SL. No. 15/25

-X-

BEFORE THE NATIONAL GREEN TRIBUNAL,

EASTERN ZONE BENCH, KOKATA.

Original Application No.115 of 2024/EZ

IN THE MATTER OF:

Concern For Kolkata

-VS - .....Applicant

State of west Bengal & Ors

.....Respondent

INDEX

Paushali Banerjee

PAUSHALI BANERJEE

ADVOCATE

7A, KIRON SHANKAR ROY ROAD,

KOLKATA-700001

GOVERNMENT OF WEST BENGAL ★ NOTARY ★
Subhendu Banerjee
Kolkata-144
Regd. No. 008/2022
Expiry Date 1/4/2027

26 AUG 2025

BEFORE THE NATIONAL GREEN TRIBUNAL,

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AFFIDAVIT ON BEHALF OF KOLKATA METROPOLITAN DEVELOPMENT AUTHORITY .

I, Sri Dipto Roy Chowdhury, son of Late J.P. Roy Chowdhury, aged about 45 years, by occupation service, working for gain as Executive Engineer, Kolkata Metropolitan Development Authority, having office at Unnayan Bhavan , Block-A, Sector- II, Salt Lake City, Kolkata- 700-091, do hereby solemnly affirm and state as under:-

1. That I am the Executive Engineer , Estate & Asset Management Sector, Kolkata Metropolitan Development Authority . I am well acquainted with

NOTARY Subhendu Banerjee Kolkata-144 Regd. No. 008/2022 Expiry Date 1/4/2027 GOVERNMENT OF WEST BENGAL

the facts and circumstances of the case and I have been duly authorized to affirm this affidavit on behalf of the Kolkata Metropolitan Development Authority.

2. I submit that the answering respondent have complied with the orders of this Hon'ble Tribunal arising out of different matters before this Hon'ble Tribunal .

3. I submit that this Original Application is a letter Petition where the Applicant have prayed to take immediate action for dredging and desiltation of the lake .

4. I submit that in this instant Application an Affidavit was affirmed on 28/11/24 by this answering respondent wherein it was already stated that one Expert Committee consisting of (I) Dr Kalyan Rudra, Chairman WBPCB, (ii) Smt. Nandini Ghosh, Secretary KMDA, (iii) Dr Anirban Roy Research Officer, WB Bio-Diversity Board, (iii) Advisor KMDA (iv) Chief Engineer, E & AM Sector, KMDA, (vi) The Senior law Officer KMDA, (vii) Executive Engineer, BPPD-I E&AM Sector KMDA, (viii) Representative from clubs located within Rabindra Sarobar , was constituted by KMDA and meeting was held on 3/10/24. In the meeting of the expert committee held on 3/10/24 it was decided a Bathymetric survey needs to be conducted.

GOVERNMENT OF WEST BENGAL ★ NOTARY ★
Subhendu Banerjee
Kolkata-144
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5. I submit that the work for Bathymetric survey at Rabindra Sarobar was entrusted to Jadavpur University. A report of the Bathymetric study was placed before the Expert Committee of Rabindra Sarobar at a meeting held on 07.07.2025. The minutes of the meeting is annexed herewith and marked as Annexure A.
6. I submit that it was decided by the expert committee to get a comprehensive picture of the yearly rate of sedimentation and depths of water body.
7. It was suggested by the committee that the manual de-siltation of the Lake along the periphery is to be carried out which is exposed during dry season due to receding of the water level as per prevailing system.
8. Final report on Bathymetric Survey by Jadavpur University was received and dredging at selective locations using Cutter Suction Dredger methodology was suggested in the said report . Copy of the Bathymetric Survey report is annexed herewith and marked as annexed as Annexure B.

GOVERNMENT OF WEST BENGAL ★NOTARY★
Subhendu
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VERIFICATION

I, the deponent above named do hereby verify that the contents of the above affidavit are true and correct to the best of my knowledge which are derived from the relevant office records. No part of it is false and nothing material has been concealed there from.

Verified at Kolkata on this 26th August, 2025.

Identified by me
Paushali Banerjee
Advocate

Dipto Roy Chowdhury
Executive Engineer
BPPD-I/E & AM Sector
KMDA
DEPONENT

Solemnly Affirmed and
Declared before me u/s
139 CPC and u/s 333BNSS 2023.
Notary
Govt. of West Bengal
26.08.2025

GOVERNMENT OF WEST BENGAL ★ NOTARY ★
Subhendu
Banerjee
Kolkata-144
Regd. No. 008/2022
Expiry Date
1/4/2027

26 AUG 2025

Annexure - 'A'

Minutes of the Meeting regarding Rabindra Sarobar held at the Conference Room, 2nd Floor, Paribesh Bhawan, Salt Lake on 07.07.2025.

Reference meeting notice vide no. 134/KMDA/PR-776/2019 dtd. 20.06.2025 of Deputy Secretary, KMDA.

Officials & Experts Present: -

1. Dr. Kalyan Rudra, Chairman, WBPCB, GoWB.
2. Smt. Nandini Ghosh, IAS, Secretary, KMDA
3. Dr. Anirban Roy, Research Officer, West Bengal Bio- Diversity Board, GoWB.
4. Dr. Utpal Kr. Sar, Joint Director, Department of Fisheries, Govt. of West Bengal.
5. Prof. Arunabha Majumdar, Professor Emeritus, School of Water Resources Engineering, Jadavpur University.
6. Dr. Gourav Banerjee, Assistant Professor, School of Water Resources Engineering, Jadavpur University.
7. Sri Supriya Maity, Advisor, KMDA.
8. Sri Dipankar Roy, Chief Engineer, E&AM Sector, KMDA.
9. Sri Dilip Kr. Baral, Superintending Engineer, E&AM Sector, KMDA.
10. Sri Dipto Roy Chowdhury, Executive Engineer, E&AM Sector, KMDA.
11. The Law Officer, KMDA.
12. Sri Arindam Panda, Addl. O.C., Rabindra Sarobar P.S.
13. Representatives from various clubs within Rabindra Sarobar premises.

The meeting commenced with detailed discussion on the preliminary report of the recently conducted Bathymetric Survey of Rabindra Sarobar Lake by School of Water Resources Engineering, JU and and the presentation was given by Prof. Arunabha Majumdar of Jadavpur University in front of the members present in the meeting.

i. After detailed discussion it was decided that the report is to be modified based on the available official records/data of the year 2005 and 2025, to get a further comprehensive picture of yearly rate of sedimentation and depths of the waterbody. The report shall also include the reduction of area of the islands (if any) located in the main waterbody in the last 20 years.

ii. It was also decided that a joint visit would be held on 9th July 2025 at 12:00 Noon at Rabindra Sarobar in presence of Dr. Anirban Roy, Senior Scientist, Bio Diversity Board and Dr. Utpal Kr. Sar, Joint Director of Fisheries, Investment Promotion Unit, Fisheries Department, GoWB to recommend remedial measures for excessive growth of aquatic weeds and hyacinth, especially in the Public pool and Padmapukur. In addition to this, protective measures to reduce the erosion of the banks of the islands by plantation of specific type of plants/saplings bordering the islands shall also be assessed during the visit.

iii. The manual de-siltation of the waterbody along periphery which is exposed during the dry season due to receding of water level to be carried out as per the prevailing system.

iv. Strict regime for manual cleaning of the floating materials from the water body to be followed throughout the year.

v. The incident regarding the recent drowning of the teenager at the Public Swimming Pool was discussed. The draft SOP was read out and the members present agreed to it. Various other proposals from the club representatives regarding implementation of rules at the Public Swimming pool were discussed. A model SOP will be drafted by taking into consideration, the suggestions and the recommendations of the Committee and will be placed before the Competent Authority of KMDA.

vi. In the meeting a request from the Additional O.C., Rabindra Sarobar P.S. was made for providing a battery-operated vehicle if possible for surveillance and monitoring work at Rabindra Sarobar. He was requested to submit a letter to the Senior Special Secretary, Department of UD & MA, GoWB with an intimation to KMDA and the matter shall be taken care of subsequently.

vii. In the recent past, several organizations have approached KMDA for permission to carry out plantation programme within Rabindra Sarobar premise. In the said meeting, it was decided that all such proposals/ requests would be placed before the existing Sub Committee of Rabindra Sarobar for decision. Banners at various locations within Rabindra Sarobar to be displayed to restrict indiscriminate planting of saplings without prior permission from KMDA.

viii. The club representatives were requested to obtain 'No Objection Certificate' from Fire & Emergency Services, GoWB for Fire Safety protocol to be followed and submit a copy of the same to KMDA at the earliest.

As there was no other issues to discussed, the meeting ended with vote of thanks to and from the chair.

(Dr. Kalyan Rudra)
Chairman, WBPCB

KMDA

Kolkata Metropolitan Development Authority

No. 69/1(20)/EM/18/2024-25.

Date: 16/07/2025

1. Dr. Kalyan Rudra, Chairman, WBPCB.
2. The CEO, KMDA.
3. The Secretary, KMDA.
4. The Scientist, ZSI, Kolkata-Member.
5. The representative of Botanical Survey of India. – Member.
6. The representative of West Bengal Biodiversity Board. – Member.
7. The Secretary General, Social Security Association of India. – Member.
8. The Deputy Commissioner of Police, South East Division, Kolkata Police-Member.
9. Shri Sambaran Banerjee, Ex-National Cricketer & Coach, CAB. – Member.
10. Shri Bikram Ghosh, (Percussionist) – Member.
11. The Law Officer, KMDA- Member.
12. One Representative from each of the Rowing Clubs in Rabindra Sarobar- Members.
13. One representative from each of the Swimming Clubs in Rabindra Sarobar premises- Member.
14. The Advisor, KMDA- Special Invitee.
15. Prof. Asis Mazumdar, School of Water Resource Engineering, Jadavpur University. – Special Invitee.
16. Sri Sudip Mukherjee, Joint Director, Department of Fisheries, West Bengal. – Special Invitee.
17. Dr. Utpal Kumar Sar, Joint Director of Fisheries, Investment Promotion Unit, Department of Fisheries, West Bengal.
18. The Chief Engineer, E&AM Sector, KMDA.
19. The Superintending Engineer, Construction Circle, E&AM, KMDA.
20. The Executive Engineer, BPPD-I, E&AM Sector, KMDA.

Sub: Minutes of the review meeting on various issues related to Rabindra Sarobar held at the Conference room, 2nd Floor, Paribesh Bhawan, Salt Lake on 07.07.2025 chaired by Dr. Kalyan Rudra, Chairman, WBPCB.

Sir,

I am directed by the Authority of KMDA to communicate the **Minutes of the review meeting held on 07.07.2025 on the above mentioned subject.**

This is for your information please.

Enclo: Minutes of the meeting dated. 07.07.2025.

Deputy Secretary
KIT Wing, KMDA.

Annexure - 'B'

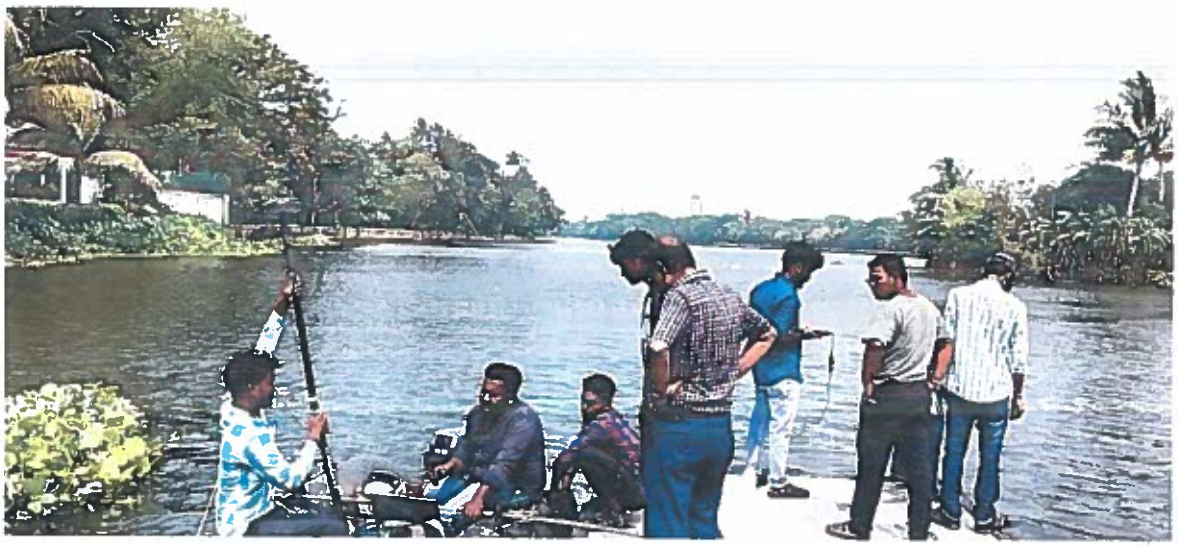
Report

On

Bathymetric Survey of Rabindra Sarobar

Study Sponsored by

Kolkata Metropolitan Development Authority (KMDA)



Study Conducted by

School of Water Resources Engineering
Jadavpur University
Kolkata-700 032
2025

BACKGROUND OF STUDY

Rabindra Sarobar, situated in the heart of South Kolkata, is a prominent artificial lake spread over 73 acres (approximately 300,000 m²), bordered by extensive urban development. This lake is a vital hydrological asset offering multiple ecosystem services—supporting biodiversity, regulating microclimate, and providing recreational amenities. Historically recognized under the National Lake Conservation Plan (NLCP), it has received periodic attention for preservation, yet is under increasing ecological stress due to sedimentation, catchment encroachment, and nutrient influx. Past bathymetric assessments, along with empirical observation by stakeholders, indicated progressive siltation affecting both hydraulic and ecological functions. Responding to this, the Kolkata Metropolitan Development Authority (KMDA) commissioned a detailed bathymetric and ecological evaluation to be executed by the School of Water Resources Engineering, Jadavpur University. Recognizing the need for precise depth monitoring and siltation impact, the KMDA entrusted the School of Water Resources Engineering, Jadavpur University, under the leadership of Prof. Asis Mazumdar, to conduct a detailed bathymetric study of the lake. The effort aimed to scientifically quantify morphometric changes from 2005 to 2025 and explore sustainable interventions. A Differential GPS (DGPS)-based hydrographic survey, integrated with Acoustic Doppler Velocimetry (ADV) and singlebeam Echo Sounder (Echotrac E-20), was used to construct high-resolution contour and depth distribution maps. Data collection was executed from a motorized survey vessel systematically navigating a GIS-based grid. Special focus was given to the central island zone, inlet vicinity, and areas subject to heavy recreational boating, to assess dynamic sedimentation patterns and flow-induced re-suspension zones. The integrated analysis informs bathymetric details, siltation mapping, sediment budgeting, and ecological interpretation—particularly habitat constraints for benthic species and fish under shifting morphometry. The data also enables forecasting future capacity loss and setting priorities for sustainable dredging under National Green Tribunal (NGT) compliance. The study aims to provide scientific insight into bathymetric status, lakebed morphology, and suggest feasible dredging options without ecological disruption.

INTRODUCTION

Rabindra Sarobar Lake, a National Lake Conservation Plan (NLCP)-recognized water body, has long served as an ecological, recreational, and aesthetic landmark in South Kolkata. With growing urbanization and increased organic and inorganic load from the catchment, siltation, depth reduction, and eutrophication have emerged as major threats to its sustainability. In recent years, citizen concerns and judicial directives—including those of the National Green Tribunal (NGT)—have emphasized the need for environmentally sound conservation practices. Rabindra Sarobar is a 73-acre artificial lake in South Kolkata that plays a vital role in urban ecology, recreation, and hydrology. With increasing anthropogenic pressure, the lake has been facing progressive sedimentation, water quality deterioration, and habitat shrinkage. To support sustainable management, this study

investigates bathymetric changes over time and quantifies siltation rates to guide future conservation measures.

OBJECTIVES

The main objective of this initiative was to evaluate changes in the bathymetric profile of the lake and their implications on the fresh water ecosystem. Furthermore, the study aimed to identify siltation-prone zones and provide viable, non-invasive dredging options aligned with **National Green Tribunal (NGT) guidelines**, ensuring that ecological balance is maintained during restoration.

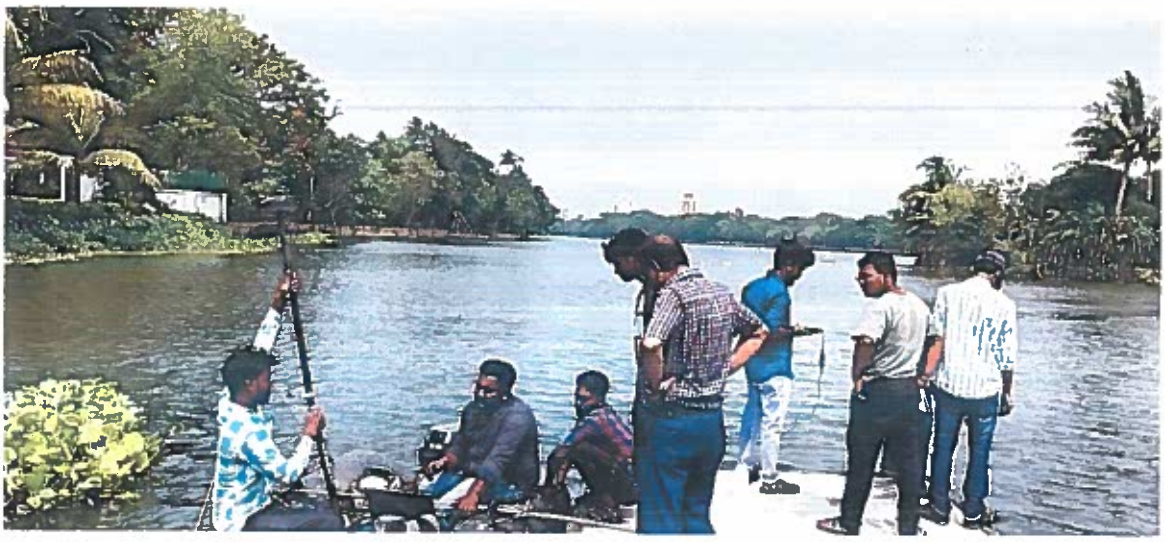
SCOPE OF STUDY

This study is designed to quantify and map the rate of siltation in Rabindra Sarobar Lake based on multitemporal bathymetric surveys and to evaluate potential remediation strategies. The key objectives are:

- Conduct DGPS and ADV-supported bathymetric surveys to capture precise depth variations.
- Develop GIS-integrated contour maps highlighting morphological changes.
- Identify spatial trends in siltation and shallow zone expansion.
- Interpret hydrological and implications of morphometric changes.
- Provide actionable recommendations for improving lake ecosystem.

METHODOLOGY

The bathymetric assessment involved the integration of advanced hydrographic tools, gridbased data acquisition, and a limnologically informed scientific approach.



Photograph :1 Starting of bathymetric survey from Calcutta Rowing Club point on 13th May 2025

Grid Design: The lake was divided into a 25 m × 25 m GIS grid network to ensure uniform spatial resolution across its full 73-acre expanse. Bathymetric data collection was conducted at the center of each grid cell, and the spatial referencing was aligned with UTM Zone 45N. Elevations were corrected using fixed lake level control points (RS-1 and RS2) to normalize against Mean Sea Level (MSL).

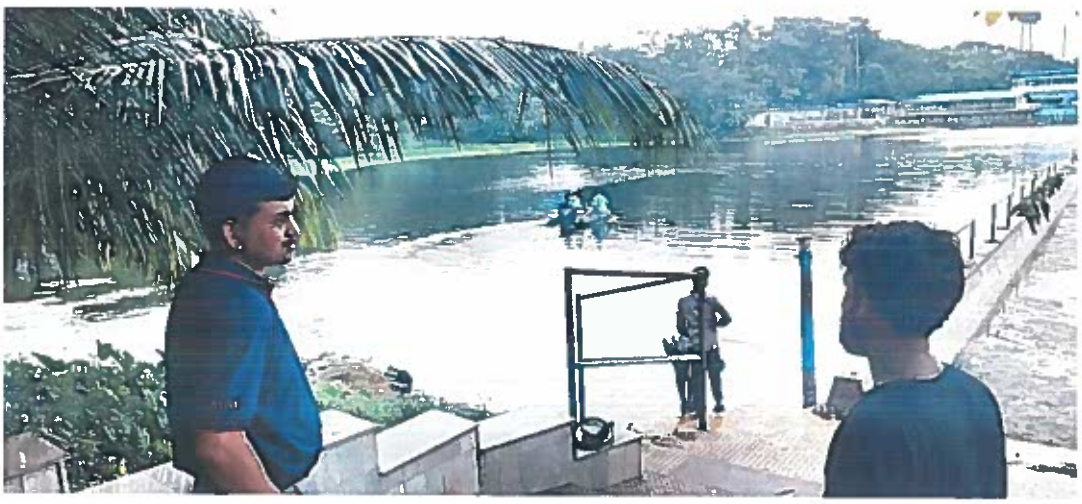
Photograph : 2 Physical verification of the desigh grid alongthe Lake on 7th May 2025

Photograph :3 Bathymetric Survey in Rabindra Sarobar on 13th May, 2025

Survey Equipment and Tools: The field team employed a suite of high-precision instruments for depth and velocity measurement. Differential GPS (DGPS, Trimble SPS986) ensured sub-decimeter horizontal and vertical positioning accuracy. A single-beam Echo Sounder (Echotrac E-20) was used to obtain continuous depth measurements, while Acoustic Doppler Current Profiler (ADCP, Teledyne RDI Workhorse) and Acoustic Doppler Velocimeter (ADV) instruments captured water column velocity profiles.

Survey Duration and Execution: Field data collection was carried out from 13th to 15th May 2025, using a motorized survey vessel. The equipment suite was mounted on board and systematically navigated along predefined transects.

Photograph:4 Survey at Padmapukur, Rabindra Sarobar on 15 May, 2025



Photograph :5 Bathymetric Survey at Public Swimming Pool, Rabindra Sarobar on 15 May, 2025

Hydrodynamic and Limnological Observations: ADCP and ADV instruments were used to profile current velocities across different depths and locations, particularly near inlets and around the central islands. These measurements helped identify low-velocity zones that act as sediment traps and assess flow-induced sediment resuspension around boating areas.

Scientific Approach to Siltation Estimation: Depth measurements from 2005 and 2025 were compared grid-by-grid to determine sediment accumulation rates. The difference in elevation per cell, divided by the time interval (20 years), provided the annual average siltation rate (3 cm/year). Limnological principles and sediment transport models were referenced to interpret the ecological implications of depth loss, applying methods consistent with Wetzel (2001) and other lake morphometry frameworks.

This multipronged methodology ensured high-resolution bathymetric mapping, dynamic flow assessment, and an ecologically grounded analysis of sedimentation trends

RESULTS AND INTERPRETATION

INTERPRETATION OF BATHYMETRIC STUDY (2005–2025)

The comparative bathymetric assessment of Rabindra Sarobar over the past two decades (2005–2025) reveals a clear trend of progressive morphometric transformation, shaped by gradual sediment deposition, shifting hydrodynamics, and intensifying catchment pressures. This transformation is characterized by a measurable reduction in mean lake depth—from approximately 3.60 meters in 2005 to 3.00 meters in 2025—and a comparatively higher increase in shallow water zones, with the proportion of lake area registering depths less than 2 meters growing from 12% to 28% over the past two decades.

The estimated average siltation rate of 3.0 cm/year, though moderate in absolute terms, reflects a sustained accumulation process that, if left unaddressed, may progressively compromise the lake's storage capacity, aquatic habitat distribution, and water quality buffering functions. Importantly, zones exhibiting elevated sediment deposition—particularly in the northern part, central margins, and eastern inlet areas—have been consistently identified as siltation hotspots through spatial grid analysis and velocity profiling.

Despite these trends, Rabindra Sarobar continues to retain over 60% of its area with depths greater than 4 meters, providing thermally stable refuges for fish populations and maintaining oxygenated benthic zones. No critical anoxic or hypoxic events were recorded during the assessment period, suggesting that the lake's ecological structure remains functionally intact, though increasingly vulnerable to further morphometric change.

Table 1: Summary of Bathymetric and Ecological Findings (2005–2025)

Parameter	2005 Value	2025 Value	Observation
Total Mean Depth (Lake)	3.60 m	3.00 m	0.6 m decrease in mean depth
Maximum Recorded Depth	5.5 m	4.9 m	Minor reduction in deepest points
Area with Depth <2m	12%	28%	16% increase in shallow zones
Average Annual Siltation Rate	—	3.0 cm/year (over the period of 20 years)	Moderate but cumulative accumulation
Zones with >4 cm/year Siltation	—	Northern & Inlet Zones	Spatially demarcated through grid analysis
Fish Habitat Depth (>4m) Coverage	~65%	~60%	Still viable for ecological functions
Resuspension due to Boating	Not significant	Localized near eastern bank	Low-intensity impact

Lotus Pond and Public Swimming Pool

The bathymetric and siltation surveys of the two ponds, **Lotus Pond** and **Public Swimming Pool** were conducted using contour data referenced to **Mean Sea Level** with actual water depths computed as the difference between the fixed water surface elevation and the bed elevation. In **Lotus pond** , the water level is **3.297 m**, and the bed level of the Lotus pond ranges from approximately **+3.1 m** near the banks to **–0.8 m** at the central depression, resulting in water depths from **0.2 m to 4.1 m**. The contours indicate gentle slope from the bank to the central part. However, flat and slightly raised contour areas in the northeastern and southern portions of the pond suggest **visible siltation**, with accumulated sediment reducing local depths by approximately **0.3–0.5 m**. The deposition appears gradual and fine-textured, likely due to low hydraulic activity and organic input from surrounding vegetation. In contrast, **Public Swimming Pool** , with a water level of **2.574 m**, shows much more varied bathymetry, with bed elevations ranging from **+2.4 m** near the shore

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(depth 0.17 m) to **–5.4 m** in the central zone around **an island**, resulting in a **maximum water depth of 7.97 m**. Steep slopes dominate the southern and eastern zones, marked by tightly spaced contours, while broader, flat-bottomed shelves between **0 and –1 m** suggest zones of **sediment accumulation**, particularly near inflow areas and at the base of the banks . In these regions, silt layers appear more consolidated, with observed thicknesses ranging from **0.6 to 1.2 m**. The bathymetric profile of **Public Swimming Pool** indicates both deeper regions and actively filling with some small shallow zones while, **Lotus Pond** reflects a more stable, gradually in filling basin. These observations highlight comparatively low to moderate sediment deposition patterns.

DEPTH TRENDS IN RABINDRA SAROBAR (2005–2025)

The comparative bathymetric analysis of Rabindra Sarobar from 2005 to 2025 highlights a persistent decline in lake depth, signifying sustained sedimentation and morphological transformation over the two-decade period. During this time:

- **Mean depth decreased from 3.60 meters in 2005 to 3.00 meters in 2025**
- **Maximum recorded depth reduced from 5.5 meters to 4.9 meters**
- **Area with depth less than 2 meters expanded from 12% to 28% of the total lake area**

These changes reflect a net reduction in water-holding capacity and a steady expansion of shallow zones, most prominently in the northern part central basin margins, and near the eastern inlet. This trend corresponds with zones of reduced flow velocity and elevated sediment loading, as observed through ADCP velocity profiling and field-based observations during the recent survey.

The increase in shallow areas poses concerns for lake health. Shallow zones are more prone to thermal fluctuations, oxygen stress, and aquatic weed proliferation—conditions that may compromise fish habitats and overall ecological balance. However, the broader ecosystem impact remains moderate at present, as **over 60% of the lake area continues to maintain depths greater than 4 meters**, supporting core aquatic functions such as benthic productivity, thermal refuge, and oxygen stratification.

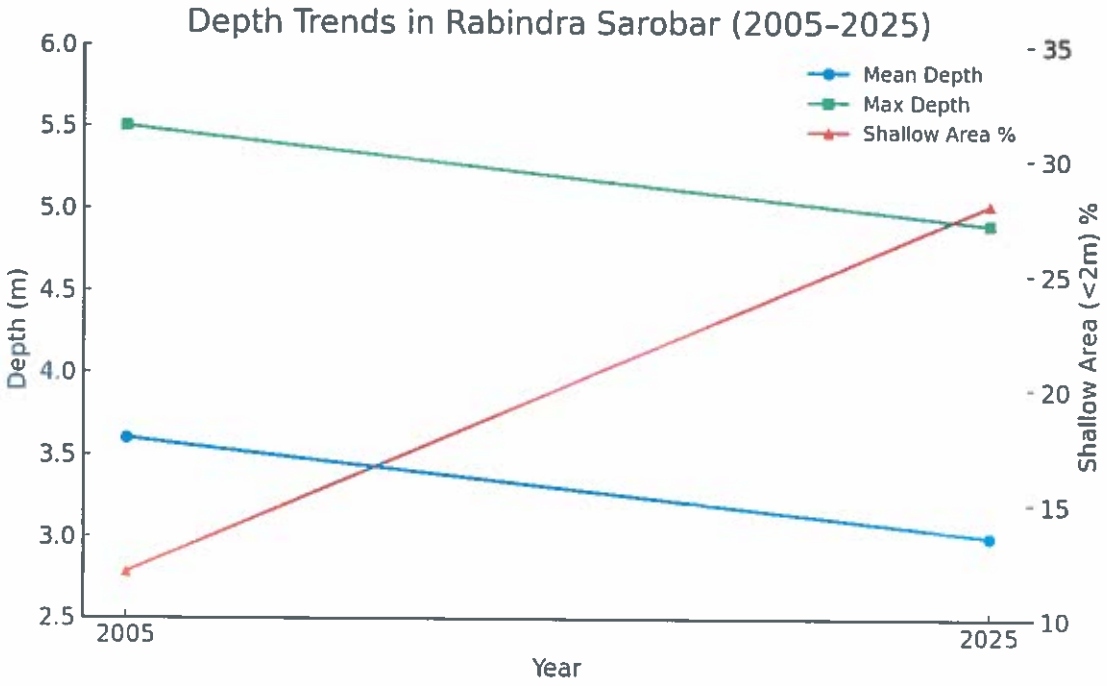

Figure 1: Depth Trends in Rabindra Sarobar (2005–2025)

BATHYMETRIC ZONE DISTRIBUTION

The bathymetric zone distribution of Rabindra Sarobar Lake, derived from the comparative DGPS and Echo Sounder surveys of 2005 and 2025, offers a stratified classification of depth-based ecological zones. This classification is instrumental for interpreting habitat suitability, sedimentation dynamics, and prioritizing lake management strategies over time.

The lakebed is segmented into three key ecological zones, each with distinct functional implications:

• Deep Zone (>4.0 m):

In 2005, this zone accounted for approximately **50%** of the lake area, primarily along the western and southern boundaries. By 2025, its coverage declined to **35%**, reflecting a **15% reduction** over two decades. These deep segments remain ecologically vital, serving as thermal and oxygen refugia for fish during extreme seasonal conditions. Despite their decreasing extent, they are relatively less affected by siltation and continue to offer **ecological stability**, making them high-priority areas for protection.

• **Moderate Depth Zone (2.0–4.0 m):**

This zone remained relatively stable—**38% in 2005** and **37% in 2025**—forming transitional bands around the central island and adjacent to deeper pockets. While it continues to support aquatic biodiversity and water circulation, parts of this zone are witnessing **gradual depth loss** due to sediment creep from adjacent shallow sectors. These transitional areas are sensitive to ecological shifts and merit regular bathymetric monitoring to prevent them from becoming unstable or overly silted.

• **Shallow Zone (<2.0 m):**

The most dynamic transformation occurred in this zone. From covering only **12% of the lake area in 2005**, it expanded to **28% by 2025**, signifying a **16% increase in shallow area**. These zones, concentrated in the northern embayment, eastern inlets, and northeastern margins, act as **primary sediment deposition basins**. Their shallowness contributes to **increased aquatic weed growth**, **algal bloom susceptibility**, and potential **hypoxic conditions** during summer months. These areas are ecologically vulnerable and should be prioritized for **non-invasive sediment management** and **ecological restoration measures**.

Integrated Management Relevance:

This long-term bathymetric zone mapping provides a foundational tool for **ecological zoning** and **restoration planning**. For instance:

- **Shallow zones** can be selectively targeted for **low-impact sediment removal** and weed control.
- **Moderate zones** may serve as **adaptive buffers**, allowing for the installation of **floating wetlands**, **bio-islands**, or **oxygenation zones**.
- **Deep zones** should be preserved as **core conservation sanctuaries** essential for maintaining thermal refuge and dissolved oxygen continuity.

By linking bathymetric zones with **hydrodynamics**, **sediment behavior**, and **ecological functions**, this classification supports a comprehensive, **NGT-aligned** restoration strategy that balances biodiversity conservation with urban recreational access and long-term water body sustainability.

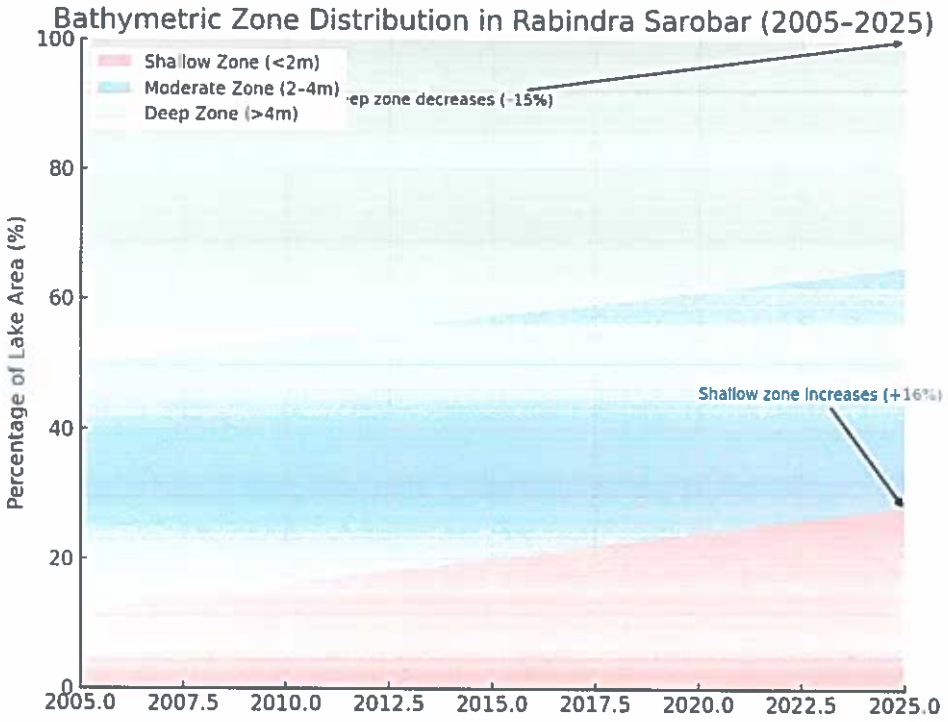

Figure-2. Bathymetric Zone Distribution

BATHYMETRIC SURFACE MAP (2025) WITH LATITUDE LONGITUDE GRID

The 3D Bathymetric Surface Map for 2025, overlaid with latitude and longitude coordinates, provides a spatially resolved visualization of the current lakebed morphology of Rabindra Sarobar. This representation enables stakeholders to identify both localized and regional variations in lake depth, offering critical insight into sediment distribution and aquatic habitat structure. The map reveals that the **northern and central sectors of the lake exhibit pronounced depth reduction**, with many zones registering depths below 2.0 meters. These shallow patches correspond closely with low-velocity hydrodynamic regions, as validated by Acoustic Doppler profiling, and are most vulnerable to silt accumulation. The **central island area**, although maintaining moderate depth, shows encroachment by expanding shallow margins, which could threaten aquatic biodiversity if unchecked. Conversely, the **southern zone and deeper pockets along the western perimeter** retain greater depth, exceeding 4 meters, and continue to serve as essential refugia for fish and benthic organisms, particularly during periods of thermal stress or low dissolved oxygen. The latitude-longitude referencing enables seamless integration with GIS tools and facilitates comparison with future or historical datasets, making this map a powerful resource for planning **site-specific restoration interventions**, such as selective dredging or ecological zoning. Moreover, the 3D elevation gradient aids in visualizing the **lakebed undulation**, helping to model sediment transport pathways and predict future siltation hotspots. It also allows engineers and planners to assess the feasibility of deploying

nature-based solutions like floating wetlands in stable hydro-morphological zones. In conclusion, the 3D map provides a comprehensive bathymetric benchmark, guiding both immediate conservation actions and long-term lake management under NGTcompliant, environmentally sensitive frameworks.

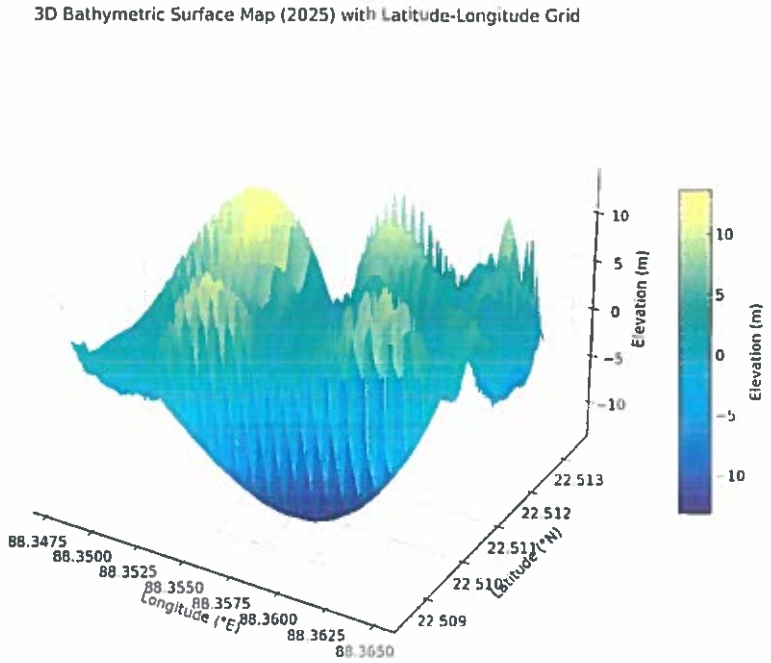

Figure 3: 3D Bathymetric Surface Map with Latitude-Longitude Grid (2025)

SEDIMENTATION RATE AND SILTATION MAPPING

The siltation rate assessment of Rabindra Sarobar between 2005 and 2025, based on long-term bathymetric comparisons, reveals a cumulative sediment deposition of approximately **0.60 meters (60 cm)** over the 20-year period—equivalent to an average annual siltation rate of **3.0 cm/year**. This gradual but persistent infilling has been most pronounced in the northern part, central basin margins, and inlet-adjacent zones, which exhibit the highest deposition intensities due to low hydrodynamic energy and sediment-laden inflows. While these shallow zones have expanded considerably, the southern and western basins have largely retained their morphometric stability, preserving critical ecological functions such as deep-water refugia and oxygen-buffered habitats. Given the current bathymetric resilience and biodiversity observed in these deeper regions, immediate mechanical intervention may not be essential. However, if future monitoring indicates significant ecological decline or functional habitat loss, then selective sediment management, including the possibility of controlled dredging, may be reconsidered within a framework that prioritizes biodiversity conservation and long-term ecological sustainability.

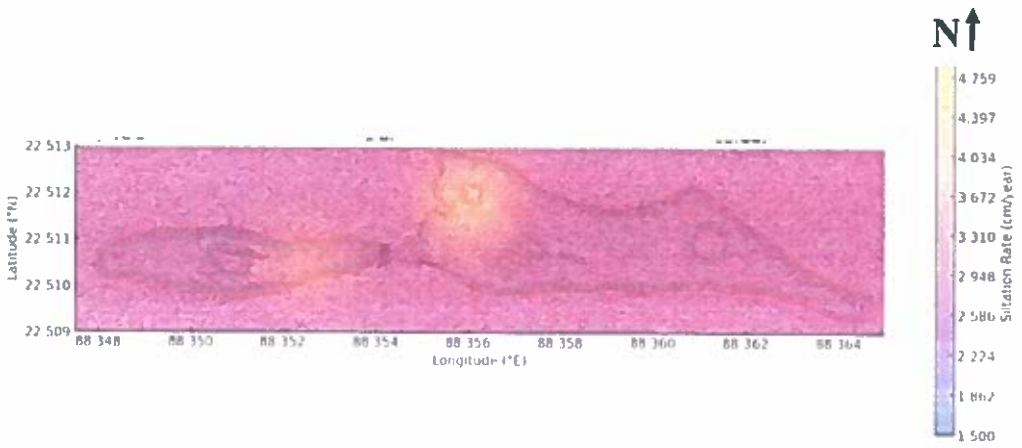

Figure 4 : Siltation Rate Map (2005–2025) – Latitude/Longitude Grid

EVAPOTRANSPIRATION DATA

The Rabindra Sarobar experiences substantial amount of evaporation from its storage which is one of the key components of its water budget. To assess this evaporation loss, following has been done. Preliminary overlay of the 500 m-resolution MODIS evapotranspiration (ET) product on the lake polygon shows that evaporation is not a minor loss term but a dominant control on Rabindra Sarobar's depth distribution. Summing the 12 monthly ET layers for 2024 yields an annual evaporative withdrawal approaching one metre of water column over the ~0.8 km² water body—equivalent to roughly a sixth of the lake's live storage. Because this loss accrues gradually, it amplifies late-dry-season drawdown, exposing the broad, shallow littoral shelves first and steepening the effective nearshore slope. If a bathymetric survey is carried out near the end of this evaporative deficit (typically January–March), depth soundings can be several decimetres lower than those obtained immediately after the monsoon refill, leading analysts to over-estimate sediment infill rates and under-estimate residence time. Incorporating a seasonally explicit evaporation correction when converting depth soundings to storage curves therefore becomes critical for reliable volume–area relationships, hydraulic modelling, and restoration planning for Rabindra Sarobar.

i) MODIS evapotranspiration (ET) data (Mu et al., 2013) has been acquired for the particular area from the month of January to December of 2024 as a sample year. ii) The ET product has a spatial resolution of 500 m. iii) Monthly sums of ET (from January to December) have been calculated in GIS interface.

iv) A tentative lake area has been prepared in a GIS shapefile format to identify the amount of ET associated to lake pixels. Fig. 5 shows the location of Rabindra Sarobar and its surrounding area for estimation of evapotranspiration.

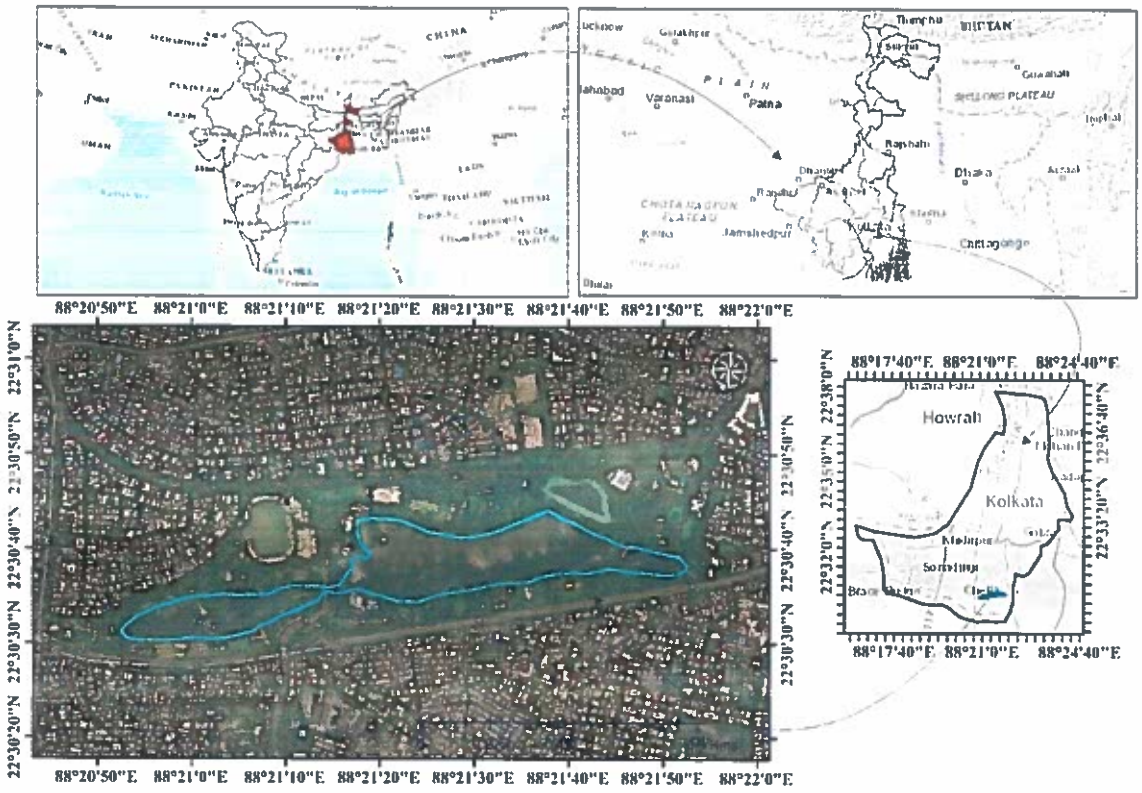

Figure 5- Location of Rabindra Sarobar

ii) The monthly ET sum from January to December of 2024 is shown in the fig. 2.

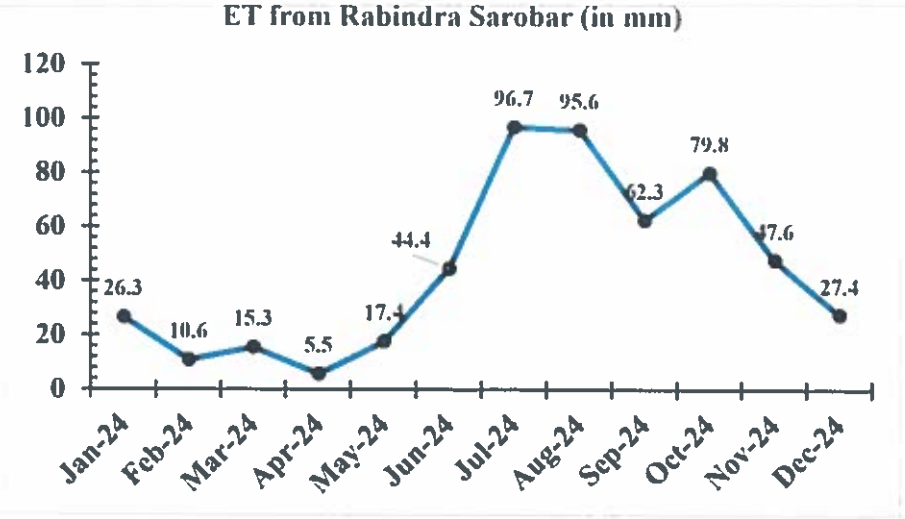

Fig. 2- ET sum from January to December in Rabindra Sarobar

iii) The mean ET of each month of 2024 is shown in the fig. 3.

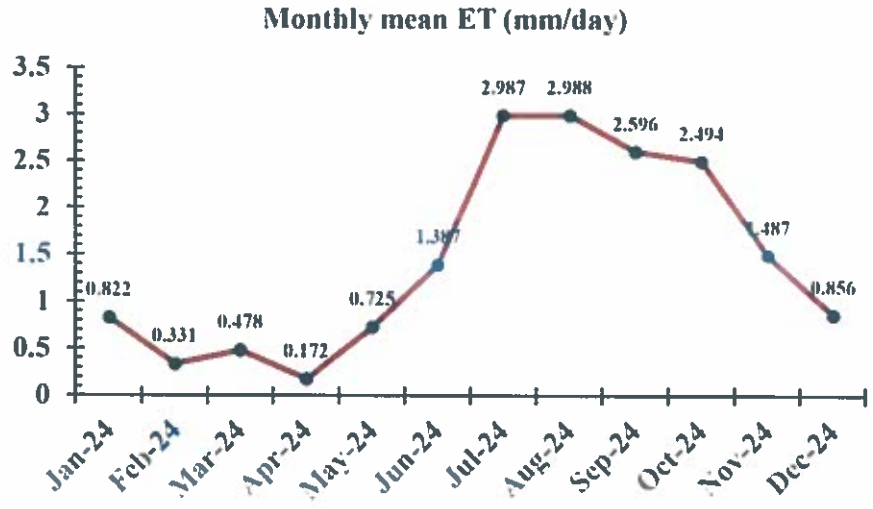

Fig. 3- Monthly mean ET of Rabindra Sarobar (for 2024)

ECOLOGICAL IMPACT: FISH HABITAT AND BATHYMETRIC CHANGE

Despite cumulative sedimentation between 2005 and 2025, the essential bathymetric features that support fish habitats in Rabindra Sarobar have remained functionally intact. The 20-year assessment indicates that while shallow zones (<2 m) have expanded considerably—particularly in the northern embayment and inlet regions—the deeper pockets of the lake, especially in the southern and western sectors, continue to maintain depths exceeding 4 meters across more than 55–60% of the total lake area. These deeper zones provide critical thermal refuge, stable oxygen conditions, and suitable spawning environments for fish populations. Importantly, no evidence of widespread anoxic or hypoxic conditions was observed in recent field monitoring, indicating that the bathymetric degradation has not yet crossed a critical ecological threshold. Therefore, observed fish mortality events are more plausibly linked to episodic eutrophication, organic loading, or seasonal thermal stress rather than directly to changes in lake depth. The findings underscore the need to maintain depth diversity while monitoring nutrient inflow and biological responses under ongoing sedimentation pressure.

To support the interpretation of results and provide transparency in data acquisition, the following documents related to the **2025 survey** have been appended in the annexure:

- **Detailed Bathymetric Contour Map (2025):** This high-resolution GIS-based map displays the spatial distribution of lake depths and clearly identifies zones of sediment accumulation, shallow margins, and ecological depressions.
- **Topographical Map and Feature Layout:** The map illustrates the lake's perimeter, central island, boating zones, inlet points, and surrounding catchment features relevant to hydrological analysis.
- **Hydrographic Survey Report (May 2025):** This report includes survey methodology, grid alignment strategy (25 m × 25 m), instrument specifications, calibration records, and raw depth/velocity profiles collected during the field campaign.

These annexures provide detailed technical substantiation of the analysis and are intended to facilitate deeper understanding for planners, ecologists, and waterbody managers involved in the long-term conservation of Rabindra Sarobar.

SUSTAINABLE DREDGING STRATEGY

Sediment dredging is often considered a corrective measure to restore hydraulic and ecological balance in urban lakes affected by progressive siltation and eutrophication. However, evidence from long-term studies (e.g., Li et al., 2020) indicates that dredging alone yields only short-term ecological benefits unless paired with broader, ecosystem-based interventions. The 20-year bathymetric comparison of Rabindra Sarobar (2005–2025) reveals a gradual but spatially uneven sedimentation pattern—most prominent in the northern embayment, inlet areas, and central basin margins. Although the lake's mean depth has declined and shallow zones have expanded, deep and stable regions (>4.0 m) continue to support key ecological functions, reducing the immediacy of dredging interventions. Nevertheless, to enhance long-term sustainability, a carefully designed and ecologically sensitive sediment management framework is proposed.

Selective Dredging Methodology (If considered necessary)

- **Approach:**
  Focused dredging may be undertaken only in shallow areas (<2.0 m) with high siltation rates (>60–80 cm accumulation over 20 years), prioritizing the northern and central sectors where ecological degradation is more likely.
- **Technique:**
  Employ Cutter Suction Dredger (CSD) equipped with geotextile dewatering bags to minimize sediment resuspension and water quality impacts. Where appropriate, utilize water injection dredging and predefined route planning to further reduce disturbance to benthic habitats and aquatic life. Sensitive deep-water regions must be strictly avoided.

- **Sediment Handling:**
  Extracted material should be transported to geofabric-lined drying beds for volume reduction, with provisions for reuse in landscaping or non-sensitive fill applications.

- **Monitoring:**
  Implement real-time turbidity monitoring using sensors and Acoustic Doppler Velocimeters (ADV), supported by monthly water quality sampling and benthic biodiversity surveys during and after operations.

Integrated Ecological Restoration Measures

- Deploy **floating wetlands** or **bio-islands** post-dredging to enhance nutrient uptake and habitat diversity.
- Strengthen **pollution interception infrastructure**, including trash barriers and stormwater filters, at key inflow points.
- Foster **community stewardship programs** to build awareness and ensure local involvement in long-term lake care

This integrated approach ensures that if dredging is undertaken, it is done not as an isolated intervention but as part of a broader, adaptive lake management framework. The long-term assessment affirms that while immediate large-scale dredging may not be essential; **targeted, eco-sensitive sediment management**—executed with scientific oversight and community participation—can contribute meaningfully to the sustained ecological resilience of Rabindra Sarobar.

CONCLUSION

The comprehensive bathymetric assessment of Rabindra Sarobar, conducted using advanced DGPS, Echo Sounder, and ADCP-integrated techniques, documents a clear trajectory of morphological evolution from 2005 to 2025. Over this period, the lake's mean depth has reduced from approximately 3.60 m to 3.00 m, while shallow zones (<2.0 m) have expanded from about 18% to over 28% of the total lake area. These changes, most notable in the northern part, inlet zones, and central margins, reflect cumulative sedimentation influenced by catchment inflows, internal resuspension, and recreational activity. Despite this, the persistence of deep zones exceeding 4.0 m, particularly in the southern and western basins, continues to provide vital ecological functions, including thermal refuge and stable fish habitat, thereby indicating that the lake retains significant hydrological and ecological integrity in these zones.

While immediate large-scale dredging may not be critically required, the findings suggest that maintaining long-term sustainability will benefit from targeted sediment management interventions. In this regard, the selective deployment of Cutter Suction Dredger (CSD) technology is proposed for silt-laden, non-sensitive shallow areas.

Such an approach, if executed, with real-time turbidity monitoring and under the indicative guidelines for restoration of water bodies by CPCB in compliance to Hon'ble National Green

Tribunal (NGT) order dated 10.05.2019 M.A.No. 26/2019 in OA No.325 of 2015, could help to restore the water depth heterogeneity without disturbing the lake's ecological balance.

Importantly, the study highlights that dredging alone cannot serve as a standalone solution. Lasting restoration must be complemented by upstream pollution control, sediment load interception, ecological buffers such as floating wetlands, and active community stewardship.

This state-of-the-art assessment, executed by the School of Water Resources Engineering, Jadavpur University, under the guidance of Prof. Asis Mazumdar and supported by KMDA, offers not only a detailed scientific evaluation of bathymetric change but also a forward-looking management framework. It reinforces the need for holistic, ecologically informed lake governance to ensure Rabindra Sarobar remains a resilient and multifunctional urban ecosystem.

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