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BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL,  
EASTERN ZONE BENCH, KOKATA

ORIGINAL APPLICATION NO. \_\_\_\_\_ OF 2022

Under Section 14 and 17 of the National Green Tribunal Act 2010

IN THE MATTER OF:

Suprova Prasad

.....Applicant

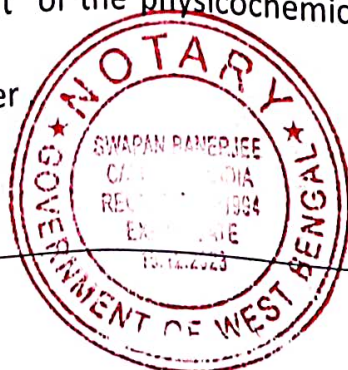
VERSUS

Ministry OF Environment Forest and Climate Change & Ors

.....Respondent

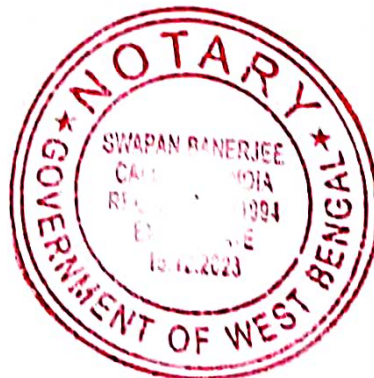
INDEX

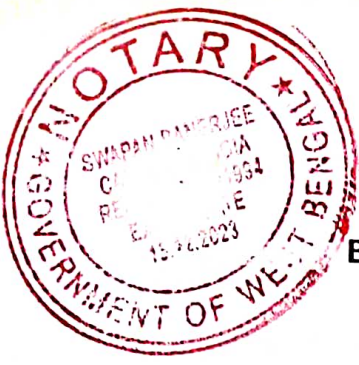
	Synopsis	3-4
	List Of Dates	5-6
	Application	7-23
	Verification	24
	Copy of the report published on 1/10/21	Annexure A 25-32
	Copy of the report of the physicochemical analysis of the river	Annexure B 33-38



Copy of the Pictures of the Ahiritola Ghat	Annexure C 39-40
Copy of the pictures of the Nimtala Ghat	Annexure D 41
Copy of the pictures of the Mayer Ghat	Annexure E 42
Copy of the pictures of the Sutanuti Ghat	Annexure F 43
Copy of the pictures of the Kumartuli Ghat	Annexure G 44
Copy of the pictures of the Cossipore Ghat	Annexure H 45-48
Copy of relevant portions of the report of 2003 of WBPCB	Annexure I 49 - 50
Copy of CPCB report dated 2013	Annexure J 51 - 53
Copy of CPCB report March 2021	Annexure K 54 - 55
Vokalatnama	56

**Paushali Banerjee**  
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**7A, Kiron Shankar Roy Road**  
**Kolkata-700001**





-3-

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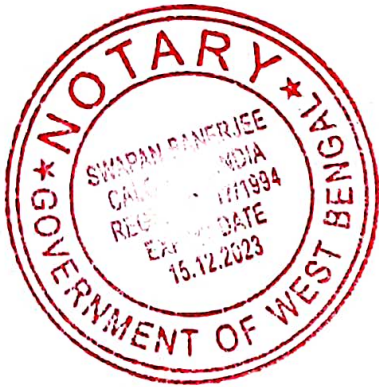
SYNOPSIS

The applicant above named begs to present the Memorandum of application against the inaction of the respondent authorities to protect to protect the river Ganga and the pollution of the ghats of the river Ganga, leachate from the waste accumulated on the ghats flow into the river and pollutes the river. The Applicant is a resident of one of the ganga district and visited the polluted ghats

- 4 -

and found that various activities in the ghats like bathing, last rites, transport, dumping of solid waste, leachate from waste flowing into the river, outfalls of municipal drains and Industrial waste into the river polluting the river , Hence this Application.

**Paushali Banerjee**  
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(Under Section 14 and 17 of the Green Tribunal Act 2010)

IN THE MATTER OF:

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Ministry OF Environment Forest and Climate Change & Ors

.....Respondent

LIST OF DATES

	2003	WBPCB conducts a survey of river Ganga
	2013	CPCB Assessment of River Ganga
	7/10/2016	Notification of MOEF
	October 2020	CPCB have framed guidelines for setting up of biodiversity parks in the flood plains of river Ganga

March 2021	recent report of CPCB of March 2021 states the condition of STPs at present in West Bengal .
1/10/21	the report divides the ghats into separate zones conducts a details analysis of pollution on each one of them
23/11/21	The applicant takes the pictures of different Ghats of Ganga

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- 7 -

BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL,

EASTERN ZONE BENCH, KOKATA

ORIGINAL APPLICATION NO. \_\_\_\_\_ OF 2022

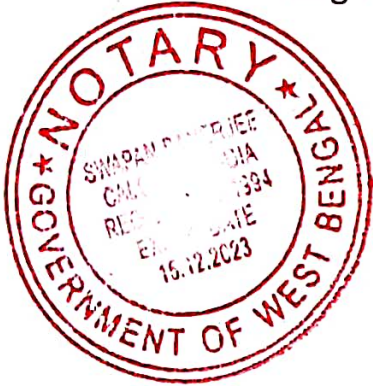
(Under Section 14 and 17 of the Green Tribunal Act 2010)

**IN THE MATTER OF:**

Suprova Prasad, wife of Jadagish Prasad, 148, Rajendra Avenue Uttarpara,

District- Hooghly, P.S. Uttarpara, Pin- 712258. Paushali\_b@yahoo.com

.....Applicant



VERSUS

1. Ministry of Environment, Forest and Climate Change, through the Secretary,

Indira Paryavaran Bhawan, Jorbagh Road, New Delhi-110003. secy-moef

@nic.in. PH No- 24695262

2. Department of Water Resources, RD & GR, through the Secretary, 2<sup>nd</sup> Floor,

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Ph. No. 2252-7456

3. West Bengal Pollution Control Board, through the Chairman, Paribesh

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wb@bangla.gov.in. Ph. No. - 2335-9088

4. Department of Environment, through the Chief Environmental Officer,

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Kolkata- 700106.environmentwb@gmail.com, Ph. No. 2335-5246

5. The Central Pollution Control Board through the Chairman, Paribesh

Bhawan, Maharshi Valmiki Marg, East Arjun Nagar, Vishwas Nagar,

Shahdara, New Delhi-110032. ~~ceb.cpcb@nic.in~~, Ph. No. - 2230-7233.

6. Kolkata Municipal Corporation through the Commissioner, 5 S.N. Banerjee

Road, PIN-700013.mc@kmc.gov.in, Ph. No. 2286-1000



MOST RESPECTFULLY SHOWETH:

.....RESPONDENTS

1. The applicant is a citizen of India having address as stated above for the purpose of service of notices pertaining to the instant application.
2. The addresses of the respondents are stated above for the purpose of service of notices pertaining to the instant application. All the acts, actions and inactions of the respondent authorities are amenable to the jurisdiction of this Hon'ble Tribunal.
3. The applicant above named begs to present the Memorandum of application against the inaction of the respondent authorities to protect the river Ganga and the pollution in the ghats of the river Ganga that pollutes the Holy River therefore this Application have been filed by the Applicant on the grounds set-out hereunder:

4. FACTS IN BREIF:

- A. That the Petitioner is a citizen of India and a resident of one of the Ganga towns who is aware of the indiscriminate pollution in Ganga caused by the Ghats of the River. The Applicant have visited all the ghats herself and found the ghats indiscriminately polluting the river Ganga.



B. The 2,525 km river Ganga rises in the western Himalayas in the Indian State of Uttarakhand and flows south and east through the Gangetic plains of India and Bangladesh, eventually emptying into the Bay of Bengal. From its source in the high Himalayas, the Ganges flowed in a broadly southeasterly direction across the Indian plains before descending to the loose alluvial soil of Bengal and charting a southward course through what would become known as the Hooghly basin. The Hooghly weaves through the Indian state of West Bengal from the Ganges, its parent river, to the sea. At just 460 kilometers (approximately 286 miles) it is a lifeline to 40 percent population of India who live along its course and by discharge, it is the fifth largest river in the World

C. That the applicant states that The river flows through 100 cities with populations over 100,000, and 97 cities and 48 towns with populations between 50,000 to 100,000 and a swift increase in the urbanization through out the cities along the river side have contributed to the imbalance in the growth of population and the pollution control system. The long stretch of the river Hugli on the western side of Kolkata is characterized by the presence of numerous ghats they serve for embankment protection of the river.



D. That the Hugli river ghats are used for multiple purposes be it religious or domestic or transport, river ghats have turned into a dumping point. This has not only resulted in environmental imbalance but also negatively affected the levels of Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD) and Coliform bacteria. According to the research paper of Falguni Dey assistant coordinator of the post graduate department of university of Calcutta , the Sources of pollution in different ghats are a cumulative result of taking bath, regular immersion of idols, Human excreta, sources of the toxic municipal outfall, and also availability of ferry service.

E. That the applicant states that different ghats of the Hooghly river contributes to the pollution in the Hooghly river in one way or the other. The out falls from the drains and other sources, bathing , garbage accumulation in Ahiritola Ghat and different other ghats contributes to the pollution in the Hooghly river. A research Fellow of the Department of Geography, Women's Collage, University of Calcutta conducted a study which was published in website on 1/10/2021, the study divides the ghats into separate zones conducts a



details analysis of pollution on each one of them and also the probable reasons.

Copy of the report published on 1/10/21 is annexed herewith and marked as annexure A.

F. That The Applicant states that the physicochemical analysis of the river was done by some researchers and sample of water was collected from different ghats including Mangal Pandey Ghat, Rani Rashmoni Ghat, Dhobi Ghat etc it was found that the turbidity of water was high and also the Ca and Mg content of the River is higher than other river, probably because of the use of detergent for bathing and washing of clothes on the ghats. Copy of the report of the physicochemical analysis of the river is annexed herewith and marked as Annexure B.

G. That the Applicants states that to appropriately provide the picture of the ghats and the pollution created by the indiscriminate use of the ghats the history of the Ghats and the sources of pollution from the Ghats are given below:

**AHIRITOLA GHAT**

- (i) previous name of the ghat is Golpara. Babu Baichandra established this ghat. The Ghat also held two river transport route one is Ahiritola to Howrah and other is Ahiritola to Salkia



which is situated in Howrah. A large number of people used this to reach their destination. Also a large number of people used this for different purpose i.e. bathing, transport and different types of work. The ghat is presently filled with garbage and the waste water from municipal drains drain directly into the river ganga. Copy of the Pictures of the Ahiritola Ghat are annexed herewith and marked as annexure C.

**N1MTALA GHAT**

- (ii) This ghat was established beadon street and this ghat was build in 1827. State Government have replaced the wood burning process with electric burning system. Every day more than eighty bodies are cremated. The last rites performed in the ghats leads to huge amount of disposed flowers , plastic waste and other waste leading to pollution in the river. Copy of the pictures of the Nimtala Ghat are annexed herewith and marked as annexure D

**MAYER GHAT**

- (iii) This ghat is situated in the east side of the Hooghly river , Sarada Ma used this ghat from 1909 to 1920 nearly about 12 years for bathing and puja and purposes. Sarada Ma breathed her last in the house of Sarada Ma situated near this ghat on 20<sup>th</sup> of July



1920. This ghat is known as Mayer ghat in the memory of Sarada Ma. Solid waste accumulation at this ghat is the source of pollution, the Copy of the pictures of Mayer ghat is annexed herewith and marked as annexure E.

#### SUTANUTI GHAT

- (iv) Sutanuti was a famous place of Bengal. The founder of Kolkata, Job Charnak reached Kolkata and settled in Sutanuti. Kolkata at that time was build with three villages (sutanuti, gobindapur, Kolkata). Sutanuti, this village was under the jamindar of sovabazar. The jamindar of sovabazar build this bathing ghat for the use of general people. The condition of this ghat is more or less a dumping yard .Copy of the pictures are annexed herewith and marked as annexure F.

#### KUMORTULI GHAT

- (v) The British colonization of Bengal and India started following the victory of the British East India Company in the Battle of Plassey in 1757. The Company decided to build new settlement at Fort William at the site of the Gobindapur village. Most of the existing population shifted to Sutanuti. While such neighborhoods as Jorasanko and Pathuriaghata became the



- (vi) centers of the local rich, there were other areas that were developed simultaneously. The villages of Gobindapur, Sutanuti and Kalikata were developed to give rise to the later day metropolis of Calcutta. The present Kumartuli ghat is polluted with solid as well as liquid wastes. Copy of the pictures of the Kumartuli Ghat are annexed herewith and marked as Annexure G.

#### COSIPORE GHAT

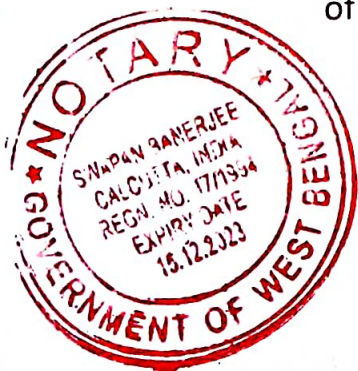
- (vii) The British East India Company purchased thirty eight villages in 1717 and added them to the property of Calcutta , they latter reconstituted them as fifty five villages, Cossipore was one of them. The present ghat of Cossipore is used to perform last rites, pujas, bathing etc the left over flowers, plastics and other materials used in last rites, human excreta etc are disposed off in the ghats causing pollution. Copy of the pictures of the Cossipore ghat and few other ghats are annexed herewith and marked as annexure H.



- H. The applicant states that respondent no 3 during 2003 conducted a rapid estimation of major waste water discharges into the Hoogly river from Palta to Dhanketi Khal, it was found during the survey that

municipal solid waste was dumped on both banks of the river and leachate of these waste flow into the river. Copy of relevant portions of the report of 2003 of WBPCB is annexed herewith and marked as annexure I

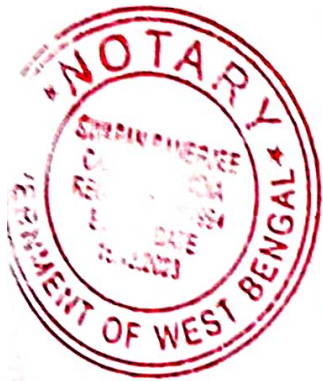
- I. The applicant states that the respondent no 5 (CPCB) did an pollution assessment of the river ganga during 2013 it was found that most of the Sewerage Treatment Plant were not functional and West Bengal needs immediate attention. It was found that out of all the cities West Bengal generates maximum sewerage i.e.1311 MLD which is fifty percent of the total sewerage generated , whereas the treatment capacity of West Bengal was lowest among all cities. Copy of the relevant portion of the CPCB report of 2013 is annexed herewith and marked as annexure J.
- J. The applicant states that the Sewerage Treatment Plants located near different ghats are not functional therefore the sewerage drains directly into the river. The recent report of CPCB of March 2021 states the sorry state of affairs at present West Bengal generates 5,457 MLD of waste and the installed capacity of treatment of waste is only



sixteen percent. Copy of the relevant portions of the report of CPCB of March 2021 is annexed herewith and marked as Annexure K

K. The applicant states that to reduce pollution in river Ganga and improve the quality of the water in the river, the Ghats need to be free from pollution, the respondent no 6 should take measures to clean the ghats and treat the different out falls of the ghats before it drains directly into the river. The unhygienic condition of the ghats from dumped solid waste, human excreta, waste water outfalls are creating pollution in the river and dangerously unhygienic conditions. In M. C. Mehta (ii) v. Union of India and Others (1988) 1 SCC 471 , Supreme Court directed the Kanpur Nagar Mahapalika to construct sufficient number of public latrines and urinals for the use of the poor people in order to prevent defecation by them on open land, directions were also given to keep the city clean, the directions were forwarded to all the municipalities of the ganga towns.

L. That the applicant states that the authorities entrusted with the work of pollution control cannot be permitted to sit back with folded hands on the pretext of financial or other limitations. Pollution is a civil wrong. By its very nature, it is a tort committed against the community as a whole. Right to life being a fundamental right under Article 21 of



the Constitution of India, includes the right of enjoyment of pollution-free water and air for full enjoyment of life. There is a vested right in the applicants and all others to have pollution free water and air in that area of which they are the residents. There itself the duty of the State to prevent and control pollution of water and air and to provide cleaner environment to the citizenry.

M. The applicant states that on October 2020 CPCB have framed guidelines for setting up of biodiversity parks in the flood plains of river Ganga and Respondent no1 on 7/10/16 issued a notification to rejuvenate the river Ganga construing the bank of river Ganga and its flood plain to be construction free zone and there shall be no discharge of any waste into the banks or in the River. The Applicant craves leave to produce the copies of the notification and guidelines at the time of hearing.



**5. Grounds:**

- I. FOR THAT the respondent authorities have miserably failed to avert the Ganga water pollution in flagrant violation of the Environment (Protection) Act, 1986, the Water (Prevention and Control of Pollution) Act, 1974 and the rules framed thereunder;

- II. FOR THAT the respondent authorities have failed to appreciate that the Ghats of the river Ganga are breeding ground of pollution and if not maintained and cleaned the ghats will be a continuous cause of pollution of the river Ganga.
- III. FOR THAT the respondents have failed to appreciate that it was incumbent upon them to comply with the Directions of the Apex Court for Pollution free river Ganga;
- IV. FOR THAT the respondent authorities ought to have appreciated the the provisions of Environment (Protection) Act 1986 and the Water (Prevention and Control of Pollution) Act, 1974 point out that both quantity and quality of water are required to be preserved by the concerned authorities, in the interest of public having an access to the water from lakes , ponds and rivers;
- V. FOR THAT the respondent authorities have failed to appreciate that the natural resources of the community like forests, tanks, ponds, hillocks, mountain etc. are nature's bounty. They maintain delicate ecological balance. They need to be protected for a proper and healthy environment which enables people to enjoy a quality life which is the essence of the right guaranteed under Article 21 of the Constitution;



VI. FOR THAT by remaining inactive and maintaining stoic silence with regard to the pollution caused on the ghats of Ganga, the respondent authorities have, in effect, abated such illegality and have made themselves liable to be proceeded against for such blatant defiance of the relevant provisions contemplated in the Environment (Protection) Act,1986 , the Water(Prevention and Control of Pollution)Act,1974 and the rules framed thereunder;

VII. FOR THAT by allowing unabated Water pollution and the contamination of the River Ganga, the respondent authorities have acted in grave violation of their statutory duties;

VIII. FOR THAT the absolute lackadaisical attitude demonstrated by the respondent authorities in protecting the environment , smacks of malafide attitude on their part;

IX. FOR THAT the inaction on the part of the respondent authorities in failing to prevent the pollution of environment calls for immediate and strict intervention of this Hon'ble Tribunal;



- X. FOR THAT the inaction on the part of the respondent authorities in failing to prevent pollution of River Ganga is otherwise bad, illegal and can not sustain the test of legality;

**6. LIMITATION:**

The applicant declares that the cause of action in the instant case, accrues and continues from day-to-day. Such cause of action is renewing on a day-to-day basis and as such the question of applicability of the limitation prescribed in Section 14 (3) of the National Green Tribunal Act, 2010 does not arise.

**7. Interim prayer:**

Pending final disposal of the application the applicant seeks issuance of the following interim orders:

- a) An interim order of injunction directing the respondents and/or their servants and/or their employees and/or their agents to take stop dumping garbage on the ghats of Ganga , in any manner whatsoever, till the disposal of the instant application;

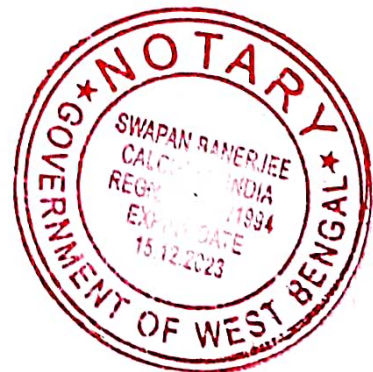


- b) Ad-interim order in terms of prayers (a) as above.

8. Prayer:

In view of the facts mentioned in paragraphs 4 & 5 above the applicant prays for the following reliefs :

- a) Mandatory order do issue commanding the respondents each one of them and their men, agents, assigns and subordinates to certify and transmit to this Hon'ble Tribunal all records forming the basis of their inaction regarding Ganga River pollution caused by turning the ghats into Dumping ground and untreated outfalls in and around the ghats, so that conscionable justice may be rendered ;
- b) Direct the respondents and/or their servants and/or their employees and/or their agents to take action to stop throwing garbage in the ghats of the river Ganga , in any manner whatsoever, till the disposal of the instant application.



- c) Direct the respondents to clean the ghats of the river Ganga and monitor the condition of ghats so that leachate from the dumped waste doesn't enter the river Ganga .
- d) Direct the respondents and/or their servants and/or their employees and/or their agents to ascertain the number of outfalls from the municipal drains and Industries draining directly into the river Ganga and stop such outfalls and divert the outfalls so that there is no direct waste water drainage without treatment into the river .
- e) Mandatory order do issue commanding the respondents each one of them and their men, agents, assigns and subordinates to take adequate measures and steps to prevent any further contamination of the river Ganga;
- f) Any other appropriate direction/directions and/or order/orders as this Hon'ble Tribunal may deem fit and proper;

Cost of and/or incidental to the instant application;



VERIFICATION

I, Suprova Prasad, wife of Jadagish Prasad, aged about 49 years, by religion Hindu, by occupation- Housewife , residing at 148, Rajendra Avenue Uttarpara, District- Hooghly, P.S. Uttarpara, Pin- 712258, I am the Applicant in this instant matter , I do hereby verify that para 1 of the Affidavit are true to the best of my belief, rest are humble submissions before this Hon'ble Court and no part of the report is false and nothing has been concealed therefrom.



Verified at Kolkata on this 7<sup>th</sup> day of February, 2022.

Prepared in my office

*Pankaj Bera*  
Advocate

Suprova Prasad

DEPONENT



Solemnly affirmed and declared  
before me on identification

*Swapan Banerjee*  
S. Banerjee, Notary, Kolkata, India  
Govt. of W. B. Regn. No. 17/1994  
City Civil Court, Bar Association  
(2nd Floor), Calcutta-700011

07 FEB 2022

# DYNAMICS OF URBAN GROWTH AND ENVIRONMENTAL CHALLENGES: A CASE OF KOLKATA, INDIA

**Falguni Dey**

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Received: October 30<sup>th</sup>, 2020 / Accepted: August 2<sup>nd</sup>, 2021 / Published: October 1<sup>st</sup>, 2021

<https://DOI-10.24057/2071-9388-2020-194>

**ABSTRACT.** The history of development of Kolkata as a megacity in India dates back to 300 years. The scenario changed when the administrative headquarter of the British East India Company was established in erstwhile Calcutta, located at the bank of the River Hugli in the lower Gangetic plain. Since its inception, Kolkata has undergone rapid formal and functional change. Both national and international migration has led to the demographic explosion, urban industrial development and an increase in economic opportunities which caused environmental degradation. Until 1793, the urban dynamics of Kolkata followed a linear pattern along the left bank of the Hugli River. A similar trend continued along the right bank from 1793 to 1947 and extended up to its periphery post-independence. In this paper, an attempt was made to explore the influence of river ghats on the urban environment along the selected stretch of the River Hugli. Human activities like garbage disposal (0.089), sewage disposal (0.088) and idol immersion (0.084) have a negative impact on the river water. Secondly, this paper attempts to study the vertical expansion of Kolkata. It has been observed that the average height of buildings in the CBD area is 84.6 meters while along the peri-urban area it is only 10.61 meters proving the distance decay effect ( $R^2 = 0.405$  and  $R^2 = 0.314$ ). Besides, the mean values of DO (5.179mg/l), BOD (8.5mg/l) and COD (34.5mg/l) in the river water reflect the degrading water quality for the aquatic environment. Geospatial assessment techniques were used to understand the research problems and combat the environmental challenges. Complex functional development and decaying urban quality of life along the Hugli River has led to critical environmental transformation.

**KEYWORDS:** Urban Morphology, Distance Decay Effect, Sustainable Development, River Water Pollution, River Ghats

**CITATION:** Falguni Dey (2021). Dynamics Of Urban Growth And Environmental Challenges: A Case Of Kolkata, India. *Geography, Environment, Sustainability*, Vol. 14, No 3, p. 24-31 <https://DOI-10.24057/2071-9388-2020-194>

**Conflict of interests:** The author reported no potential conflict of interest.

## INTRODUCTION

Since its inception Kolkata, or erstwhile Calcutta, has undergone a rapid change in terms of its urban morphology, environmental interaction, ambient air and water quality management (Roy 1982; Kosambi and Brush 1988; Mahadevia 2001; Bardhan et al. 2011; Mukherjee 2012). Due to rapid industrial growth, expansion of trade routes, progress in communication and commerce as well as irrigation in the agricultural sector there has been a swift increase in the urbanization in Kolkata along the river Hugli (Ghosh 1950; Helmer and Hespanhol 1997; Singh et al. 2015). As a result, exodus number of people from the vast hinterland started settling within the urban centres in search of job. The banks of the river Hugli experienced an imbalance in the growth of population because the river acted as a natural barrier that hindered people from settling alongside equally (Dhar 2014). This phenomenon led to the foundation of the crisscross transport network to connect either side of the river by rail and roadways development (Mandal 2000; Chatterjee 2007). Besides, densely settled urban pockets along the river discharge toxic waste which contaminates the water and is then transported further down the stream to reach the Bay of Bengal (Mukherjee 2009; Cengiz 2013). The long stretch of the river Hugli on the western side of Kolkata is characterized

by the presence of numerous ghats ('Ghat' means series of broad and flat steps leading down to a river or water body. The term is commonly used in many parts of South Asia), which sprung up during different periods of history. They served for embankment protection apart from the services they rendered for trading, loading of merchandise on barges, boarding passengers on vessels and other religious and household chores (Chakraborty and Nath 1995; Dey 2013). With increasing layers of complex functional attributes, urban centres started flourishing in both vertical and horizontal dimensions at the cost of the environment (Sarkar and Bandyopadhyay 2013; Mitra et al. 2012). Therefore, to answer the research questions raised in this paper, the following objectives are taken into consideration, a) explore the status of the Hugli river based urbanization and adjacent urban environment in terms of land use patterns; b) assess the quality of ferry services that connect Howrah and Kolkata; and c) examine the status of water pollution in the Hugli river and people's perception of the possible causes. The Hugli river as a part of the Ganga action plan (National Mission for Clean Ganga, Ministry of Water Resources, River Development & Ganga Rejuvenation 2018) requires thorough investigation regarding human interference in Kolkata through the assessment of municipal solid and liquid waste management, agricultural effluents, ferry transportation services, idol immersion etc'.

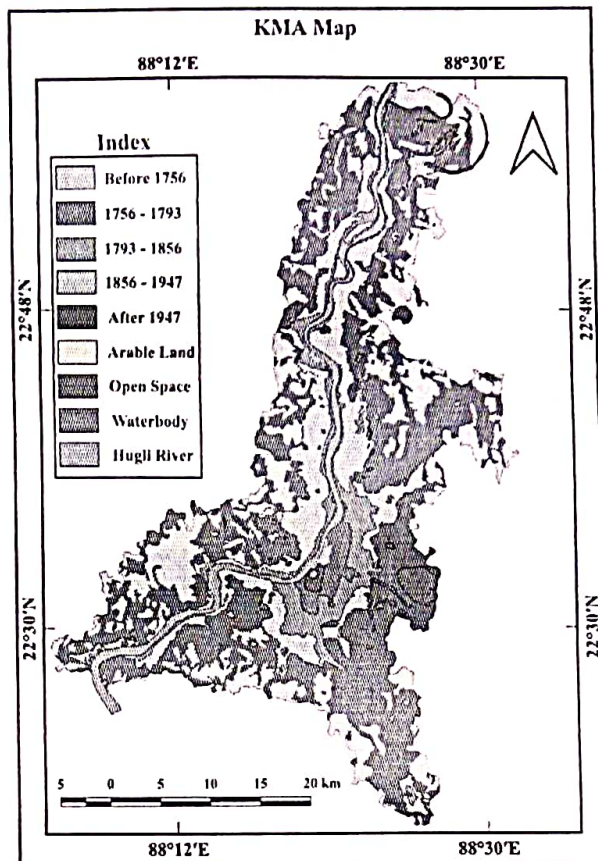
The nineteenth century ushered in a new era of development in commerce, which made Kolkata a centre of trade and capital. However, it was in 1690 when Job Charnock realised the potential of this region and laid the foundation of British Calcutta<sup>1</sup> on the site of the *Sutanuti, Govindapur and Kalikata* villages on the eastern bank of the Hugli river (Murphey 1964; Mitra 1977). With the growth of trade, attention was given to the improvement of communication systems, and mercantile activities in Calcutta received a tremendous stimulus with the opening of railways and other new lines of communications (Ghosh 1991; Bhattacharyya 2018). Naturally, the port of Calcutta called for further improvements, which led to the construction of docks (Bhatta 2009). It must be noted that up until 1860 the port of Calcutta had a very small hinterland<sup>2</sup> comprising only Howrah, Hugli, 24 Parganas, and a small part of eastern Bengal (Fig. 1). But the establishment of jute and cotton factories in Calcutta and its suburbs and the opening of the new lines of communication expanded this hinterland (Table 1). With the development of heavy machinery and production units, manufactured goods were distributed to various parts of India from Calcutta. The major items of export from this region were indigo, jute, cotton etc. (Bhaskaran 2014; Mitra and Mitra 2015).

**STUDY AREA**

Kolkata Metropolitan Area (KMA) extends beyond Kolkata Municipal Corporation (KMC) area and stretches over the neighbouring districts like Howrah and Hugli along the right bank of the Hugli river, whereas, Nadia, North 24 Parganas and South 24 Parganas are located along the left bank. Since the Hugli river flows through the middle of the KMA area, it divides the area into western and eastern halves (Majumder 2020). The study area (Fig. 2) for the present paper stretches between Hugli bridge or *Vidyasagar Setu* in the south to Bally bridge or *Nivedita Setu* in the north, with Howrah bridge or *Rabindra Setu* in the centre. The total length of the right bank which is under the Howrah Municipal Corporation is 11.76 km. The left bank stretches about 12.42 km. Regarding the location of the linking bridges, Hugli and Howrah Bridge belong to the KMC area and Bally Bridge is located outside of KMC. The selected stretch of the river within the study area is meandering and concaving towards Kolkata.

**MATERIALS AND METHODS**

This paper is a blend of both quantitative and qualitative analysis based on both primary and secondary data. While studying the selected stretch, the area was divided into four zones. The criteria of classification of the zones are mainly



**Fig. 1. Growth of Kolkata Metropolitan Area (KMA)**

based on administrative jurisdictions (KMC and KMA), distance from Central Business District (CBD) of Kolkata and orientation of the three main bridges passing through the river Hugli. With the help of GPS, ghats, bridges and riverside buildings were digitally observed to understand their geospatial pattern. A total of 11 ghats on the left bank (4 ghats in Zone I and 7 ghats in Zone II) and 3 ghats on the right bank (1 ghat in Zone III and 2 ghats in Zone IV) are taken into consideration in this study. The criteria of sub-grouping the ghats are mainly based on their accessibility in terms of taking bath, regular immersion of idols, sources of the toxic municipal outfall, religious site, burning ghats and availability of ferry service. Water samples were collected on a stratified random selection basis to measure the water quality and different water properties. The map of Land Use Land Cover (LULC) pattern showing its evolution from erstwhile Calcutta to contemporary Kolkata is referred from the National Atlas and Thematic Mapping Organization (NATMO) map which was prepared by P. Nag (1997)<sup>3</sup>.

**Table 1. Growth and Development of Kolkata Metropolitan Area along the Hugli River**

TIMELINE	SPRAWL AND OUTGROWTH
Till 18 <sup>th</sup> century	Mainly colonial Calcutta was developed during this era. Along with it other colonial towns like Sreerampore, Chandannagar and Chunchura also developed in different isolated pockets
Early 19 <sup>th</sup> century	The outgrowth of urban areas in a linear pattern along both east and west bank of the Hugli river from Kalyani in the north to Uluberia in the south
Mid 19 <sup>th</sup> to mid 20 <sup>th</sup> century	Extensive urban development and spreading off to peri-urban areas of the adjacent districts away from the Hugli river
Late 20 <sup>th</sup> century to early 21 <sup>st</sup> century	Calcutta conurbation development because of increased linkage with neighboring towns along the Hugli river.

<sup>1</sup>Mitra 1952

<sup>2</sup>Kundu 2003

<sup>3</sup>NATMO 1997

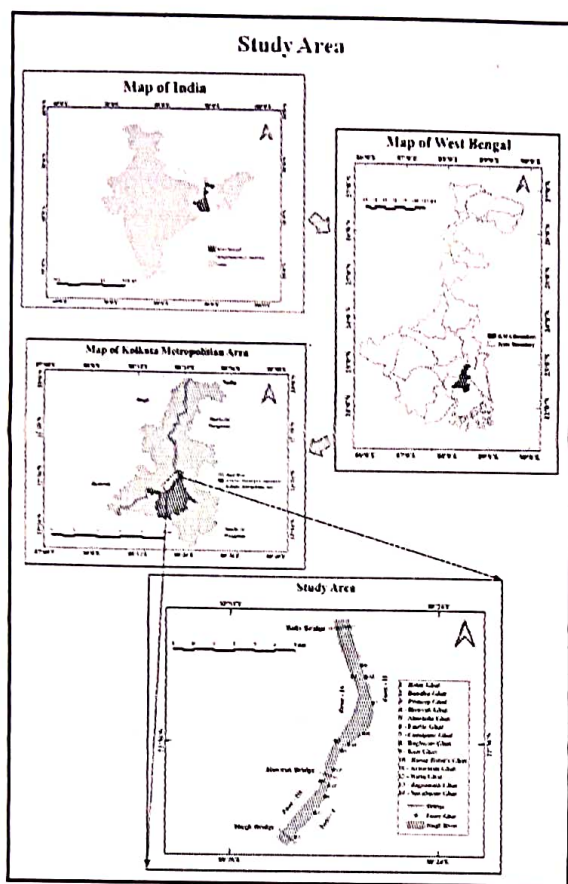


Fig. 2. Location of the Study Area in Kolkata, India

This land use land cover map comprises the historical evolution of Kolkata over the past 300 years. Location map is prepared and analysed using Q-GIS mapping software. Round-the-clock ferry service analysis was prepared based on the data collected from the West Bengal Transport Corporation Department (2016). A perception study on 488 respondents which is about 0.6 percent of the average daily number of passengers through a Ferry ghat

was conducted to understand the ferry service quality. Another perception study on 209 respondents which is about 3.12 percent of the daily average number of visitors of a Ghat was conducted to understand water pollution in the Hugli River on a random sampling basis. The Average Weighted Index (AWI) technique was employed to verify the ground truth and correlate the opinions to combat the environmental challenges.

RESULTS AND DISCUSSION

Urban Morphology of Kolkata

Kolkata started developing around the Esplanade and BBD Bag area, which currently functions as the Central Business District (CBD) of the city. The area is occupied with the law and administrative offices, business and commercial centres, sports and entertainment venues, market and transport headquarters, which characterizes its land use pattern as that of a business district area. Over time, the urbanization process has achieved its highest rate and reached distant suburban places (Rajashekariah 2011), although the land value and demand decrease with increasing distance from the CBD area. The city has experienced rapid growth mainly in its south, east, south-east, and south-west direction (Fig. 1). Apart from horizontal expansion, the CBD area has experienced vertical extension with skyscrapers, high-rise administrative and residential buildings. Towards the north along the left bank of the Hugli river, Kolkata experiences a gradual and rapid transformation of land use from administrative to old and native residential type (Table 2). Jute, cotton, chemical industries etc. are found away from the CBD area and mostly along the river bank.

On the other hand, the scenario of urban development along the right bank of Hugli river under the Howrah Municipal Corporation area (HMC) is indeed different. The area is mainly covered by densely populated residential areas like Bally, Belur, Liluah, Salkia, Ghosuri etc. being the headquarter of the southeastern railway, Howrah station is located on the right bank of the Hugli river and extends over a vast area. Other than that, Avani riverside mall has come up as an alternate recreational destination. Peri-

Table 2. Zone-wise Land Use analysis along the Hugli River

ZONES	MAJOR LANDMARKS ALONG THE RIVER	MAJOR LAND USE TYPES
Zone – I (3.88 km)	Lord Princep memorial park, Victoria Memorial, Racecourse, Fort William, Esplanade, New Market, Shahid Minar, Eden Gardens, Netaji Indoor Stadium, Babu Ghat bus terminus, Ordinance factory headquarter, Calcutta high court, Calcutta swimming club, Raj Bhavan, St. Johns Church, New Secretariat building, GPO, Flotel, SBI headquarter, Millennium park, Laldighi, BBD Bag, Writers building, Lalbazar, Fairley place, Kolkata Port Trust headquarter, Bengal chamber of commerce, Armenian church, Barabazar, Mahatma Gandhi road, Mallick ghat flower market etc.	Law, Administrative and Defence, Business and Commercial, Sports and Games, Leisure and Entertainment, Market area and Transport
Zone – II (8.54 km)	Loha patti, Jorasanko, Jorabagan, Nimtala burning Ghat, Rambagan, Garanhatta, Ahiritola, Beniatola, Hatkhola, Rabindra Sarani, Kumartuli, Sovabazar, Hatibagan, Bagbazar, Canal and Lock gate, Circular railway, Chitpur, Ghoshbagan, Chunibabu Bazar, Cossipore, Paikpara, Tala, Swadagar Pally, Goshala Basti, Mitra Bagan, Satchasi Para, Ramlila Bagan, Sinthi, Sajye Bagan, Rabindra Bharati University, Baranagar, Baranagar Jute Mill, Bon-Hugli, Alambazar, Ashokegarh, U B colony, Dakshineswar Temple, etc.	Mainly pockets of old residential areas which are named after the occupation class of the natives. Mixed land use and partly Industrial
Zone – III (3.66 km)	Avani river side mall, Choura basti, Lichu bagan, Railway museum, Railway club, Howrah railway station, Howrah bus depot, Howrah taxi stand etc.	Rail transport and warehouses, partly residential
Zone – IV (8.10 km)	Gulmohar Railway Quarter, Pilkhana, Mali Panch Ghara, Salkia, Ghosuri, Bhorbagan, Vivekananda Pally, Liluah, Belur, Belur Bazaar, Belur Math, Barendra Para, BBD Nagar, Bally etc.	Mostly mixed residential and party industrial

urban expansion along this bank has no limit as it has already reached the interior of the Howrah and Hugli districts. Apart from horizontal expansion, the vertical urban limit along this bank is inadequate, although newly built residential complexes are increasing the limit of the skyline.

It has been observed that the river Hugli which flows southward is gradually reaching sea level. The extension of the Hugli river towards its downstream between Bally bridge (MSL 14 meters) and Hugli bridge (MSL 05 meters) shows a trend of descending elevation. Contrary to it, from the CBD to the suburban areas, the vertical urban extension of Kolkata is gradually decreasing as we move upstream along the Hugli river. The majority of the high-rise buildings are located within the CBD area<sup>1</sup>. For example, Chatterjee International (91m, 24 floors), Tata Centre (79m, 18 floors), The 42 (245m, 62 floors), Everest House (84m, 21 floors), Birla House (60m, 16 floors), New Secretary Building (38m, 12 floors) etc. Peripheral areas do not only transform to residential land use, but the average height of buildings in areas like Shovabazar, Ahiritola, Cossipore, Baranagar, Bally, Belur etc. have shown gradual decrease (Fig. 3a and 3b).

**Ferry Service over the Hugli River**

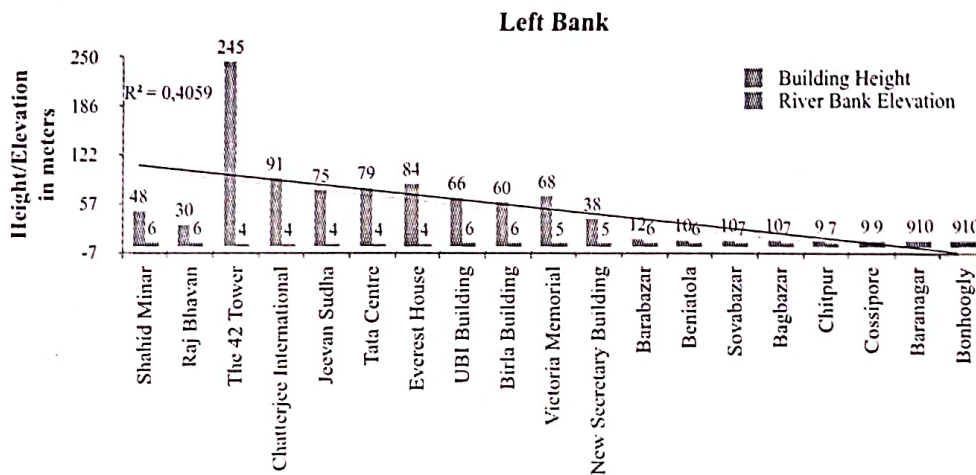
Days before steamers and railways made their appearance in India, the principal means of transport in Bengal and the province of Hindustan was by boats, laboriously towed or sailed over the magnificent waterways of the Ganges and its affluent (Munsi 1980). The present study area is a part of the National Waterway – 1 (NW-1 runs

1620 km from Haldia in West Bengal to Allahabad in Uttar Pradesh) which passes through the Ganges, Bhagirathi and Hugli river systems<sup>2</sup>. A total of 28 ghats that are found within the study area are either used for ferry services and or for public bathing. Ferry service on the Hugli river is a transport breakpoint between Howrah and Kolkata. Compared to other modes of transport available in Kolkata, the ferry service is not the ultimate choice for passengers. Perhaps due to its nominal fare, it was initially used by industrial labourers to reach their workplaces which were situated along the bank of the river Hugli.

Perception study on the quality of the ferry service reveals that passengers are highly satisfied with low transport cost, level of comfort during journey and contribution of ferry service to mass transportation in Kolkata. They are also satisfied with the service frequency and connectivity of the ghats they commute through. On the other hand, the majority of people are partly satisfied with the surrounding environment of the Ghats, travel time and speed of the vessel. And lastly, people are not satisfied with the late-night security for both men and women due to increasing antisocial activities in the city (Table 3). Ferry service as a mode of transport is a dying sector in Kolkata. Since it connects the breakpoint of transport between Howrah and Kolkata, its significance cannot be denied.

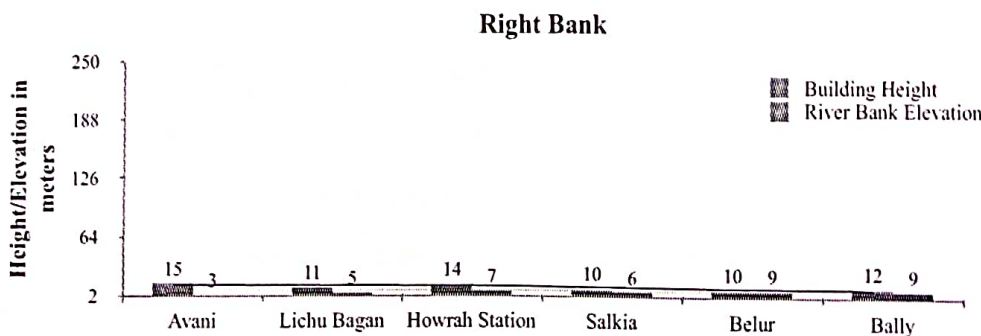
**Water Pollution in Hugli River**

Wastewater discharges did not disturb the balance of the ecosystem since the nature has the capacity to degrade the wastes and restore. With the increasing pressure of



Notable buildings and areas in order of distance from CBD

Fig. 3a. Comparing River Bank Elevation and Building Height in Kolkata along the Left Bank of the Hugli River



Notable buildings and areas in order of distance from CBD

Fig. 3b. Comparing River Bank Elevation and Building Height in Howrah along the Right Bank of the Hugli River

<sup>1</sup>www.skyscrapercenter.com 2015

<sup>2</sup>www.iwai.nic.in 2021

**Table 3. Passengers' Perception on the Quality of Ferry Service over the Hugli River**

ISSUES	HIGHLY SATISFIED	SATISFIED	PARTLY SATISFIED	NOT SATISFIED	NOT AT ALL SATISFIED	AVERAGE WEIGHTED INDEX (AWI)
Service Frequency	124	182	125	49	8	0.069
Passenger Fare	252	101	75	46	14	0.077
Vessel Quality	127	113	162	80	6	0.064
Crowd and Queue	129	83	160	101	15	0.061
Travel time and Speed	92	110	189	81	16	0.060
Late night Security	53	74	129	162	70	0.044
Ghat Connectivity	141	147	110	90	0	0.067
Ghat Environment	49	109	243	70	17	0.055
Journey Comfortability	323	139	21	5	0	0.090
Contribution to Mass Transport	247	147	52	42	0	0.081
Total Number of Respondents						N = 488

population and the shooting up level of pollution, the replenishing capacity of nature had gradually slowed down (Monanta and Goel 2014). Municipal and industrial wastewaters are directly released into water bodies with or without treatment (Rudra 2015). In addition, other anthropogenic activities such as agriculture result in a non-point discharge of pollutants into rivers causing serious environmental problems and therefore posing a threat to human health (Table 4). This has led to deterioration in water quality rendering it unsuitable for human consumption and sustenance of aquatic life (Shaw 2005). Taking the selective parameters into consideration and their threshold limit, the Hugli river ghats exhibit an escalating pollution profile (Basu and Main 2001; Biswas 2003). Maximum and minimum values were recorded and the permissible limit was also noted to measure the vulnerability of ghats. These ghats are used by the local people for bathing, washing clothes and performing other daily rituals. Unlike Banaras ghats where people visit for religious ceremonies as well as for recreation, Kolkata ghats are not only devoid of such provision but are struggling for existence. (Bhaduri 2012).

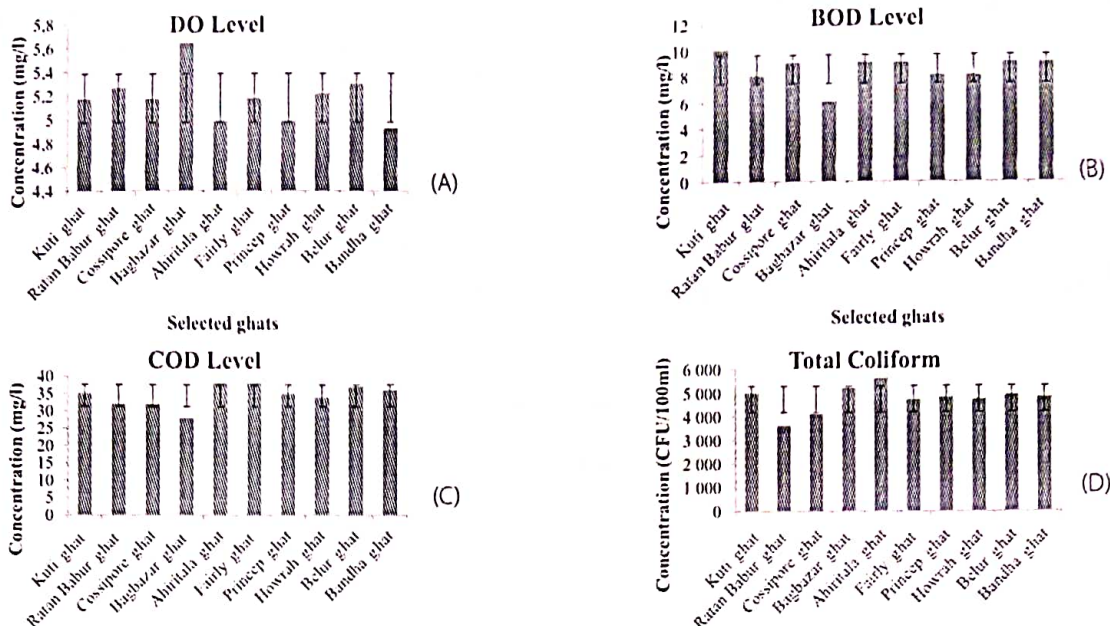
However, to commemorate the hundred years of Kolkata Port Trust (KPT), entire ghats, bridges and amusement parks were lit up for urban renewal and aesthetic beauty.

The Hugli river ghats are used for multiple purposes which has influenced the degree of association of people with it. Be it religious or domestic or transport, river ghats have turned into a dumping point. This has not only resulted in environmental imbalance but also negatively affected the levels of Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD) and Coliform bacteria. Excessive growth of algae and eventually lowering level of dissolved oxygen in water poses a serious threat to aquatic life. This can result in insufficient amounts of dissolved oxygen available for fish and other organisms. At sea level, typical DO concentrations in 100-percent saturated fresh water will range from 7.56 mg/L at 30 degrees Celsius to 14.62 mg/L at zero degrees Celsius<sup>1</sup>. An inter-ghat analysis of DO level shows that the aquatic system of the Hugli river is under serious threat (Fig. 4A). BOD test was also performed to determine the effect of dirty water containing bacteria and organic materials on

**Table 4. Details of Selection Criteria of Water Sample Collection from different Ghats**

SELECTED GHATS	SOURCE OF OUTFALL	CRITERIA OF SELECTION
Kuti ghat	Outfall from burning ghat	Burning Ghat, idol immersion
Ratan babur ghat	Outfall from burning ghat and local drains	Burning Ghat, idol immersion
Cossipore ghat	Outfall from temples and factory areas	Temples, small factories, ferry service
Bagbazar ghat	Outfall from temples and burning ghat	Temples, ferry service and circular railway
Ahiritola ghat	Outfall from burning ghat and local drains	Nimtala burning ghat, temple and ferry service
Fairly ghat	Outfall from parks and stations	Ferry service, frequent movement of boats, circular railway station and Millennium Park
Princep ghat	Outfall from army campus	Military camp, Hugli Bridge and circular railway station
Howrah ghat	Outfall from Howrah railway station	Ferry service
Belur ghat	Outfall from Belur math and surrounding areas	Ferry service
Bandha ghat	Outfall from Salkia area	Bathing ghat, idol immersion

<sup>1</sup>Minnesota Pollution Control Agency 2009



Source: Envirocheck 2009

Fig. 4A to 4D. Level of different Chemical and Biological Parameters in the Water of the Hugli River

animal and plant life when released into a stream or lake (Fig. 4B). Chemical Oxygen Demand is another important water quality parameter because it provides an index to assess the effect of discharged wastewater on the receiving environment (Fig. 4C). Higher COD levels mean a greater amount of oxidizable organic material in the sample, which will reduce Dissolved Oxygen (DO) levels. Therefore, DO is inversely correlated with COD and BOD. The presence of Coliform bacteria in water on the other hand indicates faecal contamination and can cause diarrhoea and other dysenteric symptoms. A minimum of 3600 to maximum 5600 mg/l threshold of Coliform bacteria presence is safe but the results of ghat-wise analysis shows an alarming state of the Hugli River water for human consumption (Fig. 4D).

Peoples' views and concerns regarding the emerging environmental problems were analysed through a perception study on 209 individual respondents, randomly selected from different ghats. People strongly agree upon the threats arising due to industrial waste, garbage

disposal, sewage disposal and idol immersion. People are unsure about their opinion on bathing and washing in the Hugli river but they agree that dead bodies and animal waste play a significant role in the contamination of the river Hugli. Thus, people indirectly blame the municipal discharge of sewage water and industrial waste but are not ready to take any voluntary initiative at a micro level to keep the Hugli clean. Ever-increasing pressure of population on either side of the Hugli river and escalating index of urban growth act as a catalyst towards further environmental decay (Table 5).

CONCLUSION

The discussion in the preceding paragraphs has directed attention to the changing trend and pattern of urbanisation in the Kolkata Metropolitan Area along the river Hugli, which will be insightful in guiding the future planning and policy execution for the city. Fundamentally, it was observed that

Table 5. People's Perception on Causes of Water Pollution in the Hugli river

CAUSES	STRONGLY AGREE	AGREE	PARTLY AGREE	NOT AGREE	NOT AT ALL AGREE	AVERAGE WEIGHTED INDEX (AWI)
Idol Immersion	118	50	37	4	0	0.084
Bathing	19	92	75	14	9	0.062
Washing	31	45	60	55	18	0.052
Animal Waste	45	59	25	65	15	0.056
Agricultural Waste	96	51	38	6	18	0.074
Industrial Waste	138	45	18	8	0	0.087
Garbage Disposal	129	66	14	0	0	0.089
Sewage Disposal	135	51	23	0	0	0.088
Ferry Service	31	43	61	41	33	0.050
Dead Bodies	22	74	81	19	13	0.059
Total Number of Respondents						N = 209

urban dynamics and river hydrodynamics are negatively correlated. Horizontal urban sprawling along with skyscrapers and high-rise projects in Kolkata have extended the vertical limit of the city challenging the environment and urbanization balance during the last three decades. The urban morphology of Kolkata is therefore changing into a complex functional landscape due to growing interaction and direct dependence of people on the river Hugli. Crisscrossing bridges and river transport connectivity between both banks of the Hugli have influenced the urban economic opportunities for both Howrah and Kolkata. Due

to the continental drift of the Indian plate in the northeast direction against the Asian plate, the Meghna basin is getting deeper and the river Hugli is suffering from a lack of water flow. The Ganga action plan is therefore of much significance to increase the navigability of this river, sustain the water flow and reduce bacterial concentration with seasonal variation. Symbiotic consideration of issues like urban development, environmental protection, economic growth, morphometric dynamics of the river, socio-cultural interaction etc. can make the city environmentally sustainable and develop as a complex urban morphology.

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## A short period assessment of water physicochemical characteristics of Hooghly river, West Bengal, India

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### Abstract

A systematic study has been conducted to assess the water quality of Hooghly river at Shyamnagar, from September 2015 to March 2016. The site is densely populated as well as one of the important industrial belt of West Bengal. Water samples were collected fortnightly from four sampling stations and Dissolved oxygen (DO), free carbon dioxide (free CO<sub>2</sub>) and pH were determined. Study revealed a significant inverse relation between DO and free CO<sub>2</sub>. Moreover, water pH also found to alter with the level of free carbon dioxide. Overall assessment of alkalinity (263.485±15.69 ppm) and salinity (51.47±2.41 ppm) indicated the levels within acceptable limit. Whereas, turbidity (70.378±7.36 NTU) of Hooghly river water was above the acceptable limit and was probably due to silt and also industrial effluents, sewage, as well as partly and fully decomposed organic matters received during the long journey of Ganga and finally these materials are flown through Hooghly river and water in this region is more turbid than the upper stream. Study also revealed that river water of this area have moderate hardness as well as Ca and Mg level with in permissible limit.

**Keywords:** Physicochemical parameters, Hooghly river, Dissolved oxygen, Hardness, Turbidity.

### Introduction

As a vital and vulnerable freshwater ecosystem all rivers of the world are becoming critical for the sustenance of all aquatic life. It is a matter of serious concern that the degenerating water quality of fresh water systems put at risk their sustainability. People use the river water for different purposes. But continuous urbanization along with other unscrupulous human activities and domestic wastes are deteriorating water quality of river<sup>1,2</sup>. An excess level of some parameters like pH, TDS, turbidity etc. from water samples of Ganga<sup>3</sup>. Analyses of physicochemical characteristics of the water sources are required to measure the degree of water pollution<sup>4</sup>. Animal and plants are finally affected due to unacceptable changes in the different characteristics of an ecosystem by the conscienceless human activities on our planet earth<sup>5</sup>. When an industry discharges a litre of waste water, in turn that water pollutes on an average eight litres of freshwater<sup>6</sup>. Good quality water is essential for improved life and to prevent diseases. Natural water is polluting continuously by mining, and other human activities as well as disposal of unprocessed industrial and domestic wastes directly in the river<sup>7</sup>. Water quality of river was found to deteriorate mainly due to industrial runoff and household wastes and high hardness as well as alkalinity and a low level of dissolved oxygen were the indications of water pollution<sup>8,9</sup>.

All organisms including terrestrial and aquatic, as well as microorganisms to man requires water, are facing serious problems today. The problems arise because of unplanned

urbanization and industrialization<sup>10</sup>. Hooghly river, a tributary of Ganga, originating near Farakka, Bhagirathi enters in West Bengal and another part flows through Bangladesh as Padma. Also known as Bhagirathi-Hooghly, approximately 260 km long, and an integrated part of the life of the people of West Bengal. Hooghly is receiving different industrial and domestic effluents, while flowing through West Bengal<sup>11</sup>. A regular survey of different physicochemical parameters of Ganga river water is essential as this river is regularly exposed to anthropogenic interferences and the information on such parameters are very scanty. Here an attempt has been made to overcome these lacunas.

### Methodology

Hooghly river, a tributary of Ganga, originated near Farakka of Murshidabad district and enters in South Bengal. The study was conducted near Barrackpore (located at 27°76' N, 88°37'E), which was extended about 4 km at the East bank of Hooghly river. This is an densely populated area and an important industrial zone of West Bengal. The study site was divided into four sampling stations namely MPG (Mangal Pandey Ghat), RRG (Ranirashmoni Ghat), GPG (Ghatakpara Ghat) and DBG (Dhobi Ghat) respectively.

Sampling was done between September 2015 and March 2016. Sample of subsurface water were collected fortnightly in the morning between 7 am and 8 am. Sampling was done carefully to avoid spilling of water and air bubble. Dissolved Oxygen,

free Carbon dioxide, Alkalinity, Salinity, Hardness, Calcium and Magnesium were assessed at the sampling stations following the standard methods<sup>12</sup>. Whereas, Turbidity and pH were measured by Naphlo Turbidity Meter (Systronics 135) and Digital pH Meter (Systronics 335). Results were subjected to statistical analyses.

**Results and discussion**

Dissolved Oxygen (DO) at MPG ranged between 2.0ppm and 3.3 ppm with minimum in March and maximum in January (Figure-1). RPG revealed maximum level 3.57 ppm during the month of January and a minimum was recorded at 1.76 ppm in March. The DO content at GPG was minimum in March (1.55 ppm) and 4.91 ppm maximum in November. Whereas, DBG showed minimum 1.9 ppm and maximum 3.69 ppm during the month of March and January respectively. Data also revealed a mean DO of 2.73±0.195ppm, 2.83±0.24ppm, and 2.97±0.38ppm and 2.82±0.3 ppm at MPG, RRG, GPG and DBG respectively. Pooled data exhibited an average DO of 2.87±0.14 ppm (Table-1).

In compare to the DO, free CO<sub>2</sub> of Hooghly river water at MPG ranged from 1.8 ppm to 2.51ppm with minimum in March and maximum in November (Figure-2) with a mean value of 2.1±0.087 ppm (Table-1). At RRG the range was 1.9 ppm in September and maximum 2.15 ppm during March with a mean of 2.01±0.041ppm. Free CO<sub>2</sub> at GPG ranged from 1.8 to 2.3 ppm with minimum in December and maximum in March. In this sampling site the mean value was 1.98±0.067 ppm. D BG exhibited a range between 1.75 and 2.0 ppm with an average of 1.9±0.038 ppm. Pooled data showed a mean of 2.0 ±0.03 ppm free carbon dioxide in the study area.

The total alkalinity at MPG ranged from 185 to 460 mg/ml with minimum in March and maximum in September (Figure-3). At station B, alkalinity ranged between 180 to 470 mg/ml. The alkalinity at Station C was minimum in March (150 mg/ml) and maximum in September (350 mg/ml), whereas, it was ranged between 175 and 450 mg/ml with a minimum during March and

maximum during September with an average of 261.071±33.60 mg/l at DBG (Table-1).

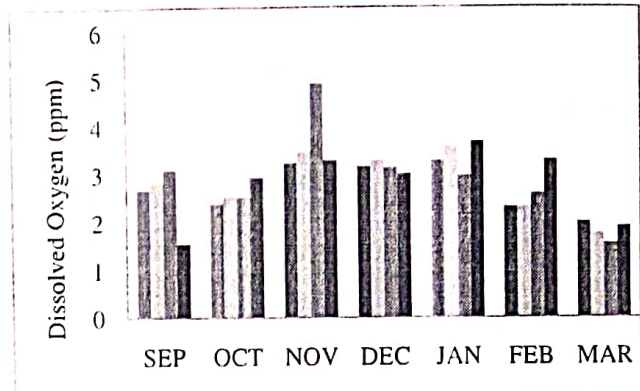


Figure-1: Level of Dissolved Oxygen in Ganga water collected from four sites.

The water hardness varied from 152 to 257 ppm at MPG (Figure-6) with calcium (Ca) content ranged between 26.9 and 74.03 ppm (Figure-7) and magnesium (Mg) content from 9.41 to 24.326 ppm (Figure-8.). Hardness was minimum during November and reached it maximum level at February whereas, Ca and Mg reached the maximum level in January. After September Hardness gradually increased at RRG and reached the maximum level during January (261 ppm) then came down to 167 ppm in the month of March. Ca content ranged between 39.5 ppm (March) and 91.6 ppm (February). Whereas, Mg was found minimum (2.78 ppm) in October and reached the maximum level September (17.79 ppm). Hardness ranged from 153 ppm to 292 ppm at GPG, where Ca and Mg were ranged between 38.6 and 103.8 ppm and 7.96 and 18.09 ppm respectively. At DPG Site lowest hardness was observed 173 ppm in November and reached the maximum level (284 ppm) during February. Ca showed its lowest value 27.75 ppm in September and highest 80.76 ppm during the month of February. On the other hand, Mg had lowest value (10.4 ppm) in November and highest 35.3 ppm during September.

Table-1: Mean values with SE of different parameters of different stations.

Sampling Station ----->	Mangal Pandey Ghat	Ranirashmoni Ghat	Ghatakpara Ghat	Dhobi Ghat	Pooled Data
DO (ppm)	2.73±0.195	2.83±0.24	2.97±0.38	2.82±0.3	2.87±0.14
Free CO <sub>2</sub> (ppm)	2.1±0.087	2.01±0.041	1.98±0.067	1.9±0.038	2.0±0.03
pH	6.521±0.09	6.328±0.15	6.642±0.08	6.457±0.15	6.49±0.06
Alkalinity (mg/ml)	275.614±33.58	274.685±36.28	242.571±22.12	261.071±33.60	263.485±15.69
Salinity (mg/ml)	43.911 ± 5.18	55.73±4.21	51.83±5.34	54.621±4.51	51.47±2.41
Turbidity (NTU)	67.53±11.41	76.66±15.56	61.7±16.57	75.59±15.39	70.378±7.36
Hardness (ppm)	197.27±14.16	194.35±16.02	206±20.45	217.14±16.18	203.69± 8.35
Ca (ppm)	50.45±6.75	55.54±6.42	58.35±9.31	54.4±16.18	54.68±3.79
Mg (ppm)	19.10±1.93	10.75±1.93	14.67±2.91	20.19±3.10	16.18±1.23

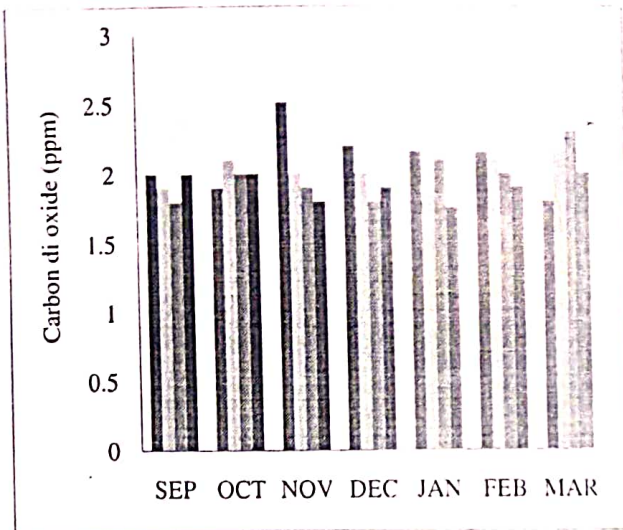


Figure-2: Level of Free Carbon di oxide in Ganga water collected from four sites.

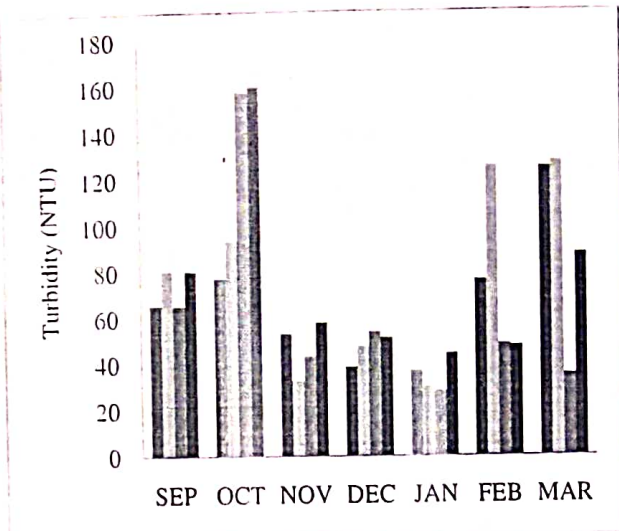


Figure-5: Turbidity of Ganga water collected from four site.

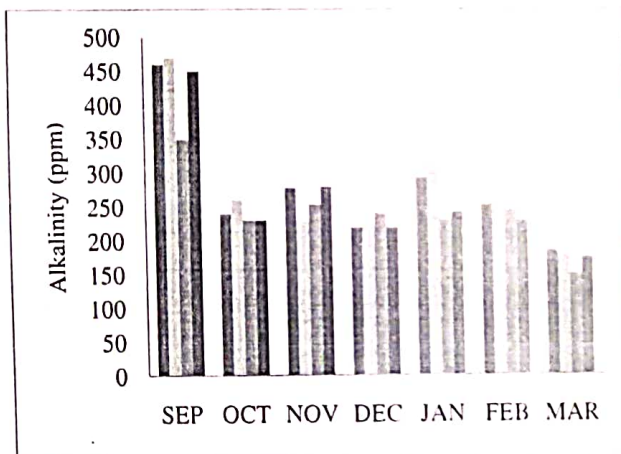


Figure-3: Alkalinity of Ganga water collected from four sites.

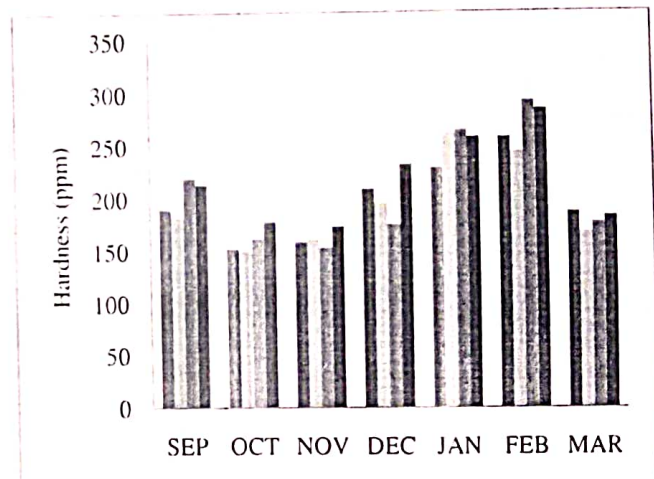


Figure-6: Hardness of Hooghly water collected from four sites.

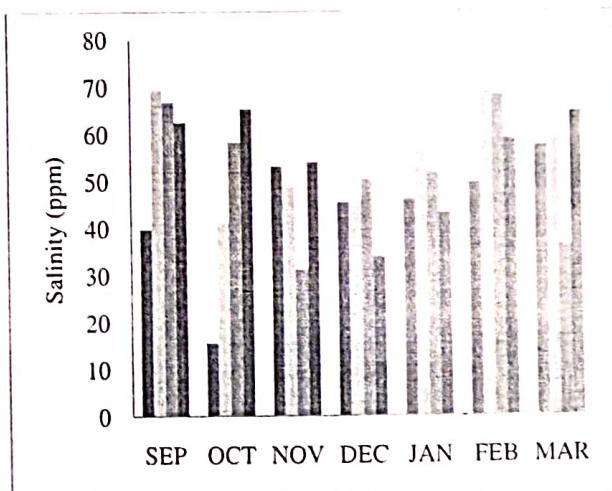


Figure-4: Salinity of Ganga water collected from four sites.

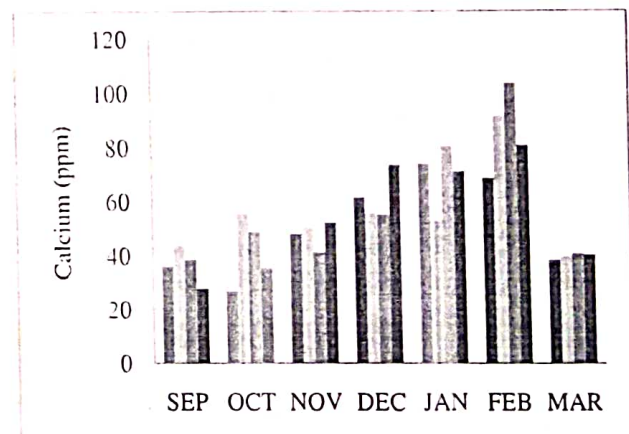


Figure-7: Level of Calcium in Hooghly water collected from four sites.

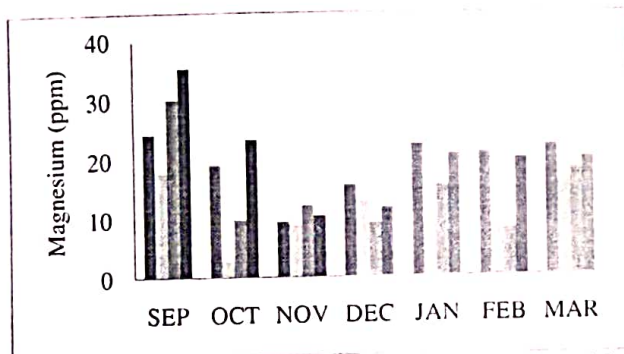


Figure-8: Level of Magnesium in Hooghly water collected from four sites.

The present study revealed that DO was below the normal level i.e. 5 ppm<sup>13</sup>. Seasonal observations also showed similar trend in the study area. Study also revealed a low level of DO in the month of March in all the Stations in comparison to other months. Whereas, during September and October ranged from 1.54 to 2.67 ppm which was increased during the month of November. September and October are post monsoon period and various ritual practices take place during these period in these areas which includes immersion of Goddess Durga and other activities. As a result different inorganic and organic substances are deposited near the bank of the river. Though local municipality takes immediate action to remove all the materials from the water. As a result pollution is under control in Hooghly river water, but not totally removed which was the probable cause of decrease in DO level during that period. The rise in temperature, respiration of biota and decomposition of organic materials reduced the oxygen level in the Ganga water near Kanpur<sup>14</sup>. With advent of season, increase in the growth of algae and phytoplankton raise the photosynthesis rate and DO of water subsequently which was in conformity with Roy<sup>15</sup>.

Study also revealed a gradual decrease in DO during January to March in all the sites in comparison to other months. That was probably due to seasonal increase in the activity of coliform bacteria, degrades organic matters by consuming dissolved oxygen and thus decreases DO level during those months indicating organic pollution. Moreover, maximum growth of zooplanktons also takes place during this period, which probably leads to reduce the DO of Hooghly river water as was proposed by Kreutzweiser<sup>16</sup>.

Table-2: Relation between parameters considered during the study.

Sampling Station ----->	Mangal Pandey Ghat	Ranirashmoni Ghat	Ghatakpara Ghat	Dhobi Ghat
DO- Free CO <sub>2</sub>	Y=1.146-0.35x r = 0.7808 t = 2.794*	Y=2.38-0.13x r = 0.788 t = 2.86*	Y= 2.314-0.11x r = 0.777 t = 2.76*	Y=2.194-0.102x r = 0.796 t = 2.94*
Hardness- Ca	Y=18.99+1.74x r = 0.869 t = 3.93*	Y=19.64+ 1.34x r = 0.553 t = 1.48	Y= 9.6+1.88x r = 0.858 t = 3.74*	Y=13.2+1.57x r = 0.77 t = 2.70*

\*Significant p<0.05

Level of Carbon dioxide almost maintained 2 ppm throughout the study period in this region. Statistical analyses revealed a significant inverse relation (p<0.05) between DO and free CO<sub>2</sub> (Table-2). CO<sub>2</sub> is highly soluble in water (0.5 mg.l<sup>-1</sup> at normal 25°C conditions). Free carbon dioxide can alter pH of the water. Fish may suffer a stress and chance of death is high if the pH drops below 5 or rises above 10. Our study showed an average water pH of 6.49±0.06 and that was probably due to low free CO<sub>2</sub> the water. The low level of free CO<sub>2</sub> is probably due to flowing water and the gas is diffused back into the atmosphere<sup>17</sup>. It was also reported that free CO<sub>2</sub> facilitates the formation of stable bicarbonate and subsequently lowers the carbon dioxide level in the water<sup>18</sup>. That might be the cause of reduced carbon dioxide level in the present study area.

The study revealed that the alkalinity was highest during September that is post monsoon period at all the stations studied. Study also showed moderate range of alkalinity during the winter and reached the lowest level during Spring (March). Phytoplankton and alkalinity have direct relation, as plenty of phytoplanktons increase carbonate and carbon dioxide level by dissociating bicarbonate present in water, which is used in photosynthesis and alkalinity level comes down<sup>19,20</sup>. After monsoon, the level of water reduced and alkalinity of water increase. The alkalinity of water is caused mainly due to stagnancy of water and reduced level of water help in the increase of alkalinity as was observed such variation during the present study<sup>21</sup>. In a similar study, higher alkalinity was recorded due to excess of free carbon dioxide due to decomposition, as the level of river water decrease after monsoon<sup>22</sup>. Such seasonal variation in alkalinity also recorded in river Ganga at Varanasi and in natural water bodies in tropics<sup>23,24</sup>. In MPG, salinity of river water varied from 15.62 to 57.31 mg/l, with an average of 43.911±5.18 mg/l (Table-1). In RRG salinity ranged between 41.18 and 69.5 mg/l (Figure-4). Study also revealed a range of 36.21 to 68.16 mg/l salinity with an average of 51.83±5.34 mg/l at GPG and between 33.84 and 65.32 mg/l with an average of 54.621±4.1 ppm at DBG was observed. Low salinity was observed during post monsoon period i.e. October in all the stations, except DBG. Then the level increased gradually and maintained a moderate salinity in all the sampling sites. That was probably change in the temperature, evapotranspiration by water as was observed in Adyar river by Govind and Sundaresan<sup>25</sup>.

It was also appeared that salinity was higher at DBG in compare to other stations and that was probably due to regular ferry service as well as sewage water released from public toilet and mix with river water of this site. Increasing trend of chloride concentration is contemplated due to mixing of organic wastes of animal origin which is common at DBG. Water with high concentration of chloride or salinity is unpalatable and, therefore, incompetent for drinking and livestock watering. Overall assessment revealed  $51.47 \pm 2.41$  ppm of salinity (Table-1) of Hooghly river water during the present survey, indicated a trend which was within the acceptable limit (IS: 10500:2012). Quite low chloride concentration in river water, reflects that organic waste as well as municipal and industrial wastes were discharged in smaller quantity which was also true for the present study area<sup>18</sup>.

Turbidity varied from 36.8 to 125 NTU at MPG, with highest turbidity in March and lowest in January (Figure-5) with an average of  $67.53 \pm 11.41$  NTU (Table-1). In RRG and GPG, turbidity ranged between 30 and 127.3 NTU and 28.3 and 157.3 NTU respectively with low turbidity in January and highest in March and October. In DBG, turbidity ranges between 44.33 and 160 NTU with highest in October and lowest in January. Turbidity was comparatively high at RRG probably due to regular refuge of religious practices and DBG due to ferry services from this station respectively. Overall assessed turbidity ( $70.378 \pm 7.36$  NTU) of Hooghly river water during the present survey, indicated a trend, which was above the acceptable limit (IS: 10500:2012). In an almost similar observation Trivedi *et al.*<sup>26</sup> has been reported the turbidity on higher side in all seasons. Turbidity ranged between 30 and 125 NTU during Maha Kumbh-2010 at different bathing ghat of Ganga<sup>27</sup>. So it is appeared from the present study that average turbidity of Hooghly water is higher due to natural causes as well as anthropogenic activities. Because during its long journey from Gangotri to Sagar, river Ganga carries huge amount of silt and also receives industrial effluents, sewage, as well as partly and fully decomposed organic matters. These materials are finally flown through Hooghly river and water in this region is more turbid than the upper stream of the river Ganga.

The present study revealed that hardness of water remains moderate<sup>28</sup> throughout the year, which ranged between  $194.35 \pm 16.02$  and  $217.14 \pm 16.18$  but it was maximum in December to January, then the level was comedown in March (Fig. 6). That was probably due to the low level of water in winter in comparison to summer and monsoon<sup>21</sup>. Lowest hardness was 152 ppm and overall hardness was within the permissible limit as suggested by IS Tolerance limit at the present study area<sup>29</sup>. Study also revealed that Ca and Mg content of river Hooghly were  $54.68 \pm 3.79$  ppm and  $16.18 \pm 1.23$  ppm respectively (Table-1) and comparatively higher than the normal river water as reported previously<sup>30</sup>. Statistical analyses also exhibited a significant relationship ( $p < 0.05$ ) between hardness and calcium in all the sites studied (Table-2). Ca also reached highest level during winter probably due to low water level.

Such higher level of these two elements probably due to uses of detergents for washing clothes at ghats as well as due to regular disposal of some domestic and industrial effluents in the river water. This was in conformity with Sinha and Das<sup>31</sup> who studied the physicochemical parameters of river Ganges near Patna. Though such disposal is controlled by local Municipality, but it should be stricter and more awareness is required to check all such disposal.

### Conclusion

Desolved oxygen had an average of  $2.87 \pm 0.14$  ppm in the study area and maintained a significant relation with the level of free Carbon dioxide. With the variable levels of alkalinity, salinity showed a level, which was within acceptable limit. Hardness of water was moderate throughout the year which had significant relation with the Calcium content of the Hooghly river water. Whereas, turbidity was recorded above the acceptable limit.

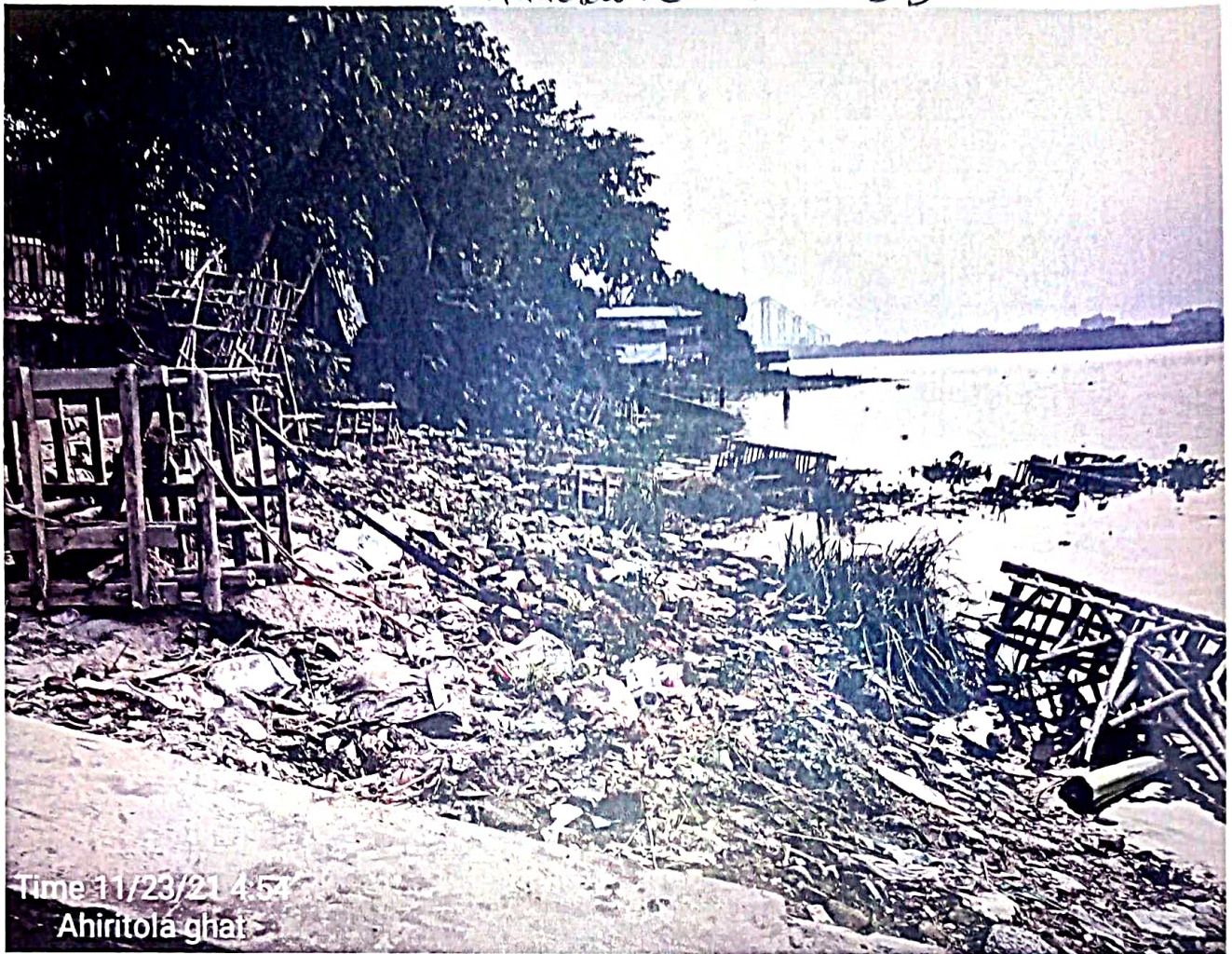
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Time 11/23/21 4:57  
Ahiritola ghat



Time 11/23/21 4:10  
Ahiritola ghat



Time 11/23/21 4:10  
Ahiritola ghat



Time 11/23/21 4:06  
Ahiritola ghat

- 41 -

Annexure - D

**PICTURES OF SURROUNDING ENVIRONMENT OF NIMTALA GHAT**



-42-  
Annexure - E



-43-  
Annexure - F

**PICTURES OF SURROUNDING ENVIRONMENT OF SUTANUTI GHAT**



**PICTURES OF SURROUNDING ENVIRONMENT OF**  
**KUMORTULI GHAT**



**PICTURES OF SURROUNDING ENVIRONMENT OF  
COSSIPORE SARBAMANGALA AND CHITTESWARI GHAT**





Time 11/23/21 3:11  
bagbazar ghat



Time 11/23/21 3:07  
Bagbazar ghat



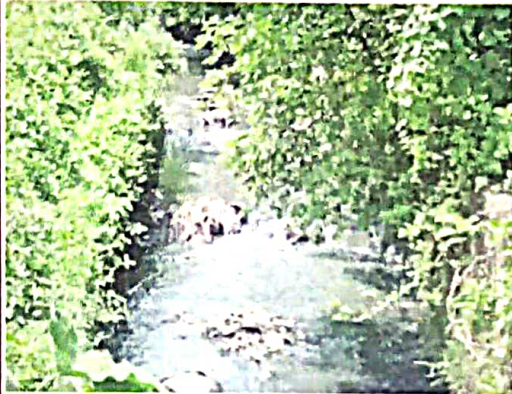
Time 11/23/21 4:36  
Burrabazar ghat



Time 11/23/21 4:22  
Ahiritola ghat



**Rapid Estimation of  
Major Wastewater Discharges to River Hooghly  
between the stretch of  
Palta to DhanKheti Khal**



2003



**West Bengal Pollution Control Board**

*Paribesh Bhawan*

10A, Block LA, Sector III, Salt Lake, Kolkata - 700 098

outfalls must be covered to compare the amount of BOD discharged to the river currently with that of the previous study. One new major outfall is also considered for monitoring.

### **4.3. Selection of sampling schedule**

Samplings were scheduled in such a manner that dilution due to intrusion of tidal water from the river Hooghly remained minimal. The zone VIII was selected as the first stretch of the river for this survey. Three samples were collected at an interval of four hours at each of the eight outfalls from both banks and at three points in the river.

Three different teams were assigned to collect the samples from the outfalls at both banks. Another team collected river water.

The sampling was conducted in the stretch from Howrah Bridge to Dhan Kheti Khal on 24.2.2003. The sampling in the upstream stretch upto Palta was conducted on 22.4.2003 and 23.4.2003. During this survey zone V VII was covered. The study included monitoring of the following parameter:

- The flow in outfalls by surface float method or by weir wherever applicable.
- pH, Temperature, BOD, COD and TKN (Total Kjeldhal Nitrogen) were measured for the samples collected from the outfalls.
- pH, Temperature, DO, BOD, COD and TKN were measured for the river water.

## **5. Results and Observations**

The results of this survey are scaled to obtain average BOD loading and average flow discharged from these outfalls. The average waste load in terms of BOD is estimated by multiplying the average BOD by the average flow data. The BOD discharge results available in NEERI-KMDA report are also converted to obtain average BOD discharges from these outfalls during 1991. The 2003 results are compared with 1991 results (*Table-2*) and (*Figure-6*). The results indicate there is an overall reduction in BOD load, discharged through these 38 outfalls. The BOD load, discharged through many of these outfalls has reduced considerably but in certain outfalls this has increased many fold during the last twelve years.

During this survey it was noticed by the survey team that in many areas municipal solid wastes are dumped on both banks of the river. The leachates of these wastes flow to the river. This waste also flows with the surface run-off to the river during monsoon period and also during high tide and contribute to increase the BOD level of the river.

Moreover, the survey team also observed that at many places the lockgates and the interceptions meant for diversion of wastewaters are not maintained properly. These lockgates, interception and diversion works need regular maintenance.



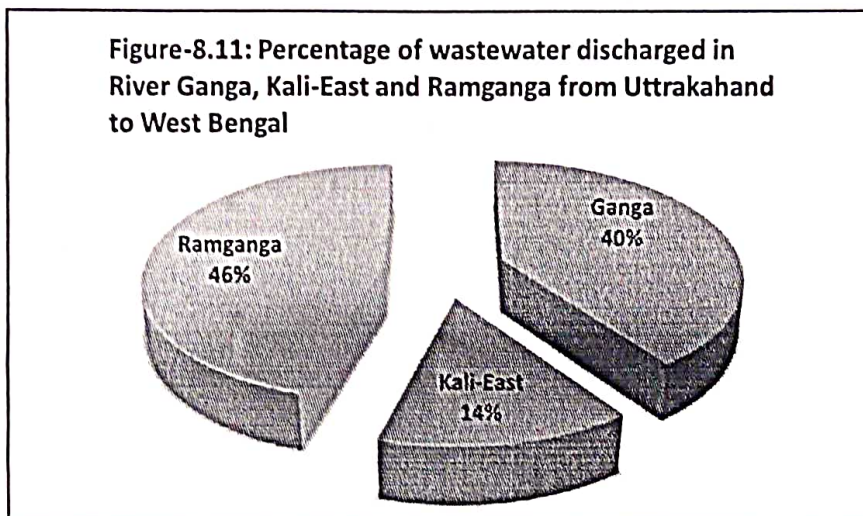
## POLLUTION ASSESSMENT : RIVER GANGA



JULY 2013

CENTRAL POLLUTION CONTROL BOARD  
Ministry of Environment and Forests, Govt. of India  
Parivesh Bhawan, East, Connaught Place,  
New Delhi - 110032  
Website: [www.cpcb.nic.in](http://www.cpcb.nic.in)

**POLLUTION ASSESSMENT : RIVER GANGA**



**8.3.5 Sector specific wastewater generation in terms of water consumption**

- In Uttarakhand, Uttar Pradesh, Bihar and West Bengal all together it is observed that average wastewater generation by grossly polluting industries is approx 45% of water consumed by these industries.

**Table 8.11: Percentage of sector specific wastewater generation with respect to consumption**

Industrial Sector	Chemical	Distillery	Food, Dairy & Beverage	Pulp & Paper	Sugar	Textile, Bleaching & Dyeing	Tannery	Others
% of wastewater generation with respect to consumption	46.4	47	58	65.8	31.5	80.9	77	17

- Tannery; Distillery; Dairy, food and beverage; Dyeing, Textile & Bleach and Pulp & paper are the sectors which generate more than 50% wastewater in terms of water consumed by these categories of industries. The details are given in Table-8.11.

**8.4 CONCLUSION**

- There are 764 grossly polluting industries discharging wastewater to main stem of River Ganga (either directly or through drains) and its two important tributaries Kali-east and Ramganga in

**POLLUTION ASSESSMENT : RIVER GANGA**

Uttarakhand, Uttar Pradesh, Bihar and west Bengal. Out of 764 industries, 687 are located in Uttar Pradesh.

- The water consumed by grossly polluting industries is 1123 MLD.
- Total wastewater generated by grossly polluting industries is 501 MLD. This is 45% (approx) of total water consumed.
- In terms of number of industrial units, tannery sector is dominating where as in terms of wastewater generation Pulp & paper sectors dominate followed by chemical and sugar sector.
- It is observed that GPI in Bihar generate minimum wastewater (19%) in terms of water consumed whereas GPI in West Bengal generate maximum wastewater 75.5% in terms of water consumed this followed by Uttarakhand (56.7%) and Uttar Pradesh (39%%).
- In the riverine system Ramanga carries maximum industrial wastewater followed by main stream of river Ganga and Kali-East respectively.

**8.5 ACTION TAKEN**

Central Pollution Control Board has inspected 441 industries (as on 30/06/2013) to check the compliance and inventory provided by State Pollution Control Board and to check the adequacy of industries in terms of wastewater pollution. Details of industries monitored and their action taken are provided in Annexure-VIII.

- 54 -

Annexure - K

# National Inventory of Sewage Treatment Plants

March 2021



**Central Pollution Control Board**  
**Parivesh Bhawan**  
**East Arjun Nagar, Delhi**

### 4.35 STPs AT WEST BENGAL

Estimated sewage generation for the State of West Bengal is 5,457 MLD and total capacity (incl. proposed) is 1,202 MLD (65 STPs). Figure 4.26 represents statistics on sewage generation, treatment capacity, operational capacity, actual utilization, complied capacity, capacities of non operational STPs, under construction STPs and proposed STPs. Based on the data analysis, following observations are made:

1. Installed capacity is 897 MLD (16.43 %) against the sewage generation of 5,457 MLD. It shows that there is gap of 4,560 MLD (83.57 %) in treatment capacity.
2. Out of 897 MLD of installed capacity developed, operationalized capacity is 337 MLD (37.56 %) and actual utilized capacity is 213 MLD (63.20 %). Further, capacity of complied STPs is only 126 MLD.

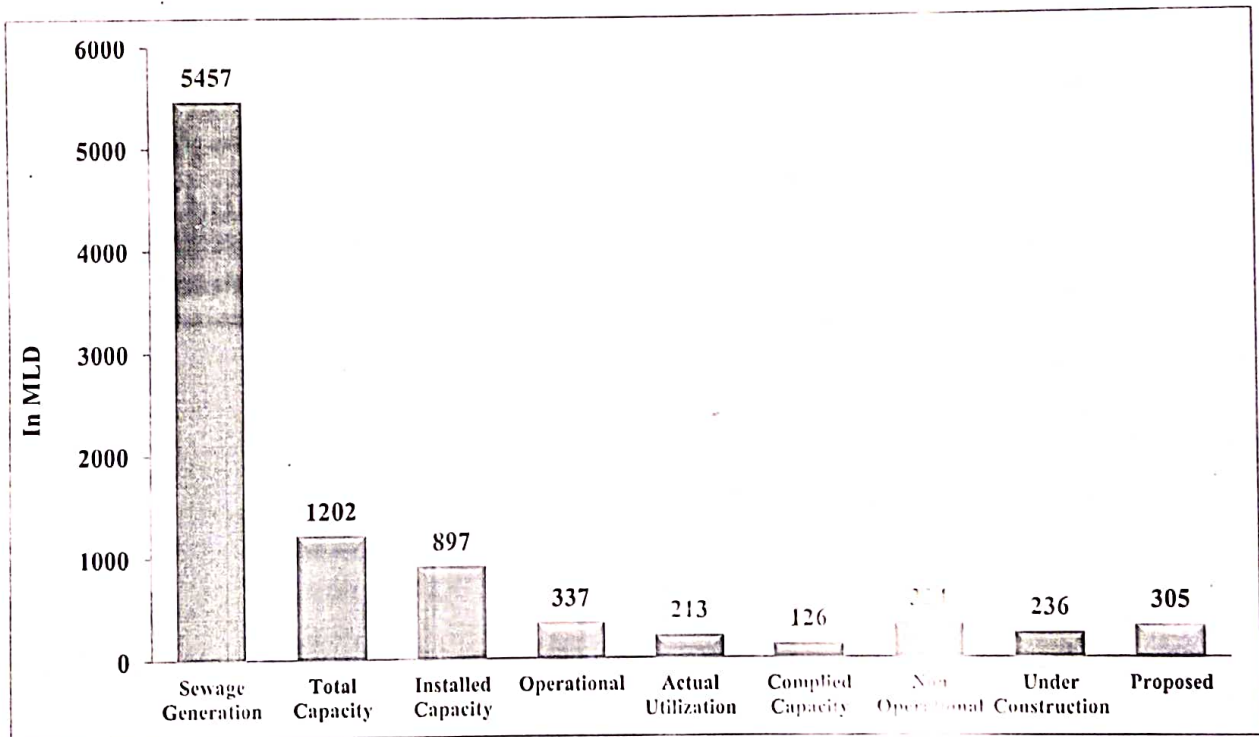


Figure 4.26: Sewage Generation and Treatment Capacity (MLD) - West Bengal

# VAKALATNAMA

## IN THE NATIONAL GREEN TRIBUNAL EASTERN ZONE BENCH, KOLKATA

District: \_\_\_\_\_

OA/ MA / RA/ Contempt No. \_\_\_\_\_ of 20 \_\_\_\_\_

Suprova Prasad

{Appellant  
{Petitioners

- Versus -

Ministry of Environment Forest and e & org.

{Respondent  
{Opposite Party

Vakalatnama on behalf of Suprova Prasad

Know all men by these presents that by Vakalatnama, I/We appoint the Advocates noted below or any one of them my/our lawful Advocate or Advocates Paushali Banerjee of entering appearance

in the above matter for appearing conducting and arguing the same for depositing or withdrawing any money in connection therewith for moving the Court in any matter connected therewith, for preparing the paper book in the case and for putting in papers, petitions etc. On my/ our behalf for filing, taking back any documents for withdrawing suits or appeals or petitions with permission to institute fresh suit etc. For signing and filling petitions of compromise in connections with the said matter and for taking copies of paper from the Record and I / We further say that any act. Done by my / our said Advocate or Advocates or by any one of them after accepting this Vakalatnama, shall be considered as my/our own true and lawful act.

And I/We further hereby agree and undertake to pay the said Advocates his or their fees as settled and all others sums that may be necessary to carry out the requisition of the Court and otherwise to enable the said Advocates to conduct the case properly. Failing which the said Advocates after notice to me/us will be at liberty to withdraw from further conducting the case.

IN WITNESS WHERE OF I/WE sign and execute this Vakalatnama on this the 7th day of February 2022

Paushali Banerjee  
Name of Advocates

**Ms. Paushali Banerjee,**  
High Court, Calcutta,  
NPS Business Centre,  
Ground Floor, Kolkata - 700001  
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