhecolobium	10.53
3	Devdaru	8.08	16	Mayna	10.53
4	Mayna	7.07	17	Nim	8.77
5	Bakul	4.04	18	Aam	5.26
6	Kathabadam	4.04	19	Chatim	3.51
7	Krishnachura	4.04	20	Tal	3.51
8	Mahogany	4.04	21	Arjun	2.63
9	Pithecolobium	4.04	22	Mahogany	2.63
10	Kolkey Phul	3.03	23	Tantul	2.63
11	Chatim	2.02	14	Devdaru	1.75
12	Sirish	23.68			
13	Kadam	10.53			

II. Beliaghata Branch Canal

Plant Name	Percentage	Plant Name	Percentage
Sirish	21.53	Tal	3.12
Neem	10.76	Bakul	2.83
Mayna	10.76	Mahogany	2.83
Pithecolobium	9.63	Jarul	2.55
Kadam	7.65	Kathbadam	2.55
Devdaru	7.65	Tantul	2.27

III. Bagjola Canal

Plant Name	Percentage	Plant Name	Percentage
Sirish	18.29	Kadam	2.44
Arjun	15.85	Karanj	2.44
Debdaru	13.41	Neem	2.44
Mayna	10.98	Bel	1.22
Jarul	7.32	Chatim	1.22
Pithecolobium	6.1	Mahogany	1.22
Kathbadam	4.88	Sisoo	1.22
Mango	3.66	Sabeda	1.22
Jiyol	3.66	Tentul	1.22
Tal	1.22		

IV. Tollygunge-Panchannagram (TP) Main Canal

Plant Name	Percentage	Plant Name	Percentage
Neem	20.75	Arjun	3.77
Sirish	20.75	Tentul	1.89
Kathbadam	13.21	Kanthal	1.89
Mango	11.32	Kamranga	1.89
Mayna	7.55	Sagun	1.89
Kadam	7.55	Pithecolobium	1.89
Mahoganny	5.66		

V. Tollygunge-Panchannagram (TP) Branch Canal

Plant Name	Percentage	Plant Name	Percentage
Debdaru	15.63	Pithecolobium	3.13
Mango	12.5	Kanthal	3.13
Kadam	12.5	Sagun	3.13
Neem	9.38	Gamari	3.13
Arjun	6.25	Kathchapa	3.13
Chatim	6.25	Saswara	3.13
Sirish	6.25	Simul	3.13
Karanj	3.13	Cassia Javanica	3.13
Mahogany	3.13		

VI. A0-A1 Canal

Plant Name	Percentage	Plant Name	Percentage
Sirish	32.08	Kathbadam	2.83
Pithecolobium	24.53	Bel	2.83
Coconut	10.38	Tentul	1.89
Mango	4.72	Neem	1.89
Kanthal	3.77	Chatim	1.89
Mayna	2.83	Ashfall	1.89
Kadam	2.83		

VII. GTP Main Canal

Plant Name	Percentage	Plant Name	Percentage
Kadam	22.36	Mango	3.25
Sirish	13.82	Chatim	3.25
Pithecolobium	12.60	Debdaru	3.25
Mayna	10.16	Arjun	2.85
Kathbadam	4.07	Java Cassia	2.44
Neem	4.07	Tentul	1.63
Kanthal	3.06		

3.10. WILDLIFE:

When Kolkata as a city was born, more than three hundred years ago, the entire area was dominated by the type of ecosystem that still persists in the mangrove forests of Sundarbans. In course of time with human settlements man introduced flora within human settlements and has completely replaced indigenous mangrove forests. Yet it is amazing to find how a variety of wildlife , although in limited number has worked out their own niche and has survived in parks , orchards , wide expanse of Maidan , Tollys Club , Rajbhawan ,Rabindra Sarovar,parts of East Kolkata Wetlands falling within KMC. Today the mangrove forests have reduced far away. Natural trees and forests have been completely replaced by man-made orchards, and even these are being swallowed up by the concrete jungle. Yet with amazing resilience, a verity of wildlife still survives in the tiny patches of 'wildernesses looked within the sprawling urban agglomeration.

3.1A. Habitats – Wildlife Habitats in and around the city are of 3 broad types:

I. The Wetlands: Though our study area does not include the East Kolkata Wetlands in ward 57, 58 and 108 but it supports the largest bio diversity of the city. Rabindra Samovar, Subhas Sarobar and the lake of Alipur Zoo are the major wetlands along with some other smaller and larger waterbodies with adjoining areas, the bank and shallow areas along Hugli River and major drainage canals with their wooded banks. The most important wetland mammals are carnivores .Of special significance is the *marsh mongoose*. Obviously, they survive in very small numbers if at all. The fishing cat has been pushed to the brink of extinction. The jackal has fared better, being adaptable and partly commensal with man. Otters, surprisingly, survive in isolated patches despite being ruthlessly haunted for their skin.

The wetlands still harbour common resident species of birds, including the *little cormorant*, *little grave*, *waterhen*, *moorhen*, *bronze winged jacana*, *red wetted lapwing*, various *ducks*, *herons*, and *great cormorants*, *brahmini kites* etc. More localized residents include the *purple heron*, *night heron*, *purple moorhen*, *whiskered tern*, and *weaver bird*. But these can be spectacularly outnumbered in winter by flocks of migratory birds including Lesser Whistling Teal, Comb Duck, Cotton Geese, Teal etc. The best known haunt of these waterfowl, the large lake inside the Alipur Zoo, attracts alarmingly few migrants today.

II. Small orchards and rapidly shrinking crop land: Kolkata city is hardly a habitat for **wild mammals**, except for small rodents like, the Indian mole rat or and insectivore like the house shrew. But the adaptable jackal still survives in the bigger tracks of greenery like the Maidan, Rabindra Sarobar or Tollygunge Golf links, resting by day and emerging at night to feed on the refuse dumps. Two species of mongoose are also common in some localities, and the common palm civet or toddy cat survives here and there among old houses and ancient trees.

III. Built-up area The city proper shelters Pariah Kite, Blue Rock Pigeon, Spotted dove, House Swift, Mynah, Bulbul, Sunbirds, Tailorbirds and Magpie Robin. House crow and House sparrow are ubiquitous. Other common species are little Cormorants, Kingfishers and Crested Serpent Eagle, Black Kite, Shikra.

The drastic change of habitat from wetland to concrete jungle should have banished all wildlife from Kolkata. Yet miraculously, the wild animals have not disappeared entirely, and the bird life is in particular is still worthy to note.

In 2012, the first official study on Kolkata's biodiversity was conducted by a city based NGO, Society for Environment and Development on behalf of the West Bengal Biodiversity Board (WBBB). The study lasted for a year and took the help of students from colleges and university.

The result of the study is an exhaustive list of flora and fauna that continue to call Kolkata home, in spite of all the pressures of the urban world. This includes:

- 20 species of mammals
- 107 kinds of birds
- 1 amphibian species
- 8 local varieties of fish
- 64 butterfly species
- 35 species of flies
- 10 species of ants
- 13 species of insects
- 2 species of snails
- 35 spider species

The research team found that Kolkata is also home to three of India's Endangered species, namely the **Indian Mongoose**, **Jackal** and **Gangetic Dolphin**. The Small Indian Mongoose and the Gangetic dolphin, both Schedule I animals, still existed in Kolkata but were not widely observed. Jackal, a schedule II species, was left in a few pockets of north and east Kolkata, the study says.

On 25th April, 2020, the critically endangered **Gangetic Dolphin / South Asian Dolphin was sighted in the Kolkata Stretch of Hugli river after a gap of 30 years. A couple of Dolphins were sighted near Babughat amidst lockdown. Environmentalists are predicting that due to temporary shutting of Ferry Services in Hugli River and because of less pollution, South Asian Dolphins or Susuk which are very rare can be traced in the river again. – Times of India , 26th April,2020.*

3.1B. AVIFAUNA - This city is also quite rich in avian diversity consisting of more than 360 species including 28 species of diurnal birds of prey. Three species of kites viz. black-shouldered kite Elanus caeruleus, brahminy kite Haliastur indus and black kite Milvus migrans govinda are reported from Kolkata (Sen 2013).

3.10B. Birds commonly found in the waterbodies and green patches –Based on survey (Table 10)**:**

Sl.	Species Name (common)	Habitat Location	Present Status and cause	Best place for sighting
1	Lesser Whistling Teal	Seen mainly in the waterbody covered with vegetation.	Depleting waterbody	East Kolkata Wetlands
2.	White Breasted Kingfisher	Overhead wires, trees branches near water bodies	Depleting waterbody	All Wetlands
3.	Common Kingfisher	trees branches near water bodies	Depleting waterbody	All Wetlands
4.	Little Cormorants	In water bodies	Depleting waterbody	Alipur ZooWetland/East Kolkata Wetlands/Brace Bridge/Rabindra Sarovar/Subhas Sarovar
5.	Pond Heron	In water bodies	Depleting waterbody	DO
6	Purple Heron	In water bodies	Depleting waterbody	DO
7	Night Heron	In water bodies	Depleting waterbody	All Wetlands
8	White breasted Waterhen/Moorhen	In water bodies	Depleting waterbody	All Wetlands

Sl.	Species Name	Habitat Location	Present	Best place for
9.	Swallow	Near waterbodies/cultivated fields	Depleting waterbody	East Kolkata Wetland
10	Lesser Golden Back Woodpecker	Trunks of trees	Depleting trees	Common in all areas
11	Coppersmith Barbet	Trunk of trees	Depleting trees	Common in all areas
12	Rose Ringed Parakeet	Fruit trees	Depleting trees	Common in all areas
13	Sparrow (house)	Old houses		Reducing in numbers

Plate 21: State Bird of Kolkata, White Breasted Kingfisher

Plate 22: Squirrel, Victoria Memorial

Plate 20: Local Avifauna of the city – a. Flycatcher; b. Coppersmith Barbet; c. Long Tail Shrike; d. Sterling

Plate 23 : Mongoose , found surrounding Wetlands

Plate 24 : Egret , Subhas Sarovar - Commonly sighted in the Wetlands

Plate 25 : Flame Back Woodpeckar , sighted in Victoria Memorial

Plate 26: Flocks of Rock Pigeon, commonly sighted in the city

Plate 26a – Critically endangered South Asian Dolphin was sighted in Kolkata after 30 years . Source – Times News

Plate 26b: Critically endangered Fishing Cat , Alipur Zoo.

Plate 27 : Fruit Bat , Rabindra Sarovar

Plate 28 : Tiger Butterfly, Subhas Sarovar

Chapter 4: Documenting Nature & Properties of Natural Heritage

4.1. The Canal system associated with the drainage conditions of the City

Due to Kolkata's proximity to the sea and location on the east bank of the RiverHugliin India, it used to experience tidal influence through its canals. This prompted commerce and trading, and Kolkata became an important trading port. The city was also influenced by the river Bidyadhari, which runs parallel to Hugli. These two rivers and their tributaries and distributaries provided unique opportunities for commerce to British colonisers. *Tolly's Nullah* was excavated in 1778 to connect these two rivers. Interestingly, for even a decade after the introduction of the Eastern Bengal State Railway in the nineteenth century, water trafficking was the predominant mode of transport. The canal system also provided irrigation water during the tidal period by controlling lock gates at strategic locations. Drainage of Kolkata mostly gravitated eastwards to Kultigong of the Matla estuary system, which ultimately led to the River Bidyadhari. Since 1856, it had served as an outlet for the city drainage, which was supplemented by excavating new channels in 1928. This created a network of an organised 'canal system', which had sustained the city for centuries.

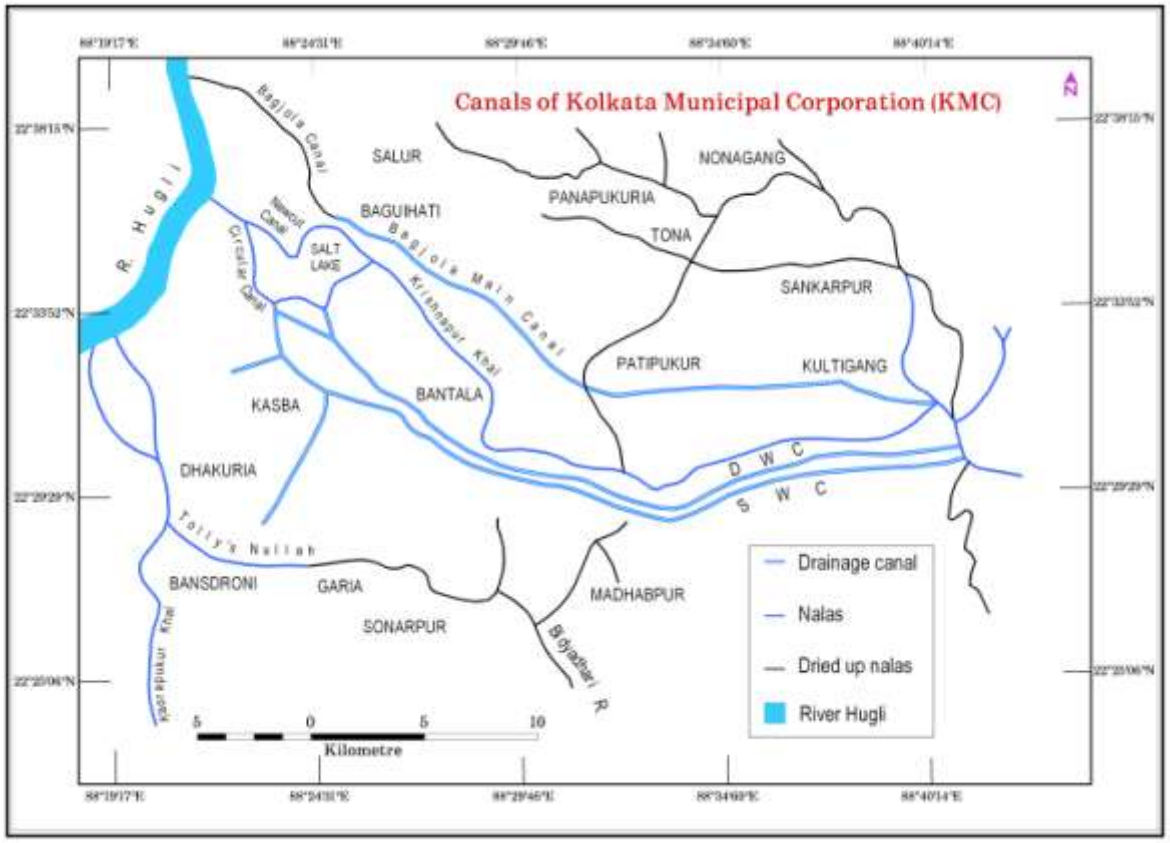
The city of Kolkata and its adjoining metropolitan areas are thus drained by a network of drainage channels excavated, handed over and maintained over years by the Irrigation & Waterways Department. Around 1970, a number of new channels were excavated in the areas adjoining the main city where people started to live after the partition of Bengal by the fund available from the Calcutta Metropolitan Development Authority (CMDA) the present Kolkata Metropolitan Development Authority.

Kolkata Municipal Area has 8 major Drainage Basins. They are – (Table: 11)

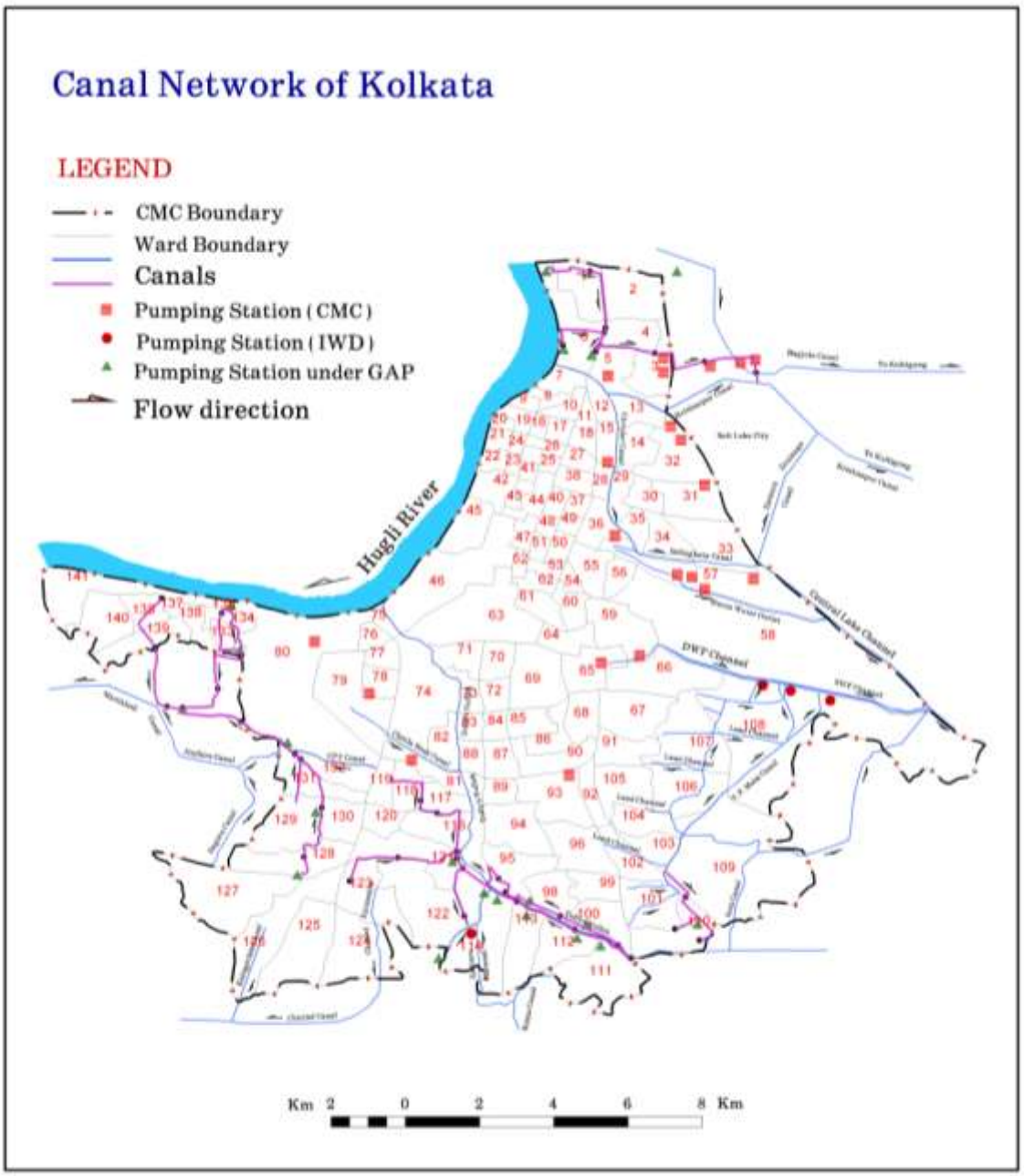
Major Drainage Basins	Canals and Tributaries	Borough Covered
Manicktala Basin	Circular Channel	III
	Beliaghata Channel	
	New cut Channel	
	Kestopur Canal	
	Eastern Drainage Channel	
Kolkata Basin	Dry Weather flow Channel	II,IV,V,VI,VII,VIII And XII (part)
	Storm Water Flow channel	
	Central Lake Channel	

Hugli Basin	-	1(part) and XV (part)
Tollyguange Panchannagram Basin	Tollyguange Panchannagram	XI (part) and XII (part)
	TP Main Canal	
	Intercepting Channel	
	Lead Channel	
	Guniagacchi Branch Channel	
	Suti Canal	
Tolly's Nullah Basin	Tolly's Nullah	IX(part),X,XI(part) and XIII(part)
	Boat canal	
	Keorapukur Canal	
	Western Channel	
	Rania Canal	
Manikhali Basin	Manikhali Canal	IX (part) XIV(part) and XV (part)
	Begore Canal	
	Parnasree Canal	
	CPT Canal	
	Santoshpur Canal	
	Jinjira Canal	
Churial Basin	Churial Canal	XIII (part) and XIV (part)
	Churial Canal extension	
	Kalagachia Canal	
	Suti Canal	

Source- KMC



Map 23 – Canal Network of Kolkata



Map 23 – Canal Network with KMC Boundary

Plate 29: Regular activity in Adi Ganga, Kalighat

4.1a. Manicktala Basin/Circular-Beliaghata-New cut-Kestopur Canal-Bhangar Canal

At one point of time, **Circular Canal** was the most important canal for navigation. It takes off from the Hugli River at Chitpur (22°36’29.32” N & 88°22’2.02” E) and then bifurcates near Gajnabi Bridge (near R.G. Kar Hospital). The eastern branch is known as **i. New Cut canal** which joins with **ii. Kestopur canal (** Map 26**)**. The Circular Canal then joins with **Beliaghata Canal** to join with Central Lake Channel.

Plate 30: Off Take Point, Circular Canal, 22°36'28.88"N, 88°22'2.96"E

I. Beliaghata Canal: Beliaghata canal is a natural water course. It was a distributary, came out of the river Bhagirathi in the ancient period on account of geological reasons. Since then it had been flowing eastward and met with the eastern lake channel near Dhapa and finally emerged with the river Bidyadhari.

In the early 18th century, British East India Company started to develop Calcutta as the capital of India. From that time, an immense development of Calcutta took place. During this period the company formed a "Lottery Committee" to design the Metropolitan of Calcutta. This committee planned to fill up the "Maharatta Ditch"(Present Circular Canal). The "Maharatta Ditch" was filled up from Chitpur to Beliaghata canal within 1800 A.D. While filling the Maharatta Ditch a portion of the Beliaghata Canal from Hastings Street to Entally was filled up due to construction of roads and buildings. This is how the Beliaghata Canal lost its connection from Bhagirathi. A road was constructed parallel to the former Maharatta Ditch encircling Calcutta and this road was known as the "Circular Road". In 1810, this canal was fully reformed for the navigation purpose. After that the transportation again started via the Bidhyadhari River and Beliaghata Canal. But at present it stretches from 22°34'9.21"N, 88°22'41.49"E , east of Sealdah Station till Chingrihata 22°33'30.40"N 88°24'38.60"E. It is heavily polluted because of encroached settlements.

Plate 31– Condition of Beliaghata Canal, 22°34'8.05"N 88°22'45.29"E

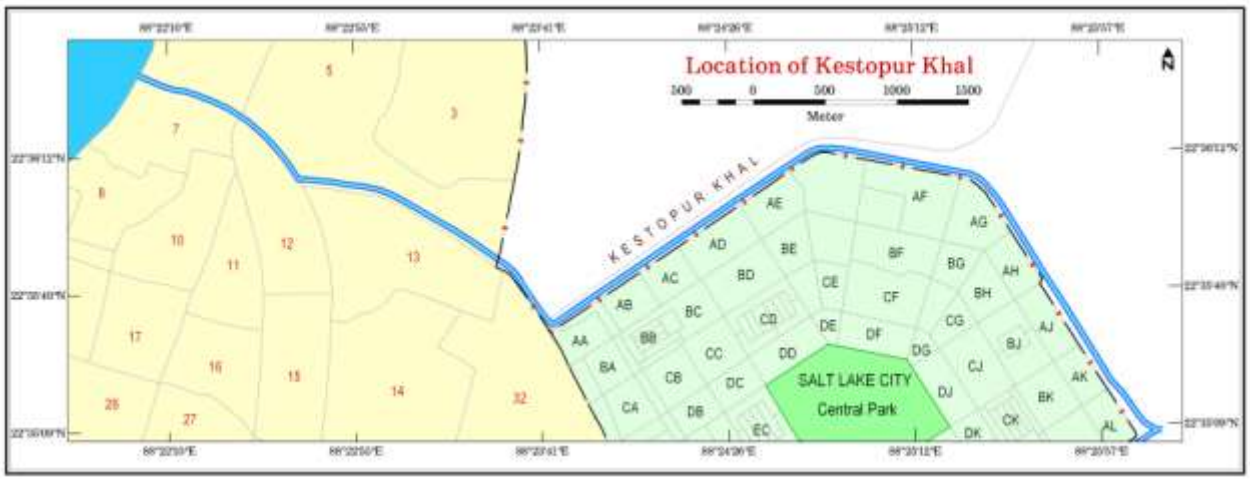
II. Circular Canal: Major William Tolly proposed the company to excavate and repair the canals for water transportation within Calcutta. According to his plan the Tolly Canal, **Chitpur Canal** and the **Beliaghata Canal** were renovated. In 1824, Tiretta and Major Shalch proposed to excavate a new canal parallel to the original route of Maharatta Ditch for the purpose of water navigation. This proposed canal started from Chitpur and ended in the Beliaghata Canal near Sealdah. This excavation started in 1829 and finished in 1833. Thereafter, the Circular canal and the Beliaghata Canal played a major role in inter-Bengal transportation. In 1836 the toll tax was first started over Circular and Beliaghata Canal. In 1858 another canal was excavated, which started at from Circular canal near Belgachia and ended in Beliaghata Canal near Dhapa. After formation of the Circular Canal the main stream of Beliaghata Canal, would flow through Circular Canal. This caused the deviation of the stream of the original Beliaghata Canal and thereby depth of the other branch of the Beliaghata canal was decreased near Entally. In 1861 the portion of Beliaghata canal from Entally road to Palmer Bridge pumping station was filled up due to construction of railway and underground drainage system. Finally the British government filled this canal up to Chunapatti for the construction of offices and buildings.

Plate 32 –Encroached Bank of Circular Canal , 22°34'57.27"N 88°23'18.55"E

III. Kestopur or Krishnapur Canal: Kestopur Canal forms the Northern boundary of Bidhannagar Municipal area. One end is directly connected to river Hugli in the West through **New-cut canal—Circular Canal** and the other end, passes down to the river Kultigung in the East through Kestopur- Bhangarkata khal. The Circular canal, has bifurcation near Gaznavi Bridge as two separate and distinct canals. One part flows down towards Beliaghata as Circular –Beliaghata canal and other part passes down through New Cut- Kestopur-Bhangarkata to meet at Kultigong. The Circular –Beliaghata canal is extended upto Chingrighata, E.M Bye-pass. From there, it is connected with an excavated channel named as theEastern Drainage Channel along the South-Eastern boundary of Salt-Lake city under Bidhannagar Municipal area. This Eastern Drainage channel also has its outfall in the Kestopur Canal :From the Drainage point of view, **the Kestopur Canal** is the lifeline of the Bidhannagar area especially for the planned township of Salt lake.

Plate 33: Polluted Krishnapur Canal,
22°35'33.55"N 88°23'41.55"E

In 1910 the Kestopur Canal was excavated extending to the Bidyadhari River. Due to deterioration of the river Bidyadhari, the channel was subsequently extended as the Bhangar canal from Katatala to the Kultigong river. With the provision of navigation locks at the Chitpur and Kulti which served as navigation link between the river Hugliat Kolkata and the Sunderbans for many decades. However, it is no longer in use for navigation. Further chitpur lock was also constructed during this year. The other branch canal from the Circular Bridge known as the Circular-Beliaghata Canal goes up to EM Bypass and from there it is connected with an excavated channel along the south-eastern boundary of the Salt Lake City. The length of Circular-Beliaghata Canal is 8.4 km and that of Kestopur-Bhangar Canal is about 39 km. The Circular-Beliaghata-Kestopur-Bhangore Canal now drains a part of the Kolkata city in the north and also the satellite township of Salt Lake City (Bidhannagar) and a vast rural area on its bank. The Circular-Beliaghata New Cut-Bhangar Canal system which serves as a primary means of drainage to the storm runoff at northern part of the city of Kolkata and the upper Bagjola Canal system serving the six northern municipalities is rather been said to be misused for dumping domestic and other municipal wastes. Indiscriminate dumping of various obnoxious industrial wastes by innumerable industrial establishments and small scale units has chocked the canal system totally.



Map 26: Circular Canal – New Cut Canal – Kestopur Canal with ward boundaries

Plate 34 – Old photograph Circular Canal (Fiebag Collection)

Plate 35: Present Condition of New-Cut Canal, near R.G Kar Hospital,

22°36'11.91"N 88°22'37.07"E

Plate 36: Krishnapur Canal along Bidhannagar, 22°35'50.65"N, 88°24'11.70"E

Plate 37: New Cut Canal, near Calcutta Station, 22°35'47.18"N 88°23'28.22"E

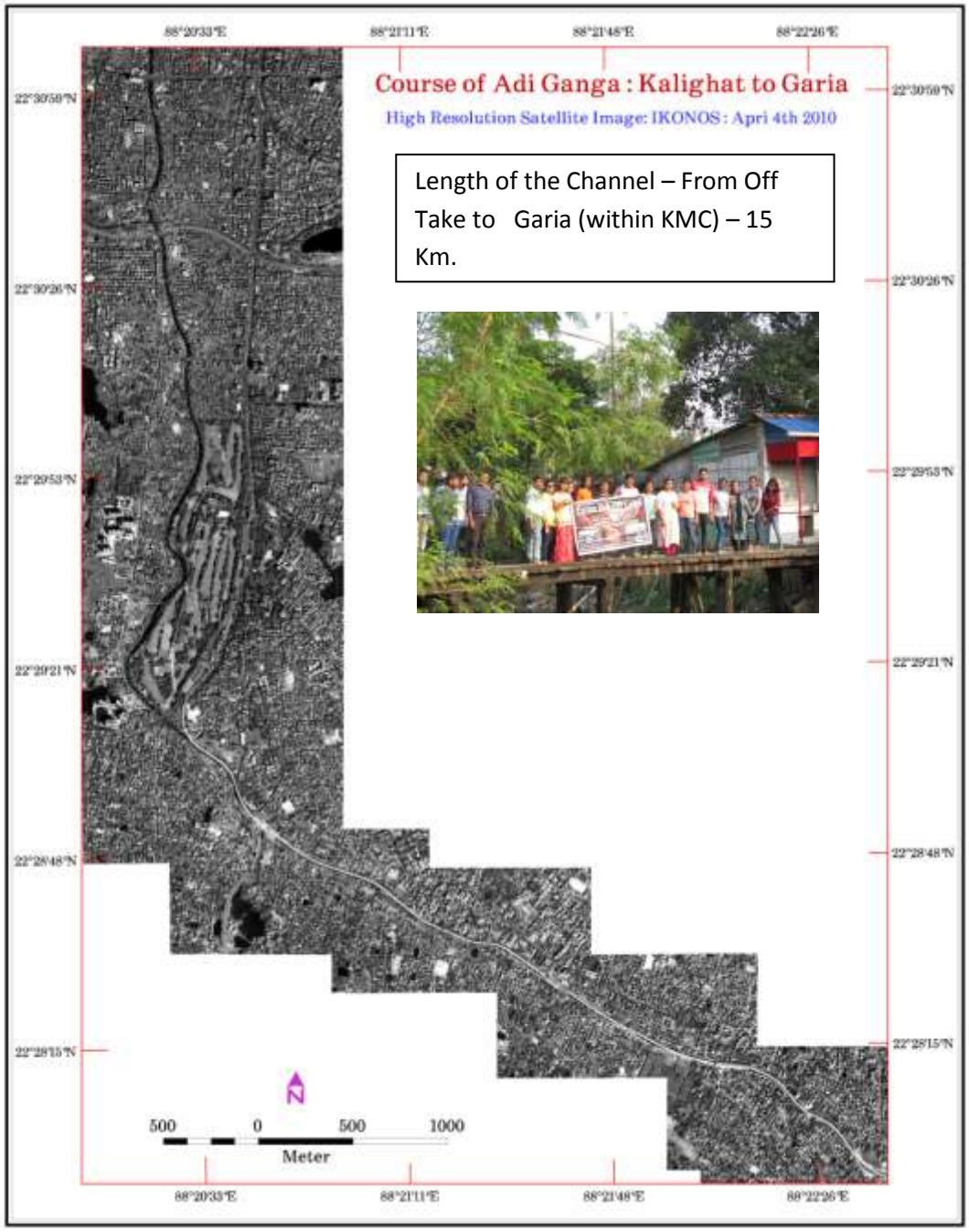
4.1B. TOLLY'S NULLAH / ADI GANGA

Holwell noted that 'a small brook' near Kalighat deemed to be the original course of the Ganges by the local Brahmins (Holwell 1771). This channel was shown to be draining into Bidyadhari (upper Matla) below Baruipur in 1778 Bengal Atlas of James Rennel. The initial written accounts of its moribund course ,described in the early maps variously as the Govindapur Creek, Ganga Nullah , Surman's Nala (nala –small creek) etc were provided by the Calcutta Review (1852) and Sherwill (1858) . Subsequently Hunter (1875) identified it as Adi Ganga and observed how the Hindus still consider the route of the channel, sacred, and burn the bodies on the side of the tank dug in its bed.

Plate 38: Adi Ganga, old photograph

Plate 39: Off take point Adi Ganga and Hugli River
22°33'2.51"N 88°19'28.85"E

In 1778, Mr. Tolly obtained permission to excavate part of the course of the Adi Ganga, a distributary of theHugli river, to link up with a new port at Taratala on the Bidyadhari (Government of West Bengal, Department of the Environment, 1997). This channel is still known as Tolly's Nala. Though no longer used for navigation, it is still an important waterway, draining a substantial part of the south Kolkata. It is 27.4 km long, from the riverHugliend near the old Kidderpore Dockyard (Hastings) to the river Bidyadhari (now almost dead) at the other end near Sambalpur. Its improvement will lead to better quality of life of a large number of people living either on its banks or in its peripheral areas.



Map 27: High Resolution Image showing Adi Ganga Course

Location and Route of Tolly's Nala or Adi Ganga

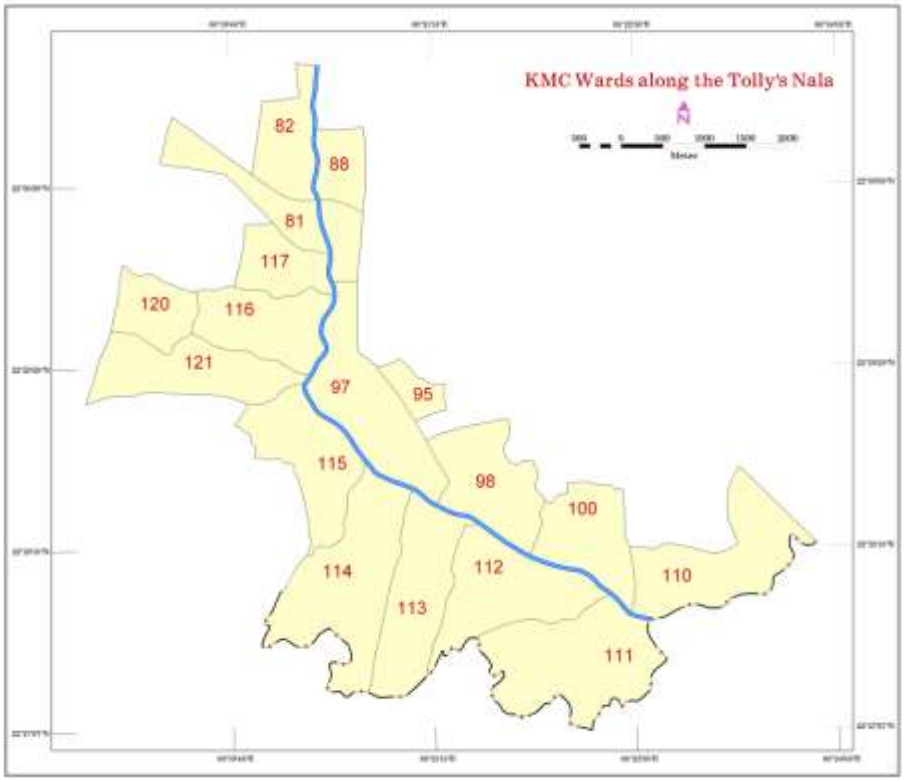
Off Take Point - 22°33'1.67"N 88°19'31.10"E. Near Dai Ghat, Watguange Pumping Station.

Wards Covered- 75,74,71,73,83, 88, 88,82,81,117,116,97,115,114,113,112,111,110,100,98.

Area Covered – Hastings, Watguange,Alipur,Chetla,Kalighat, Khidirpur,Bhowanipur,Tollyguange, Bansdroni,Kudghat,Garia.

Connecting Canals – Chetla Boat Canal, Keorapukur Khal.

Important Heritage Sites – Kalighat, Mysore Garden,Boro Rasbari , Chhoto Rasbari Temples , Balaram Bosu Ghat , Keoratal Mohashasan (Burning Ghat)



Map 28 & 29– Ward Map of Kolkata showing the course of Adi Ganga

The *Boat Canal*, a tributary of the Tolly's Nullah, is the main contributor of pollution to the Nullah, which in turn pollutes the river Hugli. A number of huge pipe and big inlets carrying untreated effluents from the surrounding municipal areas of the nullah have lead to like siltation and pollution. Heavy siltation results due to disposal of industrial wastes, municipal wastes and carcasses into the canal.

Plate 40: Alipur Bridge and Adi Ganga, 22°32'0.15"N 88°20'14.83"E

Map 31: Tolly Nala and Chetla Boat Canal 22°30'36.34"N 88°20'24.67"E

This has resulted in to a complete deterioration of the Tolly's Nullah. Parts of Borough XI and borough XII are served by Tolly's Nullah and also by three others drainage canal namely Keorapukur canal, Western channel and Rania canal. Keorapukur canal is tributary to Tolly's Nullah while Western channel and Rania canal are twin tributaries of Keorapukur canal. Drainage for northern part of Wards 111 to 114 (in Borough X3) is towards Tolly's Nullah while southern part of the said wards is within Keorapukur drainage sub-basin comprising Rania, Western and Keorapukur canals.

Plate 41: Kalighat (up) 22°31'12.12"N 88°20'23.95"E, Plate 42: Keoratala Burning Ghat (below)

A considerable portion of Ward 111 is having underground drainage system developed by KMWSA under Kamdahari drainage improvements scheme. This is again a combined system. The DWF reaching Kamdahari pumping station finds its way to South suburban East STP while the SWF is discharged to Tolly's nullah. The remaining portion of this borough within this basin is mostly served by surface drainage system. Wards 115 to 118, 120 and parts of Wards 119, 122 and 123 in borough XIH are served through a combination of piped conduits and surface drains. The borough is partially covered by underground sewerage system. The Wards in northern part of this borough are mostly skewered. The coverage of underground drainage system is partial and there are several areas in each of the wards where underground sewers and open drains runs parallel to each other. Storm water drains have also been connected to sewers at number of places through manholes or catch pits. As such, there is no functional difference between the underground sewer and surface drain. Large amount of untreated sewage flowing into Tolly's nullah pollutes the river Hugli. Some sewer lines were laid under Ganga Action Plan (GAP). All these sewers were designed to handle dry weather flow only. Under GAP scheme, the DWF in the sewers discharging to Tolly's Nullah have been intercepted. In borough XI a trunk interceptor together with a series of lift stations viz. Kamdahari, LA-1A, LS-1B, LS-2A, LS-2B and LS-5 have been constructed to convey DWF to South Suburban East STP which also receives DWF generated from a portion of borough XU The DWF generated flow from Wards 97, 98 and 100 of borough X on the northern side of Tolly's Nullah and finding their way into the said canal have been intercepted under GAP scheme and is taken to LS5 as mentioned above and subsequently reaches the South Suburban East STP located within Churial basin. The sewers discharging to Tolly's Nullah within Borough XIH have also been intercepted and the DWF is diverted to the South Suburban East STP through intermediate lifting stations on Buro Sibtala Road, James Long Sarani and B. L. Saha Road (LS-1, LS-2 and LS-3) and main pumping station (MPS) located near Keorapukur Canal close to the STP site. This system has also got a few overflow manholes to discharge the flow in excess of DWF to nearby Nullahs (Tolly's nullah, Keorapukur canal, Churial canal extn. etc.). Roads along which GAP sewers have been laid include S N Roy Road, Buro Sibtala Road, Basantalal Saha Road, James Long Sarani, Raja Ram Mohan Roy Road and Mahatma Gandhi Road. Secondary and tertiary sewers have been laid (in Wards 117, 118, 116, 119, 120 and 121 - in order of coverage) by various agencies like CMC, KMDA and KMWSA and connected to GAP sewer. Conditions

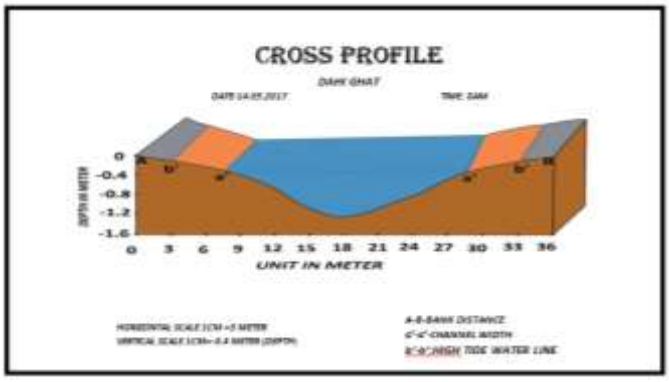
of the GAP sewers are satisfactory except at a few localities like Panchanantala More (Junction of Rammohan Roy and Kalipada Mukheijee Road) and Sarada Park - Bhasapara on Rammohan Roy Road.

Plate 43: Metro Rail on Adi Ganga Channel at Garia, 22°29'3.92"N 88°20'35.87"E

Plate 44: Religious activities in Adi Ganga, Kalighat

I. Cross Sections of the canal at various locations:

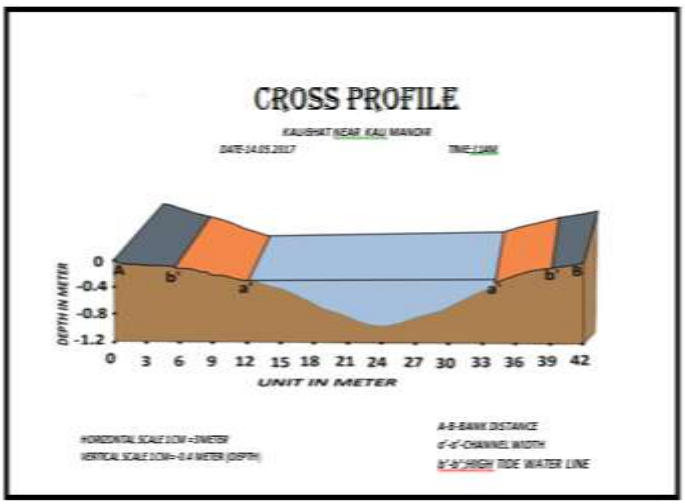
a. At Dahi Ghat (Off take point) –- Latitudinal and longitudinal extension of the cross section point is 22°33′0.38"N 88°19′30.85“. Tidal influence is present in this area. In off take point highest depth is 1.25 meter and lowest is 0.4 meter. The width of this channel is 21 meter. Total length of the bank is 36 meter. As per height of this channel its refers the amount of sedimentation is high on the left bank.



NAME OF THE GHAT	STATION	DISTANCE(IN METER)	DEPTH(IN METER)	WIDTH(IN METER)	TOTAL LENGTH OF THE BANKIN METER)	LEFT BANK		RIGHT BANK	
						HWL(IN METER)	LWL(IN METER)	LWL(IN METER)	HWL(IN METER)
DAHI GHAT	A1	7.5	0	21	36	3	7.5	28.5	33
	A2	9	0.4						
	A3	12	0.75						
	A4	15	1.1						
	A5	18	1.25						
	A6	21	1.05						
	A7	24	0.8						
	A8	27	0.4						
	A9	28.5	0						

Plate 45: Off Take point, Adi Ganga / Tolly’s Nala

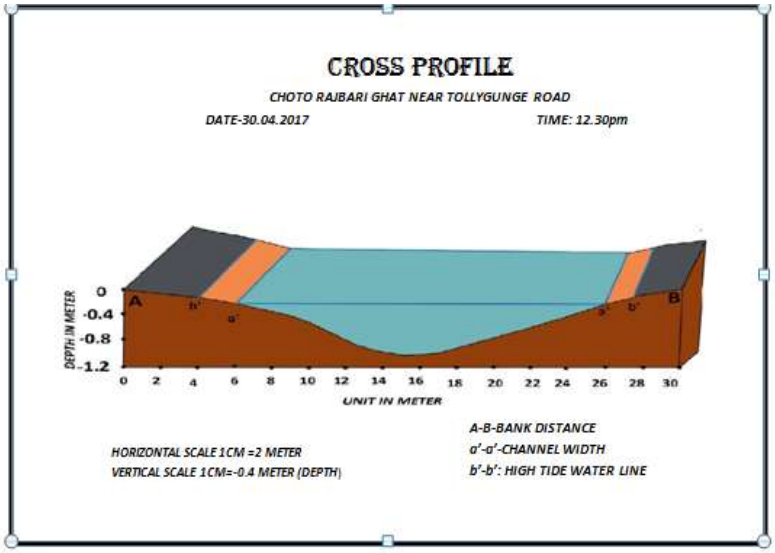
b. At Kalighat - The diagrams show the depth of the Adi Ganga at Kalighat. Latitudinal and longitudinal extension of the cross section point is 22°32´52.69"N 88°19´29.37"E “. As we see that the depth is low from the previous ghat. Tidal influence is present in this area. In off take point highest depth is 0.9 meter and lowest is 0.3 meter. The width of this channel is 21.9 meter. Total length of the bank is 42 meter. As per height of this channel it refers the amount of sedimentation is high on the left bank.



NAME OF THE GHAT	STATION	DISTANCE(IN METER)	DEPTH(IN METER)	WIDTH(IN METER)	TOTAL LENGTH OF THE BANKIN METER)	LEFT BANK		RIGHT BANK	
						HWL(IN METER)	LWL(IN METER)	LWL(IN METER)	HWL(IN METER)
KALIGHAT MANDIR,WARD NO-83	A1	12	0	21.9	42	4.5	12	33.9	39
	A2	15	0.4						
	A3	18	0.6						
	A4	21	0.8						
	A5	24	0.9						
	A6	27	0.8						
	A7	30	0.6						
	A8	33	0.3						
	A9	33.9	0						

Plate 46: Ghat along Kalighat temple

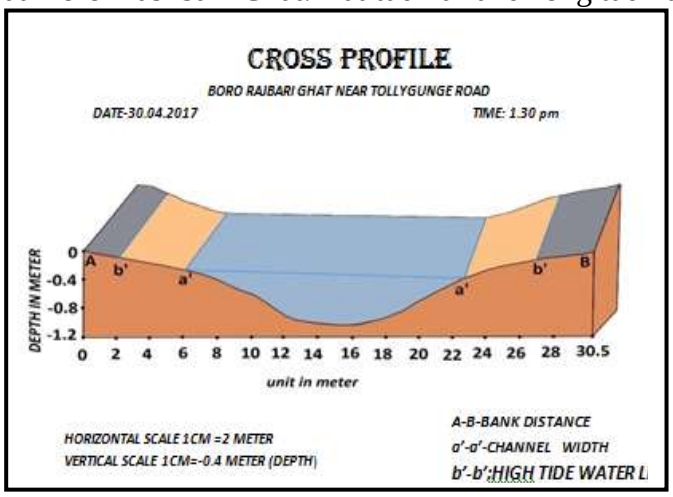
c. At Choto Rasbari Ghat (near Keoratala Burning Ghat) –Latitudinal and longitudinal extension of the cross sectional point is 22°30´17.43"N 88°20´30.68"E As we see that depth is low on this ghat. Tidal influence is present in this area. In off take point highest depth is 1 meter and lowest is 0.25 meter.The width of this channel is 20 meter. Total length of the bank is 30 meter. As per depth of this channel it refers the amount of sedimentation is high on



NAME OF THE GHAT	STATION	DISTANCE(IN METER)	DEPTH(IN METER)	WIDTH(IN METER)	TOTAL LENGTH OF THE BANKIN METER)	LEFT BANK		RIGHT BANK	
						HWL(IN METER)	LWL(IN METER)	LWL(IN METER)	HWL(IN METER)
CHOTO RASH BARI,WARD NO-81	A1	6	0	20	30	4	6	26	28
	A2	7	0.25						
	A3	10	0.5						
	A4	13	0.9						
	A5	16	1						
	A6	19	0.8						
	A7	22	0.6						
	A8	24	0.4						
	A9	26	0						

Plate 47 – Choto Rasbari Ghat along Adi Ganga,
22°30'44.73"N 88°20'27.00"E

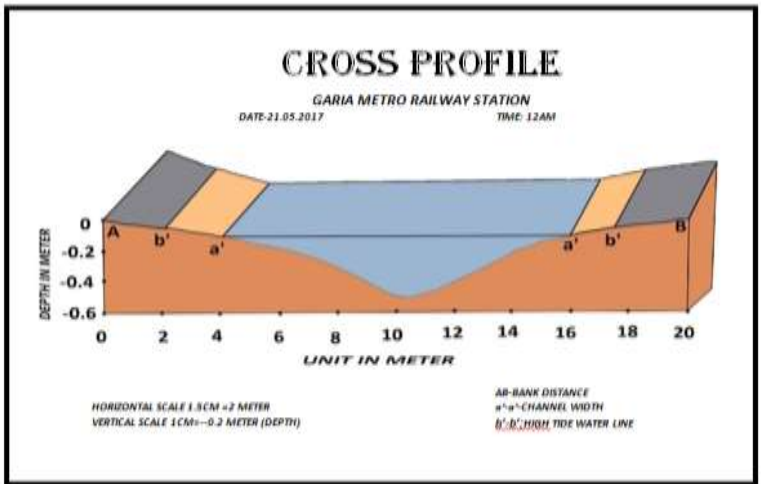
d. At Boro Rasbari Ghat (Chetla) -The diagrams show the depth of the Adi Ganga channel at Boro Rashbari Ghat. Latitudinal and longitudinal extension of the cross section point is 22°30'13.00"N 88°20'32.22"E. As we see that the depth is better from the previous ghat. Tidal influence is present in this area. In off take point highest depth is 1.05 meter and lowest is 0.4 meter. The width of this channel is 16 meter. Total length of the bank is 30.5 meter. As per depth of this channel its refers the amount of sedimentation is low from other Ghats of Adi Ganga



NAME OF THE GHAT	STATION	DISTANCE(IN METER)	DEPTH(IN METER)	WIDTH(IN METER)	TOTAL LENGTH OF THE BANKIN METER)	LEFT BANK		RIGHT BANK	
						HWL(IN METER)	LWL(IN METER)	LWL(IN METER)	HWL(IN METER)
PANCHANANDATALA GHAT (NEAR BORO RAJBARI)TOLLYGUNGE ROAD,WARD NO-81	A1	7	0	16	30.5	0.8	7	23	27
	A2	8	0.4						
	A3	10	0.6						
	A4	12	0.9						
	A5	14	0.9						
	A6	16	1.05						
	A7	18	0.9						
	A8	20	0.6						
	A9	22	0.4						
	A10	23	0						

Plate 48: Near Baro Ras Bari Ghat along Adi Ganga, Chetla
22°30'39.03"N 88°20'24.79"E

e. Near Garia Metro Station: The diagrams show the depth of the river Adi Ganga channel at Garia metro station. Latitudinal and longitudinal extension of the cross section point is 22°3´0.55"N 88°24´13.38"E . In off take point highest depth is 0.5 meter and lowest depth 0.3 meter and there is width of the channel 12meter. Total length of the bank is20 meter.



NAME OF THE GHAT	STATION	DISTANCE(IN METER)	DEPTH(IN METER)	WIDTH(IN METER)	TOTAL LENGTH OF THE BANKIN METER)	LEFT BANK		RIGHT BANK	
						HWL(IN METER)	LWL(IN METER)	LWL(IN METER)	HWL(IN METER)
GARIA METRO STATION	A1	4	0	12	20	2	4	16	17.4
	A2	6	0.2						
	A3	8	0.3						
	A4	10	0.5						
	A5	12	0.4						
	A6	14	0.2						
	A7	16	0						

Plate 49: Adi Ganga near Garia Metro Station

22°27'57.19"N 88°23'30.58"E

II. Water Quality of the canal water at various locations:

Water samples were collected from 11 points within the 15 km stretch of Adi Ganga / Tolly Nala in KMC boundary. These points are – 1. Dahi Ghat (Watguange), 2.Dahu Ghat (Hastings), 3. Alipur (Near Taj Hotel), 4. Bhabani Bhaban Ghat (Bhowanipur) 5. Balaram Basu Ghat (Bhowanipur), 6. Kalight 7. Choto Ras Bari Ghat (Chetla), 8. Panchanandatala Ghat (Boro rasbari, Chetla), 9.Korunamoyee Bridge (Tollyguange) 10. Kudghat Bus Stop 10. Garia Metro Station.

Various water quality parameters like – pH value , Conductivity, Turbidity , Dissolved Oxygen, Chemical Oxygen on Demand (COD), Biochemical Oxygen on Demand (BOD) were tested from the sample water collected from the different sites . Here is a detail study of the parameters from the 11 sampling sites.

SL. NO	LOCATION (NAME OF GHAT)	WATER QUALITY PARAMETERS MEASURED				
		PH	D.O	CONDUCTIVITY	TURBIDITY	COD
1	DAHI GHAT	6.86	6.24	409	39.6	225
2	DAHU GHAT (HASTING GAS AGENCY)	6.47	6.18	375	29.1	179
3	TAJ BENGAL (ZOOLOGICAL GARDEN)	6.89	0.19	946	30.5	231
4	BHABANI BHABAN GHAT	6.93	0.258	911	50.7	215
5	OM BALARAM BASU GHAT	6.99	0.24	904	101	192
6	KALIGHAT MANDIR	6.97	0.34	850	20.7	174
7	CHOTO RAJBARI	6.93	0.36	1276	80.9	240
8	PANCHANANDA TALA GHAT(NEAR BORO RAJBARI)	6.92	0.14	1187	57.4	222
9	KARUNA MOHI BRIDGE	7.03	0.22	1700	25.6	214
10	KUDGHAT BUS STOP	7.02	0.12	1617	26.4	210
11	GARIA METRO STATION	7.1	0.12	1182	26	198

a. pH value - The pH value is an expression of the ratio of [H+] (Hydrogen concentration) to [OH-] (hydroxide ion concentration). Hence, if the [H+] is greater than [OH-], the solution is acidic. Conversely, if the [OH-] is greater than the [H+], the solution is basic. The range goes from 0 to 14, with 7 being neutral. pHs of less than 7 indicate acidity, whereas a pH of greater than 7 indicates a base. The pH of water is a very important measurement concerning water quality.

The data of pH value shows that the sampling sites beyond Karunamoyee Bridge, Tollyguange is acidic because pH value of water is less than 7 measuring by the pH scale while after Tollyguange the water is more alkaline.

b. Turbidity - It is the cloudiness or haziness of a fluid caused by large numbers of individual particles is generally invisible to the naked eye similar to smoke in air. The measurement of turbidity is a key test of water quality Turbidity can be use silt, sand and mud; bacteria and other germs; chemical precipitates. The most preferred turbidity rate is 0.

Turbidity in the water Sampling Sites like Dahi Ghat, Kalighat, Karunamoyee Ghat, Kudghat and Garia are less than 30 NTU. While Balaram Basu Ghat, Choto Rasbari Ghat shows a very high NTU indicating high turbidity.

c. Conductivity -This is a measure of the capability of a solution such as water in a stream to pass an electric current. This is an indicator of the concentration of *dissolved electrolyte ions in the water*. The basic unit of measurement for conductivity micro Siemens per centimeter (µS/cm).. Distilled water has a conductivity ranging from 0.5 to 3 µS/cm, while most streams range between 50 to 1500 µS/cm. Freshwater streams ideally should have conductivity between 150 to 500 µS/cm to support diverse aquatic life.

As per the test data the minimum conductivity level is 375 µS/cm in Dahl ghat , Hastings gas agency .Its refers the concentration of dissolved electrolyte ions and flow of electric current is better in this water and support diverse aquatic life .On the other hence the conductivity level of the Kalighat is 904 µS/cm and Karunamohi bridge we notified that the conductivity level of this ghat is 1700 µS/cm . So the flow of current in this water is very low and water is very polluted for aquatic life and human being.

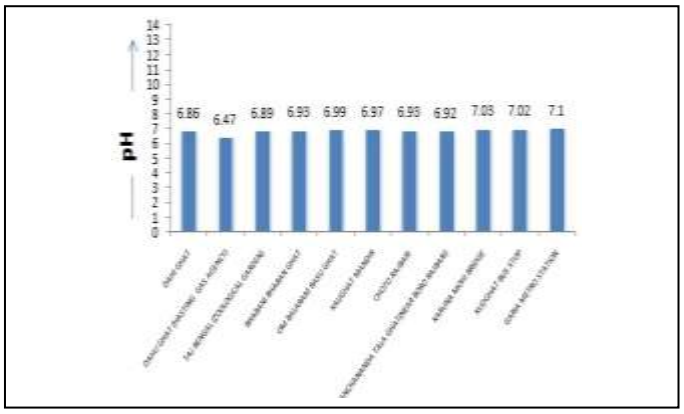
d. Dissolved Oxygen (DO) - Dissolved oxygen is oxygen gas molecules (O2) present in the wate rDissolved oxygen is measured in mg/L. 0-2 mg/L: not enough oxygen to support life. 2-4 mg/L: only a few fish and aquatic insects can survive. 4-7 mg/L: good for many aquatic animals, low for cold water fish 7-11 mg/L: very good for most stream fish.

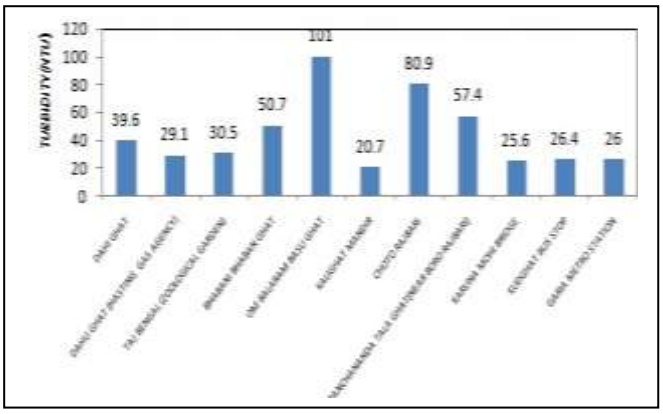
The maximum value of DO is 6.24 in Dahi Ghat which is good for aquatic animals and less polluted. On the other hand the Kudghat and Garia area sampling sites shows low rate of oxygen gas molecules . In fact all the sites beyond Hastings the quality is very alarming . High pollution rates affects the dissolved oxygen level.

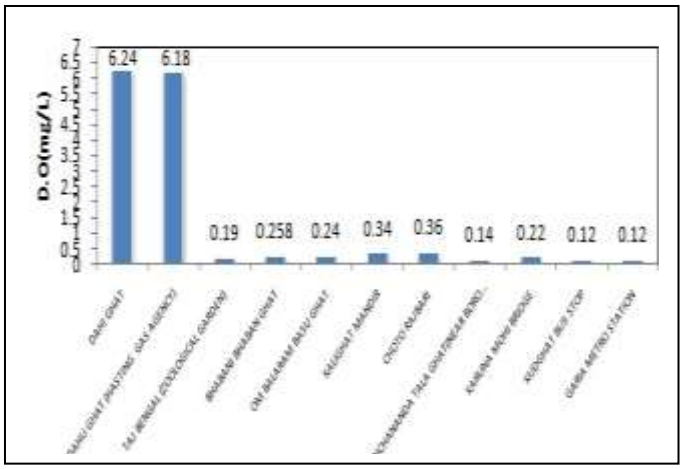
e. Chemical Oxygen Demand or COD is a measurement of the oxygen required to oxidize soluble and particulate organic matter in water. Depending on the industrial activity and the situation the maximum chemical oxygen demand (COD) levels between 200-1000 mg/l must be reached in order to release the wastewaters back into the environment.

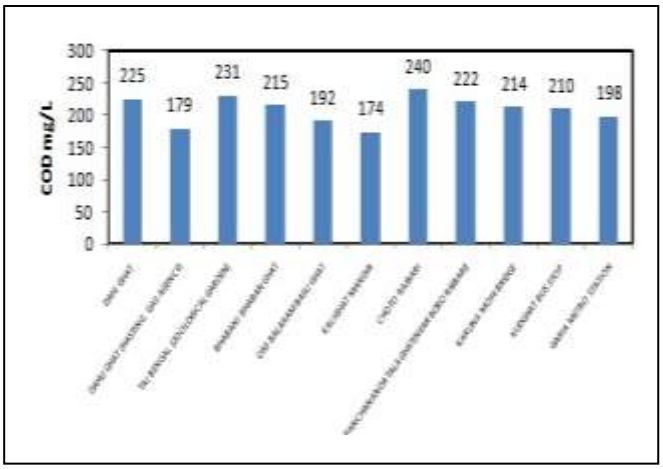
The quality of the water samples taken from Chhoto Rasbari Ghat is the highest COD with 240mg/l and lowest Dissolved Oxygen that means it is by far the most polluted stretch of the canal. Though most of the Water Samples except Hastings Dai Ghat and Kalighat ,are having more than 200 mg/l of COD indicating highly polluted water quality.

Statistical Analysis of the various water quality parameters collected from 11 Sampling sites across the stretch of Adi Ganga / Tolly's Nullah with KMC Boundary









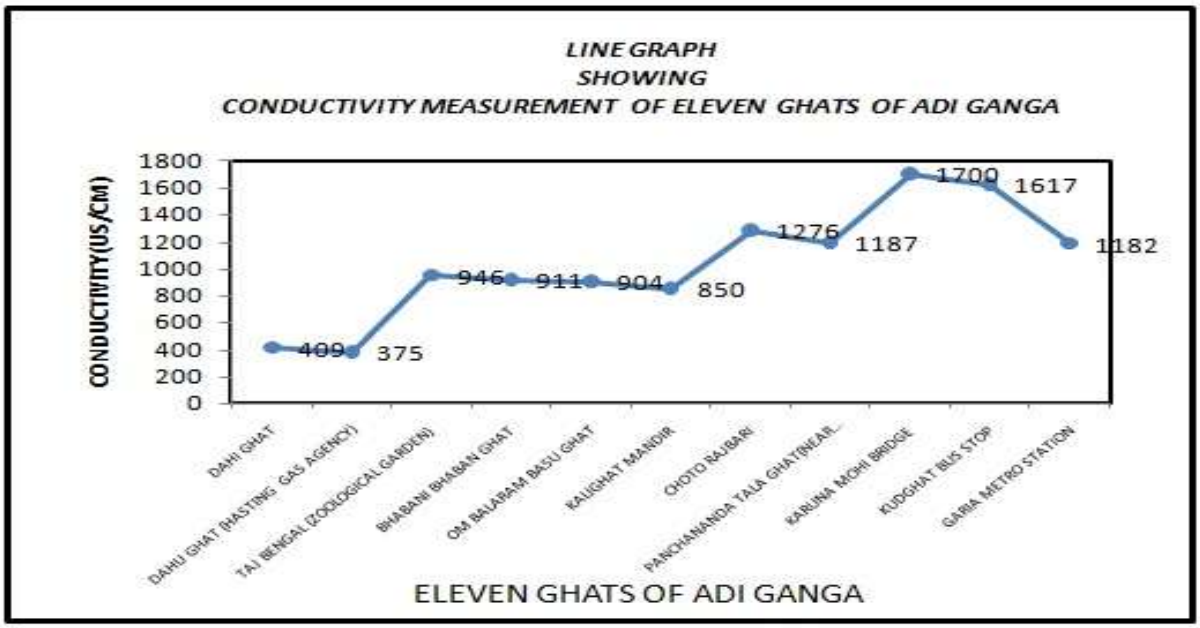


Plate 50: Water Quality Test is taking place

Plate 51: Water Testing is getting done in the sampling sites

III: GROUND CONTROL POINTS OF IN AND AROUND KOLKATA MUNICIPALITY-Table 12

SL. No	GCP	Points
1	1115	Nandakumar Phansi Point
2	1116	Mewalal Park (Adi Ganga)
3	1117	Chhot Pujo Ghat
4	1118	Port Bridge
5	1119	Zeerat Bridge
6	1120	National Library
7	1121	Alipore Women Correction Centre
8	1122	Alipore Bridge (1932)
9	1123	Bhawanipore Cemetry
10	1124	Commonwealth War Graves
11	1125	Alipore correction Centre
12	1126	Kalighat Temple
13	1127	Shyam Rai Mandir
14	1128	Kalighat Ganga
15	1129	Railway Crossing (Chetla)
16	1130	Choto Rasbari Ghat
17	1131	Boro Ras Bari
18	1132	Garia Metro
19	1133	Bypass Patuli Crossing
20	1134	Jheel Paar
21	1135	Crossing Kalikapur
22	1136	Chowbaga Khal
23	1137	Lala Kuthi
24	1138	Old Course Bidyadhari
25	1139	Canal Crossing

4.1C. Tollygunge-Panchannagram Canal (T. P. Canal)

T.P. Canal plays a very important role so far as the sewages of Jadavpur, Santoshpur, Kasba, Tiljala area of KMC are concerned. This area was basically a very low marshy land. From 1934-1940, the area was submerged under water and likewise the inhabitants suffered badly, particularly in Kasba and Haltu areas. In 1941, the then Tollygunge Municipality tried to discharge the stagnant storm water into the SWF Channel and therefore authority excavated a new 'Khal' near Chowbaga. Thereafter they made a scheme for discharging storm water within an area of 33.15 sq. km of which 22.53 Sq. kms in urban sector and rest in rural sector. The length of T.P. Channel is 6.76 km. Except this there are a large number of intercepting channels, as well as a number of tributaries criss-crossed with this channel. Pumps having a capacity of 150 cusec were installed near Chowbaga in 1966-1967. Then and thereafter the necessity was felt to install more pumps because of urban expansion.lt was then realized that to combat with the discharging problems of storm water in TP Basin, Chowbaga Pumping Station need to be modernized. The entire basin has a good canal network system. The drainage from the entire area leads to TP Main Canal through a system of lead channels, which may further be divided into fourteen sub-basins. The discharge from T.P Main Canal water is pumped into the SWF channel through three pumping stations at Chowbaga having a continued discharge capacity of 41 cusec from ultimate discharge into the Kulti River at Ghusighata, 36 km away.

The SWF channel, in addition, also caters the storm water discharges from Kolkata basin via Palmer Bridge pumping station and suburban basin via Ballygunge Drainage Pumping Station. The areas covered under this basin include Wards 101, 102 and 110 of Borough XI and major portion of Borough XU covering Wards 103 to 109. KMWSA has laid underground conduits over the entire basin covering wards 108 and 109, where only insignificant portion of the road network is covered with piped system. CMC has subsequently extended the drainage network of the area.

4.1D. Keorapukur Canal: Keorapukur canal is a 32 km long drainage canal aligned to approximately north-south direction and having outfalls at both ends. The 7.2 km northern section drains to Tolly's Nullah, while the southern section ultimately drains to the river Hugli via the **Churial Canal**. The northern section is silted up and this leads to waterlogging in the monsoon. Another drainage channel in the Keorapukur basin is known as the Keorapukur Western Channel. This is 1.74 km in length and also drains into Tolly's Nullah, through a pumping station

4.1E. Kolkata Drainage Outfall (SWF and DWF) Channels: Kolkata lies on the land that slopes towards the east, away from the river Hugli. Thus area is very flat and low, more or less saucer-like shape, with scattered local low pockets. Therefore during rainy seasons, with 100 mm rainfall a day this runoff rate exceeds and results into prolonged and extensive inundation. There is about 115 km long extensive sewerage extending from Bagbazar and Manicktala in the north to Tollygunge in the south of Kolkata has extensive sewerage. The storm water and sewage from the entire area is pumped out for disposal into two important drainage arteries. C.M.C has excavated Storm Water How Channel (SWF Channel) and Dry Weather How channel (DWF Channel) between 1937 and 1939. This system also serves some rural areas stretching along its flow line from the city to the outfall covering an area of about 150sq km. These outfalls play a very vital role in Kolkata's sewerage system. The SWF Channel system comprises of three separate channels, inclusive ofthe pumping stations at Ballygunge, Palmerbazar and Dhapa. This system also receives storm water and sewage water from the pumping stations at Chowbagha. These three channels meet at Bantala and the combined SWF Channels reaches the river Kultigong at Chusighata. known as the Kolkata Drainage Outfall system, and the channels take care of storm water flow ofthe central, southern and south-eastern parts of Kolkata. The DWF is brought to the Topsia Point 'A' from Palmerbazar and Ballygunge pumping stations through underground sewers and thereafter carried by the open lined DWF channel. From the Dhapa pumping stations, there is also a small stretch of DWF channel that receives city sewage during dry season and meets DWF channel at Bantala. After that, the DWF channel runs more or less parallel to the SWF channel and reaches its outfall at the Kulti River. The construction ofthe SWF and DWF channels split the Bidyadhari river into two halves. The southern half, which lead to the Matla estuary, has been subjected to heavy siltation through tidal action.

Plate - Tollygunge-Panchannagram Canal

Plate – Lead Channel

4.1F.HUGLIBasin

A considerable portion of Garden Reach area (part of borough XV) lies within this basin. Almost the entire portion of this basin is thickly populated except part of Wards 140 and 141 which are under the process of urbanization. The under developed areas are generally low lying pockets and prone to submergence during rains. A large number of industrial and commercial establishments viz, Rajabagan Dock Yard, South Jute Mill, Sree Ram Ware House, Kesoram Cotton Mill, Garden Reach Ship Builders and Engineers Limited, Hindustan Level, Brickfields etc. are located along the bank of River Hugli. The existing drainage pattern of this basin is predominantly open surface drains, with Dhankheti canal and Khaldhari canal as the two major drainage outlets. Apart from these, there exist a large number of surface drains, which discharge the combined flow directly to the river.

Hugli basin is broadly divided into three drainage sub-basins viz. **Dhankheti canal sub-basin, Khaldhari canal sub-basin and Hugli sub- basin.** The industrial and commercial establishment along the bank of the river have their independent sewerage and drainage system draining into the river directly. For abatement of pollution to river Hugli, pipelines were laid along few roads under Ganga Action Plan (GAP) scheme together with construction of interception arrangements and pumping stations. Although, it was primarily meant to carry DWF, but as the drainage network with the area is not fully developed, at many places drainage connections have been given to the GAP sewers. As a result, in reality the sewers laid under GAP are at present catering storm water flow (SWF) as well. Under the GAP system **Dhankheti Canal** - one of the major source of pollution to river Hugli was intercepted and the dry weather flow was diverted through trunk sewer laid along Paharpur Road and Trenching Ground Road aided by two numbers of intermediate pumping stations viz. Dhankheti Sewage Pumping Station (SPS) and Trenching Ground SPS (located within Manikhali basin area). From Trenching ground of SPS, DWF is conveyed to Santoshpur main Sewage Pumping Station (MSPA) lying within Maheshtala Municipality and subsequently to Garden Read STP located on the southern side of the railway line between Santoshpur and Brace Bridge railway station outside the study area. The entire GAP system is under utilised at present as evident from the fact that average flow reaching the STP is about 17 mid while the installed capacity is 47.5 mid. Treated effluent from STP is ultimately discharged to Manikhali Khal. Two pumps each having capacity of 50 lps, 7.5 m head and three pumps

each having capacity of 100 lps, 7.5 m head are installed in the existing Dhankheli Sewerage Pumping Station. Underground drainage system partially exists in the Nadial area.

4.1G. Manikhali Basin

Part of borough XIV covering the area on the north of Biren Roy Road West (Wards 128 to 132) with a limited portion of Ward 127 to the south of the above road gets drained to Manikhali Canal through its tributaries viz. Begore canal, Begore Branch canal, CPT canal, Pamasree canal and Jinjira canal. Additional part of borough XV (Wards 136 and 139) also gets drained to Manikhali basin through Mudiali drain and Santoshpur canal via Maheshtala Municipality. Besides these, the waste water and storm runoff from north western part of Ward 119 within borough XIII finds its way into CPT canal through an existing box drain below Diamond Harbour Road. In addition, a portion of borough IX located outside the study area also gets drained to CPT canal via a surface drain along D.H. Road.

There are two sewages systems which exists in Manikhali basin having an area of 54.00sq km viz: **(1) New Manikhal of 6.931 km in length and (2) old Manikhal** having an area of 4.998 km .The drainage system of the entire basin has been developed with surface drains,a limited portion of which is covered. Moreover, considerable length of the existing drains is of unlined section. Besides storm runoff, all these drains carry septic tank effluents also. There is an underground drainage system, laid under Ganga Action Plan (GAP) scheme along a few roads. Though designed to carry dry weather flow (DWF), the system at present receives storm water flow (SWF) too. For abating pollution to river Hugli, sewer lines were laid in Borough XIV under GAP scheme which in general flows in south to north direction upto Jinjira Bazar Pumping Station aided by two intermediate pumping stations - Behala Node ‘C\ near Sakuntala Park and Behala Node ‘N\ near Islamia Ground. In addition, the DWF catered through CPT canal has been intercepted and taken to Jinjira Bazar pumping station. From this pumping station the entire flow is pumped to Garden Reach STP through a 750 mm diameter cast iron pumping main. It is reported that the GAP sewer at certain sections along Parui Kutcha Road, Becharam Chatteijee(ward no -113) Road are prone to frequent subsidence. In such stretches the pipeline needs to be replaced. Moreover, non synchronization ofBehala Node ‘C’ and Behala Node ‘N’ pumping stations often fails to deliver desired result and causes water logging.

4.1H. Churial Khal (Canal)

Sewerage area covered under the Churial Canal is 164.989 sq.km (63.70 sq. mile) out of which 141 sq. km (54 sq. mile) is within CMC and 23.33 sq. km (9.01 sq. mile) of areas lies outside the city juridiction of C.M.C. Main canal having length of 17.59 km, passes through Behala to East Barisha and finally meets Hugliriver, through five points sluice with capacity of 28.32 cumec (1000 eusec) under BudgeBudge Municipality. Another Khal of 7.01 km is length, flows from Mithapukur through Pujali and meets Hugl iriver through 56.33 cumec (1989 cumec) sluice, covering the area from Motilal Gupta Road to the east of Barisha. Churial Khal is 1.99 km in length, together with 15 branch Khal and 20 sub branch covering a total area of 50.32 km. These khals discharge sewage of Budge Budge, Bishnupur, Mahestala and the areas under Thakurpukur police station, parts of borough XHI and borough XIV are also served by Churial basin. Considerable portions of Wards 122 and 123 in borough XIII and the area lying to the south of Biren Roy Road (west) and a certain portion of ward 127 in borough XIV (covering Wards 124 to 126 and part of 127) gets drained to Churial canal aided by its tributaries (Fig-6.6) namely Churial Canal extension, Kalagachia Canal and Suti Canal.

The drainage system within this area is grossly inadequate and mostly occur through open drainage network.Moreover, substantial length ofthe exiting drains is of unlined section. Besides storm runoff, all the drains cater sewage water as well. No underground drainage system persists within this basin. South Suburban East STP constructed under GAP Scheme to treat dry weather flow generated from Tolly's Nullah basin is located within this basin. As already discussed, although the GAP sewers are designed to cater DWF only, but in reality those are catering SWF as well. As a result, a considerable quantity of SWF is also reaching to the STP. It has been observed that the outlet system from the STP is not fully developed and due to lack of adequate disposal arrangement of the storm water flow catered by the GAP system, the flood situation in Ward 124 has aggravated. Southern portion of this basin is predominantly rural in nature, low lying and devoid of organized drainage system. It has been observed that flooding situation in this area persist for months together.

Table:13 A TIME LINE ON THE DEVELOPMENT OF THE CANALS IN KOLKATA	
Year	**Event**
1775-1776	Major William Tolly excavated the silted bed of Adiganga.
1800	Central Lake Channel and Beliaghata khal became abandoned
1803	Lord Wellesley noticed that drainage system of Kolkata is extremely defective
1821	On behalf of Lottery committee, Lt. Schalch, Engineer of Irrigation Dept., Bengal government, proposed to construct a masonry sewers
1829-1833	Excavation of Circular canal
1830	The Government of India wanted to reclaim the Salt Lake to expand cite.
1833	Construction of the Cossipore Lock.
1840	The Fever Hospital Committee reported that the main cause of the deterioration of public health was the poor drainage system
1853	Mr. William Clarck, Chief Sanitary Engineer, prepared a new detailed drainage scheme
1857	Mr. William Clarck's plan of underground drainage system was accepted.
1864	A portion of the swampy area in the Salt Water Lake Region was acquired for dumping of garbage.
1865	A Salt Lake Reclamation Company offered to undertake the reclamation works. But due to financial problems it did not take place.
1868	The refuse was first time dumped
1872	A fish ghat was established and a channel was cut from Raja's khal leading to this ghat.
1874	The fish market had been started successfully
1876	The dumping ground had been leased out to Nandalal Das for three years.
1876	The fishery had been leased out to Durga Charan Kundu for four year.
30th April 1879	Bhabanath Sen got the leas of whole land and water bodies for next 20 year
1881	A part of the leased land was acquired for works in connection with the storm water channel
1882	Construction of Dhapa Lock
1884	Underground city sewers were laid
1887	A new fish ghat, named Pagladanga, was established.
1895-97	Construction of Bhangor Canal
1897	Some additional land was acquired for Drainage work.
	Bhangor Kata khal was excavated

1904	It was noticed that 452 bigha out of 1658 bighas leased land were under cultivation (mainly garbage farming).
1906	A five-mile storm-water reservoir was excavated from Palmer Bazar to The Bidyadhari river at Bantala.
1908-1910	Krishnapur (kestopur) khal was excavated
1929	First time the commercial pisciculture was practiced by a private entrepreneur.
1947	After Independence a large no. of refugees were coming to Kolkata
1947	The actual development of Salt lake was started after the formation of the committee to examine the drainage problem.
30th Jan. 1953	A preliminary report presenting the general outlines to solve the problem of reclamation, was prepared
1953	The Government finalized the scheme known as Reclamation of Salt Lake Area.
4th October 1956	CPI criticized the Govt. decision to issue land acquisition notice for the proposed scheme at Bamanghata, Hatkhola area in 24 Parganas district.
February, 1957	CPI again criticized the Govt.'s decision of city expansion in a mass meeting in Bamanghata.
1959	The team of WHO reviewed the complicated sanitation problem of Kolkata.
16th June, 1959	A meeting of the Fact Finding committee was held in which a resolution was adopted to place the question of feasibility before the high-level commission with judicial and technical experts.
24th July,1959	A Fact Finding committee consisting leading Congressmen and bheri owners approached the Secretary to the Chief Minister.
9th September, 1959	A Fact Finding committee consisting leading Congressmen and bheri owners submitted a memorandum recommending abandonment of the proposed reclamation plan the Chief Minister.
1960-1961	Some Planning decision has been taken place for Calcutta metropolitan district regarding water supply sewage drainage
15th February 1961	The preliminary works of reclamation was started.
1961-1971	The growth rate of the East Kolkata was 15.1% and the growth rate of the core Kolkata was 7.2%.
March, 1962	The actual works of reclamation was started
1965	The Essential Commodities Act was formed. Following this Act The licensing system in Pisciculture was introduced to control prices of fish.
1966	The Traffic and Transportation Plan-16 (T. T. Plan) was formed.

Till 1968	About 110 wagons of garbage was distributed daily.
1969	The contract with the Sen. family was expired. And the total land holding was taken over by C.M.C.
1974	The tipper truck and pay-loader vehicles replaced the system of railway.
1978	Though no major conversion took place, but more and more water bodies were transformed into rice fields.
1980	Few wetlands in the East Kolkata region were acquired for the construction of Eastern Metropolitan Bye-pass.
1992	A PIL was launched by Calcutta based NGO named PUBLIC against the proposed plan of converting 800 acres of land for the further extension of Salt Lake city and later for the construction of World Trade Center. The High Court Verdict delivered by Justice Umesh Ch. Banerjee showed the waste-recycling region of East Kolkata Area as the East Kolkata Wetland area. The High Court ruled that no development activity could take place without its prior permission. The map was later interpreted by Land and Land reforms department, and department of Environment, Govt. of West Bengal, in a government order that outlined 32 mouzas.
2002	East Kolkata wetland was finally declared as Wetland of International Importance by Ramsar Bureau.
2005	West Bengal Ordinance no. VII of 2005: The East Kolkata Wetlands (Conservation and Management) Ordinance, 2005
2006, January	Formation of East Kolkata Management Authority
	Bill No. 2 of 2006: The East Kolkata Wetlands (Conservation and Management) Bill, 2006
2006, March	West Bengal Act VII of 2006: The East Kolkata Wetlands (Conservation and Management) Act, 2006
2008	Management Plan for East Kolkata Wetlands

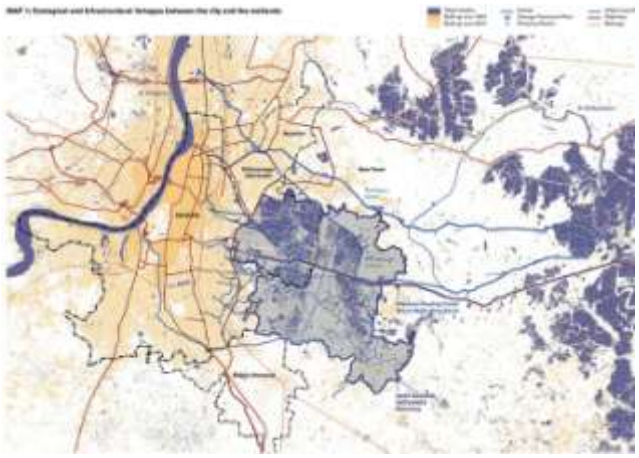
4.2. WATER BODIES OF KOLKATA

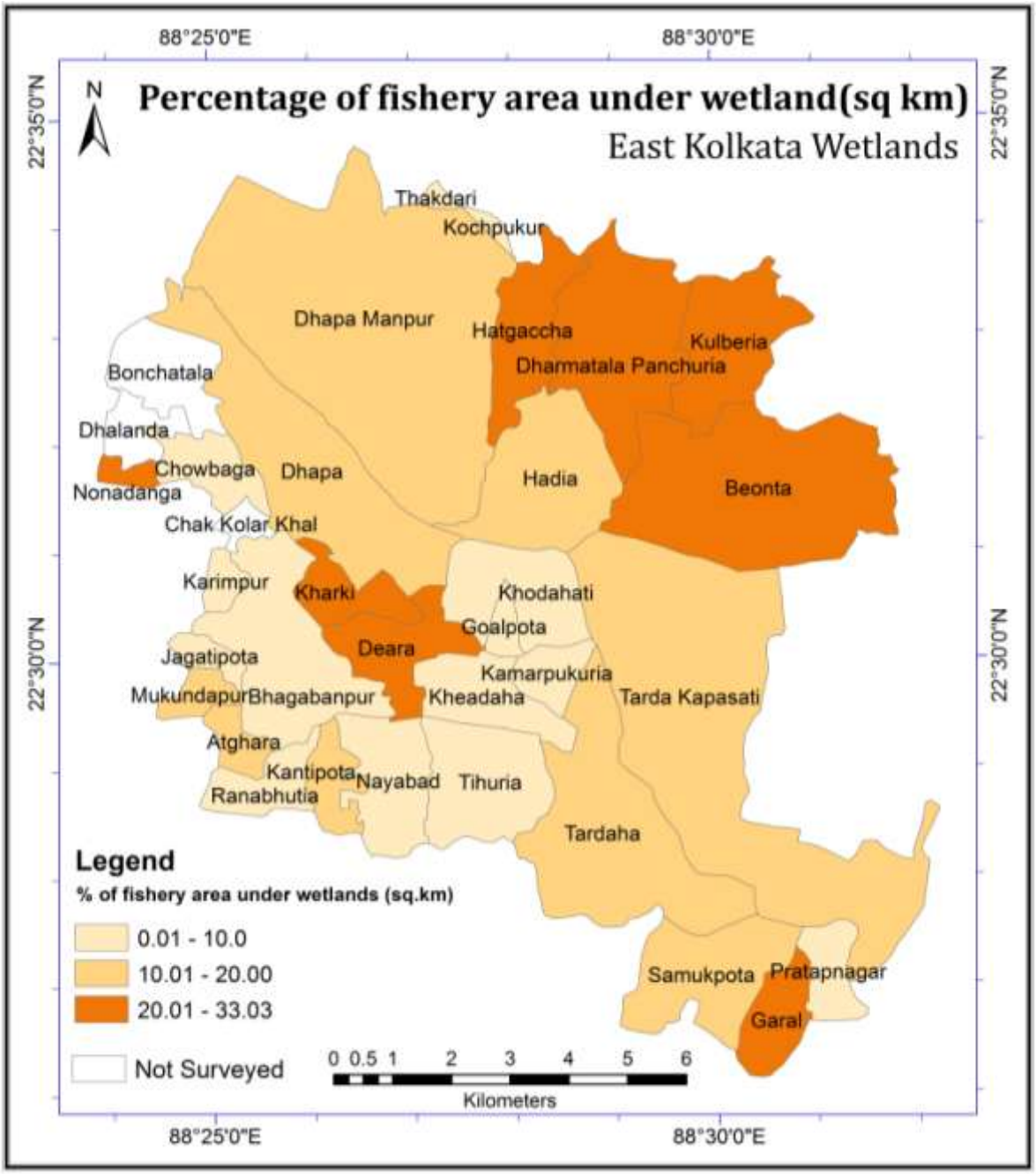
Kolkata has taken shape in a land of flood plain, marshes, rivers and streams . Kolkata's waterbodies can be divided into 3 major groups –

a. East Kolkata Wetlands – Ramsar Site.
b. Public Waterbodies including 2 major lakes
c. Private water bodies often termed as Ponds (*pukurs*) or Jhils of various sizes.

4.2A. East Kolkata Wetlands – Though EKW lies in the extreme eastern fringe of the city and is beyond our study area but still we have kept it in our study since it plays a very significant role in the Kolkata Drainage System. As for the East Kolkata Wetlands, this unique ecosystem impacts the daily lives of people in Kolkata and in the region in several ways. If the Maidan is the lungs of Kolkata, the East Kolkata Wetlands may well be described as the kidneys of the city. Originally a patchwork of low-lying salt marshes and silted-up rivers, East Kolkata Wetlands is a vast network of man-made wetlands bordered by green embankments and channels.

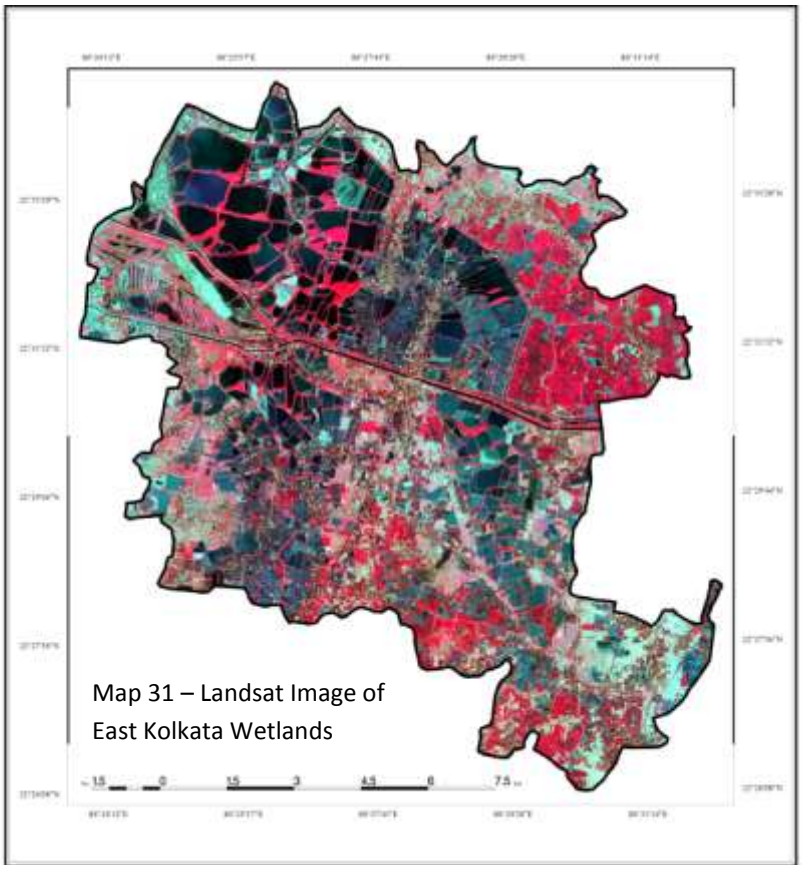
Plate 52: East Kolkata Wetland, located in the fringe area of Kolkata, 22°33'9.96"N 88°24'41.21"E





Map 30– Location of the EKW in the fringe area of Kolkata, Percentage of fishery under wetlands (sq.km)

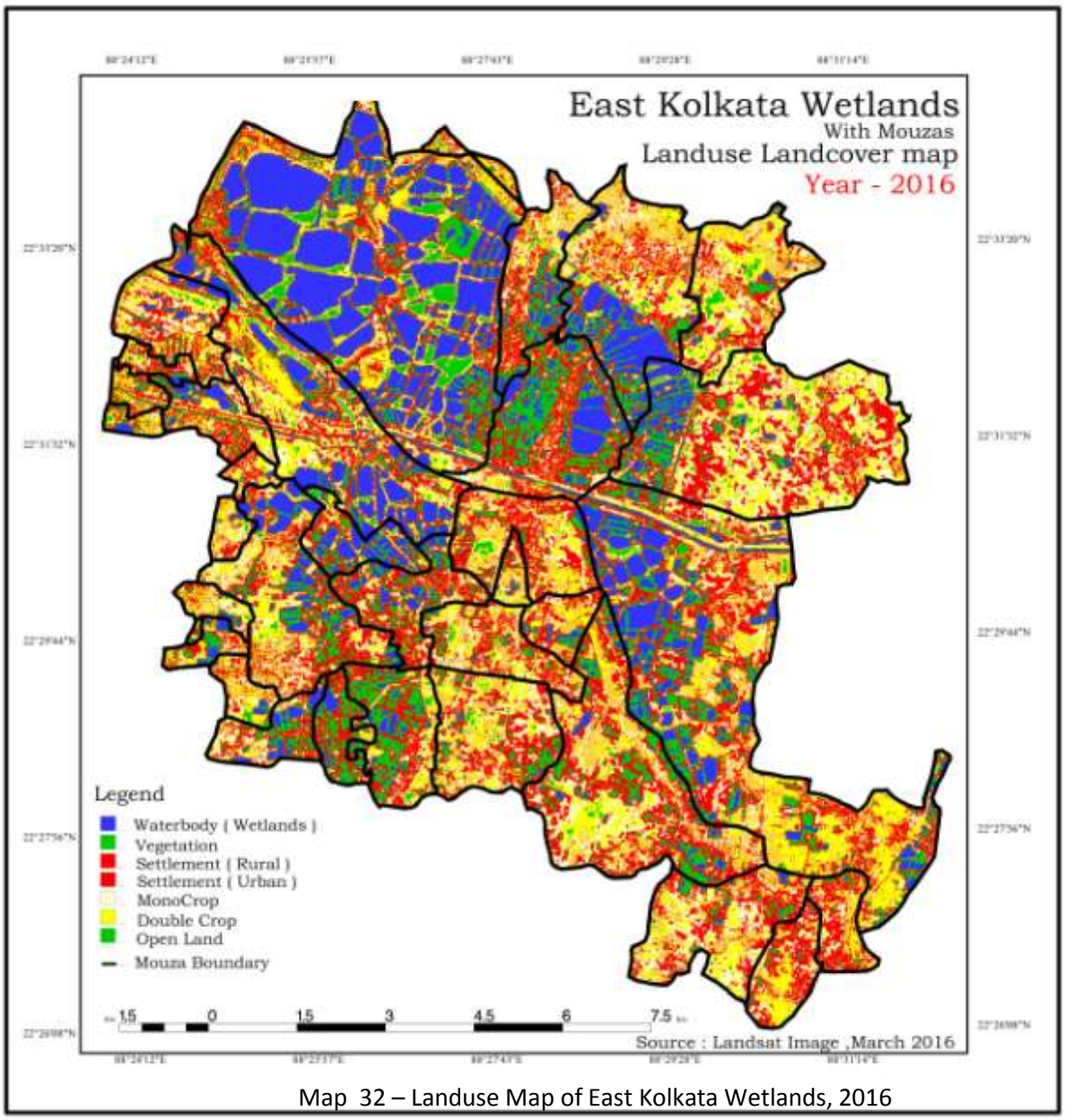
The wetlands to the east of Kolkata (22^0 27' N 88^0 27' E) comprises a large number of water bodies distributed across the districts of South and North 24 Parganas. The multifunctional wetland ecosystem is spread over 12,500 hectares. It has, along with the wetlands, 254 sewage-fed fisheries, agricultural and solid waste farms and some built up areas. The resource recovery system developed by the local people over many years using waste water from the city is the largest and the only one of its kind in the world. It also helps in water treatment, and is home to waterfowl and a large biodiversity. In August 2002, 12,500 hectares of the East Kolkata Wetland area was included in the 'Ramsar List' making it a 'wetland of International Importance'. (The Ramsar Bureau List was established under Article 8 of the Ramsar Convention.). The hydrology of this wetland is different from any other aquatic systems. The wetland has no catchment of its own, though approximately 250 million gallons of sewage flows into it every day. There are hardly any aquifers even up to a depth of 400 feet. Water can be found only in perched aquifers. The total dissolved solid content sometimes exceeds 1800 ppm. The water table is approximately at a depth of 8 metres which falls by 1 - 2 metres during summer. The average pH in the fish ponds is 7.5. The BOD (a measure of the organic pollution) in the fisheries is between 35 and 50 ppm and the COD between 55 and 140 ppm.



Map 31 – Landsat Image of East Kolkata Wetlands

II. What the wetlands offer – **a. Fish:** The city of Kolkata gets its huge volumes of daily sewage treated at no expense and gets in addition a substantial daily supply of highly edible freshwater fish (a very essential protein supplement in their daily food). In fact, Kolkata city receives about one third of its daily requirement of fish from the sewage-fed fisheries (about 11,000 metric tonnes annually). **b. Garbage:** Kolkata generates roughly 2,500 metric tons of garbage (solid waste) a day which is collected and dumped at designated sites in the wetlands. The garbage filled areas are extensively used to raise a variety of vegetables. The city receives roughly 150 metric tons of vegetable everyday from its garbage farms. **c. Food grains:** The paddy fields in the wetlands (many of which are irrigated by the effluent water of the fisheries) produce 15,000 metric tons of paddy annually. **d. Air purification:** It is claimed by environmentalists that these wastewater bodies and fisheries act as a carbon-dioxide sink and help to improve the quality of air of Kolkata and its environs. Any loss of the wetlands, therefore, will have a negative impact on the overall environmental condition of the area. So, the role and importance of the wetland in relation to its surroundings cannot be undermined.

The East Kolkata Wetlands and waste recycling region serve to: **a)** absorb and treat in the most efficient, economical and natural way the huge volume of sewage and wastewater and urban solid and air wastes generated by Kolkata at no cost to the city. **b)** Fulfil substantially the requirement of fish, vegetables and food-grains in the city. **c)** Absorb the pollution from, and purify the air that citizens breathe. **d)** Absorb and pass to downstream creeks and the sea the flood waters that the monsoon brings to the city. **e)** Provide a habitat for a variety of flora and fauna and living organisms endemic to wetlands. **f)** Provide the food chain and waste-to-wealth recycling so unique and essential to this city. **g)** Maintain the micro-climatic condition of the region. **h)** Maintain the delicate ecological balance in a fragile environment and eco-system. **i)** Provide livelihood support for thousands of local villagers who also have the unique skill of using wastewater to grow fish and vegetable and thereby help sustain a stable urban fringe.



Map 32 – Landuse Map of East Kolkata Wetlands, 2016

Plate 53b: Vegetation adjoining Wetlands

Types of Fish found in EKW- The commercially important aquatic species in the EKW includes 58 species of fish, 11 species of prawns, 3 species of crabs and 20 species of molluscs. Among the 58 species 10 are exotic and 48 are indigenous fish species. In EKW, among the 58 species of fish, 17 are culture species and 41 are wild species.

Eight indigenous fish, viz., *Catla catla*, *Cirrhinus mrigala*, *Labeo bata*, *Labeo calbasu*, *Labeo rohita*, *Lates calcarifer*, *Liza cephalous*, *Liza parsia* and 9 exotic fish, i.e., *Aristichthys nobillis nobilis*, *Clarias gariepinus*, *Ctenopharyngodon idela*, *Cyprinus carpio*, *Hypothalmicthyes molithrix*, *Oreochromis mossambica*, *Oreochromis nilotica*, *Pangassius sutchi*, *Piaractus brachypomus* are being used for aquaculture.

Forty five indigenous and 9 exotic fish species which are available naturally in EKW have good ornamental potential. Among the prawns commercially important species are: *Macrobrachium lamarraei*, *Macrobrachium rude* and *Macrobrachium malcomonii*. *Sartoriana spinigera* is an important crab species among all. Among the molluscan species important gastropods are: *Bellamya bangalensis* and *Pila globosa*, and Lamellidens *marginalis* is an important bivalve species in EKW.

Plate - *Labeo bata, catch in East Kolkata Wetlands .Plate - Pangassius sutchi*

III. Public owned water bodies: Kolkata has a number of man-made lakes within its municipal borders. They provide habitat for a number of aquatic and avian species and accommodate various recreation activities. Urban development has adversely affected the environment of these lakes. Surface water bodies in Kolkata are many. Apart from part of the water bodies of East Kolkata Wetlands falling in Wards 57, 58 and 108 there are two large lakes – **Rabindra Sarobar** in the southern part of the city (also known as Dhakuriya Lake) **Subhas Sarobar** (also known as Beliaghata lake) in the eastern part of the city and a fairly large wetland – Brace bridge Nature park (also known as Taratala Jheel) in the western part of the city. Here is a list of public owned water bodies within KMC.

Table 14 - Lakes/Waterbodies in KMC exceeding 1 hectare in Surface area

Sl.	Lake / Waterbody / Maintained by	Area (Ha.)	Location	Uses	Coordinates
1.	**Brace Bridge Jheel**	65.0		Recreation, Swimming, Boating, Sports, Waterfowl habitat, Nature conservation etc.	22°31'22.77"N 88°17'42.33"E
2	**Rabindra Sarobar**	29.5		Rowing , Pisciculture, Waterfowl habitat, Nature conservation, Sewage disposal, Domestic water disposal, Water supply, Washing, Bathing etc.	22°30'41.77"N 88°21'42.53"E
3.	**Victoria Memorial Hall Pond**	24.2		Beautification	22°32'45.24"N 88°20'39.67"E
4.	**Subhash Sarobar**	16.0		Recreation	22°34'8.35"N 88°24'2.04"E
5.	**Alipur Zoo Garden Pond**	4.0		Recreation	22°32'22.75"N 88°19'51.92"E
6.	**Eden Garden Jheel**	4.0		Recreation	22°33'53.08"N 88°20'29.68"E
7.	**Laldighi / Tank Square / B.B D Bagh**	1.2	Ward 45	Angling, Nature conservation, Waste disposal, Deflection, Water supply, Washing, Bathing etc.	22°34'19.28"N 88°20'56.03"E
8.	**Goldighi / College Square / Vidyasagar Udyan**	1.0	Ward 40	Angling, Nature conservation, Waste disposal, Deflection, Water supply, Washing, Bathing etc.	22°34'28.85"N 88°21'49.58"E

a. Rabindra Sarobar

In 1940 Kolkata Improvement Trust (KIT) undertook deteriorated excavation works for developing an area popularly known as Dhakuria Lake. The area adjoined the Sealdah - Budge Budge railway line and was the most prominent open space in Kolkata after the Maidan. In 1958 KIT renamed it Rabindra Sarobar. Rabindra lake covers an area of about 77.6 ha, of which about 72 ha, is occupied by water. The total complex includes four islands , three children's park, a mosque (on one of the islands) , a safari park , a stadium , an open air theatre (Nazrul Mancha) and eight club premises for rowing , swimming and aquatic sports . There used to be a fish sanctuary, but this attraction was lost because of the deterioration in water quality. Conservation problems in Rabindra lake include congestion of the drainage system resulting undesirable water logging and an unsanitary condition in general. Southern part of the lake is extensively used for bathing, washing, cleaning and other community purposes by the local residents. Even though there is a provision of public toilet in the lake premises the people still use the lake water for their daily necessities. There are recreation facilities like boat clubs and swimming clubs in that area. There is heavy eutrophication of the lake water due to excessive human interference. There is no systematic lake sanitation or park maintenance.

Map 33 – Location of Rabindra Sarobar

Plate 54: Rabindra Sarobar

Plate 55: Different activities in Rabindra Sarobar

The area around this excavated lake was later dev developed to build recreational complexes, which included children' parks, gardens and auditoria. Today the lake and its surrounding areas are one of the most popular recreational areas in Kolkata. Around 38% of the total area (73 acres) constitutes the water body while the residual area comprises of varieties of plant/tree species some of which are century old. It is surrounded by Southern Avenue to the north, Russa Road to the west, Dhakuria to the east, and the Kolkata Suburban Railway track to the south.

There are four islands inside the lake, one of which is connected to the shore by a hanging bridge and harbours a Masjid. Rest of the three islands are uninhabited and forms important roosting and nesting grounds for resident water birds like *Cormorants, Egrets, Night Herons, Pond Herons, Painted Storks, Asian Openbill*, etc.

A partial tree census in 2012 recorded 50 different species. In the winter, one can spot some migratory birds around the lake, though the numbers are dwindling because of the rise in pollution level.

Some parts of the wetland have emergent and floating vegetation like Lotus (*Nelumbo nucifera*), Sushnishak (*Marsilea minuta*), Hingcha (*Enhydra fluctuans*), Water Chestnut (*Trapa natans*), Borati (*Panicum paludosum*), Kachu (*Colocasia esculenta*), *Hydrilla Verticillata, Vallisneria spiralis, Pistia stratiotes, Lemna perpusilla, Salvinia molesta, Spirodela polyrhiza, Azolla pinnata* etc.

There is seasonal invasion of Water-hyacinth (*Eichhornia crassipes*) as well that has to be removed every year. The lake itself is home to many varieties of fish. Fishing is strictly prohibited.

A number of people come for a walk around the lake in the mornings to enjoy the fresh air. Many visit the sunrise point to offer their prayers to the sun. During the day, it is visited by families on a picnic, tourists, young lovers and joggers. The transition of Dhakuria lakes to parks and recreation grounds from a situation seemingly impossible of improvement being malariously marshy to its present state of sylvan retreat represented sustained supervision and maintenance: known as Rabindra Sarobar, today it represents the Lungs of South Calcutta with massive environmental fillip of extensive tree planting carried out under the supervision of the Calcutta Horticultural Society.

Based on KMC records of 2016 , there are about 142 species of trees in Rabindra Sarovar. Based on our Survey we found the following ones-Table 15

Sl No	Name of the common trees	Scientific Name	GPS Coordinates
1	Earpod Wattle Akashmoni	*Acacia auriculiformis*	22.51101N, 88.36419E
2	Pakur	*Ficus benjamina*	22.51111N, 88.36345E
3	Saranga		
4	Tumri8/Pitali tree (Femal Le)	*Trewia nudiflora*	22.51105N, 88.36508E
5	Kanak Champa	*Pterospermum acerifolium*	22.51101N,88.36464E
6	Wild Almond Tree		22.51102 N, 88.36427 E
7	Black Bean tree	*Castanospermum australe*	22.51100N, 88.36418E
8	Canon Ball tree	*Couroupita guianensis*	
9	Takoli	*Dalbergia lanceolaria ssp. lanceolaria*	22.51111N, 88.36375E
10	Mahogany	*Swietenia mahagoni*	22.51119N, 88.36380E
11	Shirish	*Albizia saman*	22.51111N, 88.36375E
12	Soap Nut Tree	*Sapindus mukorossi*	22.51107N, 88.3634E
13	Shisam	*Dalbergia sissoo*	22.51110N, 88.36346E
14	Weeping Fig		
15	Casurina	*Casuarina equisetifolia*	22.51127N, 88.36293E
16	Karanj	*Pongamia pinnata*	22.51128N, 88.3629E
17	Hijal	(*Barringtonia acutangula*)	22.51131N, 88.36272E
18	White Teak	*Gmelina arborea*	22.51135N, 88.36269E
19	Mock Bodhi Tree	*Ficus rumphii*	22.51134N, 88.36259E
20	Peepul	(*Ficus religiosa*	22.51178N, 88.36176E
21	Banyan	*Ficus bengalnesis*	22.51202 N, 88.36118 E
22	Fragrant Padri Tree	(*Stereospermum chelonoides*)	22.51222 N, 88.36060 E

Plate 57: *Dalbergia lanceolaria ssp. lanceolaria*

Plate 58 – Cormorants (*Phalacrocoracidae*) are very common in Rabindra Sarovar.

Plate – 59 – Blue Throat Barbet *Megalaima asiatica* in Rabindra Sarovar

Plate 59 a. – Fish Biodiversity in Rabindra Sarovar

Plate 59 b – Migratory birds of Rabindra Sarovar

Water quality of Rabindra Sarobar is monitored each month by WBPCB and the data pertaining to 2011 is given in table. The tabulated data shows the following characteristics:

• DO varied from 7.2 to 12.1 mg/I with no systematic seasonal variation.

• BOD varied from 0.9 to 7.55 mg/I with no systematic seasonal variation.

• pH was mildly alkaline and varied from 7.55 to 8.41 with no systematic seasonal variation .

• Generally low (less than 50 mg/l) Total Suspended Solid

• Faceal coliform varied from low (4000-13000 MPN/100ml) during monsoon to high (13000 reaching up to 17000 MPN/100 ml.) during winter months

• Total Coliform varying from (8000 MPN/100 ml) during rainy months reaching up to a high of 280000 MPN/100 ml during winter months

• Total Dissolve Solid average around 200 mg/l with no seasonal trends

• Nitrate-N was mostly below detection limit reaching a high of about 0.14 mg/l

Concentration of heavy metals like Lead, Chromium, Cadmium, Nickel, Copper, and Zinc were below their respective detection limits.

Plate 58: Neglecting NGT's order, *Chhath* Puja celebrated at Rabindra Sarobar lake in presence of police (Source – TOI)

b. Subhas Sarobar (22°34'6.36"N 88°24'3.55"E)

Subhash Sarobar is located in the north eastern part of Kolkata and covers a total area of 37 ha of which the water area is about 16.2 ha. Two islands, one small and the other large constitute an excellent habitat for diverse species of life. The water area is leased to the Department of Fisheries of the Government of West Bengal and the responsibility for pond sanitation rests with the license. It has a swimming club, an angler's club and a cafeteria.

Map 34– Location of Subhas Sarobar, High Resolution Image

Plate 60a: Subhas Sarobar, Beliaghata

Water Quality in Subhas Sarobar-WBPCB (submitted by Institute of wetlands Management and Ecological Design) systematically studied lake water quality of the Subhash Sarobar Lake during 1998-2000. Concentration of total solids in water was around 1000mg/l with BOD and DO concentration varying between 10 and 20 mg/l & between 5 and 7 mg/l respectively. Pb in the lake was detected in very low concentrations throughout the year . Zn concentration in lake water was more or less constant throughout the year. Hg, Cd and Cr co concentration were below their respective detection limits. In Lake Bottom sediments, Pb was measured in appreciable amount throughout the year. Subhash Sarobar

As a part of implementation of EMP of KEIP Phase 1, lake water of Subhas Sarobar was analyzed during late winter of 2012. BOD and DO of the lake water were around 15mg/l and 5mg/l respectively. Total and Faceal coliform load of the water were of the order of 10^3 MPN/100 ml of water. (Table 16)

Parameters	Values
Temperature	31.5^{o}C
Colour Unit	2.0
Turbidity	8.67 NTU
Odour	2 TON
pH	7.18
Total Solids	610 mg/l
Dissolved Oxygen	5.2mg/l
B.O D	15mg/l
C.O.D	50mg/l
Total Coliform	1.2x103mpn/100ml

Based on the data from WBPCB, 2012-13.

Plate 60b: Subhas Sarobar, Beleghata

IV. Private lakes and other water bodies

In addition to the afore-mentioned three lakes, there are innumerable ponds and squares present throughout the city. Some of them have been converted to cement banked pools. However, a majority of the rest of them are unbanked and are used by people for bathing and cleaning. Many of these ponds are simultaneously used for Pisciculture. These water bodies not only serve the purpose of having open space amidst concrete jungle of the city but also serve mane ecological, micro climatic, civic, and social functions. KMC listed about 3874 ponds within its municipal area. Ray (2010) studied 48 traditional ponds having an approximate age varying from 75 to 750 years especially in terms of their history and present condition. Notable amongst these ponds are Sendighi (750 years, ward 111), Raydighi (400 years, ward 127), Kamala (400 years, ward 127), Bimala (400years, ward 127) and Lal Dighi (350 years, ward 45). The distribution of water bodies in the KMC area is shown in figure.

A large number of lakes and other water bodies in the KMC area are in private ownership. These are described as follows (Table 17)

Name	Ward	Area m^2	Uses	Observed Environmental Quality	GPS COORDINATES
Bosepukur	107	4149	Bathing, washing clothes, washing vehicles	Water quality is very bad. The water is highly infested with duckweed. The pond situated adjacent to the road, heavy surface runoff. The sewage goes into the road. Solid waste disposal site at a close proximity, rubbish thrown in pond. Overall environment is polluted.	22°31'5.20"N 88°22'59.95"E
Anandapur	108	669	Bathing Fishing	Solid waste disposal into the pond. Heavy growth of water hyacinth. Sewage disposal. Open defecation. Surface run-off. Overall environment quality is poor, but it can be improved. Heavy growth of water hyacinth. Sewage disposal. Open defecation. Surface run-off. Overall environment quality is poor, but it can be improved.	22°30'52.14"N 88°24'37.91"E

Name	Ward	Area m^2	Uses	Observed Environmental Quality	GPS COORDINATES
Bengal Lamp Pond	93	13500	Washing, Bathing	Totally eutrophicated pool. Water quality is very bad. Sewage directly falls into the pond. Surface run-off. Surrounding area is institutional. Overall environment is good and the lake can be developed.	22°29'58.86"N 88°22'5.74"E
Santoshpur	103	8470	Swimmimg , Bathing,washing, Fishing	The water quality is moderate. Solid waste disposal site in the close proximity. Garbage thrown into the water. Heavy growth of algae. Overall environment is congential for future development.	22°29'28.81"N 88°23'43.35"E
Survey Park Pond	109	8471	Swimming, Bathing, Washing, Fishing	The water quality is good. Less of water weeds and algae. An ideal environment for developing the lake.	22°29'30.74"N 88°23'29.46"E
Jadavpur Employees cooperative housing society pond	109	13383	Swimming Bathing Washing Fishing	Water quality is fairly good. An ideal environment for development. Solid waste disposal is nnot seen at the place.	22°30'20.35"N 88°21'57.66"E
Patoli Pond	101	3645	Swimming ,Bathing Washing ,Fishing	Water quality is good. Ideal environment for development. Not much of greenery in the surrounding area	22°28'13.45"N 88°23'27.69"E
Haltu – Kayaspara more	105	4215	Washing , Bathing Washing vehicles	A polluted lake. Water quality is bad. Poor environment quality and development requires a lot of efforts .	22°30'15.23"N 88°23'11.64"E
Kantal beria	140	9250	Washing, Bathing, Sewage Disposal , Solid waste disposal	Environment quality is very bad and cannot be developed	

Name	Ward	Area m^2	Uses	Observed Environmental Quality	GPS COORDINATES
Satgharia Big Lake	140	2630	Washing, Bathing, Sewage disposal Solid waste disposal	Environment quality is very bad	
Heydara(Badartala)	139	6830	Washing, Bathing, Sewage disposal , Solid waste disposal	Very poor Environment quality	22°32'3.91"N 88°15'10.05"E
Pond Prince Anwar Shah road	93	1823	Bathing Washing	Water is fairly good.	22°30'6.77"N 88°21'4.11"E
Tiljala	66	10,706	Washing clothes Bathing Solid waste Dumpsite	Environment is also good for devepolment. Water quality is bad. Surrounding environment is not very good.	22°31'38.99"N 88°23'28.53"E

Map 35– Location of Bosepukur 22°31'5.18"N 88°22'59.97"E

Map 36 – Location of Survey Park

Map 37– Location of Water body in Tiljala

V. Traditional (heritage) Ponds of Kolkata – Mohit Roy (2010) studied 48 Traditional Ponds having approximately age varying from 75 to 750 years especially in terms of their history and present condition. Most of these ponds also have some fascinating history. During the British rule especially to meet the need of drinking water for the city residents these water bodies were excavated. Presently, nearly a million people use these water bodies and thus make them important natural resources for the city.

Table 18 :Important / Heritage Waterbodies of Kolkata more than 200 years old

SL	NAME OF THE POND	LOCATION	NEARBY LANDMARK	GPS COORDINATE		WARD NO	AGE YEARS	STATUS
				Longitude (E)	Latitude (N)			
1.	Azad Hind Bag	Bidhan Sarani	Scottish Church College	88°22′00″	22°35′16.5″	27	>200	Good
2.	Balali Pukur/ Rash Bagan	Raja Rajendra Lal Mitra Road	Old Temple	88°23′22.9″	22°35′59.43″	34	>200	Bad
3.	Bhukailas Rajbarir Pukur	Khiddirpur	Shiva Temple	88°32′05.34″	22°29′01.86″	79	230	Poor
4.	Bimala	Sarsuna Bus Stand	-	88°17′43.6″	22°28′51.07″	127	415	Poor
5.	Birjee Talao	J. L. Nehru Road	Nehru Children's Museum	88°20′47.81″	22°32′33.46″	63	>200	Poor
6.	Chandi Pukur	Barisha	-	88°18′32.63″	22°28′50.29″	126	279	Moderate
7.	Chatterje e Para Pukur	Sarsuna Main Road	Six Siva Temple	88°17′26.23″	22°28′49.86″	127	>200	Poor
8.	Chetla Mosque	P. M. Roy Road	Chetla Mosque	88°20′57.30″	22°30′12.93″	82	>200	Poor
9.	Collage Square / Gol Dighi	Collage Street	Calcutta University	88°21′50.91″	22°34′19.56″	40	>200	Good
10.	Garia Smasaner Pukur	Boral Road	The Crematorium	88°22′44.91″	22°27′04.49″	111	>200	Moderate
11.	Jhinjiri Talao	Dr. Md. Isaque Road	Govt. Art College	88°21′06.08″	22°33′23.13″	52	>200	Poor
12.	Kamala	Sarsuna Main Road	Sarsuna Market	88°17′38.00″	22°28′46.5″	127	415	Bad
13.	Lal Dighi	BBD Bag	Writer's Building	88°02′56.85″	22°34′19.22″	45	>300	Good
14.	Mandir Pukur	Mandirtala	Shitala Temple	88°17′22.20″	22°28′30.70″	127	>200	Moderate
15.	Manohar	J. L. Nehru	Opposite	88°20′59.94″	22°33′35.29″	46	218	Poor

SL	NAME OF THE POND	LOCATION	NEARBY LANDMARK	GPS COORDINATE		WARD NO	AGE YEARS	STATUS
				Longitude (E)	Latitude (N)			
	Das Tarag	Road	Lindsay Street	/				
16.	Minto Park	J. L. Nehru Road	Opposite Lindsay Street	88°20′59.94″ /	22°33′35.29″	42	218	Good
17.	Murari Pukur	Murari Pukur	Ramkrishna Sevadal Club	88°23′01.8″	22°35′14.1″	14	>100	Moderate
18.	Padda Pukur	Sarat Bose Road	-	88°21′09.3″	22°31′53.06″	72	>200	Good
19.	Pagla Pirer Pukur	Jubilee Park	Tollygunge Tram Depot	88°20′54.7″	22°29′40.5″	94/89	350	Bad
20.	Raghu Mollar Pukur	Sarsuna	Near Shitala Mandir	88°20′57.30″ /	22°30′15.93″	127	>200	Bad
21.	Rasbarir Pukur	Sarsuna	Das Family House	88°17′35.6″	22°28′25.6″	126	>250	Bad
22.	Ray Dighi	Biren Roy Road	-	88°17′46.03″ /	22°28′58.84″	127	>400	Bad
23.	Sen Dighi	Boral	Tripursundari Temple	88°22′12.79″ /	22°27′14.94″	111	>750	Moderate

Plate 61: Lal Dighi, Tank Square, B.B D Bag. Heritage of the city

Map 38: High Resolution Satellite Image showing the location of Lal Dighi

Plate 62: Old Photograph of Tank Square in front of GPO

4.2.3a Lal-Dighi (Benoy-Badal-Dinesh Bag)– With an area of 25acres of land it is one of the most important waterbody in the history of Kolkata. This waterbody existed before the city was formed (approximately 300 years). However this waterbody was renovated by the British in 1707 and was named as The Great Tank . Presently this waterbody is under West Bengal Fisheries .There is an angling Club there .

Plate 63 : Lal Dighi , overlooking Writer's Building

Water Quality - Tests carried out by SAFE (South Asian Forum for Environment) in 2016-17 reveal that the biological oxygen demand and turbidity of the water is high, making Lal Dighi non-conducive to aquatic life. Barring silver carps, rohu and catla, no other variety of fish survives in the tank. Smaller varieties of indegenous fish, which are indicators of good water quality, have disappeared from the waterbody. Phytoplanktons and other micro-organisms, along with other aquatic animals, are dying out due to lack of oxygen in the water.

Map 39: High Resolution Satellite Image Showing Sen Dighi

Plate 63: Sen Dighi, Boral, Perhaps the oldest water body of Kolkata

b. Sen Dighi - Boral: Dating back to the 12th century, Sen Dighi in Boral is possibly the oldest water body in south Bengal. Sen Dighi in Boral on the southern fringes of Kolkata has survived centuries of negligence, contamination and encroachment. It has seen change of rule, dynasties, eras and witnessed the metamorphosis of the region from a marsh-infested forest land to a thriving habitat. While more than half the water bodies in the area have vanished and an expanding city has consumed wetlands, Sen Dighi has existed for an incredible 800 years. The 23-bigha pond, a heritage waterbody, now faces a challenge from immersion-induced pollution and its fragile banks are steadily being eaten into by garbage dumps. Around 20 km from Kolkata, Sen Dighi was dug by Ballal Sen, the second ruler of Bengal's Sen dynasty, in the late 12th century. It must have measured close to a hundred bighas then and was the principal source of water for a large swathe of area to the south of Kolkata, according to Madhu Basu, who has chronicled the history of Sen Dighi. "The city didn't exist then and it was a practice to dig huge waterbodies that would be taken care of by locals. Almost every house had a tank attached to it. But Sen Dighi stood out due to its size and the fact that it was maintained by the local Tripura Sundari temple that still survives. It is one of the last symbols of the regions past prosperity. Till a hundred years ago, the pond would be surrounded by brick kilns. Legend has it that a trader named *Maheshwar Shau* from Odisha had introduced fish cultivation at Sen Dighi.

A study of its water revealed that the biological oxygen demand of Sen Dighi is high. The water quality has taken a beating ever since the pond was thrown open to immersions and Chhat festivities, according to locals and experts. Even though idols are removed quickly, the residue is enough to affect the water, they say. Perhaps, a bigger threat to the pond is posed by the eroding banks, made unsteady by devotees who have been clearing vegetation along the edges during Chhat. It has led to the uprooting of two trees and another has been left unsteady. These trees are crucial to the survival of Sen Dighi since they have been holding the banks together.

c. College Square: This is one of the oldest waterbodies in Kolkata. Situated on College Street, an area full of academic institutions and the main complex of Calcutta University, it has remained a centre of activities for many years. It is one of the waterbody which has been renovated by Lottery Committee in 1820 .Originally it has been round shape but later in 1912-13 changed into a square.

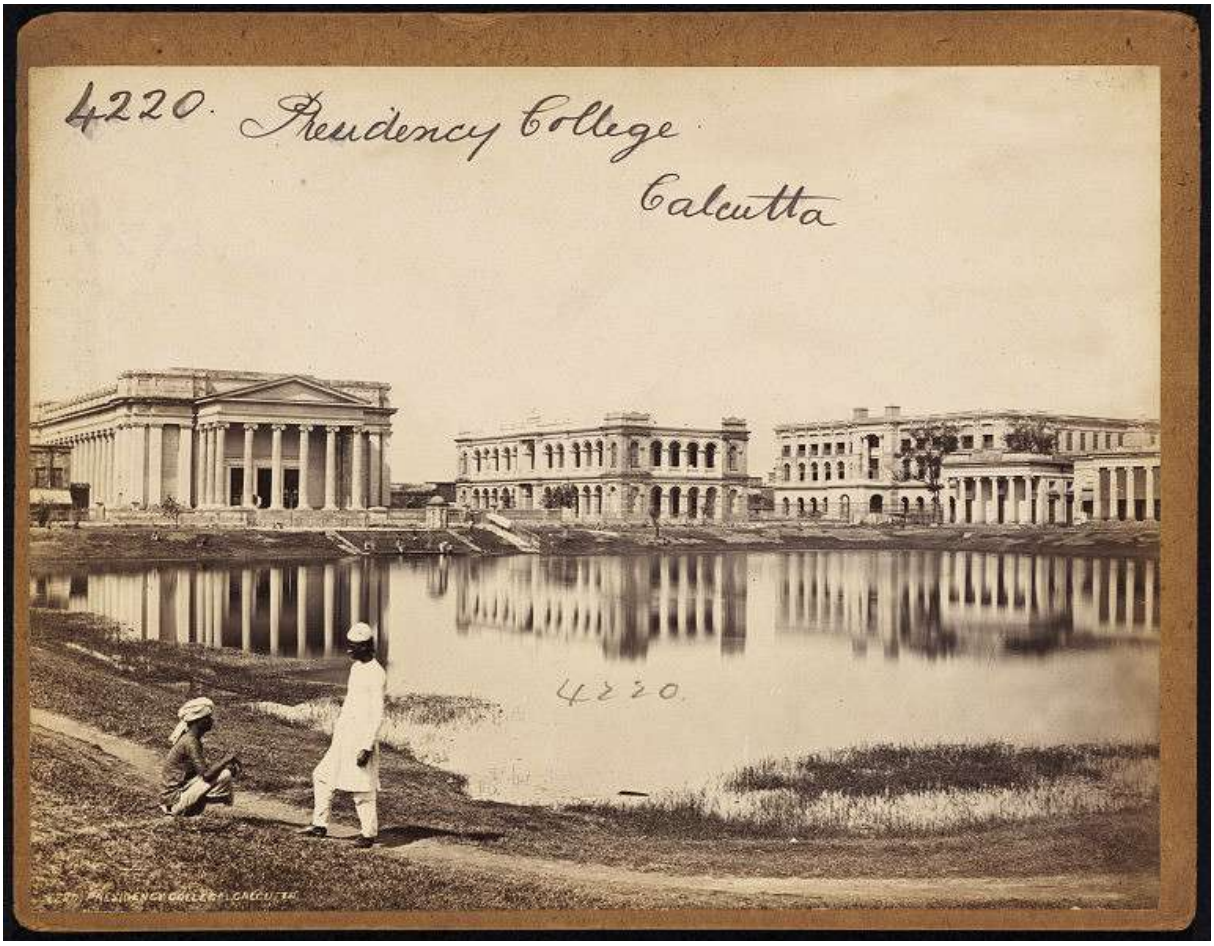


Plate 64: Old Photograph of College Square

d. Azad Hind Bagh: Hedua

Map 40 – Goldighi, College Square or Iswar Chandra Vidyasagar Udyan

Plate 65 & 66-The original name of the waterbody was Hedua or Hedo, probably from Sanskrit word Hrad (Lake). another idea is that it is transformed from Endo, Endo to Hedo to Hedua . Once part of the estate of Maharaja Nandakumar, the pond was dilapidated (endo) and later renovated by Lottery Committee (1738-1805). The pond was named as Cornwallis Square and later changed into Azad Hind Bagh. This waterbody also had one of the first swimming clubs in the country in the year 1924. An English lady started this club but was associated with important nationalist leaders like Deshbandhu Chittaranjan Das or Netaji Subhas Chandra Bose. This area was used as a hide out for the revolutionaries. The primary educational institutions surrounding this pond were – Bethune School and College- 1849 (the first female school of the country) and Scottish Church College -1837.

There are 3 swimming clubs in this pool and KMC looks after the maintenance of the pool. This pool has an underground link with River Hugli.

e. Manohar Das Tarag: This 218 years old waterbody was excavated by Manohar Das Shah ,a reputed banker . The waterbody was excavated in 1790 and was referred in Calcutta Gazette.

Plate 67: Old Photo of Manohar Das Tarag

Map 42 – Manohar Das Tarag

f. Shaheed Bhagat Singh Udyan, Minto Park

Plate 68: Minto Park, Source : Wikipedia

Map 44 – Maior Waterbodies of Kolkata

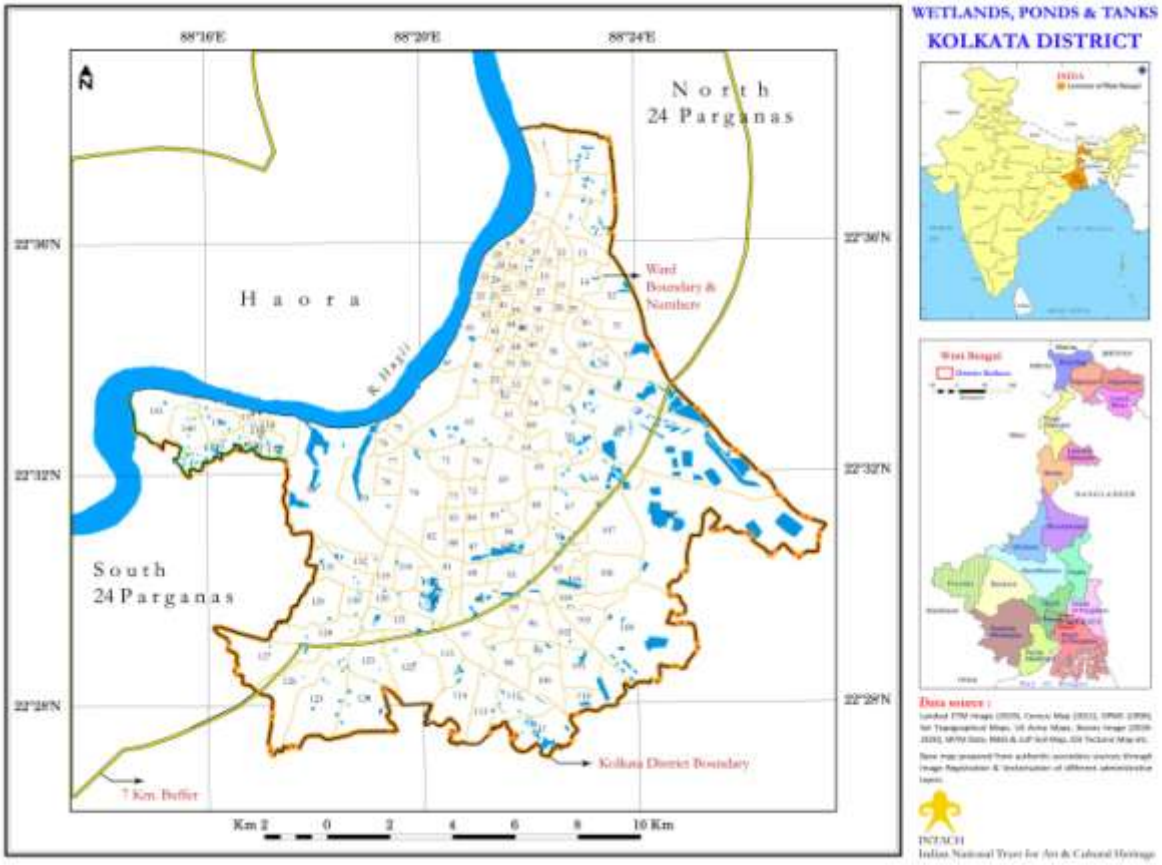
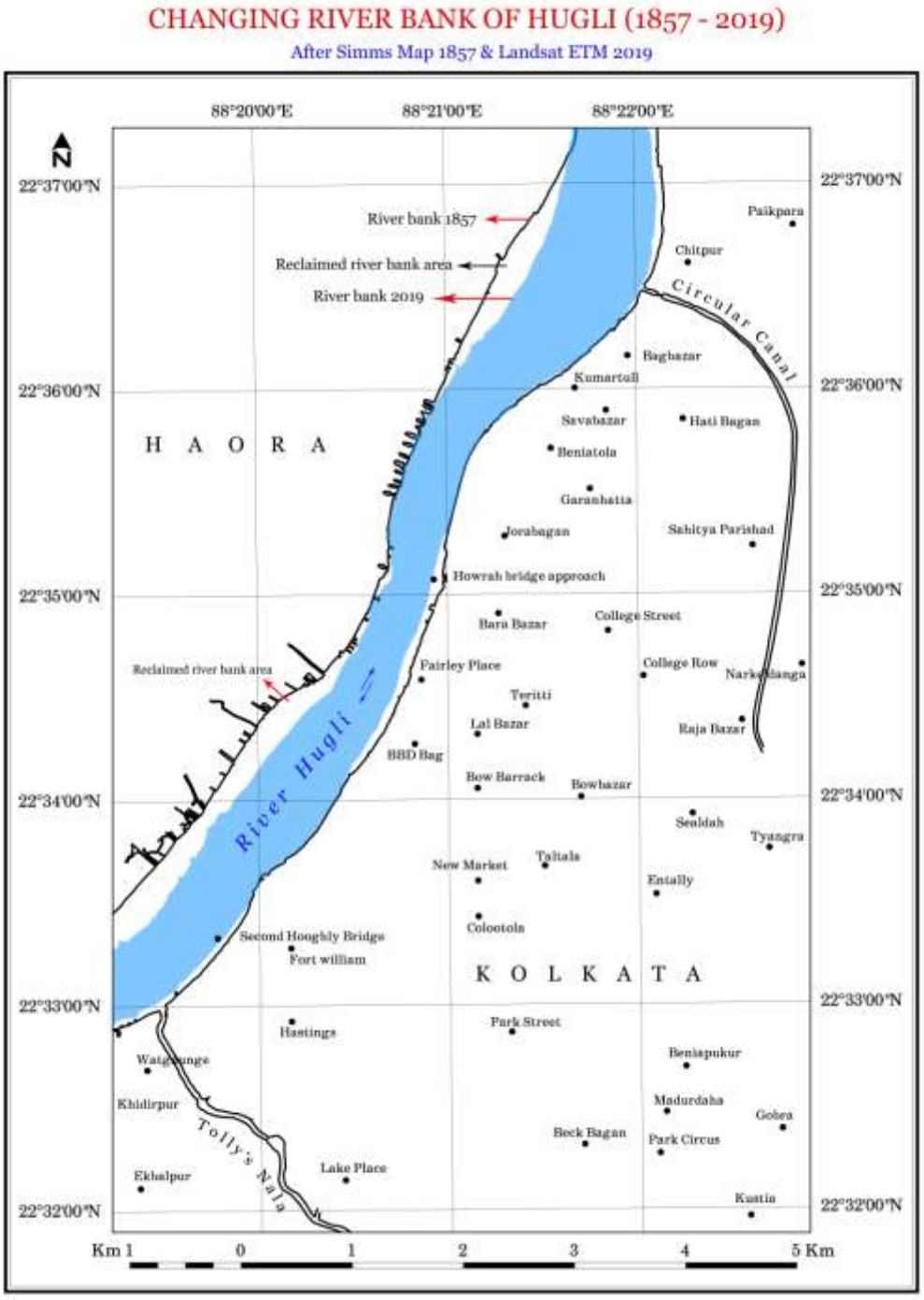


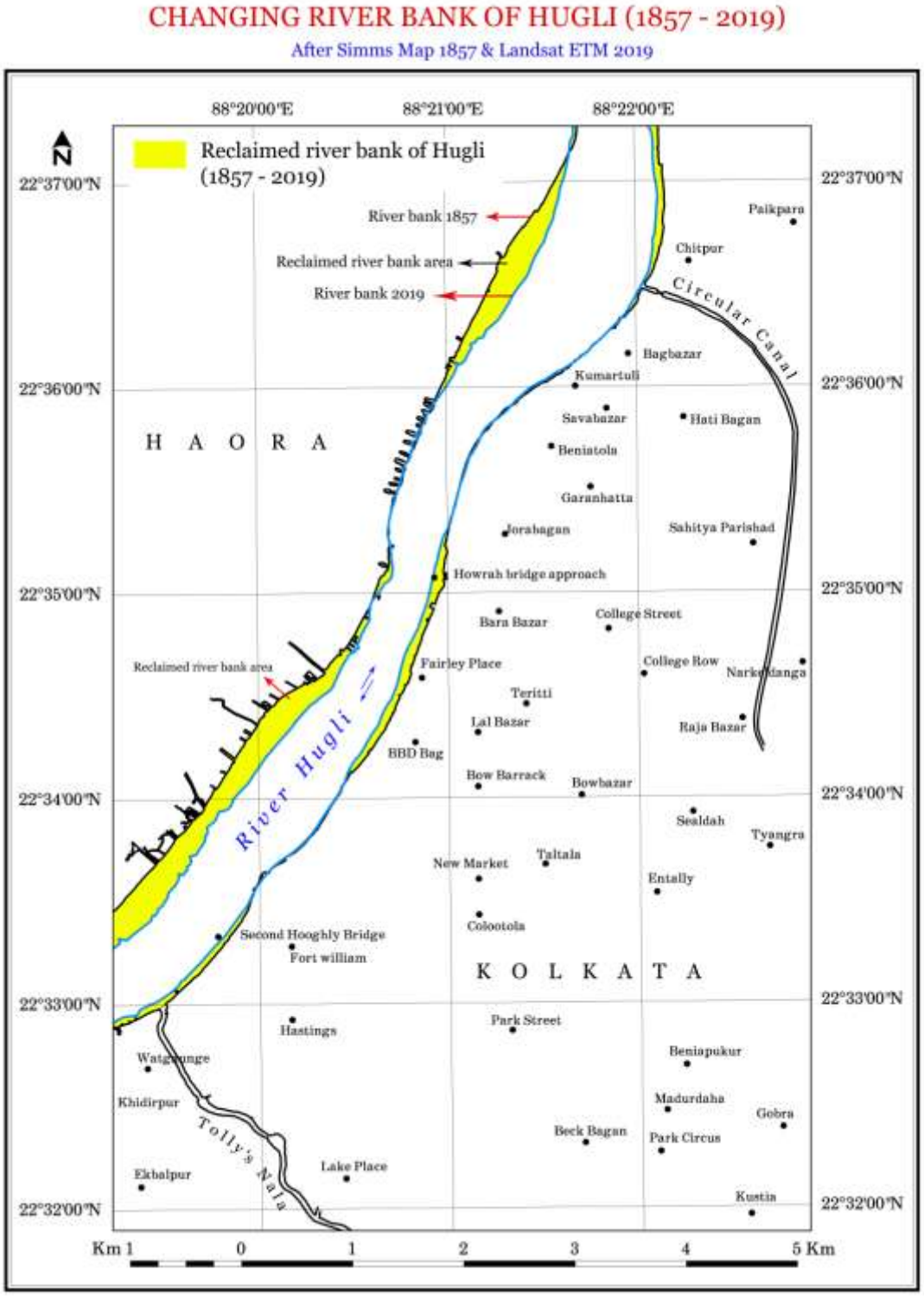
Plate 65 : Domestic activities in Bikramgarh Jheel, 22°29'54.40"N 88°21'43.57"E

Plate – Waterbodies near Tiljala area 22°32'0.72"N 88°23'41.59"E

Waterbodies near Panchannagram Canal area 22°32'3.48"N 88°23'32.77"E

4. 2B. River Hugli – Changing Characterestics - Change Detection in the River Bank Line– Within the stretch of Kolkata District (KMC) the river Hugli is highly regulated by embankments and Ghats. A map of Calcutta by Simms of 1857 is overlaid on the present day High Resolution Satellite Image to find out the changes in the bank line of the river. Changes were found in 3 sections from North to south. They are – a) Kashipur in the extremely northern side upto Chitpur Khal. b) From Jorabagan to Babughat c. Near the Off take point of Adi Ganga or Tolly's Nala.





Map 45 – Amount of river bank area reclaimed in Haora District is more significant than Kolkata side.

4.2C. Condition of the Confluence Points -Table 19

Within the boundary of Kolkata Municipal Corporation there are 2 major confluence points.

Sl. No	Name of the Confluence Points	GCP	Location	Condition
1.	**Circular Canal Off-Take Point**	22°36'29.15"N 88°22'2.16"E	**Chitpur/ Bagbazaar**	The Circular Canal or the Maratha Ditch as it was earlier called, begins at the River Hugli, near Baghbazar. Originally this channel was a shallow channel which became partly dry around 1800. Thereafter, widening and construction of the lock gate by the authorities were made in1810 on the Hugli. The canal becomes bifurcated near into two branches, the Krishnapur Canal and the Beliaghata Canal. The Krishnapur Canal or the Kestopur Khal moves north east and runs parallel to Salt Lake. It encircles the Salt Lake City and joins the river Kulti at Ghusinghata. The Beliaghata Canal flows along the Canal East and Canal West Road. The Lake Channel, was the natural drainage channel of the city. It was a spill khal (channel) of the Bidhyadhari. It extended from Dhapa to Bamanghata where it joined the Bidhyadhari and moved further south to the Samukpota and Tardah. This Central Lake Channel was affected by the construction of the Dhapa Lock in 1883.
2.	**Tolly's Nullah / Adi Ganga Off-Take Point**	22°33'2.19"N 88°19'29.29" E	**Hastings/ Khidirpur**	The Tolly's Nala was originally called the "Adi Ganga"(original Ganga). It begins at the Hugli, Dholghat Bridge. It passes through the Khiddirpur becomes bifurcated near Kudghat and flows along Tollygunj till it reaches Garia. Beyond Garia the flow diminishes till it meets the Bidyadhari at Samukpota. Mr. William Tolly, a major in the Military service, re-excavated the canal in the years 1770 to

				1777. It was constructed with a loan from the Government and was leased to him for a period of twelve years within which he could collect the toll from it. After his death it was extended for another 15 years to his widow Anna Maria Tolly. The other part of the southern canal proceeds from Kudghat up to Sundarbans passing Sonarpur, Canning, and Matla river. This canal is a major source of water for irrigation agricultural lands it passes through.

Map 47 & Plate 69 – Confluence Point of Adi Ganga

Plate & Map 48– Confluence of
Circular Canal and Hugli River

Plate 70: Confluence Point of Circular Canal (Chitpur area)

4.3. RIPARIAN / INSTREAM FLORA & FAUNA

The biodiversity of the lower Ganga Basin is largely controlled by freshwater flux, nutrient inputs and changing environmental condition like salinity, rainfall and temperature. Salinity is the most important chemical factor which affects the diversity and abundance of the biota of this basin directly. Because of the different physiological adaptability of different species of animals and plants to salinity ranges, specific biotic communities colonize different stretch of the basin depending upon the prevailing level of salinity and the tolerance limits of individuals in the community. Depending on the different groups of animals and plants found in the basin, the diversity can be differentiated between *Phytoplankton*, *Zooplankton*, *Macrobenthos*, *Nekton*, *Macrofauna* and *Angiosperms*.

Dutta, Malhotra and Basu (1954) were the earliest to study the characteristics of planktonic population (as part of aquatic ecology) of the Hugli River along the stretch near Baghbazaar. The phytoplankton consisted mainly of diatoms and green algae . Blue Green algae though present was less conspicuous. The peak period of the phytoplankton was during January. Average of the relative abundance of the three main groups of algae were diatoms (78.8%-85.15%) ,the green algae ((10.7%-18%),and the blue green algae (2.9%-4.2%) for two block years (1949-50,1950-51). *Euglenineae* and *Dinoflagellates* were grouped together as a residential group (0.06%-0.3%).The phytoplanktons consisted of mainly of fresh water forms. Only during the high salinity period (May-June) some brackish water forms were also found. The *Bacillariophyceae* (diatoms) were among the most numerous in the phytoplankton at all times of the year. Zooplanktons showed two maxima: one during November-March and other during May-June with fresh water forms predominating from July to October. *Protozoans* occurred in large numbers in the Hugli river at the station near Baghbazar. They were most abundant from November to February when salinity was low. *Rotifers* were the most characteristic group of fresh water animals in the zooplankton. *Copepoda* was most abundantly represented and formed the bulk of zooplankton in all collections throughout the period of survey of Hugly River. The total number and percentages of the zooplankton for the 2 years were *protozoans* [10168(42.7%)], *rotifers* [358(1.4)], *cladocera* [909 (3.7)], *copepod* [9026(35.5)], *nauplii* [2510(10.1) and *molluscs* [1178(4.8)].

Santra and Paul observed the *phytoplankton* of Hugli River (1989) near Outramghat for a period of 3 years (1984-87) and a total of 26 species of were recorded .Although species

belonging to *Cyanophyeeae*, *Chlorophyceae*, *Euglenophyceae* were present. *Bacillariophycean* members were always the dominant group. Due to industrial discharge of effluent and also discharge from cities and urban settlements, water of Hugly river had become polluted which was reflected by the presence of pollution tolerant phytoplankton species like *Euglena viridis*, *Phacus triqueter*, *Cyclotella striata* etc.Certain algal species were highly sensitive to sewage and industrial pollutants and presence of these forms (*Eunotia Gandhi*,*Fragilaria intermedia*,*Gomphonema tergestinum* and *Peridinium sp*) were restricted to only clean water.

In an effort to characterise the benthic faunal composition of Hugly estuary in and around Kolkata , Paul and Nandi (2003) identified and listed intertidal *macrozoobenthos* of Hugli River at 4 locations – **Baghbazaar, Kidderpore, Taktaghat, Kidderpore Doighat** and **Kidderpore Jettygate**. The macrobenthic fauna comprised species belonging to *Gastropoda* were dominant throughout the year owing to their larger body size and weight. However the biomass fluctuated highly due to difference in taxonomic composition in different station.

The highest value of index of dominance[5] (0.84 to 0.99) was recorded at Kidderpore Jettyghat and the other locations it varied from 0.3 to 0.90.

The estuarine stretch of Ganga is well known for its fauna richness. Vass et al (2010) noted that about 36 species of fish belonging to 19 families can be seen in the estuarine stretch. Among them *Notopteridae* and *Cyprinidae* families were in majority which included fishes like *Lobo rohita* , *Catla catla*, *Cirrhinus marigala*, *Notopterus Chitala*,*Notopterus notopterus*, *Rhinomuhil corsula*,*Lates Calcarifer*, *Sperata aor*, *Channa Striatus*,*Mystus Cavasius* etc. Among these sp *Tenuslosa Elisha* is very famous which is locally known as **Illish**.

The general characteristics of the estuarine stretch of Hugli river are as follows –

- a.Total Plankton in Hugly estuary varies from 29-935 1^{-1}
- b.Bulk plankton in the marine estuary is – *Bacillariophyceae* (70-95)%
- c.Other plankton group are – *Chlorophyceae*,*Cyonophyceae*
- d.Macro-benthos populations in the fresh water zone of Hughly mainly are *Gastropods*,followed by *Polychaetes* , *Oligochaetes*,*Decapods* and *Bivalves*.
- e.Density of Macro benthos varies from 74-1472 m^{-2}

Plate 71 – Hilsa Fish delicacy from lower Ganga

Plate 72: Prawn collected from Kolkata Bheri (East Kolkata Wetland)

4.4. SACRED TREES & THEIR HISTORICAL IMPORTANCE

There are many old trees in the city which are worshipped and treated as Sacred. Specially adjoining River Hugli and Adi Ganga there are many Banyan and Peepul trees which are worshipped everyday by the regular bathing folks residing in the vicinity . However there are 2 very important sacred trees in Kolkata , which are related with the city's old history.

Let us start with **Kalighat** and its association with the sacred tree. The famous Kalighat temple dedicated to the goddess Kali is situated on the banks of the Adi(original) Ganga near Kolkata. In fact, the name Kolkata (formerly Kalighat)is said to derive from this temple. The Kalighat temple is one of 51 Sakti Peetas of Goddess Sakti, where the toes of the right foot of the Dakshayani or Sati fell during the course of Shiva's Rudra Tandava. There is also an interesting legend connected with this temple. It is said that once a devotee saw a brilliant rayof light emanating from the Bhagirathi river bed and at its source he discovered a piece of stone carved in the form of a human toe. He also found a Swayambhu Linga of Nakuleshwar Bhairav nearby and started worshipping Kali in the midst of the thick jungle. The dominant species in the jungle is a cactus plant called **Sosthi Tala** (Balakrishnan, 2003) 4. Next to the main temple there is a large rectangular covered platform called Natmondir. From here, the face of the image can be seen. A large veranda called the Jor-bangla faces the main temple. From the Natmondir and through the Jor-bangla, one can have a clear view of the rituals being performed in the sanctum sanctorum. There is a three feet high rectangular altar with a **cactus plant called Shosthi Tala**. Below the tree, there are three stones placed on an altar representing the Goddesses Shosthi, Shitola and Mongol Chandi. This altar was constructed by Gobinda Das Mondal in 1880. The place of the altar is the Samadhi of Brahmananda Giri. Here all the priests are female. No daily worship or offering of Bhog (food offering) is done here. The Goddesses here are considered as part of Maa Kali.

Plate 73: Sacred Trees of Kalighat

Kalpaturu Day in Cossipur Udyan Bati- 1 January 1886, was "an event of unusual consequence and meaning" in the life of Ramakrishna and his followers. Ramakrishna was suffering from throat cancer at that time, and his health was declining. He and his closest followers had moved to a garden house in the northern Calcutta neighbourhood of Cossipore. 1 January was a relatively good day for him, and he took a walk in the garden. There, he asked one of his followers, Girish, a question he hd often asked before, "Who do you say that I am?" Girish responded that he believed that Ramakrishna was "God incarnate, come to Earth out of mercy for humankind". Ramakrishna replied, "What more shall I say? May you be awakened." Ramakrishna then entered an "ecstatic state" and began touching all of his followers. Those he touched reported experiencing a variety of new states of consciousness, including vivid visions. For one, Vaikuntha, the visions persisted and interfered with daily life, so that he feared that he might be going insane.

Plate 74: Kalpataru Tree

One disciple, Ramachandra Dutta, explained that Ramakrishna had, in effect become Kalpataru (also called *Kalpavriksha*), the "wish-fulfilling tree" of Sanskrit literature and Hindu mythology. Dutta named the commemoration of this mystical event "Kalpataru Day" as a result. This event "carried meanings and memories of cosmic import for the disciples and also prepared them for Ramakrishna's death",which occurred only a few months later, on 16 August 1886.

Beside these two very famous sacred trees of Kolkata ,there are many trees all along the Hugly River specially Peepul, Banyan, Neem which all are worshipped by the local people after taking bath in the river. river Sometimes directly the trees are worshipped but in many

cases some small temples or deities are kept under the trees for worshipping. There is a list of trees along with the GCP points.

4.4A. Sacred Trees along the bank of Hugli river : KMC (Table: 20)

SL. NO	LOCATIONS	SPECIES	GCP POINTS	DEITY WORSHIPPED
1.	Baghbazaar Maayer Ghat	Banyan Tree	22°36'22.77"N 88°21'57.47"E	Hanumaanji
2	Baghbazaar Battala Ghat	Banyan Tree	22°36'14.56"N 88°21'49.58"E	Shiva
3	Kashi Mitra Ghat Crematorium	Banyan Tree	22°36'9.06"N 88°21'43.37"E	Shiva/Kali and Mixed
4	Gopaler Ghat	Banyan Tree	22°35'59.53"N 88°21'27.68"E	Mixed
5	Ahiritola Ghat	Peepul Tree	22°35'45.02"N 88°21'11.07"E	Shiva
6	Manik Bose Ghat	Banyan Tree	22°35'43.15"N 88°21'9.80"E	Bhuteswar /Shiva
7	Nimtala Ghat	Banyan Tree	22°35'36.35"N 88°21'6.30"E	Bhuteswar /Shiva
8	Adya Shraddha Ghat	Peepul Tree	22°35'22.30"N 88°21'3.07"E	Tree
9	Jagganath Ghat	Banyan Tree	-	Jagganath
10.	Ram Chandra Goenka Ghat	Banyan Tree	22°35'3.48"N 88°20'56.33"E	Shiva
11	Chhote Lal Ghat	Banyan Tree	22°34'58.24"N 22°34'58.24"N	Hanumaan
12	Babu Ghat	Banyan Tree	22°33'58.48"N 88°20'23.94"E	Shiva
13	Pani Ghat	Banyan Tree	22°33'42.34"N 22°33'42.34"N	Mixed
14	Judges Ghhat	Peepul Tree	22°33'25.09"N 22°33'25.09"N	Shiva and the Tree
15	Doi Ghat	Peepul Tree	22°33'0.27"N 88°19'26.29"E	Tree

SOURCE - SURVEY

Plate 75: The Sacred Peepul Tree at the Adya Shraddha Ghat

Plate 76: The Sacred Peepul Tree near Dai Ghat

Plate 77: The Sacred Peepul tree at Pani Ghat 2

Plate 78: The Banyan Tree of the Battala Ghat is worshipped in North Kolkata

4.4B. Some other Historical Trees from the city Table -21

There are some historic trees associated with some iconic structures of Kolkata. They are landmark trees.

Sl. No	Name of the species	GCP	Location	Importance
1.	**Banyan Tree**	22°32'3.50"N **88°20'1.48"E**	National Library, Alipur	*A hulking banyan tree near the National Library in downtown Calcutta serves as a shade tree and a backdrop to a weekend football game*
2.	**Sundari Tree**	22°32'1.31"N 88°20'1.46"E	National Library, Alipur	*Once Kolkata was part of Sundarbans which has actually derived its name from Sundari Tree. Now because of environmental stress this species has almost become extinct.*
3	**Mango Tree**	22°32'47.66"N 88°21'36.68"E	Park Street Cemetery	*Calcutta's Park Street Cemetary is a final resting place for many Britisher's, and also home to some massive mango trees like this one*
4.	**Ghost Tree** or **Kulu Tree**	22°32'38.92"N 88°20'34.61"E	Victoria Memorial, Calcutta,	*This tree at Victoria Memorial, Calcutta, demonstrates one surprising use for the buttressed trunk-compartments for young couples to snuggle together.*
5	**Bodhi Tree / Peepul Tree**	22°32'42.83"N 88°20'50.04"E	Birla Planetarium	*Near Nehru's Planetarium and an Indira Gandhi Memorial at the Calcutta Maidans, this impressive peepal tree stands over a busy intersection*
6.	**Malsauri** or **Dhanva**	22°32'34.77"N 88°20'36.12"E	Victoria Memorial Hall	*A declining tree, dramatically placed in front of the Victoria Memorial's reflecting pool*
7.	**Bodhi Tree or Peepal**	22°33'16.92"N 88°21'1.18"E	Park Street	*At one of Calcutta's most crowded intersections, this small tree-shrine is passed by countless pedestrians and motorists going about their business on Park St.*
8	**Banyan Tree**	22°33'31.27"N 88°21'5.81"E	Fairlawn Hotel	*The Fairlawn is a Heritage hotel on Sudder Street in downtown Calcutta, and a large banyan tree offers much needed shade and*

Sl. No	Name of the species	GCP	Location	Importance
				oxygen there
9.	**Banyan or Baragad or Bad**	22°33'29.26"N 88°21'10.15"E	Sudder Street	*Sudder Street is Calcutta's backpacker haven, and a banyan tree on the streetside offers some welcome bit of green life*
10	**Banyan or Baragad or Bad**	22°33'21.67"N 88°23'22.62"E	Tyangra	*The Tangra 'Chinatown' area of Calcutta is home to many Chinese immigrants, and this large banyan is visible at a major crossing on South Tangra road.*
11.	**Banyan or Baragad or Bad**	22°35'33.58"N 88°21'9.72"E	Nimtala	*The Shri Bhootnath Baba Temple, Kolkata is one of the most famous temples designated to Lord Shiva. He is associated with all the spirits and bhoots hence the name Bhootnath. The Hindus rever Him especially in this regard because He is known to calm down the spirits and save the living. They also regard the Shri Bhootnath Baba Temple Prasad as the most sacred offering. This Shri Bhootnath Baba Temple is the ultimate destination to visit during the Shivratri season when Bhootnath Baba Himself is His fullest avatar. It is a spectacle worth watching.*

Plate 79: Ghost Trees of Kolkata Maidan

Plate 80: Malsauri or Dhanva in Victoria Memorial Hall

Plate 81: *Shri Bhootnath Baba Temple,Bargad Tree*

Chapter 5: Documenting major Structures in the River bank

5.1. MAJOR BRIDGES

There are 5 major bridges on Bhagirathi-Hugli River. Out of these 5 bridges 2 major bridges are found over Bhagirathi-Hugli River in the stretch of Kolkata. These two major bridges are – a. Rabindra Setu commonly known as Howrah Bridge and b. Vidyasagar Setu or 2nd HugliBridge.

5.1A. Rabindra Setu or Howrah Bridge

Plate 79: Construction of Bridge (Source BBJ Website)

Official Name: Rabindra Setu
Design: Suspension type Balanced Cantilever and truss arch
Total Length: 705 m (2,313.0 ft)
Width: 71 ft (21.6 m) with two footpaths of 15 ft (4.6 m) on either side
Height: 82 m (269.0 ft)
Longest Span: 1,500 ft (457.2 m)
Construction Begin & End: 1936 - 1942
Opened: 3rd Feb, 1943
Daily Traffic: 100,000 vehicles and 150,000 pedestrians

Plate 80: View of Howrah Bridge (Rabindra Setu)

The Howrah Bridge / Rabindra Setu is a cantilever bridge with a suspended span over the Hooghly River in West Bengal, India. Commissioned in 1943, the bridge was originally named the New Howrah Bridge, because it replaced a pontoon bridge at the same location

linking the two cities of Howrah and Kolkata (Calcutta). On 14 June 1965 it was renamed Rabindra Setu, after the great Bengali poet Rabindranath Tagore, who was the first Indian and Asian Nobel laureate. It is still popularly known as the Howrah Bridge. The bridge on the Hooghly River is a famous symbol of Kolkata and West Bengal. It weathers the storms of the Bay of Bengal region, carrying a daily traffic of approximately 100,000 vehicles and possibly more than 150,000 pedestrians, easily making it the busiest cantilever bridge in the world. The third-longest cantilever bridge at the time of its construction, the Howrah Bridge is the sixth-longest bridge of its type in the world.

In the view of the increasing traffic across the Hooghly river, a committee was appointed in 1855-56 to review alternatives for constructing a bridge across it. The Calcutta Port Trust was founded in 1870, and the Legislative department of the then Government of Bengal passed the Howrah Bridge Act in the year 1871 under the Bengal Act IX of 1871, empowering the Lieutenant-Governor to have the bridge constructed with Government capital under the aegis of the Port Commissioners. Eventually a contract was signed with Sir Bradford Leslie to construct a **pontoon bridge**. So a pontoon bridge was ordered from England and was assembled in Calcutta by the Port Trust. The bridge was considerably damaged by the great cyclone on 20 March 1874. A steamer named Egeria broke from her moorings and collided head-on with the bridge, sinking three pontoons and damaging nearly 200 feet of the bridge. The bridge was completed in 1874, at a total cost of 2.2 million, and opened to traffic on 17 October of that year. The bridge was then 1528 ft. long and 62 ft. wide, with 7-foot wide pavements on either side. Initially the bridge was periodically unfastened to allow steamers and other marine vehicles to pass through. Before 1906, the bridge used to be undone for the passage of vessels during daytime only. Since June of that year it started opening at night for all vessels except ocean steamers, which were required to pass through during daytime. From 19 August 1879, the bridge was illuminated by electric lamp-posts, powered by the dynamo at the Mullick Ghat Pumping Station. As the bridge could not handle the rapidly increasing load, the Port Commissioners started planning in 1905 for a new improved bridge.

Plate 81: Pontoon Bridge. BBJ Website

The Chief Engineer of the Port Trust, Mr. J. Mc. Glashan, wanted to replace the pontoon bridge, with a permanent structure, as the present bridge interfered with North/South river traffic. Work could not be started as World War I (1914-1918) broke out. Then in 1926 a

commission under the Chairmanship of Sir R. N. Mukherjee recommended a suspension bridge of a particular type to be built across the River Hoogly. The bridge was designed by one Mr. Walton of M/s. Rendel, Palmer & Triton. The order for construction and erection was placed on M/s. Cleveland Bridge & Engineering Company in 1939. Again World War II (1939-1945) intervened. All the steel that was to come from England were diverted for war effort in Europe. Out of 26,000 tons of steel, that was required for the bridge, only 3000 tons were supplied from England. In spite of the Japanese threat the then (British) Government of India pressed on with the construction. Tata Steel was asked to supply the remaining 23,000 tons of high tension steel. The Tata's developed the quality of steel required for the bridge and called it Tiscom. The entire 23,000 tons was supplied in time. **The fabrication and erection work was awarded to a local engineering firm of Howrah. It was the famous Braithwaite Burn & Jessop Construction Company Limited (BBJ).**

Because of the war there was no opening ceremony and it was opened to the public in 1943. It is a unique bridge - one of its kind in the world at that time. The bridge was official classified as "Suspension Type Balanced Cantilever". When it was commissioned it was the third longest cantilever bridge. The bridge does not have any nuts and bolts. It is of riveted construction. The bridge deck hangs from 39 pairs of hangers suspended from the main trusses.

With the completion of this bridge, India came of age in bridge construction and bridge building. But the actual tribute should go to the workers of The Tata Steel and Braithwaite Burn & Jessop Construction Company Limited (BBJ). In spite of Japanese air attacks (the last Japanese air attack took place on 5th.December 1941) the work was competed in time. It took only four years to complete the bridge and that too during war years when both men and materials were in short supply. Work went on round the clock in spite of strict black out in the city and there were no major accident during the construction.

The main tower was constructed with single monolith caissons of dimensions 55.31 x 24.8 m with 21 shafts, each 6.25 metre square. The fabrication was done by **The Braithwaite Burn & Jessop Construction Company Limited** at four different shops in Kolkata. The two anchorage caissons were each 16.4 m by 8.2 m, with two wells 4.9 m square. The caissons were so designed that the working chambers within the shafts could be temporarily enclosed by steel diaphragms to allow work under compressed air if required. The caisson at Kolkata side was set at 31.41 m and that at Howrah side at 26.53 m below ground level. The entire project cost 25 million (£2,463,887). The project was a pioneer in bridge construction, particularly in India, but the government did not have a formal opening of the bridge due to fears of attacks by Japanese planes fighting the Allied Powers. Japan had attacked the United States at Pearl Harbour on December 7, 1941. The first vehicle to use the bridge was a **solitary tram.**

5.1B. Vidyasagar Setu or Hugli Bridge

Official Name: Vidyasagar Setu
Design: Cable Stayed Road Bridge with dead load composite deck structure
Total Length: 822.96 metres (2,700 ft)
Width: 35 metres (115 ft)
Longest Span: 457.2 metres (1,500 ft)
Construction Started: 3 July 1979
Opened to Traffic: 10th October 1992
Daily Traffic: 85,000 vehicles
Salient features: Side Spans- 182.88m each, Pylon- 122m high, 152 cables, Cable Weight- 1400 mt. Steel Work- 13200 mt. (appx), Supply, Fabrication & erection.

Vidyasagar Setu is the longest cable-stayed bridge in India and one of the longest in Asia with a total length of 823 metres (2,700 ft). It was the second bridge builds across the Hooghly River; the first, the Howrah Bridge (also known as Rabindra Setu) 3.7 kilometres (2.3 mi) to the north, was completed in 1943. This bridge named after the educationist reformer Pandit Ishwar Chandra Vidyasagar, it cost Indian Rupees 3.88 billion to build. Construction began on 3 July 1979, and the bridge was commissioned on 10 October 1992 by the Hooghly River Bridge Commission. The bridge is under the control of the Hooghly River Bridge Commissioners. The bridge is used by around 30,000 vehicles daily, considerably less than the bridge's capacity of 85,000.

Plate 82: Vidyasagar Setu

5.2. OTHER HERITAGE BRIDGES ON TOLLY'S NULLAH / ADI GANGA

Colonel William Tolly wanted to create a functioning canal in the city by enlarging the dried-up bed of the Kidderpore Creek, to facilitate the passage of ships from the river Hooghly to the delta in the east. Completed in 1777, the 17-mile long canal was popularly known as Tolly's Nulla (nullah meaning creek-bed). Kidderpore, Alipore and Bhowanipore were three suburbs of Calcutta, south of the Maidan. They were set apart from it by Tolly's Nullah (canal), which necessitated the building of such bridges.

There are about twelve bridges across Adi Ganga or Tolly's Nullah from Hastings to Garia and some of them are more than 100 years old. Table -22

Sl No.	Name	GPS Coordinate	Road	Nearest Landmark
1	Dudh Ghat Loha bridge	22°33'0.48"N 88°19'29.74"E	Garden Reach Road - Napier road	Watganj
2	Khidirpur Loha Bridge	22°32'33.57"N 88°19'40.37"E	D.H Road	Hastings
3	Zeerut Bridge	22°32'21.39"N 88°20'1.81"E	Alipur Road-Orphanguange Road	Alipur Zoo
4	Alipur Bridge	22°32'0.24"N 88°20'14.70"E	Debendra lal Khan Road	Alipur jail
5	Kalighat Boat Bridge	22°31'12.14"N 88°20'23.73"E	Kali Temple Road	Near Kalighat Temple
6	Chetla Shah Nagar Bridge	22°31'0.79"N 88°20'24.17"E	Chetla Central road	
7	Kaath pool	22°30'26.14"N 88°20'27.86"E	Kundan lal Saigal Sarani	
8	Tollyguange Bridge	22°30'12.45"N 88°20'31.74"E	New Alipur Road	
9	Karunamoyee Bridge	22°29'10.79"N 88°20'26.89"E	Mahanayak Uttam Kumar Sarani-	Tollyguange Metro Station
10	Ramkrishnanagar Bridge	22°29'37.68"N 88°22'31.56"E	Bansdroni Road	Netaji Subhas Metro
11	Usha Bridge	22°28'47.06"N 88°23'23.63"E	Subodh Garden Road	
12	Garia Bridge-	22°28'2.76"N 88°24'13.21"E	Garia Station Road	Kavi Nazrul Metro

5.2A. Khiddirpur Bridge

Plate 84– The view of the Kidderpore Bridge above is from a hand-coloured photograph print belonging to the Frederick Fiebig Collection: Views of Calcutta and Surrounding Districts, published in 1851. The inset photographic view of the 'Tolly Nullah' is also by Frederich Fiebig

The Kidderpore Bridge, the earliest stone-and-iron suspension bridge in India, lay at the end of the Course – the road that crossed the Maidan. It was the oldest road on the *Maidan* and was described in 1768 as being made to take the air.

5.2B. Zeerut Bridge:

Plate 85 – Hastings Bridge

5.2C. Alipur Bridge - W.H. Carey describes it as connecting "Calcutta and Alipore", the latter evidently not being considered within the strict municipal limits. The nullah or creek-bed was completed in 1777, and was meant to facilitate passage of ships from Hooghly to the delta region by making use of the Khiddirpur creek. It was the work of Colonel William Tolly. On 27 August 1795 the old Alipore bridge, "which had been in a ruinous condition gave way and fell into the nullah." Calcutta, it appears, is not new to the phenomenon of collapsing bridges. Thankfully it happened at night and there were no casualties. It nearly took another forty years for a bridge to be put in place. Once again, Captain John Thomson was assigned the task, and at the expense of rupees 26,430, he built the shortest iron bridge in Calcutta at the time, with a single curve of 89 feet and a roadway that was 24 feet wide.

Plate 86 – Sir Charles D'Oyly, The Suspension Bridge at Alipore (1848), British Library collection

Pate 87: A hand-coloured print of Alipore Bridge, from the Fiebig Collection: Views of Calcutta and Surrounding Districts, taken by Frederick Fiebig in 1851.

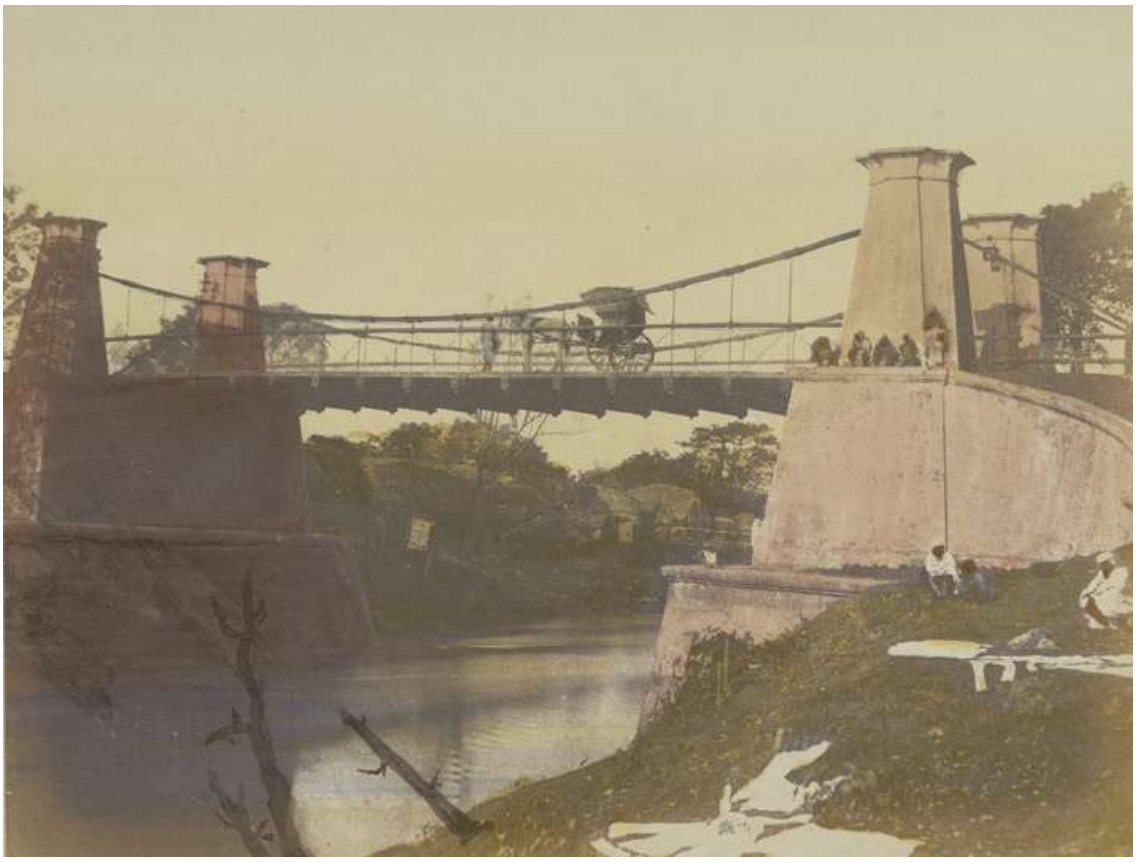


Plate 88: Photograph of Alipur Bridge, Bourne and Shepherd 1881

Plate 89: Bridge on Adi Ganga near Dai Ghat, Plate 90 –New Alipur Bridge, 1932

Plate 91 – Boat Bridge on Adi Ganga

Plate 92 – The New Bridge on Adi Ganga replacing the old Boat Bridge, Kalighat

5.3. BRIDGE ON CIRCULAR CANAL -

Plate 93 : Chitpur Bridge

Plate 94: Chitpur Bridge

5.4. Bridge on Rabindra Sarobar:

The Hanging Bridge in Rabindra Sarobar or Dhakuria Lake is right in the hurly-burly of the city with an unknown identity and wears a forlorn look awaiting its admirers but only to be dejected at large. Stepping out of a transport and getting through the passage the view is breath-taking. Allegorically, **'the–arm-spread-hanging-bridge'** looked like a young girl and the lake its protector draping beneath the bridge which also gives an opportunity for the swans to play. Standing on the bridge to a large horizon is a subtle peace adorned by the beauty of the bridge, a 25 feet deep lake and nature. It sets a perfect frame for scenic synchronisation of tranquillity, adventurous voyage and photography. The hanging bridge gives a befitting surrounding and is a definite place for lone-seeking lovers. Though just when the bridge starts, the opposite wall refrains lover saying 'No lover point' which is

Plate 95 – A cable-stayed bridge, constructed by Burn & Co. in 1926, at the RabindraSarobar Lake, Kolkata (Website – BBJ)

5.5. SHYAMA PRASAD MUKHERJEE PORT OR KOLKATA PORT -

Kolkata Port Trust (officially renamed by the name of BJS founder as Dr. Shyama Prasad Mukherjee Port Trust), is the only riverine major port of India located in the city of Kolkata, India, around 203 kilometres (126 miles) from the sea. It is the oldest operating port in India, and was constructed by the British East India Company. Kolkata is a freshwater port with no variation in salinity. As Kolkata grew in size and importance, merchants in the city demanded the setting up of a port trust in 1863.The colonial government, formed a River Trust in 1866, but it soon failed, and administration was again taken up by the government. Finally, in 1870, the Calcutta Port Act (Act V of 1870) was passed, creating the offices of Calcutta Port Commissioners. In 1869 and 1870, eight jetties were built on the Strand. A wet dock was set up at Khidirpur in 1892. The Khidirpur Dock II was completed in 1902. As cargo traffic at the port grew, so did the requirement of more kerosene, leading to the building of a petroleum wharf at Budge Budge in 1896. In 1925, the Garden Reach jetty was added to accommodate greater cargo traffic. A new dock, named King George's Dock, was commissioned in 1928 (it was renamed Netaji Subhash Dock in 1973).

Plate 96 – The oldest riverine port of India

Though the port was conceived to be a commercial port and gateway of eastern India, the port played a very important role in the Second World War. It was bombed twice by the Japanese forces. After independence, the Commissioners for the Port of Kolkata were responsible for the port till January 1975 when Major Port Trusts Act, 1963, came into force. The Port is now run by a Board of Trustees having representatives from the Government, Trade Bodies, various Port Users, Labour Unions and some nominated members.

On 12 January 2020 the port was renamed to **Sri. Syama Prasad Mukherjee** Port by **Hon'ble Prime Minister Narendra Modi** on occasion of 150 years of operation of Kolkata Port at economic Indoor Stadium.

The Port has two distinct dock systems - Kolkata Docks at Kolkata and a deep water dock at Haldia Dock Complex, Haldia. In the 19th century, the Kolkata Port was the premier port in British India. After slavery was abolished in 1833, there was a high demand for laborers on sugar cane plantations in the British Empire. From 1838 to 1917, the British used this port to ship off over half a million Indians from all over India — mostly from the Hindi Belt (especially Bhojpur and Awadh) — and take them to places across the world, such as Mauritius, Fiji, South Africa, Trinidad and Tobago, Guyana, Suriname, and other Caribbean islands as indentured laborers. There are millions of Indo-Mauritians, Indo-Fijians, and Indo-Caribbean people in the world today. After independence, the port's importance decreased because of factors including the Partition of Bengal (1947), reduction in size of the port hinterland, and economic stagnation in eastern India. 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).

5.6. SWING BRIDGE AT KHIDDIRPUR DOCK

Khiddirpur Swing Bridge is one of the Heritage Structure of Kolkata which was constructed in 1895. This bridge is located at Kidderpore in Kolkata and plays an important role for

Plate 97 : Photograph taken in 1891 by an unknown photographer of the Calcutta Docks with the swing-bridge gates at the entrance to the half-tide basin as seen from the river. The Calcutta Port is the only major riverine port in India and constitutes the Calcutta Dock System. In March 1884, the Secretary of State confirmed the adoption of the Kidderpore site

for new docks. The entrance to the dock was to be through a tidal basin about 600 ft by 650 ft, and from the tidal basin to the river were two entrances, one 80 ft wide and the other 60 ft. In 1889-90, the tidal basin had been completed and brought into use, and dock number one was almost finished. The swing-bridges move on a central vertical pivot, allowing shipping to pass in and out of the half-tide basin which remains open for a few hours either side of high-tide.

letting ships pass through channel on Hooghly River. It takes approximately 30 mins for the bridge to swing on 90° on its axel. It withstood two world wars: World War I and World War II.The biggest ship M. V. Nicobar, that sails from West Bengal to Port Blair, the capital of Andaman and Nicobar Islands, passes through this channel. Most importantly, this Century old bridge is still in action and fit to serve another few centuries. In short, this Swing Bridge, is must see sight for the tourists who come not only to Kolkata, but to India as well.

5.7. BASCULE BRIDGE AT KHIDDIRPUR DOCK

A bascule bridge (also referred to as a drawbridge or a lifting bridge) is a moveable bridge with a counterweight that continuously balances a span, or leaf, throughout its upward swing to provide clearance for boat traffic. It may be single- or double-leafed. The name comes from the French term for balance scale, which employs the same principle. Bascule bridges are the most common type of movable span because they open quickly and require relatively little energy to operate, while providing the possibility for unlimited vertical clearance for marine traffic.

Plate 98: The Khiddirpur Bascule Bridge is only one of three bascule bridges in the country. The others are at the Mumbai port (single leaf not double-leaf likes the Kidderpore one) and in Tamil Nadu. It became operational on November 15, 1966. Waagen Biro Bridge System AG of Austria had built the bridge. In August 2017, the two leafs of the bridge got stuck while being lowered. The

problem was traced to a fault in the electrical control panel and repaired. But the same thing happened again within four days. On both occasions, the bridge remained parted for seven to eight hours disrupting traffic between Kidderpore on one end and Garden Reach and Metiabruz on the other.

5.8. GHATS ON RIVER HUGLI

The twin cities, Calcutta and Howrah, run their parallel courses. Touching them both dividing and yet linking them, is the actual wide course of a river. From long before sunrise, this course is touched in turn by stream of men and women on either bank. As the day wears on ,the water grows darker, intenser and lonelier. There were once hordes of men who chanted Sanskrit hymns as they hitched their sacred threads round their ears and plunged into Ganga , hungry for redemption: today there are only few. Rich house wives of old Calcutta would be brought here in curtained Palanquins and given a holy dip, palanquin and all. The scene is not imaginable today. Neither Sahibs, Nawabs nor Zamindar sails down the river in the pleasure barge. Some country boats can be laden with straw or bales can still be seen making their way, but their number has declined, as even more drastically has the clutch of ferry boats.

Plate 99 : Regular activities found in the Ghats of Kolkata , Jagannath Ghat,2020

Biprads Piplai has left us a vivid picture of the river activities of 15th century in his Manasamangal Kavya. The river routes , the trading centres , the life of the people on the banks ,their arts and industries are all brought in to an account of the Chand Saudagar's

voyage : past Katwa, Nadia, Phulia, Tribeni, Saptagram, Bhatpara, Kankinara, Mulajore, Khardah, Sukchar, Konnagar-on to Chitpur, Kalikata and Kalighat. The last 2 names are probably interpolated, but the picture remains valid, coloured by the uncertainty of even a river voyage in those days and the aura surrounding the lives of the rulers, traders, priests and pilgrims who inhabited this flourishing spectrum of towns. The coming of the white traders only increased the alchemic fascination of the river.

Plate 100 - Regular life in a Ghat of Kolkata, Bourne and Shephard, 1880

Plate101 - Regular life in a Ghat of Kolkata, Water Colour William Baille Fraser, 1836

Soul saving apart, the river had 2 functions – trade and transport. Both have dwindled and thus the ghats , jetties along the strand have crumbled with them. The old or "Adi Ganga" have silted up, and the new flow of the Hugli Bhagirathi carries the water of the Hugly river below Kalikata. If we walk from Ghat to Ghat along the stretch of the bank , we may meditate on the transience of Ganges Civilization: *for Calcutta has neither mountain , nor sea only a river.* The river linked the city to the land; it brought the white men who founded the city in the first place. But then came the railway and then the motor roads .The children of the river began to desert their mother. The desertion is not evident, for the river bank is largely over populous to this day: and some of the denizens are truly children of the river. There are many children who all have taken birth in these Ghats. They know the shops there, the gambling dens, the places where Mahabharata is chanted and also the Burning Ghats and all the rituals. Many of them have not seen the interior of the city. Their home lies around the canopied ancient trees. They live, they play, they earn and they die with the river. The river activities might have dwindled but the stream has remained in the city lives. The river has entered deep into the Bengali language and traditions. As the readers of the Bengali literature would know *Gangajal* or Ganga water was once the address that marked a special tie of affection, especially between two women. The river has entered deep into the Bengali language and its speaker's roots. Declared religious or superstitious beliefs may have dwindled .But the underlying mystique lingers, anchored in sheer physical compulsion, in a hot country, to drink and bathe continually. Hence almost all the ghats remain in usable state crowded by bathers and water seekers.

Plate 102 – P.K Thakur Ghat

Plate 103 : Nimtala Ghat

Plate 104 – Dusk at River Hugli

From Hastings in North to Hastings at the mouth of the Adi Ganga in the south, the river bank is broken by ghat after ghat, with a corresponding series across the stream on Haora Bank. They are like hands stretching out the river, invariably broad and gently sloping like so many mute symbols of the land's past relations with the river: bathing, trading and travelling. The state of most of the Ghats leaves no doubt that these relations are indeed past .But they are quiet dilapidated: they enshrine history that is also captured in their names.

There is a lane in Khidirpur called Nazir Lane. Its original name was Nazir Muhammad Ghatmajhi Lane. This *"Ghatmajhi"* was not really a *majhi* or boatman but a more exalted functionary. He would arrange for the hire of various types of boats from his boats from his ghat , engage oarsmen for ferries for ferries and porters for loading and unloading. Still more exalted were the *Mirbahars* ,the harbour masters of Mughal time whose role is commemorated in the name of Mirbahar Ghat. All sorts of people have had their ghats named after them .Many of them were the benefactors who built the Ghats usually upper caste names,often from the Great Houses of old Kolkata. But they also include the names of other orders ,regions and religions: Huzoorimal a Punjabi Sikh ,Kashinath Tandon, another Punjabi ,Rustomji Kawasji a Parsee ,Joseph Baretto a Portuguese ,unknown Englishmen like Jackson, Foreman and famous ones like Clive and Outram. There is an Old Fort Ghat and an Old Powder Mill Ghat : Keto or Ketua Ghat, Pathuriaghat , or Takta Ghat or jetty laid with planks up which shackled prisoners would carry their packs to the ship that was to transport them to the Cellular Jail in Andaman and Nicobar islands. In his survey ,Upjohn located 40 ghats in 1792-93 between Chitpur Bridge Ghat to Chandpaul Ghat. Radharaman Mitra identified 82 numbers in 19th Century .But over the years ,we have identified 56 Ghats mostly emphasising the decline importance of the City's Ghats .

Plate 105 – Mobile Saloon, Ahiritola Ghat

The Ghats of Kolkata still sustains number of livelihoods. One can find wrestlers, masseurs, priests, holymen, tea sellers, barbers as well as ubiquitous bathers, traders, and boatmen. Some come here to chat and recreate themselves: others are habitual riverside idlers, down and outs, gamblers and drug addicts. Yet some come to hear hymns, discourses and readings from holy texts. Lovers come here for peace and romance and as everywhere in Kolkata, the

Plate 10[illegible] Shraddha taking place in Addya Shraddha Ghat

homeless come to seek shelter. “Ganga feeds us” says some as for generations they either sell the holy water or Mati (Ganga Clay) from house to house. There are many priests who goes around the markets (Hatibagan or Sovabazar) blessing each shop with Ganga water and flower petal. Later in the day they become Ghat Brahmins helping people to execute the last rites of the departed souls. Many of them have loads of towel, oil and holy clay in their trunks which they use it for varied purposes.

Plate 108– Woods stack adjoining Burning Ghat , 22°35'36.45"N 88°21'7.14"E Plate 109 : Commodities getting transported in Haora from Jagannath Ghat. 22°35'16.26"N 88°20'59.20"E

Even an all embracing city like Kolkata cannot afford us such a range of types anywhere so much as long as the river. A few represent the outgrowths of officialdom: the attendant doctor at the crematorium, for instance. Kashipur, Nimtala or Kashi Mitra burning Ghat also affords other strange functionaries inured to death: funeral priests , or dead man's Brahmin, the funeral photographer and on the outskirts of the crematorium ,holy men sit alongside criminals and potential suicides, smoking pipes of ganja after a call to Shiva or Kali. During Monsoons fishermen from many parts of South Bengal row towards Kolkata for the Hilsa season from August to October. For fishermen Ganga is a generic term that they apply to all the rivers: not all of them operate on the actual stream of that name. The hilsa fishermen use number of nets – Bhasa or Floating,the fixed or Bandha,the up gathered or guti and the finger –net or anguley jal. A standard practice is to make a kind of well or enclosed area in the water.Hilsa is caught along Khidirpur,Garden Reach, Chandpaul Ghat,Kalighat or Ahiritola Ghat and also across the river near Botanical Garden. Traditionally no tax has been levied on the fishermen from the time of Rani Rashmoni but the catch has dwindled because of pollution. Increase in Ferry and Launch services have also affected fishing.

Plate 110: River still acts as a means of transporting commodities , sand and brick from Ghusuri , Haora is transported to Bagbazaar Ghat. 22°36'18.13"N 88°21'54.19"E

Plate 111 - Suriname Memorial at the Suriname Ghat along the banks of river Hooghly. The statue, of a plainly-dressed couple carrying a potli, honours those Indian indentured workers who had migrated to Suriname, the small country located on the northeast Atlantic coast of South America, from 1873 to 1917. The memorial is an alluminium representation of 'Baba and Mai' or 'Mai Baap' - a depiction of the male and female indentured workers who had left the Indian coasts to work as labourers in sugarcane plantation.

In 1863, slavery was abolished by the Dutch and they entered into an agreement with the East India Company to recruit labourers from India to work in the sugarcane plantations in Suriname. Men, known as Arkatias were sent out to recruit people from Uttar Pradesh and Bihar. They entered into a five-year contract and came to be known as the Contrakees or Agreemanees. They were to receive 25-pence a week for their labour but payment was often delayed. Of the 34,000-odd Indians who reached Suriname, 65% stayed back. Indentured labour was finally abolished 100 years ago in 1917," The first ship, named Lalla Rookh and carrying Indian indentured labourers, had arrived in Suriname in June 1873. Today, the largest ethnic group in Suriname are the East Indians, descendants of the 19th century indentured labourers primarily from Bihar and Eastern UP.

"In 1863, slavery was abolished in the Dutch colony of Suriname, but as a plantation colony it needed skill labourers. So with the assistance of the East India Company, the Dutch looked to

Legend has it that Ganga came to earth to save it from destruction ad fill it with life. This faith, anchored in the nation's deepest myths, imperceptibly colours such individual poetic visions of the river as that above. But the reality is somehow different. As stated in CMDA brochure – Calcutta does not perhaps offer much by way of natural scenery, but the River Ganga ,about half a mile wide, flowing between the main city and the town of Howrah ,with its ships ,barges and boats always presents a picturesque scene. The river has lost its wonder in this account. The educated Kolkata dwellers no longer admit it into his life. But still it exists as a myth amidst the faith, tradition sustaining lives of many.

Plate 112 - Immersion of Durga Idol, Babu Ghat 22°33'54.53"N 88°20'21.77"E

The images of Durga and other Gods and Goddesses are immersed in the Ganga after puja every year. In low water the straw frames of the clay Gods lie rotting in water like a symbol. Again from it the clay is taken out by the nearby potters to create new deities. The Ganga Action Plan is underway and may be it will make a difference. But the question is , will it be able to bring back the life of the river.

Plate 113: Clay idols ultimately mix with water to become clay again

5.8A. Ghats according to 2020 Survey between Pramanick Ghat to Rajabagan Ghat (Table 23)

Sl. No	Name of the Ghats	GPS Locations	Remarks (Activities)
1	Paramanick Ghat	22°37'53.86"N 88°21'51.13"E	Domestic
2	Cossipur Burning Ghat	22°37'51.39"N 88°21'52.97"E	Funereal Ghat
3	Ratan Babu Ghat	22°37'48.42"N 88°21'53.98"	Ferry Service
4	Sadhu Ghat	22°37'43.97"N 88°21'54.98"E	Domestic
5	Gopaler Ghat	22°37'42.08"N 88°21'55.71"E	Domestic
6	Rustumjee Parsee Ghat	22°37'37.63"N 88°21'57.32"E	Dock
7	Cossipur Gun & Shell Ghat	22°37'10.60"N 88°22'6.04"E	Domestic
8	Cossipur Ferry Ghat	22°37'6.03"N 88°22'5.91"	Ferry Service
9	Debendrabala Ghat	22°36'50.47"N 88°22'7.23"E	Domestic
10	Baishnabi Ghat	22°36'45.40"N 88°22'6.90"E	Domestic
11	Indra Ghat	22°36'41.70"N 88°22'6.30"E	Domestic
12	Loha Pool	22°36'29.34"N 88°22'2.29"E	Canal Mouth
13	Baghbazar Mayer Ghat	22°36'15.99"N 88°21'50.61"E	Domestic
14	Baghbazaar Bathing Ghat	22°36'6.77"N 88°21'40.11"E	Domestic
15	Baghbazaar Ferry Ghat	22°36'15.22"N 88°21'51.10"E	Ferry Service
16	Thakurbari Ghat	22°36'13.39"N 88°21'48.70"E	Domestic
17	Gopal Ghat	22°36'11.42"N 88°21'46.70"E	Domestic
18	Kashi Mitra Burning Ghat	22°36'7.69"N 88°21'41.94"E	Funereal
19	Coomertully Ghat	22°36'6.87"N 88°21'40.52"E	Domestic
20	Sovabazar Ferry Ghat	22°35'57.02"N 88°21'24.22"E	Ferry Service
21	Champatola Ghat	22°35'56.08"N 88°21'23.10"E	Domestic
22	Ruth Ghat	22°35'55.49"N 88°21'22.40"E	Domestic
23	Ahiritola Ghat 1	22°35'54.33"N 88°21'18.67"E	Domestic
24	Ahiritola Ghat 2	22°35'45.58"N 88°21'10.93"E	Ferry Service
25	Ahiritola Ghat Extension	22°35'44.28"N 88°21'10.41"E	Domestic
26	Manik Bose Ghat	22°35'42.70"N 88°21'9.28"E	Domestic
27	Nimtala Kishor Bani Ghat	22°35'41.01"N 88°21'8.49"E	Domestic
28	Nimtala Burning Ghat	22°35'36.39"N 88°21'6.59"E	Funreal
29	Modi Ghat	22°35'31.14"N 88°21'5.36"E	Domestic
30	Prassana Kumar Ghat	22°35'23.91"N 88°21'2.69"E	Domestic
31	Jaggannath Ghat	22°35'12.08"N 88°20'59.19"E	Domestic
32	Ram Chandra Goenka Ghat	22°35'2.37"N 88°20'56.77"E	Domestic
33	Chote lal ki Ghat	22°34'59.01"N 88°20'55.04"E	Domestic
34	Armenian Ghat	22°34'55.07"N 88°20'53.63"E	Domestic
35	Fairlie Place	22°34'49.39"N 88°20'50.05"E	Ferry Service
36	Millenium Park	22°34'45.52"N 88°20'49.68"E	Jetty
37	Floatel	22°34'33.73"N 88°20'43.51"E	Restaurant
38	Babughat old	22°34'31.69"N 88°20'43.40"E	Domestic
39	Babughat New	22°34'28.95"N 88°20'42.67"E	Ferry Service
40	Kadamtala Baja Ghat	22°34'13.25"N 88°20'34.88"E	Domestic
41	Chandpaul Ghat	22°34'7.04"N 88°20'28.61"E	Domestic
42	Outram Ghat	22°33'48.74"N 88°20'16.77"E	Defence
43	Sea Explorer's /institute	22°33'40.33"N 88°20'5.14"E	Defence

Sl. No	Name of the Ghats	GPS Locations	Remarks (Activities)
44	Pani Ghat 1	22°33'44.83"N 88°20'12.68"E	Domestic
45	Pani Ghat 2	22°33'41.51"N 88°20'7.84"E	Domestic
46	Judges Ghat	22°33'39.04"N 88°20'3.27"E	Domestic
47	Manuar Ghat	22°33'34.77"N 88°19'59.17"E	Domestic
48	Prinsep Ghat 1	22°33'25.82"N 88°19'53.42"E	Domestic
49	Prinsep Ghat 2	22°33'22.87"N 88°19'49.88"E	Domestic
50	Bidhan Ghat	22°33'0.22"N 88°19'24.22"E	Domestic
51	Dai Ghat	22°32'57.81"N 88°19'18.81"E	Domestic
52	Garden Reach	22°32'51.50"N 88°19'4.29"E	Dockyard
52	Surinam Ghat	22°33'4.44"N 88°17'8.60"E	Public
53	Bichali Ghat	22°33'17.60"N 88°16'15.34"E	Ferry service
54	Raja Bagan	22°33'24.66"N 88°15'39.34"E	Domestic
55	Badartala Ghat	22°33'33.83"N 88°14'38.17"E	Domestic
56	Badartala Shosan Kali ghat	22°33'5.93"N 88°14'38.18"E	Domestic

5.8B. Ghats according to 1857 Simms Map between Cossipur Gun Foundary Ghat to Garden Reach, Table -24

Sl No.	Name of the Ghats	GPS Locations	Activities
1	Cossipur Gun Foundary	22°37'9.56"N 88°22'5.88"E	Commercial
2	Nawab's Ghat	22°36'53.56"N 88°22'6.87"E	Domestic
3	Chitpur Ghat	22°36'50.59"N 88°22'7.13"E	Domestic
4	Dabee Roy's Ghat	22°36'41.35"N 88°22'6.13"E	Domestic
5	Paran Babu Ghat	22°36'35.99"N 88°22'4.93"E	Domestic
6	Huree Poddar Ghat	22°36'33.16"N 88°22'3.86"E	Domestic
7	Loha Pool	22°36'26.62"N 88°22'10.82"E	Commercial
8	Permit Ghat	22°36'26.96"N 88°22'0.16"E	
9	Doorgacharan Mookherjee Ghat	22°36'15.64"N 88°21'50.99"E	Domestic
10	Bagbazaar Ghat	22°36'19.51"N 88°21'54.80"E	Domestic
11	Annapurna Ghat	22°36'15.85"N 88°21'50.77"E	Domestic
12	Rasik Niyogi Ghat	22°36'14.72"N 88°21'49.86"E	Domestic
13	Poonteepal's Ghat	22°36'13.91"N 88°21'49.10"E	Domestic
14	Thakoorbari Ghat	22°36'12.76"N 88°21'48.30"E	Domestic
15	Golabari Ghat	22°36'11.29"N 88°21'46.45"E	Domestic
16	Cassy Mitter's Ghat	22°36'8.30"N 88°21'42.99"E	Domestic
17	Raja Radhakanth's Ghat	22°36'7.62"N 88°21'42.04"E	Domestic
18	Hurrolall Koondoo Ghat	22°36'8.91"N 88°21'42.98"E	Domestic
19	Koomar Tolle Ghat	22°36'6.97"N 88°21'40.52"E	Domestic
20	Radhakisto Dutt's Ghat	22°36'7.38"N 88°21'40.11"E	Domestic
21	Dahparah Ghat	22°36'5.03"N 88°21'38.22"E	Domestic
22	Champatalla Ghat	22°36'2.94"N 88°21'35.62"E	Domestic
23	SapoolRamjoy Shah's Ghat	22°36'0.53"N 88°21'29.98"E	Domestic
24	Kawal Shah's Ghat	22°35'58.81"N 88°21'26.92"E	Domestic
25	Ruth Ghat	22°35'55.96"N 88°21'22.94"E	Domestic
26	MohunToney's Ghat	22°35'52.54"N 88°21'18.71"E	Domestic

27	Dhurmotollah Ghat	22°35'50.12"N 88°21'15.76"E	Domestic
28	Ahiritola Ghat 1	22°35'46.04"N 88°21'10.88"E	Domestic
29	Manik Bose Ghat	22°35'39.90"N 88°21'8.35"E	Domestic
30	Nimtala Burning Ghat	22°35'36.39"N 88°21'6.86"E	
31	Jorabagan Ghat	22°35'30.35"N 88°21'4.60"E	Domestic
32	Prassana Kumar Ghat	22°35'21.91"N 88°21'1.24"E	Domestic
33	Night Soil Ghat	22°35'19.88"N 88°20'59.84"E	Domestic
34	Jaggannath Ghat	22°35'15.37"N 88°20'59.04"E	Domestic
35	Mint Ghat	22°35'9.43"N 88°20'57.00"E	Domestic
36	Meerbohur's Ghat	22°35'8.09"N 88°20'56.89"E	Domestic
37	Raja Burdwans Ghat	22°35'0.76"N 88°20'54.45"E	Domestic
38	Burra bazar Ghat	22°35'0.17"N 88°20'54.41"E	Commercial
39	Mullick Ghat	22°34'57.27"N 88°20'52.75"E	Domestic
40	Railway Jetty	22°34'52.96"N 88°20'52.57"E	Public
41	Strand Mill Ghat	22°34'48.40"N 88°20'49.74"E	Domestic
42	Jackson Ghat	22°34'44.09"N 88°20'51.34"E	Commercial
43	Clive Ghat	22°34'41.37"N 88°20'49.27"E	Commercial
44	Bonded Warehouse Ghat	22°34'36.82"N 88°20'47.90"E	Commercial
45	Custom House Ghat	22°34'33.73"N 88°20'45.86"E	Commercial
46	Coilah Ghat	22°34'26.80"N 88°20'41.84"E	Public
47	Timber Jetty	22°34'23.84"N 88°20'39.87"E	Commercial
48	Banks Hall Ghat	22°34'21.13"N 88°20'38.99"E	Commercial
49	Police Ghat	22°34'18.91"N 88°20'37.25"E	Commercial
50	Colvins Gha	22°34'13.04"N 88°20'33.86"E	Commercial
51	Chandpaul Ghat	22°34'6.41"N 88°20'28.90"E	Commercial
52	Water Works	22°34'4.73"N 88°20'27.72"E	Public
53	Babughat	22°34'2.59"N 88°20'26.30"E	Domestic
54	Pani Ghat 1	22°33'39.48"N 88°20'3.64"E	Domestic
55	Prinsep Ghat 1	22°33'21.20"N 88°19'49.55"E	Public
56	Baloo Ghat	22°33'9.77"N 88°19'39.79"E	Public
57	Commissariat Ghat	22°33'7.66"N 88°19'37.33"E	Commercial
58	New Jetty	22°33'6.76"N 88°19'35.12"E	Commercial
59	Cooly Bazar Ghat	22°33'3.94"N 88°19'31.63"E	Commercial
60	Garden Reach	22°32'55.30"N 88°19'12.81"E	Commercial

Plate 114 – Simms Map showing the location of Pontoon Bridge and the Ghats .

PHOTOSTORY OF GHATS IN KOLKATA (Plate 115-152)


WEST BENGAL TRANSPORT CORPORATION
পশ্চিমবঙ্গ পরিবহন নিগম
শোভাবাজার জেটি
SHOVABAZAR JETTY


RUTH GHAT
FOR BATHING.


AHIRITOLA GHAT


MANIK BOSE
GHAT


নিমতলা মহাশ্মশান
কলকাতা পৌরসংস্থা


নিমতলা মহাশ্মশান
বৈদ্যুতিক চুল্লী
কলকাতা পৌরসংস্থা
NIMTALA CREMATORIUM
ELECTRIC FURNACE
KOLKATA MUNICIPAL CORPORATION


Millennium Park


WEST BENGAL TRANSPORT CORPORATION
FAIRLIE PLACE JETTY NO-2
পশ্চিমবঙ্গ পরিবহন নিগম


WELCOME TO
BABUGHAT FOOT
OVER BRIDGE


IMPROVEMENT & RE-DEVELOPMENT
OF
RAJA KADAMTALA GHAT
FUNDED BY N.G.R.B.A


পানি ঘাট - ১
PANI GHAT-1


BEAUTIFICATION & MAINTENANCE OF
JUDGES GHAT
BY
CENTRAL KOLKATA
PRERNA FOUNDATION
IN COOPERATION WITH
KOLKATA PORT TRUST
&
THE KOLKATA MUNICIPAL CORPORATION
Courtesy : GLOSTER LIMITED


IMPROVEMENT & RE-DEVELOPMENT
OF
PRINCEP GHAT-II
FUNDED BY N.G.R.B.A

5.9. Ghats on Adi Ganga / Tolly Nullah:

Once the Adi Ganga was revitalised by William Tolly, a number of ghats grew up on the banks of the canal including ***Balaram Basu's Ghat, Mukherjee's Ghat, Hindu Mission Ghat, Kalighat, Ghatak Ghat, Prasannamayi's Ghat, Rashbarir Ghat, Tarpan Ghat, Kudghat, Rathtala Ghat,*** etc. In 1862, Prankrishna Halder's (influential elite of 19th century Bengal) mother established the burning ghat of Keoratala on its bank. The tract was a lively route and the locals are still nostalgic about how *Bhatiali* (boatman songs) was sung under the full moon sky providing an intense satiety to people living on its banks. But gradually since the 1960s the water route lost its vigour though it still continued to be a discharging outlet for the southern part of the city. The once navigable canal transformed into a mere *nullah* (drain) due to lack of restoration and maintenance.

Over a period of time, several "illegal" settlements grew up on both banks of the entire stretch of the Tolly's Canal. The settlers were mostly from different areas of rural West Bengal who migrated to Kolkata thinking of the opportunities of work that the city would have provided. For 40 years the canal bank was occupied with people who were already victims of development from the countryside facing landlessness, alienation of land, poverty and flood (Seabrook 2002)

Plate 153,154,155 – Balaram Basu Ghat 22°31'44.05"N 88°20'28.32"E

Plate 156 – Kalighat , 22°31'1.19"N 88°20'24.38"E

Plate 157 – Dai Ghat, 22°32'58.34"N 88°19'19.88"E

Chapter VI:
Documenting Livelihood Pattern & Activities In & Around The Hugli River

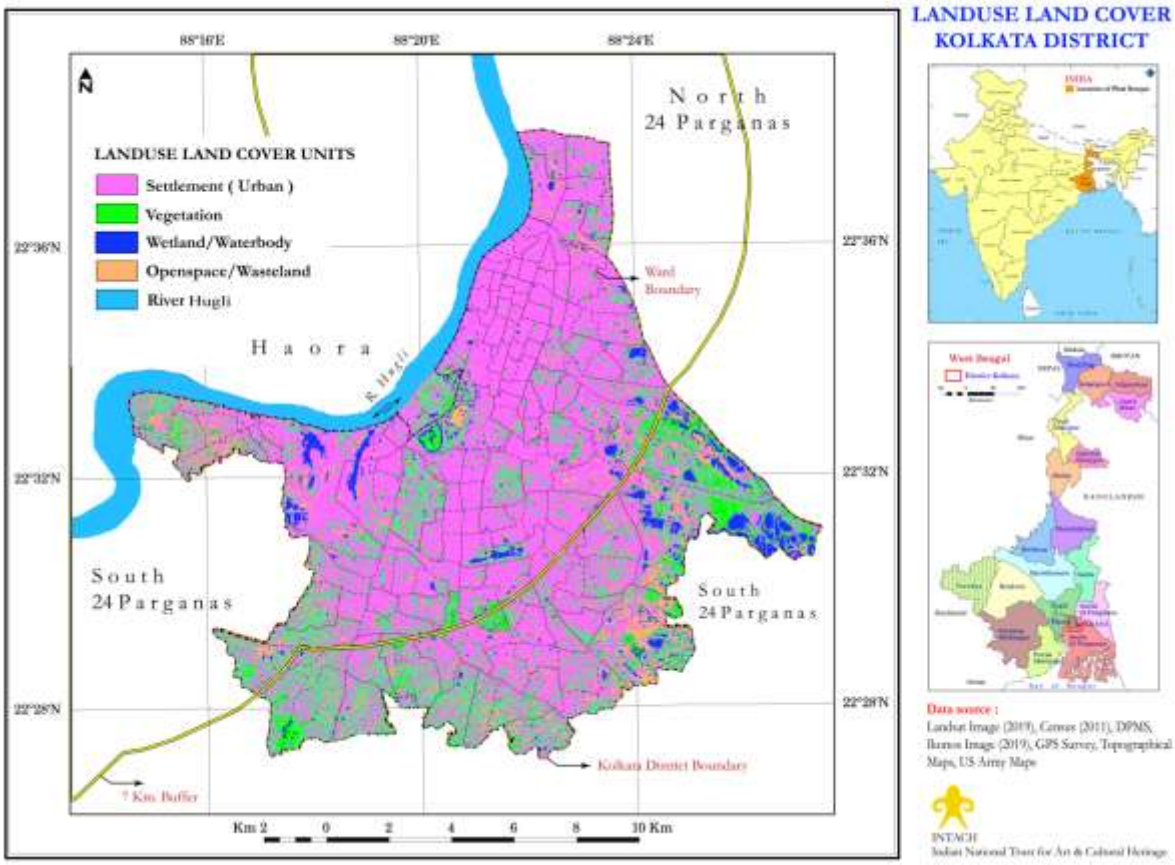
6.1. Landuse Landcover Study in the Study Area

The land use land cover of an urban area generally denotes different types of physical and anthropocentric two dimensional uses of land. Basically, in an urban area most of the land is used for building up residential and commercial areas. In the present situation the human-oriented land use and land cover in an urban area have been changed dramatically due to the heavy expansion of urban population and residential area. Such, in a city the degree of land use land cover changes of urban area is determined by multivariate factors as the expansion of municipal area, increasing city population, increasing the number of settlements sprawling residential area, commercial area and transport networks. But in an urban arena, the most affective factors on land use land cover changes are rapid increasing of population and residential area as well as substituting usage of urban land by the city-dwellers.

6.1A. Land Use in KMC Based on Secondary Data (1990)

It is difficult to answer in a straight way why Kolkata is not functioning properly as a metropolitan city. One of the reasons seems to be the fact that the appointment of city land under different uses is rather unbalanced. In terms of the secondary recorded data about how land space in the city is utilised, it is found from per survey carried out by Calcutta Metropolitan Planning Organization (C.M.P.O) that a major share of land (42.7%) is used as residential areas (C.M.P.O, 1963). The main reason why such a large chunk goes for living space only, is that Kolkata is still a low-rise city. In many areas some land could be saved for other purposes if more living space has been made available in more valuable residential areas by building upward. Some 11.8% of land space in the city was used for carrying on transportation. Kolkata streets are getting so clogged up everyday with heavy traffic that is imperative to have more land for this purpose to keep on the circulation system functioning properly. At that time, valuable urban land (7.5%) has been used up by industry. Kolkata being basically a service-oriented city, has as much as 7.12% of land devoted to public and semipublic uses needed for administrative, educational buildings, hospitals and public utilities. Kolkata has constructed open recreational areas to the extent of 4.43% of the city land, which was inadequate. The city was regarded as the commercial metropolis of eastern India, but only 3.77% of land was developed to carry out the volume of commerce. As a result, much of commercial activities in Kolkata had to be performed on residential houses to the detriment of good urban living (Mitra, 1979). Contrary to the usual impression of Kolkata, a lot of land in the city was still derelict, vacant, or put to agricultural uses. Such undeveloped areas cover as much as 16.9% of the city, spread over some 1600 hectares of valuable metropolitan land. Most of these derelict lands are located in the eastern and

southern fringes of Kolkata and still await more careful identification, demarcation and mapping.



Map 52 – Landuse landcover map of KMC, Source – Landsat Image , 2019

6.1B. Land Use in KMC Based on Landsat Image (2019)

The supervised classification was applied to detect the Land Use-Land Cover (LULC) within the Kolkata Municipal corporation area (KMC) using Landsat Data of 2019. Following classes of LULC were mapped. 1. Urban Settlements including commercial, industrial and residential. 2. Vegetation patches including parks, grounds, roadside, canal side, riverside vegetation, open spaces in form of bare spaces and Wetlands including ponds, lakes and canals. The study area of 7km from the River Bank is the most densely urbanised area accommodating major commercial markets , Office Complexes and at the same time residential areas. All along the River Hugli from Cossipur to Metiaburuz , Slums and squatters occupy the maximum Landuse Class.

Table 25-Temporal Landuse Change Detection of Kolkata Municipal Corporation

Sl. No	Land use Category	Area of Landuse (ha) % of Landuse (1990)	% of Landuse (2019)
1.	**Built-Up Area** (Commercial Area+Industrial Area+Mixed Residential Area+Public and Semi Public+Residential Area)	14140.0 76.62%	15453.68 85.54%
2.	**Green patches**	2945.22 15.23%	1933.58 10.34%
3.	**Waterbody**	764.73 3.95 %	366.52 1.96%
4.	**Wasteland / Open Space/others**	850 4.2 %	411.4 2.2%
	Total Area	18700	18700

The Municipal Area under Kolkata has grown from few villages to its present status as India's most populous city. Naturally the predominant landuse category will be residential which comes under the Built Up Class. As we have compared the categories of LULC in a span of 20 years, we have observed that –

a. The area under Built-Up including Residential, Commercial, Industrial, Public and Semi Public has shown remarkable increase from 1990 to 2019 which is very natural keeping in mind the huge increase in population.

b. Now this increase of built up land is either by transforming green patches or by shrieking waterbodies. 15.23% of Green patches in 1990 was reduced to 10.34 % in 2019.

c. The area under waterbodies including wetlands has shown negative growth reducing from 4.2% to 2.2 %. It has become a very common sight that waterbodies are dried up and taken over by the land sharks.

d. The wastelands / open spaces and miscellaneous category of LULC is mostly found in the riverbank or canal side. Though mostly taken over by squatters but still in some areas these

vacant places are found adjoining rivers, canals or railway lines. But with time this category is also dwindling .From 4.2 % in 1990 it has reduced to become 2.2% in 2019.

6.1C. General Landuse Scenario in the Study Area

Plate 158: A. Ghat adjoining River Hooghly where regular domestic activities takes place

159: B. Mullick Ghat flower market adjoining the Hugli River

Plate 160: Commercial Built up area

Plate 161 – Commercial Built up area, along Hugli River, Source – Kolkata Police

6.2. RIVER / CHANNEL BANK USING FOR VARIOUS ECONOMIC ACTIVITIES

6.2A. Industrial & Manufacturing economy: Past & Present

The **Hugli Industrial Belt** or **Kolkata Industrial Belt** is India's oldest and second largest Industrial area (Shilpanchal). All along the banks of the Hugli river from north to the south of (Triveni-Kalyani, Uluberia-Biralapura) 100 km long and 15–10 km wide zone there lies the Industrial zone with Kolkata being the primary market area. It is very well- connected by the Ganga and its tributaries with the rich hinterland of Ganga-Brahmaputra plains. Besides navigable rivers, roads and the railways provided subsequent links to the great benefit of Kolkata port.

The discovery of coal and iron ore in Chotanagpur plateau, tea plantations in Assam and northern parts of West Bengal and the processing of deltaic Bengal's jute led to the industrial development in this region.

Cheap labour could be found easily from the thickly populated states of Orissa, Bihar, Jharkhand and eastern part of U.P. Kolkata, having been designated capital city of the British India (1773-1912) attracted large scale British investment of capital.

Establishment of first jute mill at Rishra in 1855 ushered in the era of modem industrial clustering in this region. A chain of jute mills and other factories could be established on either side of Hugli River with the help of Damodar valley coal.

The port site was best-suited for export of raw materials to England and import of finished goods from that country. Similarly engineer-ing, leather goods and consumer goods industries were also set up in the region by drawing in the raw materials from the adjoining regions and distribut-ing the finished goods to the consuming points. Hence, role of communication network has been as important as the favourable location factors in the growth of this region.

The city of Kolkata has the predominance of service industries employing more than one-third of the labour force. Trade and commerce and manufacturing contribute 24 and 25 per cent of the city's labour force respectively.

However the Kolkata-Hugli industrial region is experiencing the stagnation and relative decline in indus-trial growth in recent years. The region is facing the problem of congestion, traffic jam, and paucity of space, insanitation, shortage of drinking water and civic amenities

and environmental pollution. The dimin-ishing flow of the Hugli River causing silting of the Kolkata port has rendered the shipping facilities somewhat difficult.

Some of the existing industries of Kolkata adjoining Hugli River are - **Garden Reach Shipbuilders & Engineers Ltd**, abbreviated as GRSE, is one of India's leading shipyards, located in Kolkata, West Bengal. It builds and repairs commercial and naval vessels. Presently GRSE has also started building export ships in a mission to expand its business.

Founded in 1884 as a small privately owned company on the eastern bank of the Hugli River, it was renamed as Garden Reach Workshop in 1916. The company was nationalised by the Government of India in 1960. It was awarded the Miniratna status, with accompanying financial and operational autonomy in September 2006. It is first Indian shipyard to build 100 warships.

Some of the **small scale Cotton Textile industries** (Hosiery and Thread Making) are still located near the Strand Bank Road of Sovabazar, Ahiritola of the north Kolkata.

Plate 162: Cotton Thread making is going on in the small workshops of Shovabazar area

Plate 183&184: Cotton Thread Making is going on in Hosiery Textile making unit , Sutanuti

6.2B. Economy related to various Religious Activities

There are 3 major Burning Ghats along River Hugli . They are – a. Cossipur Ghat b. Kashi Mitra Ghat (Baghbazar) and Nimtala Ghat (Nimtala) . There is another big crematorium at Keoratala along Adi Ganga . Surrounding these Ghats there are many people who all are associated with the rituals like *Shraddha*. Ganga Clay and sacred water is also sold all along the River Belt . There are also many small temples on which priest communities dwell on their livelihoods. Festivals like Durga Puja, *Chhat* Festival; Dipavali often involves religious customs involving priests. Most of them are from Bihar, Odisha and Uttar Pradesh.

Plate 165: Ganga mati / Clay from Hugli river is getting sold at the river bank

Plate 166 : Shraddha is getting place in the Ghat

Plate 167 Holy Ganga water is sold in the adjoining bank

6.2C. Fishing as a livelihood activity -

Kolkata is one of the biggest consumers of fish but most of its supply comes from other districts of West Bengal like South 24 Parganas or Purba Medinipur etc and even from different states like Andhra Pradesh & Maharashtra. But along with them the East Kolkata Wetlands with 12,500 acres of *"Bheris"* (Fishing ponds) lying in the fringe area of the city supplies about 10,000 tonnes of Wastewater fed fish / year to the city dwellers. (Source- Central Institute of Fresh Water Aquaculture). It provides living of almost 50,000 cultivators.

According to **Bhery Fisherman's Co-operative Society Ltd** (based on our Survey) there are 5 stages involved in Fish Farming – a. Preparation of Pond (Winter months) b. Primary Fertilization by introduction of wastewater into ponds c.Fish Stocking where farmers introduce small number of fish to the test the water quality d. Secondary Fertilisation which involves a patterned introduction of nutrient-rich wastewater into the ponds in keeping with the lifecycle of the fish e. Finally, the fish are harvested at various times in the year depending on the fish species.

Plate 168 : Fishing Activities in EKW, Source - India Water Portal. The majority of the fisheries in the East Kolkata Wetlands area are under private ownership. Though there are a few fishermen's cooperatives, most of these are run informally. There are only two state-owned fisheries run by the State Fisheries Development Corporation in the East Kolkata Wetlands area. Seventy two percent of the sewage-fed fisheries in the East Kolkata Wetlands area are under private ownership, 27 per cent under Fishermen's Cooperatives and 1 per cent State-owned.

Plate 169 & 170 : Fishing activities in EKW

Plate – Traditional Ways of Fishing in Bheris.

Apart from this **Bheri Fishing**, in the heart of Kolkata along the bank of Hugli, in Bagbazaar area near the Lock Gate of Chitpur Canal, there also exists a fishermen community. Though the number of fishermen is negligible but still they mainly lead their livelihood by fishing in River Hugli.

Plate 171 – Fishing in Hugli , Baghbazaar Ghat 22°36'17.01"N 88°21'52.23"E

Plate 172: Fishing in Hugli , Bagbazaar Ghat

6.2D. Pottery as a traditional livelihood - There is a major potter's hub along Hugli River where the potters from generations earn their livelihood by making idols and other earthen pots. Kumortuli, a neighbourhood of Bagbazar and Sovabazar in north Kolkata. During Durga Puja, from all over the world these artists get orders to prepare Durga Idols. The Durga idols are generally priced between Rs 10,000 to 3 lacs. Rest of the year these artisans are engaged in making other deities like Kali, Lakshmi, Saraswati etc.

Plate 173: Kumortuli, Potter's Hub

6.2E. Navigation and riverine trade, landing spots: The Ganga-Bhagirathi Hugli river system from Haldia to Allahabad (1,620 km) has been declared as **National Waterway No. 1** as per National Waterway (Allahabad-Haldia stretch of the Ganga Bhagirathi - Hugli river) Act 1982 (49 of 1982). It became operative from 27th Oct 1986 after the formation of the Inland Waterway Authority of India (IWAI). The waterway extends from Haldia to Allahabad for a distance of 1620 kms. NW-1 passes through Uttar Pradesh, Bihar, Jharkhand and West Bengal.The Hugli river portion of the waterway from Haldia to Nabadwip is tidal. Sea going vessels navigate up to Calcutta (140 kms) and the fairway up to Calcutta is maintained by the Calcutta Port Trust.

Ferry Services - In our study area there are 10 Ferry Service Jetties through which the twin cities of Kolkata and Howrah are connected. Close to 2 lakh people cross the river on diesel-run boats on a weekday and about one lakh on a non-working day. Kolkata Port Trust

Table 26: Details of Ferry Services in the Study Area

Daily Commuting Route Chart of Ferry Services					
Authorities	**Routes**	**GCP**	**Service Duration**	**Frequency**	**Ticket Prices**
Hugli Jalapth Paribahan Samabai Samiti Limited (HJPSSL) + West Bengal Surface Transportation Corporation(WBSTC)	Howrah – Bagbazar (via Golabari, Ahiritola & Sovabazar Ghat)	22°36'15.79"N 88°21'50.67"E	7:40 am - 9:00 pm	10 min approx.	Rs 6
	Howrah – Armenian Ghat	22°34'57.10"N 88°20'53.64"E	8:00 am - 8:00 pm	10 min approx.	Rs 5
	Howrah – Fairlie Ghat	22°34'31.32"N 88°20'42.50"E	8:00 am - 8:00 pm	10 min approx.	Rs 5
	Fairlie Ghat – Dakshineswar, Belur and Aryadaha		8:00 am - 8:00 pm	2 hours approx	Rs 10
	Howrah – Chandpal Ghat	22°33'58.92"N 88°20'22.71"E	7:30 am - 8:30 pm	10 min approx.	Rs 5
	Chandpal Ghat – Ramkrishnapur Ghat	22°33'58.92"N 88°20'22.71"E	5:50 am - 8:50 pm	10 min approx.	Rs 5

Daily Commuting Route Chart of Ferry Services					
Authorities	**Routes**	**GCP**	**Service Duration**	**Frequency**	**Ticket Prices**
	Howrah – Shipping Corporation Ghat		8:00 am - 8:00 pm	10 min approx.	Rs 5
Ghatal Stream Navigation Private Limited + Indo-Swiss Trading Company Private Ltd.	Badhaghat – Ahiritola Ghat	22°35'46.47"N 88°21'10.20"E	5:30 am - 9:30 pm	10 min approx.	Rs 5

Source - WBTC

Plate 174: Ferry Service, Ahiritala , 22°35'49.68"N 88°21'16.03"E

6.2F. Town Forestry / Urban Green Spaces: In spite of huge urbanization, Kolkata has plenty of well-maintained scenic parks and green spaces. **According to KMC reports there are 512 big and small parks within the boundary of KMC.** By far the most important one is the Maidan which is often termed as the "Lungs of Kolkata".

I. Maidan: The Maidan (literally, open field), also referred to as the Brigade Parade Ground, is the largest urban park covering about 1283 acres (170 acres for the fort and 1113 acres for the glacis) of land in Kolkata. It is a vast stretch of field that includes numerous play grounds, including the famous cricketing venue Eden Gardens, several football stadiums and the Kolkata Race Course. It is the biggest carbon sink and Regional Centre of National Afforestation and Eco Development Board (Jadavpur University) have concluded that it is responsible for absorbing 120 tonnes of carbon di oxide annually.

The Maidan stretches from the Raj Bhavan building on the Esplanade in the north to the National Library on Belvedere Road in Alipore in the south. The wide field stretches from the Hugli River in the west to the Victoria Memorial in the east. It is a historical and cultural center of Kolkata as well as a center of leisure and entertainment for Calcuttans.

Plate 175: Maidan – The Lungs of Kolkata

In 1946, Benthall **listed 58 species of trees in Maidan that included** *Polythia Longifolia* **(Debdaru) ,** *Pterospermum acerifolium* **(Kanak Champa),** *Swietenia Mahogoni* **(Spanish Mahogany),** *Dalbergia Sissoo* **(Sisu),** *Enterolobium Saman* **(Belati sirissa), Lagerstroemia** *Speciosa* **(Jarul),** *Mimusops elengi* **(Bakul),** *Patranjiva Roxburghii* **(Jia Pata),** *Ficus Infectoria* **(Pakur),** *Ficas bengalensis* **(Bot).**

At present there are 132 species of Flowering Plants as recorded by KMC. Some of the major species are –

*Alstonia scholaris (*Chaatim*), Anthocephalus kadamba (*Kadam*), Pterospermum acerifolium (*Kanak champa*),Casia Fistula (* Amaltas/Sondal*), Michelia champaca (*Swarna Champa*).*

Plate 176: Kolkata Maidan Trees

II. Millennium Park: Running parallel to the Hugli River for a stretch of about 2.5 kilometres, this popular park provides a stunning view of the Howrah Bridge. With plenty of trees, well-maintained lawns, and seating by the waters, this much needed meditative space is a huge hit among Kolkatans of all ages. The park also has play areas and rides for children.

Plate 177: Millennium Park

III. Mohor Kunja

Earlier known as Citizen's Park, this park on Cathedral Road by the historic Victoria Memorial is a popular spot to host open-air cultural events in the city. Its stunning musical fountains and well-maintained greenery has made it one of Central Kolkata's most important green space.

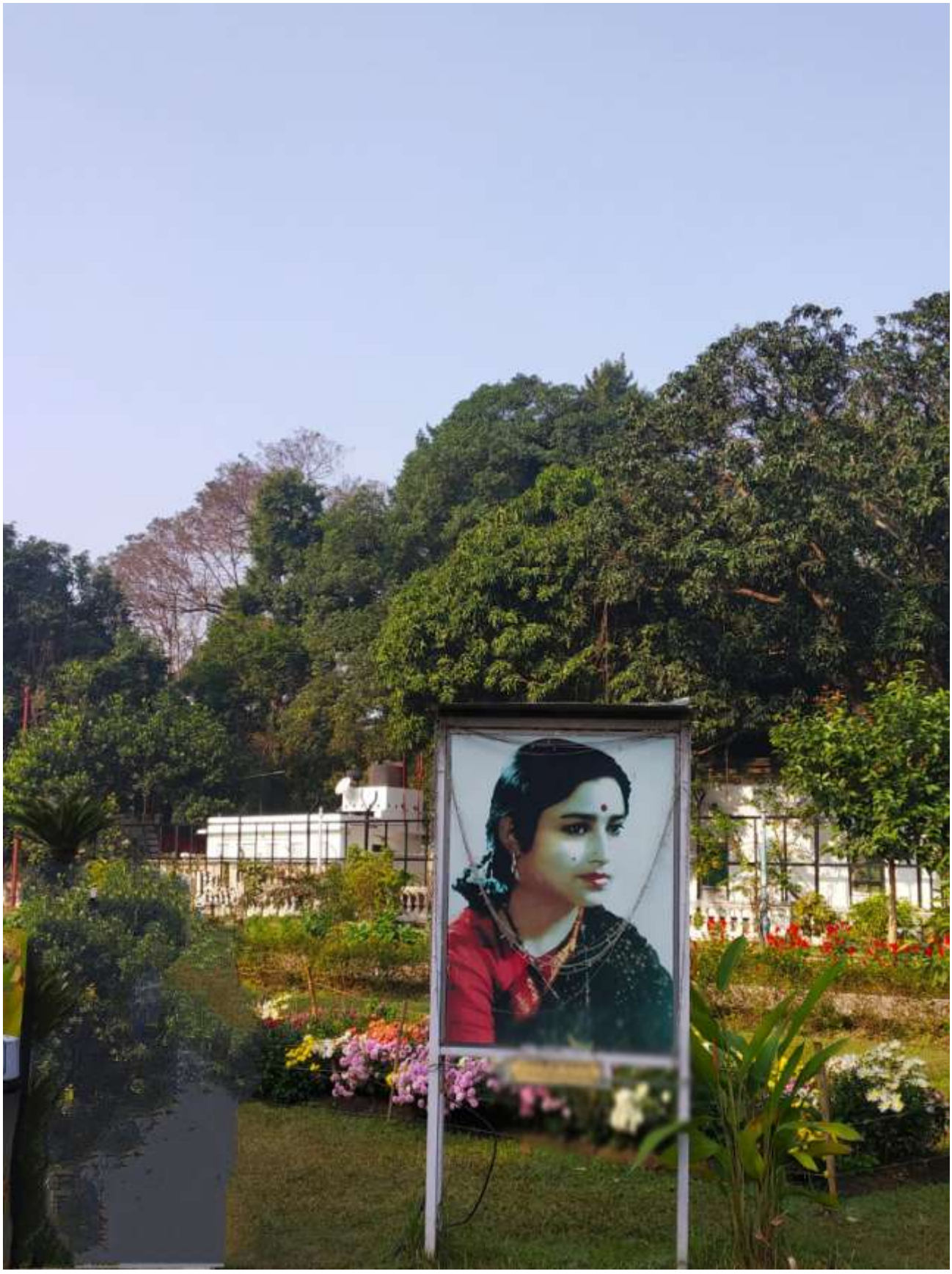


Plate 178: Mohor Kunja

Beside these major landmarks some of the other parks of the KMC are as follows:

Table 27: List of major parks within KMC (Data from KMC Website)

SL No	Borough	Ward	Name	Amenities	Area (sq.m)
1	I	4	C.I.T. Park at Rani Harashamukhi Rd.	Children's Park & Playground	
2	I	5	Bengal Gymkhana Ground	Nursery & Playground	
3	I	5	Children & Ladies Park at Tarasankar Sarani	Nursery & Playground	27759
4	I	5	Jatindra Mohan Park (Tala Jheel Park)	Nursery	27759
5	I	7	Sister Nivedita Uddyan	Playground & Children's Park	
6	I	9	Kumartully Park at 18 Abhoy Mitra St.	Playground & Children's Park	
7	I	2	Children's Park at Biswanath Colony South Sinthi Road		1227
8	I	2	Children's Park at Panchanantala	Children's Park	
9	I	2	Park at Sabji Bangan	Playground	
10	I	4	Children's Park at Northern Avenue	Children's park	
11	I	4	Biplobi Ganesh Ghosh Uddyan Northern Avenue	Children's Park & Playground	
12	I	5	Talapark Circus Maidan, Tara Sankar Sarani	Playground	
13	I	9	Maharaja Narendra K. Deb. Jatindra Mohan Avenue Park		
14	II	12	Gouribari C.I.T. Park	Children's Playground	1543
15	II	12	Deshbandhu Park at Raja Dinendra St.	Nursery, Ladies corner Playground	72311
16	II	16	Goabagan C.I.T. Park	Playground	3110
17	II	19	B.K.Pal Park	Children's Park	4433
18	III	29	Bagmari Park (At Maniktola Main Rd.), beside housing estate	Playground	
19	III	30	New Park at 106/C, Narkeldanga Rd. (Vivek Uddyan)	Children's Park	
20	III	31	A.P.C. Park at Ramkrishna Samadhi Rd.	Children's park, Nursery, Green house, Playground	
21	III	32	Prafulla Khudiram Uddyan at CIT Sect. VIII M	Children's corner, Landscape, Garden fountain, Lighting.	
22	III	31	Ramkrishna Mahila Sishu Uddyan	Children's Park	

23	IV	21	Jorabagan Park, 2, Baisnab Sett St.	Playground, Children's Park, Religious Function Club	
24	IV	23	Satyanarayan Park at the Junction of Kalakar St. & Cotton St.	Children's Park	2846
25	IV	25	Girish Park at the Junction of C.R.Avenue & Vivekanda Rd.	Children's Park, Landscape, Garden Fountain, Lilypool with over bridge.	3650
26	IV	25	Kalisinghi Park	Playground	2782
27	IV	26	Rabindra Kanan at 9, Beadon St.	Playground, Children's Park, Religious Centre, CMC building, Club Temple	14084
28	IV	27	Azad Hind Bag at 5, Bidhan Sarani	Tank at the Centre for Swimming Practice, Children's park, Shelter Shed & Flower Garden	5786
29	IV	28	Sadhana Sankar Uddyan at 204/2, APC Rd.	Mohila Yoga Kendra	3545
30	IV	38	Vidyasagar Park at 26/1, Badur Bagan Lane	Children's Park	3357
31	IV	38	Hrishikesh Park	Children's Park	
32	IV	23	Tarasundar Park, 56, Ratan Sankar Garden Lane	VAT CESC's Room	1616
33	IV	25	Saroda Banerjee Park	Playground	2782
34	IV	38	Jhama Pukur Square at 36, Guru Prosad Chowdhury Lane	Playground	1896
35	V	40	Vidyasagar Uddyan (College Square) 53/1, College St.	Children's Corner & Swimming Tank	17792
36	V	45	Millenium Park from Babughat to Kadamtala	Garden	
37	V	45	Town Hall & Millenium Park	Landscape & Flower Bed	
38	V	49	Shradhananda Park at 34, Suyra Sen St.	Children's Playground, Nursery, Flower Bed, KMC Office	6614
39	V	50	Santosh Mitra Square (Lebutola Park), Ram Narayan Motilal Lane	Children's Playground, Nursery	9833
40	VI	46	Chaplin Square & CMO Bldg. 5/2, Chowringhee Place, Kol-13	Children's Corner	
41	VI	47	Girin Banerjee Park on Ganesh Ch. Avenue	Children's Corner & Nursery	2742
42	VI	55	Convent Park at 13, Convent Rd.	Children's Corner, Nursery	4298

43	VI	55	Ramlila Park	Playground & Children's Park	
44	VI	55	C.I.T. Padyapukur Park	Playground	
45	VI	62	Hazi Mohammed Mahasin Square	Pond	16588
46	VI	62	Mireea Elliod Square (Ripon Square)	Playground	2325
47	VI	62	Triangular Park Jn. of Rafi Ahmed Kidwai St. & Ripon St.		
48	VI	46	Park opposite Pearless Inn		
49	VII	63	Rana Pratap Uddyan (Mc. Pherson Square) at 14/1, Loudon St.	Park & Nursery	
50	VII	63	Loudon Square (Nature Park) at 4, Loudon St.	Nature Study Park	7625
51	VII	63	Gopinath Saha Uddyan (Allen Park) at 28, Park St.	Children's Park	5493
52	VII	63	Victoria Sq./Albent T Rd.	Park & Water Body	13311
53	VII	63	Mintoo Park, 5/1, A.J.C. Bose Rd.	Park & Water Body	14782
54	VII	64	National Congress Park (Park Circus Maidan)		36954
55	VII	68	Children Park on Ekdalia Rd.	Children's Corner	
56	VII	85	Deshapriya Park	Playground, Tennis Court, Children's Park	27629
57	VII	56	Children's Park at 108, D.C.Dey Rd.	Children's Park	3854
58	VII	68	Park at 7, Carnfield Rd.	Children's Corner	
59	VIII	69	Maddox Square at 9, Pankaj Mallik Sarani	Children's Playground	
60	VIII	70	Dwarkanath Mitra Square at 13, Ashutosh Mukherjee Rd., Kolkata-20	Children's Playground	
61	VIII	70	Northern Park at 48, Allenby Rd.	Children's Playground	
62	VIII	70	Woodburn Park at 28 Woodburn Rd.	Children's Corner & Playground	
63	VIII	72	Landsdown Square at 49, Padmapukur	Water Tank	
64	VIII	73	Harish Park at 16, Harish Mukherjee Rd. Kolkata-25	Children's Corner & Playground	
65	VIII	73	Jatin Das Park at 9/1, S.P.Mukherjee Rd. Kolkata-25	Children's Corner & Playground	
66	VIII	84	Kalighat Park at 125, S.P.Mukherjee Rd.	Children's Corner & Playground	

67	VIII	86	Sarat Chatterjee Park (Triangular Park) at 172/2, R.B.Avenue. Kolkata-29		
68	IX	76	Padmapukur Square (Khidirpore)	Tank & Garden	
69	IX	78	Nabab Ali Park (Ekbalpur)		
70	IX	82	Chetla Park at 30, Chetla Central Rd.	Children's Corner & Playground	8568
71	IX	88	Mysore Garden (Tollygunge Rd.)	Flower Garden	3015
72	IX	88	Triangular Park on Pratapaditya Rd.	Garden	
73	IX	74	Alipore Office Garden	Nursery	
74	IX	82	Mani Sannyal Uddyan	Garden	
75	IX	83	Deshpran Sashmal Park at 10, Nepal Bhattacharjee St.	Playground & Children's Park	4266
76	IX	88	Desh Bandhu C.R.Das Memorial. 111, Tollygunge Road	Flower Garden with memorial tomb of Deshbandhu C.R.Das	
77	X	81	Datu Fadkar Memorial (New Alipur)	Children's park	
78	X	92	Tanupukur Park at Sarat Ghosh Garden Rd.	Children's park	
79	X	93	Jodhpur Children's Park	Children's park	
80	X	95	Tilak Nagar Park	Children's park	
81	X	96	Sishu Uddyan at Regent Estate Park	Children's Playground	
82	X	97	Regent Park in Govt. Estate at N.S.C.Bose RD.	Children's park	
83	X	99	Niranjan Sengupta Park	Children's Park & Playground	
84	X	81	Park at New Alipore 'O' Block	Children's park	
85	X	81	Park at New Alipore 'H' Block	Children's park	
86	X	92	Tarakeswar Sen Uddyan at Babu Bagan	Playground	
87	X	92	Bimal Ghosg Uddyan	Children's park	
88	X	96	Layalka Park (N.S.C. Bose Rd.)	Children's Park & Playground	
89	X	96	Bijoygarh Park (Bijoygarh Rd.)	Children's Park & Playground	
90	X	97	Rabindra Vivekananda Sardha Satabarsho Smarak Uddan	Playground & Nursery	
91	X	98	Jibananda Park	Children's park	
92	X	99	Park at Sree Colony Block, Block-1	Children's Park & Playground	

93	X	100	Lakshi Narayan Park	Children's Park	

6.2G. Markets along Hugli River: From the historical times, even before the British landed in the city, Kolkata had been a market place and the River Hugli played a vital role in this aspect.

Here is a list of markets which all have developed based on River Hugli and Adi Ganga .

I. Burra Bazaar or Burrabazar –The "Great Bazaar" or strictly "Buro Bazaar " (from Buro, the fond appellation of Lord Shiva) existed before British arrived 300 years ago. Sutanuti Hat ,the thread and yarn market ,gave its name to the riparian village on Bhagirathi River and spread over a quarter of its 1692 bighas. By 1707, 80 % of the area was crowded with houses and shops and simply it was the most populous part of the young city. No wonder , when British came they named it as a Great or Bara Bazaar. The Sheths , Bysacks , Sheels and Dattas were the pioneers of the trade and banians of Bengal moved in from Hugli town and settled in Gobindapur after the decline of Saptagram Port. They started doing bussiness from Sutanuti r Haat. Thursdays and Sundays were the market days and sellers of iron and silver, rice and lentils, fish and meat, sugarcane and vegetables all assembled at what was basically a cotton market. The market started to flourish and it was the reason why Job Charnock chose Kolkata for setting up the factory. Like some lodestone Barabazar attracted traders from near and far like Armenians, the Jews, and Chinese, who even brought their countrymen to settle down here. Greeks came too and Portuguese were already well ensconced. More crucial were the Marwaris who all came with brass pots and blankets. The brass soon became gold at the Midas touch of Barabazar. Most of the marwaris settled in Barabazar and replaced the Bengali merchant class in economic power. Marwaris still dominates in Barabazar and it is one of the most important money generating units of Kolkata bearing the traditional occupation of trading and business. The 13th storey market building is unauthorized and runs without water and electricity. All of Burrabazar is divided into specific areas or specilaised sub-markets named after the commodity it deals in – Dhotipatti, Fancypatti, Tulapatti, Chinipatti etc. These are further divided into katras. Each katra is known for a particular item. For instance, Raja Katra shops deal in spices, Manohar Das Katra is mostly about hardware and textile, the Vikram Chand Market and Khangrapatti sell electronic goods and artificial ornaments, and so on. During a major festival like Diwali, Kalakar Street and surrounding areas would be covering all items dealing with the festival – idols, their costumes, and Puja items, designer earthen lamps for the occasion, boondi ladoos, gift items, novelties and many

others. Literally the whole of Kolkata would be flocking to this destination to make their purchases.

Plate 179 : Burrabazar Market

II. Mallick Ghat Flower Market - Mullick Ghat is a 130 year old flower market, the largest wholesale market in Kolkata, and one of the biggest in Asia. People travel all over the city and suburbs to sell flowers here. Located right under the southeast end of the Howrah Bridge, the market runs along the riverside. It's primarily for people who want to pick up flowers for temple offerings and prayers. It is also located right next to the famous Jagannath Ghat, a heritage place for its European architecture style. It was constructed in the 1760s by an Indian.

Plate 180: Burrabazar market

At present there are 250 Stalls selling variety of flowers like –marigold, rose sunflower, tuberose, lotus, and even different type of orchid, and lots more. Not only flowers you get the huge number and verity of garland and flower petals for Puja and reception purposes.
The flower vendors bring their flowers from Bagnan, Vangor, Khirai, Kolaghat etc. of Hugli, Paschim Medinipur and Haora districts

Plate 181: Flower Market, Mallick Ghat

Plate 182, 183 & 184 – Flower market

Chapter 7: Documenting Environmental Problems

Kolkata is vulnerable to Environmental hazards of various kinds because of its - Location, Natural settings as well as Anthropogenic activities. As noted earlier KMC lies along the tidal reaches of the River Hugli and was once mostly under the Sundarban type wetland area. Also the elevation of KMC area averages around 6m above MSL with some areas with only about 1.5 m above MSL. The overall slope in KMC area is from north to south and from west to east – from the east bank of the Hugli river to the Salt Lakes. The highest parts of KMC lie along the eastern bank of the Hugli River. As in the natural situation Kolkata is vulnerable to a number of natural hazards including earthquakes (tsunamis),cyclones and flooding. Other hazards include tidal upsurge and extreme local precipitation that also leads to water logging and flooding. A special feature of the population of KMC is its large share of slum population that increases vulnerability to natural disasters.

7.1. SEISMICITY

Seismicity of Kolkata is in part related to the tectonic features present below the cover of Quaternary sediments. Details of such tectonic features present in the sub surface in and around Kolkata are given in GSI (2000).

7.1A. Past Records of Earthquake

Record documents indicate that though Kolkata has not suffered major damages from earthquakes during the last 350 years, there are many records of felt earthquakes and some have triggered moderate level of damages.

Table 28 – Records of Earthquake in the city

Sl.	Date	Place	Intensity/ Magnitude	Remarks
1	**01 February, 1811**	Kolkata area	VI	
2	**03 April ,1822**	Kolkata area	VII	
3	**08 July, 1828**	Kolkata area	VII	
4	**06 August , 1845**	Kolkata area	VII	
5	**09 February ,1851**	Kolkata area	VII	
6	**16 February,1861**	Kolkata area	VIII	
7	**11 November,1842**	Bihar	IX	Felt at Kolkata and was observed in Kolkata
8	**12 June,1897**	Assam-Meghalaya	Mw 8.1	Most Powerful intra plate earthquake in the Indian Sub Continent

9	**29 September,1906**	Kolkata area	V	
10	**02 July,1930**	Dhubri,Assam	V7.1	
11	15th January,1934	Indo-Nepal Border	Mw8.0	Tremors were felt in many places of Bengal including Kolkata.
12	21st March,1935	Pabna, Bangladesh	Ms 6.2	Prolonged tremors were felt in Kolkata
13	15th August,1950	Arunachal Pradesh	Mw 8.6	Most powerful earthquake in South Asia .
14	15th April,1964	Sagar Island	Mb.5.2	Maximum intensity in Kolkata was V
15	26th December,2004	Indonesia	8.7	Tremor felt in Kolkata
16	11th April,2012	Gangtok,Sikkim	5.4	Tremor felt in Kolkata
17	11th May , 2012	Assam	5.5	Tremor felt in Kolkata

Source : *(http:/asc.india.org/seismi/seis-west-bengal.htm)*

7.2. FLOOD EVENTS / WATER LOGGING:

a. Flooding is one of the main vulnerabilities of Kolkata . The major causes can be categorised as

7.2A. Natural Factors: Flat Topography with low relief vulnerable to flooding and drainage condition.

7.2B. Development factors: Unplanned and unregulated urbanization ,ageing drainage and sewerage infrastructure in the core city and lack of infrastructure in parts of added areas ,siltation in available drainage channels and reclamation of natural drainage areas increasing surface flows from paved areas.

7.2C. Climate factors: Probable increase in intensities of rainfall, sea level rise and increase in storm surge caused by climate change effects.

Even without climate change factors, flooding in KMC is and will continue to be an annual feature during monsoon and it has the potential to be devastating when accompanied with major storm. In KMC about 15% of total population lives beside river side and remain vulnerable to flooding from the Hugli river. A large number of populations also live in canal slopes and in low lying areas. The magnitude of flooding events, although primarily dependant on rainfall intensities in the city and in the catchment area is eventually controlled by natural drainage discharge and sewerage & pumping capacity in place. Other key factors include tide levels and storm surge in the receiving waterbody. A combination of the adverse situations can impede and /or overwhelm the normal discharge, sewerage and pumping capacity.

In 2009, a list has been prepared identifying the flood prone areas:

They are – **a.** College Street, **b.** B.B. Ganguly Street and Central Avenue Crossing **c.** B.B. Ganguly Street near Writers Building, **d.** S.N.Banerjee Road near Moulali, **e.** Free School Street, **f.** Elliot Road g. Park Street-Camac Street area **g.** South Sub urban system related to Ballyguange Pumping Station, **h.** Hide Road area **i.** Swinhoe Street, **j.** Ballyguange Phanri area, **k.** Bhawanipur, Chakraberia & Elgin Road area, **l.** Baker Road & Gopal Nagar area, m. Junction of National Medical College, Lady Brabourne College & Darga Road, **n.** Southend Park & Panchanantala area, **o.** Southern Avenue & Rabindra sarobar area, **p.** Ultodanga Area, **q.** Manictala Main Road and **r.** Narkeldanga, Kankurgacchi & Beliaghata area .

Three indices - **flood**, **social** and **landuse** have been developed by World Bank, 2011 to assess the vulnerability of Kolkata from flooding. The ward level analysis indicates that W14,W57,W58 & W66 are among the top 20 most vulnerable in all 3 indices and W63, W67, W74, W80, W108 are among the top 20 most vulnerable wards in flood and either social or landuse vulnerability index . Ward 58 is the most vulnerable of all. In this ward, almost the entire population 99.8% lives in slums and 44.8% of the population is illiterate. These characteristics result in a very high ranking in social vulnerability scale. Though about 90% of the area under ward 58 has underground sewerage, most of the pipelines have inadequate carrying capacity, have been laid out in a flat topography and are silted up. In addition the pipes have deteriorated due to industrial waste discharged into pipes mainly from leather industries. Of the most vulnerable wards, 6 wards (14, 57, 58, 66 ,67 and 108) in the eastern part and ward 80 suffer from inadequate sewerage and infrastructure facilities and high slum population .

7.3. CYCLONES

The word ‘cyclone’ was coined in erstwhile Calcutta by British geo-scientist Henry Piddington, the first in the world to start storm research in the Annals of the Asiatic Society. Looking at the structure of the natural phenomenon, Piddington compared it to the coil of a snake, which is what ‘cyclone’ means. By the time he published his landmark, ‘Laws of Storms’ in 1842, the city had witnessed the Great Bengal Cyclone of October 11-12 in 1737 and would soon face another one in October 5 in 1864. The former is considered one of the first 5 recorded cyclones of the world while the latter is also known as “**the Great Calcutta Cyclone**”. Both are considered amongst the most severe till date in terms of loss of life and property. Information about the 1737 cyclone is limited; some details can be traced in the Reports of “London Magazine” and Gentleman’s Magazine” both published from London. In

this storm that the Steeple of St. Anne's Church, called the first English Church which was located in the western corner of Writer's Buildings and the Nabagraha temple Tower, built by Gobindaram Mitra near Kumartuli, fell. Governments Record said the storm induced 40ft high waves and floods that inundated 60 leagues or 330 km and killed over 300,000 people across Bengal.

"*Early in the morning on October 11, 1737, a large cyclone made landfall inside the Ganges River Delta, located just south of Calcutta, West Bengal, India. The cyclone caused a storm surge 10-13 m (30-40 ft) in the Ganges with a reported 381 mm (15 in) of rain falling in a 6-hour period. The storm tracked approximately 330 km (200 mi) inland before dissipating. In the city of Calcutta, the majority of structures, which were mostly made of mud with straw roofs, were destroyed, with many brick structures also damaged beyond repair. A spire on the St. Anne's church reportedly sunk and listed to side, and was not approved for repair until 1751. The East India Company's records report 3,000 deaths occurring in Calcutta alone. In the Ganges, 9 out of 8 boats were lost along with most of their crews, and 3 out of 4 Dutch ships also went down. Overall the cyclone reportedly destroyed 20,000 water going vessels, ranging from ocean worthy ships to canoes, and killed 300,000 to 350,000 individuals, likely including ships' crews as well as the local populations in low-lying Bengal.*"

7.3A. The Great Calcutta Cyclone of 1864 raged between 4pm and 10pm. "The avenues of Fort William were destroyed, Eden Gardens was a wilderness, the iron rails overthrown, Garden Reach roads were blocked by trees, the roof of Free School, the Roman Catholic Church tower at Bowbazar, the steeple of Free Church of Scotland, the minarets of the mosque at Dharmatala and the roof of St James' Theatre were blown away. Even telegraph lines were broken, bringing communication to a halt," Researcher Bibhor Das, who studied the impact of the 1864 cy clone on Bishop's College in Howrah, cited reports of two ships Vessel Bengal and Mail Steamer Nemesis which broke into pieces and were flung on to the campus where IIEST now stands.

7.3B. Cyclone "Aila" (JTWC designation: 02B, also known as Severe Cyclonic Storm Aila) was the second named tropical cyclone of the 2009 North Indian Ocean cyclone season. Warned by both the Regional Specialized Meteorological Center (RMSC) and Joint Typhoon Warning Center (JTWC), Aila formed over a disturbance over the Bay of Bengal on May 23, 2009 and started to intensify and organize reaching sustained wind speeds of 110 km/h

(70 mph).Though it is considered as the deadliest cyclone of Bangladesh , it had a very less impact on Kolkata.

7.3C. Super Cyclonic "Amphan" 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 Ganga 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 3rd super cyclone that hit West Bengal since 1582, after 1737 and 1833, as well as being the strongest. 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. The first tropical cyclone of the 2020 North Indian Ocean cyclone season, Amphan originated from a low-pressure area persisting a couple hundred miles (300 km) east of Colombo, Sri Lanka, on 13 May 2020. Tracking northeastward, the disturbance organized over exceptionally warm sea surface temperatures; the Joint Typhoon Warning Center (JTWC) upgraded the system to a tropical depression on 15 May while the Indian Meteorological Department (IMD) followed suit the following day. On 17 May, Amphan underwent rapid intensification and became an extremely severe cyclonic storm within 12 hours. On 18 May, at approximately 12:00 UTC, Amphan reached its peak intensity with 3-minute sustained wind speeds of 240 km/h (150 mph), 1-minute sustained wind speeds of 260 km/h (160 mph), and a minimum central barometric pressure of 920 mbar (27.17 inHg). The storm began an eyewall replacement cycle shortly after it reached its peak intensity, but the continued effects of dry air and wind shear disrupted this process and caused Amphan to gradually weaken as it paralleled the eastern coastline of India. On 20 May, between 10:00 and 11:00 UTC, the cyclone made landfall in West Bengal.

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.[49] Wind speed along coastal areas were measured up to 150–160 km/h (93–99 mph). In Canning a 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.

7.4D. Table 29: Historical Records of Extreme events including Cyclones in the vicinity of Kolkata, West Bengal

Period	Description	Location
17-10-1737	An Earthquake possibly affected by Storm	Kolkata
3-10-1854	The surge went up to 12m and the water level increased at Kolkata and its vicinity.About 50k deaths recorded.	Kolkata
02-05/10/1864	Caused Flooding upto 13 km from the banks of Hugli with 80k deaths	Kolkata
13-20/08/1974	Cyclonic storm over land with maximum wind speed of 139 kmph . Caused floods in several districts.	Kolkata
04/05/2005	Affected 61 wards of Kolkata , N&S 24 Parganas,Howrah,Hugli etc	Kolkata
25/5/2009	Cyclone Aila affected all the districts including Kolkata with winds blowing 70 mph over the land.	Kolkata

Cyclone Amphan , the devastated city (Photo Documentation – TOI, March 28th2020)

Plate 185 & 186 : Cyclone devastated Kolkata City

Plate 187: Flooded Airport , Dumdum

7.4. River Bank Erosion / Condition of Embankment

River Hugli once upon a time was so deep in the eastern flank of Calcutta that the entire stretch, from the mouth of Adi Ganga to Sovabazar Ghat in the north would be inundated. A considerable number of dockyards were constructed in this tract for ship repairing between the present Hastings Street and Armenian Street on Strand Road. The front part of the dockyards faced the Strand Road with their backside on Clive Street. From 1808, the water level of Ganga began decreasing.

When the Lottery Committee was set up in 1817 to collect funds through pubic lotteries for planning and construction of the town's houses, roads, offices for the various departments of the government, water had receded from Strand Road. After six years, construction of the Strand Road began from Chandpal Ghat in the west to Rathtola Ghat in the east. And once roadwork began in the northern part of the city, one by one, all the dockyards in this area shut down permanently. The Strand, road was constructed in 1820-21, over a 'Chur' that passed through two Zamindaries, that of Calcutta and Sootanaty .

The first portion of Strand Road that was completed extended upto Princep Ghat near Fort William to Hatkhola in the northern part of the original village of Sutanati. In 1828 Strand Road was extended upto Garden Reach "The improvement of Strand Bank is closely linked up with the history of Strand Road. At its first formation the land appears to have been the result of alluvial deposit" subsequently spurs were thrown out westward from the road by the Military Board with 1he object of protecting the river side of the Fort from erosion.

Plate 189 – Strand Bank Road, Sovabazar

Plate 190– Condition of Embankment near Sovabazaar Ferry Ghat

Plate 191 - Condition of Embankment in Bagbazar Ghat

The Municipality contributed largely in the reclamation of this valuable land by depositing for many years the sweeping of the town upon the alluvium so formed, and in course of time the assumption grew up that the Corporation, in who was vested the right of property in the town sweeping, had acquired a title in Strand Bank itself. By 1826, within three years of the road construction, eight major dockyard owners shut their business and relocated to the west bank of Ganga, between Ghusuri and Shibpur. New dockyards and engineering firms came up in the western side of the river in Howrah. Ganga continued to recede further west for many years, long after construction of Strand Road was completed. That's how another Strand Road was built further west to the original Strand Road. It was named Strand Bank Road to differentiate it from the original road.

Here is an attempt to photo-document the present condition of the Embankment along Hugli from Bagbazaar to Garden reach.

1. Plate 192- Location – In between Chitpur and Bagbazaar Ferry Ghat.

Plate 193 – The broken condition of Embankment , near Sovabazaar .

Plate194– Condition of Embankment near Ahiritola.

Plate 195 – Condition of Embankment, in between Nimtala Ghat and P.KTagore Ghat .

Plate 196– Condition of Embankment near Prassana Kumar Ghat

Plate 197 – Condition of Embankment near P.K Thakur Ghat

Plate 198 – Condition of Embankment near Jagannath Ghat

Plate 199 – Condition near Jagannath Ghat

Plate 200 – Condition of Embankment, Chhote Lal ki Ghat

Plate 201 – Embankment near Millennium Park

Plate 202 – Condition of Embankment near Fairlie Jetty

Plate 203 – Condition of Embankment near Judges Ghat

Plate 204 – Condition of Embankment near Outram Ghat

Plate 205 – River Front Beautification near Prinsep Ghat

Plate206: River Front Beautification near Prinsep Ghat

Plate 207: Embankment near Takta Ghat

Plate 208: Embankment near Bidhan Ghat

Plate209 – Mouth of Tolly's Nala or Adi ganga

7.5. SHRINKING WETLANDS:

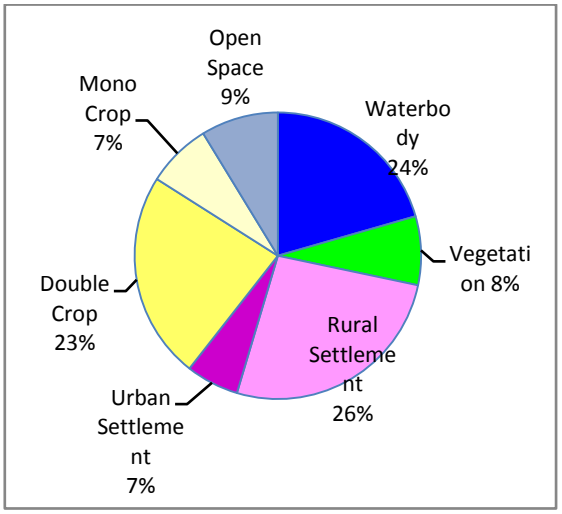
The wetlands in the east of Kolkata are part of a unique ecosystem that thrives on wastewater from India's third-most populated metro city. It's the world's largest organic sewage treatment system that doubles up as a vegetable garden and fishery that supply more than a half of the city's daily requirement. The brackish, low-lying marshes beyond east Kolkata are a natural ecosystem shaped wisely by human intervention. They were brought into use more than a century ago by a clever arrangement of sewage, sunlight and gravity channels to rid a city of its organic waste.

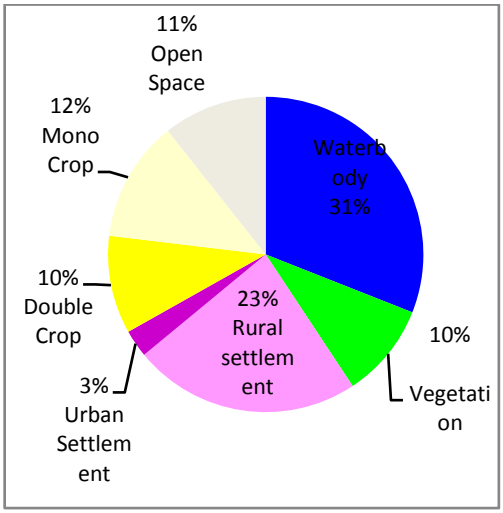
Despite their usefulness, the wetlands have been rapidly shrinking due to the hunger for real estate in a crowded city. After being declared a Ramsar site of international importance in 2002, steps have been taken to protect the ecosystem, but with limited success.

We have taken Landsat Satellite Images of 2 years – 2011 and 2019 of East Kolkata Wetlands and ran unsupervised classification on the images . Here are our observations –

Table 30 : Change in LULC in EKW

Sl No.	LULC Categories	2011 Area in ha	2019 Area in ha
1	Waterbody	3945	2617
2	Vegetation	1237	987
3	Rural Settlement	2969	3350
4	Urban Settlement	360	760
5	Double Crop	1280	2980
6	Mono Crop	1585	927
7	Open Space	1356	1111
	Total area	12732	12732





2011 Landsat Image shows that about 31 % of the total area is under the waterbody while in 2019 the percentage of Landcover under the Water body has decreased to mere 24%. Even after being declared as a Ramsar site, there is a systematic shrinking of water body.

Beside East Kolkata Wetlands, there are many water bodies within the city area which are reducing in size and slowly getting converted into urban scapes

7.6. WATER POLLUTION:

Like any other big cities of India, Kolkata also faces an acute problem of water pollution. Starting from the main river to the major canals to any water body, there is pollution everywhere. "Untreated sewerage is the biggest problem," said Dr. Kalyan Rudra, Chairman, West Bengal Pollution Control Board (WBPCB). According to him it accounts for about 85% of the pollution in the river.

i. River Pollution – Through our survey we found that there are about 6 major sewage outfall (sources) within our stretch of about 20 km, dumping city pollutants in the river. The other 2 major pollution sources are Circular Canal in north and Tolly's Nullah in South. Table 31: Sources of River Pollution

Sl. no.	GCP	Location	Condition
1	22°36'17.41"N 88°21'53.10"E	Baghbazaar	Poorly maintained
2	22°36'9.46"N 88°21'44.17"E	Sovabazaar	Poorly maintained
3	22°35'43.95"N 88°21'10.59"E	Nimtala	Poorly maintained
4.	22°35'18.26"N 88°21'0.67"E	Barabazaar	Poorly maintained
5.	22°34'25.75"N 88°20'40.96"E	Babughat	Poorly maintained
6.	22°32'58.67"N 88°19'20.53"E	Dai Ghat , Watgaunj	Poorly maintained

Plate 210: Sewage Outfall near Bagbazaar

Plate 211 - Sewage Outfall near Sovabazaar

Plate 212: Sewage Outfall near Nimtala

Plate 213: Sewage Outfall near Jagannath Ghat

Plate 214: Sewage Outfall near Barabazar

Plate 215: Sewage Outfall near Babughat

Plate 216: Sewage Outfall near Watganj

Beside these point sources like the Sewer lines, the Ghats are also the areas where huge amount of human activities are carried out resulting in huge amount of non point sources pollution. During our survey we found that most of the Ghats , specially the stretch between Nimtala Burning Ghat to Armenian Ghat in the central Kolkata and the stretch near Metiaburuz in extreme south , the Ghats are in very sorry state . Bathing Ghats are falling into pieces. Their facades are almost hidden behind a clutter of hoardings and illegal squaters. Heaps of garbage lie on the steps and an appalling stench fills the air. Strand Bank Road is simply out of bounds to public because 100 s of good vehicles are there in perfect disorder. Along this roads are the century old bathing ghats all categorized under Grade 1 heritage structures.But all these ghats are stations of filths. Their entrace are blocked by mounds of garbages and all encroachers. Say as in Jagganath Ghat,the entire structure has been converted into some dharmasalas with all encroachers. Another example is Ram Chandra Goenka Ghat or Pathuriaghata Ghat . During evening these Ghats are filled with Drunks, ruffins, enunchs, dead animals etc .Pavement dwellers drink in open, and prostitutes solicite clients. They all become drug dens and sleaze shops. Smoking ganja is a common site in these areas.

Plate 217: Polluted River Bank, Jagannath Ghat

Plate 218: Polluted Ram Chandra Goenka Ghat

Plate219: Polluted near Nimtala Ghat

Plate 220: Polluted banks near Barra Bazar

Plate 221: Polluted Bank near Ahiritala

7.6B. Canals: All the canals of Kolkata have become the major sources of pollution. Throughout the banks of the canal we found squatters and slums giving shelters to thousands of people who all come to this city for their livelihood. The condition of Tolly's Nullah Nullah is in worst condition. Concrete houses with foundations eating into the riverbanks have drains that release effluents directly into the canals. In addition to that, in the Kolkata stretch alone, there are thousands of shanties on both banks, with makeshift latrines right on top of the water. All this is regularly interspersed by cattle sheds, small factories and even neighborhood recreation clubs along the banks. Discarded polythene packets flutter around Metro rail pillars and obscure the dark water wherever the water hyacinth does not do so. Nothing can obscure the stink. (A Detail Report on the water quality of Adi Ganga has been already mentioned)

Plate 222: Encroached Canal Banks

Plate 223: Plastic Garbage dump near Beliaghata

Plate 224 : Garbage Dump near Beliaghata

Plate 225 : Polluted Circular Canal

Plate 226 : Slums and Squatters surrounding the Canal

7.6C. Pollution in the Wetlands: East Kolkata Wetlands of Kolkata is confronting with a major problem of Water Pollution. The industries in the adjacent areas have made unauthorized connection to the sewers to empty their untreated wastewater. The sewers on the other hand empty the water into the channels that later on join the wetlands. This is causing a deposition of the heavy metals in the canals and ultimately the quality of fish and vegetables produced in the wetlands is far below the edible standard. Bantala , an area located in the vicinity of EKW has about 500 tanneries . Many of them dump their toxin wastes in these wetlands. Toxins flowing into the nearby fish farms (bheris) are killing hundreds of fish and the ones that survives pass on the deadly pollutants to the consumers.

As we surveyed the area we found leather wastes mostly scraped out of animal hides containing chemicals are dumped all along the EKW area . These chemicals that are extremely dangerous seeps into the soil and flows in the waterbody. According to experts these pollutants include tannin, lead and different kinds of chromium.

Plate 227: Leather wastes getting dumped in East Kolkata Wetlands

Plate - Polluted Waterbody near Tiljala, 22°31'59.53"N 88°23'35.63"E

Plate – Shrinking Waterbodies , 22°32'3.07"N 88°23'40.98"E

7.7. Rapid Urbanisation (Slums / Squatters):

Urbanization is a process of population increase in urban area following some non-agricultural activities. The higher is the percentage of population the greater is the level of urbanization and vice versa. The process of urbanization in Kolkata is a continuous process of human settlement spread over time. This concentration is owing to different factors like economic, social, geographical and political.

Partition of India in 1947 created a great flow of population to Kolkata. Hundreds of thousands of people often in clusters of a number of families known as 'displaced persons' or 'refugees' migrated to Kolkata in waves and sought shelters in accordance with their means and opportunities. The rich bought properties at offered prices. Those who could not afford such prices simply encroached on vacant land. The River and the canal bank were the preferred area . The poorest flocked into relief camps. Kolkata slowly secured their placements in the urban economy and imparted new attributes to the process of urbanization Increase in population in Kolkata has led to greater demands for goods and services. At present the city of Kolkata is one of the **densest** on earth. Its population density is 63,000 per square mile (22,000 per square kilometre - Based on 2011 Census).

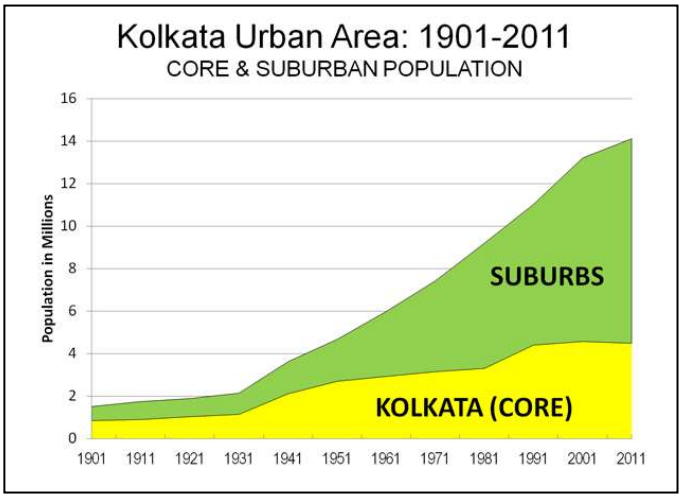
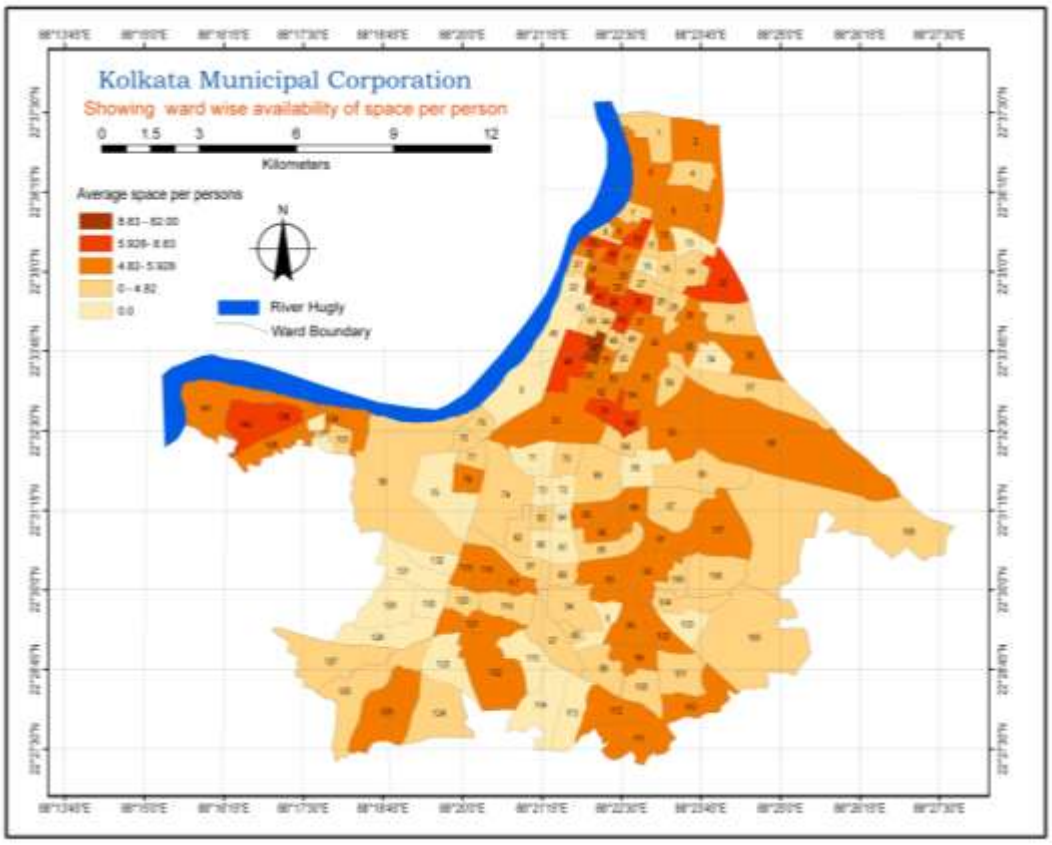


Table 32 -Kolkata Urban Area: Population 1901-2011

Year	Kolkata Municipal Corporation (KMC)	Suburbs	Kolkata Urban Area (Urban Agglomeration)	KMC Share of Growth	KMC Growth	Suburban Growth
1901	848,000	662,000	1,510,000	56.2%		
1911	896,000	849,000	1,745,000	51.3%	5.7%	28.2%
1921	1,031,000	854,000	1,885,000	54.7%	15.1%	0.6%
1931	1,141,000	998,000	2,139,000	53.3%	10.7%	16.9%
1941	2,109,000	1,512,000	3,621,000	58.2%	84.8%	51.5%
1951	2,698,000	1,972,000	4,670,000	57.8%	27.9%	30.4%
1961	2,927,000	3,057,000	5,984,000	48.9%	8.5%	55.0%
1971	3,149,000	4,271,000	7,420,000	42.4%	7.6%	39.7%
1981	3,305,006	5,888,994	9,194,000	35.9%	5.0%	37.9%
1991	4,400,000	6,622,000	11,022,000	39.9%	33.1%	12.4%
2001	4,573,000	8,633,000	13,206,000	34.6%	3.9%	30.4%
2011	4,487,000	9,626,000	14,113,000	31.8%	-1.9%	11.5%

7.7A. Slums and Squatters: High population pressure and dearth of land has effected on the creation of slums and squatters, Kolkata has some of the biggest slums with maximum density of population . In 2011, one third of the central city population (1.52 million) live in slums and shantytowns .They are crammed into just 2 square miles (5 square miles). Kolkata has always been a city of migrants. They are the people who have made the city so large. In the first half of the 20th century the largest group of migrants were the working-class people from Bihar. The slum population has grown at a much faster rate than the total city population, thereby indicating a growing ratio of the impoverished working population of the city. P. Thankappan Nair writes, "The six square miles within the Maratha Ditch (the original core of Calcutta) thus came to have the world's highest density of population . It was a heterogeneous population, sinking differences of caste, creed and colour under the sheer compulsion to interact and survive together. Most of these slums are located beside the River Hugli and the canals. This huge pressure of population has attributed to the rapid pollution of the river and other water bodies.



Map 54 – Ward wise Slum Pockets

Plate 227 – Khidirpur Bustee along River Hugli , Plate 228– Muraripukur Bustee

7.7. CLIMATE CHANGE AND VULNERABILITY:

A number of recent studies have shown that coastal areas are vulnerable to a range of risks related to climate change including coastal flooding. Among these coastal areas, the Inter Governmental Panel on Climate Change specifically identifies as hotspots the heavily urbanized megacities in the low-lying deltas of Asia (IPCC, 2007). Within Asian countries, India is particularly vulnerable with its 7,500 km long predominantly low-lying densely populated coastline. The first global assessment of the exposure of port cities lists Kolkata and Mumbai in India among the top ten cities that have high exposure to flooding under the current climate change forecasts (OECD, 2007). (Source -Environment, Climate Change and Water Resources Department South Asia Region)

World Bank in 2011 predicted that there might be a rise in temperature of about 1.8^0C to 2^0C by 2050 and also predicted in an increase in precipitation by 16%.The sea level is most likely to rise about 0.27m by 2050. The rising sea surface temperature can intensify Tropical Cyclones with large extremes of waves and storm surges. This altogether can result in partial drowning of the city.