BEFORE THE NATIONAL GREEN TRIBUNAL

EASTERN BENCH, AT KOLKATA

Original Application No. 16/2025/EZ

BETWEEN:

Sumita Banerjee & Ors.

...Applicant(s)

-VERSUS-

State of West Bengal & Ors.

...Respondent(s)

INDEX

Sl. No.	**Particulars**	**Page Nos.**
1	Affidavit	1 – 10
2	Annexure A/9 – NPCA Guideline	11 – 113
3	Annexure A/10 – EIA Study Report	114 – 255
4	Annexure A/11 – Photography and Map	256 - 258

Kolkata

Abhishek Sikdar

Advocate

MD. TAZAMMUL HUSSAIN NOTARY Regd. No.-22/96 KOLKATA Govt. of West Bengal

SL NO.....

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COMPOSITE REJOINDER TO THE AFFIDAVITS OF RESPONDENT NO. 2, 6 AND 8 DATED 12TH FEBRUARY, 2025, 13th FEBRUARY, 2025 AND 13TH FEBRUARY, 2025 RESPECTIVELY

I, Sumita Banerjee, D/o Gobinda Gopal Banerjee, aged 69 years, R/o 125, Rashbehari Avenue, Sarat Bose Road, Circus Avenue, Kolkata, West Bengal 700029, am the Applicant No. 1, in the above-mentioned Original Application and I am authorised by the other applicants to affirm this affidavit which is an affidavit in response to the affidavits submitted by Respondent Nos. 2, 6 and 8 in the instant Original Application. I do hereby solemnly state as follows:

1. That the original application was filed for seeking protection of the Rabindra Sarobar Lake, spread over 30 hectares, which was conferred with the status of lake of national importance by the Respondent no. 7 in 2002 and is the second largest water body in Kolkata and situated in the southern part of the city (22°30'.30" -22°30'.42" N, 88°21'-88°22' E). Around 38% of the total area (73 acres) constitutes the water body while the residual area comprises of varieties of plant/tree species some of which are century old. It is surrounded by Southern Avenue to the north, Russa

Road to the west, Dhakuria to the east, and the Kolkata Suburban Railway track to the south.

2. The applicants have previously approached this Hon'ble Tribunal alleging several violations that were making the Rabindra Sarobar Lake vulnerable and was appreciated by this Hon'ble Tribunal and a detailed order was passed on 15th November, 2017 with several specific directions upon the State Respondent for dealing with specific problems and for overall conservation and protection of the Rabindra Sarobar Lake and its surrounding land.

3. However, the applicants are once against forced to approach this Hon'ble Tribunal alleging blatant violations of the very same directions by this Hon'ble Tribunal passed in Original Application No. 136/2016 and 40(THC)/2017 vide order dated 15th November, 2017, by the State Respondents. That despite specific directions being passed regarding no new construction or extension of existing construction in the Rabindra Sarobar Lake without the leave of this Hon'ble Tribunal, Respondent No. 2 had undertaken construction activities to extend an existing Gallery building and built-up area known as 'Maa Phire Elo' gallery. The Original Application also highlights and prays for creation of a management plan for the Rabindra Sarobar as per law, which is also in accordance with the previous directions of the Hon'ble Tribunal vide order dated 15th November, 2017. A copy of the said order has already been placed as Annexure A/1 in the original application.

4. At the outset I deny and dispute all allegations and submissions made in the affidavits affirmed by Respondent nos. 2, 6 and 8 except the ones which are specifically admitted herein. I shall first address the averments contained in the affidavit affirmed by Respondent no. 2 and subsequently Respondent nos. 6 and 8.

AGAINST AFFIDAVIT OF RESPONDENT NO. 2 AFFIRMED ON 12TH FEBRUARY, 2025

5. It is submitted at the outset that the Respondent no. 2 had failed to produce any document in support of their contention, no work order or proposed plan has been produced. That Respondent no. 2 has admitted to carrying out the said construction activity and has not been able to show that any prior leave was taken from the Hon'ble Tribunal before commencing with the said construction activity as per the order dated 15th November, 2017. Furthermore, the answering Respondent has failed to produce any document in support to show how they have complied with the previous directions of the Hon'ble Tribunal contained in order dated 15th November, 2017 or with the National Plan for Conservation of Aquatic Ecosystems' (NPCA), wherein specific provisions have been made for an Integrated Management Plan and Framework Management Plan for protecting wetlands and Lakes.

   The applicants had sought leave to refer to the said NPCA guidelines at paragraph 12 of the Original Application and the same is annexed herewith and marked as "ANNEXURE – A/9".

6. The averments made in paragraph 1 of the impugned affidavit are matters of record and as such are not required to be dealt with by the applicants herein.

7. The averments made in paragraph 2 of the impugned affidavit is denied and disputed as the answering Respondent has failed to take any leave prior to commencing of the said construction and has not taken any steps to prepare DPR for implementations of the recommendations under "Flora and Fauna, water quality of the

MD. TAZAMMUL HUSSAIN NOTARY Regd. No.-22/96 KOLKATA Govt. of West Bengal

Sarobar (Lake) and Lake sediments & sub surface soil" contained in the EIA study report on Rabindra Sarobar Lake Premises by the Respondent no. 4. The answering Respondent has further failed to prepare the detailed phase wise Action Plan with timeline as directed by this Hon'ble Tribunal vide order dated 15th November, 2017.

The applicants had sought leave to refer to the said EIA study at paragraph 1 of the Original Application and the same is annexed herewith and marked as "ANNEXURE – A/10".

8. The averments made in paragraph 3 of the impugned affidavit are matters of record and as such are not required to be dealt with by the applicants herein. However, it is highlighted that the Hon'ble Tribunal passed a series of directions along with the direction not to undertake any new construction or extension of building without the leave of the Tribunal.

The said order of the Tribunal has already been annexed as Annexure A/1 to the original application.

9. The averments made in paragraph 4 of the impugned affidavit is denied and disputed as the answering Respondent has failed to annex any documents or record in support of the contention. Furthermore, the contention raised by the answering respondent that only strengthening of the foundation was carried out and steel beams of temporary nature has been placed are denied as false and misleading.

It is submitted that the answering respondent has carried out extensive digging and cutting of trees to prepare the foundation and have poured concrete foundation beams and the structure being raised are not temporary but permanent in nature. That the applicants had annexed several photographs in support of their contention as Annexure A/3 in the original Application. A seirs of

photographs showing the foundation as it is today along with a Google Map showing the position of the said construction site is being annexed hereto and collectively marked as "ANNEXURE – A/11".

10. The averments made in paragraph 5 of the impugned affidavit are bare denial of the contention of the applicants without any substantiation and as such are denied and disputed.

11. The averments made in paragraph 6 of the impugned affidavit are denied and disputed as photographs annexed as Annexure A/3 shows heaps of earth has been dug out to pour concrete and prepare the foundation and that several greenery in the area has been destroyed. Furthermore, the answering Respondent has not undertaken any prior assessment of the impact of such construction nor provided any plan or map of the area in support of their contention. That mere statement that greenery has not been affected cannot replace meticulous study by expert. In the EIA study annexed as Annexure A/10 to this affidavit, the experts have inter alia recommended:

"The land and water bodies forming open space of Rabindra Sarovar play a very important role in the metropolitan city of Kolkata. The environmental imbalance that has occurred in the Rabindra Sarobar deserves special consideration and steps have to be taken by the Rabindra Sarobar authority to control the situation and to restore the original ambience as well as aquatic and terrestrial biodiversity of the Sarovar area.

Xxx

By conserving plant diversity around Rabindra Sarovar, the variety of insect life will also be conserved...

Xxx

To maintain the pristine quality of the lake water and for the long term sustainability of the lake, anthropogenic activities have to be controlled to a large extent and retrieval strategies to remove immersed idols need to be undertaken to prevent the loading of toxic metal ions into the lake water."

It is submitted that by the act and actions of the answering Respondent both the water bodies and land surrounding the water bodies have been threatened and although without an assessment of the said damage, it would be difficult to quantify the damage, it is submitted that on the grounds of precautionary principle the construction work must not be allowed any further and prayers for restoration of the said area may be considered by the Hon'ble Tribunal.

12. The averments made in paragraph 7 of the impugned affidavit to the extent of stating that construction materials are temporary in nature are repeatations of the contention taken by the answering respondent in paragraph 4 and as such same has been dealt with by the applicants in the preceding paragraph 7 of this instant affidavit.

The averments to the extent that respondent no. 3 has not started an enquiry as alleged by the applicants vide a letter dated 08/01/2025 placed as Annexure A/7 is denied and disputed and the answering respondents are put to the strictest proof of the same. The said letter categorically sought for a report to be submitted by the answering respondent based on the demand of justice letter issued by the counsel of the applicant, placed as Annexure A/6 in the Original Application.

13. The averments made in paragraph 8 of the impugned affidavit are denied and disputed as misleading and an attempt to dodge questions regarding the act and actions undertaken by the answering respondent as required for protection of Rabindra

Sarobar as a National Lake. Furthermore, the answering respondent has failed to answer whether they have taken any action as per the guidelines of the National Plan for Conservation of Aquatic Ecosystems (NPCA). Furthermore, the answering respondent has failed to provide any supporting document for the contention that work was being done in 20% of the area. That no project plan, maps, prior sanction, reports, etc. have been placed on record by the answering respondent in support of the said contention.

14. The averments made in paragraph 9 of the impugned affidavit are denied and disputed as misleading as the annexure A/8, being the National Wetland Inventory clearly includes Rabindra Sarobar in serial number 211158 and 211159 at page 90 of the Compilation II in the original application.

It is submitted that the answering Respondents have failed to appreciate and understand that the National Wetland Inventory included and protects water bodies of all nature and type including Lakes. That the purport of the protection regime through NPCA has been extended to include both Lakes and Wetland areas, as well as their catchment area, flood plain, etc. This further underscores the submission of the Applicants that despite being the custodian of the National Lake, the answering Respondent has failed to carry out its duties as required by law.

15. The averments made in paragraphs 10 and 11 of the impugned affidavit are bare denial without any substantiation and as such are denied and disputed and the contentions have been dealt with extensively in the preceding paragraphs of this affidavit.

AGAINST AFFIDAVIT OF RESPONDENT NO. 6 AFFIRMED ON 13TH FEBRUARY, 2025

16. It is submitted at the outset that Respondent no. 6 has filed their compliance report and as such has made no contention against the submission of the Applicants.

17. It is however submitted that the answering respondent was made a party to a Monitoring Committee tasked with overseeing the implementation of the directions contained in the order passed by this Hon'ble Tribunal on 15th November, 2017 vide order 21/10/2019 in Miscellaneous Application No. 09/2019(EZ). That the said order dated 21/10/2019 has already been placed as Annexure A/2 in the Original Application.

18. It is submitted that though the Applicants contended that the said Monitoring Committee failed to carry out the directions contained in the order dated 15th November, 2017, no reply or comment has been made regarding the said contention by the answering Respondent herein.

MD. TAZAMMUL HUSSAIN NOTARY Regd. No.-22/96 KOLKATA Govt. of West Bengal

19. It is submitted that the submission of the answering Respondent further supports and underscores the submission of the Applicants that the Monitoring Committee and its members including the answering respondents have failed to carry out their function and have failed to follow the directions of this Hon'ble Tribunal vide order dated 15th November, ,2017.

AGAINST AFFIDAVIT OF RESPONDENT NO. 8 AFFIRMED ON 13TH FEBRUARY, 2025

20. It is submitted at the outset that Respondent no. 8 has not made any comments against the contentions of the Applicants in the entire affidavit. Furthermore, they have merely annexed the Guidelines of the Environment Management of Construction and Demolition Wastes, but

have failed to show any steps taken by them to visit or enquire regarding the alleged violations and pollution caused.

21. It is submitted that the Respondent no. 8 being the nodal department to deal with pollution of water bodies has failed to take any action, even after receiving reports of violations and construction in the fragile ecosystem of Rabindra Sarobar, which is a National Lake.

22. That the inaction on the part of the answering Respondent no. 8 is surprising in view of the fact that the EIA study on the said Rabindra Sarobar Lake premises was conducted by the expert committee constituted by them and findings and recommendations were published by them. That in cases of alleged pollution of water bodies, the Respondent no. 8 is the statutory authority and they ought to have conducted their own independent enquiry into the alleged violations. However, it is evident that the answering Respondent has failed to carry out its statutory duties.

MD. TAZAMMUL HUSSAIN NOTARY Regd. No.-22/96 KOLKATA Govt. of West Bengal

That in light of the averments made above, I humbly request the Hon'ble Tribunal to reject the contentions and answers made in the affidavits of respondent no. 2, 6 and 8 an as untenable and baseless both in law and fact. For this act of kindness, the Applicant as is duty bound, shall ever pray.

Abhisheksikdar — Prepared

Sumita Banerjee — Deponent

And Identified by me

Solemnly affirmed and declared before me on Identification

MD. T. HUSSAIN Notary
City Civil Court
Kolkata
Regd. No. 22/96, Govt. of W.B.

02 MAY 2025

VERIFICATION

I, Sumita Banerjee, D/o Gobinda Gopal Banerjee, aged 69 years, R/o 125, Rashbehari Avenue, Sarat Bose Road, Circus Avenue, Kolkata, West Bengal 700029, do hereby verify that the contents of the Paras 1 to 22, and the Annexures A/9, A/10 and A/11 and the sub-paragraphs thereof, are true to the best of my personal knowledge and belief and that I have not suppressed any material fact to the best of my personal knowledge and belief.

KOLKATA

DATE: 01.05.2025

Sumita Banerjee

DEPONENT

Identified by me

Abhishek Sikdar

Advocate

Email- advaarattikapaul@gmail.com

Ph- 9831865139 / 7003400084

MD. TAZAMMUL HUSSAIN
NOTARY
Regd. No.-22196
KOLKATA
Govt. of West Bengal

National Plan for Conservation of Aquatic Ecosystems (NPCA)

Guidelines




सहभागिता से समृद्धि




Wetlands Division
Ministry of Environment, Forest and Climate Change
Government of India

February 2024

Front cover paintings by:

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7. Mohd Salman
8. Priyanka Rautray
9. Noela Joann N
10. Subhadip Garai

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सत्यमेव जयते

Guidelines
for
National Plan for Conservation of Aquatic Ecosystems (NPCA)

February 2024

Wetlands Division
Ministry of Environment, Forest and Climate Change
Government of India

मंत्री
पर्यावरण, वन एवं जलवायु परिवर्तन
और
श्रम एवं रोजगार
भारत सरकार

सत्यमेव जयते

MINISTER
ENVIRONMENT, FOREST AND CLIMATE CHANGE
AND
LABOUR & EMPLOYMENT
GOVERNMENT OF INDIA

एक कदम स्वच्छता की ओर

आज़ादी का अमृत महोत्सव

भूपेन्द्र यादव
BHUPENDER YADAV
MESSAGE

Wetlands are one of the most productive ecosystems representing prominent features of landscapes that fulfil crucial functions. Wetlands possess unique attributes as part of humanity's cultural heritage and stand as important elements of our natural wealth, serving as valuable "liquid assets" for development. This emphasizes the significance of preserving and utilizing wetlands for sustainable growth and prosperity.

India has demonstrated commendable leadership by significantly enhancing the network of Ramsar Sites, designating 80 wetlands, with an impressive addition of 54 sites in the past 10 years. These sites play a crucial role in conserving global biological diversity and providing essential habitats for migratory species along the Central Asian Flyway. This underscores India's commitment to environmental preservation and underscores the nation's contribution to global conservation efforts.

Deeply rooted in India's conservation ethos and cultural heritage, wetland conservation holds significant importance. Recognizing the value of preserving Ramsar Sites and promoting their unique conservation attributes, the Government of India has introduced the 'Amrit Dharohar' initiative in 2023.

The implementation of Amrit Dharohar signifies a shift in the conservation focus of Ramsar Sites, moving beyond biodiversity-driven agendas to integration with sectoral development initiatives. This approach allows the seamless incorporation of conservation and management of Ramsar Sites into development plans, programs, and investments related to tourism, fisheries, disaster management, water resources, and more.

I am delighted to introduce the revised "Guidelines for the National Plan for Conservation of Aquatic Ecosystems." These guidelines reflect the knowledge and experience gained since the last set of guidelines released in 2019.

The revised guidelines mandate several preparatory stages before implementing a plan for wetland conservation and represent a significant advancement, urging a more pragmatic strategy in formulating conservation plans. These guidelines emphasize the importance of state governments taking ownership and stewardship for wetland management, while the Central Government assumes a facilitating role. The guidelines also delineate the specific procedures to be followed in preparing and submitting proposals and underscore the utilization of diverse schemes from both the Central and State Governments to bolster the execution of wetland projects.

These revised guidelines are designed to evolve dynamically, aligning with the insights and experiences to be gained in the future. This marks a promising commencement of a new era in wetland and aquatic ecosystem conservation.

I congratulate the team that has put together these guidelines and look forward to the implementation of these guidelines.

Date: 31 **.01.2024**

(Bhupender Yadav)

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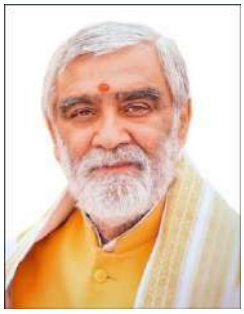
आज़ादी का अमृत महोत्सव

अश्विनी कुमार चौबे
Ashwini Kumar Choubey

राज्य मंत्री
पर्यावरण, वन एवं जलवायु परिवर्तन
उपभोक्ता मामले, खाद्य और सार्वजनिक वितरण
भारत सरकार
MINISTER OF STATE
ENVIRONMENT, FOREST AND CLIMATE CHANGE
CONSUMER AFFAIRS, FOOD & PUBLIC DISTRIBUTION
GOVERNMENT OF INDIA



संदेश

आर्द्रभूमि दुनिया की सबसे अधिक जैव विविधतापूर्ण और पारिस्थितिक रूप से संवेदनशील पारिस्थितिक तंत्रों में से एक है। वे पौधों और जानवरों की प्रजातियों की एक विस्तृत श्रृंखला के लिए महत्वपूर्ण आवास प्रदान करते हैं, प्रवासी पक्षियों, मछली नर्सरी, बाढ़ और अन्य प्राकृतिक आपदाओं के खिलाफ, प्राकृतिक बफर के रूप में कार्य करते हैं। वे पानी की गुणवत्ता बनाए रखने और हमारी जलवायु को विनियमित करने में भी महत्वपूर्ण भूमिका निभाते हैं। इस प्रकार, आर्द्रभूमियाँ अनिवार्य रूप से 'धरा के किडनियों' के रूप में कार्य करती हैं।

भारत के पास एशिया के सबसे अधिक 80 रामसर स्थल है। जब आर्द्रभूमियों को रामसर स्थलों के रूप में नामित किया जाता है, तो इसमें उनका 'विवेकपूर्ण उपयोग' के प्रति समर्पण शामिल होता है। इसे संधारणीय विकास के ढांचे के भीतर पारिस्थितिकी तंत्र दृष्टिकोण के अनुप्रयोग के माध्यम से पूरा किया जाता है। माननीय प्रधानमंत्री जी के कुशल नेतृत्व में रामसर स्थलों के अद्वितीय संरक्षण मूल्यों को बढ़ावा देने के लक्ष्य के साथ 'अमृत धरोहर' पहल की शुरुआत की गयी। इनके सरंक्षण और प्रबंधन में आमजनों और हितधारकों की भागीदारी सुनिश्चित करने के लिए 'सहभागिता मिशन' एवं व्यापक जागरुकता फैलाने के प्रयोजन से 'वेटलैंड बचाओं अभियान' शुरु किया गया।

विभिन्न स्तरों पर संरक्षण कार्यनीतियों को और सुगम बनाने हेतु, राष्ट्रीय जलीय पारिस्थितिकी संरंक्षण योजना के मौजूदा दिशानिर्देशों को संशोधित किया गया है, जिसमें एक व्यापक प्रबंधन योजना भी शामिल है।

मैं, इन संशोधित दिशानिर्देशों के लिए मंत्रालय के आर्द्रभूमि प्रभाग और सभी संबंधित भागीदारों को बधाई देता हूं। मुझे उम्मीद है कि ये संशोधित दिशानिर्देश देश भर में आर्द्रभूमियों के और अधिक प्रभावी संरक्षण एवं विवेकपूर्ण उपयोग के मार्ग को प्रशस्त करेंगे।

(**अश्विनी कुमार चौबे**)

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LEENA NANDAN

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SECRETARY
GOVERNMENT OF INDIA
MINISTRY OF ENVIRONMENT, FOREST
& CLIMATE CHANGE

Foreword

The preservation and sustainable management of wetlands in the country has been accorded utmost priority by the Ministry of Environment, Forest and Climate Change. The National Wetlands Programme, currently known as the National Plan for Conservation of Aquatic Ecosystems, provides a comprehensive range of activities in this regard.

India has shown exemplary leadership by expanding its network of Ramsar Sites to 80 and committing to the goal of wise use of these sites, as also of other wetlands. To promote the unique conservation values of Ramsar Sites, the Amrit Dharohar initiative has been launched. It comprises four key areas namely Species and Habitat Conservation, Wetlands Livelihoods, Nature Tourism and Wetland Carbon assessments, the objective being creation of demonstrable models of sustainable wetlands management.

The NPCA guidelines released in 2019 aim to provide an integrated and scientific framework for wetlands. The guidelines have since been revised and include a graded two-stage approach for Integrated Management Plan preparation.

I congratulate the wetlands division of MoEFCC and its knowledge partners for preparing these revised guidelines and finalising them after incorporating the suggestions from stakeholders as also inputs based on practical experience. I am confident these guidelines will simplify the management planning process and empower as well as support State Governments in enhancing the effective management of their respective wetlands.

(Leena Nandan)

Place: New Delhi
Date: 30.01.2024

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डॉ. सुजीत कुमार बाजपेयी
संयुक्त सचिव
DR. SUJIT KUMAR BAJPAYEE
JOINT SECRETARY

सत्यमेव जयते

भारत सरकार
पर्यावरण, वन और जलवायु परिवर्तन
GOVERNMENT OF INDIA
MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

Preface

India's approach to wetlands conservation centres around rapidly expanding conservation efforts, engaging stakeholders through Mission Sahbhagita, and integrating wetlands into development planning. These initiatives align with the 'whole-of-society' and 'whole-of-government' approach for wetlands conservation.

The Government of India's Amrit Dharohar initiative is a significant stride towards maintaining a robust network of Ramsar Sites. The implementation strategy of Amrit Dharohar, centered on the principle of conservation through community participation and the promotion of prosperity via conservation, marks a significant departure from the traditional approach that primarily focuses on biodiversity conservation. Instead, it emphasizes integration into sectoral development agendas.

Through the various regional consultations held under the Mission Sahbhagita, the challenges faced by the State/UT Wetland Authorities in the formulation of the Integrated Management Plans were discussed. Majority of the sites including those designated as Wetlands of International Importance under the Ramsar Convention, do not have Integrated Management Plan in place given the extensive data requirement and need for specific skills and capacities. The lack of an Integrated Management Plan leads to inefficient and inadequate addressal of the adverse drivers of wetland degradation. The site management, thus, is insufficient to secure the full range of wetland ecosystem services and biodiversity values. A need to revise the existing NPCA guidelines was strongly felt.

In the revised guidelines, a graded two-stage approach for Integrated Management Plan preparation has been adopted with the introduction of Framework Management Plan. This enables acting on the available information and, at the same time, builds an evidence base through assessments and stakeholder consultations for developing a comprehensive Integrated Management Plan for the site.

These revised NPCA guidelines aim at strengthening the specific guidance to the State/UT Wetland Authorities, Ramsar Site managers and knowledge partners on Framework Management Plan structure and steps to be followed for its preparation.

I present to you the revised NPCA guidelines that have been prepared in consultation with the experts and knowledge partners. I hope the guidelines will ensure achieving the objectives of the Amrit Dharohar initiative and contribute towards a holistic and participatory conservation of wetlands for wise use.

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Contents

Abbreviations

a.m.s.l.	above mean sea level
BSI	Botanical Survey of India
CEPA	Communication, Education, Participation and Public Awareness
CO2	Carbon Dioxide
CPCB	Central Pollution Control Board
CSR	Corporate Social Responsibility
CWC	Central Water Commission
DC/ DM	District Collector/ District Magistrate
DPR	Detailed Project Report
DRDA	District Rural Development Agency
EAICP	Environmental Information, Awareness, Capacity Building and Livelihood Programme
EIA	Environment Impact Assessment
FMP	Framework Management Plan
GHGs	Greenhouse Gas
GoI	Government of India
ha	Hectare
IMP	Integrated Management Plan
LiFE	Lifestyle for Environment
MAP	Management Action Plan
MLA	Member of Legislative Assembly
MoEF&CC	Ministry of Environment, Forest and Climate Change
MP	Member of Parliament
NLCP	National Lake Conservation Plan
NPCA	National Plan for Conservation of Aquatic Ecosystems
NRCD	National River Conservation Directorate
NWCP	National Wetlands Conservation Programme
SWA	State Wetlands Authority (State Nodal Agency)
UT	Union Territory

Photo credits: Wetlands International South Asia

1. Background

India, owing to wide variations in rainfall, hydrology, physiography, geomorphology and climate, is bestowed with a rich diversity of wetlands, which play a significant role in providing ecological and economic security through their wide-ranging ecosystem services and biodiversity values. In these Guidelines Aquatic Ecosystems refer to wetlands including lakes.

Notwithstanding the high level of dependence, wetlands have been stressed by a range of anthropogenic and non-anthropogenic pressures, such as conversion for alternate usages, land use change, fragmentation of natural water regimes, pollution, siltation, species invasion, over harvesting of natural resources, unsustainable tourism and climate change.

India is committed to conservation of wetlands. The Indian Constitution, in its Article 51-A(g) stipulates that "it shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures". The MoEFCC, at its inception in 1985, identified wetland conservation and sustainable management as one of its important programming themes. India's assent to the Ramsar Convention in September 1982 provided an important backdrop to this decision. The Ministry established the National Wetlands Conservation Programme (NWCP) in 1986 to provide the overarching policy framework and financial assistance to the State Governments for implementation of site management plans. In 2001, the National Lake Conservation Plan (NLCP) was introduced to address pollution issues in urban and semi-urban environments through interception, diversion and treatment of pollution load entering lakes. Priority sites under the two schemes were identified based on specific criteria laid under the two schemes.

In February 2013, considering the need for a common approach to the conservation and management of wetlands and urban and peri-urban lakes, the Union Cabinet decided to merge

Healthy catchment is essential for sustaining wetland ecosystem health

1

Photo credits: Harsh Ganapathi

the two schemes into a unified scheme entitled 'National Plan for Conservation of Aquatic Ecosystems' (NPCA) to enable the application of uniform policy and guidelines and promote an integrated and multi-disciplinary approach with a common regulatory framework.

The conservation and *wise use* of wetlands figure significantly in various policy commitments. The National Environment Policy of 2006 identifies wetlands as components of 'freshwater resources' and recommends integration in developmental planning, management based on prudent use strategies, promotion of ecotourism and implementation of a regulatory framework. Wetlands also figure significantly in 3 of the 12 National Biodiversity Targets, framed by the MoEFCC in line with the Convention on Biological Diversity's Strategic Plan 2011-2020. Wetlands have direct reference in Target 3 (*Strategies for reducing rate of degradation, fragmentation and loss of natural habitats are finalized and actions put in place by 2020*), Target 6 (*ecologically representative areas on land and in inland waters, as well as coastal and marine zones, especially those of particular importance for species, biodiversity and ecosystem services, are conserved effectively and equitably*), and Target 8 (*by 2020, ecosystem services, especially those related to water, human health and livelihoods and well-being are enumerated and measures to safeguard them are identified*). These targets will guide investment and resource allocation for biodiversity conservation at the national level, and therefore bear high significance for wetlands.

The National Water Policy (2012) recommends adoption of a basin approach for water resources management, and identifies conservation of river corridors, water bodies and associated ecosystems as an important action area.

Wetlands are also essential for human well-being, economic security and climate change mitigation and adaptation. The multiple benefits provided by wetlands are essential in achieving Sustainable Development Goals (Figure 1).

Ministry of Environment, Forest and Climate Change (MoEFCC), the nodal ministry of the Government of India for matters related to wetlands, has been supporting State/UT Governments for conservation and integrated management of wetlands through various schemes and initiatives. The National Plan for Conservation of Aquatic Ecosystems (NPCA), in implementation since 2013, is the Ministry's flagship scheme for wetlands and has an aim of '*mainstreaming the full range of wetland ecosystem services and biodiversity values in development plans and programmes at all levels*'.

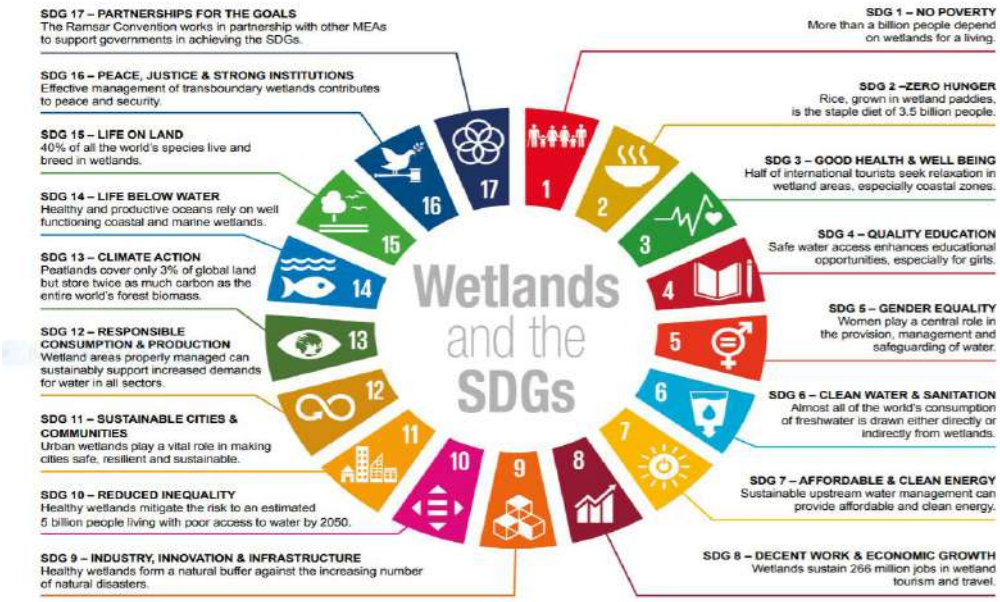

Figure 1: Wetlands and Sustainable Development Goals

Financial support to the State / UT Governments for implementing an Integrated Management Plan (IMP) is provided under NPCA. Since 2020, funding under the scheme has been exclusively on the basis of IMP, as against the previous practice of considering the Annual Plan of Operations (APO). This is to ensure that the implementation of IMP is linked with a comprehensive and long-term plan and vision.

The NPCA recommends that the management of wetlands is guided by an Integrated Management Plan. An IMP reflects a common understanding between various stakeholders on the management purpose, significant threats and constraints limiting conservation and *wise use*, opportunities and specific actions for addressing these threats, and mainstreaming wetlands within the wider developmental planning.

The integrated management plan is formulated to serve the following purposes:

- Identify the objectives of wetland management
- Identify the factors that affect or may affect the wetland
- Resolve conflicts between various stakeholders having an interest in the wetland
- Define monitoring requirements and research needs
- Help obtain financial resources for managing the wetland
- Enable communication between different wetland managers, organisations and stakeholders
- Ensure compliance with extant laws and regulation
- Demonstrate that management is effective and efficient

In May 2022, the Ministry launched *Mission Sahbhagita* as a whole of society approach for wetland conservation and management. As a part of the consultation for the Mission, four regional workshops were held in Srinagar, Goa, Kochi, and Imphal, wherein the IMP preparation process and key challenges were discussed. The State/UT Wetland Authorities identified lack of capacities, trained professionals, and the limited availability of data and finances are key barriers for IMP preparation. The Ministry also organised a virtual consultation on June 23, 2023, to reflect on the challenges and successful approaches for management plan preparation. At the concluding workshop held in Bhopal in July 2023, the representatives of state governments and knowledge partners deliberated on a graded two-stage approach for management plan preparation. A Framework Management Plan (FMP) was proposed wherein the existing knowledge and capacities are not sufficient to support the preparation of an IMP.

The Ramsar Convention is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and *wise use* of wetlands and their resources. India ratified the Convention in 1982. As a fulfilment of her commitments to the Convention and as a significant milestone on her 75th year of independence by declaring 75 wetlands to the list of Wetlands of International Importance of the Ramsar Convention, also known as the Ramsar List. The network of Indian Ramsar Sites is increasing and currently covers an area of approx. 1.33 million ha, the second largest in Asia.

Acknowledging the importance of conservation of Ramsar Sites, Government of India introduced '*Amrit Dharohar'* in budget of FY 2023-24, to promote conservation values of Ramsar Sites. *Amrit Dharohar* is to be "implemented over the next three years to encourage optimal use of wetlands, and enhance bio-diversity, carbon stock, eco-tourism opportunities and income generation for local communities."

The Government of India launched the *Amrit Dharohar* implementation strategy on June 5, 2023, with the goal of promoting the unique conservation values of Ramsar Sites. *Amrit Dharohar* operates within the broader framework of NPCA and is structured around the four components: a) Species and habitat conservation, b) Nature tourism, c) Wetland livelihoods, and d)

Wetland carbon. The implementation approach for *Amrit Dharohar* is depicted in Figure 2.

This NPCA guidelines aims at strengthening the specific guidance to the State/UT Wetland Authorities, Ramsar Site managers and knowledge partners on FMP structure and steps to be followed for its preparation. The modifications are based on the outcome of multiple consultative meetings held with the stakeholders.

The NPCA envisages halting and reversing the continued degradation and loss of wetlands in the country and ensuring their conservation and integrated management by promoting a cross sectoral planning and decision making. The programme mandates a shift from the sectoral approaches adopted till date for management of these ecosystems, and instead focuses on mainstreaming their full range of biodiversity and ecosystem services into development programmes being pursued at national and state / UT levels.

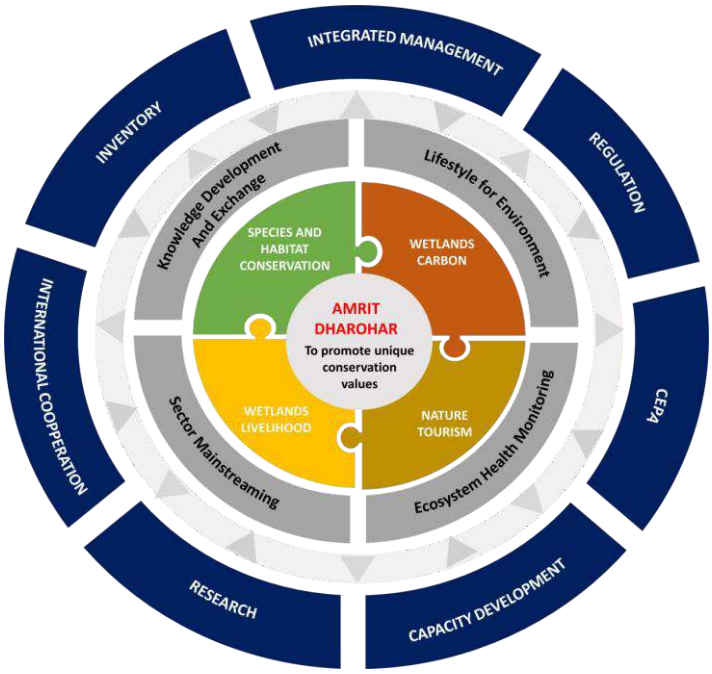

Figure 2: *Amrit Dharohar* – Implementation Approach

Photo credits: Wetlands International South Asia

2. Guidelines' Purpose and Scope

These guidelines outline an implementation framework for NPCA built on an evaluation of implementation experiences so far. The basic features that have been kept in mind while preparing these guidelines are:

- Collaborative effort between Central Government and State Governments/Union Territories, particularly ownership and stewardship of wetlands resources by the latter, is crucial to overall sustainability of restoration and management efforts.

- Effective institutional structures need to be created within the States and UTs to ensure cross sectoral decision making for wetlands. This is also mandated by the Wetlands (Conservation and Management) Rules, 2017 (Annexure IV: Wetlands (Conservation and Management) Rules, 2017).

- Mainstreaming wetlands in State level policy and decision making by building convergence with ongoing developmental sector investments is an important pathway to address anthropogenic and climatic threats to wetlands (Annexure II: Suggestive list of Central and State Government Schemes which can support implementation of NPCA projects (Annexure VII: Checklist for submission of integrated management plan).

- Management of wetlands need to be based on a diagnostic evaluation of their ecological, hydrological, socio-economic and institutional features, and factors governing these features to arrive at an action plan suited to specific context. Participation of stakeholders as well as experts are key enablers to such a process.

- Wetlands need to be integrated with water resources management to ensure that land and water use decisions within catchments and coastal zones do not adversely impact these ecosystems, rather are able to apply wetland ecosystem services values synergistically to achieve water, food and climate security solutions.

- Being inherently dynamic, the ecological character of wetlands is always changing due to natural causes (such as ecological succession) or human-induced causes (such as changes in water inflow and outflow patterns). For wetland management to be effective, it has to

    - provide the enabling conditions for ecosystem functioning (such as ensuring that water in the desired quantity, quality, and periodicity is available to the wetland) and

    - mitigate or reduce the threat of human-induced adverse change in wetlands (such as reducing pollution, proliferation of invasive species, conversion of wetland to non-wetland use)

- Integrated management of wetlands must consider the scale aspects (the interactions of the river basin and coastal zone with the wetland and wetland complex), stakeholder aspects (the views, rights and capacities of different stakeholders linked with wetlands) and sector aspects (the interactions of different conservation and development sectors with wetlands).

- Wetland management approach seeks maintenance of ecological character or wetland *wise use* with emphasis to maintain the capability of wetland to support human well-being at present and in future.

- Preparation of IMP can be a resource-intensive exercise requiring evaluation of key ecological features of the wetland and comprehensive stakeholder engagement throughout the planning process.

- An intermediate approach of FMP enables acting on the available information and, at the same time, builds an evidence base through assessments and stakeholder consultations for developing a comprehensive IMP for the site.

These guidelines supersede the NPCA Guidelines (issued in April 2019)

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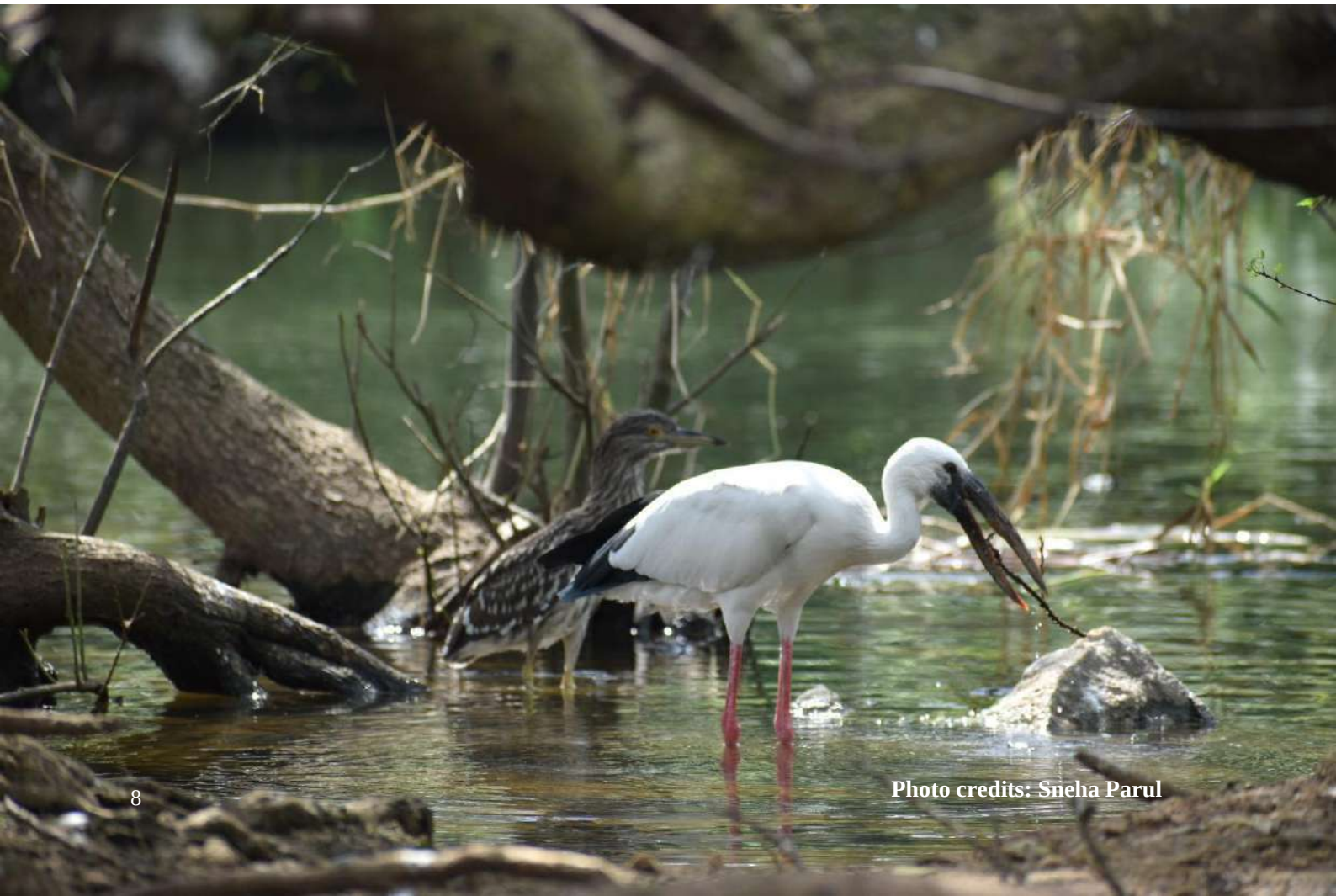
3. Managing Wetlands

3.1 Extent of Wetlands in India

The Himalayas are interspersed with a number of glacial lakes, swamps, and floodplain marshes spread across Jammu and Kashmir, Uttarakhand, Himachal Pradesh, Sikkim and Assam, several of which are the headwaters of major rivers. The alluvial plains of River Ganga and Brahmaputra have extensive riverine wetland formations as floodplains and oxbows known variously as maun, beel, chaur, jheel and pat in different parts of the country. These sustain highly productive agriculture and fisheries, besides acting as natural flood defence for communities. In arid and semi-arid zones of the peninsular and western India, several water bodies have been constructed to support domestic water and irrigation needs. The arid zone spanning Rajasthan and Gujarat has vast saline flats, monsoon fed freshwater lakes as well as salt lakes (for example, Sambhar, Pachpadra, Deedwana and Lukransar). The Peninsular Deccan region is studded with human-made lakes providing water for various human needs. Several of these also act as good habitats for water birds (e.g., Varthur, Rachenahalli and Amruthalli Lakes in Bangalore, and Kolleru in Andhra Pradesh). Several urban agglomerations such as metropolitan area of Hyderabad and Ahmedabad have strikingly high number of human-made lakes (over 400 and 600 in numbers, respectively). The narrow plains of the east and the west coasts are dotted with lagoons, backwaters, mangroves, coral reefs and salt lakes.

It is estimated that India has 15.98 million ha area under wetlands, roughly equal to 4.86% of its land area, as per the National Wetlands Atlas, 2021 published by Space Applications Centre, Ahmedabad. Of this, inland wetlands constitute 74.1% (11.85 million ha).



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3.2 Importance of Wetlands: Ecosystem Services and Biodiversity

Wetlands are lifelines of the society. They provide vital support to human well-being through their wide-ranging ecosystem services and biodiversity values. As these ecosystems degrade or are adversely altered, the water cycle, and the interlinked carbon and nutrient cycles are also adversely altered, leading to water, food and climate insecurity, and loss of biodiversity. Some of the major ecosystem services provided by wetlands are:

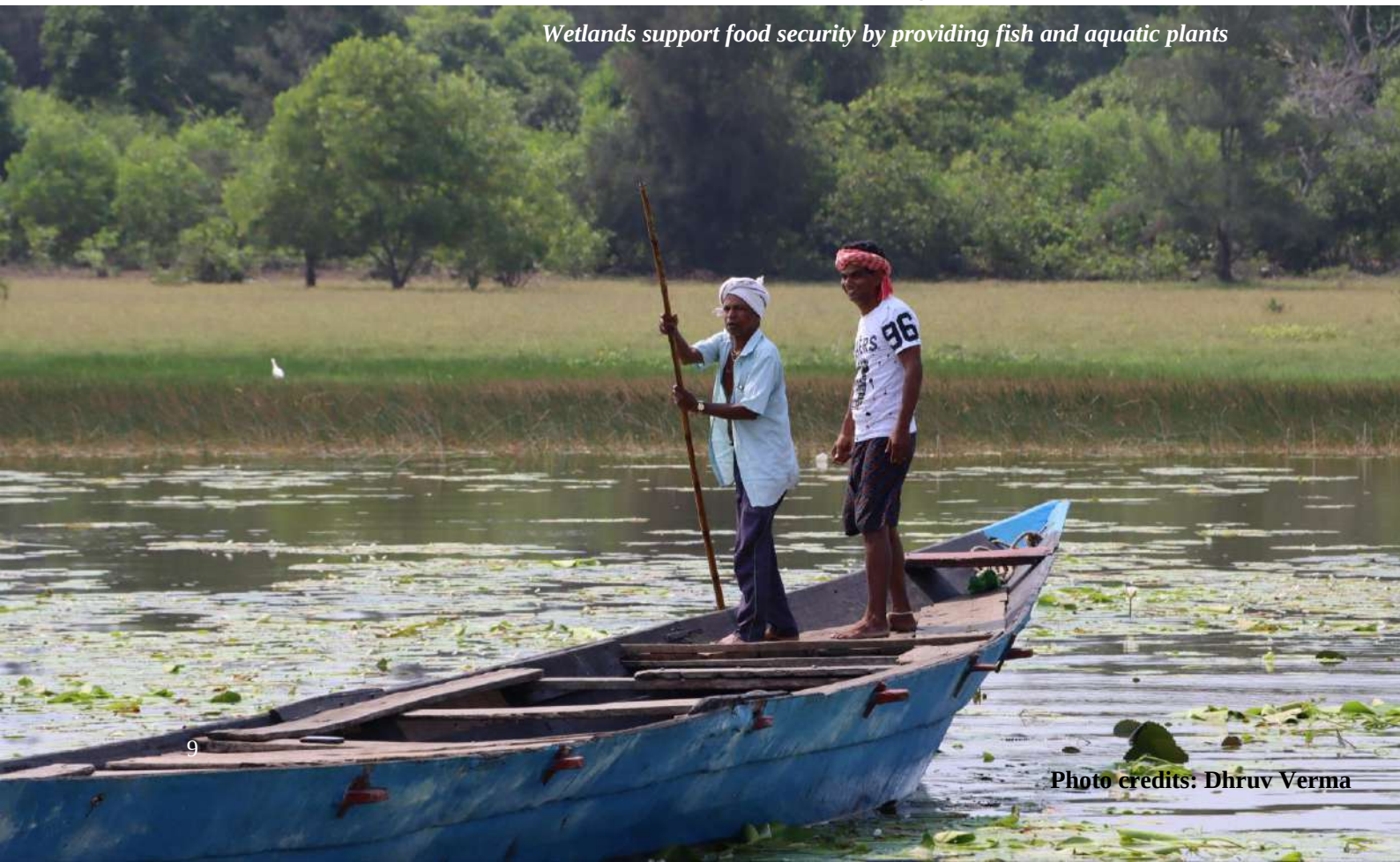
- Water storage;
- Support livelihoods by providing food, water and fiber;
- Regulation of water regimes and stream flows;
- Ground water recharge;
- Water purification;
- Nutrient recycling;
- Buffer shorelines from erosion;
- Buffer communities against floods, droughts, cyclones and wave surges;
- Support a variety of life forms through extensive food webs;
- Habitat to diverse flora and fauna, including resident and migratory species;
- Habitat for migratory species such as waterbirds and fish;
- Provide recreational opportunities;
- Integral part of cultural identities;
- Enhance landscape aesthetics; and,
- Stabilize local climate.

The ability of a wetland to provide the aforementioned ecosystem services and support biodiversity is dependent on local conditions, geomorphic settings and linked livelihood systems.

3.3 Major Threats and Impacts

Wetlands are subject to a number of threats emanating from anthropogenic and non-anthropogenic drivers and pressures. Some of the major threats to these ecosystems are:

- Fragmentation of hydrological regime;
- Siltation;
- Pollution;
- Encroachment and land reclamation;
- Species invasion including alien species;
- Unregulated recreation and tourism;
- Over-harvesting of resources; and,
- Climate change.



Wetlands support food security by providing fish and aquatic plants

Photo credits: Dhruv Verma

Degradation of wetlands affects biodiversity and human well-being in a number of ways, as is evident from following examples:

- Changes in water regimes of Loktak Lake, a floodplain wetland complex of Manipur River, in order to withdraw water for hydropower generation has led to enhanced peripheral flooding, near complete decimation of migratory fisheries and rapid degradation of habitat of globally endangered ungulate species - Brow Antlered Deer (*Rucervus eldii*) or Sangai for which the wetland is the only known natural habitat.
- Conversion of marshes associated with Wular Lake for agriculture and afforestation has reduced the capacity of the wetland system to regulate the flow regime leading to increased floods and droughts.
- Enhancement of permanent agriculture has adversely affected the livelihoods of over 15,000 fishermen living around Kanwar Jheel in North Bihar. Agriculture in turn has been impacted by lowering of ground water levels and flooding attributed to the shrinkage in wetland area.
- Reclamation of urban lakes in Bangalore and Chennai is one of the major factors leading to increased urban flooding.
- Agriculture in the backwaters of Vembanad-Kol has often created distress to the farmers and also caused irreversible changes to the wetland habitat.

3.4 Management Gaps and Challenges

Following gaps and challenges have limited effectiveness of interventions made for conservation and management of wetlands:

3.4.1 Sectoral Approaches

The full range of wetland ecosystem services and biological diversity values are rarely integrated in sectoral developmental plans, impeding their ecological and hydrological functioning and leading to stakeholder conflicts. In most States, wetlands are not recognized as a unique land use category and these are often clubbed with 'wastelands' meant to be used for alternate developmental purposes. Sectoral approach also results due to multiple departments pursuing different objectives *(for example, water resources department aiming at enhancing water holding capacity, fisheries department at enhancing fish production, tourism department at developing tourist potential)* with disparate outcomes related to wetlands, and often working for cross-purposes.

Photo credits: Suchita Awasthi

3.4.2 Partial Approach to Implementation of Management Plans

The management plans for wetlands are mostly formulated, financed and implemented on annual cycles, and in several cases, these are not based on comprehensive landscape scale management plans. Most of the plans are therefore prescriptive in nature, and do not address the root causes of degradation (e.g., change in hydrological regimes, pollution or loss of biodiversity). Post project sustainability strategies are also not worked out. Only in a few States/UTs, allocation has been made for wetlands within their budgets, and wherever such allocations are made, it is mostly for establishment expenses and not for supporting restoration. Similarly, though NLCP was implemented on a cost-sharing basis, the operation and maintenance of urban and peri-urban lakes by the respective State Government departments is marginal.

3.4.3 Weak Cross – Sectoral Governance

Integrated management of wetlands requires cross-sectoral institutional arrangements. This was envisaged to be achieved through creation of dedicated authorities responsible for developing management plans, site monitoring and evaluation and implementation through line departments. However, only a few States have been able to designate specific authorities. Further, only in few cases, these authorities have regulatory backing. The Wetlands (Conservation and Management) Rules, 2017 has constituted State/UT Wetlands Authorities as the nodal policy making and regulating bodies for wetlands within their jurisdiction.

3.4.4 Insufficient Capacity for Integrated Management

Review of management plans submitted to the Ministry indicates lack of knowledge and experience in the formulation of management plans addressing the full range of drivers of ecosystem degradation. Equally significant is the lack of training and capacity building opportunities for the site managers.

3.4.5 Limited Research Management Interface

Management of wetlands calls for continuous research inputs to address the drivers of change. However, research has not been given due importance in case of most of the wetlands. Much of the research is focused on structural elements of wetlands (limnology, biodiversity) with very limited emphasis on functional aspects

Encroachment is a major threat to wetlands

Photo credits: Harsh Ganapathi

such as ecosystem services and community livelihoods.

3.4.6 Impact of Climate Change

The sea level rise is expected to adversely affect the coastal wetlands; some of them might disappear; several others would experience changes to their morphology, water balance, salinity levels and biodiversity. The mudflats and coral reefs could be considerably affected by sea level rise. The high altitude wetlands would suffer due to problems associated with the reduction in the thickness and area of glaciers. The variation in precipitation pattern would have its impact on wetland ecosystems and their *wise use*. Therefore, there is a need to plan for the future considering the climate change and its impact on wetlands.

The NPCA is designed to address the aforementioned gaps through focus on integrated wetland management in relation to their drainage basins, strengthening institutional arrangements and governance mechanisms, enhancing capacity and improving knowledge base and developing decision support system.

3.5 The need for integrated management

Wetlands are one of the most embedded and interlinked ecosystems with human livelihoods and well-being. A balanced management approach addressing biodiversity conservation values while providing for sustainable utilization in a way compatible with maintenance of natural properties of the ecosystem needs to be adopted for these ecosystems. This forms the core philosophy of '*wise use*', which is "*maintenance of ecological character within the context of sustainable development, and achieved through implementation of ecosystem approaches*." This approach builds on the critical linkages that exist between people and sustainable development of aquatic ecosystems; and encourages community engagement and transparency in negotiating trade-offs and determining equitable outcomes for conservation.

The NPCA therefore recommends that management of each wetland is guided by an IMP. The plan refers to a document which describes strategies and actions for achieving *wise use* of the wetland and includes objectives of site management; management actions required to achieve the objectives; factors that affect, or may affect, the various site features; monitoring requirements for detecting changes in ecological character and for measuring the effectiveness of management; and resources for management implementation.

While it is recognized that each site has its own distinctive ecological and hydrological features and thereby distinctive management needs, the following broad planning principles need to be kept in mind while formulating IMP:

- **Integrated planning:** Aquatic and terrestrial ecosystems are intimately linked by the process of the water flowing through them. Every land use decision has a consequence on water availability. Management planning for wetlands should not be restricted to a defined administrative boundary, but rather take into account wider planning and management context of the basin or coastal zone within which the site is located. Delineating a basin or a coastal zone enables demarcation of a distinct hydrological unit which is the natural integration of all hydrological processes within its boundary and therefore an ideal and rational unit for soil, water and bio-resources conservation and management.

- **Diagnostic approach:** Given the uniqueness associated with each wetland, it is important that '*one size fit all*' approach is replaced with a diagnostic approach, wherein the ecological, hydrological, socioeconomic and institutional features are comprehensively assessed and trends therein determined to be able to spell out management objectives and actions clearly.
- **Adaptable management:** Wetlands are influenced by a range of drivers and pressures that act at multiple spatial,

temporal and political scales. Their management plan, therefore, needs to be prepared to be accommodative of uncertainties and challenges. This can be achieved by using an adaptable management approach, which allows for suitable modification of management based on continuous site monitoring and assessment of new information. In several instances, the ability of future to sustain human use cannot be determined off-hand due to lack of information. In such circumstances, as is the practice in other spheres of ecosystem management, use of precautionary principle is recommended. This means that lack of full scientific uncertainty should not be used as a reason to postpone measures to prevent ecological degradation. With more data collected from the field as part of implementation of management action plan, better understanding of the system can be achieved and appropriate models developed.

- **Stakeholder participation:** The condition of any wetland is an outcome of actions by a range of stakeholders, which are linked to the ecosystem in a number of ways. Management planning therefore needs to recognize these linkages, and build a mechanism for participation of stakeholders in design, review and implementation processes.

- **Governance:** Being located at the interface of land and water, wetlands are influenced by a range of developmental activities which take place within their direct and indirect basins and coastal zones. Institutional arrangements for managing aquatic ecosystems need to be such that they are capable of integrating activities across multiple sectors (such as agriculture, water resources, forests, rural development , urban development, forests and wildlife and others), and balancing the needs of a group of diverse stakeholders while ensuring that ecological integrity of these fragile ecosystems is not adversely affected. This need can be best served by designating wetland authorities within States and UTs to serve as a distinct regulatory, planning and policy making body for conservation, restoration and sustainable management of its wetlands. This is also mandated by Wetlands (Conservation and Management) Rules, 2017.

3.6 Need for Framework Management Plan

- The FMP preserves the diagnostic approach recommended under the NPCA. However, it recognizes that the preparation of IMP can be a resource-intensive exercise requiring evaluation of key ecological features of the wetland and comprehensive stakeholder engagement throughout the planning process. An FMP, therefore, enables acting on the available information and, at the same time, builds an evidence base through assessments and stakeholder consultations for developing a comprehensive IMP for the site.

- FMP is essentially a stepping stone towards an IMP and, therefore, has to be linked with an overarching vision and management framework. FMP cannot be a standalone Annual Plan of Action which may not contribute to the maintenance of ecological character or wetland *wise use*. FMP will ensure that a stakeholder-endorsed IMP is available by the end of the FMP period. FMP pinpoints urgent actions needed to address threats on the wetlands and reinforces the implementation of the *Amrit Dharohar* implementation strategy in Ramsar Sites and other wetlands.

Photo credits: Adnan Abubakar

4. National Plan for Conservation of Aquatic Ecosystems

4.1 Scheme Coverage

Wetlands include an area of marsh, fen, peatland or water; whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters. Conservation and management of mangroves and coral reefs shall continue to be guided by the Centrally Sponsored Scheme entitled Conservation and Management of Mangroves and Coral Reefs.

4.2 Goal and Purpose

The goal of NPCA is to develop and maintain a network of healthy wetlands which contribute to human well-being through their diverse ecosystem services, as well as sustain diversity and populations of wetland-dependent species.

The purpose is to mainstream full range of wetlands biodiversity and ecosystem services within developmental plans and programmes at various levels.

4.3 Objectives

The NPCA aims to provide an integrated and scientific framework for the conservation and sustainable management of wetlands in the country. The specific objectives of the plan are:

- Developing policy guidelines for conservation and sustainable management of wetlands;
- Supporting, promoting and strengthening conservation of prioritized wetlands through integrated management;
- Facilitating the development of a national inventory, and setting up an information decision support system for the management of wetlands;
- Strengthening the capacity of wetlands managers and stakeholders for effective management of wetlands; and
- Strengthening the implementation of international commitments related to wetlands.

4.4 Strategy

The NPCA promotes the leadership and stewardship of States / UT administrations for the conservation and management of wetlands, with the MoEFCC providing facilitation in terms of setting policy directions, supporting the creation of linkages with developmental sectors, strengthening research-management interface and building capacity of site managers and other stakeholders. The vision on integration within the NPCA is guided by the following strategies:

4.4.1 Integrated Management

Investment for the conservation of wetlands shall be on the basis of integrated management plans which secure ecosystem functioning for sustained provision of ecosystem services as well as maintenance of biodiversity. These plans will serve to integrate wetlands into sectoral developmental planning within the associated catchment and coastal zones. This is in difference to present single function investment to integrated and sustainable development considering asset management planning, drainage management planning and land use planning and control.

It is necessary to determine the state and condition of the wetlands to conserve and protect them from stresses and resultant degradation. Baseline information needs to be therefore gathered, the areas and degree of degradation need to be determined, the causes need to be identified and measures that would restore the wetlands to the desired state need to be designed and implemented. Besides these interventions,

the wetland is to be managed so that it is sustained in a sound ecological health, retains biodiversity and provides the expected ecosystem services in an efficient and effective manner.

The IMP is formulated for wetlands by State/UT Wetland Authorities and wetland managers with support from various organisations including organisations with domain expertise in wetlands and its services based on the Guidelines for IMP preparation provided under the NPCA (Annexure I: Guidelines for Preparation of Integrated Management Plan). Given the uniqueness of each wetland, the Guidelines recommend a diagnostic approach wherein the ecological, hydrological, socio-economic and institutional features are comprehensively assessed, and trends therein are determined to define management objectives and actions. The Guidelines also recommend recognition of linkages the stakeholders have with wetlands and building a mechanism for the participation of stakeholders in design, review and implementation processes. An adaptable management approach, which allows for suitable modification of management based on continuous site monitoring and assessment, is emphasized in the Guidelines.

Given the extensive data requirement and need for specific skills and capacities, a majority of sites, including those designated as Wetlands of International Importance under the Ramsar Convention (Ramsar Sites), do not have IMP in place. The lack of an IMP creates a risk that the site management does not adequately address the adverse drivers of wetland degradation or is insufficient to secure the full range of wetland ecosystem services and biodiversity values.

4.4.2 Framework Management Plan

The Framework Management Plan (FMP) is an interim and supplementary step towards the preparation of the IMP. FMP will be prepared on the basis of available information, proposes implementation of non-regrettable activities, and identifies activities/studies required for the preparation of the IMP. FMP will also bring in commitment from the State/UTs for the preparation and implementation of IMP in a time-bound manner.

4.4.3 Funds Convergence

Funding for implementation of restoration plans will be largely through developmental sector programmes (from public as well as private sources) which have a bearing on wetlands functioning, and provide an opportunity for supporting integrated management. NPCA shall only provide the core funding required to trigger and support integrated management for prioritized wetlands. Local/ District/ State level agencies/ committees, responsible for conservation and management of wetlands, as applicable, in consultation with State/UT Wetlands authorities shall ensure that the identified activities under IMP or FMP of the wetland are allocated appropriate funds for completion of the IMP / FMP.

4.4.4 Cross-Sectoral Governance

State Government / UT administration will need to put in place a nodal State / UT level authority for planning, policy-making and integrated management of aquatic ecosystems in their jurisdiction. These authorities will have representation of all sectors concerned with aquatic ecosystem functioning and will also ensure the support of concerned State Governments, Urban local bodies and NGO's political, technical and administrative leadership within the respective State/UT. The Wetlands (Conservation and Management) Rules, 2017 have constituted State Wetlands Authorities to ensure cross-sectoral governance and stakeholder participation.

4.5 Financial Support from Central Government

State Governments / UT administrations can seek financial assistance under NPCA for IMP/ FMP of wetlands. The MoEFCC will bear the

cost of activities funded by it as per the prevalent policy of the Central Government to State/ UTs/ Special/North–Eastern state.

Each integrated management plan will identify a comprehensive set of activities that will need to be implemented to conserve and sustainably manage wetlands. The action plan must be examined for convergence with existing funding opportunities/ schemes/ programmes of Central/State Government Ministries, agencies, and private sector (a suggestive list is given in Annexure II: Suggestive list of Central and State Government Schemes which can support implementation of NPCA projects).

The activities which do not have any alternate source of funding, and fall within the list of core and non-core activities can be considered for financial support under NPCA (Annexure III: Core and non-core activities corresponding to management action plan components).

Overall, the core activities shall be allocated higher weightage, and be allocated 75% of the budget. The non-core activities may receive a maximum 25% of the overall allocation.

In addition, the MoEFCC will implement the following activities to enhance the management effectiveness of aquatic ecosystems in the country:

4.5.1 National inventory and decision support system for conservation and management of wetlands

The Ministry shall facilitate the development of a national inventory on wetlands to assist State Governments/Union Territory Administrations in:

(a) Identifying wetland locations and extent;
(b) Assess spatial and temporal changes in wetlands extent;
(c) Prioritize wetlands by overlaying with layers on water regimes, land use and land cover and high conservation values sites.

4.5.2 Research projects with regional / thematic relevance to support conservation and management of wetlands

The Ministry shall make available a list of priority research themes to support conservation and management of wetlands, and keeping in view MoEFCC's existing guidelines. MoEFCC shall set up a process for seeking inputs of State Governments/ UT Administrations in identifying the priority research topics and organizations to implement the research.

The funding for the wetland carbon component of *Amrit Dharohar* for scientific and research studies may be undertaken from the NPCA budgetary outlay.

4.5.3 Regional and national capacity building programmes to improve management effectiveness of wetlands

MoEFCC shall do a capacity building needs assessment based on which training workshops and other hand-holding mechanisms shall be implemented.

4.5.4 Promotional campaign for *Amrit Dharohar*

MoEFCC shall undertake a promotional campaign to meet the objective of *Amrit Dharohar* after due convergence from the line ministries. The implementation arrangement under the implementing strategy of *Amrit Dharohar* will extend the guidance on convergence for the identified activities.

MoEFCC may also extend some financial assistance from the NPCA funds to promote the associated activities of Mission LiFE and Save Wetland Campaign, with the approval of the Technical Appraisal Committee, as constituted as per these guidelines.

4.6 Institutional Arrangements

The Institutional arrangements at National and State/UT levels are provided below:

4.6.1 National Level

MoEFCC is responsible for the overall coordination of NPCA. NPCA is implemented by a designated division of the Ministry. Its specific functioning includes the following:

- Providing a national policy framework for conservation and sustainable management of wetlands;
- Providing financial assistance (on a cost-sharing basis) for the implementation of activities identified in the integrated management plans and FMP
- Providing need-based advice to the State Governments / UT Administration in leveraging funds from various central government ministries and departments;
- Providing detailed guidelines and technical know-how for wetlands restoration and management;
- Funding, supporting and conducting capacity building and training programmes;
- Financing research and capacity development to support integrated management of wetlands;
- Periodic evaluation of interventions made under the programme and suggesting mid-course corrections including evaluation of management plans;
- Facilitating the development of a national inventory, and setting up an information decision support system for the management of wetlands;
- Communication and outreach on wetlands; and
- Any other task assigned by Central Government

4.6.1.1 National Wetlands Committee

The National Wetlands Committee (NWC), constituted under the provisions of the Wetlands (Conservation and Management) Rules, 2017 shall be the nodal advisory body for NPCA. The composition and functions of NWC are laid down in the said Rules (Annexure IV: Wetlands (Conservation and Management) Rules, 2017).

4.6.1.2 Technical Appraisal Committee

A Technical Appraisal Committee (TAC) shall be constituted by MoEFCC for assessment of the FMP / IMP comprising of individual/institutional subject experts, Finance Division and other line divisions of MoEFCC, including representatives (Not below the rank of Director) from the line ministries. Following shall be essential terms of reference of the TAC, other than as defined by MoEFCC, while constituting the TAC:

a) Evaluate the FMPs for its comprehensiveness to meet the objective of IMP,
b) Assess the sufficiency of studies and assessments,
c) Adequacy of timelines and estimated cost,
d) Feasibility of actions and other associated parameters required for fulfilling the preparation of IMP.
e) Recommend the budget for FMP/IMP and timeline for its implementation.
f) Recommend an expert or agency for assessing progress on implementation of FMP or IMP, as the case may be.
g) TAC may conduct site visits and/or hold periodic review meetings to assess progress and suggest mid-course corrections.

4.6.2 State Government/UT Administration

The primary responsibility for the conservation and sustainable management of wetlands shall be with the State Governments/UT Administrations. The State/ UT Wetlands Authorities constituted

as per provisions of Wetlands (Conservation and Management) Rules, 2017 will be the nodal agency for all matters concerned with the implementation of NPCA. The composition and functions of the State/UT Wetlands Authority are laid down in the said Rules (Annexure IV: Wetlands (Conservation and Management) Rules, 2017).

4.7 Implementation Strategy

NPCA envisages creating a network of well-conserved and sustainably managed wetlands which support biodiversity and provide their full range of ecosystem services on long-term basis. The implementation strategy to achieve the above is as follows:

a) Proactive engagement of State Governments and UT Administrations to ensure that a representative set of wetlands are identified for management. Emphasis shall be placed on wetlands which are located outside the protected area network, and are highly vulnerable to various anthropogenic pressures.
b) Capacity development and handholding support would be provided by the Ministry by holding regional and national capacity building programmes for strengthening the capacity of wetlands managers and stakeholders for effective management of wetlands.
c) Preserving biodiversity, fostering ecological equilibrium and ensuring the sustainability of ecosystem. Species conservation measures may include protection and conservation of endangered or threatened wetland animal and plant species and the management and preservation of natural environment to maintain the ecological balance and biodiversity of the particular region.
d) Development of tourism infrastructure would be in strict conformity with the extant application regulations and aligned with wetland *wise use* so as to ensure that ecological character of the wetland is not compromised.
e) Integration of *wise use* ecosystem services with other livelihood capitals particularly in socio economic context of the dependent communities for sustainability of livelihood strategies as well as well-being of wetland communities.
f) Wetlands to be a major source of long-term carbon sink with healthy climate change mitigation tool.

Photo credits: Dayadra Mandal

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5. Conditions and Process for Inclusion

5.1 Inclusion of Wetlands under NPCA

The Government of India has been implementing the National Plan for Conservation of Aquatic Eco-system (NPCA) in close collaboration with the State Governments/UT Administrations wherein wetlands are identified/ prioritized as a prerequisite for being considered for financial support.

Inclusion of a wetland under the NPCA shall be an indication that:

a) The State Government and the MoEFCC recognize the significance of the wetland in terms of biodiversity values and contribution to societal well-being through wide ranging ecosystem services

b) The wetland requires proactive management to be in place to secure its biodiversity and ecosystem services values

c) The State Government, recognizing the significance of wetland, is willing to demarcate the wetland boundary, designate a dedicated nodal agency for management, develop an integrated management plan, and contribute in financial terms towards implementation of management plan

d) The MoEFCC, in recognition of the significance of wetland is willing to consider providing financial and technical support towards implementation of an integrated management plan

5.2 Inclusion Criteria

Any proposal received from State/UT Wetlands Authority shall be considered for financial support under NPCA, provided the proposal pertains to the wetlands notified/proposed to be notified (process initiated) as per provisions of Wetlands (Conservation and Management) Rules, 2017.

For all wetlands, the following criteria shall apply:

a. Wetlands located within urban, peri-urban and semi-urban areas

i. Wetland holds some water throughout the year and with peak inundation area equivalent or greater than 5 ha; and,

ii. Wetland is highly degraded and cannot be put to its traditional use due to pollution resulting from discharge of domestic and /or industrial wastewater, municipal solid waste or other non-point sources of pollution. Designated best use criteria for surface waters as recommended by CPCB is provided in Annexure V: Designated Best Use Criteria for Surface Waters as recommended by CPCB.

b. Wetlands located in high altitude areas (with elevations greater than 2,500 m a.m.s.l)

i. Wetland has an area of 5 ha and above.

c. Wetlands located below 2,500 m a.m.s.l elevation

i. Wetland or wetland cluster has a peak inundation area of 100 ha and above, and meets atleast one of the following criteria:

- Is representative, rare or unique example of natural or nearly natural wetland in a biogeographic zone;
- Supports vulnerable, endangered or critically endangered species; or threatened ecological communities (as evaluated

through IUCN Red List or any other national list);

- Supports plant and/or animal species at a critical stage in their life cycle, or provides refuge during adverse conditions;
- Supports populations of plant/ or animal species important for maintaining the biological diversity of a particular biogeographic region;
- Regularly supports 20,000 or more waterbirds;
- Regularly supports 1% of individuals in a population of one species or sub-species of waterbirds or is an important breeding site for rare/migratory bird species;
- Is an important source of food for fishes, spawning ground, nursery and /or migration path on which fish stocks/ either within the wetlands or elsewhere depend;
- Provides important hydrological functions as a source of water, regulates hydrological extremes, recharges groundwater, buffers floods and purifies water;
- Is an important source of livelihoods for communities living in and around it; and
- Is of significant cultural/ religious/ recreation value.

Wetlands smaller than the above-mentioned area thresholds may be considered by the Central Government on recommendation of the State/UT Wetland Authority.

5.3 Inclusion Process

For wetlands which fulfil the criteria set above, a Brief Document (Annexure VI: Format for preparing brief document) shall be prepared by the concerned agency for consideration of respective State Government / Union Territory Administration.

An undertaking by the State Government for State share of the cost for implementation of FMP/IMP should also be provided, to avail the financial assistance under NPCA. Such undertaking should also indicate the justification for identification of the wetland and its significance.

22

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6. Steps for Submission of Proposals for Financial Support

State Governments / UT Administrations can apply for financial assistance for management of wetlands in following steps:

Step 1: Submission of proposal for inclusion of site for funding under NPCA

A proposal for inclusion of a wetland under NPCA along with Brief Document and Health Card should be forwarded through the State Govt./ Union Territory Administration/State Wetlands Authority/UT Wetlands Authority with an undertaking to provide their share of cost of implementation of FMP/IMP by State Government.

For wetlands attracting the Wetlands Rules, 2017, the Brief Document should have been prepared and submitted to State/UT Wetlands Authority for notification under 2017 Rules. A documentary evidence in this regard is also required to be submitted.

Step 2: Formulation of Integrated Management Plan

Upon approval of inclusion of site under the NPCA, the State Government/ Union Territory Administration/State Wetlands Authority/UT Wetlands Authority can opt any of the following options:

Option A

Submit an IMP in accordance with the steps and format given at Annexure I: Guidelines for Preparation of Integrated Management Plan,

- The Integrated Management Plan for the site outlining specific activities for integrated management is the most important component of NPCA. The IMP is envisaged to be a document with multiple functions, including identification of resource requirement, generating baseline information, communication with stakeholders and ensuring compliance with regulatory frameworks and policy commitments, identification of the nature of degradation of the aquatic ecosystems, sources of degradation, the measures that need to be taken to conserve and restore the wetlands, the design of these measures, the cost estimates and the expected outcome;

- Each wetland has its distinct characteristics, and thereby it is important that their site management needs are identified using a diagnostic method based on critical evaluation of the status and trends of the site's ecological, hydrological, socio-economic and institutional features;

- It is recommended that IMPs may be prepared by engaging expert agencies and in full consultation with the stakeholders, particularly dependent communities. The State Governments / UT Administration shall commission such agency at their behest;

- IMP should contain a detailed action plan, including year wise list of activities proposed to be carried out, costs, and sources of funding. All existing funding sources from Central and State Governments and private sectors under which financial support for the said activity can be accessed should be identified;

- Time frame for implementation of IMP should commensurate with the complexity of site, and be sufficient to bring about significant positive change in ecosystem features. In most cases, a time frame of 3 – 6 years is expected.

- All IMPs should categorically list specific ecological, hydrological, socioeconomic and institutional indicators, periodic measurement of which shall indicate progress made in achieving management

plan goal and objectives. Provisions for measuring and reporting on these performance indicators should be made within the IMP.

- The final IMP must be duly approved by the State Govt./ UT Administration/ State /UT Wetland Authority and submitted to the Ministry only after approval.

- A checklist for submission of IMP is provided at Annexure VII: Checklist for submission of integrated management plan.

Option B

- State /UTs Authorities can explore and submit FMP in accordance with the steps and format given at Annexure VIII: Guidelines for preparation for FMP and Annexure X: Blank Format of FMP. However, the FMP is recommended to be taken up only for those wetlands wherein

  a) The wetland is a Ramsar Site (Wetland of International Importance) or a proposed Ramsar Site or notified/proposed to be notified under the Wetlands (Conservation and Management) Rules, 2017.

  b) There is no management plan in place, and its preparation is constrained by a lack of financial assistance, capacities, and other factors.

  c) There is a commitment from the State/UT Government to prepare an IMP within the FMP Implementation period as per the NPCA guidelines.

Developing a Framework Management Plan

- FMP is a simpler document as compared with an IMP and can be developed using available information and preliminary stakeholder dialogues with key Government departments, research organisations, and civil society organisations.

- It is recommended that the State Government entrusts FMP preparation to the site manager. The manager may seek support from local EIACP centre in drafting the FMP (refer to Annexure XI: Ramsar Sites and EIACP Centres, for a list of EIACP centres mapped with Ramsar Sites). Additional support from subject matter experts, external agencies, research organisations, and NGOs may also be taken while ensuring that the quality standards as prescribed in this guidance document are met.

- FMP can be initiated by, firstly, bringing together all published information (such as journal articles, technical reports), maps, past management plans, if any, and information available in vernacular.

- The site manager must undertake a site visit to the wetland with the FMP compiling team to understand the ground conditions and recce the prominent physical and ecological features. The objective must include a dialogue with the communities and stakeholder groups to understand major issues related to the wetland.

- Based on the site visit and stakeholder inputs, a detailed wetland map must be developed. The map must indicate the wetland boundary, key physical features in the surrounding area, inlets and outlets, and major settlements. Different wetland habitats may also be indicated.

- While developing the management framework (Step 3), an ecosystem approach should guide the setting of management objectives and identification of strategies. To the extent possible, the strategy should be aligned with *Amrit Dharohar* and *Mission Sahbhagita*.

- The draft FMP must be shared with key stakeholders (such as concerned government departments, community groups, and Community Based Organisations (CBOs)),

and their comments incorporated in the revision.

- Time frame for implementation of FMP/preparation of IMP should commensurate with the complexity of site, and be sufficient to prepare an IMP as per the format given at Annexure I: Guidelines for Preparation of Integrated Management Plan. In most cases, a time frame of 6 months – 1 year is expected.

- The final FMP must be duly approved by the State Govt./ UT Administration/ State/ UT Wetland Authority and submitted to the Ministry only after approval.

- A checklist for submission of FMP is provided at Annexure XII: Checklist for submission of FMP.

The aim of FMP is to:

a) Communicate the vision and management framework of the wetland to stakeholders

b) Bringing together existing information to describe the site, the focus of management and the management framework needed for conservation and *wise use*

c) Setting the stage for preparation of a detailed IMP as per the extant guidelines of the MoEFCC

d) Identifying the immediate actions needed to preserve wetland values and address risks of adverse change in wetlands (on a clear basis that intervention cannot be delayed for want of detailed assessments), and

e) Providing an opportunity to expedite the implementation of *Amrit Dharohar* components in Ramsar Sites.

The preparation of FMP shall have the following four steps (Figure 3):

Step 1 Wetland Description
Step 2 Management Purpose
Step 3 Management Framework
Step 4 Action Plan

- The details on the requirement of each step have been provided at Annexure VIII: Guidelines for preparation for FMP.

- State Governments/ UT administrations can seek financial assistance under NPCA for the implementation of Framework Management Plan for a period as recommended by the TAC.

- The MoEFCC will bear the cost of activities funded by it as per the provisions of the NPCA scheme of the Central Government to State/ UTs/ Special/ North–Eastern and Himalayan states.
    - Union Territories – 100% Central share
    - North-East and Himalayan States – 90% Central share and 10% State share
    - Rest of India – 60% Central share and 40% State share

Step 3: IMP/FMP finalization and execution of agreements

- The FMP submitted by the States/UTs after scrutiny for its essential requirements shall be placed before the Technical Appraisal Committee.

- IMP submitted by States/UTs shall after scrutiny by the MoEFCC, shall technically cum financially appraised by TAC.

- TAC shall ensure that the work plan/activities identified under FMP are sufficient to have comprehensive IMP along with the proposed timeline with optimized fund estimates. They shall also assess whether convergence of resources from the ongoing/ proposed schemes/ projects of the Central/State government has been taken into account.

- MoEFCC shall prepare appraisal template for IMP and FMP in consultation with Knowledge Partners and the same with due approval from TAC shall be used.

- A tripartite MoU between the Government of India, State Government/UT Administration and the agency identified for implementation of IMP/FMP, will be signed inter-alia, for sharing of costs, timely implementation of IMPs, and post-project sustainability. This MoU will be the basis of providing grants to State Governments/ UT Administrations (Annexure XIII: Indicative Format for Tripartite Memorandum of Understanding for implementation of Integrated Management Plans/ Framework Management Plans).

- The State/UT Government department receiving FMP funds shall submit 6 monthly implementation progress reports to the Wetlands Division in the prescribed format (Annexure XIV: Template for Implementation Progress Reporting of IMP/FMP (subjected to decision of TAC)). Report on implementation of physical activities shall also include photographs and GPS coordinates of implementation sites.

- All management, operation and maintenance expenses shall be part of IMP and costs thereon shall be borne entirely by the State Government / UT Administration for which additional resources will have to be demonstrably raised and committed to operations and maintenance. If there is a cost overrun in a project because of delay, inflation or any other reasons, the same shall be borne by the State/UT Government. The contribution of the Government of India shall be limited only to the amount initially agreed to in the Administrative Approval and Expenditure Sanction Order.

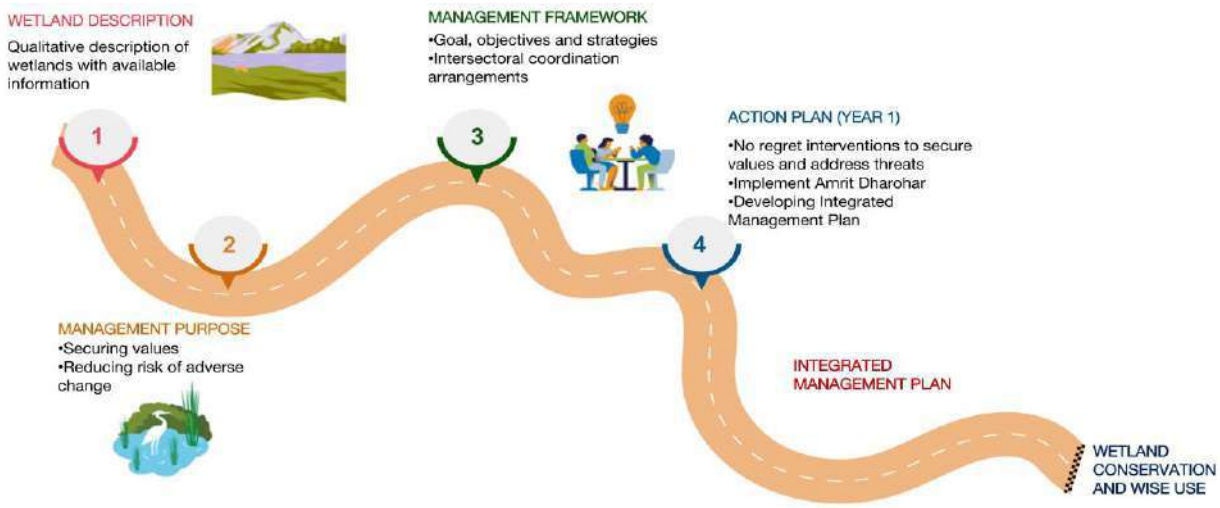

Figure 3: ***Steps for Framework Management Plan***

28

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Annexure I: Guidelines for Preparation of Integrated Management Plan

Wetlands provide wide-ranging ecosystem services which support human well-being in a number of ways. Numerous plant and animal species depend on wetlands during different parts of their life-cycle. In order to ensure that wetlands continue to provide their ecosystem services and support biodiversity, it is essential that a well-defined strategy and actions are identified for their conservation and *wise use*. An integrated management plan reflects a common understanding between various stakeholders on the management purpose, significant threats and constraints limiting conservation and *wise use*, opportunities and specific actions for addressing these threats, and mainstreaming wetlands within the wider developmental planning.

The integrated management plan is formulated to serve the following purposes:

- Identify the objectives of wetland management
- Identify the factors that affect or may affect the wetland
- Resolve conflicts between various stakeholders having an interest in the wetland
- Define monitoring requirements and research needs
- Help obtain financial resources for managing the wetland
- Enable communication between different wetland managers, organizations and stakeholders
- Ensure compliance with extant laws and regulation
- Demonstrate that management is effective and efficient

Systematic diagnosis of various wetlands features and factors influencing these features is essential to arrive at management objectives and actions. The following eight steps are recommended for developing an integrated management plan:

Step 1: Preamble

The process for management planning must begin with an exercise of setting up an overarching preamble describing the rationale for application of human, technical and financial resources for the wetland. This is a concise policy statement that expresses the commitment of the State Government/UT Administration for integrated management. The preamble can be developed on the basis of:

- Importance of the wetland for the state / UT
- Ways in which the wetlands conservation and wise use will contribute to conservation and developmental goals
- Alignment with sectoral policies, directives and planning frameworks

Step 2: Description of wetland features

This step entails collation and synthesis of existing information on various site features so as to provide a basis for the identification of management objectives. A generic listing of management information needs and data requirements are presented in Table 1.

Table 1: Information Required for Description of Wetlands Features

Wetland feature	**Management information needs**	**Data requirement**
Wetland type and extent	Location Wetland type Wetland area Significant inter-annual changes in the wetland Major changes in the wetland extent in the last 20 – 30 years	Geographical coordinates Land use and land cover data for the wetland (at least for two seasons, pre and post-monsoon) Historical map of the wetland (can be developed from the Survey of India toposheets)
Catchment/Drainage Basin	• Direct and indirect catchment of the wetland • Geological and geomorphological characteristics that have led to the formation of the wetland • Present land use and land cover of the catchment and their implication for wetland • Major developmental activities in the catchment and their impacts on the wetland	• Geology and geomorphology • Topography • Drainage pattern • Soil types • Climate setting • Land use and land cover change
Hydrological regimes	• Major sources of water inflow and outflow from the wetland • Major sources of sediments into the wetland • Inundation regime • Trends in water holding capacity and factors for the decline • Water quality and pollution status • Water use pattern within the wetland catchment and implication for wetland	• Water inflow, outflow and balance • Inundation pattern • Sedimentation • Groundwater • Water quality • Water use within the basin
Biodiversity	• Species richness • Role of the wetland in the life-cycle of migratory species • Invasive species and major contributing factors • Major changes in species richness and habitat and factors thereof	• Species richness and diversity • Biological significance of habitats • Risk of species invasion
Ecosystem Services	• Key ecological and hydrological characteristics required for the sustained provision of ecosystem services • Ecosystem services trade-offs	• Provisioning services (direct wetland products, eg: food, fibre, water) • Regulating services (the ability of an ecosystem to regulate hydrological regimes, influence micro-climate, reduce disaster risk, groundwater recharge) • Cultural services (recreational values, cultural and religious norms and beliefs related to wetlands) • Supporting services (Primary production and other ecosystem functions which enable wetlands to deliver all above ecosystem services)

Wetland feature	Management information needs	Data requirement
Socioeconomics and livelihoods	• Extent of dependence on wetlands for livelihoods • Status of community infrastructure (such as water and sanitation) and implication for wetlands • Livelihood vulnerability and relationship with changes in wetland resources • Resource use conflicts • Major shifts in livelihoods and implications for wetlands	• Demographic features of communities living in and around • The contribution of wetland to income and employment • Community resource use and management practices

Attention should be paid to the robustness of data and associated uncertainties thereof. It is recommended that the data on-site features and linked metadata are, to the extent possible, maintained in a spatial format to enable updation at a later stage as more information becomes available through monitoring programmes. The step should also include identification of data gaps.

Step 3: Evaluation of wetland features

This step entails an evaluation of information on status and trends on wetlands features (conducted in the previous step) to identify:

a) Key wetland features that should be a priority for management planning

b) Natural variability within these features, including describing thresholds, if any

c) Threats that limit (or potentially limit) maintenance of wetlands features in the desirable state

Evaluation of wetland features can be done on the basis of criteria such as:

- Naturalness
- Rarity
- Criticality for ecosystem functioning
- Socioeconomic importance
- Requirement under the extant regulatory regime

The evaluation process will lead to narrowing down of the list of wetland features, for which threats may be identified. The management plan is a response to these threats. Through this process, it is ensured that the plan does not merely focus on symptoms (for example, poor water quality) but on the root causes (in this case, ineffective sewage management in wetland catchments).

Step 4: Defining an institutional arrangement for wetland management

The purpose of this step is to evaluate whether existing institutional arrangements are sufficient and effective in addressing the threats to wetlands. Based on the gaps identified, an institutional arrangement for implementation of the management plan is developed.

This step includes:

a) Enlisting of government departments having programmes which impact (or have the potential to impact) wetlands features or threats on these features

b) An analysis of laws and regulations related to wetland, access and use of wetland resources, biodiversity or any dimension

c) Ownership, rights and privileges pertaining to wetlands

d) Analysis of the role of CSOs and communities in wetlands management, with particular reference to their views, rights and capacities

e) Gaps and challenges

Based on the analysis, an institutional arrangement for wetlands management should be developed, clearly stating:

a) The nodal agency responsible for managing wetlands

b) Role of different government departments and mechanisms for inter-departmental coordination

c) Role of CSOs and communities

Step 5: Setting management objective

This step involves the identification of site management objectives that need to be met so as to ensure that site features are maintained or improved. The management objectives must be capable of addressing the threats identified in the previous step and ensuring the maintenance of wetland in a desired healthy state. While defining objectives, the following must be considered:

a) Measurable – the objectives must be measurable so as to enable reporting on progress towards meeting them (for example, reducing silt load from the wetland catchment by xx %)

   Achievable – the objectives must be achievable at least in the medium or long term. An objective that cannot be achieved can lead to an overall loss of sense of direction and misallocation of resources (for example, completely preventing nutrient enrichment in a wetland located in the intensive agricultural landscape is an unachievable objective, a much better proposition would be to reduce the current rate by xx%).

   Indicative of purpose and not the process – the objectives should not be prescriptively stating the way the objective should be achieved. It should ideally reflect the purpose of management (for example – afforestation in xxx ha is not an objective but a way to reduce siltation. Focusing just on afforestation then limits the use of other options for reducing siltation in a wetland). The processes are generally used to define the action plan for the management objective.

Step 6: Developing a monitoring and evaluation plan

This section aims at outlining a monitoring and evaluation plan to enable assessment of overall management effectiveness and identify needs for mid-term correction.

For each of management objectives, a set of performance indicators should be identified. The performance indicators provide evidence on the condition of one or a set of features (Table 2). When the full range of performance indicators for all the management objectives have been identified, it is useful to combine them into a monitoring plan to enable systematic capture of the monitoring outcomes and use in informing the planning process. Some examples are provided below:

Table 2: Performance Indicators

Wetland feature	Management objective	Performance Indicator	Means of measurement
Area	Maintain wetland area	Wetland area which has not been altered for non-wetland usages	Area estimated from analysis of remote sensing images and ground truthing
Catchments	Reduction in silt load from catchment	Silt load	Monitoring pilot watersheds
Hydrological regimes	Reduce pollution	Biological Oxygen Demand, Chemical Oxygen Demand or any other water quality parameter assessed against a threshold	Water quality monitoring
	Enhance hydrological connectivity within wetlands complex	Area of wetland complex inundated during high floods period	Analysis of remote sensing data, and hydrological surveys
Biodiversity	Maintain and enhance habitat of waterbirds	Area of wetland used by waterbirds	Physical survey
	Reduce area under invasive macrophyte	Area under invasive macrophyte	Analysis of remote sensing images and ground truthing
	Maintain fish species richness	Fish species richness	Sampling
Socioeconomics	Reduce use of harmful fishing practices	Number of destructive fishing gear used in the wetland	Survey
	Reduce direct dependence of communities on capture fisheries	Reduction in % of income derived from wetland	Socioeconomic surveys

For each performance indicator, a baseline value at the beginning of management plan implementation may be specified. These values should be tracked over the course of management plan implementation to assess whether management objectives are being met.

Besides setting up performance indicators for the management plan, it is also essential to set up a monitoring system for the wetland in order to be able to assess changes in ecosystem condition over a period of time. A generic listing of monitoring parameter, method and frequency is presented in the Table below. Parameters marked with a single asterisk (*) sign are relevant for all wetlands and must form a part of the monitoring system. In addition to these, parameters marked with a double asterisk (**) are relevant for wetlands located in urban and peri-urban areas. Other parameters may be included based on the assessment of relevance and wetland contexts.

Table 3: Parameters for wetlands monitoring

Wetland feature	Monitoring parameter	Monitoring method	Frequency
Wetland extent	• Wetland area*	Remote sensing and ground truthing	Once in a year
	• Land use and land cover within the wetland area	Remote sensing and ground truthing	Once in a year
	• Connectivity with other adjoining wetlands, river / streams, coastal zone	Remote sensing and ground truthing	Once in a year
Wetland Catchment	• Climate	Data from the nearest weather station	Atleast monthly
	• Land use and Land Cover*	Remote sensing and ground truthing	Once in 3 years
	• Total sediment yield	Stream gauging station	Monthly
	• Total nutrient yield	Stream gauging station	Monthly
Hydrological regimes	• Water inflow and outflow*	Stream gauging station	Monthly
	• Waterholding capacity	Bathymetric survey	Once in 5 years
	• Peak inundation	Remote sensing and ground truthing	Once in 2 years
	• Dissolved Oxygen, Biological Oxygen Demand *	Data from water quality sampling stations	Atleast monthly
	• Chemical Oxygen Demand **	Data from water quality sampling stations	Atleast monthly
	• Number of point sources discharging untreated sewage into the wetland **	Surveys	Once a year
Biodiversity and Habitat	• Population of majorwetland dependent species groups (such as waterbirds, mammals etc.)*	Mid-winter counts	Once a year
	• Habitat use by key species	Physical surveys	Once a year
	• Number of migratory species using the wetland as a habitat	Physical surveys	Once a year
	• Area under invasive macrophyte**	Physical surveys	Once a year
Ecosystem Services	• Annual Fish yield	Sampling	Monthly samples collated into an annual estimate
	• Number of tourists	Surveys	Monthly samples collated into an annual estimate
	• Volume of surface water abstracted from wetland	Hydrographic surveys	Monthly samples collated into an annual estimate
	• Volume of groundwater recharged	Hydrographic surveys	Once a year

Wetland feature	Monitoring parameter	Monitoring method	Frequency
	• Proportion of floodwaters stored in the wetland	Hydrographic surveys	Once a year
	• Use of wetland for research and education	Surveys	Annual estimate
Livelihoods	• Population living around the wetland*	Surveys	Once every three years
	• Population depending on wetlands for livelihoods	Surveys	Once every three years
	• Number of households around the wetland using safe sanitation practices	Surveys	Once every three years
	• Participation of communities in wetlands management	Surveys	Once every three years

Step 7 – Developing an action plan

The last stage of the management planning process includes defining the action plan, or specific interventions that address the identified management objectives. The action plan should be developed in two steps. The first step should be a comprehensive listing of activities which are required to be implemented. In the second stage, the activities should be filtered with reference to core and non-core activities prescribed under NPCA, and detailed further.

7.1 Preparing a comprehensive list of activities

A generic listing of activities that may be required for integrated management of wetlands is presented in Table 3. Each activity should have a short description indicating why the activity is required, where is the activity to be implemented, and what is the implementation priority. Following must be kept in mind:

(a) Ecosystem-based interventions should be promoted as far as possible

(b) Engineering interventions in wetlands should be taken up in a limited manner, with impact assessments conducted for all major works

(c) Operations and maintenance of all structural works should be included in project design
Participation of local communities should be included to the extent possible

Table 4: Generic listing of activities for management of wetlands

Management Plan component	**Activities**	**Key considerations**
Boundary delineation and demarcation	Boundary mapping and delineation	Site boundaries should be established with reference to inundation regimes, soil conditions and vegetation types. Landscape connectivity should also be taken into account when aquatic ecosystems exist in patches. All activities should be completed within the first year.
	Removal of encroachments	Boundaries should be notified and legally protected wherever possible. All activities should be completed within the first year.
	Shoreline management	Mostly required for wetlands in urban and peri-urban setting. For stabilizing bunds of wetlands, naturalization of slopes using vegetative measures should be preferred. Development of promenade for urban lakes can be included based on an evaluation of natural drainage and shoreline ecosystem niches.
Catchment conservation	Afforestation and aided regeneration	Catchment conservation plans should be developed at watershed scales and based on Joint Forest Management approaches. Only native species should be used for forestry operations. Pilot watershed should be periodically monitored to assess changes in soil moisture regimes. Livelihood interventions for catchment communities aimed at reducing dependence on wood as an energy source should be included as appropriate.
	Small scale engineering measures (gully plugging, check dams, gabion structures etc.)	Community participation in design, implementation and post-project maintenance of structures should be ensured.
Water management	Selective dredging and desilting to improve hydrological connectivity	Dredging to be used only selectively, and be based on assessments of bathymetric profile and species interactions. For inflowing channels, dredging ca be used to improve water inflow.
	Interception, diversion and treatment of point sources of pollution	Mostly recommended for wetlands in the urban and peri-urban setting. Provision of comprehensive sanitation and safe drinking water coverage to communities living around the aquatic ecosystem should be ensured. Engineering (STPs) as well as biological options (constructed wetlands) should be evaluated for application. Planning for Operation and Maintenance expenses should be included for all engineering structures.
	Construction and operation of hydraulic structures for maintenance of water regimes and flood control	For each significant structure, detailed environmental impact assessments should be carried out prior to construction.
	Balancing water allocation for	Environmental flows for wetlands, hydrological regimes of

Management Plan component	Activities	Key considerations
	human and ecological purposes	which are affected by hydraulic structures, should be assessed and implemented in consultation in water managers
Biodiversity conservation	Habitat evaluation and improvement	Until specifically desired, plantation of terrestrial plant species in wetlands should be avoided.
	Improvement and maintenance of migratory routes	Community groups should be involved in habitat monitoring and maintenance of migratory routes
	Maintenance of breeding and spawning grounds for key species	Community groups should be involved in the maintenance of breeding and spawning grounds
	Management of invasive species	A mix of mechanical and biological methods for controlling species invasion should be used. For plant invasives, economic utilization along with physical removal should be included.
Sustainable resource development and livelihood improvement	Microenterprise development for reducing dependence on wetlands resources for livelihoods	Identification of micro-enterprise development options should be based on an assessment of community livelihoods, capacities, resources and market linkages.
	Sustainable fisheries development	Only capture based fisheries techniques should be promoted in natural wetlands Options for improving culture fisheries in areas around wetlands may be included to reduce dependence on capture fisheries
	Sustainable agriculture development	Organic farming practices in immediate catchments should be included to minimize nutrient enrichment in wetland.
Institutional development	Setting regulatory regimes	Site regulation should be harmonized with national and State level regulations. Local customary self-regulation which supports maintenance of conservation values should be promoted
	Development of monitoring and evaluation system	Comprehensive monitoring and evaluation mechanism for hydrological, ecological, socio-economic and institutional features should be made a part of the management system Involvement of stakeholders in monitoring should be encouraged.
	Communication and Outreach	Increasing awareness on values and functions of wetland should be made an integral part of the management plan
	Research	For each site, key research areas to support management needs should be identified and included in the management plan

7.2 Preparing an action plan for NPCA support

From the generic list compiled under the previous steps, activities which fall within the list of core and non-core activities covered under the NPCA should be filtered out and elaborated. Following details should be included:

- Why is the activity important?
- How will the activity be implemented? (include intermediate steps, technical specifications and relevant drawings, as may be the case)
- Where will the activity be implemented?
- Who will implement the activity?
- What are the quantitative targets to be met?

Step 8: Developing budget and financing plan

A complete costing of the Integrated Management Plan item wise should be done for the entire tenure of the plan using the existing norms of the State and central government, as may be the case. Year wise requirement of funds for various items of work/ activities, bar and PERT charts for the works/activities should be prepared. For each of the activity, an analysis of complementarity with ongoing development or conservation sector schemes should be done to assess the extent of funding that can be generated through convergence with these schemes. Opportunities for private sector participation should also be identified. Summary of Cost Estimates and year-wise breakup of the requirement of funds may be presented in the formats given below:

Table 5: Summary of budget

S. No	**Management Plan component**	**Budget**

Once the total budget has been prepared, a mapping of funds available from various government schemes, international and national donors and private sector may be presented in the following format.

Table 6: Analysis of convergence funding

Activity	**Total Budget**	**Funds from Central Government Scheme (Scheme Name)**	**Funds from State Government (Scheme Name)**	**Funds from other donors (Project and donor name)**	**Funds from private sector (Name of the agency)**	**Funds available from convergence sources**	**Funds required to be raised**
	(a)	(b)	(c)	(d)	(e)	(f) = (b) + (c) + (d) + (e)	(g) = (a) -(f)

The management plan proposed to be covered under NPCA should be detailed in the Table 7. For each costs item, the relevant basis or schedule of rates may be referenced. Funds requirement should be spread across the entire management plan implementation duration. It may be noted that core funds may be allocated not less than 75% of the budget, and non-core upto 25% of the budget.

Table 7: Year-wise breakup of requirement of funds required from NPCA

S.No	Activity	Funds Required in Yr I	Funds Required in Yr II	Funds Required in Yr III	Funds Required in Yr IV	Funds Required in Yr V	Total

Format for compiling Integrated Management Plan

The management plan should have a cover sheet with the following information:

- Wetland Name
- Wetland Area (in ha)
- Location: (District(s), State / UT)
- Area of the direct catchment (in ha)
- Name of the nodal agency for management plan implementation
- Management plan period
- Date on which approval of State / UT Wetland Authority was obtained
- Total budget
- Total funds available from convergence sources
- Funds requested from the MoEFCC

Table 8: The management plan may be compiled in the following eight chapters:

Chapter heading	Sub-headings	Explanation	Reference to Management Planning Steps
1. Introduction	1.1 Rationale for management planning	Describe the importance of wetland, ways in which wetlands conservation and *wise use* will contribute to state conservation and development goals and alignment with state and central government policies, directives and planning frameworks	Step 1
	1.2 Terms of reference	Enlist the overall terms of reference for the management plan	Step 1
	1.3 Approach and Method	Provide an overview of approach (ways in which the recommended steps have been used) Describe the data sources and research carried out for	Step 1

Chapter heading	Sub-headings	Explanation	Reference to Management Planning Steps
		management planning if any	
2. Description of wetlands features	2.1 Description of wetland features • Location and extent • Wetland catchments • Hydrological regimes • Biodiversity • Ecosystem Services • Socioeconomics and livelihoods	Describe wetland features. As far as possible, present the data in maps.	Step 2
3. Evaluation of wetlands features	3.1 Evaluation • Priority wetland features that need to be maintained and thresholds thereof • Threats	From the wetlands features described in the previous section, enlist the priority wetlands features. Describe the threats that adversely affect the priory wetland features.	Step 3
4. Institutional arrangements	4.1 Review of existing arrangements • Key organizations and programmes • Rules and regulations • Role of civil society and community-based organizations	Provide an overview of the current institutional arrangements in the context of wetlands management	Step 4
	4.2 Gaps	Discuss why the current institutional arrangements are insufficient in ensuring wetlands conservation and *wise use*.	Step 4
	4.3 Proposed arrangements for wetland management	Propose institutional arrangement for wetland management, which specific focus on a) nodal agency, b) role of various departments and agencies and coordination mechanism, and c) the role of civil society and communities. Develop an organogram for management plan implementation.	Step 4

Chapter heading	Sub-headings	Explanation	Reference to Management Planning Steps
5. Setting Management Objectives	5.1 Goal and purpose	Provide a statement of the overall goal that the management plan seeks to achieve	Step 5
	5.2 Benefits (ecological as well as societal)	Summarize the ecological and economic benefits that are expected from management plan implementation	
	5.3 Management objectives	Enlist the specific objectives	Step 5
	5.4 Strategies	Describe strategy(ies) for achieving each of the management objectives	Step 5
6. Monitoring and evaluation plan	6.1 Monitoring strategy	Present an overview of monitoring the wetland, and management plan implementation	Step 6
	6.2 Monitoring parameters, frequency and responsibility	Describe the monitoring parameters, the frequency of monitoring and the agency that will be responsible for monitoring	Step 6
	6.3 Institutional design	Describe how coordination between different monitoring agencies will be achieved.	Step 6
	6.4 Infrastructure and human resources design	Discuss the infrastructure and human resource requirement for implementing the management plan. As far as possible, including local universities, research organizations and NGOs in wetlands monitoring	Step 6
	6.5 Reporting	Discuss the frequency in which reporting shall be done and the responsible agency.	Step 6
	6.6 Review and adaptation	Discuss how the monitoring outcomes will be used to adapt management	Step 6
7. Developing an Action Plan	7.1 Component wise activities linked with management objectives	Generic listing of activities indicating: • What will be done? • Where will the activity be done?	Step 7.1

Chapter heading	Sub-headings	Explanation	Reference to Management Planning Steps
		• What is the priority for the activity?	
	7.2 Components for consideration for support under NPCA	For all activities eligible for support under NPCA indicate: • Why is the activity important? • How will the activity be implemented? (include intermediate steps, technical specifications and relevant drawings, as may be the case) • Where will the activity be implemented? • Who will implement the activity? • What are the quantitative targets to be met?	Step 7.2
8. Budget and activity phasing	8.1 Activity linked budget	Present a summary budget in line with Table 5 Provide details of funding available from convergence sources in line with Table 6 Provide detailed budget for NPCA in line with Table 7	Step 8
	8 2 Time planning	Present a monthly Gantt Chart for management plan implementation	Step 8

The proposal for which FMP has been approved under NPCA or otherwise, following information should be submitted separately:

a) The activities which are covered under FMP along with status of its implementation and expenditure incurred
b) An undertaking that no duplication or overlap of activities between the FMP and IMP
c) List of Schemes/Programmes under Central/State Government has been examined for convergence while preparing the IMP

Annexure II: Suggestive list of Central and State Government Schemes which can support implementation of NPCA projects

Name of Scheme	Areas for convergence	Implementing Ministry
Atal mission for rejuvenation and urban transformation (AMRUT)	Enhancing amenity value of cities by creating and upgrading green spaces, parks and recreation centres, sewage facilities	Ministry of Urban Development
Heritage City Development and Augmentation Yojana (HRIDAY)	Holistic development of services such as water supply, sanitation, roads, etc.	
Smart Cities Mission	Area-based development for improvement, renewal and greenfield development.	
Different Schemes	Green	Ministry of Panchayati Raj
National Afforestation Programme	Catchment conservation	Ministry of Environment, Forest and Climate Change
Green India Mission	Catchment conservation	
National Action Programme to Combat Desertification	Assessment and mapping of land degradation, Drought Preparedness and Mitigation in the Context of Climate Change	
National Afforestation and Eco-Development Board (NAEB)	Ecological restoration and eco-development activities	
National Coastal Management Programme	Conserve and protect coastal stretches and to promote Sustainable development	
National Mission on Himalayan Studies	Conservation of Himalayan Ecosystem and sustainable development	
Repair, Renovation and Restoration of Water Bodies	Restoration of aquatic ecosystems used as sources of drinking water	Ministry of Water Resources, River Development & Ganga Rejuvenation
Natural Resources Management, Rainfed Farming System, Horticulture, Integrated Nutrient Management	Sustainable agriculture	Ministry of Agriculture and Farmers Welfare & Department of Animal Husbandry, Dairying and Fisheries (DADF)
National Scheme on “Welfare of Fishermen” and “Development of Inland Fisheries”	Sustainable fisheries development	
Swachh Bharat Mission (SBM)	Development of sanitation infrastructure to improve water quality of Urban and Rural Ecosystems	Ministry of Urban Development & Ministry of Drinking Water and Sanitation
National Mission on Pilgrimage Rejuvenation and	Beautify and improve amenities and infrastructure at major pilgrimage sites	Ministry of Tourism

Spiritual Augmentation Drive (PRASAD)	in the country	
State Government schemes on fisheries, agriculture, forestry, wildlife protection, irrigation development etc.	Various components of DPR	Various State Governments and their Concerned Ministries.

Annexure III: Core and non-core activities corresponding to management action plan components

Management Plan Components	Core Activities	Non-core activities
Wetland boundary delineation and demarcation	• Wetlands boundary survey and mapping • Wetlands demarcation using geotagged pillars	• Fending of wetlands boundary • Development of promenade for urban wetlands
Catchment conservation	• Afforestation and aided regeneration within direct catchments • Small scale engineering structures (such as gully plugging, check dams, gabion structures, silt traps) • Monitoring pilot watersheds to assess degree of reduction in siltation and improvement of moisture regimes	• Large engineering structures within wetlands direct or indirect catchment
Water management	• Assessment of water requirements of wetlands and aligning operational rules for hydraulic structures for achieving the desired regime • Dredging of critically silted up wetlands areas based on consideration of bathymetric profiles and impacts on ecosystem components and processes • Dredging of inflowing channels to improve water availability in the wetland • Constructed wetlands to treat pollution from diffuse sources • Construction of Sewage Treatment Plants	• Procurement of machinery • Construction of toilets and bathing ghats • Operation and maintenance expenses
Biodiversity conservation and habitat management	• Assessment of habitat quality and species interactions • Population assessment of wetlands dependent species • Enforcement of regulation • Animal disease surveillance • Regulating species invasion by biological and habitat manipulation • Economic use of harvested biomass of invasive species	• Construction of rescue centers • Mechanical removal of invasive species biomass
Sustainable resource development and livelihood improvement	• Sustainable capture fisheries within carrying capacity of the wetland • Wetlands vegetation based micro-enterprise • Community based eco-tourism linked with wetlands • Conservation of cultural heritage linked with wetlands	• Aquaculture • Promotion of organic agriculture in wetlands catchments • Promotion of water efficient agriculture systems in wetlands catchments • Promotion of ornamental fisheries based culture

Management Plan Components	Core Activities	Non-core activities
	• Micro-enterprise development for wetlands dependent communities to diversify livelihoods	• Development of fish nurseries and seed banks • Development of tourism related infrastructure • Development of water, sanitation and health infrastructure for wetland communities • Micro-enterprise development for communities not-directly dependent on wetlands
Institutional development	• Wetlands monitoring and assessment • Research addressing specific wetlands management needs • Construction of wetlands interpretation center • Organization of World Wetlands Day and other events to enhance appreciation of wetlands values and functions • Publication of Ecosystem Health Report Cards or any other assessment of wetlands condition	• Construction of laboratories • Refurbishing of existing wetlands interpretation centers • Infrastructure development for Wetlands Authorities • Meetings of State Wetlands Authority

Annexure IV: Wetlands (Conservation and Management) Rules, 2017

MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE NOTIFICATION

New Delhi, the 26th September, 2017

G.S.R. 1203(E). —Whereas the wetlands, vital parts of the hydrological cycle, are highly productive ecosystems which support rich biodiversity and provide a wide range of ecosystem services such as water storage, water purification, flood mitigation, erosion control, aquifer recharge, microclimate regulation, aesthetic enhancement of landscapes while simultaneously supporting many significant recreational, social and cultural activities, being part of our rich cultural heritage;

And whereas many wetlands are threatened by reclamation and degradation through drainage and landfill, pollution (discharge of domestic and industrial effluents, disposal of solid wastes), hydrological alteration (water withdrawal and changes in inflow and outflow), over-exploitation of their natural resources resulting in loss of biodiversity and disruption in ecosystem services provided by wetlands;

THE GAZETTE OF INDIA: EXTRAORDINARY [PART II—SEC. 3(i)]

And whereas clause (g) of article 51A of the Constitution stipulates that it shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures;

And whereas the Environment (Protection) Act, 1986 is a comprehensive legislation to provide protection and improvement of the environment, including *inter-alia*, wetlands, and for matters connected therewith;

And whereas the National Environment Policy, 2006 recognises the ecosystem services provided by wetlands and emphasizes the need to set up a regulatory mechanism for all wetlands so as to maintain their ecological character, and ultimately support their integrated management;

And whereas India is a signatory to the Ramsar Convention on Wetlands and is committed to conservation and *wise use* of all wetlands within its territory;

And whereas the Central Government has published the Wetlands (Conservation and Management) Rules, 2010, vide number G.S.R. 951(E), dated the 4th December, 2010;

And whereas conservation and *wise use* of wetlands can provide substantial direct and indirect economic benefits to state and national economy, and thereby the Central Government stands committed to mainstreaming full range of wetland biodiversity and ecosystem services in development planning and decision making for various sectors;

And whereas the State Governments and Union Territory Administrations need to take into account wetland ecosystem services and biodiversity values likewise within their developmental programming and economic well-being, also taking into cognizance that land and water, two major ecological constituents of wetland ecosystems, are enlisted as State subjects as per the Constitution;

And whereas the Central Government considered it necessary to supersede the Wetlands (Conservation and Management) Rules, 2010 for effective conservation and management of wetlands in the country;

And whereas the Central Government had, in exercise of the powers conferred by section 25, read with subsection (1) and clause (v) of sub-section (2) and sub-section (3) of section 3 of the Environment (Protection) Act, 1986, published the draft Wetlands (Conservation and Management) Rules, 2016, vide number G.S.R. 385 (E) dated 31st March, 2016 for information of the public likely to be affected thereby; and notice was given that the said draft rules would be taken into consideration by the Central Government after expiry of a period of sixty days from the date on which copies of the Gazette notification is made available to the public;

And whereas the Central Government has received the suggestions and objections from the State Governments, Union Territories and its organisations, individuals and civil society organisations on the draft Wetlands (Conservation and Management) Rules, 2016;

And whereas the suggestions and objections received in response to the above-mentioned draft rules have been duly considered by the Central Government in consultation with State Governments and Union Territory Administrations.

Now, therefore, in exercise of the powers conferred by section 25, read with sub-section (1) and clause (v) of sub-section (2) and sub-section (3) of section 3 and section 23 of the Environment (Protection) Act, 1986 and in supersession of the Wetlands (Conservation and Management) Rules, 2010, except as respects things done or omitted to be done before such supersession, the Central Government hereby makes the following rules for conservation and management of wetlands, namely: —

1. Short title and commencement.—

(1) These rules may be called the Wetlands (Conservation and Management) Rules, 2017.
(2) These shall come into force from the date of their publication in the Official Gazette.

2. Definitions.—

(1) In these rules, unless the context otherwise requires,-

(a) "Act" means the Environment (Protection) Act, 1986;
(b) "Authority" means the State Wetlands Authority or Union Territory Wetlands Authority, as the case may be;
(c) "Committee" means the National Wetlands Committee referred to in rule 6;
(d) “ecological character” means the sum of ecosystem components, processes and services that characterise the wetlands;
(e) “integrated management plan” means a document which describes strategies and actions for achieving wise use of the wetland and the plan shall include objectives of site management; management actions required to achieve the objectives; factors that affect, or may affect, the various site features; monitoring requirements for detecting changes in ecological character and for measuring the effectiveness of management; and resources for management implementation;
(f) "Ramsar Convention" means the Convention on Wetlands signed at Ramsar, Iran in 1971;
(g) “wetland" means an area of marsh, fen, peatland or water; whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters, but does not include river channels, paddy fields, human-made water bodies/tanks specifically constructed for drinking water purposes and structures specifically constructed for aquaculture, salt production, recreation and irrigation purposes;

(h) “wetlands complexes" means two or more ecologically and hydrologically contiguous wetlands and may include their connecting channels/ducts;

(i) “wise use of wetlands” means maintenance of their ecological character, achieved through implementation of ecosystem approach within the context of sustainable development;

(j) “zone of influence” means that part of the catchment area of the wetland or wetland complex, developmental activities in which induce adverse changes in ecosystem structure, and ecosystem services.

(2) The words and expressions used in these rules and not defined, but defined in the Act, shall have the meanings assigned to them in the Act.

3. Applicability of rules.—These rules shall apply to the following wetlands or wetlands complexes, namely:—

(a) wetlands categorised as 'wetlands of international importance' under the Ramsar Convention;
(b) wetlands as notified by the Central Government, State Government and Union Territory Administration:

Provided that these rules shall not apply to the wetlands falling in areas covered under the Indian Forest Act, 1927, the Wild Life (Protection) Act, 1972, the Forest (Conservation) Act, 1980, the State Forest Acts, and the Coastal Regulation Zone Notification, 2011 as amended from time to time.

4. Restrictions of activities in wetlands.—

(1) The wetlands shall be conserved and managed in accordance with the principle of 'wise use' as determined by the Wetlands Authority.

(2) The following activities shall be prohibited within the wetlands, namely, -

(i) conversion for non-wetland uses including encroachment of any kind;
(ii) setting up of any industry and expansion of existing industries;
(iii) manufacture or handling or storage or disposal of construction and demolition waste covered under the Construction and Demolition Waste Management Rules, 2016; hazardous substances covered under the Manufacture, Storage and Import of Hazardous Chemical Rules, 1989 or the Rules for Manufacture, Use, Import, Export and Storage of Hazardous Micro-organisms Genetically engineered organisms or cells, 1989 or the Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008; electronic waste covered under the E-Waste (Management) Rules, 2016;
(iv) solid waste dumping;
(v) discharge of untreated wastes and effluents from industries, cities, towns, villages and other human settlements;
(vi) any construction of a permanent nature except for boat jetties within fifty metres from the mean high flood level observed in the past ten years calculated from the date of commencement of these rules; and,
(vii) poaching.

Provided that the Central Government may consider proposals from the State Government or Union Territory Administration for omitting any of the activities on the recommendation of the Authority.

5. Wetlands Authorities.—

(1) The Central Government hereby constitutes the State Wetlands Authority in each State with the following members, namely:—

(i) Minister In-charge of the Department of Environment/Forests of the State Government or Minister In-charge of the Department handling wetlands - Chairperson;
(ii) Chief Secretary of the State or Additional Chief Secretary equivalent - Vice Chairperson;
(iii) Secretary in-charge of the Department of Environment - Member *ex-officio*;
(iv) Secretary in-charge of the Department of Forests - Member *ex-officio*;
(v) Secretary in-charge of the Department of Urban Development - Member *ex-officio*;
(vi) Secretary in-charge of the Department of Rural Development - Member *ex-officio*;
(vii) Secretary in-charge of the Department of Water Resources - Member *ex-officio*;
(viii) Secretary in-charge of the Department of Fisheries - Member *ex-officio*;
(ix) Secretary in-charge of the Department of Irrigation and Flood Control - Member *ex-officio*;
(x) Secretary in-charge of the Department of Tourism - Member *ex-officio*;
(xi) Secretary in-charge of the Department of Revenue - Member *ex-officio*;
(xii) Director, State Remote Sensing Centre - Member *ex-officio*;
(xiii) Chief Wildlife Warden - Member *ex-officio*;
(xiv) Member Secretary, State Biodiversity Board - Member *ex-officio*;
(xv) Member Secretary, State Pollution Control Board - Member *ex-officio*;
(xvi) Additional Principal Chief Conservator of Forests of the Regional Office of Ministry of Environment, Forest and Climate Change - Member *ex-officio*;
(xvii) One expert each in the fields of wetland ecology, hydrology, fisheries, landscape planning and socioeconomics to be nominated by the State Government; and
(xviii) Additional Secretary/Joint Secretary/Director in the Department of Environment/Forests or Department handling wetlands - Member Secretary.

(2) The Central Government hereby constitutes the Union Territory Wetlands Authority for each Union Territory with the following members, namely:—

(i) Administrator or Chief Secretary of the Union Territory - Chairperson;
(ii) Secretary in-charge of the Department of Environment - Vice Chairperson;
(iii) Secretary in-charge of the Department of Forests - Member *ex-officio*;
(iv) Secretary in-charge of the Department of Urban Development - Member *ex-officio*;
(v) Secretary in-charge of the Department of Rural Development - Member *ex-officio*;
(vi) Secretary in-charge of the Department of Water Resources - Member *ex-officio*;
(vii) Secretary in-charge of the Department of Fisheries - Member *ex-officio*;
(viii) Secretary in-charge of the Department of Irrigation and Flood Control - Member *ex-officio*;
(ix) Secretary in-charge of the Department of Tourism - Member *ex-officio*;
(x) Secretary in-charge of the Departments of Revenue - Member *ex-officio*;
(xi) Director, Remote Sensing Centre - Member *ex-officio;*
(xii) Member Secretary, Union Territory Pollution Control Committee - Member *ex-officio*;
(xiii) Member Secretary, Biodiversity Board of the UT - Member *ex-officio*;
(xiv) Chief Wildlife Warden - Member *ex-officio*;
(xv) Additional Principal Chief Conservator of Forests of the Regional Office of Ministry of Environment, Forest and Climate Change- Member *ex-officio*;
(xvi) One expert each in the fields of wetland ecology, hydrology, fisheries, landscape planning and socioeconomics to be nominated by the Union Territory Administration; and
(xvii) Additional Secretary/Joint Secretary/Director in the Department of Environment/Forests or Department handling wetlands - Member Secretary.

(3) The State Wetlands Authority or Union Territory Wetlands Authority may co-opt other members, not exceeding three in number, if required.

(4) The State Wetlands Authority or Union Territory Wetlands Authority shall exercise the following powers and perform the following functions, namely:-

(a) prepare a list of all wetlands of the State or Union Territory within three months from the date of publication of these rules;
(b) prepare a list of wetlands to be notified, within six months from the date of publication of these rules; taking into cognizance any existing list of wetlands prepared/notified under other relevant State Acts;
(c) recommend identified wetlands, based on their brief documents, for regulation under these rules;
(d) prepare a comprehensive digital inventory of all wetlands within a period of one year from the date of publication of these rules and upload the same on a dedicated web portal to be developed by the Central Government for the said purpose; the inventory to be updated every ten years;
(e) develop a comprehensive list of activities to be regulated and permitted within the notified wetlands and their zone of influence;
(f) recommend additions, if any, to the list of prohibited activities for specific wetlands;
(g) define strategies for conservation and wise use of wetlands within their jurisdiction; wise use being a principle for managing these ecosystems which incorporates sustainable uses (such as capture fisheries at subsistence level or harvest of aquatic plants) as being compatible with conservation, if ecosystem functions (such as water storage, groundwater recharge, flood buffering) and values (such as recreation and cultural) are maintained or enhanced;
(h) review integrated management plan for each of the notified wetlands (including trans-boundary wetlands in coordination with Central Government), and within these plans consider continuation and support to traditional uses of wetlands which are harmonized with ecological character;
(i) in cases wherein lands within boundary of notified wetlands or wetlands complex have private tenancy rights, recommend mechanisms for maintenance of ecological character through promotional activities;
(j) identify mechanisms for convergence of implementation of the management plan with the existing State/Union Territory level development plans and programmes;
(k) ensure enforcement of these rules and other relevant Acts, rules and regulations and on half-yearly basis (June and December of each calendar year) inform the concerned State Government or Union Territory Administration or Central Government on the status of such notified wetlands through a reporting mechanism;
(l) coordinate implementation of integrated management plans based on wise use principle through various line departments and other concerned agencies;
(m) function as nodal authority for all wetland specific authorities within the State or Union Territory Administration;
(n) issue necessary directions for conservation and sustainable management of wetlands to the respective implementing agencies;

(o) undertake measures for enhancing awareness within stakeholders and local communities on values and functions of wetlands; and

(p) Advise on any other matter *suo-motu*, or as referred by the State Government/Union Territory Administration.

(5) The concerned Department of the State Government or Union Territory shall provide all necessary support and act as nodal Department and Secretariat to the Authority.

(6) The Authority shall, within ninety days of publication of these rules, shall constitute,—

(a) a technical committee to review brief documents, management plans and advise on any technical matter referred by the Wetland Authority; and

(b) a grievance committee consisting of four members to provide a mechanism for hearing and forwarding the grievances raised by public to the Authority;

(7) The Committees referred to in sub-rule (6) shall meet at least once in every quarter to perform their functions.

(8) The Authority shall meet at least thrice in a year.

(9) The term of non-official members of the Authority nominated by State Government or Union Territory Administration, shall be for a period not exceeding three years.

6. Constitution of National Wetlands Committee.—

(1) The Central Government, hereby constitutes the National Wetlands Committee with the following members, namely:—

(i) Secretary, Ministry of Environment, Forest and Climate Change, Government of India - Chairperson;

(ii) Special Secretary or Additional Secretary dealing with wetlands, Ministry of Environment, Forest and Climate Change, Government of India-Vice Chairperson;

(iii) Additional Director General, Wildlife, Ministry of Environment, Forest and Climate Change, Government of India - Member *ex-officio*;

(iv) Adviser or Joint Secretary dealing with wetlands, Ministry of Environment, Forest and Climate Change - Member *ex-officio*;

(v) Joint Secretary, Ministry of Tourism, Government of India- Member *ex-officio*;

(vi) Joint Secretary, Ministry of Water Resources, River Development and Ganga Rejuvenation, Government of India- Member *ex-officio*;

(vii) Joint Secretary, Ministry of Agriculture and Farmers Welfare, Government of India- Member *exofficio*;

(viii) Joint Secretary, Ministry of Social Justice and Empowerment, Government of India- Member *exofficio*;

(ix) Joint Secretary, Ministry of Urban Development, Government of India- Member *ex-officio*;

(x) Joint Secretary, Ministry of Rural Development, Government of India- Member *ex-officio*;

(xi) The Chairman, Central Pollution Control Board - Member *ex-officio*;

(xii) Director, Zoological Survey of India or Scientist F- Member *ex-officio*;

(xiii) Director, Botanical Survey of India or Scientist F- Member *ex-officio*;

(xiv) Director, Space Application Centre, Ahmedabad or Scientist F- Member *ex-officio*;
(xv) Member, Central Water Commission - Member *ex-officio*;
(xvi) Adviser, Niti Aayog - Member *ex-officio*;
(xvii) Three representatives of State Government or Union Territory Administration on a rotational basis for a tenure of two years each;
(xviii) One expert each in the fields of wetland ecology, hydrology, fisheries, landscape planning & socioeconomics; and
(xix) Director/Additional Director/Joint Director dealing with wetlands, Ministry of Environment, Forest and Climate Change - Member Secretary.

(2) The National Wetlands Committee may co-opt other members, not exceeding three in number, if required.

(3) The National Wetlands Committee shall perform the following functions, namely:-

(a) advise the Central Government on appropriate policies and action programmes for conservation and wise use of wetlands;
(b) evolve norms and guidelines for integrated management of wetlands based on wise use principle;
(c) monitor implementation of these rules by the Authority;
(d) advise the Central Government on proposals received from State Governments or Union Territory Administrations for omission of the prohibited activities as referred in sub-rule (2) of rule 4;
(e) recommend designation of wetlands of international importance under Ramsar Convention;
(f) recommend trans-boundary wetlands for notification;
(g) review progress of integrated management of Ramsar sites and transboundary wetlands;
(h) advise on collaboration with international agencies on issues related to wetlands; and
(i) advise on any other matter *suo-moto*, or as referred by the Central Government.

(4) The tenure of non-official members of the Committee shall not exceed three years.

(5) The Committee shall meet at least once in every six months.

7. Delegation of powers and functions to the State Governments and Union Territory Administrations.—

(1) The concerned Department of the State Government or Union Territory Administration shall, within a period of one year from the date of publication of these rules, prepare a Brief Document for each of the wetland identified for notification, providing:—

(a) demarcation of wetland boundary supported by accurate digital maps with coordinates and validated by ground truthing;
(b) demarcation of its zone of influence and land use and land cover thereof indicated in a digital map;
(c) ecological character description;
(d) account of pre-existing rights and privileges;
(e) list of site-specific activities to be permitted within the wetland and its zone of influence;
(f) list of site-specific activities to be regulated within the wetland and its zone of influence; and
(g) modalities for enforcement of regulation;

(2) Based on the Brief Document, the Authority shall make recommendations to the State Government or Union Territory Administration for notifying the wetlands.

(3) The State Government or Union Territory Administration shall, after considering the objections, if any, from the concerned and affected persons, notify the wetlands in the Official Gazette, within a period not exceeding 240 days from the date of recommendation by the Authority.

(4) (a) In case of trans-boundary wetlands, the Central Government shall coordinate with concerned State Governments and Union Territory Administrations to prepare the Brief Document containing information as listed in sub-rule (1).

(b) Based on the Brief Document, the National Wetlands Committee shall make recommendations to the Central Government for notification of the wetland.

(c) The Central Government shall, after considering the objections, if any, from the concerned and affected persons, notify the wetlands in the Official Gazette, within a period not exceeding 240 days from the date of recommendation by the Committee.

(5) (a) The Central Government shall create a dedicated web portal for information relating to wetlands.

(b) The Central Government, State Government and Union Territory Administration shall upload all relevant information and documents pertaining to wetlands in their jurisdiction.

[F. No. J-22012/78/2003-CS (W) Pt. V]

Dr. A. DURAISAMY, Scientist 'G'

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Annexure V: Designated Best Use Criteria for Surface Waters as recommended by CPCB

Designated Best Use	Class of Criteria	Criteria
Drinking Water Source without conventional treatment but after disinfection	A	1. Total Coliforms Organism MPN/100ml Shall be 50 of less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 6mg/l or more 4. Biochemical Oxygen Demand 5 days 20^0C 2mg/l of less
Outdoor bathing (Organised)	B	1. Fecal Coliforms organism MPN/100 ml shall be 500 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen Demand 5 mg/l or more 4. Biochemical Oxygen Demand 5 days 20^0C 3 mg/l or less
Drinking water source after conventional treatment and disinfection	C	1. Total coliforms organism MPN/100 ml shall be 5000 or less 2. pH between 6 to 9 3. Dissolved oxygen 4 mg/l or more 4. Biochemical Oxygen Demand 5 days 20^0C 3mg/l or less
Propagation of Wildlife and Fisheries	D	1. pH between 6.5 to 8.5 2. Dissolved Oxygen 4mg/l or more 3. Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	1. pH between 6.0 to 8.5 2. Electrical Conductivity at 250C micro mhos/cm Max 2250 3. Sodium absorption Ratio Max 26 4. Boron Max 2 mg/l
	Below E	Not Meeting A, B, C, D, & E Criteria

Annexure VI: Format for preparing brief document

State / Union Territory: _____

Name and address of person(s) compiling this information _____

Section 1: Identification, Location and Jurisdiction

1.1 Name of the Wetland (Alternative names, including in local language should be given in parenthesis after official name)

_____

1.2 Name of the Village(s), Tehsil(s), Municipal area(s)

_____

1.3 Name of the District(s) in which wetland complex is located

_____

1.4 Geographical coordinates (Latitude and Longitude, to degree, minutes and second)

Latitude: From _____ to _____

Longitude: From _____ to _____

1.5 Name of the Department / Agency which has jurisdiction over the wetland / wetlands complex

_____

Section 2: Site Characteristics

2.1 Area of wetland / wetlands category (ha) _____

2.2 Wetland type (Please tick appropriate categories and sub-categories)

Category	Subcategory
❒ Natural (Inland)	❒ Permanent lakes
	❒ Seasonal/ intermittent lakes
	❒ Permanent streams/ creeks
	❒ Seasonal/ intermittent streams/ creeks
	❒ Oxbow
	❒ River floodplain
	❒ Permanent freshwater marshes
	❒ Seasonal/ intermittent freshwater marshes
	❒ Shrub-dominated wetlands
	❒ Tree-dominated wetlands
	❒ Geothermal wetlands
	❒ Karst and other subterranean hydrological systems

Category	Subcategory
❒ Natural (Coastal)	❒ Coastal lagoon ❒ Estuary ❒ Intertidal mud, sand or salt flats ❒ Mangroves ❒ Coral reefs
❒ Human-made	❒ Aquaculture pond ❒ Tank ❒ Saltpan ❒ Dam / Reservoir

2.3 Depth (m) Average _____ Maximum _____

2.4 Elevation (m above mean sea level) _____ m

2.5 Water regimes

a) Main source of water (tick all applicable)

❒ Rainfall ❒ Groundwater ❒ Catchment runoff ❒ Direct / indirect inflow from river
❒ Others, please specify_____

b) Water permanence

❒ Mostly permanent ❒ Mostly intermittent

c) Destination of water from wetland

❒ Feeds groundwater ❒ To downstream catchment ❒ To river ❒ To sea

d) Water pH

❒ Acid (< 5.5) ❒ Circumneutral (5.5 – 7.4) ❒ Alkaline (> 7.4) ❒ Not known

e) Water salinity

❒ Fresh (< 0.5 g/l) ❒ Brackish (0.5 – 30 g/l)) ❒ Euhaline (30- 40 g/l) ❒ Hypersaline (>40g/l)
❒ Not known

f) Nutrient in water

❒ Eutrophic ❒ Mesotrophic ❒ Oligotrophic ❒ Not known

2.6 Climatic setting

a) Annual Rainfall /Snowfall(mm) _____

b) Temperature (°C) Minimum _____ Maximum _____

c) Humidity (%) Minimum _____ Maximum _____

2.7 Area of zone of influence (in ha) _____

2.8 Major land use within zone of influence (provide as approximate % of catchment area)

Forests _____%

Plantation _____%

Agriculture _____%

Settlements (Rural) _____%

Settlements (Urban) _____%

Industrial _____%

2.9 Map of wetland complex and zone of influence

(To be enclosed as Annex I and II to this proposal)

Section 3: Biodiversity

3.1 Notable plant species present in wetland

_____

3.2 Notable animal species present in wetland

_____

3.3 Species of conservation significance (rare, endangered, threatened, endemic species)

_____

3.4 Major plant invasive alien species

_____

3.5 Major animal invasive alien species

_____

Section 4: Ecosystem services

Importance	Relevant for the site (please tick yes or no)	If Yes, Details (upto 50 words for each category)
Source of drinking water for people living and around	❒Yes ❒No	
Source of water for agriculture	❒Yes ❒No	
Fisheries	❒Yes ❒No	
Cultivation of aquatic food plants	❒Yes ❒No	
For buffalo wallowing and use of domesticated animals	❒Yes ❒No	
Medicinal plants	❒Yes ❒No	
Is a recreational site	❒Yes ❒No	
Buffering communities from extreme events as floods and storms	❒Yes ❒No	
Groundwater recharge	❒Yes ❒No	
Water purification	❒Yes ❒No	
Acts as a sink for sediments	❒Yes ❒No	
Has significant cultural and religious values	❒Yes ❒No	
Is a site for recreation and tourism	❒Yes ❒No	
Supports noteworthy plants species	❒Yes ❒No	
Supports noteworthy animal species	❒Yes ❒No	
Site of high congregation of migratory water birds	❒Yes ❒No	

-⊗-

Importance	Relevant for the site (please tick yes or no)	If Yes, Details (upto 50 words for each category)
Supports life cycle of fish or amphibians	❒Yes ❒No	
Mining	❒Yes ❒No	
Any other, please list		

Section 5: Pre-Existing Rights and Privileges

Nature of right and privilege	Relevant for the site (please tick yes or no)	Does this negatively impact the wetland's ecological health?	Brief description (upto 50 words for each category)
Community Fishing (without any lease or permission from government department)	❒Yes ❒No	❒Yes ❒No ❒Not assessed	
Fishing under lease from government department	❒Yes ❒No	❒Yes ❒No ❒Not assessed	
Harvest of plants (without any lease or permission from government department)	❒Yes ❒No	❒Yes ❒No ❒Not assessed	
Harvest of plants under lease from government department	❒Yes ❒No	❒Yes ❒No ❒Not assessed	
Agriculture or horticulture within wetland	❒Yes ❒No	❒Yes ❒No ❒Not assessed	
Grazing	❒Yes ❒No	❒Yes ❒No ❒Not assessed	
Religious practices	❒Yes ❒No	❒Yes ❒No ❒Not assessed	
Withdrawal of water for domestic use	❒Yes ❒No	❒Yes ❒No ❒Not assessed	
Withdrawal of water for agriculture or fisheries	❒Yes ❒No	❒Yes ❒No ❒Not assessed	
Bathing or wallowing of domestic animals	❒Yes ❒No	❒Yes ❒No	

Nature of right and privilege	Relevant for the site (please tick yes or no)	Does this negatively impact the wetland's ecological health?	Brief description (upto 50 words for each category)
		❒Not assessed	
Plying of boats	❒Yes ❒No	❒Yes ❒No ❒Not assessed	
Any other, please list here	❒Yes ❒No	❒Yes ❒No ❒Not assessed	

Section 6: Present and Potential Threats

Threat	Degree	Present or Potential	Additional information, if any
Changes in water inflow and outflow	❒High❒Medium ❒Low	❒Present ❒Potential	
Pollution	❒High ❒Medium ❒Low	❒Present ❒Potential	
Unsustainable harvest of biological resources	❒High ❒Medium ❒Low	❒Present ❒Potential	
Mining	❒High ❒Medium ❒Low	❒Present ❒Potential	
Siltation	❒High ❒Medium ❒Low	❒Present ❒Potential	
Encroachment	❒High ❒Medium ❒Low	❒Present ❒Potential	
Spread of invasive species	❒High ❒Medium ❒Low	❒Present ❒Potential	
Any other, please list	❒High ❒Medium ❒Low	❒Present ❒Potential	

Section 7: Activities Proposed to be prohibited (other than those listed in Rule 4(2) of Wetlands Rules)

Activity	Prohibited within wetlands or zone of influence	Details of specific area wherein activity is prohibited	Name of department / agency responsible for regulation	Additional information, if any
	❒ Wetland / Wetlands complex boundary ❒ Zone of influence			

Section 8: Activities Proposed to be regulated

Activity	Place a tick mark if relevant	Regulation within wetlands or zone of influence	Level of regulation (in terms of people, restricted area or any other)	Name of department / agency responsible for regulation	Additional information, if any
Withdrawal of water / impoundment/diversion or any other hydrological intervention	❒	❒ Wetland / Wetlands complex boundary ❒ Zone of influence			
Harvesting of resources (living / non-living)	❒	❒ Wetland / Wetlands complex boundary ❒ Zone of influence			
Grazing	❒	❒ Wetland / Wetlands complex boundary ❒ Zone of influence			
Discharge of treated sewage/ effluent / wastewater	❒	❒ Wetland / Wetlands complex boundary ❒ Zone of influence			
Construction of boat jetties, and facilities for temporary use, as pontoon bridges	❒	❒ Wetland / Wetlands complex boundary ❒ Zone of influence			
Aquaculture, agriculture and horticulture activities within the wetland boundaries.	❒	❒ Wetland / Wetlands complex boundary ❒ Zone of influence			
Any other, please list		❒ Wetland / Wetlands complex boundary ❒ Zone of influence			

Section 9: Activities Proposed to be permitted

Activity	Place a tick mark if relevant	Within wetlands or zone of influence	Additional information, if any
	❒	❒ Wetland / Wetlands complex boundary ❒ Zone of influence	
	❒	❒ Wetland / Wetlands complex boundary ❒ Zone of influence	
	❒	❒ Wetland / Wetlands complex boundary ❒ Zone of influence	
	❒	❒ Wetland / Wetlands complex boundary ❒ Zone of influence	
	❒	❒ Wetland / Wetlands complex boundary ❒ Zone of influence	
	❒	❒ Wetland / Wetlands complex boundary ❒ Zone of influence	
		❒ Wetland / Wetlands complex boundary ❒ Zone of influence	

Section 10: Listing of Available Scientific Resources Used

_____
_____
_____
_____
_____

CHECKLIST

- ❒ Responsible agency has been clearly identified and details of contact person included
- ❒ Wetland/ wetlands complex boundary has been delineated using GIS and firmed up by adequate ground truthing
- ❒ Wetland/ wetlands complex map has been provided at required scale
- ❒ Zone of influence has been delineated and included in wetland map or a separate map
- ❒ Wetland zone of influence is sufficient to manage all activities
- ❒ Site's importance has been listed, and for major categories, justification is provided
- ❒ Site's biodiversity values are listed, and for major categories, justification is provided
- ❒ List of pre-existing rights and privileges is provided
- ❒ Consistency or inconsistency of pre-existing rights and privileges is indicated to be best of available knowledge
- ❒ Threats to site are listed, and for major categories details are provided
- ❒ Activities prohibited, beyond those already listed in Rule 4(2) have been mentioned
- ❒ List of activities to be regulated within wetlands and zone of influence is provided
- ❒ List of activities to be permitted is provided

Annexure VII: Checklist for submission of integrated management plan

- ❒ Approved by the State govt./UT Administration / State Wetlands Authority / UT Wetlands Authority (**approval of the competent authority/minutes of meeting to be enclosed**)
- ❒ Forwarding letter states commitment of the State Government / UT for providing their share of budget (supporting document indicating concurrence to be enclosed)
- ❒ Integrated management plan has a cover sheet providing details on wetland, catchment area, implementing agency, total budget and fund requested from NPCA
- ❒ Health card is enclosed with the management plan (as per Annex XV)
- ❒ Brief document is enclosed with the management plan (as per Annex VI)
- ❒ Wetlands map is provided in a standard GIS format
- ❒ Map of Zone of influence in provided in a standard GIS format
- ❒ Management plan is aligned with recommended format of eight chapters
- ❒ All activities proposed to be funded by NPCA fall within the list of core and non-core activities
- ❒ Necessary drawings and technical specification for major activities is provided
- ❒ Core activities have been allocated not less than 75% of the budget
- ❒ Non- core activities have been allocated not more than 25% of the budget
- ❒ Budget has been prepared with reference to an approved Schedule of Rates

Annexure VIII: Guidelines for preparation for FMP

Step 1: Wetland Description

- Step 1 of FMP brings together the available information to describe a wetland. It is important that the description is broad-based and takes into account not just the ecosystem but its connectivity in the landscape and with communities living in and around the wetland. A partial description of wetlands (for example, on the basis of water regimes) often leads to an isolated approach to wetland management (for example, as a waterbody for storage). The idea is, to begin with whatever is available and systematically connect pieces of information to provide a robust basis for decision-making. The manager also needs to be mindful that information exists in diverse forms, from highly technical publications to Google Earth and localised colloquial forms such as customary practices. It is stressed that information in all forms is useful and needs to be internalised and assessed in terms of management utility.

- The following details should be considered while describing the wetland features:

    a. What are the physical characteristics of the wetland? (such as area, location, type, elevation, major landuse within and around the wetland based on the defined buffer area, and fragmentation, if any)
    b. What is the catchment and hydrology of the wetland? (such as sources of water into the wetland, destination of water from the wetland, area under permanent and seasonal inundation, groundwater levels around the wetlands, water quality (pH and Dissolved Oxygen), water levels, and extent of wetland catchment)
    c. What is the climatic setting of the wetland catchment? (such as average annual rainfall, min and max temperature, and extreme events)
    d. What are the key species found in the wetland? (such as the number of plant and animal species recorded in the wetland, species of high conservation value found in the wetland, migratory waterbirds, migratory fish and others) What are the major habitat types in the wetland? (such as open water areas, wet grasslands, areas with floating vegetation and others)
    e. What is the livelihood system around the wetland? (such as economic activities associated with the wetland and preexisting rights and privileges of the communities)
    f. What is the institutional setup for wetland management? (the nodal agency responsible for wetland management, whether located within a protected area, whether notified under Central/ State Acts and Rules)

- For each wetland and wetlands complex, a map should be prepared using a Geographical Information System (WGS84 datum and UTM (Universal Transverse Mercator) projection) and adopting professional cartographic standards. Essential features to be included in the map are as follows:
    a. Wetland boundary
    b. The boundary of settlements located within and around the wetland
    c. Connecting drainages, inflows and outflows
    d. Main roads and railway (if any)
    e. Major habitats (such as waterbird congregation areas, fish migration pathways, open water area, area under submerged/ floating/ emergent macrophytes)
    f. Major landmarks
    g. Protected area boundary/ Ramsar Site boundary

- Recommended scale for producing the wetlands maps is as follows:

Wetland / Wetlands complex area	Recommended scale
Below 100 ha	1: 4000
Between 100 – 500 ha	1: 10,000
Between 500- 4000 ha	1: 25,000
4000 ha and above	1: 50,000

- These scales have been recommended on the basis of spatial data available for preparing wetlands maps and details that may be extracted for management planning and monitoring decisions. Resources at 2 LISS IV data that may be used to prepare a map of wetlands below 100 ha render an approximate scale of 1:4000. Even larger wetlands can be mapped using finer resolution data. However, for expedience and cost-effectiveness, a lower scale may be sufficient for meeting management needs.

Step 2: Management Purpose

- Wetland management, as described in previous sections, aims to create enabling conditions for wetland ecosystem functioning (and thus securing biodiversity and ecosystem services) and reducing the risks of human-induced adverse change in the ecosystem. These risks, once manifest, can alter the natural functioning of the ecosystem (such as the capability to moderate hydrological regimes), thus, impacting ecosystem services (such as flood buffering) and species and ecological communities (such as flood pulse-dependent wetland species). This step of the FMP focuses on identifying the risks of adverse change, which provides a basis for setting up a management framework. The guiding questions for this step are:
    A. What are the key values associated with the wetlands?
    B. What are the present and potential threats that impact (may impact) these values?
    C. What is the overall risk of adverse change for the wetland?

- Wetland values are the preferences society attaches to these ecosystems. These can be related to:
    a) ***The inherent properties of the wetland ecosystem*** (such as wetlands as habitats for species and ecological communities, uniqueness and naturalness of the habitats, presence of high-conservation value species, wetlands as ecological corridors for migratory species and others)
    b) ***The direct and indirect contributions wetlands make to community livelihoods and wellbeing*** (such as a source of income to communities from wetland fisheries, vegetables, fodder, minerals, and medicinal products; protection to communities from floods and droughts; wetlands as sites for nature tourism and recreation; wetlands as living labs for research; wetlands as a source of freshwater and others)
    c) ***The contribution of wetlands to a meaningful relationship amongst people and nature*** (such as faith, customs and traditions associated with wetlands, myths and folklores associated with wetlands, historical significance, wetlands as heritage)

- The wetland values are (can be) adversely impacted by threats. Threats are adverse changes in a wetland which alter its natural functioning and reduce its capacity to deliver benefits to society. Direct threats are those which modify the wetland; indirect threats modify the wetland through their influence on direct threats. Following are the major categories of direct threats which are known to adversely impact wetlands:
    a) ***Structural modification***: Structural modification alters the wetlands and their immediate environment through adverse changes in hydrology, conversion or fragmentation (such as concretisation of shoreline, conversion of wetland to a non-wetland use, construction of linear infrastructure which fragments the wetland or reduces its size).
    b) ***Physical regime change***: These relate to alteration of water and sediment inflow quantity,

quality and frequency (such as reduction in water reaching the wetland, drying or wetting which exceeds the natural variation).

c) ***Unsustainable extraction***: These relate to the harvest of wetland products beyond their regeneration capacity (For example, extraction of water, species and soil beyond their regenerative capacity, sand mining which alters bed profile and flow patterns).

d) ***Introduction of non-native and external material***: These relate to introducing material and biota not naturally present in the wetland (nutrient enrichment, solid waste dumping, discharge of untreated sewage, proliferation of invasive macrophytes such as water hyacinth, introduction of non-native fish).

e) ***Local climate change impact***: Climate change has an influence on water volumes, flows, temperature, invasive species, nutrient balance and fire regimes (for example, observed expansion in high-altitude wetlands due to deglaciation, shoreline changes in coastal wetlands due to sea level rise).

- The threats (present or potential) create a risk of adverse change in the ecosystem, its functions and values. For example, the construction of a road across a wetland (structural modification) can lead to wetland fragmentation and reduced capacity to absorb floods (indirect contribution to community livelihoods) and reduced population of migratory fish species (inherent property of the wetland ecosystem). The risk analysis can be done by responding to the following questions:
    a) What is the risk of adverse change due to threats? (such as damage to the inherent properties of the ecosystem (through impact on ecosystem components[1] and ecosystem processes[2]), impact on benefits wetlands provide to community livelihoods (such as reduced availability of wetland products), and reduced quality of relationship amongst people and nature (such as diminished recreational and aesthetic value).
    b) What is the level of risk to wetlands? (High when most ecosystem components and values are affected; Medium when some ecosystem components and values are affected; and Low when the impact is potential)
    c) Which of these risks are manageable? (For example, the risks from the discharge of untreated sewage can be managed through interception, diversion and treatment measures. However, risks due to geological events, such as the impact of earthquakes on wetlands, are unmanageable).
    d) What are the knowledge gaps in risk identification and determination? (such as risks due to upstream water diversion projects; risks due to climate change).

[1] These are the living and non-living constituents of the wetland ecosystem. These include biota, wetland soils, water regimes, and others.

[2] These are the processes that occur between organisms and within and between populations and communities, including interactions with non-living environment. These include physical processes (such as water stratification and mixing, sedimentation and erosion), energy-nutrient dynamics (such as primary production and nutrient cycling), processes that maintain animal and plant population (such as migration, recruitment) and others.

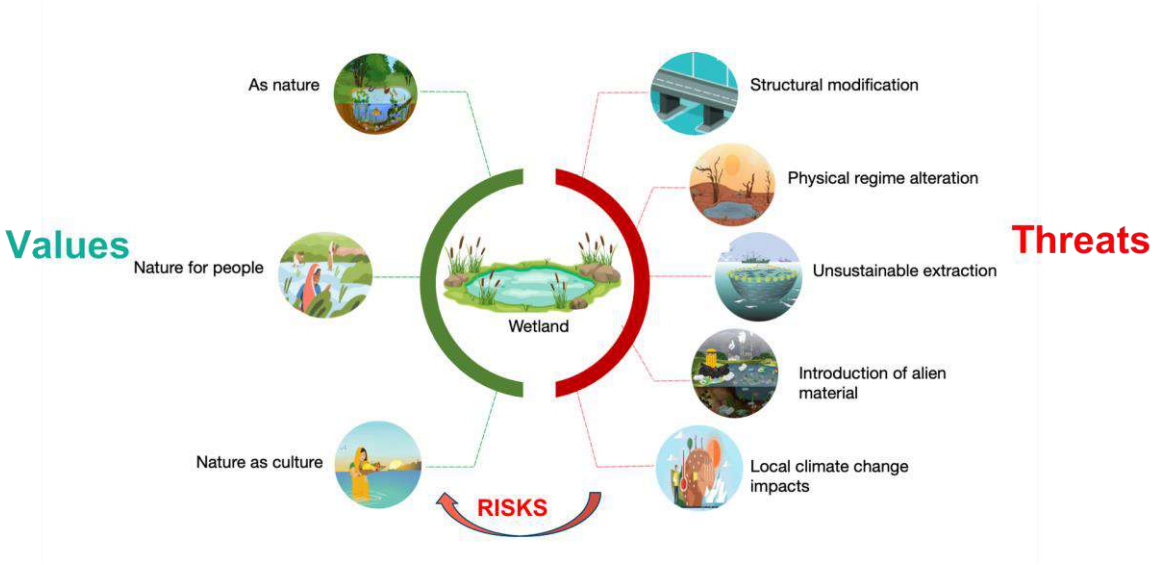


Figure 2: Values, threats and risks associated with wetlands

Step 3: Management Framework

- The management framework establishes the goal, objectives, and strategies for wetland *wise use* by taking into reference the risks identified in Step 2. The framework also includes identifying the partnerships needed to fulfil these objectives. Following are the guiding questions for this step:
    a) What is the goal that wetland management seeks to achieve?
    b) What are the objectives of management? (these should be sufficient to address risks identified in Step 2)
    c) What are the strategies needed to achieve the objectives? Which of these are immediate and long-term? Which of these needs more information for implementation?
    d) Which departments, agencies and organisations should the wetland managers work with to achieve these objectives?

- The goal statement reflects the ultimate result that the wetland management seeks to achieve. It is recommended that the goal statement aligns closely with wetland *wise use*.

- Management objectives describe the outcome of management. These objectives may relate to the following outcomes:

    a) Conservation of species, ecological communities and habitat
    b) Preserving societal benefits
    c) Strengthening wetland institutions for integrated management

- For each management objective, broad strategies need to be spelt out. The strategies indicate the set of interventions needed to achieve the objectives and, at a later stage, provide the basis for developing detailed action plans. Implementing the strategies often would require the engagement of different government departments and agencies, civil society networks, and education and research organisations. These organisations also need to be specified, as this helps to scope up the institutional arrangement needed for integrated management of the wetland. This analysis also helps identify convergence opportunities with existing development schemes, plans and programmes of different line departments and ministries. Wherever possible and relevant, corporate sector engagement can also be built in.

- A generic list of management objectives, strategies and institutional coordination needs has been provided in Annexure IX: List of management objectives, strategies and institutional coordination.

Step 4: Action Plan for FMP

- The action plan is proposed to include:

a) **Actions to develop an IMP:** These include conducting ecological, hydrological, socio-economic and institutional assessments to address knowledge gaps identified under steps 1 and 2. Stakeholder consultations for firming up the management framework (Goal, Purpose, Management objectives and Performance indicators) and action plan (detailing the nature of management intervention, geographic location, implementing agencies, physical and financial estimates, and monitoring mechanisms) may also be included. During this timeframe, the IMP drafting as per the NPCA guidelines is also to be completed.

b) **No-regret actions to address risks:** These are management interventions that are needed to address the risk of adverse change in wetlands, and the implementation of these interventions is not likely to create any unintended adverse consequences for the wetland ecosystem and its dependent communities. It is recommended that the no-regret actions include a) wetland delineation and boundary demarcation using geotagged pillars or bio-fencing (at least maintaining 50m buffer from wetland shoreline and the buffer be at least 3m wide, b) catchment area treatment c) clearing of inlets and outlets, d) establishing wetland monitoring stations, e) pollution abatement through interception, diversion and treatment of sewage flowing into wetlands, f) promoting awareness on the significance of wetlands.

c) **Actions to implement *Amrit Dharohar* components:** These need to be aligned with the four components, Species and Habitat, Nature Tourism, Wetland Livelihoods and Wetland Carbon. These should be achievable within FMP period, and the necessary information (geographic location, technology, implementing agencies, monitoring mechanism, stakeholder engagement processes) is available.

- For each of the three actions, key performance indicators must be specified. Some illustrative examples are as follows:

  a) **Actions to develop an IMP:** Number of assessments, Number of Stakeholder consultations, Availability of a draft and final Integrated Management Plan at the end of the FMP period.
  b) **No-regret actions to address risks:** Availability of a wetland boundary map, Percentage wetland boundary demarcated by geo-tagged pillars or bio-fence, Area of catchment under afforestation and aided regeneration using native species, Degree of change in key water quality parameters as a result of pollution abatement actions, Number of communities connected through outreach actions.
  c) **Actions to implement *Amrit Dharohar* components:** Availability of species and habitat inventory, Number of People's Biodiversity Registers including wetland species, Number of nature tourism amenities created, Availability of carbon assessments, Number of people provided with additional livelihood options.

- An activity-wise budget for the entire FMP should be prepared using the existing norms of the State and Central government, as may be the case. Approved Schedule of Rates or relevant documents may be enclosed in support of cost estimates for activities. The budget should also be presented as per the quarter-wise requirement of funds for various activities in the Action Plan.

- For each activity, an analysis of complementarity with ongoing development or conservation sector schemes should be done to assess the extent of funding that can be generated through convergence with these schemes. Opportunities for private sector participation may also be identified.

Annexure IX: List of management objectives, strategies and institutional coordination

Management Objective cluster	Management objectives	Strategies to achieve objectives	Institutional coordination needs
Conservation of species, ecological communities and habitat	Maintain naturalness	• Restrict changes in land use and land cover of the wetland • Prevent concretisation of shorelines • Prevent the construction of linear infrastructure through the wetland • Maintain a buffer area around the wetland where no permanent construction is permitted • Prepare a zonal management plan • Do not undertake plantation of tree species inside a wetland • Do not remove native natural vegetation	Department of Forest; Department of Urban Development; Department of Rural Development; Village Panchayat; Department of Revenue
	Maintain the population of all native and indigenous species.	• Assess habitat quality and species interactions • Assess the population of wetland-dependent species • Restrict human disturbance in bird and fish breeding areas • Protect breeding and spawning grounds and migration corridors • Restrict expansion of invasive and feral species • Constitute bird protection committees for surveillance • Maintain habitat diversity • Construct animal rescue centres • Maintain natural water regimes that can support diverse habitats	Department of Forest; State Biodiversity Boards; Bombay Natural History Society; Department of Animal Husbandry; Wildlife Institute of India; ICAR- Central Inland Fisheries Research Institute; Research and academic institutes; Village Panchayat; Wetland Mitra

Management Objective cluster	Management objectives	Strategies to achieve objectives	Institutional coordination needs
		• Control the spread of zoonotic diseases • Regulate the proliferation of invasive species by acting on invasion pathways and promoting the economic use of invasive species • Promote citizen science-based wetland species and habitat monitoring programmes (such as Asian Waterbird Census)	
	Maintain environmental flows	• Determine water needs for ecological and human purposes • Determine water use conflicts and impact on wetland ecosystem processes • Develop water allocation rules to provide water for ecological and human purposes • Monitor implementation of water allocation rules and adapt as necessary • Regulate extraction of groundwater in line with the gradient along the Ramsar site	Department of Water Resources; Department of irrigation; Research and academic institutes
	Maintain water holding capacity	• Conduct bathymetric surveys and hydrological assessments to determine water holding capacity status and trends • Revegetate degraded catchments • Small-scale engineering measures for soil and water conservation • Selective desiltation of	Department of Forest; Village Panchayat; Rural Works Department

Management Objective cluster	Management objectives	Strategies to achieve objectives	Institutional coordination needs
		silted-up wetland areas (after ecological and hydrological assessments) ● Monitoring pilot watersheds to address the degree of reduction in siltation and improve moisture regimes	
	Maintain natural inundation regime	● Assess natural hydroperiods ● Establish monitoring stations ● Dredge silted-up inflowing channels (after ecological and hydrological assessments) ● Prevent shoreline concretisation and landuse change ● Prevent wetland fragmentation	Department of Water Resources; Department of Irrigation; Rural Works Department; Department of Forest; Research and academic institutes
Preserving societal benefits	Enhance and sustain wetland livelihoods	● Ensure sustainable wetland resource harvest ● Incentivise stakeholder and community stewardship ● Promote additional livelihoods for wetland-dependent community ● Promote organic agriculture in peripheral areas around the wetland ● Promote value-added products with due consideration of benefit sharing with the communities ● Map and develop the capacity of the Self Help groups for strengthening wetland-based livelihoods	Department of Agriculture; Department of Fishery; Department of Micro, Small and Medium Enterprises; Village Panchayat; Wetland Mitra
	Maintain water quality	● Establish water quality monitoring stations	Village Panchayat; Wetland Mitra;

Management Objective cluster	Management objectives	Strategies to achieve objectives	Institutional coordination needs
		• Interception, diversion and treatment of inflowing sewage • Constructed wetlands to treat pollution from diffused sources • Construct sewage treatment plans • Solid waste management around wetlands • Promote awareness on the impacts of water pollution on community and ecosystem health	Department of Forest; State Pollution Control Board
	Development of nature tourism	• Develop nature tourism infrastructure • Develop capacities of stakeholders on nature tourism livelihoods • Construct and manage wetland interpretation infrastructure • Communication, Education, Participation and Awareness programmes	Department of Tourism; Forest Department; Village Panchayat; Wetland Mitra; Research and academic institute
Strengthening wetland institutions for integrated management	Ensure compliance with extant regulations	• Ensure implementation of Wetland (Conservation and Management) Rules, 2017 and other regulations • Strengthen awareness on regulations related to wetlands • Promote a community-based surveillance system	Department of Forest; Village Panchayat; Wetland Mitra; Knowledge Partners
	Ensure systematic use of Wetland Inventory, Assessments, Monitoring and System (WIAMS) Data	• Develop a wetland monitoring programme • Establish a network of stations to monitor hydrological and ecological parameters • Put in place a database management system for storing, analysis	Research and academic institutes; Village Panchayat; Knowledge Partners

Management Objective cluster	Management objectives	Strategies to achieve objectives	Institutional coordination needs
		and retrieving monitoring data ● Publish ecosystem health cards	
	Promote affirmative behaviour towards wetland *wise use*	● Conduct sensitisation programmes for different stakeholders ● Organise events such as World Wetlands Day, World Environment Day and others ● Document cultural practices related to wetlands ● Promote cultural activities in line with wetland wise ● Document and highlight heritage values	Department of Culture; Research and Academic institutes; Department of Forest; Village Panchayat; Wetland Mitra; Knowledge Partners

Annexure X: Blank Format of FMP

Section A: Summary

1. Wetland name: _____
2. Wetland area (Ha): _____
3. Location (District(s)): _____
4. Name of nodal agency for Framework Management Plan (FMP) implementation:

   _____

8. FMP period: _____
9. Total budget: _____
10. Funds requested from State Government and other Schemes/Plans/Programmes:

    _____

11. Funds requested from MoEFCC under NPCA: _____

Section B: Framework Management Plan

Step 1: Wetland Description

1. Physical characteristics (75 words)

2. Catchment and hydrology (75 words)

3. Climatic setting of the wetland catchment (75 words)

4. Key species, ecological communities and habitat types (100 words)

For faunal species: https://indianwetlands.in/wp-content/uploads/library/1635227120.pdf
For invasive species: http://nbaindia.org/uploaded/pdf/Iaslist.pdf
For a checklist of waterbirds of India: https://bnhsenvis.nic.in/Database/IndianWaterbirds_836.aspx
For wetland plants of India: https://bsi.gov.in/uploads/userfiles/file/Rare%20Books/Aquatic%20And%20Wetland%20Plants%20Of%20India.pdf
For aquatic insects of India : https://indiabiodiversity.org/biodiv/content/documents/document-3345fd78-8c3b-4e1c-8978-8a3e29efa493/830.pdf
For freshwater fishes of India: https://faunaofindia.nic.in/PDFVolumes/hpg/002/index.pdf
For mangroves in India: https://bsienvis.nic.in/Database/IndianMangroves_3941.aspxFor amphibians of India: https://www.indianamphibians.org/

5. Livelihood system around the wetland (75 words)

6. Institutional setup (75 words)

Step 2: Management Purpose

1. Key Values

1.1. Inherent properties of the wetland ecosystem (50 words)

Describe the inherent properties of the wetland ecosystem, such as wetlands as habitats for species and ecological communities.

1.2.Direct and indirect contributions wetlands make to community livelihoods and well-being (50 words)

Describe the direct and indirect contributions wetlands make to community livelihoods and well-being (such as a source of income to communities from wetland fisheries.

1.3. Contribution of wetlands to a meaningful relationship amongst people and nature (50 words)

Describe the contribution of wetlands to a meaningful relationship amongst people and nature (such as faith)

1.4. Knowledge gaps on wetland values (100 words)

Describe the studies that are needed to assess wetlands values

2. Threats (250 words)

2.1. Structural modification (50 words)

Mention whether the threat is present or potential and summarise evidence for the threat (such as part of the wetland encroached)

2.2. Physical regime change (50 words)

Mention whether the threat is present or potential and summarise evidence for the threat (such as such as reduction in water reaching the wetland)

2.3. Unsustainable extraction (50 words)

Mention whether the threat is present or potential and summarise evidence for the threat (such as removal of water, species and soil beyond their regenerative capacity)

2.4. Introduction of material and biota (50 words)

Mention whether the threat is present or potential and summarise evidence for the threat (such as solid waste dumping)

2.5. Climate change impact (50 words)

Mention whether the threat is present or potential and summarise evidence for the threat (such as shoreline changes of coastal wetlands due to sea level rise)

2.6. Knowledge gaps in identifying and assessing threats (100 words)

Describe the studies that are needed to assess identify the threats and assess their impacts on wetlands

3. Risk of Adverse Change (250 words)

3.1. Risk of adverse change due to threats (50 words)

Describe the impact of the threats on the wetland ecosystem.

3.2. Level of risk to wetlands (50words)

Assign a risk category (High, Medium, Low) and provide the reason thereof

3.3. Manageable and non-manageable risks (50 words)

Mention the risks that are manageable and risks that are non-manageable?

3.4. Knowledge gaps in addressing the risks (100 words)

Describe the studies that are needed to assess the risks and their impacts on their wetlands

Step 3: Management Framework

1. Goal (50 words)

Specify the goal of the Framework Management Plan

2. Objectives

In the table below mention the objectives to achieve the goal of the FMP. Refer Step 3 and Annex XI

Sr no	**Objective**
List objectives related to Conservation of species, ecological communities and habitat	1.1…….. 1.2…….. 1.3……..
List objectives related to Preserving societal benefits	2.1……... 2.2…….. 2.3……
List objectives related to Strengthening wetland institutions for integrated management	3.1…….. 3.2……. 3.3……..

3. Strategies

In the table below list strategies needed to achieve objectives. Refer to Annex XII of these guidelines

Objective Statement	**Strategies**
1.1	
1.2	
1.3	
2.1	
2.2	
2.3	
3.1	
3.2	
3.3	

4. Departments, agencies and organisations engaged in the implementation of FMP

Name nodal agency for implementation

List the collaborating State Government Departments and agencies

List the Panchayati Raj Institutions and Urban Local Bodies

List the collaborating Research and Academic organisations ((including local organisations)

List the collaborating NGOs and CBOs

List any other organisations

Step 4: Action Plan (2 pages)

Activity	**Sub activity**	**Key Performance Indicators**	**Responsible Agency**	**Deliverable**
Activities for developing IMP				
1.1				
1.2				
1.3				
No regret actions to address risks				
2.1				
2.2				
2.3				

Actions to implement *Amrit Dharohar* components				
3.1				
3.2				
3.3				

*Add more rows if needed

Section C: Work Plan and Budget

1. *Work plan (0.5 page)*

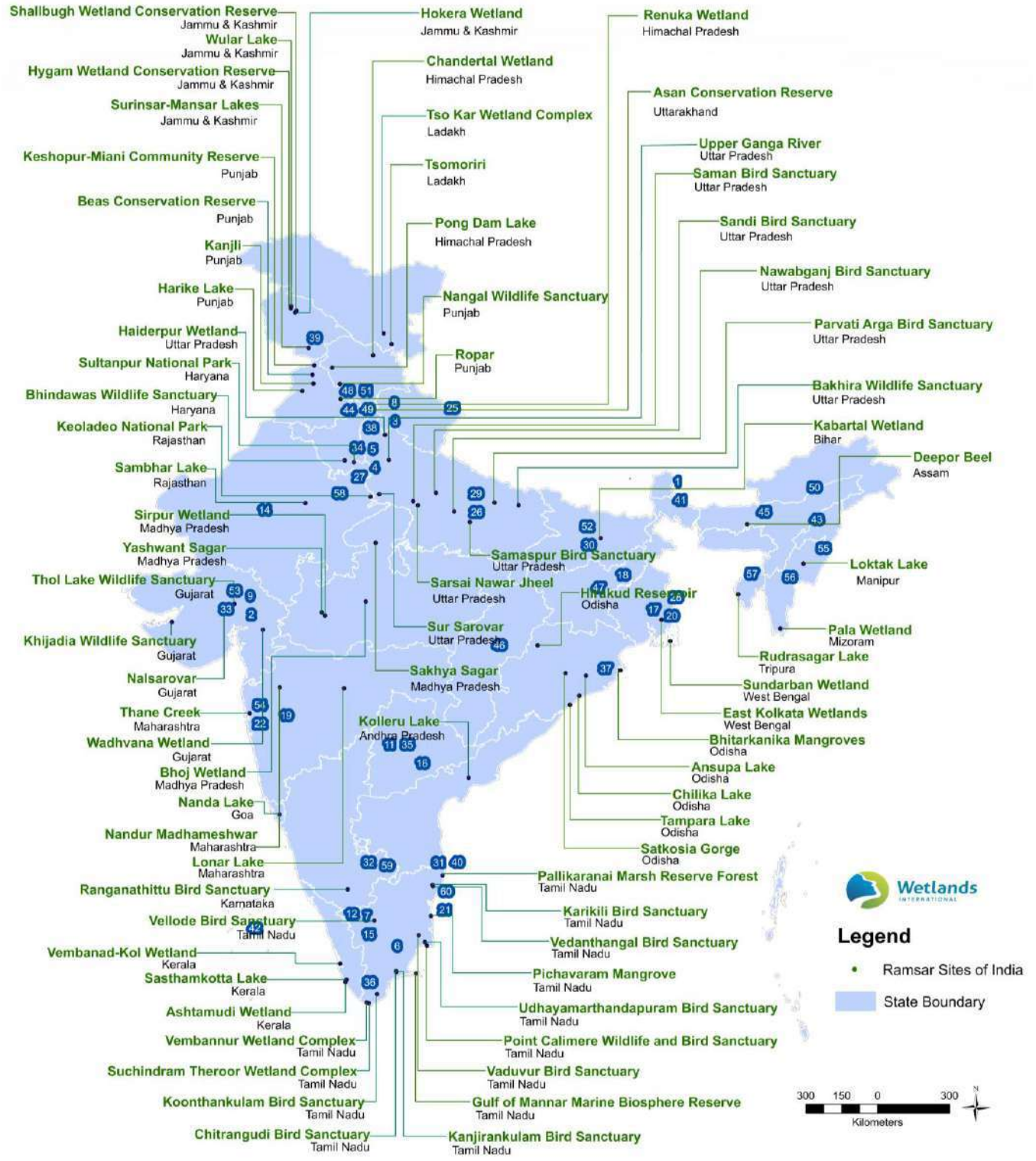
	Months											
Key Activities (refer to Step 4)												
Activity 1:												
Activity 2:												
Activity 3:												
Activity 4:												

2. Budget (1 page)

Provide a detailed budget, in particular with the activities mentioned in Section B for all items for which grant support is being requested. Use the template below to prepare the budget.

Management Activity	**Activity (refer to Step 4)**	**Total Budget**	**Funds from Central Govt. NPCA Share**	**Funds from State Govt. NPCA Share**	**Funds from other donors (Project &/or donor name)**	**Funds from Private Sector (Agency Name)**	**Funds available from convergence sources**	**Funds to be raised**
		(a)	(b)	(c)	(d)	(e)	(f) = (b) + (c) + (d) + (e)	(g) + (a) – (f)

Annexure XI: Ramsar Sites and EIACP Centres



EIACP Centres

Sr. No.	Centre Name	Sr. No.	Centre Name
1	EIACP RP SIKKIM on ECOTOURISM (RP)	31	DZUM EIACP PC- RP (RP)
2	NIOH-EIACP (PC-RP), Ahmedabad, Gujarat (RP)	32	Centre for Ecological Sciences- Indian Institute of Science (IISc) (RP)
3	ICFRE-Forest Research Institute (RP)	33	Gujarat Cleaner Production Centre (GCPC) (RP)
4	SPA-EIACP PC RP (RP)	34	The Energy and Resources Institute (TERI) (RP)
5	JNU EIACP Resource Partner on 'Geodiversity and Impact on Environment' (RP)	35	EPTRI EIACP Hub on Status of Environment Related Issues (Hub)
6	TCE EIACP PC-RP (RP)	36	EIACP PC Hub, KSCSTE, Kerala (Hub)
7	ICFRE-IFGTB EIACP PC RP, Coimbatore (RP)	37	Centre for Environmental Studies (CES), Forest, Environment & Climate Change Department, Government of Odisha (Hub)
8	EIACP Programme Centre 'Wildlife and Protected Areas Management, Wildlife Institute of India, Dehradun (RP)	38	EIACP Hub, Uttarakhand Pollution Control Board (Hub)
9	Consumer Education and Research Centre-Ahmedabad, EIACP-PC RP (RP)	39	EiACP DEE&RS J&K (Hub)
10	CPREEC EIACP PC - RP, CHENNAI (RP)	40	Tamil Nadu EIACP PC HUB (Hub)
11	EPTRI EIACP RP on Ecology of Eastern Ghats (RP)	41	Sikkim EIACP Hub (Hub)
12	SACON EIACP (RP)	42	EIACP- CENTER LAKSHADWEEP (Hub)
13	IIHH-EIACP (RP)	43	EIACP PC Hub Nagaland (Hub)
14	EIACP RP on Combating Desertification, ICAR-CAZRI, Jodhpur (RP)	44	EIACP PC-HUB HIMCOSTE, SHIMLA HIMACHAL PRADESH (Hub)
15	EIACP at Amrita Vishwa Vidyapeetham, Coimbatore (RP)	45	EIACP PC Hub Assam (Hub)
16	CSIR-IICT EIACP RP Programme Centre on Climate Change and Public Health (RP)	46	CECB EIACP (Hub)
17	ZSI EIACP RP-PC on Biodiversity (Fauna) (RP)	47	EIACP-PC-HUB JHARKHAND (Hub)
18	IIT(ISM) EIACP (PC-RP) (RP)	48	EIACP CENTRE PC HUB, Department of Environment, Chandigarh Administration (Hub)

Sr. No.	Centre Name	Sr. No.	Centre Name
19	Indian Institute of Tropical Meteorology (IITM-EIACP PC-RP), Pune (RP)	49	Directorate Environment & Climate Change Haryana (Hub)
20	EIACP PC-RP on Biodiversity (Flora), Botanical Survey of India (RP)	50	EIACP- Arunachal Pradesh (Hub)
21	CASMB EIACP PC RP (RP)	51	EIACP Hub Punjab (Hub)
22	Avian Ecology at the Bombay Natural History Society (BNHS-EIACP) (RP)	52	Bihar State Pollution Control Board (Hub)
23	IOM EIACP PC RP Chennai (RP)	53	Gujarat Ecology Commission (GEC) (Hub)
24	CPCB EIACP PC RP (RP)	54	Environment and Climate Change Department Govt. of Maharashtra (Hub)
25	EIACP Centre on Himalayan Ecology (RP)	55	Directorate of Environment & Climate Change, Govt. of Manipur (Hub)
26	NBRI-EIACP (RP)	56	Mizoram Pollution Control Board (MPCB) (Hub)
27	WWF-India (RP)	57	Tripura State Pollution Control Board (TSPCB) (Hub)
28	DESKU EIACP PC RP (RP)	58	Rajasthan State Pollution Control Board (RSPCB) (Hub)
29	Institute of Wildlife Sciences, University of Lucknow (RP)	59	EMPRI EIACP Hub (Hub)
30	Asian Development Research Institute (RP)	60	Puducherry EIACP PC HUB (Hub)

Annexure XII: Checklist for submission of FMP

- ❒ Approved by the State govt./UT Administration / State Wetlands Authority / UT Wetlands Authority (**approval of the competent authority/minutes of meeting to be enclosed**)
- ❒ Forwarding letter states commitment of the State Government / UT for providing their share of budget (supporting document indicating concurrence to be enclosed)
- ❒ FMP has a cover sheet providing details on wetland, catchment area, implementing agency, total budget and fund requested from NPCA for preparation of IMP
- ❒ Health card is enclosed with the management plan (as per Annex XV)
- ❒ Brief document is enclosed with the management plan (as per Annex VI)
- ❒ The strategy is aligned with *Amrit Dharohar* and *Mission Sahbhagita*, to the extent possible.
- ❒ The draft FMP shared with key stakeholders, and their comments incorporated.

Annexure XIII: Indicative Format for Tripartite Memorandum of Understanding for implementation of Integrated Management Plans/ Framework Management Plans

(to be signed on Rs. 100/- Non Judicial Stamp Paper)

MEMORANDUM OF UNDERSTANDING (MOU)

Between

THE MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE, GOVERNMENT OF INDIA

THE STATE GOVERNMENT OF _____

And

THE IMPLEMENTING AGENCY (IA) – _____

This MoU provides a framework of commitments by concerned stakeholders not only for successful implementation of the project, on '_____' (project name) at _____ (name of place), but also for proper Operation and Maintenance (O&M) of the assets created. This agreement lays down the conditions, which the State Government and the Implementing Agency will undertake on the basis of the financial support provided by Government of India through the Ministry of Environment, Forest & Climate Change (MoEF&CC).

THIS AGREEMENT is made on this _____day of ___ (month), ___ (year) between the Government of India, through the MoEF&CC,

and

The State Government of _____ through its _____ (Name of the Department)

and
_____ (name of Implementing Agency)**,** the Implementing Agency (IA).

WHEREAS

The MoEF&CC will provide financial support to the State Government in their efforts for '_____' (project name) at _____ (name of place), under their jurisdiction.

The _____ has committed to provide the State's share of the capital cost of the project

NOW THE PARTIES WITNESSED AS FOLLOWS:

1. MoEF&CC shall release the first installment of Rs. _____ (__% of Central Share) of grant to the State Government/UT Administration upon signing of the MoU and when the corresponding State Share is deposited by (IA) in a separate account and a proof is submitted in this regard to the Ministry.
2. The release of further installments of funds will be performance based, and will depend on submission of physical and financial progress reports and proper Utilization Certificates as well as on fulfillment of conditions as set out in Administrative Approval & Expenditure Sanction (AA&ES) and the first installment.
3. MoEF&CC shall release subsequent installments of grant to the State Government after the corresponding State Share is deposited by (IA) and a proof is submitted in this regard to the Ministry.
4. The (IA) will bear 40% of the cost of the project or their share as decided from time to time. (IA) (O&M Agency) shall bear the costs for full O&M and also responsible to carry out O&M after implementation of the project.
5. The State Government will also ensure commitment from (IA) (O&M Agency) to take over the assets of the project on completion of project.
6. The State Government will constitute a Project Review Committee headed by the Secretary of the Nodal Department for reviewing the progress of the project on quarterly basis. A representative of MoEF&CC will be a member of this Committee.
7. (IA) will coordinate with ULBs (Urban Local Bodies) as well as other agencies to ensure synergy between programs like Jawaharlal Nehru National Urban Renewal Mission / Urban Infrastructure Development Scheme for Small and Medium Towns, and other schemes/programmes with convergence potential and approved components under the NPCA (National Plan for Conservation of Aquatic Eco-systems).
8. The State Government and the (IA) will be responsible for implementing, monitoring and reporting under the project.
9. The State Government shall be responsible for necessary coordination mechanism between the IA and ULBs.
10. The State Government will ensure that the Physical Progress, Expenditure Reports and Utilization Certificates are furnished by the IA to MoEF&CC on a quarterly basis. In case the IA fails to submit such a report, further installment of GoI's share may be withheld, until such submission.
11. MoEF&CC or any agency nominated by it, may undertake periodic site visits to ascertain the progress of the project and compliance of the conditions in the AA&ES and for release of instalments.
12. The State Government and the IA shall institute mechanism to ensure timely completion of the project.
13. The State Government will provide certification of completion of the project works.
14. In case of dispute between the parties, the matter will be resolved through mutual discussion.
15. In case of any breach regarding the terms and conditions of the MoU, MoEF&CC shall be entitled to withhold release of subsequent instalments of the grant.
16. The funds routed through MoU mechanism will be liable to statutory audit by the Controller and Auditor General of India.
17. This MoU will be effective from the date of signing and would remain operative unless terminated by parties concerned by mutual consent.

SIGNATORIES

For Government of India, through Joint Secretary, Ministry of Environment, Forest & Climate Change

Name & Designation

For State Government, through State Secretary of Nodal Department

Name & Designation

For Implementing Agency, through Commissioner, _____ Municipal Corporation/other bodies

Name & Designation

Annexure XIV: Template for Implementation Progress Reporting of IMP/FMP (subjected to decision of TAC)

A) Format for Implementation Progress Report

Activity (Refer to Step 4)	**Sub activity**	**Key Performance Indicators**	**Implementation progress**			
			Q1	Q2	Q3	Q4
Activities for developing IMP						
1.1						
1.2						
1.3						
No regret actions to address risks						
2.1						
2.2						
2.3						
Actions to implement *Amrit Dharohar* components						
3.1						
3.2						
3.3						

B) Format for Expenditure

Management Activity	**Activity (refer to Step 4)**	**Total Budget**	**Fund Sanctioned**	**Expenditure**			
				Q1	Q2	Q3	Q4

Annexure XV: Template for Wetland Health Card

Wetland Health Card

State/UT Name: District:
Village/City Name: Rural/urban:
Wetland ID: Wetland Name:
Latitude: Area (in Ha):
Longitude: Wetland Type:
Protection Status:

Features	Indicator	Desired Value	Actual Value	A	B	C	D	E
Area	% wetland converted to non-wetland use since 2000			0%	1-5%	6-10%	11-20%	More than 20%
Hydrology and catchment	Ratio of number of natural inlets choked and diverted to total number of natural inlets.			0-0.2	0.3-0.4	0.4-0.6	0.7-0.8	More than 0.8
	Ration of number of natural outlets choked and diverted to total number of natural outlets			0-0.2	0.3-0.4	0.4-0.6	0.7-0.8	More than 0.8
	Biological Oxygen Demand			80-100% sample meet the criteria	60-80% sample meet the criteria	40-60% sample meet the criteria	20-40% sample meet the criteria	Less than 20% sample meet the criteria
Biodiversity	% wetland area covered by invasive macrophytes.			<10%	11-20%	21-30%	31-40%	More than 40%
	Annual waterbird count as a proportion of average count of last 5 years			More than 0.7	0.6-0.7	0.5-0.6	0.4-0.5	less than 0.5
Governance	Clearly demarcated wetlands map			Wetlands map prepared and approved by SWA	Wetlands map prepared and under consideration of SWA	Wetlands map prepared but not placed under SWA	Wetland map under preparation	Wetlands map not prepared
	Wetland Management plan			Management plan prepared and approved	Management plan prepared and	Management plan prepared, not	Management plan under preparation	No management plan

				by SWA	submitted to SWA	submitted to SWA		
	Wetlands notification			Final notification under extent regulation	Draft notification	Regulation under process	Regulation planned, process initiated	No regulation
Health Score			Excellent	0.96-1.00	A+			
			Very Good	0.91-0.95	A			
			Good	0.86-0.90	B+			
			Moderate	0.81-0.85	B			
			Fair	0.76-0.80	C+			
			Bad	0.71-0.75	C			
			Very Bad	0.61-0.70	D			
			Worse	0.51-0.60	E			

Subjected to modification by TAC

Wetlands Division
Ministry of Environment, Forest and Climate Change
Government of India
www.indianwetlands.in

Annexure A/10

ENVIRONMENTAL IMPACT ASSESSMENT STUDY REPORT ON RABINDRA SAROBAR LAKE PREMISES, KOLKATA

FINAL REPORT

APRIL, 2017

Published by West Bengal Pollution Control Board on 05 June 2018

Acknowledgement

The West Bengal Pollution Control Board wishes to thank the Hon'ble NGT (EZ) for constituting a five member committee consisting of eminent scientists and engineers to study and submit a report on the probable impact of the activities in the Rabindra Sarovar stadium during the nights, connected with ISL matches, on "physical environment", "biodiversity of the lake environment" and on the survivability scope of the migratory birds and required preventive measures.

The West Bengal Pollution control Board extends heartiest thanks to the expert committee members, constituted to undertake Rapid EIA study in the Rabindra Sarovar: Dr. A.K. Sanyal, Chairman, WBBB (Chairman of the Expert Committee), Dr. Ujjal Kumar Mukhopadhyay, Chief Scientist, WBPCB, Dr. Anirban Roy, Research Officer, WBBB , Dr. Rajib Gogoi, Scientist-D, BSI, Kolkata, Dr. Rita Saha, Scientist-D, CPCB, Kolkata Regional Office, Dr. Deepanjan Majumdar, Sr. Scientist, NEERI, Dr. S.I. Kazmi, Scientist, ZSI, Kolkata and Mr. Ashoke Kumar Das, Secretary, KIT, Kolkata (Convenor).

The background information and Literature survey provided by West Bengal Biodiversity Board and Botanical Survey of India were intently helpful to prepare this " EIA Report of Rabindra Sarovar, Kolkata " . This could not have been possible to prepare and publish this without their great help.

We are also thankful to the team from the West Bengal Biodiversity Board for visiting Rabindra Sarobarlake and premises and contributed their effort & energy to prepare general biodiversity documentation, one of the essential source for this report, with their expertise.

The West Bengal Pollution Control Board wishes to acknowledge the assistance provided by the Kolkata Improvement Trust For providing boat to collect water samples; CAL Herbarium for identification of aquatic macrophytes; Central National Herbarium (CNH, BSI, Howrah) for Macromorphological characterization; Zoological Survey of India, Kolkata for identification of insects; CSIR-NEERI for first initiation of the noise monitoring exercise and the team of West Bengal pollution Control Board for sound monitoring exercise.

Dr.Kalyan Rudra

Chief Editor

1.0. INTRODUCTION

1.1. Background of the rapid EIA study

With reference to the case no. O.A. 136/2016/EZ filed by Subhash Dutta-Vs-State of West Bengal & Ors., the Hon'ble NGT (EZ) constituted a five member committee consisting of eminent scientists and engineers to study and submit a report on the probable impact of the activities in the Rabindra Sarovar stadium during the nights connected with ISL matches, on physical environment, biodiversity of the lake environment and the migratory birds and the preventive measures. In compliance to the above, the committee submitted its report on 26.09.2016. The committee in the report agreed with the applicant that an Environmental Impact Assessment study in the lake area would be needed to frame regulations in respect of ISL matches in the Sarovar Stadium. The Hon'ble NGT in its order mentioned, "However, whether or not such event should be allowed in future shall be finally decided after we receive further inputs and report of the EIA studies which we shall direct later".

In pursuance of the order of the Hon'ble Tribunal passed in O.A. No. 136/2016/EZ dated 12.01.2017 as mentioned above, the Registrar NGT (EZ) convened a consultative meeting on 16.01.2017 with the Chairman West Bengal Biodiversity Board; Chairman, West Bengal Pollution Control Board; Director, Zoological Survey of India; Director, Botanical Survey of India; Head, Regional Office, Central Pollution Control Board; Head, Regional Office, National Environmental Engineering Research Institute, Kolkata; Secretary, Kolkata Improvement Trust, Kolkata and Mr. Subhash Dutta. In view of the above, an expert committee was constituted to undertake Rapid EIA study in the Rabindra Sarovar, with the following members.

1. Dr. A.K. Sanyal, Chairman, WBBB (Chairman of the Expert Committee)
2. Dr. Ujjwal Kumar Mukhopadhyay, Chief Scientist, WBPCB
3. Dr. Anirban Roy, Research Officer, WBBB
4. Dr. Rajib Gogoi, Scientist-D, BSI, Kolkata
5. Dr. Rita Saha, Scientist-D, CPCB, Kolkata Regional Office
6. Dr. Deepanjan Majumdar, Sr. Scientist, NEERI
7. Dr. S.I. Kazmi, Scientist, ZSI, Kolkata
8. Mr. Ashoke Kumar Das, Secretary, KIT, Kolkata (Convenor)

1.2. The terms of Reference

(I) The area of studies has been set out as under:

1. Listing of plant and animal species from the aquatic body (both from primary and secondary sources).
2. List of plant (Tree, shrub and herbs) and animal species from the land (both from primary and secondary sources).
3. Listing of migratory birds and animals (both from primary and secondary sources).

4. Classification of existing animals and plants according to "schedule" under Wild Life Protection Act, 1972.
5. Ambient Air Quality monitoring including noise level.
6. Water quality based on CPCB classification of "designated best use".
7. Nutrients (Phosphate, Nitrate) and heavy metals (Hg, As, Cd, Pb) quantity in the water.
8. Lake sediment characteristics including (Phosphate, Nitrate) lead and heavy metals (Hg, As, Cd, Pb) quality.
9. Trophic status of the lake (to find out whether the lake is in Oligotrophic, Mesotrophic or Eutrophic stage based on qualitative (colour, presence of hydrophytes) and quantitative (oxygen profile, algal diversity and dominance) studies.
10. Methodology for collection of samples (minimum No. of samples and sampling locations) and analysis will be decided by the Committee.

(II) Impact Assessment:

Probable impact on ecology, biodiversity and pollution of the Rabindra Sarobar lake environment due to anthropogenic activities undertaken in Rabindra Sarobar lake and stadium, such as organization of mega events like cricket and football matches with bursting of fire crackers and emission of high intensity noise, night lighting, organizing Chat Puja and picnic parties, activities of various clubs existing in the premises, movement of large number of vehicles in the park area etc.

2.0. STUDY AREA

❖ Rabindra Sarobar

Rabindra Sarobar, a lake of national importance is the second largest water body in Kolkata and situated in the southern part of the city (22°30′.30″ -22°30′.42″ N, 88°21′-88°22′ E). Rabindra Sarobar and its vicinity is a heaven for floristic diversity, both aquatic and terrestrial that provides a natural CO_2 sink of the metropolitan city, aparts from its pristine beauty and aesthetic value. It also serves as suitable habitat for a variety of amphibians, fishes, reptiles, waterfowls and migratory birds.

Rabindra Sarovar

The story of the gradual transition of the Dhakuria Lakes park and recreation grounds from a malarious marshy jungle, is too long to recount in detail here, but it is of great interest nevertheless, and is outstanding evidence of the success that can be made of any site, however unattractive and seemingly impossible of improvement it may appear in its original state. The excavations here were carried out to a pre-conceived plan with the object of creating ornamental lakes after the excavation works was finished. While this work was in progress the sections reserved for park land and playing fields were being raised and leveled and extensive tree planting, under the supervision of the Director of the Calcutta Horticultural Society, was simultaneously undertaken. Blocks of earth were left undisturbed in the centre of the excavations and the tops were raised and planted with trees and flowering shrubs. These earth blocks are now islands, and are extremely attractive features in the Lakes. Another form of ornamentation has been the mounting of old cannon found during the course of the Trust's operations thorough out Calcutta. A tablet has been fixed at each emplacement giving details of the sites where these ancient weapons were discovered.

The area around this excavated lake was later developed to build recreational complexes, which included children' parks, gardens and auditoria.

Today the lake and its surrounding areas are one of the most popular recreational areas in Kolkata. Around 38% of the total area (73 acres) constitutes the water body while the residual area comprises of varieties of plant/tree species some of which are century old. It is surrounded by Southern Avenue to the north, Russa Road to the west, Dhakuria to the east, and the Kolkata Sub-urban Railway track to the south. The area has a humid tropical climate with a maximum temperature of 40˚C and a minimum temperature of 10˚C. There are four islands inside the lake, one of which is connected to the shore by a hanging bridge and harbours a Masjid. Rest of the three islands are uninhabited and forms important roosting and nesting grounds for resident water birds like Cormorants, Egrets, Night Herons, Pond Herons, Painted Storks, Asian Openbill, etc. A partial tree census in 2012 recorded 50 different species. In the winter, one can spot some migratory birds around the lake, though the numbers are dwindling because of the rise in pollution level. Some parts of the wetland have emergent and floating vegetation like Lotus (*Nelumbo nucifera*), Sushnishak (*Marsilea minuta*), Hingcha (*Enhydra fluctuans*), Water Chestnut

(*Trapa natans*), Borati (*Panicum paludosum*), Kachu (*Colocasia esculenta*), *Hydrilla verticillata, Vallisneria spiralis, Pistia stratiotes, Lemna perpusilla, Salvinia molesta, Spirodela polyrhiza, Azolla pinnata* etc. There is seasonal invasion of Water-hyacinth (*Eichhornia crassipes*) as well that has to be removed every year.The lake itself is home to many varieties of fish. Fishing is strictly prohibited. In 2012 an abandoned water house in the premises of lake turned into a museum run by Kolkata Improvement Trust as a gallery for installation art, locally called as "thakur-der gallery" - a place for some of the award-winning Durga idols of Kolkata.

A number of people come for a walk around the lake in the mornings to enjoy the fresh air. Many visit the sunrise point to offer their prayers to the sun. During the day, it is visited by families on a picnic, tourists, young lovers and joggers.

The transition of Dhakuria lakes to parks and recreation grounds from a situation seemingly impossible of improvement being malariously marshy to its present state of sylvan retreat represented sustained supervision and maintenance: known as Rabindra Sarobar, today it represents the lungs of South Calcutta with massive environmental fillip of extensive tree planting carried out under the supervision of the Calcutta Horticultural Society.

The provision made for sport and recreation at the Dhakuria Lakes includes a large open air swimming pool ,three full size football grounds and an athletic ground laid out and equipped for high and long jumps, running track, and 'Putting the shot'. Two playgrounds for children have also been laid out and are equipped with shelters, swings, sides and so on, but the most popular feature in the summer time in these children's grounds are the bathing pools.

The present scenerio of the Recreation space is as follows:

- A Stadium with a seating capacity of 30,000 persons enclosing a football ground as well as Athletic and Cycle tracks together.
- Land on the banks of the main Lake leased out from as far back as 1937 to several rowing clubs e.g. Calcutta, Lake, University, Bengal Club, N.C.C. Naval Cadets.
- Land leased to different swimming clubs, viz, Indian Life Saving Society, Calcutta Sports Association, Lake Friends to promote swimming besides a public swimming pool of the C.I.T.
- Two Children's Parks within the area providing for seesaws, swings, etc. besides a Lily Pool on the south bank including a miniature zoo.
- Two football grounds and one hockey ground in addition to the football ground within the Stadium.
- A fish sanctuary under the hanging bridge leading to the Mosque.
- An auditorium with 625 seats.
- Open air Theatre being constructed with funds being provided by 'Bengal Chamber of Commerce'.

In pre-Independence days with less than one acre per one thousand populations the city fell far below the standard of 7 acres per one thousand populations for public open space and recreation grounds. The maidan which was the main lungs of the city served at that time only a very limited population. Recreation space outside the city proper was then being represented by

Shibpur gardens and a portion of Barrackpore Park. After Independence the objectives of C.I.T. were therefore identified, among other things, as:

(i) Construction of parks and playgrounds within the municipal area;
(ii) Provision for public resort or picnic spots with planned landscape outside the municipal area (if feasible by extending the provisions of the Act under Sections 1(3) & 147 of the C.I. Act.)

For the first objective, schemes were framed for combining bustees clearance and rehousing with provision of playgrounds being made on bustee sites. The C.I.T. was in fact adding one or two small playgrounds almost every year prior to the outbreak of the Second World War. But the need for looking further afield in the neighbourhood of Calcutta for creation of spots of scenic beauty was clearly urgent.

The following gradual developments shaped the site into what now is known as Rabindra Sarobar:

- 1926: The cable suspended bridge erected by Burn & Co., Howrah to connect the mosque island with the mainland & strengthened in 1962 by the same Company.
- May 1958: Dhakuria Lakes identified as CIT Scheme LXXIV and renamed as *Rabindra Sarobar* after Kabiguru Rabindra Nath Tagore.
- May 1960: Construction of 26,000 capacity Stadium at the N-W corner
- 1980: Construction of 3,500 capacity OAT.
- 1985-89: Installation and operation of the Toy Train, the tracks of which still circumscribe the lake.
- 1991: Conversion of the OAT into a covered auditorium for the 10^{th} International Film Festival in Kolkata, and named *Nazrul Mancha.*

3.0. Floral Diversity of Rabindra Sarobar and its premises

Flora, the collective plant life naturally occurring in a particular region, is very significant for sustaining ecosystem functioning and maintaining diversity of life as well. Flora includes different taxonomic groups of plants starting from algae to angiosperms and also encompasses the fungi as fungal flora. Actually plant species are the main productive units of the ecosystem and they contribute largely in the functional aspect of the wetlands.

3.1. Materials and Methods

A. Background information/ Literature survey

The background history of undertaking the present study is given above. In this connection, the West Bengal Biodiversity Board and Botanical Survey India were assigned the following works:

1. Listing of plant from aquatic body (both from primary and secondary sources).
2. Listing of plant (tree, shrub and herbs) from the land (both from primary and secondary sources).
3. Classification of existing plants according to "Schedule" under Wild life Protection act, 1972.

Besides, WBBB and BSI have also studied algal diversity in the Lake and macrofungal diversity of the Rabindra Sarobar lake premises. Literature was surveyed for works related to the biodiversity of Rabindra Sarobar lake and its premises through various published digital sources and printed documents.

B. Details of Visits

Team from WBBB visited Rabindra Sarobar lake and premises for general biodiversity documentation on 11th and 12th February, 2017. The tree census was conducted during 16th, 17th and 19th February, 2017, whereas, phytoplankton sampling were conducted on 23rd February, 2017 and 06th March, 2017. The team members of BSI visited Rabindra Sarobar Lake in four occasions' *viz*., 19.01.2017, 28.01.2017, 01.02.2017 and 28.02.2017 to conduct the floristic exploration and survey in the area. On 28.02.2017 the team visited the Island areas and different parts of lake areas. For collection of samples from water, boat was provided by Kolkata Improvement Trust.

Table 3. 1. Area or site wise survey to document the "Floral Diversity in Rabindra Sarobar"

Name of the area/site	Latitude & Longitude	Altitude, a.s.l.
19.01.2017		
Site 1- Near Stadium	22°30.627'N 88°21.039'E	18 m
Site 2- Towards Railway tract from Stadium	22°30.538'N 88°20.892'E	19 m
Site 3- South end of the stadium	22°30'37.19"N 88°21'9.15"E	20 m

Site 4- Near Railway tract from Stadium	22°30.513'N 88°20.859'E	18 m
Site 5- Near water fountain side	22°30.497'N 88°20.906'E	18 m
28.01.2017		
Site 6- East of Lake garden Flyover side	22°30.517'N 88°21.224'E	15 m
Site 7- Lake garden bridge side	22°30.532'N 88°21.147'E	17 m
Site 8- Railway station side	22°30.506'N 88°21.037'E	17 m
01.02.2017		
Site 9- CSIR Guest house entrance and nearby area	22°30.675'N 88°21.894'E	16 m
Site 10- Side of Najrul Manch	22°30'47.94"N 88°21'48.02"E	17 m
Site 11- East of Lotus Pond area	22°30.686'N 88°21.772'E	17 m
Site 12- Lotus Pond	22°30.729'N 88°21.671'E	18 m
Site 13- Southern bank side	22°30'35.73"N 88°21'38.27"E	17 m
Site 14- Bengal Rowing Club side	22°30'32.21"N 88°21'20.96"E	18 m.
28. 02.2017		
Site 15- 1st Island from Stadium side	22°30.547'N 88°21.045'E	20 m
Site 16- 2nd Island from Stadium side	22°30.671'N 88°21.635'E	19 m
Site 17- 3rd Island from Stadium side	22°30.601'N 88°21.425'E	21 m
Site 18- Northen bank side	22°30'45.29"N 88°21'27.89"E	20 m
Site 19- North western side of Lotus pond	22°30'47.65"N 88°21'36.61"E	20 m

3.2. Algae/ Phytoplankton

a. Sampling sites

Seven sampling sites in various parts of the lake were demarcated from where the samples were collected for qualitative and quantitative estimation of phytoplankton. The periphytic algae on different aquatic macrophytes and other substrata were also collected from various parts of the lake.

b. Quantitative assessment

For quantitative assessment 1 ml concentrated sample was transferred to Sedgwick Rafter Counter and counted the number of individuals/cells of each species in every quadrat. Finally the number of individuals of each species in per liter was calculated. Data analysis was performed in MS Excel.

3.3. Aquatic macrophytes

a. Collection and identification

Aquatic macrophytes were collected randomly during period of study with respective photographs. Specimens were identified with standard literature (Cook, 1996; Prain, 1981) or with consultation in CAL Herbarium.

3.4. Terrestrial plants including macrofungi

a. Collection and identification

***i) Qualitative assessment of* Vascular Plants**

The specimens of terrestrial plants (Pteridophytes, Gymnosperms and Angiosperms) including macrofungi were collected following standard techniques (Jain and Rao, 1977).

Plant specimens are deposited at Central National Herbarium (CAL). The specimens were identified according to standard literature.

***ii) Qualitative assessment of* Macrofungi**

Survey and collection trips were undertaken during dry winter season (January end to mid March-2017). Macromorphological characterization was made based on fresh fruiting bodies both in the field (Rabindra Sarobar) and in the Central National Herbarium (CNH, BSI, Howrah).

***iii) Quantitative assessment :* Tree Census and Mapping**

Quantitative assessment was done by WBBB to prepare species wise numerical distribution map of trees of Rabindra Sarobar. GPS locations were taken on field for demarcating quadrats of size and plotting using Garmin Etrex-20 GPS machine. Subsequently, whole Rabindra Sarobar lake and its premises were marked into 35 sampling areas. Islands were marked separately in order of 1-5. The number of individual(s) of each tree species was/were counted in each sampling area. Mapping was

done with QGIS version 2.14.3 and DIVA GIS version 7.5. Digital image were processed in Photoshop CS5 extended.

3.5. Identification of Scheduled species

Classification of existing plants according to "schedule" under Wild life Protection act, 1972 was verified from website of Ministry of Environment, Forest and Climate Change (http://www.moef.nic.in/legis/wildlife/wildlife2s6.pdf). Rare, Endangered and Threatened (RET) plants available in the study area were checked from "**The IUCN Red List of Threatened species"** (http://www.iucnredlist.org/).

3.6. Observation and Discussion
i) Algae/Phytoplankton

Phytoplankton, photosynthesizing microscopic free-floating organisms that inhabit the upper layer of all ocean and fresh water, is accounted for half of all photosynthetic activity on the earth. Phytoplankton and other algal components are the key sources of primary productivity that maintains the diversity of other animal life and overall health of the lake. The more diversity of phytoplankton in the aquatic system suggests its healthier condition. On the other hand dominance of opportunistic taxa with their blooming indicates the deterioration of the system. In freshwater, the phytoplankton constitutes the members of Cyanophyceae and Chlorophyceae, Euglenophyceae and the groups with siliceous skeletons, such as diatoms. Dinoflagellates, Xanthophytes and Chrysophytes are rather feeble in number in the fresh waters.

Table: 3.2. List of Phytoplankton and algal components of Rabindra Sarobar; (+) indicates presence

Sl. No.	Name	Family	Class	Earlier report	Present study
1	*Achnanthes* sp.	Achnanthaceae	Bacillariophyceae	Khan and Sinha (2002)	(+)
2	*Achnanthidium minutissimum* (Kütz.) Czarnecki	Achnanthaceae	Bacillariophyceae		(+)
3	*Actinastrum hantzschii* Lagerheim	Chlorellaceae	Trebouxiophyceae		(+)
4	*Agmenellum* sp.	Merismopediaceae	Cyanophyceae	Roy et al. (2009)	
5	*Anabaena* sp.	Nostocaceae	Cyanophyceae	Roy et al. (2009); Khan and Sinha (2002)	
6	*Anacystis* sp.	Microcystaceae	Cyanophyceae	Roy et al. (2009); Khan and Sinha (2002)	
7	*Ankistrodesmus convolutus* Corda	Selenastraceae	Chlorophyceae		(+)
8	*Ankistrodesmus* sp.	Selenastraceae	Chlorophyceae	Roy et al. (2009); Khan and Sinha (2002)	
9	*Aphanocapsa conferta* (West & G.S. West) Komárkova –Legnerová & Cronberg	Merismopediaceae	Cyanophyceae		(+)
10	*Aphanocapsa* sp.1	Merismopediacea	Cyanophyceae		(+)

		e			
11	*Aphanocapsa* sp.2	Merismopediacea e	Cyanophyceae		(+)
12	*Aphanocapsa castagnei* (Kützing) Rabenhorst	Merismopediacea e	Cyanophyceae		(+)
13	*Aphanothece* sp.	Aphanothecaceae	Cyanophyceae		(+)
14	*Calothrix* sp.	Rivulariaceae	Cyanophyceae	Roy et al. (2009)	
15	*Caloneis* sp.	Naviculaceae	Bacillariophyceae	Khan and Sinha (2002)	
16	*Characiopsis columnaris* Pascher	Characiopsidacea e	Xanthophyceae		(+)
17	*Chara* sp.	Characeae	Charaophyceae	Khan and Sinha, 2002	
18	*Chlorella* sp.	Chlorellaceae	Trebouxiophycea e		(+)
19	*Chlorococcum* sp.	Chlorococcaceae	Chlorophyceae		(+)
20	*Chlamydomonas* sp.	Chlamydomonad aceae	Chlorophyceae		(+)
21	*Chodatella* sp.	Oocystaceae	Trebouxiophycea e		(+)
22	*Chodatella ciliata* (Lagerheim) Lemmermann	Oocystaceae	Trebouxiophycea e		(+)
23	*Chroococcus* sp.	Chroococcaceae	Cyanophyceae		(+)
24	*Cladophora glomerata* (L.) Kütz.	Cladophoraceae	Chlorophyceae		(+)
25	*Closteriopsis* sp.	Chlorellaceae	Trebouxiophycea e	Roy et al. (2009)	
26	*Closterium* sp.	Desmidiaceae	Conjugatophycea e (Zygnematophyc eae)		
27	*Cosmarium* sp.	Desmidiaceae	Conjugatophycea e (Zygnematophyc eae)	Roy et al. (2009); Khan and Sinha (2002)	(+)
28	*Crucigenia* sp.	Trebouxiophycea e incertae sedis	Trebouxiophycea e		(+)
29	*Cocconeis* sp.	Cocconeidaceae	Bacillariophyceae	Roy et al. (2009); Khan and Sinha (2002)	
30	*Coscinodiscus* sp.1	Coscinodiscaceae	Coscinodiscophy ceae		(+)
31	*Coscinodiscus* sp. 2	Coscinodiscaceae	Coscinodiscophy ceae		(+)
32	*Coscinodiscus* sp. 3	Coscinodiscaceae	Coscinodiscophy ceae		(+)
33	*Cyclotella* sp.	Stephanodiscacea e	Mediophyceae	Khan and Sinha (2002)	(+)
34	*Denticula* sp.	Bacillariaceae	Bacillariophyceae	Khan and Sinha (2002)	
35	*Diatoma* sp.	Tabellariaceae	Bacillariophyceae	Roy et al. (2009)	
36	*Dispora* sp.	Coccomyxaceae	Chlorophyceae		(+)
37	*Encyonema caespitosum* Kütz.	Gomphonemataceae	Bacillariophyceae		(+)
38	*Encyonema minutum* (Hilse) D.G. Mann	Gomphonemataceae	Bacillariophyceae		(+)
39	*Euglena* sp. 1	Euglenaceae	Euglenophyceae	Roy et al. (2009); Khan and Sinha (2002)	(+)

40	*Euglena* sp. 2	Euglenaceae	Euglenophyceae		(+)
41	*Euglena* sp. 3	Euglenaceae	Euglenophyceae		(+)
42	*Euglena* sp. 4	Euglenaceae	Euglenophyceae		(+)
43	*Fragilaria* sp.	Fragilariaceae	Bacillariophyceae	Khan and Sinha (2002)	(+)
44	*Golenkinia* sp.	Neochloridaceae	Chlorophyceae		(+)
45	*Gloeocapsa* sp.	Microcystaceae	Cyanophyceae		(+)
46	*Gomphonema clavatum* Ehrenb.	Gomphonemataceae	Bacillariophyceae		(+)
47	*Gomphonema olivaceum* (Hornemann) Bréb.	Gomphonemataceae	Bacillariophyceae		(+)
48	*Gomphonema* sp.	Gomphonemataceae	Bacillariophyceae		(+)
49	*Gonium* sp.	Goniaceae	Chlorophyceae		(+)
50	*Grammatophora* sp.	Grammatophoraceae	Bacillariophyceae	Khan and Sinha (2002)	
51	*Heteroleibleinia epiphytica* Komárek	Heteroleibleinaceae	Cyanophyceae		(+)
52	*Hydrodictyon reticulatum* (Linnaeus) Bory	Hydrodictyaceae	Chlorophyceae	Roy and Banerjee (1998); Roy et al. (2009)	(+)
53	*Kirchneriella* sp.	Selenastraceae	Chlorophyceae		(+)
54	*Korshikoviella limnetica* (Lemmermann) P.C.Silva	Characiaceae	Chlorophyceae		(+)
55	*Lyngbya majuscula* Harvey ex Gomont	Oscillatoriaceae	Chlorophyceae		(+)
56	*Lyngbya* sp.	Oscillatoriaceae	Cyanophyceae	Roy et al. (2009); Khan and Sinha (2002)	(+)
57	*Merismopedia punctata* Meyen	Merismopediacea e	Cyanophyceae		(+)
58	*Merismopedia convoluta* Brébisson ex Kützing	Merismopediacea e	Cyanophyceae		(+)
59	*Merismopedia elegans* A.Braun ex Kützing	Merismopediacea e	Cyanophyceae		(+)
60	*Merismopedia glauca* (Ehrenberg) Kützing	Merismopediacea e	Cyanophyceae		(+)
61	*Melosira* sp.	Melosiraceae	Coscinodiscophyceae		(+)
62	*Mougeotia* sp.	Zygnemataceae	Conjugatophyceae (Zygnematophyceae)	Roy et al. (2009)	
63	*Navicula digitulus* Hust.	Naviculaceae	Bacillariophyceae		(+)
64	*Navicula* sp.	Naviculaceae	Bacillariophyceae	Roy et al. (2009); Khan and Sinha (2002)	(+)
65	*Nitzschia sigmoidea* (Nitzsch) W. Sm.	Bacillariaceae	Bacillariophyceae		(+)
66	*Nitzschia* sp.	Bacillariaceae	Bacillariophyceae	Roy et al. (2009); Khan and Sinha (2002)	
67	*Nostoc* sp.	Nostocaceae	Cyanophyceae	Roy et al. (2009); Khan and Sinha (2002)	
68	*Oscillatoria* sp.	Oscillatoriaceae	Cyanophyceae	Datta and Banik, 1987; Roy et al. (2009); Khan and Sinha (2002)	
69	*Oedogonium varians* Wittrock & Lundell ex Hirn	Oedogoniaceae	Chlorophyceae		(+)

70	*Oedogonium* sp.	Oedogoniaceae	Chlorophyceae	Datta and Banik, 1987; Roy et al. (2009); Khan and Sinha (2002)	
71	*Pediastrum tetras* (Ehrenberg) Ralfs	Hydrodictyaceae	Chlorophyceae		(+)
72	*Pediastrum duplex* Meyen	Hydrodictyaceae	Chlorophyceae		(+)
73	*Pediastrum* sp.	Hydrodictyaceae	Chlorophyceae	Khan and Sinha (2002)	
74	*Peridinium* sp.	Peridiniaceae	Dinophyceae	Roy et al. (2009)	(+)
75	*Phacus* sp.	Phacaceae	Euglenophyceae		(+)
76	*Phormidium* sp.	Oscillatoriaceae	Cyanophyceae	Roy et al. (2009); Khan and Sinha (2002)	
77	*Planktothrix suspensa* (Pringsh.) Anagnostidis & Komárek	Microcoleaceae	Cyanophyceae		(+)
78	*Pleurocapsa minor* Hansgirg	Hyellaceae	Cyanophyceae		(+)
79	*Pseudanabaena biceps* Böcher	Pseudanabaenaceae	Cyanophyceae		(+)
80	*Pseudanabaena limnetica* (Lemmerm.) Komárek	Pseudanabaenaceae	Cyanophyceae		(+)
81	*Rhizoclonium tortuosum* (Dillwyn) Kütz.	Cladophoraceae	Chlorophyceae		(+)
82	*Rhodochytrium* sp.	Endosphaeraceae	Chlorophyceae		(+)
83	*Rhopalodia* sp.	Rhopalodiaceae	Bacillariophyceae	Khan and Sinha (2002)	
84	*Schroederia planctonica* (Skuja) Philipose	Schroederiaceae	Chlorophyceae		(+)
85	*Schroederia setigera* (Schröder) Lemmermann	Schroederiaceae	Chlorophyceae		(+)
86	*Scenedesmus* sp.	Scenedesmaceae	Chlorophyceae	Roy et al. (2009); Khan and Sinha (2002)	(+)
87	*Scenedesmus abundans* (O.Kirchner) Chodat	Scenedesmaceae	Chlorophyceae		(+)
88	*Scenedesmus acuminatus* (Lagerheim) Chodat	Scenedesmaceae	Chlorophyceae		(+)
89	*Scenedesmus armatus* (Chodat) Chodat	Scenedesmaceae	Chlorophyceae		(+)
90	*Scenedesmus brasiliensis* Bohlin	Scenedesmaceae	Chlorophyceae		(+)
91	*Scenedesmus carinatus* (Lemmermann) Chodat	Scenedesmaceae	Chlorophyceae		(+)
92	*Scenedesmus dimorphus* (Turpin) Kützing	Scenedesmaceae	Chlorophyceae		(+)
93	*Scenedesmus opoliensis* P.G.Richter	Scenedesmaceae	Chlorophyceae		(+)
94	*Scenedesmus quadricauda* Chodat	Scenedesmaceae	Chlorophyceae		(+)
95	*Scenedesmus perforatus* Lemmermann	Scenedesmaceae	Chlorophyceae		(+)
96	*Scenedesmus protuberans* F.E.Fritsch & M.F.Rich	Scenedesmaceae	Chlorophyceae		(+)
97	*Spirogyra hyalina* Cleve	Zygnemataceae	Chlorophyceae		(+)
98	*Spirogyra* sp.	Zygnemataceae	Conjugatophyceae (Zygnematophyceae)	Datta and Banik, 1987; Roy et al. (2009); Khan and Sinha (2002)	(+)
99	*Spirulina* sp.	Spirulinaceae	Cyanophyceae	Roy et al. (2009); Khan and Sinha (2002)	(+)
100	*Stigeoclonium* sp.	Chaetophoraceae	Chlorophyceae	Datta and Banik, 1987	

101	*Synedra* sp.	Fragilariaceae	Bacillariophyceae	Roy et al. (2009)	(+)
102	*Tetraëdron regulare* Kützing	Hydrodictyaceae	Chlorophyceae		(+)
103	*Tetraëdron trigonum* (Nägeli) Hansgirg	Hydrodictyaceae	Chlorophyceae		(+)
104	*Tetraëdron* sp.	Hydrodictyaceae	Chlorophyceae	Roy et al. (2009)	
105	*Trachelomonas volvocina* (Ehrenb.) Ehrenb. var. punctata Playfair	Euglenaceae	Euglenophyceae		(+)
106	*Trachelomonas* sp.	Euglenaceae	Euglenophyceae		(+)
107	*Tetrastrum heteracanthum* (Nordstedt) Chodat	Scenedesmaceae	Chlorophyceae		(+)
108	*Tetrastrum punctatum* (Schmidle) Ahlstrom & Tiffany	Scenedesmaceae	Chlorophyceae		(+)
109	*Tetrastrum staurogeniiforme* (Schröder) Lemmermann	Scenedesmaceae	Chlorophyceae		(+)
110	*Thalassiosira* sp.	Thalassiosiraceae	Mediophyceae	Roy et al. (2009)	
111	*Uronema confervicola* Lagerh.	Uronemataceae	Chlorophyceae		(+)
112	*Volvox* sp.	Volvocaceae	Chlorophyceae	Roy et al. (2009); Khan and Sinha (2002)	

b) Quantitative assessment

Table 3.3. Frequency class (Fc) distribution of different phytoplankton class collected during present study

Class	**Fc% Classes (no. of species)**				**Total Species**
	A (1--25)	**B (26--50)**	**C (51--75)**	**D (76--100)**	
Bacillariophyceae	2	1	1	1	5
Chlorophyceae	9	16	4	1	30
Conjugatophyceae (Zygnematophyceae)	1	1	0	0	2
Coscinodiscophyceae	1	2	0	1	4
Cyanophyceae	4	6	0	2	12
Euglenophyceae	5	1	0	0	6
Mediophyceae	0	1	0	0	1
Trebouxiophyceae	4	1	0	0	5
Total	26	29	5	5	65

B) Aquatic macrophytes

Table 3.4. List of macrophytes of Rabindra Sarobar; (+) indicates presence

Sl. No.	Name of the species	Common Name	Family	Earlier report	Present study
1	*Alternanthera philoxeroides* (Mart.) Griseb.	Alligator Weed	Amaranthaceae	Ghosh, 2010	(+)
2	*Alternanthera sessilis* (L.) R.Br. ex DC.	Sessile joyweed	Amaranthaceae	Ghosh, 2010	(+)
3	*Azolla pinnata* R. Br.	Water velvet	Azollaceae	Roy et al. 2010; Khan, 2002	(+)
4	*Brachiaria mutica* (Forssk.) Stapf	Para grass	Poaceae	Roy et al. 2010	(+)
5	*Ceratophyllum demersum*	Horn wort	Ceratophyllaceae	Roy et al. 2010; Khan, 2002	(+)
6	*Colocasia esculenta* (L.) Schott	Taro	Araceae		(+)
7	*Commelina benghalensis* L.	bengal dayflower	Commelinaceae	Roy et al. 2010	(+)
8	*Commelina diffusa* Burm.f.	Climbing dayflower	Commelinaceae	Roy et al. 2010	(+)
9	*Crinum asiaticum* L.	Spider lily	Amaryllidaceae	Roy et al. 2010	(+)
10	*Cyperus alopecuroides* Rottb.	Purple nutsedge	Cyperaceae	Roy et al. 2010	(+)
11	*Eichhornia crassipes* (Mart.) Solms	Water hyacinth	Pontederiaceae	Khan, 2002; Ghosh, 2010; Roy et al. 2010	(+)
12	*Enhydra fluctuans* Lour.	Water Cress	Asteraceae		(+)
13	*Hydrilla verticillata* L.f. (Royle)	Hydrilla	Hydrocharitaceae	Chaudhuri and Sharma, 1978; Khan, 2002; Roy et al. 2010	(+)
14	*Hydrocharis dubia* (Blume) Backer (Syn. *Hydrocharis cellulosa* Buch.-Ham. ex Prain)	Frogbit	Hydrocharitaceae	Khan, 2002	
15	*Hygrophila auriculata* (Schumach.) Heine	March Barbel	Acanthaceae	Roy et al. 2010	
16	*Ipomoea aquatica* Forssk.	Water morning glory	Convolvulaceae	Roy et al. 2010	(+)
17	*Lemna perpusilla* Torry	Duckweed	Lemnaceae	Roy et al. 2010; Khan, 2002	(+)
18	*Limnophila* sp.	Marshweed	Scrophulariaceae	Khan, 2002	
19	*Ludwigia adscendens* (L.) H.Hara	Water Primerose	Onagraceae	Ghosh, 2010; Roy et al. 2010	(+)
20	*Najas* sp.	Waternymph	Najadaceae	Khan, 2002	
21	*Nelumbo nucifera* Gaertn.	Lotus	Nelumbonaceae	Roy et al. 2010	(+)
22	*Nymphaea pubescens* Willd.	Kumuda	Nymphaeaceae	Roy et al. 2010; Khan, 2002	(+)
23	*Nymphoides indica* (L.) Kuntze	Water Snowflake	Menyanthaceae	Khan, 2002	(+)
24	*Panicum paludosum* Roxb.	Panicum grass	Poaceae	Roy et al. 2010	(+)
25	*Persicaria hydropiper* (L.) Delarbre	Water-pepper	Polygonaceae	Roy et al. 2010	(+)
26	*Persicaria orientalis* (L.) Spach	Prince's feather	Polygonaceae	Roy et al. 2010	(+)
27	*Pistia stratiotes* L.	Water Lettuce	Araceae	Khan, 2002; Ghosh, 2010;	(+)

				Roy et al. 2010	
28	*Rumex maritimus* L.	Golden dock	Onagraceae		(+)
29	*Salvinia natans* (L.) Allioni	Floating fern	Salviniaceae		(+)
30	*Spirodela polyrrhiza* (L.) Schleid.	Duckweed	Lemnnaceae	Khan, 2002; Roy et al. 2010	(+)
31	*Trapa* sp.	Water Chestnut	Trapaceae	Khan, 2002	
32	*Utricularia* sp.	Bladderwort	Lentibulariaceae	Khan, 2002	
33	*Vallisneria spiralis* L.	Tape Grass	Hydrocharitaceae	Khan, 2002; Chaudhuri and Sharma, 1978; Roy et al. 2010	(+)
34	*Wolffia arrhiza* (L.) Hork. Ex Wimm.	Watermeal	Lemnaceae		(+)
35	*Wolffia* sp.	Watermeal	Lemnaceae	Khan, 2002	

C) Terrestrial vascular plants

Life cycle of terrestrial plants mainly completes in land. Besides the water spread area, the open space of the lake vicinity (cachment area or bank) and the island like elevated land mass within the lake harbours a wide array of diversity of terrestrial vascular flora containing trees, shrubs, climbers & lianas and herbs. The dense canopy of trees and lianas is significant for ecological security of the city Kolkata.

i) Earlier reports

The earlier works on the terrestrial flora of Rabindra Sarobar (IWMED, 2001; Ghosh, 2010; Roy et al. 2010) reveals the occurrence record of a total of 152 species of vascular terrestrial plants of which 73 species were trees, 66 species were herbs, 7 species were shrubs, 4 species were climbers and 2 species were lianas. These species were reported under 127 genera and 53 families.

ii) Present scenario

In the present study, a total of 366 species of terrestrial vascular plants in the life form of 162 trees, 8 lianas, 14 climbers, 46 shrubs and 136 herbs have been identified from Rabindra Sarobar and its premises. The 366 species were distributed under 277 genera and 43 families. The terrestrial flora of Rabindra Sarobar consists of 2 species of Pteridophytes, 3 species of Gymnosperms, and 361 species of Angiosperms. The most diverse genera include *Ficus* (11 species) followed by *Acacia* (5 species); *Alternanthera*, *Bauhinia*, *Dalbergia*, *Euphorbia*, *Ipomoea*, *Ixora*, *Phyllanthus*, *Senna*, *Sida* and *Syziygium* (4 species each) while, 10 genera had 3 species each, 25 genera had 2 species each and 230 genera had single species each.

The most diverse families include Fabaceae (43 species, 27 genera), Asteraceae (21 species, 20 genera), Euphorbiaceae (17 species, 11 genera), Poaceae (17 species, 14 genera), Moraceae (16 species, 4 genera), Arecaceae (15 species, 14 genera), Apocynaceae (13 species, 11 genera), Bignoniaceae (11 species, 10 genera), Acanthaceae (10 species, 7

genera), Rubiaceae (10 species, 6 genera), Malvaceae (9 species, 7 genera), Myrtaceae (8 species, 4 genera), Rutaceae (8 species, 4 genera), Verbenaceae (8 species, 7 genera), Amaranthaceae (7 species, 3 genera), Convolvulaceae (7 species, 3 genera), Cucurbitaceae (7 species, 4 genera), while, Meliaceae and Solanaceae were represented by 6 species each, Araceae, Commelinaceae, Sapindaceae and Sterculiaceae had representation of 5 species each, similarly other 6 families had 4 species each, 6 families had 3 species each and 12 families had 2 species each and rest 41 families had single species each.

Some potential medicinal plants viz. *Aegle marmelos*, *Aloe vera*, *Andrographis paniculata*, *Azadirachta indica*, *Catharanthus roseus*, *Hemidesmus indicus*, *Mucuna pruriens*, *Oldenlandia corymbosa*, *Ocimum tenuiflorum*, *Phyllanthus emblica*,*Phyllanthus niruri*, *Rauvolfia tetraphylla*, *Ricinus communis*, *Saraca asoca*, *Senna sophera*, *Sida cordata*, *Sphagneticola calendulacea*, *Solanum americanum*, *Terminalia arjuna*, *Terminalia bellirica*, *Tiliacora racemosa*, *Tinospora sinensis*, *Woodfordia fruticosa* etc. were documented in the premises of Rabindra Sarobar both as introduced or as naturally growing species.

D) Trees

Table 3.5. List of Trees of Rabindra Sarobar; (+) indicates presence

Sl. No.	Tree species	Common Name	Family	Earlier report	Present study	Note/importance
1	*Acacia auriculiformis* Benth.	Akashmoni; Ear-leaf Acacia	Fabaceae	IWMED, 2001; Ghosh, 2010	(+)	Ornamental
2	*Acacia catechu* (L.f.) Willd.	Cutch Tree	Fabaceae	Ghosh, 2010	(+)	Medicinal
3	*Acacia leucophloea* (Roxb.) Willd.	White Bark Acacia	Fabaceae		(+)	Edible, medicinal and fodder
4	*Acacia mangium* Willd.	Black Wattle	Fabaceae		(+)	Ornamental
5	*Acacia nilotica* (L.) Delile	Babla	Fabaceae	IWMED, 2001	(+)	Medicinal
6	*Adansonia digitata* L.	African Baobab Tree	Bombacaceae	Ghosh, 2010	(+)	Medicinal & ornamental
7	*Adenanthera pavoniana* L.	Barbados pride	Fabaceae	Ghosh, 2010	(+)	Economic
8	*Aegle marmelos* (L.) Corrêa	Atha Bel; Wood Apple	Rutaceae	IWMED, 2001	(+)	Edible & medicinal
9	*Ailanthus excelsa* Roxb.	Gokul; Indian tree of heaven	Simaroubiaceae		(+)	Medicinal
10	*Albizia lebbeck* (L.) Benth.	Sirish	Fabaceae	Ghosh, 2010	(+)	Economic
11	*Albizia saman* (Jacq.) Merr.	Khirish; Rain Tree	Fabaceae	IWMED, 2001; Ghosh, 2010	(+)	Ornamental
12	*Alstonia macrophylla* Wall. ex G.Don	Hard Alstonia	Apocynaceae		(+)	Economic

13	*Alstonia scholaris* (L.) R. Br.	Chhatim	Apocynaceae	Ghosh, 2010	(+)	State tree of West Bengal
14	*Annona reticulata* L.	Nona	Annonaceae		(+)	Edible and medicinal
15	*Anogeissus acuminata* (Roxb. ex DC.) Wall. Ex Guillem. & Perr.	Button tree	Rhamnaceae		(+)	Economic
16	*Araucaria luxurians* (Brongn. & Gris) de Laub.	Coast Araucaria	Araucariaceae		(+)	Ornamental
17	*Areca catechu* L.	Supari; Betel palm	Arecaceae		(+)	Ornamental and edible
18	*Artocarpus heterophyllus* Lam.	Jack fruit	Moraceae		(+)	Edible
19	*Artocarpus integer* (Thunb.) Merr.	Kanthal	Moraceae	IWMED, 2001; Ghosh, 2010	(+)	Edible
20	*Artocarpus lacucha* Buch.-Ham.	Monkey fruit; Deo	Moraceae		(+)	Edible
21	*Averrhoa carambola* L.	Kamranga	Oxalidaceae		(+)	Edible
22	*Azadirachta indica* A.J uss.	Neem	Meliaceae		(+)	Medicinal
23	*Barringtonia acutangula* (L.) Gaertn.	Hijol; Indian Oak	Lecythidaceae	IWMED, 2001; Ghosh, 2010	(+)	Economic
24	*Bauhinia acuminata* L.	White orchid-tree	Fabaceae		(+)	Ornamental
25	*Bauhinia blakeana* Dunn	Hong Kong Orchid Tree	Fabaceae		(+)	Ornamental
26	*Bauhinia purpurea* DC. ex Walp.	Rakta Kanchan	Fabaceae		(+)	Medicinal
27	*Bauhinia variegata* L.	Orchid Tree	Fabaceae	Ghosh, 2010	(+)	Ornamental
28	*Bombax ceiba* L.	Lal Shimul; Cotton tree	Bombacaceae	IWMED, 2001; Ghosh, 2010	(+)	Economic
29	*Borassus flabellifer* L.	Taal; Palmyra palm	Arecaceae	IWMED, 2001; Ghosh, 2010	(+)	Edible
30	*Butea monosperma* (Lam.) Taub.	Palash; Flame of the forest	Fabaceae	Ghosh, 2010	(+)	Ornamental & economic
31	*Caesalpinia pulcherrima* (L.) Sw.	Peacock flower	Fabaceae	IWMED, 2001	(+)	Ornamental and medicinal
32	*Calliandra haematocephala* Hassk.	Red powder puff	Fabaceae		(+)	Ornamental
33	*Callistemon brachyandrus* Lindl.	Bottle Brush	Myrtaceae		(+)	Ornamental
34	*Callistemon lanceolatus* (Sm.) Sweet	Lemon bottlebrush	Myrtaceae		(+)	Ornamental
35	*Calophyllum inophyllum* L.	Alexandrian laurel balltree	Clusiaceae	IWMED, 2001; Ghosh, 2010	(+)	Ornamental
36	*Carica papaya* L.	Papaya	Caricaceae		(+)	Edible
37	*Caryota urens* L.	Fishtail palm	Arecaceae		(+)	Ornamental & edible
38	*Cascabela thevetia* (L.)	Kolke	Apocyn		(+)	Ornamental

	Lippold (Syn. *Thevetia peruviana* (Pers.) K. Schum.)		aceae			
39	*Casearia elliptica* Willd.	Toothed Leaf Chilla	Flacourtiaceae		(+)	Economic
40	*Cassia fistula* L.	Bandarlathi; Golden Rain Tree	Fabaceae	IWMED, 2001; Ghosh, 2010	(+)	Ornamental
41	*Cassia javanica* subsp. *nodosa* (Roxb.) K.Larsen & S.S.Larsen	Java Cassia	Fabaceae		(+)	Ornamental
42	*Castanospermum australe* A.Cunn. & C.Fraser	Black Bean; Moreton Bay Chestnut	Fabaceae	Ghosh, 2010	(+)	Ornamental
43	*Casuarina equisetifolia* L.	She-oak	Casuarinaceae	IWMED, 2001; Ghosh, 2010	(+)	Ornamental
44	*Toona ciliata* M.Roem	Tun	Meliaceae		(+)	Timber yielding tree
45	*Ceiba pentandra* (L.) Gaertn.	Sada Shimul; Java cotton	Bombacaceae	Ghosh, 2010	(+)	Economic
46	*Citrus lemon* (L.) Osbeck	Lebu	Rutaceae		(+)	Edible and medicinal
47	*Citrus maxima* (Burm.) Merr.	Batabi lebu; Pommelo	Rutaceae		(+)	Edible
48	*Cocos nucifera* L.	Narkel; Coconut	Arecaceae	IWMED, 2001; Ghosh, 2010	(+)	Edible
49	*Colvillea racemosa* Bojer	Pitchura; Colville's Glory	Fabaceae	Ghosh, 2010	(+)	Ornamental
50	*Cordia sebestena* (Willd.) ex Spreng.	Scarlet Cordia	Boraginaceae		(+)	Ornamental
51	*Couroupita guianensis* Aubl.	Nagalingam; Cannon Ball Tree	Lecythidaceae	Ghosh, 2010	(+)	Ornamental
52	*Crescentia cujete* L.	Belaiti Bel; Begger's Bowl	Bignoniaceae	Ghosh, 2010	(+)	Ornamental
53	*Dalbergia assamica* Benth.		Fabaceae	Ghosh, 2010	(+)	Economic
54	*Dalbergia lanceolaria* L.f.	Takoli	Fabaceae		(+)	Economic
55	*Dalbergia pinnata* (Lour.) Prain (Syn. *Derris pinnata* Lour.)		Fabaceae	IWMED, 2001	(+)	Medicinal
56	*Dalbergia sissoo* DC.	Sisoo	Fabaceae	Ghosh, 2010	(+)	Economic
57	*Delonix regia* (Hook.) Raf.	Gulmohor	Fabaceae	IWMED, 2001; Ghosh, 2010	(+)	Ornamental
58	*Dillenia indica* Balanco	Chalta	Dilleniaceae		(+)	Medicinal
59	*Dimocarpus longan* Lour.	Aans Fal	Sapindaceae		(+)	Edible and medicinal
60	*Diospyros ebenum* Koenig ex Retz.	Gaab	Ebenaceae	Ghosh, 2010	(+)	
61	*Diospyros malabarica* (Desr.) Kostel.	Indian persimmon	Ebenaceae	Ghosh, 2010	(+)	Edible

62	*Dolichandrone spathacea* (L.f.) Seem.	Mangrove Trumpet	Bignoniaceae		(+)	Ornamental
63	*Dypsis lutescens* (H.Wendl.) Beentje & J.Dransf.	Golden Cane Palm	Arecaceae		(+)	Ornamental
64	*Erythrina arborescens* Roxb.	Madar	Fabaceae	IWMED, 2001	(+)	Ornamental
65	*Eucalyptus globulus* Labill.	Potash	Myrtaceae		(+)	Medicinal
66	*Euphorbia neriifolia* L.	Mansa	Euphorbiaceae		(+)	Ornamental and medicinal
67	*Ficus benghalensis* L.	Bot; Banyan	Moraceae	IWMED, 2001; Ghosh, 2010	(+)	Economic
68	*Ficus benjamina* L.	Weeping fig	Moraceae	IWMED, 2001; Ghosh, 2010	(+)	Ornamental
69	*Ficus elastica* Roxb. ex Hornem.	Rubber fig	Moraceae		(+)	Ornamental
70	*Ficus geniculata* Kurz	Dotted fig	Moraceae		(+)	Medicinal
71	*Ficus hispida* L.f.	Dumur; Hairy Fig	Moraceae		(+)	Edible
72	*Ficus longifolia* Schott	Alii Fig	Moraceae		(+)	Ornamental
73	*Ficus racemosa* L. (Syn. *Ficus glomerata* Roxb.)	Joggo Dumur; Cluster Fig tree	Moraceae	IWMED, 2001; Ghosh, 2010	(+)	Edible
74	*Ficus religiosa* L.	Ashattha; Peepal	Moraceae	IWMED, 2001	(+)	Economic
75	*Ficus rumphii* Bl.	Pakur; Mock Peepul tree	Moraceae	IWMED, 2001	(+)	Ornamental
76	*Ficus virens* Aiton (Syn. *Ficus infectoria* (Miq.) Miq.)	White fig	Moraceae	IWMED, 2001	(+)	Edible
77	*Gardenia jasminoides* J.Ellis	Gandhoraj; Cape jasmine	Rubiaceae		(+)	Ornamental
78	*Gelonium multiflorum* A.Juss.	False lime	Euphorbiaceae		(+)	Medicinal
79	*Gliricidia sepium* (Jacq.) Walp.	Quick stick	Fabaceae	IWMED, 2001; Ghosh, 2010	(+)	Ornamental
80	*Gmelina arborea* Roxb.	Beech wood; Gamar	Verbenaceae		(+)	Economic
81	*Grevillea robusta* A. Cunn. Ex R.Br.	Silver oak	Proteaceae		(+)	Ornamental
82	*Grewia asiatica* L.	Falsa	Tiliaceae		(+)	Edible and medicinal
83	*Hamelia patens* Jacq.	Scarlet bush	Rubiaceae		(+)	Ornamental
84	*Handroanthus chrysanthus* (Jacq.) S.O.Grose	Yellow Ipe	Bignoniaceae	IWMED, 2001	(+)	Ornamental
85	*Heritiera fomes* Buch.-Ham.	Sundari	Sterculiaceae		(+)	Ornamental
86	*Holarrhena pubescens*	Kurchi	Apocyn		(+)	Medicinal

	Wall. & G. Don		aceae			
87	*Hyophorbe lagenicaulis* (L.H.Bailey) H.E.Moore	Bottle Palm	Arecaceae		(+)	Ornamental
88	*Jacaranda mimosifolia* D.Don	Jacaranda	Bignoniaceae		(+)	Ornamental
89	*Khaya senegalensis* (Desv.) A.Juss.	African mahogany	Meliaceae		(+)	Economic
90	*Kigelia africana* (Lam.) Benth. (Syn. *Kigelia pinnata* (Jacq.) DC.)	Sausage Tree	Bignoniaceae	Ghosh, 2010	(+)	Ornamental & medicinal
91	*Kleinhovia hospita* L.	Guest tree	Sterculiaceae	IWMED, 2001	(+)	Medicinal
92	*Lagerstroemia javanica* Thunb.	Crepe myrtle	Lythraceae	IWMED, 2001; Ghosh, 2010	(+)	Ornamental
93	*Lagerstroemia speciosa* (L.) Pers.	Jarul; Queen's crepe-myrtle	Lythraceae		(+)	Ornamental
94	*Lannea coromandelica* (Houtt.) Merr.	Jiol	Anacardiaceae		(+)	Medicinal
95	*Lepisanthes tetraphylla* Radlk.	Kannada	Sapindaceae	IWMED, 2001	(+)	Economic
96	*Leucaena leucocephala* (Lam.) de Wit	Subabul	Fabaceae	IWMED, 2001; Ghosh, 2010	(+)	Leaves used for animal feed
97	*Licuala grandis* H.Wendl.	Ruffled Fan Palm	Arecaceae		(+)	Ornamental
98	*Limonia acidissima* Houtt.	Koth Bel	Rutaceae		(+)	Edible and medicinal
99	*Litchi chinensis* Sonn.	Lichu	Sapindaceae		(+)	Edible
100	*Litsea glutinosa* (Lour.) C.B.Rob.	Ledachhal; Indian laurel	Lauraceae		(+)	Economic
101	*Livistona saribus* (Lour.) Merr. ex A.Chev.	Taraw Palm	Arecaceae		(+)	Ornamental
102	*Madhuca longifolia* var. *latifolia* (Roxb.) A.Chev.	Indian Butter Tree; Mahua	Sapotaceae	IWMED, 2001; Ghosh, 2010	(+)	Edible
103	*Mangifera indica* L.	Aam; Mango	Anacardiaceae	IWMED, 2001; Ghosh, 2010	(+)	Edible
104	*Manilkara hexandra* Dubard	Khir Kul	Sapotaceae		(+)	Edible and medicinal
105	*Manilkara zapota* (L.) Royen	Sabeda	Sapotaceae		(+)	Edible and medicinal
106	*Melia azedarach* L.	Chinaberry tree	Meliaceae		(+)	Economic
107	*Michelia champaca* L.	Champa	Magnoliaceae		(+)	Ornamental & medicinal
108	*Millettia peguensis* Ali	Moulmein Rosewood	Fabaceae	Ghosh, 2010	(+)	Ornamental
109	*Millingtonia hortensis* L.f.	Parijat	Bignoniaceae		(+)	Ornamental

110	*Mimusops elengi* L.	Bakul; Spanish cherry	Sapotaceae	IWMED, 2001; Ghosh, 2010	(+)	Ornamental
111	*Moringa oleifera* Lam.	Sajina; Drumstick tree	Moringaceae		(+)	Edible and medicinal
112	*Morus alba* L.	Tunt; White mulberry	Moraceae		(+)	Edible
113	*Murraya exotica* L.	Kamini	Rutaceae		(+)	Ornamental & medicinal
114	*Neolamarckia cadamba* (Roxb.) Bosser	Kadam; Cadamba	Rubiaceae	IWMED, 2001; Ghosh, 2010	(+)	Economic
115	*Nyctanthes arbor-tristis* L.	Siuli; Night-flowering Jasmine	Oleaceae		(+)	Ornamental & medicinal
116	*Peltophorum pterocarpum* (DC.) K.Heyne	Radhachura	Fabaceae	IWMED, 2001; Ghosh, 2010	(+)	Economic
117	*Phoenix roebelenii* O'Brien	Pygmy Date Palm	Arecaceae		(+)	Ornamental
118	*Phoenix sylvestris* (L.) Roxb.	Khejur; Date Palm	Arecaceae	Ghosh, 2010	(+)	Ornamental & edible
119	*Phyllanthus emblica* L.	Indian gooseberry	Phyllanthaceae		(+)	Edible and medicinal
120	*Pithecellobium dulce* (Roxb.) Benth.	Jilabi; Manilla Tamarind	Fabaceae	IWMED, 2001; Ghosh, 2010	(+)	Ornamental
121	*Plumeria alba* L.	White fragipani	Apocynaceae	IWMED, 2001	(+)	Ornamental
122	*Plumeria rubra* L.	Tagar	Apocynaceae		(+)	Ornamental
123	*Polyalthia angustifolia* A.C.Sm.	Debdaru	Annonaceae		(+)	Ornamental
124	*Polyalthia longifolia* (Sonn.) Thwaites	Debdaru	Annonaceae	IWMED, 2001; Ghosh, 2010	(+)	Ornamental
125	*Pongamia pinnata* (L.) Pierre	Karanja; Indian beech	Fabaceae	Ghosh, 2010	(+)	Economic & medicinal
126	*Psidium guajava* L.	Peara; Guava	Myrtaceae		(+)	Edible
127	*Pterocarpus marsupium* Roxb.	Indian kino tree	Fabaceae	Ghosh, 2010	(+)	Economic
128	*Pterospermum acerifolium* (L.) Willd.	Muchkunda; Kanak Champa	Sterculiaceae	IWMED, 2001; Ghosh, 2010	(+)	Medicinal
129	*Pterygota alata* (Roxb.) R. Br.	Buddha Coconut	Sterculiaceae	Ghosh, 2010	(+)	Ornamental
130	*Ptychosperma macarthurii* (H.Wendl. ex H.J.Veitch) H.Wendl. ex Hook.f.	Macarthur Palm	Arecaceae		(+)	Ornamental
131	*Punica granatum* L.	Dalim; Pomegranate	Punicaceae		(+)	Edible
132	*Putranjiva roxburghii* Wall.	Putijia	Putranjivaceae	Ghosh, 2010	(+)	Medicinal
133	*Rhapis excelsa* (Thunb.) Henry	Lady palm	Arecaceae		(+)	Ornamental

134	*Roseodendron donnell-smithii* (Rose) Miranda	Primavera	Bignoniaceae		(+)	Ornamental
135	*Roystonea regia* (Kunth) O.F.Cook	Royal Palm	Arecaceae	Ghosh, 2010	(+)	Ornamental
136	*Saraca asoca* (Roxb.) Willd.	Asok; Asoca	Fabaceae		(+)	Ornamental & medicinal
137	*Schleichera oleosa* (Lour.) Oken	Kusum; Ceylon oak	Sapindaceae		(+)	Economic
138	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Minjri, Kassod tree	Fabaceae		(+)	Ornamental
139	*Spathodea campanulata* P.Beauv.	Rudra Palash; African tuliptree	Bignoniaceae		(+)	Ornamental
140	*Sterculia foetida* L.	Baxo Badam; Poon tree	Sterculiaceae	Ghosh, 2010	(+)	Edible & economic
141	*Streblus asper* Lour.	Shaora; Sand Paper Tree	Moraceae		(+)	Medicinal
142	*Swietenia mahogani* L.	Chotopata Mahogani	Meliaceae	IWMED, 2001; Ghosh, 2010	(+)	Economic
143	*Swietenia macrophylla* King	Boropata Mahogani	Meliaceae		(+)	Economic
144	*Syzygium aqueum* (Burm.f.) Alston	Watery Rose Apple	Myrtaceae		(+)	Edible
145	*Syzygium cumini* (L.) Skeels	Guri Jaam; Jamun	Myrtaceae	Ghosh, 2010	(+)	Edible
146	*Syzygium jambolanum* (Lam.) DC.	Boro Jaam	Myrtaceae		(+)	Medicinal
147	*Syzygium samarangense* (Blume) Merr. & L.M.Perry	Jamrul; Wax Apple	Myrtaceae		(+)	Edible
148	*Tabebuia rosea* (Bertol.) Bertero ex A.DC.	Pink Trumpet Tree	Bignoniaceae	Ghosh, 2010	(+)	Ornamental
149	*Tabernaemontana divaricata* (L.) R.Br. ex Roem. & Schult.	Kath Tagar	Apocynaceae		(+)	Ornamental
150	*Tamarindus indica* L.	Tentul; Tamarind	Fabaceae	IWMED, 2001; Ghosh, 2010	(+)	Edible
151	*Tecoma stans* (L.) Juss. ex Kunth	Yellow trumpetbush	Bignoniaceae		(+)	Ornamental
152	*Tectona grandis* L.f.	Segun; Teak	Verbenaceae	IWMED, 2001; Ghosh, 2010	(+)	Economic
153	*Terminalia arjuna* (Roxb. ex DC.) Wight & Arn.	Arjun	Combretaceae	IWMED, 2001; Ghosh, 2010	(+)	Medicinal
154	*Terminalia bellirica* (Gaertn.) Roxb.	Bahera; Beleric	Combretaceae		(+)	Medicinal
155	*Terminalia catappa* L.	Kath Badam; Malabar-almond	Combretaceae	IWMED, 2001; Ghosh, 2010	(+)	Economic
156	*Thespesia populnea* (L.) Sol. ex Corrêa	Parash Peepul; Portia tree	Malvaceae	IWMED, 2001; Ghosh,	(+)	Medicinal

				2010		
157	*Trachycarpus martianus* (Wall. ex Mart.) H.Wendl.	Fan Palm	Arecaceae		(+)	Ornamental
158	*Trema orientalis* (L.) Blume	Pigeon wood	Cannabaceae	IWMED, 2001; Ghosh, 2010	(+)	Medicinal
159	*Trewia nudiflora* Wight	Pituli; False white teak	Euphorbiaceae	Ghosh, 2010	(+)	Economic
160	*Vernonia amygdalina* Delile	Onugbu; Bitterleaf	Asteraceae		(+)	Medicinal
161	*Wodyetia bifurcata* A.K.Irvine	Foxtail Palm	Arecaceae		(+)	Ornamental
162	*Ziziphus mauritiana* Lam.	Topakul; Ber	Rhamnaceae	IWMED, 2001	(+)	Edible

E) Herbs, Shrubs, Climbers & Lianas

Table 3.6. List of herbs, shrubs, climber & lianas of Rabindra Sarobar; (+) indicates presence

Sl. No.	Name of the species	Common Name	Family	Habit	Earlier report	Present study	Note/Importance
1	*Abutilon indicum* (L.) Sweet	Indian Mallow	Malvaceae	Herb	Ghosh, 2010	(+)	Medicinal
2	*Acalypha hispida* Burm.f.	Chenille plant	Euphorbiaceae	Herb		(+)	Ornamental
3	*Acalypha indica* L.	Indian Acalypha	Euphorbiaceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	Weed
4	*Achyranthes aspera* L.	Apamarga	Amaranthaceae	Herb	Ghosh, 2010	(+)	Medicinal
5	*Acmella paniculata* (Wall. ex DC.) R.K.Jansen	Panicled Spot Flower	Asteraceae	Herb		(+)	Medicinal
6	*Ageratum conyzoides* (L.) L.	Billy-goat weed	Asteraceae	Herb	IWMED, 2001	(+)	Weed
7	*Allamanda cathartica* L.	Golden trumpet	Apocynaceae	Shrub		(+)	Ornamental
8	*Aloe vera* (L.) Burm.f.	Aloe	Xanthorrhoeaceae	Herb		(+)	Medicinal
9	*Alternanthera paronychioides* A.St.-Hil.	Smooth joyweed	Amaranthaceae	Herb		(+)	Weed
10	*Alternanthera philoxeroides* (Mart.) Griseb.	Alligator Weed	Amaranthaceae	Herb	Ghosh, 2010	(+)	Aquatic weed
11	*Alternanthera sessilis* (L.) R.Br. ex DC.	Sessile joyweed	Amaranthaceae	Herb		(+)	Edible

12	*Alternanthera tenella* Colla	True Yellow Calico Plant	Amaranthaceae	Herb		(+)	Weed
13	*Amaranthus spinosus* L.	Spiny Pigweed	Amaranthaceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	Medicinal and Edible
14	*Amaranthus viridis* L.	Green Amaranth	Amaranthaceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	Edible
15	*Anaphalis subdecurrens* (DC.) Gamble	Pearly everlasting	Asteraceae	Herb		(+)	Weed
16	*Andrographis paniculata* (Burm.f.) Nees	Kalmegh	Acanthaceae	Herb		(+)	Medicinal
17	*Anisomeles indica* (L.) Kuntze	Indian Catmint	Lamiaceae	Herb	Ghosh, 2010	(+)	Weed
18	*Antirrhinum majus* L.	Snapdragon	Scrophulariaceae	Herb		(+)	Ornamental
19	*Argemone mexicana* L.	Mexican Poppy	Papaveraceae	Herb	Ghosh, 2010	(+)	Medicinal
20	*Axonopus compressus* (Sw.) P.Beauv.	Broadleaf Carpet grass	Poaceae	Herb		(+)	Weed
21	*Bambusa tulda* Roxb.	Bans	Poaceae	Shrub		(+)	
22	*Bambusa ventricosa* McClure	Ghoti Bans	Poaceae	Shrub		(+)	
23	*Bambusa vulgaris* Schrad.	Sonali Bans	Poaceae	Shrub		(+)	
24	*Bixa orellana* L.	Lipstick Tree	Bixaceae	Shrub		(+)	Edible and Dye yielding
25	*Blumea lacera* (Burm.f.) DC.	Kakronda	Asteraceae	Herb		(+)	Weed
26	*Boerhavia diffusa* L.	Punarnava	Nyctaginaceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	Medicinal
27	*Bougainvillea spectabilis* Willd.	Bougainvillea	Nyctaginaceae	Shrub		(+)	Ornamental
28	*Brachiaria mutica* (Forssk.) Stapf.	Para grass	Poaceae	Herb		(+)	Weed
29	*Cajanus cajan* (L.) Millsp.	Pigeon pea	Fabaceae	Shrub		(+)	Edible
30	*Calotropis gigantea* (L.) Dryand.	Crown flower	Asclepiadaceae	Shrub		(+)	Medicinal
31	*Calyptocarpus vialis* Less.	Straggler daisy	Asteraceae	Herb		(+)	Weed
32	*Canna indica* L.	Indian shot	Cannaceae	Herb		(+)	Ornamental
33	*Cardiospermum halicacabum* L.	Balloon Vine	Sapindaceae	Herb		(+)	Medicinal

34	*Catharanthus roseus* (L.) G.Don	Nayantara	Apocynaceae	Herb		(+)	Ornamental and Medicinal
35	*Cayratia pedata* (Lam.) Gagnep.	Birdfoot grape vine	Vitaceae	Climber		(+)	Weed
36	*Cayratia trifolia* (L.) Domin	Bush Grape	Vitaceae	Climber	IWMED, 2001; Ghosh, 2010	(+)	Weed
37	*Centella asiatica* (L.) Urb.	Thankuni	Apiaceae	Herb	IWMED, 2001	(+)	Medicinal
38	*Cestrum diurnum* L.	Day-blooming Jasmine	Solanaceae	Herb	IWMED, 2001	(+)	
39	*Chenopodium album* L.	Goosefoot	Chenopodiaceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	Edible
40	*Chloris barbata* Sw.	Swollen Finger Grass	Poaceae	Herb		(+)	Weed
41	*Christella dentata* (Forssk.) Brownsey & Jermy	Christella	Thelypteridaceae	Herb		(+)	Ornamental Fern
42	*Chromolaena odorata* (L.) R.M.King & H.Rob.	Siam Weed	Asteraceae	Shrub		(+)	Weed
43	*Chrozophora plicata* (Vahl) A.Juss. ex Spreng.	Plicate Chrozophora	Euphorbiaceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	
44	*Chrozophora rottleri* (Geiseler) A.Juss. ex Spreng.	Rottler's Chrozophora	Euphorbiaceae	Herb		(+)	Weed
45	*Chrysanthemum indicum* L.	Chandramalika	Asteraceae	Herb		(+)	Ornamental
46	*Citrus medica* L.	Cedar Apple	Rutaceae	Shrub		(+)	Edible and Medicinal
47	*Cleome rutidosperma* DC.	Fringed Spider Flower	Cleomaceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	Weed
48	*Cleome viscosa* L.	Asian Spider Flower	Cleomaceae	Herb	IWMED, 2001	(+)	Medicinal
49	*Clerodendrum infortunatum* L. (Syn. *Clerodendrum viscosum* Vent.)	Hill Glory Bober	Verbenaceae	Herb	Ghosh, 2010	(+)	Medicinal
50	*Clerodendrum splendens* G.Don	Flaming glorybower	Verbenaceae	Liana		(+)	Ornamental
51	*Coccinia cordifolia* (L.) Cogn.	Scarlet gourd	Cucurbitaceae	Climber		(+)	Medicinal
52	*Coccinia grandis* (L.) Voigt	Ivy Gourd	Cucurbitaceae	Climber	IWMED, 2001; Ghosh, 2010	(+)	Edible

53	*Cocculus hirsutus* (L.) Diels	Broom creeper	Menispermaceae	Climber		(+)	Medicinal
54	*Codiaeum variegatum* (L.) Rumph. ex A.Juss.	Garden Croton	Euphorbiaceae	Shrub		(+)	Ornamental
55	*Colocasia esculenta* (L.) Schott	Kochu	Araceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	Edible
56	*Combretum indicum* (L.) DeFilipps	Rangoon creeper	Combretaceae	Liana		(+)	Ornamental
57	*Commelina benghalensis* L.	Bengal dayflower	Commelinaceae	Herb	Roy et al. 2010	(+)	Weed
58	*Commelina diffusa* Burm.f.	Climbing dayflower	Commelinaceae	Herb	Roy et al. 2010	(+)	Weed
59	*Commelina zebrina* C.B.Clarke	Purple Wandering Jew	Commelinaceae	Herb		(+)	Ornamental
60	*Crescentia alata* Kunth	Mexican calabash	Bignoniaceae	Shrub		(+)	Ornamental
61	*Crinum asiaticum* L.	Spider lily	Amaryllidaceae	Herb		(+)	Ornamental
62	*Croton bonplandianus* Baill.	Kala Bhangra	Euphorbiaceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	Medicinal
63	*Cuscuta reflexa* Roxb.	Amar Bel	Convolvulaceae	Herb	Ghosh, 2010	(+)	Parasitic Weed
64	*Cyanthillium cinereum* (L.) H.Rob. (Syn. *Vernonia cinerea* (L.) Less)	Ironweed	Asteraceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	Weed
65	*Cycas revoluta* Thunb.	Japanese Sago Palm	Cycadaceae	Shrub		(+)	Ornamental
66	*Cynodon dactylon* (L.) Pers.	Bermuda grass	Poaceae	Herb		(+)	Medicinal
67	*Cyperus alopecuroides* Rottb.	Purple nutsedge	Cyperaceae	Herb		(+)	Aquatic weed
68	*Cyperus alternifolius* L.	Umbrella sedge	Cyperaceae	Herb		(+)	Ornamental
69	*Cyperus rotundus* L.	Nut grass	Cyperaceae	Herb		(+)	Medicinal
70	*Dahlia pinnata* Cav.	Dahlia	Asteraceae	Herb		(+)	Ornamental
71	*Dentella repens* (L.) J.R.Forst. & G.Forst.	Creeping Dentella	Rubiaceae	Herb	IWMED, 2001	(+)	
72	*Desmodium gangeticum* (L.) DC.	Dhruva	Fabaceae	Herb	IWMED, 2001	(+)	Medicinal
73	*Desmodium triflorum* (L.) DC.	Tick Trefoil	Fabaceae	Herb	IWMED, 2001	(+)	Medicinal
74	*Digitaria sanguinalis* (L.) Scop.	Large crabgrass	Poaceae	Herb	IWMED, 2001	(+)	

75	*Dioscorea bulbifera* L.	Air Potato	Dioscoreaceae	Climber		(+)	Edible and Medicinal
76	*Dipteracanthus prostratus* (Poir.) Nees	Bell Weed	Acanthaceae	Herb		(+)	Weed
77	*Dracaena angustifolia* (Medik.) Roxb.	Dracaena	Asparagaceae	Shrub		(+)	Ornamental
78	*Dregea volubilis* (L.f.) Benth. ex Hook.f.	Sneezing Silk	Apocynaceae	Liana	IWMED, 2001	(+)	Medicinal
79	*Duranta erecta* L.	Golden Dew Drop	Verbenaceae	Shrub		(+)	Ornamental
80	*Eclipta prostrata* (L.) L.	False Daisy	Asteraceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	Medicinal
81	*Elephantopus scaber* L.	Elephant Foot	Asteraceae	Herb		(+)	Medicinal
82	*Eleusine indica* (L.) Gaertn.	Indian Goosegrass	Poaceae	Herb	IWMED, 2001	(+)	Weed
83	*Epipremnum aureum* (Linden & André) G.S.Bunting	Money Plant	Araceae	Herb		(+)	Ornamental
84	*Eragrostis amabilis* (L.) Wight & Arn. (Syn. *Eragrostis tenella* (L.) P.Beauv. ex Roem. & Schult.)	Love Grass	Poaceae	Herb	Ghosh, 2010	(+)	Weed
85	*Eranthemum pulchellum* Andrews	Blue Sage	Acanthaceae	Shrub		(+)	Weed
86	*Euphorbia hirta* L.	Asthma Weed	Euphorbiaceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	Weed
87	*Euphorbia thymifolia* L.	Chhoti duddhi, Makikitot	Euphorbiaceae	Herb	IWMED, 2001	(+)	
88	*Euphorbia tithymaloides* L.	Jew Bush	Euphorbiaceae	Herb		(+)	Ornamental
89	*Evolvulus alsinoides* (L.) L.	Dwarf Morning Glory	Convolvulaceae	Herb		(+)	Weed
90	*Evolvulus nummularius* (L.) L.	Musakarni	Convolvulaceae	Herb	IWMED, 2001	(+)	Weed
91	*Excoecaria cochinchinensis* Lour.	Chinese croton	Euphorbiaceae	Shrub		(+)	Ornamental
92	*Ficus pumila* L.	Creeping Fig	Moraceae	Climber		(+)	Ornamental
93	*Gnaphalium luteoalbum* L.	Weedy Cudweed	Asteraceae	Herb		(+)	Weed
94	*Heliotropium indicum* L.	Herb	Boraginaceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	Medicinal

95	*Hemidesmus indicus* (L.) R.Br.	Indian sarsaparilla	Asclepiadaceae	Liana		(+)	Medicinal
96	*Hemigraphis hirta* (Vahl) T.Anderson	Hairy Hemigraphis	Acanthaceae	Herb		(+)	Weed
97	*Hibiscus rosa-sinensis* L.	China rose	Malvaceae	Shrub		(+)	Ornamental
98	*Hodgsonia macrocarpa* (Blume) Cogn.	Lard seed	Cucurbitaceae	Climber		(+)	Edible
99	*Hydrocotyle sibthorpioides* Lam.	Lawn marshpennywort	Araliaceae	Herb		(+)	
100	*Hymenocallis littoralis* (Jacq.) Salisb.	Beach Spider lily	Amaryllidaceae	Herb		(+)	Ornamental
101	*Ipomoea aquatica* Forssk.	Water Morning Glory	Convolvulaceae	Herb		(+)	Edible
102	*Ipomoea cairica* (L.) Sweet	Messina creeper	Convolvulaceae	Herb		(+)	Ornamental
103	*Ipomoea marginata (Desr.) Verdc. (Syn.Ipomoea sepiaria Koenig ex Roxb.)*	Purple Heart Glory	Convolvulaceae	Herb	Ghosh, 2010	(+)	Ornamental
104	*Ipomoea obscura* (L.) Ker Gawl.	Obscure Morning	Convolvulaceae	Herb	Ghosh, 2010	(+)	
105	*Ixora barbata* Roxb. ex Sm.	Ixora	Rubiaceae	Shrub		(+)	Ornamental
106	*Ixora chinensis* Lam.	Jungle Geranium	Rubiaceae	Shrub		(+)	Ornamental
107	*Ixora coccinea* L.	Jungle flame	Rubiaceae	Shrub		(+)	Ornamental
108	*Ixora grandifolia* Zoll. & Moritzi	Ixora	Rubiaceae	Shrub		(+)	Ornamental
109	*Jasminum multiflorum* (Burm.f.) Andrews	Star Jasmine	Oleaceae	Shrub		(+)	Ornamental
110	*Jasminum sambac* (L.) Aiton	Arabian jasmine	Oleaceae	Shrub		(+)	Ornamental
111	*Jatropha integerrima* Jacq.	Peregrina	Euphorbiaceae	Herb		(+)	Ornamental
112	*Jatropha podagrica* Hook.	Buddha belly plant	Euphorbiaceae	Herb		(+)	Ornamental
113	*Justicia gendarussa* Burm.f.	Willow-leaved justicia	Acanthaceae	Shrub		(+)	Medicinal
114	*Justicia prostrata* Schltdl. ex Nees	Bell Weed	Acanthaceae	Herb		(+)	Medicinal
115	*Kalanchoe pinnata* (Lam.) Pers.	Cathedral Bells	Crassulaceae	Herb		(+)	Ornamental
116	*Kopsia fruticosa* (Roxb.) A.DC.	Pink Kopsia	Apocynaceae	Shrub		(+)	Ornamental

117	*Kyllinga bulbosa* P.Beauv.	White Water Sedge	Cyperaceae	Herb		(+)	Medicinal
118	*Lantana camara* L. (*Lantana camara* L. var. *aculeata* (L.) Mold.)	Red Sage	Verbenaceae	Shrub	IWMED, 2001; Ghosh, 2010	(+)	Weed
119	*Laportea interrupta* (L.) Chew	Hen's Nettle	Urticaceae	Herb		(+)	Weed
120	*Leersia hexandra* Sw.	Southern cutgrass	Poaceae	Herb		(+)	Weed
121	*Leonurus sibiricus* L.	Siberian Motherwort	Lamiaceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	Medicinal
122	*Lindernia ciliata* (Colsm.) Pennell (Syn. *Lindernia brachiata* (Link & Otto) Biswas)	Fringed false pimpernel	Linderniaceae	Herb	IWMED, 2001	(+)	Medicinal
123	*Lygodium flexuosum* (L.) Sw.	Climbing fern	Lygodiaceae	Climber		(+)	
124	*Malpighia coccigera* L.	Singapore holly	Malpighiaceae	Shrub		(+)	Ornamental
125	*Malvastrum coromandelianum* (L.) Garcke (Syn. *Malvastrum tricuspidatum* A.Gray)	Threelobe false mallow	Malvaceae	Herb		(+)	
126	*Malvaviscus arboreus* Cav.	Sleeping hibiscus	Malvaceae	Shrub		(+)	Ornamental
127	*Manihot esculenta* Crantz	Cassava	Euphorbiaceae	Shrub		(+)	Ornamental and Edible
128	*Mecardonia procumbens* (Mill.) Small	Baby Jump Up	Plantaginaceae	Herb	IWMED, 2001	(+)	
129	*Mikania micrantha* Kunth	Bitter Vine	Asteraceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	Weed
130	*Monstera dissecta* (Schott) Croat & Grayum	Monstera	Araceae	Herb		(+)	Ornamental
131	*Mucuna pruriens* (L.) DC.	Velvet bean	Fabaceae	Climber		(+)	Medicinal
132	*Mukia maderaspatana* (L.) M.Roem.	Madras pea pumpkin	Cucurbitaceae	Herb	IWMED, 2001	(+)	Medicinal
133	*Murdannia nudiflora* (L.) Brenan	Doveweed	Commelinaceae	Herb		(+)	Weed
134	*Murraya koenigii* (L.) Spreng.	Curry tree	Rutaceae	Shrub		(+)	Edible
135	*Murraya paniculata* (L.) Jack	Orange Jessamine	Rutaceae	Shrub		(+)	Ornamental
136	*Musa acuminata* Colla	Banana	Musaceae	Herb		(+)	Edible
137	*Nerium oleander* L.	Kaner;	Apocynaceae	Shrub		(+)	Ornament

		Oleander					al
138	*Nicotiana plumbaginifolia* Viv.	Tex-Mex Tobacco	Solanaceae	Herb	Ghosh, 2010	(+)	Weed
139	*Ocimum tenuiflorum* L.	Holy basil	Lamiaceae	Herb		(+)	Medicinal
140	*Oldenlandia biflora* L.	Two Flower Mille Graines	Rubiaceae	Herb	IWMED, 2001	(+)	
141	*Oldenlandia corymbosa* L.	Diamond Flower	Rubiaceae	Herb	IWMED, 2001	(+)	Medicinal
142	*Oplismenus burmannii* (Retz.) P.Beauv.	Wavy-Leaf Basketgrass	Poaceae	Herb		(+)	Weed
143	*Oplismenus compositus* (L.) P.Beauv.	Running Mountain Grass	Poaceae	Herb	IWMED, 2001	(+)	Weed
144	*Oxalis corniculata* L.	Wood Sorrel	Oxalidaceae	Herb	IWMED, 2001	(+)	Medicinal
145	*Pandanus dubius* Spreng.	Pandanus; Knob-fruited Screwpine	Pandanaceae	Shrub		(+)	Ornamental
146	*Panicum paludosum* Roxb.	Panicum grass	Poaceae	Herb		(+)	Weed
147	*Parthenium hysterophorus* L.	Congress Grass	Asteraceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	Weed
148	*Passiflora suberosa* L.	Corky Passion Flower	Passifloraceae	Climber	IWMED, 2001	(+)	
149	*Pergularia daemia* (Forssk.) Chiov.	Trellis-vine	Asclepiadaceae	Liana		(+)	Medicinal
150	*Persicaria hydropiper* (L.) Delarbre	Water-pepper	Polygonaceae	Herb		(+)	Weed
151	*Persicaria orientalis* (L.) Spach	Prince's Feather	Polygonaceae	Herb		(+)	Weed
152	*Petrea volubiliis* L.	Sandpiper Vine	Verbenaceae	Liana		(+)	
153	*Phyla nodiflora* (L.) Greene (Syn. *Lippia nodiflora* (L.) Michx.)	Frog fruit,Turkey tangle	Verbenaceae	Herb	Ghosh, 2010	(+)	
154	*Phyllanthus fraternus* G.L.Webster	Bhui Awala	Phyllanthaceae	Herb		(+)	Medicinal
155	*Phyllanthus niruri* L.	Chanca Piedra	Phyllanthaceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	Medicinal
156	*Phyllanthus reticulatus* Poir. (Syn. *Kirganelia reticulata* (Poir.) Baill.)	Black Honey Shrub	Phyllanthaceae	Shrub	IWMED, 2001; Ghosh, 2010	(+)	Medicinal

157	*Physalis minima* L.	Wild Cape Gooseberry	Solanaceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	Medicinal
158	*Platycladus orientalis* (L.) Franco	Chinese thuja	Cupressaceae	Shrub		(+)	Ornamental
159	*Portulaca oleracea* L.	Pigweed	Portulacaceae	Herb	Ghosh, 2010	(+)	Edible
160	*Pouzolzia zeylanica* (L.) Benn.	Graceful Pouzolz's Bush	Urticaceae	Herb		(+)	Weed
161	*Pseudosasa japonica* (Steud.) Makino	Dwarf Bamboo	Poaceae	Shrub		(+)	Ornamental
162	*Pteris vittata* L.	Chinese brake	Pteridaceae	Herb		(+)	Ornamental
163	*Rauvolfia tetraphylla* L.	Wild Snake Root	Apocynaceae	Herb	Ghosh, 2010	(+)	Medicinal
164	*Ravenala madagascariensis* Sonn.	Traveler's palm	Strelitziaceae	Herb		(+)	Ornamental
165	*Ricinus communis* L.	Castor Bean	Euphorbiaceae	Shrub		(+)	Medicinal and Economic
166	*Rivina humilis* L.	Blood Berry	Phytolaccaceae	Herb		(+)	Weed
167	*Rorippa indica* (L.) Hiern	Indian Field-Cress	Brassicaceae	Herb	IWMED, 2001	(+)	Weed
168	*Rosa* sp.	Rose	Rosaceae	Shrub		(+)	Ornamental
169	*Ruellia prostrata* Poir.	Prostate wild petunia	Acanthaceae	Herb	Ghosh, 2010	(+)	
170	*Ruellia simplex* C.Wright	Britton's wild petunia	Acanthaceae	Herb		(+)	Ornamental
171	*Ruellia tuberosa* L.	Britton's Wild	Acanthaceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	
172	*Rumex maritimus* L.	Golden dock	Polygonaceae	Herb		(+)	Weed
173	*Rungia pectinata* (L.) Nees	Comb Rungia	Acanthaceae	Herb		(+)	Weed
174	*Saccharum officinarum* L.	Sugar cane	Poaceae	Herb		(+)	Edible
175	*Salvia splendens* Sellow ex Schult.	Scarlet sage	Lamiaceae	Herb		(+)	Ornamental
176	*Scoparia dulcis* L.	Goat Weed	Plantaginaceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	Medicinal

177	*Senna occidentalis* (L.) Link	Coffee senna	Fabaceae	Shrub	IWMED, 2001	(+)	
178	*Senna sophera* (L.) Roxb.	Algarrobilla	Fabaceae	Shrub	IWMED, 2001; Ghosh, 2010	(+)	Medicinal
179	*Senna tora* (L.) Roxb.	Sickle Senna	Fabaceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	Medicinal
180	*Sesamum indicum* L.	Sesame	Pedaliaceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	Economic
181	*Setaria glauca* (L.) P. Beauv.	Wild Foxtail Millet	Poaceae	Herb		(+)	Weed
182	*Sida acuta* Burm.f.	Wire Weed	Malvaceae	Herb	IWMED, 2001	(+)	Medicinal
183	*Sida cordata* (Burm. F.) Borss.	Long-Stalk Sida	Malvaceae	Herb		(+)	Medicinal
184	*Sida rhombifolia* L.	Arrow leaf Sida	Malvaceae	Herb	Ghosh, 2010	(+)	Medicinal
185	*Solanum americanum* Mill. (Syn. *Solanum nigrum*)	American Black Nightshade	Solanaceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	Medicinal
186	*Solanum sisymbriifolium* Lam.	Sticky Nightshade	Solanaceae	Shrub	IWMED, 2001; Ghosh, 2010	(+)	Medicinal
187	*Solanum verbascifolium* L.	Mullein nightshade	Solanaceae	Shrub	IWMED, 2001	(+)	
188	*Sonchus arvensis* L.	Field sowthistle	Asteraceae	Herb		(+)	
189	*Sphagneticola calendulacea* (L.) Pruski (Syn. *Wedelia chinensis* (Osbeck) Merr.)	Chinese Wedelia	Asteraceae	Herb	Ghosh, 2010	(+)	Medicinal
190	*Synedrella nodiflora* (L.) Gaertn.	Pig Grass	Asteraceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	Weed
191	*Syngonium podophyllum* Schott	Nephthytis	Araceae	Herb		(+)	Ornamental
192	*Tiliacora racemosa* Colebr.	Vallikanjiram	Menispermaceae	Liana	IWMED, 2001	(+)	Medicinal
193	*Tinospora sinensis* (Lour.) Merr. (Syn. *Tinospora cordifolia* (Willd.) Miers)	Malabar Gulbel	Menispermaceae	Liana		(+)	Medicinal
194	*Typhonium trilobatum* (L.) Schott	Bengal Arum; Lobed Leaf Typhonium	Araceae	Herb	IWMED, 2001	(+)	

195	*Tradescantia spathacea* Sw.	Boat lily	Commelinaceae	Herb		(+)	Ornamental
196	*Trichosanthes cucumerina* L.	Snake gourd	Cucurbitaceae	Climber	IWMED, 2001	(+)	
197	*Trichosanthes dioica* Roxb.	Pointed gourd	Cucurbitaceae	Climber		(+)	Edible
198	*Trichosanthes palmata* L.	Mahakal; Chinese Cucumber	Cucurbitaceae	Climber		(+)	
199	*Tridax procumbens* (L.) L.	Coatbuttons	Asteraceae	Herb		(+)	Weed
200	*Urena lobata* L.	Caesarweed	Malvaceae	Shrub	IWMED, 2001	(+)	
201	*Vernonia elaeagnifolia* DC.	Curtain creeper	Asteraceae	Shrub		(+)	Ornamental
202	*Vigna trilobata* (L.) Verdc.	Wild gram; Three - lobe-leaf Cowpea	Fabaceae	Herb	IWMED, 2001	(+)	
203	*Woodfordia fruticosa* (L.) Kurz	Red Bell Bush	Lythraceae	Shrub		(+)	Medicinal
204	*Xanthium strumarium* L.	Common Cocklebur	Asteraceae	Herb	IWMED, 2001; Ghosh, 2010	(+)	Weed

The Schedule status of the above plants were verified and none were found to be included under IUCN tyhreat category and Wild nLife (Protection) Act (1972), though among trees, only mature tree of *Heritiera fomes* Buch.-Ham. locally known as “Sundari” in Bengali is under the category “Endangered A2cde ver.3.1” in “The IUCN Red Red List of Threatened Species (http://www.iucnredlist.org/details/178815/0 , accessed 06.04.2017; Kathiresan et al., 2010).

Census of Trees in Sarobar

Table 3.7. List of tree species observed during tree census of Rabindra Sarobar along with corresponding serial number used in preparation of census map.

Sl. No.	Name of the species	Common name	Family
1	*Acacia auriculiformis* Benth.	Akashmoni; Ear-leaf Acacia	Fabaceae
2	*Acacia nilotica* (L.) Delile	Babla	Fabaceae
3	*Adenanthera pavonina* L.	Barbados pride	Fabaceae
4	*Aegle marmelos* (L.) Corrêa	Atha Bel; Wood Apple	Rutaceae
5	*Acacia mangium* Willd.	Black Wattle	Fabaceae
6	*Ailanthus excelsa* Roxb.	Gokul; Indian tree of heaven	Simaroubaceae
7	*Albizia lebbeck* (L.) Benth.	Sirish	Fabaceae
8	*Alstonia macrophylla* Wall. ex G.Don	Hard Alstonia	Apocynaceae
9	*Alstonia scholaris* (L.) R. Br.	Chhatim	Apocynaceae
10	*Annona reticulata* L.	Nona	Annonaceae
11	*Araucaria luxurians* (Brongn. & Gris) de Laub.	Coast Araucaria	Araucariaceae
12	*Areca catechu* L.	Supari; Betel palm	Arecaceae
13	*Artocarpus integer* (Thunb.) Merr.	Kanthal	Moraceae
14	*Artocarpus lacucha* Buch.-Ham.	Monkey fruit; Deo	Moraceae
15	*Averrhoa carambola* L.	Kamranga	Oxalidaceae
16	*Azadirachta indica* A.Juss.	Neem	Meliaceae
17	Bambusa sp.1	Bans	Poaceae
18	Bambusa sp.2	Ghoti Bans	Poaceae
19	Bambusa sp.3	Sonali Bans	Poaceae
20	*Barringtonia acutangula* (L.) Gaertn.	Hijol; Indian Oak	Lecythidaceae
21	*Bauhinia purpurea* DC. ex Walp.	Rakta Kanchan	Fabaceae
22	*Bombax ceiba* L.	Lal Shimul; Cotton tree	Bombacaceae
23	*Borassus flabellifer* L.	Taal; Palmyra palm	Arecaceae
24	*Butea monosperma* (Lam.) Taub.	Palash; Flame of the forest	Fabaceae
25	*Calliandra haematocephala* Hassk.	Red powder puff	Fabaceae
26	*Callistemon brachyandrus* Lindl.	Bottle Brush	Myrtaceae
27	*Calophyllum inophyllum* L.	Alexandrian laurel balltree	Clusiaceae
28	*Caryota urens* L.	Fish tail palm	Arecaceae
29	*Cassia fistula* L.	Bandarlathi; Golden Rain Tree	Fabaceae
30	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Minjri, Kassod tree	Fabaceae
31	*Castanospermum australe* A.Cunn. & C.Fraser	Black bean	Fabaceae
32	*Casuarina equisetifolia* L.	She-oak	Casuarinaceae
33	*Toona ciliata* M.Roem	Tun	Meliaceae
34	*Ceiba pentandra* (L.) Gaertn.	Sada Shimul	Bombacaceae

35	*Citrus maxima* (Burm.) Merr.	Batabi lebu; Pommelo	Rutaceae
36	*Citrus lemon* (L.) Osbeck	Lebu	Rutaceae
37	*Cocos nucifera* L.	Narkel; Coconut	Arecaceae
38	*Colvillea racemosa* Bojer	Pitchura; Colville's Glory	Fabaceae
39	*Cordia sebestena* (Willd.) ex Spreng.	Scarlet Cordia	Boraginaceae
40	*Couroupita guianensis* Aubl.	Nagalingam; Cannon Ball Tree	Lecythidaceae
41	*Crescentia cujete* L.	Belaiti Bel; Begger's Bowl	Bignoniaceae
42	*Dalbergia lanceolaria* L.f.	Takoli	Fabaceae
43	*Dalbergia sissoo* DC.	Sisoo	Fabaceae
44	*Delonix regia* (Hook.) Raf.	Gulmohor	Fabaceae
45	*Dillenia indica* Balanco	Chalta	Dilleniaceae
46	*Dimocarpus longan* Lour.	Aans Fal	Sapindaceae
47	*Diospyros ebenum* Koenig ex Retz.	Gaab	Ebenaceae
48	*Erythrina arborescens* Roxb.	Madar	Fabaceae
49	*Euphorbia neriifolia* L.	Mansa	Euphorbiaceae
50	*Eucalyptus globulus* Labill.	Potash	Myrtaceae
51	*Ficus benghalensis* L.	Bot; Banyan	Moraceae
52	*Ficus benjamina* L.	Weeping fig	Moraceae
53	*Ficus elastica* Roxb. ex Hornem.	Rubber fig	Moraceae
54	*Ficus geniculata* Kurz	Dotted fig	Moraceae
55	*Ficus hispida* L.f.	Dumur; Hairy Fig	Moraceae
56	*Ficus racemosa* L. (Syn. *Ficus glomerata* Roxb.)	Joggo Dumur; Cluster Fig tree	Moraceae
57	*Ficus religiosa* L.	Ashattha; Peepal	Moraceae
58	*Ficus rumphii* Bl.	Pakur; Mock Peepul tree	Moraceae
59	*Ficus virens* Aiton (Syn. *Ficus infectoria* (Miq.) Miq.)	White fig	Moraceae
60	*Gardenia jasminoides* J.Ellis	Gandhoraj; Cape jasmine	Rubiaceae
61	*Gelonium multiflorum* A.Juss.	False lime	Euphorbiaceae
62	*Gliricidia sepium* (Jacq.) Walp.	Quick stick	Fabaceae
63	*Gmelina arborea* Roxb.	Beech wood; Gamar	Lamiaceae
64	*Grevillea robusta* A. Cunn. Ex R.Br.	Silver Oak	Proteaceae
65	*Grewia asiatica* L.	Falsa	Tiliaceae
66	*Hamelia patens* Jacq.	Scarlet bush	Rubiaceae
67	*Heritiera fomes* Buch.-Ham.	Sundari	Sterculiaceae
68	*Holarrhena pubescens* Wall. & G. Don	Kurchi	Apocynaceae
69	*Trachycarpus martianus* (Wall. ex Mart.) H.Wendl.	Fan Palm	Arecaceae
70	*Jacaranda mimosifolia* D.Don	Jacaranda	Bignoniaceae
71	*Kigelia africana* (Lam.) Benth. (Syn. *Kigelia pinnata* (Jacq.) DC.)	Sausage Tree	Bignoniaceae
72	*Kleinhovia hospita* L.	Guest tree	Malvaceae

73	*Lannea coromandelica* (Houtt.) Merr.	Jiol	Anacardiaceae
74	*Lagerstroemia speciosa* (L.) Pers.	Jarul; Queen's crepe-myrtle	Lythraceae
75	*Lepisanthes tetraphylla* Radlk.	Kannada	Sapindaceae
76	*Leucaena leucocephala* (Lam.) de Wit	Subabul	Fabaceae
77	*Limonia acidissima* Houtt.	Koth bel	Rutaceae
78	*Litchi chinensis* Sonn.	Lichu	Sapindaceae
79	*Litsea glutinosa* (Lour.) C.B.Rob.	Ledachhal; Indian laurel	Lauraceae
80	*Madhuca longifolia* var. *latifolia* (Roxb.) A.Chev.	Indian Butter Tree; Mahua	Sapotaceae
81	*Michelia champaca* L.	Champa	Magnoliaceae
82	*Mangifera indica* L.	Aam; Mango	Anacardiaceae
83	*Manilkara hexandra* Dubard	Khir Kul	Sapotaceae
84	*Manilkara zapota* (L.) Royen	Sabeda	Sapotaceae
85	*Mimusops elengi* L.	Bakul; Spanish cherry	Sapotaceae
86	*Moringa oleifera* Lam.	Sajina; Drumstick tree	Moringaceae
87	*Morus alba* L.	Tunt; White mulberry	Moraceae
88	*Murraya exotica* L.	Kamini	Rutaceae
89	*Neolamarckia cadamba* (Roxb.) Bosser	Kadam; Cadamba	Rubiaceae
90	*Nyctanthes arbor-tristis* L.	Siuli	Oleaceae
91	*Millingtonia hortensis* L.f.	Parijat	Bignoniaceae
92	*Peltophorum pterocarpum* (DC.) K.Heyne	Radhachura	Fabaceae
93	*Phoenix roebelenii* O'Brien	Pygmy Date Palm	Arecaceae
94	*Phoenix sylvestris* (L.) Roxb.	Khejur; Date Palm	Arecaceae
95	*Pithecellobium dulce* (Roxb.) Benth./*Inga dulce*	Jilabi; Manilla Tamarind	Fabaceae
96	*Plumeria alba* L.	White fragipani	Apocynaceae
97	*Polyalthia longifolia* (Sonn.) Thwaites	Debdaru	Annonaceae
98	*Pongamia pinnata* (L.) Pierre	Karanja; Indian beech	Fabaceae
99	*Psidum guajava* L.	Peara; Guava	Myrtaceae
100	*Pterygota alata* (Roxb.) R. Br.	Buddha Coconut	Sterculiaceae
101	*Pterospermum acerifolium* (L.) Willd.	Muchkunda; Kanak Champa	Sterculiaceae
102	*Punica granatum* L.	Dalim; Pomegranate	Lythraceae
103	*Putranjiva roxburghii* Wall.	Putijia	Putranjivaceae
104	*Albizia saman* (Jacq.) Merr.	Khirish; Rain Tree	Fabaceae
105	*Saraca asoca* (Roxb.) Willd.	Asok; Asoca	Fabaceae
106	*Schleichera oleosa* (Lour.) Oken	Kusum; Ceylon oak	Sapindaceae
107	*Spathodea campanulata* P.Beauv.	Rudra Palash; African tuliptree	Bignoniaceae
108	*Sterculia foetida* L.	Baxo Badam; Poon tree	Sterculiaceae
109	*Streblus asper* Lour.	Shaora; Sand Paper Tree	Moraceae
110	*Swietenia mahogani* L.	Chotopata Mahogani	Meliaceae
111	*Swietenia macrophylla* King	Boropata Mahogani	Meliaceae
112	*Syzygium cumini* (L.) Skeels	Guri Jaam; Jamun	Myrtaceae

113	*Syzygium jambolanum* (Lam.) DC.	Boro Jaam	Myrtaceae
114	*Syzygium samarangense* (Blume) Merr. & L.M.Perry	Jamrul	Myrtaceae
115	*Handroanthus chrysanthus* (Jacq.) S.O.Grose	Yellow Ipe	Bignoniaceae
116	*Roseodendron donnell-smithii* (Rose) Miranda	Primavera	Bignoniaceae
117	*Tabebuia rosea* (Bertol.) Bertero ex A.DC.	Pink Trumpet Tree	Bignoniaceae
118	*Tabernaemontana divaricata* (L.) R.Br. ex Roem. & Schult.	Kath Tagar	Apocynaceae
119	*Tamarindus indica* L.	Tentul; Tamarind	Fabaceae
120	*Tecoma stans* (L.) Juss. ex Kunth	Yellow trumpetbush	Bignoniaceae
121	*Tectona grandis* L.f.	Segun	Verbenaceae
122	*Terminalia arjuna* (Roxb. ex DC.) Wight & Arn.	Arjun	Combretaceae
123	*Terminalia bellirica* (Gaertn.) Roxb.	Bahera; Beleric	Combretaceae
124	*Terminalia catappa* L.	Kath Badam; Malabar-almond	Combretaceae
125	*Thespesia populnea* (L.) Sol. ex Corrêa	Parash Peepul; Portia tree	Malvaceae
126	*Cascabela thevetia* (L.) Lippold (Syn. *Thevetia peruviana* (Pers.) K. Schum.)	Kolke	Apocynaceae
127	*Trema orientalis* (L.) Blume	Pigeon wood	Cannabaceae
128	*Trewia nudiflora* Wight	Pituli; False white teak	Euphorbiaceae
129	*Roystonea regia* (Kunth) O.F.Cook	Royal palm	Arecaceae
130	*Ziziphus mauritiana* Lam.	Topakul; Ber	Rhamnaceae
131	*Wodyetia bifurcata* A.K.Irvine	Foxtail palm	Arecaceae

(F) Terrestrial Macrofungi

Table 3.8. List of macrofungi of Rabindra Sarobar belonging to Ascomycota

Sl. No.	Scientific Name	Common Name	Family	Habitat
1	*Daldinia concentrica* (Bolton) Ces.& De Not.	King Alfred's Cake; Cramp balls	Xylariaceae	Upon fallen hardwood log
2	*Hypoxylon haematostroma* Mont.		Xylariaceae	Upon fallen hardwood log
3	*Xylaria multiplex* (Kunze) Fr.		Xylariaceae	Upon fallen hardwood log
4	*Xylaria symploci* A. Pande, Waingankar, Punekar & Ranadive		Xylariaceae	Upon fallen hardwood log

Table 3.9. List of macrofungi of Rabindra Sarobar belonging to Basidiomycota

Sl. No.	Scientific Name	Common Name	Family	Habitat
1	*Amylosporus campbellii* (Berk.) Ryvarden.		Bondarzewiaceae	Upon cut stumps of Bamboo
2	*Auricularia mesenterica* (Dicks.) Pers.	Wood ear fungus	Auriculariaceae	Upon fallen hardwood log
3	*Cellulariella acuta* (Berk.) Zmitr. & V. Malysheva		Polyporaceae	Upon dead hardwood log
4	*Ceriporia xylostromatoides* (Berk.) Ryvarden		Phanerochaetaceae	Upon dead hardwood log
5	*Coprinopsis cinerea* (Schaeff.) Redhead, Vilgalys & Moncalvo	Khar Chhatu (Bangla)	Psathyrellaceae	Growing saprophytically upon decaying heap of straw
6	*Duportella tristicula* (Berk. & Broome) Reinking		Peniophoraceae	On the fallen branches of Albizia saman
7	*Earliella scabrosa* (Pers.) Gilb. & Ryvarden		Polyporaceae	Upon dead hardwood log
8	*Flavodon flavus* (Klotzsch) Ryvarden		Meruliaceae	Upon fallen hardwood log
9	*Fuscoporia senex* (Nees & Mont.) Ghob.-Nejh.		Hymenochaetaceae	Upon dead hardwood log
10	*Ganoderma applanatum* (Pers.) Pat.		Ganodermataceae	At the base of living hardwood
11	*Ganoderma lucidum* (Curtis) P. Karst.		Ganodermataceae	At the base of living hardwood
12	*Ganoderma philippii* (Bres. & Henn. Ex Sacc.) Bres		Ganodermataceae	At the base of living hardwood
13	*Ganoderma stipitatum* (Murrill) Murrill		Ganodermataceae	At the base of living hardwood
14	*Grammothele fuligo* (Berk. & Broome) Ryvarden		Polyporaceae	Upon dead stump of *Cocos* sp./ Palm
15	*Hjortstamias friesii* (Lév.) Boidin & Gilles		Phanerochaetaceae	On the fallen log of *Cassia* sp.
16	*Inonotus pachyphloeus* (Pat.) T. Wagner & M. Fisch.		Hymenochaetaceae	On dead branch of *Ficus* sp.

17	*Lentinus* sp.	Kath Chhatu (Bangla)	Polyporaceae	Growing saprophytically upon *Eucalyptus* logs used to guard bank of Lake
18	*Microporus xanthopus* (Fr.) Kuntze		Polyporaceae	Upon fallen hardwood
19	*Phanerochaete sordida* (P. Karst.) J. Erikss. & Ryvarden		Phanerochaetaceae	On fallen dead branch of *Mangifera indica*
20	*Phellinus allardii* (Bres.) S. Ahmad		Hymenochaetaceae	Upon living hardwood
21	*Phellinus badius* (Cooke) G. Cunn.		Hymenochaetaceae	Upon living hardwood
22	*Phellinus gilvus* (Schwein.) Pat.		Hymenochaetaceae	Upon living hardwood
23	*Phylloporia pectinata* (Klotzsch) Ryvarden		Hymenochaetaceae	Upon dead branch of *Ficus virens*
24	*Pluteus cervinus* (Schaeff.) P. Kumm.	Khar Chhatu (Bangla)	Pluteaceae	Growing saprophytically upon decaying heap of straw
25	*Polyporus grammocephalus* Berk.		Polyporaceae	Upon fallen hardwood
26	*Pycnoporus sanguineus* (L.) Murrill		Polyporaceae	Upon fallen hardwood
27	*Schizophyllum commune* Fr.		Schizophyllaceae	Upon fallen hardwood
28	*Scytinostroma duriusculum* (Berk. & Broome) Donk		Lachnocladiaceae	Upon dead branches of *Putranjiva roxburghii*
29	*Trametes apiaria* (Pers.) Zmitr.,Wasser & Ezhov		Polyporaceae	Upon fallen hardwood
30	*Trametes cingulata* Berk.		Polyporaceae	Upon fallen hardwood
31	*Trametes lactinea* (Berk.) Sacc.		Polyporaceae	On the dead branches of *Pithecellobium dulce*
32	*Trametes leonina* (Klotzsch) Imazeki		Polyporaceae	Upon fallen hardwood
33	*Ganoderma* sp.1	Kath Chhatu (Bangla)	Ganodermataceae	Growing parasitically upon base of *Delonix regia*
34	*Ganoderma* sp.2	Kath Chhatu (Bangla)	Ganodermataceae	Growing parasitically upon base of living *Leucaena leucocephala* tree

The cachment area of the lake ecosystem offers various sets of unique habitat for growth of macrofungi viz. living plants, litters, dead and decaying trunk, soil, moreover, fortified with the moisture emanating from the lake. Considering the availability of 34 species of macrofungi even in dry pre-monsoon condition, it may be proposed that the area should also be able to host manifold number of tropical mushrooms commonly called cups and saucers, puff-balls, crusts, jelly, earthstars, bird nests, bracket fungi etc. on arrival of favourable monsoon period.

Presence of saprophytic macrofungi in an ecosystem is beneficial as they help in natural recycling of nutrients. Many macrofungi like Polypores, Boletes, Russulas are important staple foods for many small organisms thus playing roles in the food chain as well as ecological succession. However, polypore fungi are responsible for majority of parasitic fungal incidence of trees. *Ganoderma* in particular is a common parasite of deciduous trees causing white rots and heart rot. Such fungal pathogenic incidence in trees of Rabindra Sarobar invites regular control, if not eradication and periodic followup for pest management.

Since the area has the ambience of anthropogenic interference (public transport, sports complex, amusements), exploration and study of macrofungi in the concerned area is of high significance. The present study gives a glimpse of macrofungal flora of pre-monsoon period for the area. Repeated survey for many seasonal variations in multiple years may bring forth valuable information regarding the macrofungal wealth of Rabindra Sarobar and its premises.

No species under "schedule" of Wild life Protection act, 1972 (http://www.moef.nic.in/legis/wildlife/wildlife2s6.pdf) was recorded during this study.

G) Classification of vascular plants/phytoplankton/fungi as per Schedule

Plants recorded in the study area were checked for Classification of existing plants according to "schedule" under Wild life Protection act, 1972, which was verified from website of Ministry of Environment, Forests and Climate Change (http://www.moef.nic.in/legis/wildlife/wildlife2s6.pdf). From the perusal of the same, only mature tree of *Heritiera fomes* Buch.-Ham. locally known as "Sundari" in Bengali came under the category "**Endangered A2cde ver.3.1**" in "The IUCN Red List of Threatened Species (http://www.iucnredlist.org/details/178815/0 , accessed 06.04.2017; Kathiresan et al., 2010).

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4.0. Faunal Diversity of Rabindra Sarobar and its premises

The State of West Bengal is adorned with remarkable richness of faunal species. So far, a lot of work on faunal diversity has already been done. The known faunal diversity of the State consists of 11,042 species, out of 91,771 species present in our country and 12, 39,166 in the world. It appears that the State is represented by 12.03% of the world's fauna (Sanyal *et al.* 2012).

Although not many studies have been done on the fauna of Rabindra Sarovar by earlier workers, records show some earlier studies on insects like Ants (Hymenoptera: Formicidae) by Ghosh *et al.* 2005; Chalcididae (Hymenoptera: Chalcidoidae) by Sheela and Tiwari 2004; Butterfly diversity by Ghosh and Siddiqui 2005 and Socoptera by Ray 1979. Besides insects group Protozoan by Bindu 2009, 2010; Earthworms by Halder *et. al.* 2007 and several study on physiochemical and biological parameters were done by Khan and Sinha (2002).

4.1. Materials and Methods

A) General Methodology

To study faunal diversity data was collected for a period of two months from February 2017 to March 2017. For schedule survey works sites were selected keeping in mind the anthropogenic factors like human interferences. Visits were made to all the selected locations preferably in the morning hours as most of the animals (insects, butterflies, birds, mammals, etc.) remain active during this hour. The listed species were thoroughly checked against the IUCN Red List of Threatened Species (*Ver. 3.1*) and Wildlife (Protection) Act, 1972 of India and their respective status is mentioned against individual species, when available. The detailed methodologies that were followed for various faunal groups are as follows –

a) Invertebrates

i) Zooplanktons

Plankton samples were collected by filtering 50 litres of surface water through 63 µm mesh size nylon plankton net and preserved in 4% formalin. During collection of surface water samples macrophytes were avoided. Investigations were carried out qualitatively and quantitatively. Taxonomic identification of zooplanktons was done following the standard literature, like - Battish (1992), Dhanapathi (2000), Edmondson (1959), Michael and Sharma (1988), and Sharma (1998). Quantitative enumeration of zooplankton and their constituent groups was done with a Sedgewick-Rafter counting cell. A comprehensive checklist of the Zooplanktons of Rabindra Sarovar was prepared by consulting existing literature and is represented in Table - 4.2.

ii) Insects

The insects specimens like Hymenoptera, Coleoptera, Hemioptera etc.were collected by the sweeping method and with the help of aspirator during the field visits of Rabindra Sarobar from mornings to late afternoons. Later these collected insects were identified in the laboratories of Zoological Survey of India, Kolkata by consulting relevant taxonomic literatures. Comprehensive checklists of Hemiptera (Bugs), Coleoptera (Beetles), Chalcids, and Psocopterans of Rabindra Sarovar were prepared by consulting existing literature and represented in Tables 4.3-4.9.

iii) Ants (Hymenoptera: Formicidae)

Ants were collected mostly by hand picking. Ants were identified by using standard literature (Bingham 1903, Bolton 1995). A comprehensive checklist of the ants of Rabindra Sarovar was prepared by consulting existing literature and represented in Table -4.7.

iv) Butterflies (Lepidoptera: Rhopalocera)

To study the butterfly diversity, paths around Rabindra Sarovar were used as fixed transects. Total four such transects were selected which almost covered the entire area. Each transect within the study area was visited once in every week during 8:00-11:00 Hrs. on bright sunny days with no rainfall. The butterflies were observed and recorded directly in the field. Enough precautions were taken, so that by no means the entire procedure can cause any damage to the target specimens. Photos of butterflies were taken using Canon EOS 7D DSLR Camera & Canon EF 100mm F/2.8 USM Macro Lens (Canon Inc., Japan) and preserved for future references. Identification of butterflies was done in the field using standard literature (Kunte 2000, Kehimkar 2008). A comprehensive checklist of the butterflies of Rabindra Sarovar was prepared and represented in Table -4.8.

v) Dragonflies & Damselflies (Odonata)

Adult dragonflies were surveyed between 8:00-11:00 Hrs. by direct search technique. Opportunistic observations have also been included in the present list (Table-9). The species were photographed using DSLR camera (Canon EOS 7D DSLR & EF 100mm F/2.8 USM Macro Lens; Canon Inc., Japan) and identified with the help of standard field guide (Subramanian 2009).

vi) Mollusca (Freshwater)

To collect data on the benthic fauna of the lake ecosystems, sampling was done from different sites of the lake, along the Littoral bottom zone extending from the lake margin to 3 m from the shore, usually surrounded by rooted aquatic vegetation. Survey/sampling was conducted over a period of one day.

Seven particular areas *viz.*, stations 1-7 (Table-4.10) were selected for sampling of benthic fauna in the lake. Sampling was done from each station by means of a box-type sampler (23 x 24.5 cm^2).

Species level identification was done by using 'Hand book: fresh water molluscs of India' (Subba Rao 1989). A comprehensive checklist of the molluscan species of Rabindra Sarovar was prepared by consulting existing literature and is represented in Table-4.11.

b) Vertebrates

i) Fishes (Chordata: Pisces)

Fish sampling was performed at different sites in Rabindra Sarovar. Hand nets (microfilament gill nets) of different mesh sizes were used for dragging. Sampling was conducted during early morning between 7:00-9:00 Hrs. All the species captured were released in the water without causing any harm. Species identification and confirmation were carried out using standard fish taxonomy textbooks (Jayaram 1981, Talwar and Jhingram 1991). Apart from that, to get the secondary information regarding fish diversity, people who live adjacent to Rabindra Sarovar were interviewed through semi-structured questionnaire. A comprehensive checklist of the fishes of Rabindra Sarovar was prepared by consulting existing literature and is represented in Table-4.12.

ii) Amphibians (Chordata: Amphibia)

Amphibian sampling was performed at different sites in Rabindra Sarovar using three different techniques. Visual surveys (through direct sighting method) were performed around the lake edges during day hours. The areas where the lake has submerged vegetation, searching was done by netting. The amphibians that were captured through netting were released in the same habitat after identification. At dusk the lake area was again searched from the bank using flashlight. Standard literature (Chanda 2002, Daniels 2004) was used for

field identification. A comprehensive checklist of the Amphibians of Rabindra Sarovar was prepared and is represented in Table-4.13.

iii) Reptiles (Chordata: Reptilia)

Reptiles are cold-blooded animals and they warm up by basking under direct sunlight or lying over warm objects. Direct search methods were applied for reptilian survey. During cool weather the animals need to bask for longer duration. The edges of vegetation and sheltered areas were also searched for recording their presence. When possible photographs were taken by using Canon EOS 7D DSLR Camera & Canon EF 100-400 mm F/4-5.6L IS II USM Lens (Canon Inc., Japan) and kept for further references. For identification standard literature was consulted (Whitaker and Captain 2004). A comprehensive checklist of the Reptiles of Rabindra Sarovar was prepared and is represented in Table-4.14.

iv) Birds (Chordata: Aves)

The fixed paths around the lake were used as permanent transects. Total four such transects were selected which almost covered the entire area. Each transect was walked in between 6:00-9:00 Hrs. atleast once a week during the study period. While walking at a constant pace along the transect birds that were encountered within 10m on both sides were noted. Birds flying overhead were also recorded. A Nikon 8×42 (Nikon Corporation, Japan) binocular was used for observation. In addition to the fixed transects, opportunistic sightings of birds also recorded. A large number of birds that perches on the trees in the islands were observed from the bank of the lake. Standard literature (Grimmett *et al.* 2011) was used for field identification; also, conspicuous birds were identified by hearing their calls. When possible photographs of birds were taken by using Canon EOS 7D DSLR Camera & Canon EF 100-400 mm F/4-5.6L IS II USM Lens (Canon Inc., Japan) and kept for further references. A comprehensive checklist of the birds of Rabindra Sarovar was prepared by consulting existing literature and is represented in Table -4.15.

v) Mammals (Chordata: Mammalia)

To study the diversity of mammalian species, transect method was adopted. Paths around Rabindra Sarovar were used as fixed transects. Total four such transects were selected which almost covered the entire area. Entire length of each transect was trekked early in the morning atleast once a week. However, rodents and chiropterans (bats) were observed during evening hours. For identification, the books by Prater (1971) and Menon (2003) were followed. The area was also searched for obtaining indirect evidences like pug marks, scats etc. A comprehensive checklist of the mammals of Rabindra Sarovar was prepared by consulting existing literature and is represented in Table -4.16.

B) Results and Discussion

a) Invertebrates

i) Zooplankton

A total of 51 zooplanktons belonging to 18 families (Table 4.2) were observed. Sub-family Chydoridae represents highest number of species (17) followed by sub-family Brachionidae (8 species). Conservation status of each species was evaluated against the IUCN Red List of Threatened Species (*Ver. 3.1*) and Wildlife (Protection) Act, 1972 respectively. However, not a single species is mentioned in those lists.

ii) Insects

A total of 4 Hemipteran species (Bugs) of belonging to 4 families, 1 Coleopteran species (Beetles) under 1 family, 12 Chalcids belonging to 2 families, 3 Psocopteran species under 2 families, and 14 Protozoan species distributed under 10 families were recorded (both from primary data and secondary sources) (Table 4.3-4.6). Conservation status of each species was evaluated against the IUCN Red List of Threatened Species (*Ver. 3.1*) and Wildlife (Protection) Act, 1972 respectively. However, not a single species is mentioned in those lists.

iii) Ants (Hymenoptera: Formicidae)

A total of 29 ant species belonging to 5 families (Table-4.7) were observed (both from primary data and secondary sources). Sub-family Myrmicinae represents highest number of species (17). Conservation status of each species was evaluated against the IUCN Red List of Threatened Species (*Ver. 3.1*) and Wildlife (Protection) Act, 1972 respectively. However, not a single species is mentioned in those lists.

iv) Butterflies (Lepidoptera: Rhopalocera)

In the present study, a total of 57 butterfly species belonging to 13 sub-families under 5 families (Table-4.8) were observed. Sub-family Polyommatinae represents highest number of species (14). Conservation status of each species was evaluated against the IUCN Red List of Threatened Species (*Ver. 3.1*) and Wildlife (Protection) Act, 1972 respectively. Not a single species is mentioned in the IUCN Red List. However, three butterflies (namely Pointed Ciliate Blue, Gram Blue and Pea Blue) and two butterflies (namely Striped Albatross and Paintbrush Swift) were listed under Schedule II Part II and Schedule IV of IWPA, 1972 respectively. It is to be noted that butterfly population is very much influenced by various seasons. Therefore, a year-long study may reveal many other species.

v) Dragonflies & Damselflies (Insecta: Odonata)

In the present study, a total of 13 species of dragonflies and damselflies (Odonates) belonging to 2 families under 2 sub-order (Table 4.9) were observed. Family Libellulidae

represents highest number of species (8). Conservation status of each species was evaluated against the IUCN Red List of Threatened Species (*Ver. 3.1*) and Wildlife (Protection) Act, 1972 respectively and has already been mentioned in the table. Saffron-faced Blue Dart and Ditch Jewel were the most common species.

vi) Mollusca (Freshwater)

A total of 20 molluscan species belonging to 9 families (Table-4.11) were observed (both from primary data and secondary sources). Family Thiaridae represents highest number of species (5). Conservation status of each species was evaluated against the IUCN Red List of Threatened Species (*Ver. 3.1*) and Wildlife (Protection) Act, 1972 respectively and already been mentioned in the table.

b) Vertebrates

i) Fishes (Chordata: Pisces)

In the present study, a total of 40 freshwater fish species belonging to 18 families under 7 orders (Table-4.12) were observed (both from primary data and secondary sources). Family Cyprinidae represents highest number of species (17). Conservation status of each species was evaluated against the IUCN Red List of Threatened Species (*Ver. 3.1*) and Wildlife (Protection) Act, 1972 respectively. Two fishes namely Feather Back (Folui) and Giant Gourami (Kholisa) are evaluated as Near Threatened in the IUCN Red List.

ii) Amphibians (Chordata: Amphibia)

In the present study, a total of 5 amphibian species belonging to 3 families (Table-4.13) were observed. Family Dicroglossidae represents highest number of species (3). Conservation status of each species was evaluated against the IUCN Red List of Threatened Species (*Ver. 3.1*) and Wildlife (Protection) Act, 1972 respectively. Indian Bull Frog is listed in the Schedule IV of the IWPA, 1972.

iii) Reptiles (Chordata: Reptilia)

In the present study, a total of 11 reptilian species belonging to 6 families (Table-4.14) were observed. Family Colubridae represents highest number of species (4). Among reptiles were two species of turtles (Indian Flap-shell Turtle and Indian Roofed Turtle) that were regularly seen basking on floating logs in winter. Both of these belong to the Schedule I Part II of IWPA, 1972 and need to be protected. Two other species (namely Monocellate Cobra and Chequered Keelback Snake) are listed under Schedule II Part II of IWPA, 1972.

iv) Birds (Chordata: Aves)

In the present study, a total of 107 bird species (both from primary data and secondary sources) belonging to 46 families (Table-4.15) were observed, of which 69 were non-migratory or resident species, 23 were long-distant migrant, 14 species were local

migrant, and one species was summer visitor. Family Muscicapidae represents highest number of species (13). Except few, most of the non-migratory birds were found to be nesting on the trees at the Rabindra Sarobar. Some of the resident birds like Cormorants, Egrets, Storks, Night Herons, and Pond Herons nest regularly on two islands inside the lake. These islands have few trees but due to pressure of nesting, all the trees have been denuded of their leaves and flowers as the dung, guano excreted daily by these birds have a lot of white uric acid crystals. Sooner or later all these trees will die and the birds will have no proper nesting place. None of the migratory species were found to be nesting at the lake area. White-rumped Vulture is listed in Schedule I Part III of IWPA, 1971 and the same is listed as Critically Endangered in IUCN Red List of Threatened Taxa. However, during the present study no White-rumped Vulture was observed either flying or perching. A total 70 bird species is listed under Schedule IV of IWPA, 1972.

v) Mammals (Chordata: Mammalia)

In the present study, a total of 10 mammalian species belonging to 8 families under 5 orders (Table-4.16) were observed (both from primary data and secondary sources). Families Muridae and Viverridae both represent highest number of species (2). Conservation status of each species was evaluated against the IUCN Red List of Threatened Species (*Ver. 3.1*) and Wildlife (Protection) Act, 1972 respectively. Indian Grey Mongoos, Common Palm Civet and Small Palm Civet are listed in the Schedule II Part I of the IWPA, 1972. Five-striped Palm Squirrel was the most common species as it was frequently encountered at the time of survey.

Nocturnal mammals, reptiles, amphibians etc. were less studied and when fully documented, the species list of each group is likely to increase further.
No comprehensive studies on the Insect/Arachnid fauna of Rabindra Sarobar have so far been made that really have any idea of the possible number of taxa inhabiting the area to give a comprehensive zoogeographic treatment. Hence, in absence of any adequate/ sufficient data on the Insect/Arachnid fauna of Rabindra Sarobar it is too early to establish the existence of dominant group of taxa.

C) Discussion

As a part of rapid EIA of Rabindra Sarovar evaluation of faunal resources of the area has been done based on previous reports and also present study. A concise list of species groups available in the area is depicted in Table-4.17. It is revealed on the table that no record was there in respect to Reptiles, Amphibians, Dragonflies & Damselflies, Butterflies etc. This study has enriched the list particularly of those mentioned groups which are mostly considered as the indicators of the environment. Butterflies have been studied extensively during this period and 57 species have been recorded. Besides 107 birds have been recorded, of which many are migratory species. It is clear from the study that the area in particular is an abode for diversified faunal resources. This indicates that the Rabindra sarovar is the only place which is inhabited by diversified faunal components in the concrete jungle of Kolkata.

A detailed year-long study may enhance the quality of the list. Therefore, it is imperative to say that this biodiversity-rich area should be conserved giving proper attention to it.

D) References

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Table 4.1. Diversity of Protozoans of Rabindra Sarovar

Sl. No.	Scientific Name	Common Name	Family	Order	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks
1	*Chilodonella cucullus* (O. F. Müller) Ehrenberg, 1833	-	Chilodonellidae	Cryptophorida	+ (1)	-	-	-	Marine & Brackish Water
2	*Coleps hirtus* (Müller, 1786)	-	Colepidae	Prostomatida	+ (1)	-	-	-	
3	*Colpoda aspera* Kahl, 1926	-	Colpodidae	Colpodida	+ (1)	-	-	-	
4	*Holophrya annandalei* Ghosh, 1919	-	Holophryidae	Prostomatida	+ (1)	-	-	-	
5	*Holophrya bengalensis* Ghosh, 1919	-	Holophryidae	Prostomatida	+ (1)	-	-	-	
6	*Leptopharynx torpens* Kahl, 1931	-	Leptopharyngidae	Nassulida	+ (1)	-	-	-	
7	*Loxodes magnus* Stokes, 1887	-	Loxodidae	Karyorelictida	+ (1)	-	-	-	
8	*Loxodes striatus* (Englemann, 1862)	-	Loxodidae	Karyorelictida	+ (1)	-	-	-	
9	*Loxodes vorax* Stokes, 1884	-	Loxodidae	Karyorelictida	+ (1)	-	-	-	
10	*Loxophyllum levigatum* Sauerbrey, 1928	-	Amphileptidae	Pleurostomatida	+ (1)	-	-	-	Marine
11	*Loxophyllum undulatum* Sauerbrey, 1928	-	Amphileptidae	Pleurostomatida	+ (1)	-	-	-	Marine
12	*Nassula ornata* Ehrenberg, 1833	-	Nassulidae	Nassulida	+ (1)	-	-	-	
13	*Paramecium caudatum* Ehrenberg, 1834	-	Parameciidae	Hymenostomatida	+ (1)	-	-	-	Marine
14	*Prorodon discolor* Ehrenberg, 1831	-	Prorodontidae	Prostomatida	+ (1)	-	-	-	

1. Nair KN, Das AK, Mukherjee RN. 1979. On some freshwater Rhizopoda and Heliozoa (Protozoa) from Calcutta and its Environs, Part-I. Records Zoological Survey of India. 65(Part 1-4): 1-16.

Table 4.2. Diversity of Zooplanktons of Rabindra Sarovar

Sl. No.	Scientific Name	Common Name	Family	Order	Sub-Class	Class	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks
1	*Acropus harpae* (Baird, 1834)	-	Chydoridae	Cladocera	Branchipoda	Crustacea	+ (1)	-	-	-	
2	*Alona davidi* Richard, 1895	-	Chydoridae	Cladocera	Branchipoda	Crustacea	+ (1)	-	-	-	
3	*Alona pulchella* King, 1853	-	Chydoridae	Cladocera	Branchipoda	Crustacea	+ (1)	-	-	-	
4	*Alona quadrangularis* (O. F. Müller, 1776)	-	Chydoridae	Cladocera	Branchipoda	Crustacea	-	+	-	-	
5	*Asplanchna brightwelli* Gosse, 1850	-	Asplanchnidae	Ploimida	Eurotaria	Rotifera	+ (1)	-	-	-	
6	*Bosmina longirostris* (O. F. Müller, 1776)	-	Bosminidae	Cladocera	Branchipoda	Crustacea	+ (1)	-	-	-	
7	*Brachionus angularis* Goose, 1851	-	Brachionidae	Ploimida	Eurotaria	Rotifera	+ (1)	-	-	-	
8	*Brachionus calciflorus* Pallas, 1761	-	Brachionidae	Ploimida	Eurotaria	Rotifera	+ (1)	-	-	-	
9	*Brachionus caudatus* Barrois & Daday, 1894	-	Brachionidae	Ploimida	Eurotaria	Rotifera	+ (1)	-	-	-	
10	*Brachionus fulcatus* Zacharias, 1898	-	Brachionidae	Ploimida	Eurotaria	Rotifera	+ (1)	-	-	-	
11	*Brachionus patulus* (O. F. Müller, 1786)	-	Brachionidae	Ploimida	Eurotaria	Rotifera	+ (1)	-	-	-	
12	*Brachionus quadridentatus* Hermann, 1783	-	Brachionidae	Ploimida	Eurotaria	Rotifera	+ (1)	-	-	-	
13	*Brachionus rubens* Ehrenberg, 1838	-	Brachionidae	Ploimida	Eurotaria	Rotifera	+ (1)	-	-	-	
14	*Cephalodella gibba* (Ehrenberg, 1830)	-	Notommatidae	Ploima	Eurotifera	Crustacea	-	+	-	-	
15	*Ceriodaphnia cornuta* Sars, 1885	-	Daphnidae	Cladocera	Branchipoda	Crustacea	+ (1)	+	-	-	
16	*Chydorus barroisi* Richard,	-	Chydoridae	Cladocera	Branchipoda	Crustacea	+ (1)	-	-	-	

Sl. No.	Scientific Name	Common Name	Family	Order	Sub-Class	Class	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks
	1894										
17	*Chydorus sphaericus* (O. F. Müller, 1776)	-	Chydoridae	Cladocera	Branchipoda	Crustacea	+ (1)	+	-	-	
18	*Cypris subglobosa* Sowerby, 1840	-	Cyprididae	Podocopida	Ostracoda	Crustacea	+ (1)	-	-	-	
19	*Diaphanosoma excisum* Sars, 1885	-	Sididae	Cladocera	Branchipoda	Crustacea	+ (1)	-	-	-	
20	*Diaphanosoma sarsi* Richard, 1894	-	Sididae	Cladocera	Branchipoda	Crustacea	+ (1)	-	-	-	
21	*Dunhevedia crassa crassa* King, 1853	-	Chydoridae	Cladocera	Branchipoda	Crustacea	+ (1)	-	-	-	
22	*Filinia longesita* Ehrenberg, 1834	-	Filinidae	Ploimida	Eurotaria	Rotifera	+ (1)	-	-	-	
23	*Heliodiaptomus contortus* (Gurney, 1907)	-	Calanidae	Calanoida	Copepoda	Crustacea	+ (1)	-	-	-	
24	*Heliodiaptomus viduus* (Gurney, 1916)	-	Calanidae	Calanoida	Copepoda	Crustacea	+ (1)	-	-	-	
25	*Keretella tropica* (Apstein, 1907)	-	Brachionidae	Ploimida	Eurotaria	Rotifera	+ (1)	-	-	-	
26	*Lecane aculata* (Jakubski, 1912)	-	Lecanidae	Ploimida	Eurotaria	Rotifera	+ (1)	-	-	-	
27	*Lecane (Monostyla) bulla* (Goss, 1851)	-	Lecanidae	Ploimida	Eurotaria	Rotifera	+ (1)	-	-	-	
28	*Lecane curvicornis* (Murray 1913)	-	Lecanidae	Ploimida	Eurotaria	Rotifera	+ (1)	-	-	-	
29	*Lecane leotina* (Turner, 1892)	-	Lecanidae	Ploimida	Eurotaria	Rotifera	+ (1)	-	-	-	
30	*Lecane luna luna* (O. F. Müller, 1776)	-	Lecanidae	Ploimida	Eurotaria	Rotifera	+ (1)	-	-	-	
31	*Lecane (Monostyla) hamata* (Stokes, 1896)	-	Lecanidae	Ploimida	Eurotaria	Rotifera	+ (1)	-	-	-	
32	*Macrothrix triserials* (Brady, 1886)	-	Bosminidae	Cladocera	Branchipoda	Crustacea	+ (1)	-	-	-	

Sl. No.	Scientific Name	Common Name	Family	Order	Sub-Class	Class	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks
33	*Mesocyclops hyalinus* (Rehberg, 1880)	-	Cyclopidae	Cyclopoida	Copepoda	Crustacea	+ (1)	-	-	-	
34	*Mesocyclops leuckarti* (Claus, 1857)	-	Cyclopidae	Cyclopoida	Copepoda	Crustacea	+ (1)	-	-	-	
35	*Mesocyclops leuckarti* (Claus, 1857)	-	Cyclopidae	Cyclopoida	Copepoda	Crustacea	-	+	-	-	
36	*Microcyclops varicans* (Sars, 1863)	-	Cyclopidae	Cyclopoida	Copepoda	Crustacea	+ (1)	-	-	-	
37	*Monia micrura* Kurz, 1874	-	Moinidae	Cladocera	Branchipoda	Crustacea	+ (1)	-	-	-	
38	*Mytilina ventratis* (Ehrenberg, 1832)	-	Mytilidae	Ploimida	Eurotaria	Rotifera	+ (1)	-	-	-	
39	*Oxyurella singalensis* (Daddy, 1898)	-	Chydoridae	Cladocera	Branchipoda	Crustacea	+ (1)	-	-	-	
40	*Pleuroxus similis* Vavra, 1900	-	Chydoridae	Cladocera	Branchipoda	Crustacea	+ (1)	-	-	-	
41	*Polyarthra vulgaris* (Carlin, 1943)	-	Synchaetidae	Ploimida	Eurotaria	Rotifera	+ (1)	-	-	-	
42	*Pseudochydorus globosus* (Baird, 1843)	-	Chydoridae	Cladocera	Branchipoda	Crustacea	+ (1)	-	-	-	
43	*Pseudosida bidentata* Herrick, 1884	-	Sididae	Cladocera	Phyllopoda	Crustacea	-	+	-	-	
44	*Rotatoria neptunia* Ehrenberg, 1832	-	Philodinidae	Ploimida	Eurotaria	Rotifera	+ (1)	-	-	-	
45	*Scapholebris kingi* Sars, 1903	-	Daphnidae	Cladocera	Branchipoda	Crustacea	+ (1)	+	-	-	
46	*Sida crystallina* (O. F. Müller, 1776)	-	Sididae	Cladocera	Branchipoda	Crustacea	+ (1)	-	-	-	
47	*Simocephalus expinosus* (Koch, 1841)	-	Daphnidae	Cladocera	Branchipoda	Crustacea	+ (1)	-	-	-	
48	*Simocephalus vetulus* (O. F. Müller, 1776)	-	Daphnidae	Cladocera	Branchipoda	Crustacea	+ (1)	-	-	-	
49	*Testudinella patina* (Hermann, 1783)	-	Testudinellidae	Ploimida	Eurotaria	Rotifera	+ (1)	-	-	-	

Sl. No.	Scientific Name	Common Name	Family	Order	Sub-Class	Class	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks
50	*Tropocyclops prasinus* (Fischer, 1860)	-	Cyclopidae	Cyclopoida	Copepoda	Crustacea	-	+	-	-	
51	*Vorticella* sp.	-	Vorticellidae	Sessilida	Oligohymenophorea	Ciliophora	-	+	-	-	

1. Khan RA, Sinha C. 2002. Studies on the physicochemical and biological properties of two man made lake of Culcutta. Records Zoological Survey of India. 100 (Part 3-4): 1-19.

Table 4.3. Diversity of Hemiptera (Bugs) of Rabindra Sarovar

Sl. No.	Scientific Name	Common Name	Family	Order	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks
1	*Chrysocoris purpureus* (Westwood, 1781)	-	Scutelleridae	Hemiptera	-	+	-	-	
2	*Dysdercus cingulatus* (Fabricius, 1775)	Red Cotton Bug	Pyrrhocoridae	Hemiptera	-	+	-	-	
3	*Leptocorisa acuta* (Thunberg, 1783)	Rice Earhead Bug	Alydidae	Hemiptera	-	+	-	-	
4	*Spilostethus hospes* (Fabricius, 1794)	-	Lygaeidae	Hemiptera	-	+	-	-	

Table 4.4. Diversity of Coleoptera (Beetle) of Rabindra Sarovar

Sl. No.	Scientific Name	Common Name	Family	Order	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks
1	*Coccinella transversalis* Fabricius, 1781	Transverse Ladybird Beetle	Coccinellidae	Coleoptera	-	+	-	-	

Table 4.5. Diversity of Chalcids of Rabindra Sarovar

Sl. No.	Scientific Name	Common Name	Family	Order	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks
1	*Brachymeria atteviae* Joseph, Narendran & Joy, 1972	-	Chalcididae	Hymenoptera	+ (1)	-	-	-	
2	*Brachymeria bengalensis* (Cameron, 1897)	-	Chalcididae	Hymenoptera	+ (1)	-	-	-	
3	*Brachymeria burksi* Chhotani, 1966	-	Chalcididae	Hymenoptera	+ (1)	-	-	-	
4	*Brachymeria euploeae* (Westwood, 1837)	-	Chalcididae	Hymenoptera	+ (1)	-	-	-	
5	*Brachymeria hearseyi* (Kirby, 1883)	-	Chalcididae	Hymenoptera	+ (1)	-	-	-	
6	*Brachymeria lasus* (Walker, 1841)	-	Chalcididae	Hymenoptera	+ (1)	-	-	-	
7	*Dirhinus alticornis* (Masi, 1927)	-	Chalcididae	Hymenoptera	+ (1)	-	-	-	
8	*Dirhinus auratus* Ashmead, 1905	-	Chalcididae	Hymenoptera	+ (1)	-	-	-	
9	*Neochalcis breviceps* (Masi, 1929)	-	Chalcididae	Hymenoptera	+ (1)	-	-	-	
10	*Tropimeris monodon* Boucek, 1958	-	Chalcididae	Hymenoptera	+ (1)	-	-	-	
11	*Antrocephalus fascicornis* (Walker, 1871)	-	Chalcididae	Hymenoptera	+ (1)	-	-	-	
12	*Blepyrus insularis* (Cameron, 1886)	-	Encyrtidae	Hymenoptera	-	+	-	-	

1. Sheela S, Tiwari RN. 2004. Chalcid fauna of Rabindra Sarobar. Record Zoological Survey of India. 103: 3-4.

Table 4.6. Diversity of Psocopterans of Rabindra Sarovar

Sl. No.	Scientific Name	Common Name	Family	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks
1	*Archipsocus recens* Enderlein, 1903	-	Archipsocidae	+ (1)	-	-	-	
2	*Ectopsocus bengalensis* Datta, 1965	-	Peripsocidae	+ (1)	-	-	-	
3	*Peripsocus sclerotus* Thornton & Wong, 1966	-	Peripsocidae	+ (1)	-	-	-	

1. Ray KK. 1979. Psocoptera of Calcutta and Environs (West Bengal: India). Records Zoological Survey of India. 75: 353-359.

Table 4.7. Diversity of Ants (Hymenoptera: Formicidae) of Rabindra Sarovar

Sl. No.	Scientific Name	Common Name	Sub family	Family	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks
1	*Camponotus compressus* (Fabricius, 1787)	Deon Pipre	Formiciae	Formicidae	+ (1)	+	-	-	
2	*Camponotus dolendus* (Forel, 1892)	-	Formicinae	Formicidae	+ (1)	-	-	-	
3	*Cardiocondyla nuda* (Mayr, 1866)	-	Myrmicinae	Formicidae	+ (1)	-	-	-	
4	*Cardioeondyla tiwari* sp.nov.	-	Myrmicinae	Formicidae	+ (1)	-	-	-	
5	*Carebara lignata* (Westwood, 1840)	-	Myrmicinae	Formicidae	+ (1)	-	-	-	
6	*Crematogaster rothneyi* (Mayr, 1879)	-	Myrmicinae	Formicidae	+ (1)	-	-	-	
7	*Diacamma rugosum* (Le Guillou, 1842)	-	Ponerinae	Formicidae	+ (1)	-	-	-	
8	*Meranoplus bicolor* (Guérin-Méneville, 1844)	-	Myrmicinae	Formicidae	+ (1)	-	-	-	
9	*Monomorium destructor* (Jerdon, 1851)	-	Myrmicinae	Formicidae	+ (1)	-	-	-	
10	*Monomorium floricola* (Jerdon, 1851)	-	Myrmicinae	Formicidae	+ (1)	-	-	-	

Sl. No.	Scientific Name	Common Name	Sub family	Family	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks
11	*Monomorium latinode* (Mayr, 1872)	-	Myrmicinae	Formicidae	+ (1)	-	-	-	
12	*Monomorium monomorium* (Bolton, 1987)	-	Myrmicinae	Formicidae	+ (1)	-	-	-	
13	*Monomorium pharaonis* (Linnaeus, 1758)	-	Myrmicinae	Formicidae	+ (1)	-	-	-	
14	*Oecophylla smaragdina* (Fabricius, 1775)	-	Formicinae	Formicidae	+ (1)	-	-	-	
15	*Pachycondyla rufipes* (Jerdon, 1851)	-	Ponerinae	Formicidae	+ (1)	-	-	-	
16	*Paratrechina longicornis* (Latreille, 1802)	-	Formicinae	Formicidae	+ (1)	-	-	-	
17	*Pheidole roberti* (Forel, 1902)	-	Myrmicinae	Formicidae	+ (1)	-	-	-	
18	*Pheidole* sp.	-	Myrmicinae	Formicidae	+ (1)	-	-	-	
19	*Pheidologeton diversus* (Jerdon, 1851)	-	Myrmicinae	Formicidae	+ (1)	-	-	-	
20	*Plagiolepis jerdonii* (Forel, 1894)	-	Formicinae	Formicidae	+ (1)	-	-	-	
21	*Platythyrea parallela* (Smith, 1859)	-	Ponerinae	Formicidae	+ (1)	-	-	-	
22	*Recurvidris recurvispinosa* (Forel, 1890)	-	Myrmicinae	Formicidae	+ (1)	-	-	-	
23	*Solenopsis geminata* (Fabricius, 1804)	-	Myrmicinae	Formicidae	+ (1)	-	-	-	
24	*Tapinoma melanocephalum* (Fabricius, 1793)	-	Dolichoderinae	Formicidae	+ (1)	-	-	-	
25	*Technomyrmex albipes* (Smith, 1861)	-	Dolichoderinae	Formicidae	+ (1)	-	-	-	
26	*Tetramorium* sp.	-	Myrmicinae	Formicidae	+ (1)	-	-	-	
27	*Tetramorium walshi* (Forel, 1890)	-	Myrmicinae	Formicidae	+ (1)	-	-	-	
28	*Tetraponera allaborans* (Walker, 1859)	-	Pseudomyrmecinae	Formicidae	+ (1)	-	-	-	
29	*Tetraponera rufonigra* (Jerdon,	Kath Pipre	Pseudomyrmecinae	Formicidae	+ (1)	+	-	-	

Sl. No.	Scientific Name	Common Name	Sub family	Family	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks
	1851)								

1. Ghosh SN, Sheela S, Kundu BG. 2005. Ants (Hymenoptera: Formicidae) of Rabindra Sarovar, Kolkata. Records Zoological Survey of India (Occasional Paper no. 234). p 1-40.

Table 4.8. Diversity of Butterflies (Lepidoptera: Rhopalocera) of Rabindra Sarovar

Sl. No.	Scientific Name	Common Name	Sub-family	Family	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (Ver. 3.1)	Remarks
1	*Acraea violae* (Fabricius, 1793)	Tawny Coster	Heliconiinae	Nymphalidae	-	+	-	-	
2	*Anthene emolus* (Godart, [1824])	Common Ciliate Blue	Polyommatinae	Lycaenidae	-	+	-	-	
3	*Anthene lycaenina* (R. Felder, 1868)	Pointed Ciliate Blue	Polyommatinae	Lycaenidae	-	+	Sch. II Part II	-	
4	*Appias libythea* (Fabricius, 1775)	Striped Albatross	Pierinae	Pieridae	-	+	Sch. IV	-	
5	*Ariadne ariadne* (Linnaeus, 1763)	Angled Castor	Biblidinae	Nymphalidae	-	+	-	-	
6	*Ariadne merione* (Cramer, [1777])	Common Castor	Biblidinae	Nymphalidae	-	+	-	-	
7	*Atrophaneura aristolochiae* (Fabricius, 1775)	Common Rose	Papilioninae	Papilionidae	-	+	-	-	
8	*Baoris farri* (Moore, 1878)	Paintbrush Swift	Hesperiinae	Hesperiidae	-	+	Sch. IV	-	
9	*Castalius rosimon* (Fabricius, 1775)	Common Pierrot	Polyommatinae	Lycaenidae	-	+	-	-	
10	*Catochrysops strabo*	Forget-me-not	Polyommatinae	Lycaenidae	-	+	-	-	

	(Fabricius, 1793)								
11	*Catopsilia pomona* (Fabricius, 1775)	Common Emigrant	Coliadinae	Pieridae	-	+	-	-	
12	*Catopsilia pyranthe* (Linnaeus, 1758)	Mottled Emigrant	Coliadinae	Pieridae	-	+	-	-	
13	*Cepora nerissa* (Fabricius, 1775)	Common Gull	Pierinae	Pieridae	-	+	-	-	
14	*Charaxes solon* (Fabricius, 1793)	Black Rajah	Charaxinae	Nymphalidae	-	+	-	-	
15	*Chilades lajus* (Stoll, [1780])	Lime Blue	Polyommatinae	Lycaenidae	-	+	-	-	
16	*Chilades pandava* (Horsfield, [1829])	Plains Cupid	Polyommatinae	Lycaenidae	-	+	-	-	
17	*Cigaritis vulcanus* (Fabricius, 1775)	Common Silverline	Theclinae	Lycaenidae	-	+	-	-	
18	*Danaus chrysippus* (Linnaeus, 1758)	Plain Tiger	Danainae	Nymphalidae	-	+	-	-	
19	*Danaus genutia* (Cramer, [1779])	Striped Tiger	Danainae	Nymphalidae	-	+	-	-	
20	*Delias eucharis* (Drury, 1773)	Common Jezebel	Pierinae	Pieridae	-	+	-	-	
21	*Elymnias hypermnestra undularis* (Drury, 1773)	Common Palmfly	Satyrinae	Nymphalidae	-	+	-	-	
22	*Euchrysops cnejus* (Fabricius, 1798)	Gram Blue	Polyommatinae	Lycaenidae	-	+	Sch. II Part II	-	
23	*Euploea core* (Cramer, [1780])	Common Crow	Danainae	Nymphalidae	-	+	-	-	
24	*Eurema hecabe* (Linnaeus, 1758)	Common Grass Yellow	Coliadinae	Pieridae	-	+	-	-	
25	*Euthalia aconthea* (Cramer, [1777])	Common Baron	Limenitidinae	Nymphalidae	-	+	-	-	
26	*Graphium agamemnon* (Linnaeus, 1758)	Tailed Jay	Papilioninae	Papilionidae	-	+	-	-	
27	*Hypolimnas bolina*	Great Eggfly	Nymphalinae	Nymphalidae	-	+	-	-	

	(Linnaeus, 1758)								
28	*Iraota timoleon* (Stoll, 1790)	Silverstreak Blue	Theclinae	Lycaenidae	-	+	-	-	
29	*Junonia almana* (Linnaeus, 1758)	Peacock Pansy	Nymphalinae	Nymphalidae	-	+	-	-	
30	*Junonia atlites* (Linnaeus, 1763)	Grey Pansy	Nymphalinae	Nymphalidae	-	+	-	-	
31	*Lampides boeticus* (Linnaeus, 1767)	Pea Blue	Polyommatinae	Lycaenidae	-	+	Sch. II Part II	-	
32	*Leptosia nina* (Fabricius, 1793)	Psyche	Pierinae	Pieridae	-	+	-	-	
33	*Leptotes plinius* (Fabricius, 1793)	Zebra Blue	Polyommatinae	Lycaenidae	-	+	-	-	
34	*Matapa aria* (Moore, [1866])	Common Redeye	Hesperiinae	Hesperiidae	-	+	-	-	
35	*Melanitis leda* (Linnaeus, 1758)	Common Evening Brown	Satyrinae	Nymphalidae	-	+	-	-	
36	*Moduza procris* (Cramer, [1777])	Commander	Limenitidinae	Nymphalidae	-	+	-	-	
37	*Mycalesis mineus* (Linnaeus, 1758)	Dark-brand Bushbrown	Satyrinae	Nymphalidae	-	+	-	-	
38	*Neopithecops zalmora* (Butler, [1870])	Quaker	Polyommatinae	Lycaenidae	-	+	-	-	
39	*Neptis jumbah* Moore, [1858]	Chestnut-streaked Sailer	Limenitidinae	Nymphalidae	-	+	-	-	
40	*Oriens goloides* (Moore, 1881)	Common Dartlet	Hesperiinae	Hesperiidae	-	+	-	-	
41	*Papilio clytia* Linnaeus, 1758	Common Mime	Papilioninae	Papilionidae	-	+	-	-	
42	*Papilio demoleus* Linnaeus, 1758	Lime Butterfly	Papilioninae	Papilionidae	-	+	-	-	
43	*Papilio polytes* Linnaeus, 1758	Common Mormon	Papilioninae	Papilionidae	-	+	-	-	
44	*Pareronia valeria* (Cramer, [1776])	Common Wanderer	Pierinae	Pieridae	-	+	-	-	
45	*Pelopidas mathias* (Fabricius, 1798)	Small Branded Swift	Hesperiinae	Hesperiidae	-	+	-	-	
46	*Phalanta phalantha* (Drury, [1773])	Common Leopard	Heliconiinae	Nymphalidae	-	+	-	-	
47	*Prosotas nora*	Common	Polyomm	Lycaenidae	-	+	-	-	

	(Felder, 1860)	Lineblue	atinae						
48	*Pseudozizeeria maha* (Kollar, [1844])	Pale Grass Blue	Polyommatinae	Lycaenidae	-	+	-	-	
49	*Rapala manea* (Hewitson, 1863)	Slate Flash	Theclinae	Lycaenidae	-	+	-	-	
50	*Rathinda amor* (Fabricius, 1775)	Monkey Puzzle	Theclinae	Lycaenidae	-	+	-	-	
51	*Suastus gremius* (Fabricius, 1798)	Indian Palm Bob	Hesperiinae	Hesperiidae	-	+	-	-	
52	*Telicota bambusae* (Moore, 1878)	Dark Palm Dart	Hesperiinae	Hesperiidae	-	+	-	-	
53	*Tirumala limniace* (Cramer, [1775])	Blue Tiger	Danainae	Nymphalidae	-	+	-	-	
54	*Ypthima baldus* (Fabricius, 1775)	Common Five-ring	Satyrinae	Nymphalidae	-	+	-	-	
55	*Ypthima huebneri* Kirby, 1871	Common Four-ring	Satyrinae	Nymphalidae	-	+	-	-	
56	*Zizula hylax* (Fabricius, 1775)	Tiny Grass Blue	Polyommatinae	Lycaenidae	-	+	-	-	
57	*Zizzeria karsandra* (Moore, 1865)	Dark Grass Blue	Polyommatinae	Lycaenidae	-	+	-	-	

Table 4.9. Diversity of Odonata (Dragonflies & Damselflies) of Rabindra Sarovar

Sl. No.	Scientific Name	Common Name	Family	Sub-order	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks
1	*Agriocnemis pygmaea* (Rambur, 1842)	Pygmy Dartlet	Coenagrionidae	Zygoptera	-	+	-	Least Concern	
2	*Brachythemis contaminata* (Fabricius, 1793)	Ditch Jewel	Libellulidae	Anisoptera	-	+	-	Least Concern	
3	*Ceriagrion coromandelianum* (Fabricius, 1798)	Coromandel Marsh Dart	Coenagrionidae	Zygoptera	-	+	-	Least Concern	
4	*Crocothemis servilia* (Drury, 1773)	Ruddy Marsh Skimmer	Libellulidae	Anisoptera	-	+	-	Least Concern	
5	*Diplacodes trivialis* (Rambur, 1842)	Ground Skimmer	Libellulidae	Anisoptera	-	+	-	Least Concern	
6	*Ischnura senegalensis*	Senegal Golden	Coenagrionidae	Zygoptera	-	+	-	Least Concern	

	(Rambur, 1842)	Dartlet							
7	*Onychargia atrocyana* (Sélys, 1865)	Black Marsh Dart	Coenagrionidae	Zygoptera	-	+	-	Least Concern	
8	*Orthetrum sabina* (Drury, 1773)	Green Marsh Hawk	Libellulidae	Anisoptera	-	+	-	Least Concern	
9	*Pantala flavescens* (Fabricius, 1798)	Wandering Glider	Libellulidae	Anisoptera	-	+	-	Least Concern	
10	*Pseudagrion rubriceps* (Selys, 1876)	Saffron-faced Blue Dart	Coenagrionidae	Zygoptera	-	+	-	Least Concern	
11	*Rhodothemis rufa* (Rambur, 1842)	Rufous Marsh Glider	Libellulidae	Anisoptera	-	+	-	Least Concern	
12	*Rhyothemis variegata* (Linnaeus, 1763)	Common Picture Wing	Libellulidae	Anisoptera	-	+	-	Least Concern	
13	*Trithemis pallidinervis* (Kirby, 1889)	Long-legged Marsh Glider	Libellulidae	Anisoptera	-	+	-	Least Concern	

Table 4.10. Details of the survey stations

Site 1	Calcutta University Rowing Club
Site 2	Opposite of Calcutta University Rowing Club
Site 3	1st Island near Calcutta University Rowing Club
Site 4	Opposite of Bengal Rowing Club
Site 5	1st Island near Bengal Rowing Club
Site 6	2nd Island near Bengal Rowing Club
Site 7	Gol Park End

Table 4.11. Diversity of Mollusca (Freshwater) of Rabindra Sarovar

Sl. No.	**Scientific Name**	**Common Name**	**Family**	**Earlier Reports**	**Present Study**	**IWPA, 1972**	**IUCN Red List (*Ver. 3.1*)**	**Remarks**
1	*Bellamya bengalensis* (Lamarck, 1822)	Geri Googly	Viviparidae	+ (1,2,3)	-	-	Least Concern	
2	*Brotia costula* (Rafinesque, 1833)	-	Thiaridae	+ (1,2,3)	+	-	Least Concern	
3	*Digoniostoma cerameopoma* (Benson, 1830)	-	Bithyniidae	+ (1,2,3)	-	-	Least Concern	

Sl. No.	Scientific Name	Common Name	Family	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks
4	*Gabbia orcula* (Frauenfeld, 1862)	-	Bithyniidae	+ (1,2,3)	+	-	Least Concern	
5	*Gyraulus convexiusculus* (Hutton, 1849)	-	Planorbidae	+ (1,2,3)	+	-	Least Concern	
6	*Gyraulus labiatus* (Benson, 1850)	-	Planorbidae	+ (1,2,3)	-	-	Least Concern	
7	*Indoplanorbis exustus* (Deshayes,1834)	-	Planorbidae	+ (1,2,3)	+	-	Least Concern	
8	*Lamellidens marginalis* (Lamarck, 1819)	Jhinuk	Unionidae	+ (1,2,3)	+	-	Least Concern	
9	*Lamellidens corrianus* (Lea,1834)	Jhinuk	Unionidae	+ (1,2,3)	+	-	Least Concern	
10	*Lymnaea acuminata* (Lamarck, 1822)	-	Lymnaeidae	+ (1,2,3)	-	-	Least Concern	
11	*Lymnaea luteola* (Lamarck, 1822)	-	Lymnaeidae	+ (1,2,3)	-	-	Least Concern	
12	*Melanoides tuberculata* (Mueller, 1774)	-	Thiaridae	+ (1,2,3)	-	-	-	
13	*Mieniplotia scabra* (Müller, 1774)	-	Thiaridae	+ (1,2)	-	-	Least Concern	
14	*Parreysia pachyasoma* (Benson)	-	Amblenidae	+ (1,2,3)	-	-	-	
15	*Parreysia (Parreysia) corrugata* (Mueller, 1774)	-	Amblenidae	+ (1,2,3)	-	-	-	
16	*Parreysia caerulea* (Lea,1831)	-	Amblenidae	+ (1,2,3)	-	-	Least Concern	
17	*Pila globosa* (Swainson, 1822)	-	Pilidae	+ (1,2,3)	+	-	Least Concern	
18	*Pisidium clarkeanum* (G and H Nevill, 1871)	-	Pisidiidae	+ (1,2,3)	-	-	Least Concern	
19	*Tarebia granifera* (Lamarck, 1822)	-	Thiaridae	+ (1,2,3)	-	-	Least Concern	
20	*Tarebia lineata* (Gray, 1828)	-	Thiaridae	+ (1,2,3)	+	-	Least Concern	

1. Roy M, Nandi NC. 2008. Macrozoobenthos of some Lacustrine Wetland of West Bengal, India. In: Sengupta M, Dalwani R. (Eds.). Proceedings of Taal 2007: The 12th World Lake Conference. p. 506-512.
2. Mukherji M, Nandi NC. 2004. Studies on Macrozoobenthos of Rabindra Sarovar and Subhas Sarovar in Kolkata in relation to water and sediment characteristics. Records Zoological Survey of India (Occasional Paper No. 225). p. 1-119.
3. Khan RA. 2002. Diversity of freshwater macro-invertebrate communities associated with macrophytes. Record Zoological Survey of India. 100(part 1-2): 211-228.

Table 4.12. Diversity of Fishes (Chordata: Pisces) of Rabindra Sarovar

Sl. No.	Scientific Name	Common Name	Family	Order	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks
1	*Amblypharyngodon mola* (Hamilton, 1822)	Mola Carplet/ Mourola	Cyprinidae	Cypriniformes	+ (1)	+	-	Least Concern	
2	*Anabas testudineus* (Bloch, 1792)	Climbing Perch/ Koi	Anabantidae	Perciformes	+ (1)	+	-	Least Concern	
3	*Aplocheilus panchax* (Hamilton, 1822)	Blue Panchax/ Techokha	Aplocheilidae	Cyprinodontiformes	+ (1)	+	-	Least Concern	
4	*Badis badis* (Hamilton, 1822)	Dwarf Chameleon Fish/ Pod Koi	Badidae	Perciformes	+ (1)	-	-	-	
5	*Catla catla* (Hamilton, 1822)	Catla	Cyprinidae	Cypriniformes	+ (1)	+	-	Least Concern	
6	*Chanda nama* Hamilton, 1822	Elongate Glass Perchlet	Ambassidae	Perciformes	+ (1)	-	-	-	An Introduced species
7	*Channa gachua* (Hamilton, 1822)	Dwarf Snakehead/ Cheng	Channidae	Perciformes	+ (1)	+	-	-	An introduced species
8	*Channa marulius* (Hamilton, 1822)	Giant Snakehead/ Shal	Channidae	Perciformes	-	+	-	Least Concern	
9	*Channa punctata* (Bloch, 1793)	Spotted Snakehead/ Latha	Channidae	Perciformes	+ (1)	+	-	Least Concern	
10	*Channa striata* (Bloch, 1793)	Banded Snakehead/ Shol	Channidae	Perciformes	+ (1)	+	-	Least Concern	
11	*Cirrhinus mrigala* (Hamilton, 1822)	Mrigal Carp/ Mrigal	Cyprinidae	Cypriniformes	+ (1)	+	-	-	An introduced species
12	*Clarias batrachus* (Linnaeus, 1758)	Magur	Clariidae	Siluriformes	+ (1)	+	-	Data Deficient	An introduced species
13	*Clarias gariepinus* (Burchell, 1822)	African Catfish/ Hybrid Magur	Clariidae	Siluriformes	-	+	-	Least Concern	
14	*Ctenopharyngodon idella* (Valenciennes, 1844)	Grass Carp/ Gheso Rui	Cyprinidae	Cypriniformes	-	+	-	Least Concern	
15	*Cyprinus carpio* Linnaeus, 1758	Wild Common Carp	Cyprinidae	Cypriniformes	+ (1)	-	-	Least Concern	
16	*Danio rerio* (Hamilton, 1822)	Zebrafish	Cyprinidae	Cypriniformes	-	+	-	Least Concern	
17	*Devario devario* (Hamilton, 1822)	Bengal Danio/ Nipati	Cyprinidae	Cypriniformes	-	+	-	Least Concern	

Sl. No.	Scientific Name	Common Name	Family	Order	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks
18	*Esomus danrica* (Hamilton, 1822)	Flying Barb/ Danrika	Cyprinidae	Cypriniformes	+ (1)	-	-	-	
19	*Glossogobius giuris* (Hamilton, 1822)	Bareye Goby/ Bele	Gobiidae	Perciformes	+ (1)	+	-	Least Concern	
20	*Heteropneustes fossilis* (Bloch, 1794)	Stinging Catfish/ Shingi	Heteropneustidae	Siluriformes	+ (1)	+	-	Least Concern	
21	*Hypophthalmichthys molitrix* (Valenciennes, 1844)	Silver Carp	Cyprinidae	Cypriniformes	+ (1)	+	-	Least Concern	
22	*Hypophthalmichthys nobilis* (Richardson, 1845)	Bighead Carp	Cyprinidae	Cypriniformes	-	+	-	Least Concern	
23	*Labeo bata* (Hamilton, 1822)	Minor Carp/ Bata	Cyprinidae	Cypriniformes	+ (1)	+	-	Least Concern	
24	*Labeo calbasu* (Hamilton, 1822)	Orange-fin Labeo/ Kalbos	Cyprinidae	Cypriniformes	+ (1)	+	-	Data Deficient	
25	*Labeo rohita* (Hamilton, 1822)	Rohu	Cyprinidae	Cypriniformes	+ (1)	+	-	Least Concern	
26	*Lepidocephalus guntea* (Hamilton, 1822)	Guntea Loach/ Gunte	Cobitidae	Cypriniformes	-	+	-	Least Concern	
27	*Macrognathus aculeatus* (Bloch, 1786)	Lesser Spiny Eel/ Pankal	Mastacembelidae	Synbranchiformes	+ (1)	+	-	Least Concern	
28	*Monopterus cuchia* (Hamilton, 1822)	Mud Eel/ Cunche	Synbranchidae	Synbranchiformes	-	+	-	Least Concern	
29	*Mystus vittatus* (Bloch, 1794)	Striped Dwarf Catfish/ Tangra	Bagridae	Siluriformes	-	+	-	Least Concern	
30	*Notopterus notopterus* (Pallas, 1769)	Feather Back/ Folui	Notopteridae	Osteoglossiformes	-	+	-	Near Threatened	
31	*Oreochromis mossambicus* (Peters, 1852)	Mozambique Tilapia/ Tilapia	Cichlidae	Perciformes	+ (1)	+	-	-	An introduced species
32	*Oreochromis niloticus* (Linnaeus, 1758)	Nile Tilapia/ Nilontika	Cichlidae	Perciformes	+ (1)	+	-	Least Concern	
33	*Parambassis ranga* (Hamilton, 1822)	Indian Glassy Fish/ Chanda	Ambassidae	Perciformes	+ (1)	+	-	Least Concern	
34	*Pethia ticto* (Hamilton, 1822)	Ticto Barb/ Tit Punti	Cyprinidae	Cypriniformes	+ (1)	+	-	Least Concern	
35	*Puntius sophore* (Hamilton, 1822)	Spotfin Swamp	Cyprinidae	Cypriniformes	-	+	-	Least Concern	

Sl. No.	Scientific Name	Common Name	Family	Order	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks
		Barb/ Bhadi Puti							
36	*Rasbor daniconius* (Hamilton, 1822)	Common Rasbora/ Daria/ Darkina	Cyprinidae	Cypriniformes	-	+	-	Least Concern	An introduced species
37	*Systomus sarana* (Hamilton, 1822)	Olive Barb/ Sar Punti	Cyprinidae	Cypriniformes	+ (1)	-	-	Least Concern	
38	*Trichogaster fasciata* (Bloch & Schneider, 1801)	Giant Gourami/ Kholisha	Osphronemidae	Perciformes	+ (1)	+	-	Near Threatened	
39	*Wallago attu* (Bloch & Schneider, 1801)	Boal	Siluridae	Siluriformes	-	+	-	-	
40	*Xenentodon cancila* (Hamilton, 1822)	Freshwater Garfish /Bogo/ Kakila	Belonidae	Beloniformes	-	+	-	Least Concern	

1. IWMED. 2001. Monitoring of Environmental Status of Rabindra Sarovar & Preparation of Management Action Plan. Dept. of Environment, Govt. of West Bengal. 73 p. +XXXII.

Table 4.13. Diversity of Amphibians (Chordata: Amphibia) of Rabindra Sarovar

Sl. No.	Scientific Name	Common Name	Family	Order	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks
1	*Duttaphrynus melanostictus* (Schneider, 1799)	Common Indian Toad	Bufonidae	Anura	-	+	-	Least Concern	
2	*Euphlyctis cyanophlyctis* (Schneider, 1799)	Skittering Frog	Dicroglossidae	Anura	-	+	-	Least Concern	
3	*Fejervarya* sp.	Cricket Frog	Dicroglossidae	Anura	-	+	-	Least Concern	
4	*Hoplobatrachus tigerinus* (Daudin, 1802)	Indian Bull Frog	Dicroglossidae	Anura	-	+	Sch. IV	Least Concern	
5	*Polypedates maculatus* (Gray, 1830)	Common Indian Tree Frog	Rhacophoridae	Anura	-	+	-	Least Concern	

Table 4.14. Diversity of Reptiles (Chordata: Reptilia) of Rabindra Sarovar

Sl. No.	Scientific Name	Common Name	Family	Order	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks
1	*Amphiesma stolatum* (Linnaeus, 1758)	Buff-striped Keelback	Colubridae	Squamata	-	+	Sch. IV	-	
2	*Calotes versicolor* (Daudin, 1802)	Garden Lizard	Agamidae	Squamata	-	+	-	-	
3	*Dendrelaphis tristis* (Daudin, 1803)	Bronzed-back Tree Snake	Colubridae	Squamata	-	+	Sch. IV	-	
4	*Eutropis carinata* (Schneider, 1801)	Common Grass Skink	Scincidae	Squamata	-	+	-	Least Concern	
5	*Eutropis macularia* (Blyth, 1853)	Bronzed Grass Skink	Scincidae	Squamata	-	+	-	-	
6	*Lissemys punctata* (Lacépède, 1788)	Indian Flap-shell Turtle	Trionychidae	Testudines	-	+	Sch. I Part II	Least Concern	
7	*Lygosoma albopunctata* (Gray, 1846)	White-spotted Supple Skink	Scincidae	Squamata	-	+	-	-	
8	*Naja kaouthia* Lesson, 1831	Monocellate Cobra	Elapidae	Squamata	-	+	Sch. II Part II	-	
9	*Pangshura tecta* (Gray, 1830)	Indian Roofed Turtle	Geoemydidae	Testudines	-	+	Sch. I Part II	Least Concern	
10	*Ptyas mucosa* (Linnaeus, 1758)	Indian Rat Snake	Colubridae	Squamata	-	+	Sch. II Part II	-	
11	*Xenochrophis piscator* (Schneider, 1799)	Chequered Keelback Snake	Colubridae	Squamata	-	+	Sch. II Part II	-	

Table 4.15. Diversity of Birds (Chordata: Aves) of Rabindra Sarovar

Sl. No.	Scientific Name	Common Name	Family	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks	Nest in Rabindra Sarovar
1	*Accipiter badius* (Gmelin, 1788)	Shikra/ Turki Baj	Accipitridae	+ (2)	-	-	Least Concern	Resident	Yes
2	*Acridotheres fuscus* (Wagler, 1827)	Jungle Myna/ Jhunt Shalik	Sturnidae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	Yes

Sl. No.	Scientific Name	Common Name	Family	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks	Nest in Rabindra Sarovar
3	*Acridotheres tristis* (Linnaeus, 1766)	Common Myna/ Shalik	Sturnidae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	Yes
4	*Acrocephalus aedon* (Pallas, 1776)	Thick-billed Warbler/ Mota-chonchu Tikra	Acrocephalidae	+ (2)	-	-	Least Concern	Long-distant Migrant	No
5	*Acrocephalus dumetorum* Blyth, 1849	Blyth's Reed Warbler/ Jhonp Tikra	Acrocephalidae	+ (1, 2)	-	-	Least Concern	Long-distant Migrant	No
6	*Alcedo atthis* (Linnaeus, 1758)	Common Kingfisher/ Chhoto Machhranga	Alcedinidae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	Yes
7	*Amaurornis phoenicurus* (Pennant, 1769)	White-breasted Waterhen/ Dahuk	Rallidae	+ (1, 2)	+	-	Least Concern	Resident	Yes
8	*Anastomus oscitans* (Boddaert, 1783)	Asian Openbill/ Shamuk-khol	Ciconiidae	+ (2)	+	Sch. IV	Least Concern	Resident	Yes
9	*Anhinga melanogaster* Pennant, 1769	Darter/ Goyar	Anhingidae	+ (2)	-	Sch. IV	Near Threatened	Resident	No
10	*Anthus hodgsoni* Richmond, 1907	Olive-backed Pipit/ Muchashi	Motacillidae	+ (2)	-	Sch. IV	Least Concern	Resident	No
11	*Apus nipalensis* (Hodgson, 1836)	House Swift/ Batashi	Apodidae	+ (1)	-	-	Least Concern	Resident	Yes
12	*Ardea purpurea* Linnaeus, 1766	Purple Heron/ Lal Kank	Ardeidae	+ (1)	-	Sch. IV	Least Concern	Resident	No
13	*Ardeola grayii* (Sykes, 1832)	Indian Pond Heron/ Konch Bok	Ardeidae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	Yes
14	*Athene brama* (Temminck, 1821)	Spotted Owlet/ Kuture Pancha	Strigidae	+ (2)	-	Sch. IV	Least Concern	Resident	Yes
15	*Bubulcus ibis* (Linnaeus, 1758)	Cattle Egret/ Go-bok	Ardeidae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	Yes
16	*Cacomantis merulinus* (Scopoli, 1786)	Plaintive Cuckoo/ Lalpet Bilapi Pik	Cuculidae	+ (2)	-	Sch. IV	Least Concern	Resident	No (Brood Parasite of other bird's nest)

Sl. No.	Scientific Name	Common Name	Family	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks	Nest in Rabindra Sarovar
17	*Caprimulgus macrurus* Horsfield, 1821	Large-tailed Nightjar/ Bodo Thukthukiya	Caprimulgidae	+ (2)	-	Sch. IV	Least Concern	Resident	No
18	*Centropus sinensis* (Stephens, 1815)	Greater Coucal/ Kubo	Cuculidae	+ (1, 2)	-	Sch. IV	Least Concern	Resident	No
19	*Chlidonias hybrid* (Pallas, 1811)	Whiskered Tern/ Dhenkchil	Laridae	+ (2)	-	-	Least Concern	Local Migrant	No
20	*Cinnyris asiaticus* (Latham, 1790)	Purple Sunbird/ Durga-Tuntuni/ Mouchushi	Nectariniidae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	Yes
21	*Columba livia* Gmelin, 1789	Common Pigeon/ Gola Payra	Columbidae	+ (1)	+	-	Least Concern	Resident	Yes
22	*Copsychus saularis* (Linnaeus, 1758)	Oriental Magpie Robin/ Doyel	Muscicapidae	+ (1, 2)	+	-	Least Concern	Resident	Yes
23	*Coracina macei* (Lesson, 1831)	Large Cuckooshrike/ Kabashi	Campephagidae	+ (2)	-	-	Least Concern	Resident	No
24	*Corvus macrorhynchos* Wagler, 1827	Large-billed Crow/ Dandkak	Corvidae	+ (1)	+	-	Least Concern	Resident	Yes
25	*Corvus splendens* Vieillot, 1817	House Crow/ Patikak	Corvidae	+ (1)	+	-	Least Concern	Resident	Yes
26	*Cuculus canorus* Linnaeus, 1758	Eurasian Cuckoo/ Kukku	Cuculidae	+ (2)	-	Sch. IV	Least Concern	Summer Visitor	No
27	*Cyornis rubeculoides* (Vigors, 1831)	Blue-throated Blue Flycatcher/ Ghotki/ Chatki	Muscicapidae	+ (2)	-	Sch. IV	Least Concern	Long-distant Migrant	No
28	*Cypsiurus balasiensis* (Gray, 1829)	Asian Palm Swift/ Talchodai/ Talchonch	Apodidae	+ (1)	+	-	Least Concern	Resident	Yes
29	*Dendrocitta vagabunda* (Latham, 1790)	Rufous Treepie/ Handichacha/ Takachor	Corvidae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	Yes
30	*Dendrocopos macei* (Vieillot, 1818)	Fulvous-breasted Woodpecker/ Jorod Kath-thokra	Picidae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	Yes

Sl. No.	Scientific Name	Common Name	Family	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks	Nest in Rabindra Sarovar
31	*Dendrocygna javanica* (Horsfield, 1821)	Lesser Whistling Duck/ Chhoto Saral	Anatidae	+ (2)	-	Sch. IV	Least Concern	Local Migrant	No
32	*Dendronanthus indicus* (Gmelin, 1789)	Forest Wagtail/ Jongli Khonjon	Motacillidae	+ (2)	-	-	Least Concern	Local Migrant	No
33	*Dicrurus aeneus* Vieillot, 1817	Bronzed Drongo/ Chhoto Bhujongo	Dicruridae	+ (2)	-	Sch. IV	Least Concern	Resident	No
34	*Dicrurus annectans* (Hodgson, 1836)	Crow-billed Drongo/ Kak-chonchu Phinge	Dicruridae	+ (2)	-	Sch. IV	-	Local Migrant	No
35	*Dicrurus hottentottus* (Linnaeus, 1766)	Hair-crested Drongo/ Spangled Drongo/ Keshraj	Dicruridae	+ (2)	-	Sch. IV	Least Concern	Resident	No
36	*Dicrurus leucophaeus* Vieillot, 1817	Ashy Drongo/ Nil Phinge	Dicruridae	+ (2)	-	Sch. IV	Least Concern	Local Migrant	No
37	*Dicrurus macrocercus* Vieillot, 1817	Black Drongo/ Phinge	Dicruridae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	Yes
38	*Dicrurus remifer* (Temminck, 1823)	Lesser Racket-tailed Drongo	Dicruridae	+ (2)	-	Sch. IV	Least Concern	Local Migrant	No
39	*Dinopium benghalense* (Linnaeus, 1758)	Lesser Goldenback/ Chhoto Sonali Kath-thokra	Picidae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	Yes
40	*Eudynamys scolopaceus* (Linnaeus, 1758)	Asian Koel/ Kokil	Cuculidae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	No (Brood Parasite of Crow's nest)
41	*Eumyias thalassinus* Swainson, 1838	Verditer Flycatcher/ Nil Kotkotiya	Muscicapidae	+ (2)	+	Sch. IV	Least Concern	Long-distant Migrant	No
42	*Ficedula albicilla* (Pallas, 1811)	Taiga Flycatcher	Muscicapidae	+ (2)	-	Sch. IV	Least Concern	Long-distant Migrant	No
43	*Ficedula parva* (Bechstein, 1792)	Red-throated or Red-breasted Flycatcher/ Chutki	Muscicapidae	+ (1, 2)	-	Sch. IV	Least Concern	Long-distant Migrant	No
44	*Ficedula superciliaris* (Jerdon,	Ultramarine Flycatcher/ Shada-bhuru	Muscicapidae	+ (2)	-	Sch. IV	Least Concern	Long-distant Migrant	No

Sl. No.	Scientific Name	Common Name	Family	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks	Nest in Rabindra Sarovar
	1840)	Nil Chutki							
45	*Gallinago stenura* (Bonaparte, 1830)	Pintail Snipe/ Sunchpuchchho Kadakhoncha	Scolopacidae	+ (2)	-	Sch. IV	Least Concern	Long-distant Migrant	No
46	*Gallinula chloropus* (Linnaeus, 1758)	Common Moorhen/ Jolmurgi	Rallidae	+ (2)	-	-	Least Concern	Local Migrant	No
47	*Gracupica contra* (Linnaeus, 1758)	Asian Pied Starling/ Go-shalik	Sturnidae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	Yes
48	*Gyps bengalensis* (Gmelin, 1788)	White-rumped Vulture/ Shokun	Accipitridae	+ (1)	-	Sch. I Part III	Critically Endangered	Resident	No
49	*Halcyon smyrnensis* (Linnaeus, 1758)	White-throated Kingfisher/ Sadabuk Machhranga	Alcedinidae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	Yes
50	*Hierococcyx varius* (Vahl, 1797)	Common Hawk Cuckoo/ Papia/ Chokh-galo	Cuculidae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	Yes
51	*Hypothymis azurea* (Boddaert, 1783)	Black-naped Monarch/ Kalo-matha Kotkotiya	Monarchidae	+ (2)	-	-	Least Concern	Resident	Yes
52	*Lanius cristatus* Linnaeus, 1758	Brown Shrike/ Kajolpakhi/ Karkata	Laniidae	+ (1, 2)	-	-	Least Concern	Long-distant Migrant	No
53	*Leptocoma zeylonica* (Linnaeus, 1766)	Purple-rumped Sunbird/ Durga-Tuntuni/ Moutushi	Nectariniidae	+ (1)	+	Sch. IV	Least Concern	Resident	Yes
54	*Lonchura punctulata* (Linnaeus, 1758)	Scaly-breasted Munia/ Tile Muniya	Estrildidae	+ (1, 2)	-	Sch. IV	Least Concern	Resident	No
55	*Luscinia brunnea* Hodgson, 1837	Indian Blue Robin/ Nil Shama	Muscicapidae	+ (2)	-	-	Least Concern	Long-distant Migrant	No
56	*Luscinia calliope* (Pallas, 1776)	Siberian Rubythroat/ Gupigora	Muscicapidae	+ (2)	-	-	Least Concern	Long-distant Migrant	No
57	*Luscinia cyane* (Pallas, 1776)	Siberian Blue Robin	Muscicapidae	+ (2)	-	-	Least Concern	Long-distant Migrant	No
58	*Megalaima asiatica*	Blue-throated Barbet/	Megalaimidae	+ (1, 2)	+	Sch. IV	-	Resident	Yes

Sl. No.	Scientific Name	Common Name	Family	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks	Nest in Rabindra Sarovar
	(Latham, 1790)	Nilgola Boshonto Bouri							
59	*Megalaima haemacephala* (Müller, 1776)	Coppersmith Barbet/ Chhoto Boshonto Bouri	Megalaimidae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	Yes
60	*Megalaima lineate* (Vieillot, 1816)	Lineated Barbet/ Rekha Boshonto	Megalaimidae	+ (2)	+	Sch. IV	Least Concern	Resident	Yes
61	*Merops orientalis* Latham, 1802	Green Bee-eater/ Banshpati	Meropidae	+ (1, 2)	-	-	Least Concern	Resident	No
62	*Metopidius indicus* (Latham, 1790)	Bronze-winged Jacana/ Jolpipi	Jacanidae	+ (1)	-	Sch. IV	Least Concern	Resident	Yes
63	*Micropternus brachyurus* (Vieillot, 1818)	Rufous Woodpecker/ Badami Kath-thokra	Picidae	+ (2)	-	Sch. IV	Least Concern	Resident	Yes
64	*Milvus migrans* (Boddaert, 1783)	Black Kite/ Chil	Accipitridae	+ (1, 2)	+	-	Least Concern	Resident	Yes
65	*Motacilla alba* Linnaeus, 1758	White Wagtail/ Khonjona	Motacillidae	+ (1, 2)	+	-	Least Concern	Long-distant Migrant	No
66	*Motacilla cinerea* Tunstall, 1771	Grey Wagtail/ Dhushor Khonjon	Motacillidae	+ (1)	+	-	Least Concern	Long-distant Migrant	No
67	*Motacilla citreola* Pallas, 1776	Citrine Wagtail/ Holde-matha Khonjon	Motacillidae	+ (2)	-	-	Least Concern	Long-distant Migrant	No
68	*Muscicapa dauurica* Pallas, 1811	Asian Brown Flycatcher/ Patkile Chutki	Muscicapidae	+ (2)	-	Sch. IV	Least Concern	Long-distant Migrant	No
69	*Muscicapa muttui* (Layard, 1854)	Brown-breasted Flycatcher	Muscicapidae	+ (2)	-	Sch. IV	Least Concern	Long-distant Migrant	No
70	*Muscicapa sibirica* Gmelin, 1789	Dark-sided Flycatcher/ Gadho-pash Chutki	Muscicapidae	+ (2)	-	Sch. IV	Least Concern	Long-distant Migrant	No
71	*Mycteria leucocephala* (Pennant, 1769)	Painted Stork/ Shona-jongha	Ciconiidae	+ (2)	+	Sch. IV	Near Threatened	Resident	Yes
72	*Nycticorax*	Black-crowned	Ardeidae	+ (1, 2)	+	Sch. IV	Least	Resident	Yes

Sl. No.	Scientific Name	Common Name	Family	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks	Nest in Rabindra Sarovar
	nycticorax (Linnaeus, 1758)	Night Heron/ Bachka					Concern		
73	*Oriolus chinensis* Linnaeus, 1766	Black-naped Oriole/ Kaloghad Bene-bou	Oriolidae	+ (1, 2)	+	Sch. IV	Least Concern	Local Migrant	No
74	*Oriolus kundoo* Sykes, 1832	Indian Golden Oriole/ Shona-bou	Oriolidae	+ (1, 2)	-	Sch. IV	Least Concern	Resident	No
75	*Oriolus xanthornus* (Linnaeus, 1758)	Black-hooded Oriole/ Bene-bou	Oriolidae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	Yes
76	*Orthotomus sutorius* (Pennant, 1769)	Common Tailorbird/ Tuntuni	Cisticolidae	+ (1, 2)	-	-	Least Concern	Resident	Yes
77	*Otus scops* (Linnaeus, 1758)	Eurasian Scops Owl	Strigidae	+ (1)	-	Sch. IV	Least Concern	Local Migrant	No
78	*Parus major* Linnaeus, 1758	Great Tit/ Ramgangra	Paridae	+ (1)	-	Sch. IV	Least Concern	Resident	No
79	*Passer domesticus* (Linnaeus, 1758)	House Sparrow/ Chodai	Passeridae	+ (1)	+	-	Least Concern	Resident	Yes
80	*Pelargopsis capensis* (Linnaeus, 1766)	Stork-billed Kingfisher/ Gudiyal	Alcedinidae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	Yes
81	*Phalacrocorax carbo* (Linnaeus, 1758)	Great Cormorant/ Bodo Pankoudi	Phalacrocoracidae	+ (1, 2)	-	Sch. IV	Least Concern	Resident	Yes
82	*Phalacrocorax fuscicollis* Stephens, 1826	Indian Cormorant/ Majhari Pankoudi	Phalacrocoracidae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	Yes
83	*Phalacrocorax niger* (Vieillot, 1817)	Little Cormorant/ Chhoto Pankoudi	Phalacrocoracidae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	Yes
84	*Phylloscopus collybita* (Vieillot, 1817)	Common Chiffchaff/ Badami Shakha Phutki	Phylloscopidae	+ (1)	-	-	Least Concern	Long-distant Migrant	No
85	*Phylloscopus fuscatus* (Blyth, 1842)	Dusky Warbler/ Godhuli Shakha Phutki	Phylloscopidae	+ (2)	-	-	Least Concern	Long-distant Migrant	No
86	*Phylloscopus humei* (Brooks, 1878)	Hume's Leaf Warbler	Phylloscopidae	+ (1)	-	-	Least Concern	Local Migrant	No

Sl. No.	Scientific Name	Common Name	Family	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks	Nest in Rabindra Sarovar
87	*Phylloscopus inornatus* (Blyth, 1842)	Yellow-browed Leaf Warbler/ Holde-bhuru Shakha Phutki	Phylloscopidae	+ (1, 2)	-	-	Least Concern	Long-distant Migrant	No
88	*Phylloscopus trochiloides* (Sundevall, 1837)	Greenish Warbler/ Shobje Shakha Phutki	Phylloscopidae	+ (2)	-	-	Least Concern	Long-distant Migrant	No
89	*Pitta brachyura* (Linnaeus, 1766)	Indian Pitta/ Nilpakhi	Pittidae	+ (2)	-	Sch. IV	Least Concern	Local Migrant	No
90	*Prinia inornata* Sykes, 1832	Plain Prinia	Cisticolidae	+ (2)	-	-	Least Concern	Resident	Yes
91	*Psittacula eupatria* (Linnaeus, 1766)	Alexandrine Parakeet/ Chondona	Psittacidae	+ (1)	-	Sch. IV	Near Threatened	Resident	Yes
92	*Psittacula krameri* (Scopoli, 1769)	Rose-ringed Parakeet/ Tiya	Psittacidae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	Yes
93	*Pycnonotus cafer* (Linnaeus, 1766)	Red-vented Bulbul/ Bulbuli	Pycnonotidae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	Yes
94	*Pycnonotus jocosus* (Linnaeus, 1758)	Red-whiskered Bulbul/ Shipai Bulbul	Pycnonotidae	+ (1)	+	Sch. IV	Least Concern	Resident	Yes
95	*Saxicoloides fulicatus* (Linnaeus, 1766)	Indian Robin/ Kalishama	Muscicapidae	+ (2)	-	-	Least Concern	Resident	No
96	*Stigmatopelia chinensis* (Scopoli, 1786)	Spotted Dove/ Tile Ghughu	Columbidae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	Yes
97	*Streptopelia decaocto* Frivaldszky, 1838	Eurasian Collared Dove/ Konthi Ghughu	Columbidae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	Yes
98	*Sturnia malabarica* (Gmelin, 1789)	Chestnut-tailed Starling/ Pat Shalik/ Pawai	Sturnidae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	Yes
99	*Sturnia pagodarum* (Gmelin, 1789)	Brahminy Starling/ Bamun Shalik	Sturnidae	+ (2)	-	Sch. IV	Least Concern	Resident	No
100	*Terpsiphone paradisi* (Linnaeus, 1758)	Asian Paradise-flycatcher/ Phite-bulbul/ Dudhraj	Monarchidae	+ (2)	-	-	Least Concern	Resident	No

Sl. No.	Scientific Name	Common Name	Family	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks	Nest in Rabindra Sarovar
101	*Treron phoenicopterus* (Latham, 1790)	Yellow-footed Green Pigeon/ Horiyal	Columbidae	+ (1, 2)	-	Sch. IV	Least Concern	Resident	Yes
102	*Turdoides striata* (Dumont, 1823)	Jungle Babbler/ Chhatare	Timaliidae	+ (1, 2)	+	Sch. IV	Least Concern	Resident	Yes
103	*Turdus unicolor* Tickell, 1833	Tickell's Thrush/ Machashah	Turdidae	+ (2)	-	Sch. IV	Least Concern	Long-distant Migrant	No
104	*Upupa epops* Linnaeus, 1758	Common Hoopoe/ Mohonchuda	Upupidae	+ (1, 2)	-	-	Least Concern	Local Migrant	No
105	*Vanellus cinereus* (Blyth, 1842)	Grey-headed Lapwing/ Shalang	Charadriidae	+ (1)	-	-	Least Concern	Local Migrant	No
106	*Zoothera citrina* (Latham, 1790)	Orange-headed Thrush/ Dama	Turdidae	+ (2)	-	Sch. IV	Least Concern	Resident	No
107	*Zoothera dauma* (Latham, 1790)	Scaly Thrush/ Sonali Giridama	Turdidae	+ (2)	-	Sch. IV	Least Concern	Local Migrant	No

1. Ghosh, S. 2010. Urban Biodiversity of Kolkata: Flowering Plants, Butterflies, Birds and Mammals. Zoological Survey of India (Occasional Paper no. 327).
2. Anonymous, 2016. Birds of Rabindra Sarovar. Kolkata Improvement Trust.

Table 4.16. Diversity of Mammals (Chordata; mammalia) of Rabindra Sarovar

Sl. No.	Scientific Name	Common Name	Family	Order	Earlier Reports	Present Study	IWPA, 1972	IUCN Red List (*Ver. 3.1*)	Remarks
1	*Bandicota bengalensis* (Gray, 1835)	Lesser Bandicoot Rat	Muridae	Rodentia	+ (1)	+	-	Least Concern	
2	*Cynopterus sphinx* (Vahl, 1797)	Short-nosed Fruit Bat	Pteropodidae	Chiroptera	-	+	-	Least Concern	
3	*Funambulus pennantii* Wroughton, 1905	Five-striped Palm Squirrel	Sciuridae	Rodentia	+ (1)	+	-	Least Concern	
4	*Herpestes auropunctatus* (Hodgson,1836)	Small Indian Mongoose	Herpestidae	Rodentia	-	+	Sch. II Part I	Least Concern	

5	*Herpestes edwardsii* (É. Geoffroy Saint-Hilaire, 1818)	Indian Grey Mongoose	Herpestidae	Carnivora	+ (1)	+	Sch. II Part I	Least Concern	
6	*Paradoxurus hermaphroditus* (Pallas, 1777)	Common Palm Civet	Viverridae	Carnivora	+ (1)	+	Sch. II Part I	Least Concern	
7	*Pipistrellus coromandra* (Gray, 1838)	Indian Pipistrelle	Vespertilionidae	Chiroptera	+ (1)	-	-	Least Concern	
8	*Pteropus giganteus* (Brünnich, 1782)	Indian Flying Fox	Pteropodidae	Chiroptera	+ (1)	+	-	Least Concern	
9	*Rattus norvegicus* (Berkenhout, 1769)	Brown Rat	Muridae	Rodentia	+ (1)	-	-	Least Concern	
10	*Semnopithecus entellus* (Dufresne, 1797)	Bengal Hanuman Langur	Cercopithecidae	Primates	+ (1)	-	-	Least Concern	
11	*Suncus murinus* Linnaeus, 1766	House Shrew	Soricidae	Eulipotyphla	+ (1)	+	-	Least Concern	
12	*Viverricula indica* (É. Geoffroy Saint-Hilaire, 1803)	Small Indian Civet	Viverridae	Carnivora	+ (1)	-	Sch. II Part I	Least Concern	

1. Ghosh, S. 2010. Urban Biodiversity of Kolkata: Flowering Plants, Butterflies, Birds and Mammals. Zoological Survey of India (Occasional Paper no. 327).

Table 4.17. A Concise List of the Faunal Groups and their Species number

Sl. No.	Species Group	Earlier Surveys (no. of species)	Present Surveys (no. of species)	Consolidated (total no. of species)
1	Protozoans	14	0	14
2	Zooplanktons	45	9	51
3	Hemipterans or Bugs (Insecta: Hemiptera)	0	4	4
4	Coleopterans or Beetles (Insecta: Coleoptera)	0	1	1
5	Chalcids (Hymenoptera: Chalcididae)	11	1	12
6	Psocopterans (Insecta: Psocodea)	3	0	3
7	Ants (Hymenoptera: Formicidae)	29	2	29
8	Butterflies (Lepidoptera: Rhopalocera)	0	57	57
9	Dragonflies & Damselflies (Insecta: Odonata)	0	13	13
10	Mollusca (Freshwater)	20	8	20
11	Fishes (Chordata: Pisces)	26	35	40
12	Amphibians (Chordata: Amphibia)	0	5	5
13	Reptiles (Chordata: Reptilia)	0	11	11
14	Birds (Chordata: Aves)	107	44	107
15	Mammals (Chordata: Mammalia)	10	8	12

5.0. Air Quality of Rabindra Sarobar and its premises

5.1. Introduction

Air quality of the Sarobar area was monitored with a view to understand the impact of the events that involves huge mass mobilisation in the park. Two such spots could be identified, one at Nazrul Mancha (cultural programmes, indoor activity) and the other at the Stadium (sports event, outdoor activity). During February, the Nazrul Mancha had programmes almost every day at different times, but the Stadium hosted major Football events on 02nd, 04th, 18th and 28th of February 2017. Non-event days were 12th, 16th, 21st and 26th of the same month. Such events happened during late evening and continued till late evening, movement of vehicles and people starting during 1500 to 1600 hours. The term "event day" therefore means the days when the Stadium hosted Football matches and "non-event day" means no Football match at the Stadium. Air quality data are presented below along with standards.

5.2. Methodology

Air quality monitoring was performed employing manual samplers following the standard methodologies recommended by the Ministry of Environment of Forest, Government of India (Gazette Notification of National Ambient Air Quality Standard, NOVEMBER-2009) and elaborated by the Central Pollution Control Board (CPCB) in published document "National Ambient Air Quality Series:NAAQMS/36/2012-13".

5.3. Results

5.3.1. Previous Observations

Air quality of the Rabindra Sarobar in particular has never been monitored before. However, during the Chhat Puja in month of November 2016, Air Quality was monitored in the Rabindra Sarobar area as described below.

The monitoring was done during 5th November, 2016 to 8th November, 2016 at the following locations

Sl.	Station Name	Location
1	Near Fountain (KIT Control Room)	Near Fountain (Tollygunge Lake side), Kolkata
2	Near Art Gallery	Near Art Gallery (Dhakuria Lake side), Kolkata

Parameters monitored were:

- Particulate Matter 10 (PM_{10})
- Sulphur Dioxide (SO_2)
- Nitrogen Dioxide (NO_2)

Monitoring was conducted for both the locations as per the following schedule:

Sl. No.	Date & Time
Day-1	06 AM of 05 November 2016 to 06 AM of 06 November 2016
Day-2	06 AM of 06 November 2016 to 06 AM of 07 November 2016
Day-3	06 AM of 08 November 2016 to 06 AM of 09 November 2016

- with each day of 24 hours, divided into three shifts of 8 hourly sampling for $PM_{10,}$ with the monitoring for each day, commencing from Shift – I (06:00 – 14:00) hours, thus completing the 24-hourly schedule on the subsequent days with the Shift-III (22:00 – 06:00) hours.

- with each day of 24 hours, divided into six shifts of 4 hourly sampling for Sulphur Dioxide (SO_2) & Nitrogen Dioxide (NO_2) with the monitoring for each day, commencing from Shift – I (06:00 – 10:00) hours, thus completing the 24-hourly schedule on the subsequent days with the Shift-VI (02:00 – 06:00) hours.

The results are provided below:

Location	PM10 Average (mg/m^3)	PM10 Standard (mg/m^3)	NO2 Average (mg/m^3)	NO2 Standard (mg/m^3)	SO2 (mg/m^3)	SO2 Standard (mg/m^3)
Near Fountain (Tollygunge Lake side)	81.6	100	28.1	80	2.4	80
Near Art Gallery (Dhakuria Lake side)	93.3	100	31.0	80	2.8	80

From the results it is observed that the Air Quality complies with the National Ambient Air Quality Standard and is not impacted with the event “Chhat Puja”.

5.3.2. Present Observations

The Table below summarizes the Standard for Ambient Air Quality.

Air Quality Standard	
PM10	100 micro-g/cubic meter
PM2.5	60 micro-g/cubic meter
SO2	80 micro-g/cubic meter
NO2	80 micro-g/cubic meter

From the data presented above it can be clearly observed that for both the places, the Stadium and the Nazrul Mancha, the event days recorded higher counts. It can be concluded that such higher counts, being the average of four such days, clearly carry an imprint of the event, i.e., movement of a large number of people for Football match in the Stadium and concomitant activities.

The results obtained during the monitoring in February 2017 in the Rabindra Sarobar Area may now be compared with the ambient air quality situation in the Kolkata city. The Table below summarizes the results and puts the same for comparison with the February 2017 scenario of the Kolkata City.

Location	PM10 (mg/m^3)	PM2.5 (mg/m^3)	SO2 (mg/m^3)	NO2 (mg/m^3)
Rabindra Sarobar Stadium(Event Day Average)	228	100	7	60
Nazrul Mancha(Event Day Average)	179	87	5	49
Rabindra Sarobar Stadium(Non-Event Day Average)	196	100	5	55
Nazrul Mancha(Non Event Day Average)	168	87	4	46
Kolkata City Average	208	121	6.8	56
National Standard	100	60	80	80

It is observed that the maximum non-compliance in February 2017 is for parameters PM10 and PM 2.5 and if one compares the results with those obtained in the Sarobar points one observes that the Nazrul Mancha reflects comparatively better air quality than the Kolkata average, and although the Stadium scores marginally higher value in PM10 (228 against 208 in mg/m^3), PM2.5 is higher in Kolkata city average, and the gaseous air pollutants are comparable.

5.4. Conclusion

Although the monitoring results suggest that the Sarobar air quality is impacted by events like football matches in the Stadium, the air situation of the Sarobar as a whole is

partially better in comparison with the whole of Kolkata. Therefore, the ambient air quality in the Sarobar area may not be considered in the present respect as a causal agent putting significant ecological pressure on the habitats of the Lake premise.

6.0. Water Quality of Rabindra Sarobar and its premises

6.1. Introduction

Water samples were collected from four positions of the entire stretch of the lake as described below. Pictorially the locations are presented in Fig. 1.

1. AMRI Gate (2 Nos) South Eastern Corner (Lake-1)
2. Beside Bengal Rowing Club South- West Corner (Lake-1)
3. Beside Bengal Navy NCC (Lake -2)
4. Beside Lake Gardens Railway Station (South Side) (Lake-2)

Sampling for this water quality determination exercise of the Sarobar water was performed on 07 February, 2017. The water temperature of the lake that day was rather low, at 18˚C. Considering the lower temperature the profiling (diurnal variation of dissolved oxygen) was not performed on the same day. Later, this diurnal variation of dissolved oxygen was performed during mid-day (1200 hrs) of 06th to morning (1000 hrs) of 07th of April at the site number 2, i.e., by the side of Bengal Rowing Club. Such DO profiling provides a deep insight of the behavior of dissolved oxygen, its uptake by the aquatic life and rate and extent of replenishment of the dissolved oxygen in water through two mechanisms, (i) Respiration, i.e., solubility equilibrium of dissolved oxygen in water and the partial pressure of atmospheric oxygen and (ii) Photo Synthesis, in which oxygen is provided by the greeneries inside the water pool in presence of sun light.

6.2. Methodology

Methodology adopted for sampling, preservation and analysis were developed in-house with the methods published in the manual of American Public Health Association for analysis of water and wastewater. The collected samples were analyzed and the results are presented below. The analyses were done in presence of the direction of the Hon'ble National Green Tribunal, and to understand the health of the lake water. For DO profiling, Dissolved Oxygen was measured at the site every 2 hours and sample was collected from 1 foot depth. Water quality analysis was performed on the collected fresh water within 2 hours of the collection and therefore the question of preservative did not arise.

6.3. Results

6.3.1. Observations from previous studies

The most impressive observation on the water quality relevant to the present report was obtained from the report of Modi and Saraogi (1989). According to them, at that time,

the larger lake water was used for bathing, drinking, cooking and small lake for Public Swimming Pool. Their observations on water quality parameters are provided below.

- **pH:** This value gives an idea of the acidity-alkalinity condition of water. The pH scale ranges between 0 and 14, indicating 7 as neutral i.e., neither acidic nor alkaline. Most aquatic species of biological matters, organic microorganisms and botanical entities can grow in the pH range 6.5 and 8.5. If the pH falls to 5.0 or goes above 9.0, lachrymation of the eye (water secretion) starts. The water acquires a bitter taste. Moreover, any inadvertent gulping of the bitter water, upsets the acid-alkali balance of the digestive system resulting in stomach disorder. The irritation of the skin becomes progressively intensive beyond the pH ranges 5.0-9.0. Irrigation and gardening are not possible with water of the pH ranges below 5.0 and 9.0. Corrosion of metals, cement, brick, and other building materials becomes pronounced at the lower and higher pH values. The study recorded a pH value between 7.3 to 7.7 and therefore the water condition was found to be fairly alkaline.

- **Bacterial Organisms:** These are two types – (i) pathogenic i.e. disease producing like the 'coliform' bacteria is an indication of sewage contamination of water. It is expressed in a bacterial count, called MPN (mean probable number) per 100 milliliter of water. If the count is 500 and above, it is unsafe for drinking. Even an inadvertent gulping by a bather or a swimmer may cause disease. Such pathogen contaminated water may cause dermatitis like eczema of the skin. If such water is used for irrigation and gardening, the vegetation may be affected. In some soils, bacteria further proliferates. The study identified bacterial presence like *Bacillus subtilis, Pseudomonas aeruginosa,* and other Coliform organisms including *Micrococcus* and determined innumerable bacteriological colonies on experimental culture plate and opined that the water quality did not conform to the Bacteriological Standards (1984) of the Union Ministry of Works and Housing, New Delhi.

- **Dissolved Oxygen (DO):** Oxygen dissolved in water ensures the supply of oxygen to all living botanical and biological matters in water. When the oxygen content falls below 3 mg per litre of water, the survival of fish becomes difficult. Moreover, other aquatic species begin to suffer. The higher the oxygen content the better is the water. It also indicates that the oxygen has not been consumed by degradable matter put into water as a pollutant. When its value is zero, water begins to smell.

- **Biochemical Oxygen Demand (BOD):** The BOD value indicates the amount of degradable pollutants that are present in water. Pure water has a BOD value of one milligram per litre of water. A BOD value of 2 mg/litre or less ensures that the water is almost pure. According to the British valuation system, a BOD value of 2 to 4 mg/liter is fairly clean but beyond 4, water is of poor and doubtful quality, as it contains degradable matter. Above the value of 8, it is bad water containing pollutants, which should be avoided. BOD was determined during the study in a range of 2.5 to 5.2 mg/l which is rather high. The corresponding COD values were 32 and 79 mg/l indicating more than usual presence of oxygen consuming entities which are not bio-degradable, but of chemical nature.

- **Toxic Materials:** These may be organic, like benzene, mineral oil, grease, such things that may be harmful to living bodies. Arsenic and cyanides are poisons. Heavy metals like cadmium, chromium, lead, mercury and selenium cause permanent damage to the living bodies. The study tested the water samples for Arsenic and Cadmium but could not detect any such toxic metal species in the samples.

Other previous studies include the water quality determination by the WBPCB during the Fish Death Case in June 2016. The reports are provided below.

Table 6.1. Sampling was performed on 11th June 2016 and analysis were done immediately

Sl.	Pesticides	Near RC Side	Near Padma Pukur	Near Buddha Mandir
1	pH (value)	8.97	9.0	9.15
2	DO	11.7	12.4	14.5
3	BOD	4.7	5.7	5.95
4	Ammonical N	< 0.1	< 0.1	< 0.1
5	a-BHC	NT	NT	NT
6	g-BHC	NT	NT	NT
7	MP	NT	NT	NT
8	MALATHION	NT	NT	NT
9	CPS	BDL	BDL	NT
10	Aldrin	BDL	NT	NT
11	ENDO I	NT	NT	NT
12	DIALDRIN	NT	NT	NT
13	Endo II	BDL	NT	NT
14	2,4 DDT	NT	NT	NT
15	p,p-DDT	NT	NT	NT
16	ANILOPHOS	NT	NT	NT
Results are expressed in mg/L for parameters at 2 to 4 and □g/L for parameters at 5 to 16.				
BDL: Below Detectable Limit (DL - 0.05 ppb)				
NT: Not Traceable				

The results could not indicate, other than very high pH, any causal agent for the Fish death that happened 2 days age. However, a rather in-depth study was performed by the ICAR-Central Inland Fisheries Research Institute, (Indian Council of Agricultural Research), Barrackpore, Kolkata, India- 700 120 with following details. Water sampling for this study was done at two sites, (Site 1) Near Mosque and (Site 2) Near Buddha Temple.

CIFRI observed that there was excess growth of filamentous green algae (*Spirogyra*) on bottom sediment towards the bank of the lake (lentic zone) and the growth was very high at the sampling site-II Near to Buddha *mandir*. Interestingly, the lake bottom (at least up to about 10-15 feet from banks where this study was limited) was devoid of typical soil/sediment, and instead was full of rocks and bricks. With much difficulty only few grams of sediment could be collected by the Lake personnel which was insufficient for detailed study. The hard lake bottom, especially towards the Buddha Temple, was covered with decomposed filamentous algae.

The water quality analysis showed high BOD and COD levels, more oxygen consumption for decomposition of organic matter in the lake, as well as, presence of ammonia. Biological Oxygen Demand (BOD) level of the lake is more than 6 PPM, indicating the lake is not good health condition. High BOD may create low dissolved oxygen level for the aquatic animal in early hours and this when combined with rainfall might be the reason for recurrent seasonal fish mortality. It was remarkable that DO at site-II (measured at 5:30 pm) (with much decomposed algae at bottom) was only half of that in site-I (measured at 4:45 pm), suggesting very rapid oxygen depletion from the system.

CIFRI, however, could not indicate any single of bunch of reason for the fish death event but indicated the deteriorating environmental status of the water body and strongly recommended (1) Periodic physical removal of the filamentous green algae from lentic and lotic zones of the lake, at least before and during summer, (2) Removal of semi-decomposed filamentous green algae from the lake bottom, (3) Prohibiting feeding the fish by visitors and dumping of waste food matter, discharge of waste water etc. in the lake, (4) Removal of numerous plastic materials along the bank and (5) An assessment of density and distribution of fish in the lake may be assessed.

West Bengal University of Animal and Fishery Sciences (WBUAFS) performed a scholarly study on the fish death case in June 2016. Major observations of the WBUAFS study is narrated below.

- Most of the water quality parameters were well within the optimal levels recommended for fish.
- The pH was always above 8.0 and the range of pH observed was 8.20 – 9.15.
- The water was almost clear and the Secchi disc reading was in the range of 86-90 cm, indicating poor productivity.
- The levels of ammonia and nitrate were below detectable level, thus ruling out the toxic effects of ammonia, nitrite and nitrate for fish kills.
- Analysis of pesticides by WBPCB, Kolkata revealed no traces of pesticide residues in water, thus ruling out their involvement in fish kills.
- No conclusion could be drawn from the above water quality parameters, as they were determined from the surface water samples.
- Water quality parameters especially temperature and dissolved oxygen from the bottom water samples would have thrown some light on the observed fish kills.
- Fish kill in tropical regions are frequently attributed to low dissolved oxygen concentrations; however the circumstances causing these events vary considerably.
- The fish kills in ponds and small lakes usually occur during summer and winter stratification and are specially related to critically low oxygen levels; however, pollution, fish diseases and a phenomenon known as turnover can also kill fish.

WBUAFS further performed analysis of old reports and concluded the following in relation to the environmental condition of the lake. Two publications were duly considered during this study, those of Samal et. al. of year 2009 and 2014. Detailed observations are the following.

- The lake Rabindra Sarobar exhibits anoxic (DO < 1ppm or 1 mg/l) conditions only during the peak summer and generally to a height of 0.5-0.75 m from the bottom

sediment-water interface. The oxic conditions (DO: >5 mg/l) usually occur up to a depth of 2-2.5 m from the water surface with hypoxia (DO: 1-5 mg/l) in between. The hypoxic conditions in general exist within the oxycline layer of the water column.

- Over the years, the lake Rabindra Sarobar shows hypoxic conditions of dissolved oxygen except during the summer season. The Rabindra Sarobar remains completely mixed (about 8 months) from mid-June to February until the onset of thermal stratification (from March to mid-June: summer period).
- The available scientific data revealed the development of thermal stratification and dissolved oxygen stratification in Rabindra Sarovar (Samal et al., 2009, 2014). The thermal stratification is the result of energy exchanges between water and the surrounding environment, particularly the atmosphere. Low value of dissolved oxygen near the sediment-water interface develops the hypoxic condition (DO < 5 mg/l) and it gradually extended upward throughout the summer. As a result of thermal stratification the bottom layer is cut-off from atmospheric oxygen and oxygen producing plants.
- The rate of oxygen consumption is rapid in the thermocline zone due to high temperature gradient and contribute to the development of minimum DO and is continued throughout the summer and fall and persisted until thickening of the mixed layer destroyed it in early winter.
- Low value of DO cannot enhance other chemical oxidation processes in the band of hypolimnion, resulting in increasing the toxicity of the water and the water quality becomes unfit for the sustenance of the aquatic life in the water body.
- The tolerable limit of DO has been prescribed as 40% saturation level or 3.0 mg/l for fish. In a study by Samal et al. (2009), the DO value was found to drop below 1.0 mg/l at Rabindra Sarobar from the depth of 3.5 m to the bottom, which may account for a sudden fish die off.
- Lake stratification creates a thermal/density barrier to oxygen transfer between the epilimnion and hypolimnion of a lake, thus inhibiting reoxygenation of hypolimnetic waters. The decreasing DO level with depth is indicative of hypolimnetic DO depletion.
- The depletion of dissolved oxygen in the hypolimnion and the variability in water column temperature may be highly dependent and the variability over time series is an indicator of climate change both in tropical and temperate weather conditions. Formation of a hypolimnion oxygen minimum is of great importance for fishery management.

6.3.2. Observations of the present study

The Rabindra Sarobar lake is one of the stations of the National Water Monitoring Programme and the WBPCB performs analysis of water quality of this Sarobar every month. Comparing the reports of such continuous monitoring with the data of the present job (Table-2), all were found to be within usual range found round the year. The coliform counts has always been found high in respect of use of the water for outdoor bathing predominantly because of the continuous supply of such bacterial inoculum from the bird droppings and faeces of warm blooded animals. What is rather disturbing is the BOD of the water samples, which is a measure of biodegradable component in water that can be used up as food by the bacterial inoculum discussed above and as a result the water pool gets higher counts of such bacteria. Regarding water quality therefore it can be concluded that all possible sources

contributing such components to the Sarobar (e.g., wastewater drains or sewages, kitchen waste, solid food waste etc.) are required to be identified and blocked by the Authority managing the environmental health of the Sarobar. Comparing the reports with the national water quality criteria for use of natural water resource (Attachment-1) it can be opined that the Sarobar water may be used for "Propagation of Wild life and Fisheries" if the pH of the water can be brought down below 8.5.

Table 6.2. Water Quality of Rabindra Sarobar. Date of sampling = 07 FEB 2017

parameters	**Station 1**	**Station 2**	**Station 3**	**Station 4**
Ammonia-N (mg/l)	0.101	BDL	0.112	0.105
BOD (mg/l)	13.15	4.2	2.75	4.6
Boron (mg/l)	BDL	BDL	BDL	BDL
Calcium (mg/l)	22.4	20.8	20.8	22.4
Chloride (mg/l)	31.99	31.99	29.99	33.99
COD (mg/l)	38.51	32.9	20.47	24.12
Conductivity (µs/cm)	324.1	303.5	324.9	329
Dissolved O_2 (DO)(mg/l)	14.7	11.4	12.1	15.5
Fecal Coliform (MPN/100ml)	1700	2200	1300	3000
Fluoride (mg/l)	0.234	0.23	0.25	0.274
Magnesium (mg/l)	4.86	4.86	5.83	5.83
Nitrate-N (mg/l)	0.58	0.61	0.63	0.64
pH (Unit)	9.28	9	8.89	9.24
Phenolpthalein Alkanity (mg/l)	0	0	0	0
Phosphate-P (mg/l)	0.04	0.04	0.02	0.02
Phosphate-Total (mg/l)	0.2	0.22	0.22	0.08
Potassium (mg/l)	20	20	20	19
Sodium (mg/l)	63.77	63.77	63.77	63.77
Sulphate (mg/l)	20.66	18.29	21.05	20.03
Temperature (˚C)	25	25	25	27
Total Alkalinity (mg/l)	132	132	134	136
Total Coliform (MPN/100ml)	3000	5000	2300	8000
Total Dissolved Solids (TDS)(mg/l)	226	194	206	218
Total Fixed Solids (TFS)(mg/l)	130	138	88	126
Total Hardness as $CaCO_3$ (mg/l)	76	72	76	80
Total Suspended Solids (TSS)(mg/l)	12	12	6	10
Turbidity (NTU)	7.36	4.25	3.26	6.12
Copper (mg/l)	BDL	BDL	BDL	BDL
Zinc (mg/l)	BDL	BDL	BDL	BDL
Lead (mg/l)	BDL	0.2	BDL	BDL
Chromium (mg/l)	BDL	BDL	BDL	BDL
Arsenic (mg/l)	BDL	BDL	BDL	BDL
Iron (mg/l)	0.21	BDL	0.36	BDL
Cadmium (mg/l)	BDL	BDL	BDL	BDL
Nickel (mg/l)	BDL	BDL	BDL	BDL
Manganese (mg/l)	BDL	BDL	BDL	BDL
Mercury (mg/l)	BDL	BDL	BDL	BDL

The diurnal behavior of the lake water is a very important parameter at this juncture. To evaluate that, the Dissolved Oxygen of the lake water at a single point (Near Bengal Rowing Club) was determined at the spot for 24 hours round the clock. The date selected was from 1200 hrs. of 07 April to 1000 hrs of 08 April, 2017. As the ambient

temperature on this date the air temperature was 32˚C and the water temperature was 30˚C, sufficient solubility was expected for aerobic oxygen and expectedly, during the late noon (16:10 hours), the high DO value of 11.1 mg/L was recorded (Figure-2) when the Photo-Synthesis reached its maximum, along with the respiration. But with immediate disappearance of the sun, the DO value was found to drop to around 5.2.

Table 6.3. Dissolved Oxygen at different time of the day

Time	DO (mg/L)
12:10	7.7
14:10	10.8
16:10	11.1
18:10	5.2
20:10	3.6
22:10	3.3
0:10	3.2
2:10	3.1
4:10	2.8
6:10	2.5
8:10	2.9
10:10	4.6

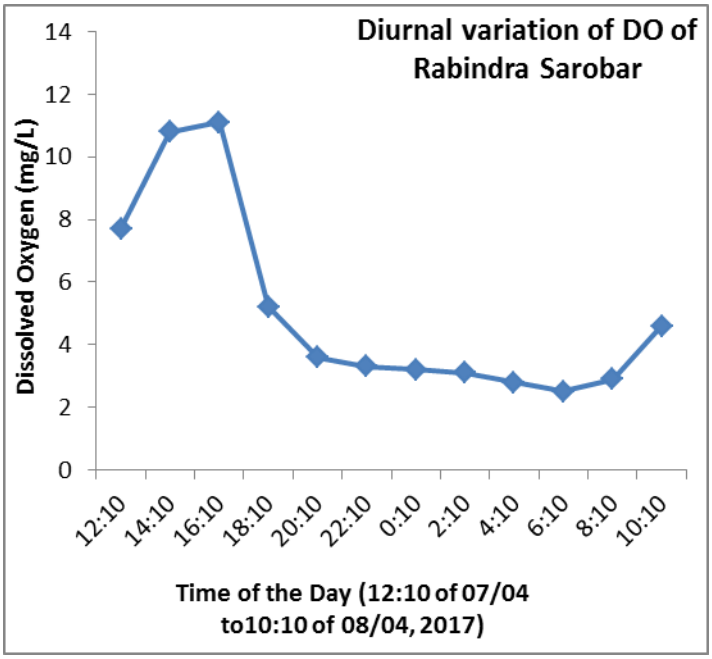
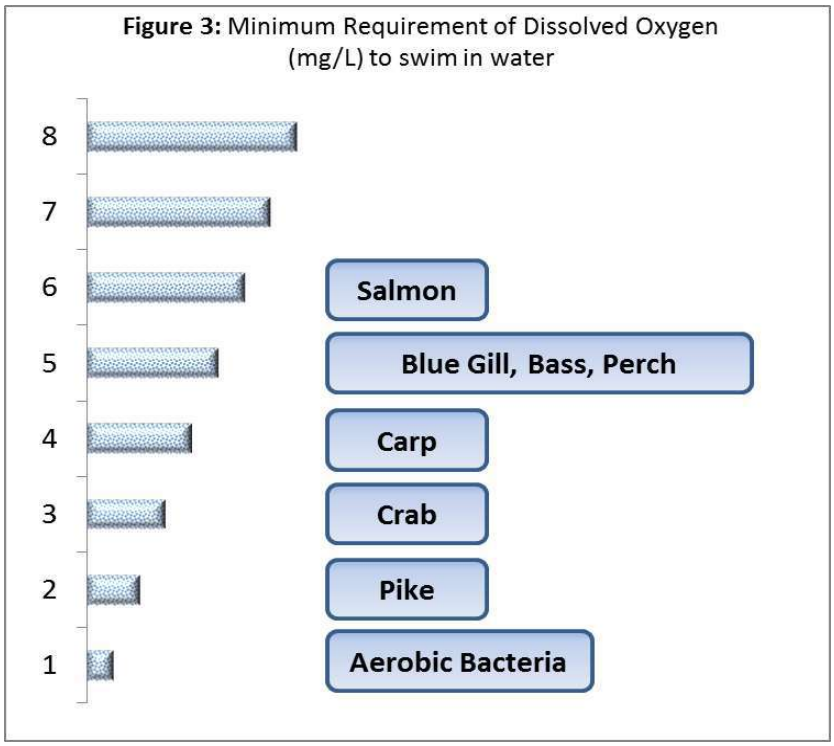


Figure 2: Diurnal behavior of Dissolved Oxygen in Rabindra Sarobar



18:10 hours. Later, during the night

and early morning before the sun rise on the following day, the DO value remained below 4.0 mg/l, reaching below 3.0 mg/l for more than 6 hours between morning 02:00 and 08:00 hours. Figure-3 provides the data on required Dissolved Oxygen for normal proliferation of different fish species. In a recent publication 'Water quality guidelines for the management of pond fish culture', Bhatnagar and Devi (2013) have categorically mentioned that the Dissolved Oxygen of 5.0 mg/l or more is a compulsory requirement for healthy fish growth. The Dissolved Oxygen Profile, compared with the values of BOD and bacteriological parameters of Sarobar equivocally indicates the environmental status of the water body towards Eutrophication.

The principal water quality parameters which were found to critical, are tabulated below with comments.

Table6. 4. Comparison of water quality parameters of concern.

parameters	Sample 1	Sample 2	Sample 3	Sample 4	Comments
BOD(mg/l)	13.15	4.2	2.75	4.6	Very high BOD leads to high bacterial count and ensures high growth of micro-organisms depleting the dissolved oxygen fast.
pH(Unit)	9.28	9	8.89	9.24	When the pH of freshwater becomes highly alkaline (> 9.0), the effects on fish are lethal. as it becomes unable to dispose of metabolic wastes. High pH may also increase the toxicity of other substances. For example, the toxicity of ammonia is ten times more severe at a pH of 8 than it is at pH 7. It is directly toxic to aquatic life when it appears in alkaline conditions. Low concentrations of ammonia are generally permitted for discharge.
Potassium (mg/l)	20	20	20	19	Potassium is more toxic to fish and shellfish than calcium, magnesium or sodium. Potassium stimulates plankton growth in lakes. Potassium in lakes from 0.4 to 1.5 mg/L in oligotrophic and mesotrophic lakes As high as 5 to 6 mg/L indicates beginning of eutrophication.
Phosphate-P (mg/L)	0.034	0.04	0.02	0.02	Phosphate Phosphorus is at standard value.
Total Phosphate (mg/L)	0.2	0.22	0.11	0.08	Average total phosphorus is 0.15 mg/l, almost 5 times over average Phosphate Phosphorus. This clearly establishes that a huge proportion of phosphorus is available in form of organically bound which indicates movement of the water resource from Oligotrophic to Mesotrophic.

The very high pH therefore may be identified as the focal issue in relation to the environmental health of the pond. A tentative reason for this is placed below.

6.3.3. Possible reasons for very high pH of Rabindra Sarobar

High pH in natural lakes is generally attributed to ill management of the underwater biological activity that controls carbon dioxide concentrations in surface water systems. Living organisms continuously produce carbon dioxide as a product of respiration and during daylight, algae and underwater plants remove carbon dioxide from the water as part of the sunlight-driven process of photosynthesis. The relative rates of respiration and photosynthesis within the pond determine whether there is a net addition or removal of carbon dioxide. In case the removal dominates, the pH of the water body increases.

pH rises during the day as underwater photosynthesis exceeds respiration, and carbon dioxide is extracted from the water followed by higher rates of photosynthesis controlled primarily by sunlight intensity, plant biomass and water temperature. With setting sun in late afternoon, rate of photosynthesis decreases and eventually stops and pH falls throughout the night as respiring organisms keep on adding carbon dioxide to the water as their metabolic outcome. The next day when the sun rises, plants resume photosynthesis and removal of carbon dioxide from water begins in the same cycle.

In cases where daily photosynthesis equals respiration, pH remains within a range tolerated by most of the aquatic species. However, with high algal growth and count of bacterial species, more carbon dioxide is removed each day by photosynthesis than is added each night by respiration. As a result, pH rises to abnormally high levels. This condition may last for many days, until photosynthesis decreases or respiration increases. Extended episodes of high pH are particularly common in ponds where filamentous algae dominate the plant community. Ponds with filamentous algae usually have clear water, allowing sunlight to penetrate deep into the water column and promote intense photosynthesis by underwater or floating mats of algae.

6.4. Conclusion

The following concluding points are provided on the basis of the previous studies and determinations performed for the present study during February to April 2017.

- The lake Rabindra Sarobar exhibits a DO profile during the sunniest days of the year with clear indication of mechanism existing in the pool that eats up the dissolved oxygen faster than should happen for healthy aquatic habitat. Hypoxic condition is expected any time with 3 / 4 consecutive overcast days.
- The high rate of oxygen consumption by the microbes tend to destroy the healthy dissolved oxygen balance and as low value of DO cannot enhance other chemical oxidation processes in the water, COD becomes very high in proportion with the biodegradable components. This makes the water to be toxic for the sustenance of the aquatic life in the water body.
- The pH was always above 9.0 and the range of pH observed was 8.89 to 9.28. Such high pH for natural water body is simply unacceptable.

- The Sarobar water is neither toxic in respect of Ammonia or any other sewage-related contamination, nor is there any threat of contamination from industrial waste or agricultural run offs, as no trace of toxic metals or pesticides could be identified ever.
- On the final count, the lake water is not fit for any of the purposes mentioned in the "Designated national use criteria of natural water and their classes" (Attachment – 1) prescribed by the Ministry of Environment and Forests, Government of India.

Attachment - 1

Designated national use criteria of natural water and their classes		
Drinking Water Source without conventional treatment but after disinfection	**A**	• Total Coliforms Organism MPN/100ml shall be 50 or less • pH between 6.5 and 8.5 • Dissolved Oxygen 6mg/l or more • Biochemical Oxygen Demand 5 days 20°C 2mg/l or less
Outdoor bathing (Organised)	**B**	• Total Coliforms Organism MPN/100ml shall be 500 or less pH between 6.5 and 8.5 Dissolved Oxygen 5mg/l or more • Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Drinking water source after conventional treatment and disinfection	**C**	• Total Coliforms Organism MPN/100ml shall be 5000 or less pH between 6 to 9 Dissolved Oxygen 4mg/l or more • Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Propagation of Wild life and Fisheries	**D**	• pH between 6.5 to 8.5 Dissolved Oxygen 4mg/l or more • Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	**E**	• pH between 6.0 to 8.5 • Electrical Conductivity at 25°C micro mhos/cm Max.2250 • Sodium absorption Ratio Max. 26 • Boron Max. 2 mg/l

6.6. References

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7.0. Lake Sediment and Subsurface Soil of Rabindra Sarobar and its premises

7.1. Introduction

Soil and sediment supply the essential nutrients, water, oxygen and root support for the plants and microbial world. They also serve as buffer to protect the delicate variations in the system. Also sediments are an important source of nutrients to fresh water ecosystem.

In the present study, the team of expert has worked in the Rabindra Sarobar Lake, popularly known as Dhakuria Lake, situated on the southern fringe of Kolkata, which is under extreme threat. Over exploitation of its resources due to urbanization, unprecedented developmental and anthropogenic activities have resulted in silting up of the Lake, choking with weeds, encroachment from all sides and subsequent shrinkage of the size of the lake, pollution and deterioration of water quality, loss of biodiversity and other biological resources. Contaminated sediment release under hydrodynamic condition is the focus area in this study. The study focused on the distribution of nutrients in the sediment(N &P) and also its toxic compounds like Cd, Pb, As & Hg.

7.2. Material and Method

For the quantification of available Nitrogen, available Phosphorus and presence of toxic chemicals like Cadmium (Cd), Lead (Pb), Arsenic (As) and Mercury (Hg) samples were collected from eight locations. The sites and mode of sampling are described in Table-I.

Table 7.1. Location Detail of Sampling of Lake Sediment

Site	Locational Detail	Sampling method
1	AMRI Gate No-2 (South- East corner)	By Boat (with Sediment Sampler)
2	Public Swimming Pool (North- East corner)	By Boat (with Sediment Sampler)
3	Besides Bengal Rowing Club (South-West corner)	By Boat (with Sediment Sampler)
4	Behind Kolkata Rowing Club (North- west corner)	By Boat (with Sediment Sampler)
5	Beside Rabindra Sarobar stadium	By Boat (with Sediment Sampler)
6	Opposite to Mother dairy Depot (North side)	By Boat (with Sediment Sampler)
7	Beside Tollygunge Railway station (south side)	By Boat (with Sediment Sampler)
8	Beside Bengal navy NCC	By Boat (with Sediment Sampler)

Apart from this sub-surface soil from in and around Rabindra Sarobar Lake was collected and the locational details are described in the Table-II.

Table 7.2. Locational detail of Sampling of Sub surface soil

Sl No.	Detail of the location of sub surface soil
1	Opposite to Tollygangue railway station

2	Near Navy NCC
3	Besides water works & Civil Defence
4	Opposite to civil Defence
5	Near Kolkata cricket Coaching Club
6	In front of Menoka

Collected samples were coded and transferred to the Laboratory for processing and analysis. Air dried samples were grinded, sieved and analysed.

7.3. Methodology

i) Available Nitrogen

Available Nitrogen of soil and lake sediments was estimated using alkaline $KMnO_4$, which oxidizes the organic matter present in the soil and hydrolysis the liberated ammonia which is condensed and absorbed in boric acid. The absorbed ammonia in boric acid was titrated against standard acid following the standard procedure (Subbiah and Asija, 1956). This method has been widely adopted to get a reliable index of nitrogen availability in soil due to its rapidity and reproducibility.

ii) Available Phosphorus

Available Phosphorus from soil and lake sediments was determined following the standard method based on the pH of the soil and sediment which is the pre requisite criteria for selection of extraction method. As the soils are neutral to slightly alkaline range, the Olsen method was adopted for extraction and determination of available phosphorous form ant. For determination of Available Phosphorus 0.5 M $NaHCO_3$ solution at pH 8.5 was used for extraction followed by color development for extraction followed by color development by Ammonium molybdate solution and Stannous Chloride solution. The intensity of the color was measured spectrophotometrically with reference to the standard solution for determination of Available Phosphorus (Jackson, 1973 and Black, 1965)

iii) Heavy Metal

Nitric acid digestion undertaken for heavy metal analysis of the Sediment/Sub surface Soil.

7.4. Results

Table 7.3. Quantification of available nitrogen, available phosphorus and Heavy metals from the sediments of the Lake

S.No	Detail of the Location	Date of Collection	Nutrients(mg/Kg)		Heavy Metals(mg/Kg)			
			Available Nitrogen	Available Phosphorus	Cd	Pb	As	Hg
1	AMRI gate (2 No) /(KIT) – South – East Corner	25.01.2017	143.62	69.2	<0.03	48	3.34	0.012
2	Public Swimming Pool North –East Corner	25.01.2017	151.61	62.0	<0.03	55	1.50	0.013
3	Beside Bengal Rowing Club South –West Corner	25.01.2017	292.57	60.0	<0.03	115	3.10	0.009
4	Behind Kolkata Rowing Club North-West Corner	25.01.2017	186.20	55.0	<0.03	65	1.73	0.006
5	Beside Rabindra Sarabor Stadium	25.01.2017	417.45	51.0	<0.03	146	2.64	0.057
6	Opposite of Mother Dairy Depot (North side)	25.01.2017	77.13	65.0	<0.03	93	1.67	0.017
7	Beside Tollygunge Railway Station (South side)	25.01.2017	212.76	70.0	<0.03	66	3.12	0.003
8	Beside Bengal Navy NCC	25.01.2017	93.1	59.0	<0.03	77	3.11	0.012

Table 7.4. Quantification of Available Nitrogen, Available Phosphorus and Heavy metals from the sub-surface soil in and around the Lake

S. No	Detail of the Location	Date of Collection	Nutrients(mg/Kg)		Heavy Metals (mg/Kg)				
			Available Nitrogen	Available Phosphorus	Cd	Pb	Fe	As	Hg
1	Opposite to Tollygunge Railway Station	21.02.2017	104	150	BDL	32	13750	1.68	0.019
2	Near Navy NCC	21.02.2017	101	78		86	15210	2.13	0.030
3	Besides Water Works & Civil Defense	21.02.2017	84	98		32	21207	2.38	0.090
4	Opposite to Civil Defense	21.02.2017	174	246.6		53	17580	2.27	0.069

5	Near Calcutta Cricket Coaching Centre	21.02.2017	204	166		79	18483	1.92	0.080
6	In front of Menoka	21.02.2017	84	163		38	33647	2.08	0.192

Sediment samples were collected from eight sites at Rabindra Sarobar Lake as elaborated in the Table-III, Results are reported from data collected during post winter season in the month of February just before the onset of summer Results in Table -III reveals wide variation in available Nitrogen ranging from 77.13 mg/kg to 417.45 mg/kg is observed in the lake sediment with the variation of sampling site. Sample site 3 & 5 shows the high content of available Nitrogen when compared with the critical limit 280 mg/kg. However, sampling site 6 & 8 shows low content i.e. less than 140 mg/kg and sampling site 1,2,4&7 shows moderate level. All the sites show high content of available Phosphorus. Among the heavy metal Lead & Arsenic are quite in the higher range whereas Cadmium and Mercury are quite low. The data reveals that the lake is under threat due to anthropogenic activity in all the sites. The Sites 3 & 5 are mostly affected sites.

Sub surface soil sample collected from six important locations in an around the lake. Results in the Table-IV reflects that available Nitrogen and phosphorus are higher in the site 4 & 5 available Nitrogen ranges 84 mg/kg to 204 mg/kg and available Phosphorus ranges from 78 mg/kg to 247 mg/kg. Heavy metals Lead and Iron were quite high but others like Cadmium, Arsenic and Mercury were found within critical limit.

7.5. Discussion

Quantification of available Nitrogen, available Phosphorus and Heavy metals like Cadmium, lead, arsenic and Mercury shows that there is a strong site wise variation in data both in the sediments of lake and sub surface soil. The sites near the banks are definitely more accessible and are ideal for anthropogenic activities like bathing, washing clothes and immersion of idols particularly after the festive season. Due to the high popularity of the Rabindra Sarobar Lake it is regularly visited by joggers, children and visitors for recreational purpose. The banks are thus often burned by pollutants which are dumped into the water by these visitors.

Phosphorus level enhancement is often related to washing and laundering activities as detergents are the main source of phosphates. In this report available phosphorus

in the sediment of lake and in the sub surface soil were found to be quite high at most sites. This could be related to extensive bathing and washing activities which is carried out on the banks of the lakes. Such high phosphorus levels are alarming as phosphorus is often regarded as the main culprit in cases of eutrophication in lakes. The concentration of algae and the tropic state of lakes correspond well to phosphorus level in water. High levels of algae reduce clarity and can lead to decrease in available dissolved oxygen as the algae decays.

Concentration of the different metal ions in the sediment of lake and in the sub surface soil Pb, Fe are found to be above the permissible levels but other metal ions like Cd in sediment as well as in sub surface soil it is below the permissible limit.

Since absorption of Lead poses a risk, where possibilities of uptake of Lead by the fishes and other aquatic organisms breeding in this area could easily lead to the death in the long run. This could mean a total disruption of the ecological balance in the aquatic ecosystem.

7.7. References

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8.0. Noise Scenario of Rabindra Sarobar and its premises

8.1. Introduction

The Rabindra Sarovar lake is a very important and notable landmark in Kolkata city. It covers about 192 acres of marshy land. Kolkata Improvement Trust (KIT) is responsible for development and maintenance of the lake. Presently, about 73 acres of this lake is covered by water. It is the natural habitat of different types of flora, fauna and birds. Many shrubs and trees are present at the banks of

the lake and some of them are more than 100 years old. According to 2012 census, about 50 different species of trees are found in the area. To the north of the lake, Rabindra Sarovar Stadium is present, having a seating capacity of approximately 26000 people. It was established in 1950s'. It is the first stadium in the city to be fully equipped with audio-visual training facilities.

It is presumed that holding football matches in Rabindra Sarovar stadium could cause ecological and environmental damages to the lake and its flora and fauna. During the match, floodlights are used along with loudspeakers, which could affect the nesting and movement of birds and animals and also detrimentally affect natural habitats of flora and fauna in and around the lake. Also, high decibel sound of the crowd, uses of drums, loudspeaker could hamper fauna and birds around the lake. A petitioner has moved the National Green Tribunal pleading that the games should not be organized at night without proper environmental monitoring and clearance. A committee was formed by NGT EZB to undertake a rapid EIA study on the baseline scenario of the lake biodiversity and the effects of football matches on the lake flora and fauna

Continuous ambient sound level monitoring study was undertaken to understand the influence of football matches on ambient sound levels in the vicinity of Rabindra Sarovar Stadium. The specific goal of sound monitoring was to understand the changes in ambient sound levels during football matches over background levels and likely positive or negative influence of sound generated during football matches on the local fauna/birds that is found to reside or nest temporarily or permanently in and around Rabindra Sarovar Lake. Also, sound level on normal non-event (no football match) days were also planned to be measured to understand business as usual scenario. The sound waves are expected to propagate even to the main lake area that is about 300 m away from the stadium towards Lake Club or definitely through the tree lines to the lake area that is just adjacent to the stadium, about 100 m away. Also, the site at Nazrul Mancha may be influenced by stadium sound, even if about 1000 m away.

Two different noise level monitoring survey were undertaken and presented at para 8.2.1 and 8.2.2 separately.

8.2. Methodology

8.2.1. Study Area for Noise Survey No. 1

The study area chosen for ambient sound level monitoring was centered around Rabindra Sarovar Stadium that held a few football matches of Mohan Bagan club during 4-28th February, 2017. Rabindra Sarovar stadium is located near Rabindra Sarovar Lake in Kolkata city. Five sampling points in and around the Rabindra Sarovar stadium were chosen for sound monitoring where the birds, animals and humans, residing or visiting the lake or surroundings may be disturbed due to sound

generated during football matches held at Rabindra Sarovar Stadium. **Table 8.1** represents a summary of the sites .

CSIR-NEERI initiated the first monitoring exercise on 4th February, 2017 near Lake Club Entrance. A mosque is situated on one of the lake's islands about 30 m away from this point, which is connected to the southern shore by a wooden suspension bridge. As this point is the interphase between stadium and the largest part of the lake, this area is of prime importance as far sound wave propagation to the largest part of lake is concerned. This site has an approximate distance of about 300 meters from the centre of stadium. Sound level monitoring was conducted at 3:00 PM to 10:00 PM. The match started at about 7:05 PM and ended at about 8:50 PM. The second sound monitoring exercise was undertaken on 7th February just beside the Press Box in the stadium to examine the sound level at a close-by point during a football match. On this day, monitoring was undertaken from 3:00 PM up to 10:00 PM and the match started at about 7:00 PM and ended at about 9:00 PM. The third and last of the monitoring exercises was undertaken on 18th February when another football match was held at 4:35 PM at the same stadium. This point is situated just adjacent to the building of Calcutta University, which is about 80 m away from the centre of stadium. This point is also a part of Rabindra Sarovar lake area. It was the nearest point outside stadium periphery where the lake biodiversity is present including birds that nest and rest on the trees. To minimize the effect of floodlight and sound on the trees that line this area and also a part of the lake that extends here, black plastic curtain has been used around the stadium periphery on this side to minimize light and sound transmission from the stadium to this area. The details of sites and monitoring are presented in Table - 1.

Another sound level monitoring exercise was initiated by WBPCB at two other positions (Behind press box in the stadium and at Nazrul Macha) during 4-18th February with the objective of capturing grab hourly average sound levels on even days (football match) and non-event (no football match) days. Monitoring on 4, 7, 12, 16, 18, 21, 26 and 28th February that included event (football matches on 4, 7, 18 and 28th February) and non-event days (12, 16, 21 and 26th February) (Table-1).

Table 8.1. Summary of sampling sites and sound monitoring exercise

Site No.	Site Location	Approx. distance from centre of stadium	Site selection justification and remarks	Sources of sound	Date, time and type of sound level monitoring
1.	Near Lake	300 m	This site represents the	Occasional loudspeakers	4th February, 2017 (Continuous sound level

	Club entrance (Code: LC)		interphase between sound propagation from stadium and the largest part of Rabindra Sarovar Lake	from Lake club, Bengal Rowing Club, Calcutta Rowing Club, vehicular traffic of Debaki Kumar Bose Sarani, Parking lot of Lake Club, prayers from the Masjid etc.	data at 1-second intervals during 3:47 PM to 9:21 PM. The match on this date was held during 7:05 PM to 8:50 PM)
2.	Left side of Press Box on terrace in the stadium (Code: PB)	50 m	This site represents a very close-by point of sound propagation in the stadium	Vehicular traffic of Sarat Chatterjee Avenue behind press box, loudspeakers of stadium	7th February (Continuous sound level data at 1 second intervals during 3:00 PM to 9:30 PM. The match on this date was held during 7:05 PM to 8:50 PM)
3.	Behind the tree line on the Southern side of stadium. Behind black curtain of stadium (Code: TL)	100 m	This site represents a tree covered fringe of the stadium where birds reportedly nest and rest at night	Vehicular traffic of Sarat Chatterjee Avenue and Debaki Kumar Bose Sarani. Also, occasional passing of trains of circular railway	18th February (Continuous sound level data at 1 second intervals during 3:00 PM to 8:15 PM. The match on this date was held during 3:45 PM to 5:30 PM)
4.	Behind Press Box in the stadium	55 m	This site represents another very close-by point of sound propagation within the stadium periphery	Vehicular traffic of Sarat Chatterjee Avenue behind press box, loudspeakers of stadium	Monitoring on 4, 7, 12, 16, 18, 21, 26 and 28th February that included event (football matches on 4, 7, 18 and 28th February) and non-event days (12, 16, 21 and 26th February). Monitoring results are reported hourly from 7 AM to 12 PM (night)
5.	Nazrul Mancha	1000 m	This site represents a far-off point from	Sound from Anderson Club activities, Nazrul	Monitoring on 4, 7, 12, 16, 18, 21, 26 and 28th February that included

			stadium beside the Eastern fringe of Rabindra Sarovar	Mancha and Southern Avenue traffic	event (football matches on 4, 7, 18 and 28th February) and non-event days (12, 16, 21 and 26th February). Monitoring results are reported hourly from 7 AM to 12 PM (night)

8.2.2. Monitoring Methodology for Noise Survey No.1

Continuous sound level monitoring was undertaken by continuously datalogging sound level meter (Cirrus Research Plc., UK). Sound level parameters like LA_{eq} (Equivalent continuous sound level with A-weighted frequency response) and LAS_{max} (The maximum level with A-weighted frequency response and slow time constant) were recorded before, during and after the football matches to understand the trend of ambient sound level affected by the football matches. Hourly grab sound level (LA_{eq}) monitoring was undertaken by another sound level meter (Lutron Electronic Enterprise Co., Ltd.).

8.2.3. Study Area for Noise Survey No. 2

The survey was for eight days (24 hours each day) for ambient noise level monitoring at two locations given in the table below:

Sl.	Station Name	Location at Rabindra Sarobar
1	Football Stadium	Roof Top of Pavilion Hall of the Football Stadium
2	Nazrul Mancha	Balcony of VIP Gate at Nazrul Mancha

The ambient noise level in dBA at the both locations was monitord from 6:00 am to 6:00 am (next day) with an interval of 1 (one) minute. At each location, monitoring was conducted for both the locations as per the following schedule:

Sl. No.	Date & Time
Day-1	06 AM of 04 February 2017 to 06 AM of 05 February 2017
Day-2	06 AM of 07 February 2017 to 06 AM of 08 February 2017
Day-3	06 AM of 12 February 2017 to 06 AM of 13 February 2017
Day-4	06 AM of 16 February 2017 to 06 AM of 17 February 2017
Day-5	06 AM of 18 February 2017 to 06 AM of 19 February 2017

Day-6	06 AM of 21 February 2017 to 06 AM of 22 February 2017
Day-7	06 AM of 26 February 2017 to 06 AM of 27 February 2017
Day-8	06 AM of 28 February 2017 to 06 AM of 01 March 2017

8.2.4. Monitoring Methodology for Noise Survey No. 2

The ambient noise level in dBA was monitored by using Sound Level Meter, HTC Instruments make SL-1352 Professional. The ambient noise level in dBA was monitored for 24 hrs with one minute interval and sound level range Automatic: (30dB~130dB) as per methodology prescribed by Central Pollution Control Board (CPCB). Also, Ambient noise level monitoring was conducted with an interval of 15 minutes using make Lutron SL-4001.

Specification of Sound Level Meter (HTC Instruments make SL-1352)

Basic Function	**Range**
Accuracy	1.4dB
Resolution	0.1dB
Frequency Range	31.5Hz ~8kHz
Dynamic Range	50dB
Level Range	Low:30dB~80dB Medium:50dB~100dB
	High:80dB~130dB Auto: 30dB~130dB
Time Wieghting	FAST (125mS),SLOW (1s)
Microphone	½ inch electric condenser microphone
Display Update	2 times/sec
Analog Output	AC/DC outputs,AC=1Vrms,DC=10mV/dB

8.3. Results

8.3.1. Previous Observations

A very important previous observation on the noise level of the Rabindra Sarobar area was obtained in a report published by Mr. Rusy Modi and Mr. Atmaram Saraogi in 1989. They performed noise level measurements at a lateral distance of 500 meters due north from the Lake Gardens Crossing and just outside the Sarobar Complex area deploying the methodology prescribed by the

Indian Standard document IS-3028:1980 prevailing at that material time. The noise level measurement was performed using a National Physical Laboratory certified machine with "A" rating average.

The back ground noise level, i.e., during "no traffic" condition, the noise level was measured to be 64 dB(A) in the morning and night hours. In contrast, with an average traffic flow of 750 to 800 per hour during high traffic period (0900 to 1100 hours in the morning and 0600 to 0800 hours in the evening), the average noise level was recorded to be 75 dB(A). The background and the high traffic noise level both were high compared to the speech interference level (SIL), i.e 50 – 55 dB(A) at which the conversations are usually made.

Noise monitoring was performed at the Rabindrasarobar during Chaat Puja by the West Bengal Pollution Control Board. Although Grab sampling was performed in such cases, levels as high as 78 to 80 db(A) were recorded inside the Sarobar premise, although very near (within 2 meter) the Chatt activity. Since a huge gathering happens during Chatt, such noise level may have been predominantly influenced by the combined speeches of the gathering and therefore may not be relevant for comparison for the present case.

8.3.2. Present Survey

Sound level monitoring was undertaken on continuous basis, starting from a few hours before the start of the football match, during the match and a little after the match and therefore the trend of sound level indicated fairly the temporal variation in sound with the effect of the football match. The LA_{eq} (Equivalent continuous sound level with A-weighted frequency response) and LAS_{max} (The maximum level with A-weighted frequency response and slow time constant) were plotted against time to understand temporal variation in sound level as affected by the football matches. The time-series sound level graph is full of spikes as expected due to various sources of sound around the sites apart from sounds from the football ground. To understand the effects of sound generated within football stadium during matches, trendline fitting was undertaken. The sound level trends (polynomial fitting) in time-series graphs of all the matches indicated a slightly elevated sound level trend during matches as presented by a blue block, representing match duration. During the match on 4th February, elevation in sound levels were not so remarkable probably as this site was about 300 m away from the stadium and was partially blocked by trees in between. The elevation in sound level was most conspicuous for the match on 7th February as the site was just adjacent to the ground on the stadium without any effective blockage .During the match on 18th, several sound peaks were observed during the match, indicating periodical sound bursts and roars and as this site was behind the tree lines outside the stadium, there could be partial sound blockages.

Descriptive statistical analysis (mean, median, mode, 50^{th}, 75^{th}, and 90^{th} percentile, standard deviation and coefficient of variation) of the sound level data generated before, during and after the football matches held on 4^{th}, 7^{th} and 18^{th} February were performed (**Table 8.2-8.4**) to evaluate summary levels of LA_{eq}, LC_{peak} (The Peak, referred to as the L_{peak} or sometimes L_{pk}, is the maximum value reached by the sound pressure. There is no time-constant applied and the signal has not passed through an RMS circuit or calculator. This is the true peak of the sound pressure wave. So, LC_{peak} is C-weighed peak of sound pressure) and LAS_{max} before, during and after the football matches by which it could be understood if the football matched indeed had some effects on ambient sound level or not. It is evident that during the football matches, there was indeed some quantifiable increase in mean, median, mode, 50^{th}, 75^{th} and 90^{th} percentile in sound levels in terms of LA_{eq}, LC_{peak} and LAS_{max}, that are important sound level evaluating parameters. The values indicating standard deviation and coefficient of variation only indicated the extent of variation in respective sound level parameters (i.e. LA_{eq}, LC_{peak} and LAS_{max}) before, during and after the matches. These two statistical parameters showed random trends amongst before, during and after match scenarios and hold little significance under present context.

Further, the continuous sound level data (LA_{eq}) was mined and hourly (when the match was started at 7:00 PM and ended at about 9:00 PM) or hourly and half-hourly (when the match was started at 4:30 PM and ended at about 6:30 PM) average LA_{eq} (dB) was extracted to evaluate time-bound periodical sound level behaviour before, during and after football matches held on 4^{th}, 7^{th} and 18^{th} February. As evident from the presented graphs, sound level (LA_{eq}) had distinct elevation during football matches over the average background sound levels (an elevation roughly in a range of about 2-5 dB) and after matches the sound levels came down to background or even lower levels in some cases especially when it was past 10 PM, when sources of sound like traffic and other anthropogenic sources came down to much lower levels.

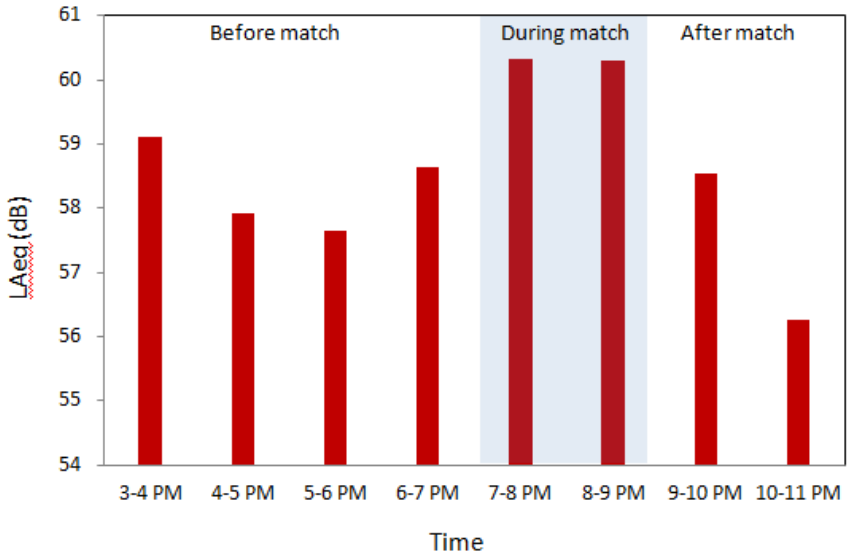

Fig. 8.1. Hourly variation of LA_{eq} before, during and after the football match held at Rabindra Sarovar Stadium on 4th February (site: Lake Club entrance)

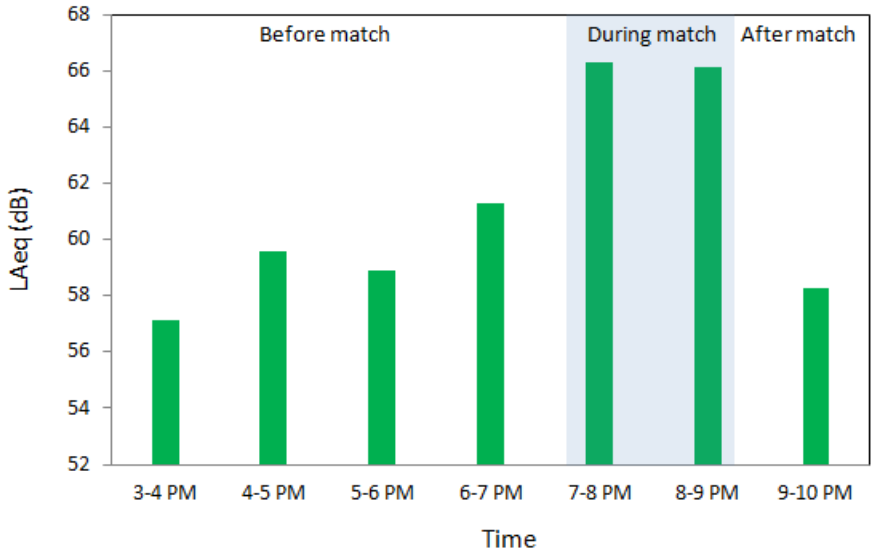

Fig. 8.2. Hourly variation of LA_{eq} before, during and after the football match held at Rabindra Sarovar Stadium on 7th February (site: Beside Press Box)

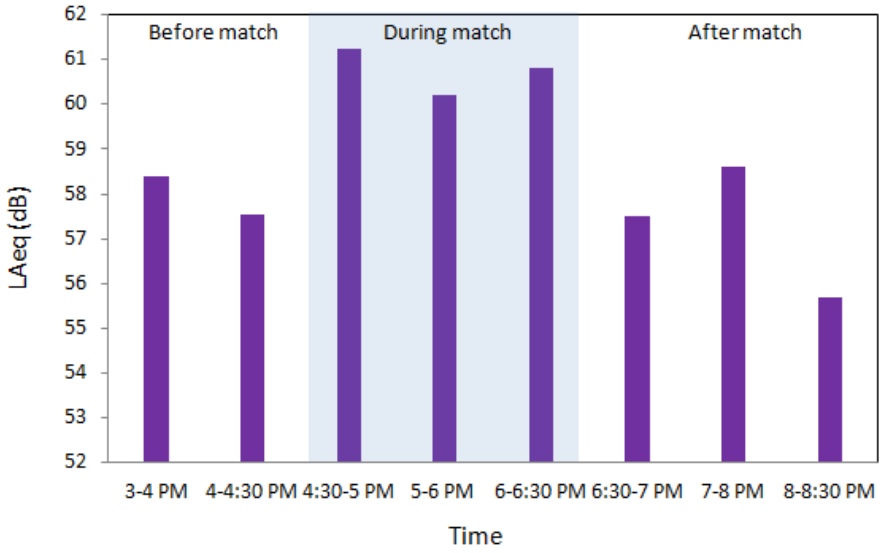

Fig. 8.3. Hourly/Half-hourly variation of LA_{eq} before, during and after the football match held at Rabindra Sarovar Stadium on 18th February (site: Behind tree line)

Table 8.2. Summary statistics of ambient sound level (dB, LA_{eq}) before, during and after the match held on 4th, 7th and 18th February

Parameter	Lake Club Entrance 4th			Beside Press box 7th			Behind tree line 18th		
	Before	During	After	Before	During	After	Before	During	After
50 percentile	57.89	59.67	57.87	58.6	65.14	57.56	57.76	60.87	58.27
90 percentile	62.4	64.62	63.40	63.64	72.17	63.206	60.89	64.65	60.55
75 percentile	59.95	61.81	60.31	60.98	67.79	59.97	59.3	62.66	58.99
Mode	56.58	58.28	57.18	57.51	64.33	55.43	56.54	61.29	58.7
Median	57.89	59.67	57.87	58.6	65.14	57.56	57.76	60.58	58.27
Mean	58.40	60.30	58.27	59.16	66.19	58.28	58.03	60.40	58.04
Standard Deviation	3.42	3.50	4.06	3.58	4.31	3.3247	2.45	3.75	2.85
Coefficient of variation (CV in %)	5.86	5.81	6.98	6.06	6.51	5.70	4.22	6.21	4.91

Table 8.3. Summary statistics of ambient sound level (dB, LC_{peak}) before, during and after the match held on 4th, 7th and 18th February

Parameter	Lake Club Entrance			Beside Press box			Behind tree line		
	4th			7th			18th		
	Before	During	After	Before	During	After	Before	During	After
50 percentile	80.48	82.08	80.59	80.23	83.55	79.17	78.12	83.79	78.46
90 percentile	83.59	86.04	83.8	83.13	88.83	82.99	80.58	88.36	81
75 percentile	81.97	83.53	82.05	81.73	85.22	81.41	79.21	86.41	79.62
Mode	79.87	81.83	80.62	81.19	81.87	77.87	78.44	78.76	77.76
Median	80.48	82.08	80.59	80.23	83.55	79.17	78.12	83.34	78.46
Mean	80.67	82.92	80.73	80.03	84.42	79.60	78.42	83.08	78.80
Standard Deviation	2.62	3.44	2.94	3.12	3.22	2.61	2.07	4.04	1.90
Coefficient of variation (CV in %)	3.25	4.15	3.64	3.90	3.82	3.28	2.64	4.86	2.41

Table 8.4. Summary statistics of ambient sound level (dB, LAS_{max}) before, during and after the match held on 4th, 7th and 18th February

Parameter	Lake Club Entrance			Beside Press box			Behind tree line		
	4th			7th			18th		
	Before	During	After	Before	During	After	Before	During	After
50 percentile	58.97	60.68	59.10	59.71	66.04	58.31	58.6	61.62	58.76
90 percentile	63.5	66.01	64.785	64.68	73.12	63.83	61.58	65.36	61.54
75 percentile	60.91	62.82	61.69	62.16	68.58	60.81	60.05	63.28	59.54
Mode	57.61	60.5	60.11	58.52	66.87	55.73	58.69	62.02	58.79
Median	58.97	60.68	59.10	59.71	66.04	58.31	58.6	61.41	58.76
Mean	59.51	61.39	59.59	60.22	67.07	58.94	58.89	61.24	58.76
Standard Deviation	3.43	3.64	4.17	3.64	4.30	3.36	2.46	3.64	2.92
Coefficient of variation (CV in %)	5.77	5.93	6.99	6.05	6.41	5.71	4.17	5.94	4.98

A rather conclusive involvement of the event, The football match in Rabindra Sarobar Stadium, and associated activities like deployment of huge sound boxes etc.. could be identified by the sound level monitoring performed under survey #2. From the presented graphs, it clearly transpired that the event day (Football Match at the Stadium) has much augmented noise level at both the locations and such higher noise levels on event days happen during the afternoon-to-midnight period at Nazrul Mancha and mid-day to mid-night at the Stadium. The Stadium obviously recorded noise levels on event days over the non-event days much higher than the Nazrul Mancha.

An average augmentation of the noise level during the time period of 1600 hours till midnight by an amount of 5.3 dB(A) at the Nazrul Mancha and 5.7 dB(A) at the Stadium were recorded which clearly establishes that the contribution in noise level in the entire Sarobar area due to the event of Foot Ball match in the stadium and associated activities is considerable. Measurements were also performed during Football Match period at locations on the Southern Side (opposite to the Lotus Pond) of the main lake and no significant difference in Noise level could be recorded between the event and non-event days.

One major previous noise measurement record needs mention at this point. Modi and Saraogi in 1989 recorded, at the Stadium, 64 dB(A) in no-traffic condition and 75 dB(A) during high traffic condition. As motorcar horns contribute enormously to the ambient noise level, and the Sarobar is located in a place heavily populated roads on three of it's sides, the nesting place of the birds, the southern side of the main lake predominantly gets noise from the automobile source.

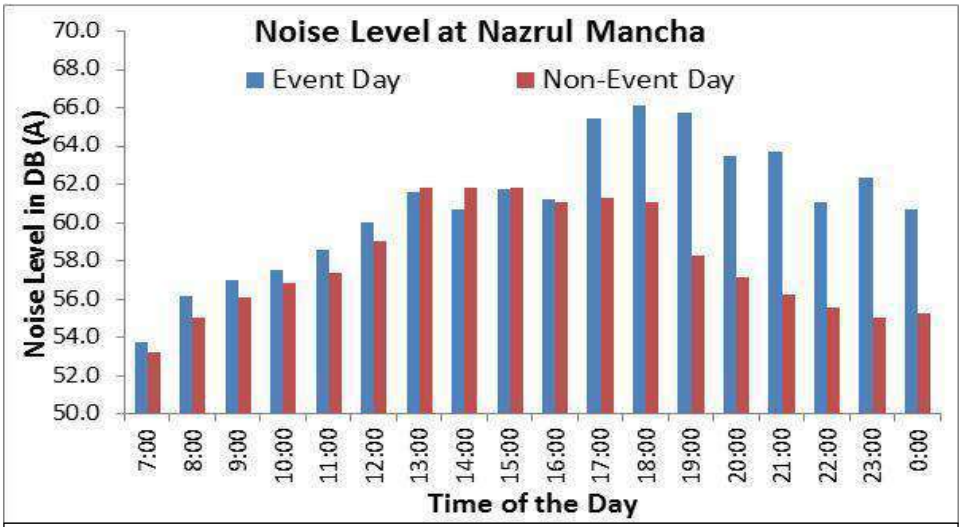

Fig. 8.4. Temporal variation of LA_{eq} at various time of day and night based on sound level monitoring undertaken during event days (football match) and non-event days (site: Nazrul Mancha)

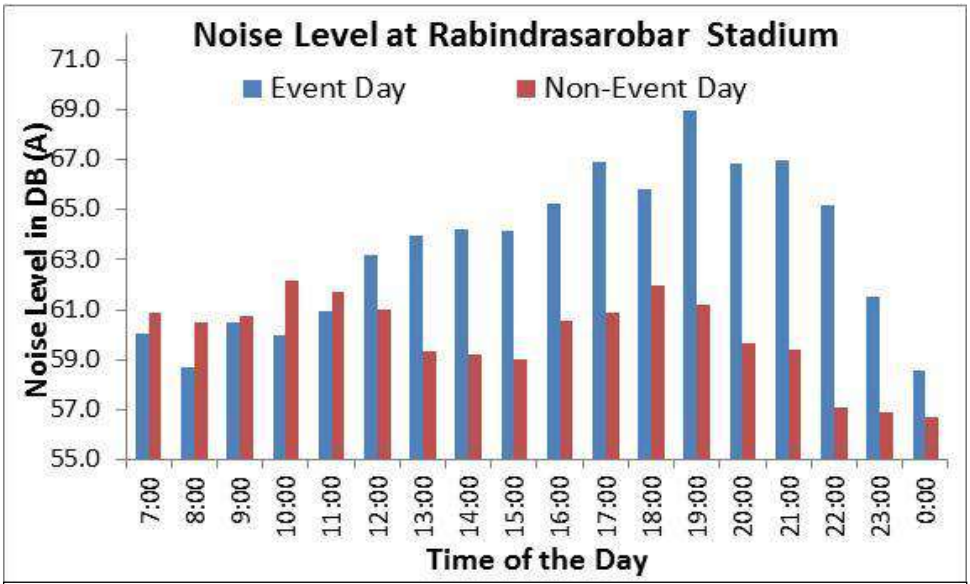

Fig. 8.5. Temporal variation of LA_{eq} at various time of day and night based on sound level monitoring undertaken during event days (football match) and non-event days (site: Behind Press Box)

8.4. Likely effects of sound on birds

As per Ortega (2012), although avian species have long been exposed to loud natural sounds such as streams, waterfalls, and wind, anthropogenic noise pollution is a relatively recent experience for birds. Early investigations on bird responses to noise tended to focus on physical damage to ears, stress responses, flight or flushing responses, changes in foraging, and other behavioral reactions. These studies were often conducted under laboratory conditions because determining effects of noise on freeranging birds is particularly difficult, in that it is impossible to isolate noise as a single testable variable. By coupling introduced noise on the landscape (e.g., from gas well compressors) with ecologically similar controls, it has been found that birds make additional responses like avoidance of noisy areas, changes in reproductive success, and changes in vocal communication. Numerous investigators have compared urban birds with their rural counterparts in quieter surroundings and found that at least some birds can compensate for the masking effect of noise through shifts in vocal amplitude, song and call frequency, and song component redundancies, as well as temporal shifts to avoid noisy rush-hour traffic (Ortega, 2012). Dooling and Popper (2007) have presented effects of highway noise in relation to distance on birds and recommended various guidelines (**Table 8.5**) on sound levels on birds, based on research data available from all over the world (http://www.dot.ca.gov/hq/env/bio/files/caltrans_birds_10-7-2007b.pdf).

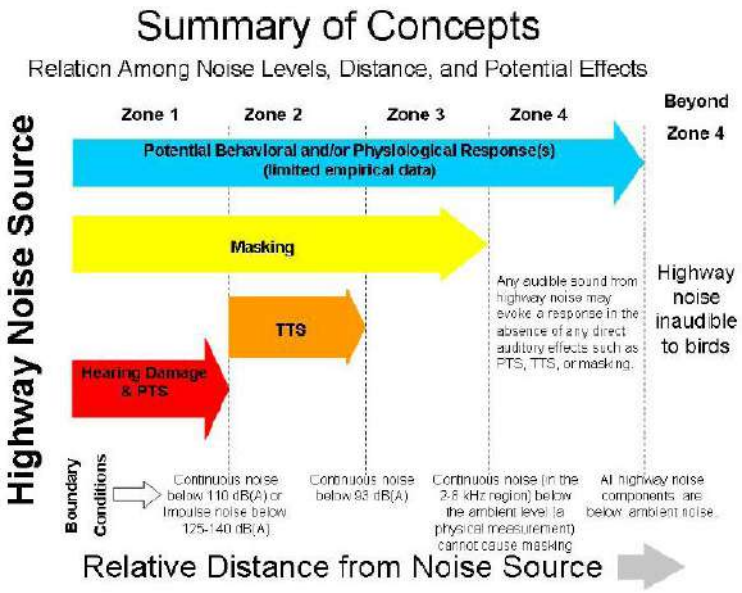

Fig. 8.6. Categories of highway noise effects on birds with distance from the source. Zone 1 is closest to the source while Zone 4 is furthest away. Sound level decreases further from the source
Source: Dooling and Popper (2007) [http://www.dot.ca.gov/hq/env/bio/files/caltrans_birds_10-7-2007b.pdf]

Table 8.5. Recommended Interim Guidelines for Potential Effects from Different Noise Sources

Noise Source Type	Hearing Damage	TTS	Masking	Potential Behavioral/ Physiological Effects
Single Impulse (e.g., blast)	140 dB(A)[1]	NA[3]	NA[7]	Any audible component of highway noise has the potential of causing behavioral and/or physiological effects independent of any direct effects on the auditory system of PTS, TTS, or masking
Multiple Impulse (e.g., jackhammer, pile driver)	125 dB(A)[1]	NA[3]	ambient dB(A)[5]	
Non-Strike Continuous (e.g., construction noise)	None[2]	93 dB(A)[4]	ambient dB(A)[5]	
Highway Noise	None[2]	93 dB(A)[4]	ambient dB(A)[5]	
Alarms (97 dB/100 ft)	None[2]	NA[2]	NA[6]	

[1] Estimates based on bird data from Hashino et al.1988 and other impulse noise exposure studies in small mammals.
[2] Noise levels from these sources do not reach levels capable of causing auditory damage and/or permanent threshold shift based on empirical data on hearing loss in birds from the laboratory.
[3] No data available on TTS in birds caused by impulse noises.
[4] Estimates based on study of TTS by continuous noise in the budgerigar and similar studies in small mammals.
[5] Conservative estimate based on addition of two uncorrelated noises. Above ambient noise levels, critical ratio data from 14 bird species, well documented short term behavioral adaptation strategies, and a background of ambient noise typical of a quiet suburban area would suggest noise guidelines in the range of 50—60 dB(A).
[6] Alarms are non-continuous and therefore unlikely to cause masking effects.
[7] Cannot have masking to a single impulse.

Source: Dooling and Popper (2007) [http://www.dot.ca.gov/hq/env/bio/files/caltrans_birds_10-7-2007b.pdf]

N.B.: Temporary Threshold Shift (TTS) lasts from seconds to days depending on the intensity and duration of the noise to which the animal was exposed. At continuous noise levels below 110 dB(A) down to about 93 dB(A), birds can experience a temporary threshold shift

As per the details given in Table-5, it may be stated that at the levels of sound that the birds are exposed to near the Rabindra Sarovar Stadium before, during and after footballs matches, chances of hearing loss to birds are rare. Data on chances of TTS based on sound levels is limited to serve any conclusion for some sound types, but where data is available, chances of TTS near Rabindra Sarovar seems to be limited. But, there could be enough chances of physiological and behavioral effects on birds at these sound levels near the stadium during matches or even without matches as there are other sources of sound within the prescribed sound level to cause this impact, but cannot be confirmed without a dedicated and specialized study on effect of sound on birds' behaviour in the area. There are also chances of masking (impairment in detection and discrimination of vocal signals by birds) at the observed sound levels, as per the data given in Table-5.

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9.0. Illumination at Rabindra Sarovar in general & before & during football match in the stadium

9.1. Introduction

General idea: Amount of light spilling out of the stadium, before and during football match has to be measured. This spill light may cause changes in ambiance and affect biodiversity in the surrounding plants of the stadium.

9.2. Present Study Details

9.2.1. Material & Methods

Lux meter is used to measure Vertical Illuminance (Light level when the instrument is kept vertical) at six feet height from top position of the gallery. Measurements were taken on surface of the black light guard, at different positions on the gallery surrounding the stadium as well as from the top of the green room of the playground.

The schematic diagram is shown in figure 1. The points A, AB, C, CD are the different positions where the measurements were taken at gallery and the top of the green room.

9.3. Results

a) Average Vertical Illuminance Level on the front of the Black Light guard at a height of six feet from the top position of the gallery is about 169.4 lux during the football match, measurement taken at different points around the whole stadium gallery as mentioned in Appendix 1 between 5:50 p.m. and 6:28 p.m. on 18th February, 2017.
b) Average Vertical Illumination at a specific portion (C5 - A in the Fig. 1) of the stadium at same height is about 131 lux during the football match, measurement taken between 5:45 p.m. and 6:00 p.m. on 28th February, 2017.
c) Black-light guard absorbs sufficient light almost 98% falling it. (Illumination value measured was 213 lux on it, 5 lux behind it at a specific measurement point C34 in fig: 1 as mentioned in Appendix 1).
d) During the match average horizontal Illuminance level on the general play ground outside the stadium is found 10.7 lux, and average vertical Illuminance level is found 41.4 lux. After the match, when Flood lights were made OFF; it is found zero.
The vertical illuminance around the stadium road is 12 lux in the front side of the street light pole at a height of 6 feet and 8 lux in the back side of the pole at the same height.
On 15th March, 2017, horizontal illuminance was measured in two zones of the road surrounding the stadium. No flood lights were ON at that time. In one zone average horizontal illuminance was found 13.85 lux and in other zone it was found 29.5 lux.

9.4. General Discussion

On 18th February, whole gallery of the stadium was full with audience; measurement could not been possible in heavily crowded audience zones with team supporters singing the team songs with drums, flutes, sound blowers etc. and waving team flags.

On 28th February, only a specific part of the stadium had audience, just opposite to the Green room (in between D5 – E2 in the figure) of the stadium.

It was not understood whether all lights were made ON during daylight in the no-audience zone on 28th February.

On 15th March, 2017 a team measured the horizontal light level on the stadium surrounding street way at two different portions of the street, illuminated by street lighting luminaires in staggered (zig-zag placement of lighting poles) orientation with different types of light sources; High pressure Sodium vapor, Metal Halide and LEDs.

Horizontal Illuminance on road surface surrounding the stadium was of different values because of presence of different tree branches below the road lighting luminaire (lighting unit) and presence of different types of light sources; High pressure Sodium vapor, Metal Halide and LEDs.

While taking the measurements from the top of green room at Rabindra Sarovar Stadium during football match, few photographs were taken and are shown in Annexure 4.

9.5. References

Light Pollution handbook by Kohei Narisada and Duco Schreuder published by Springer

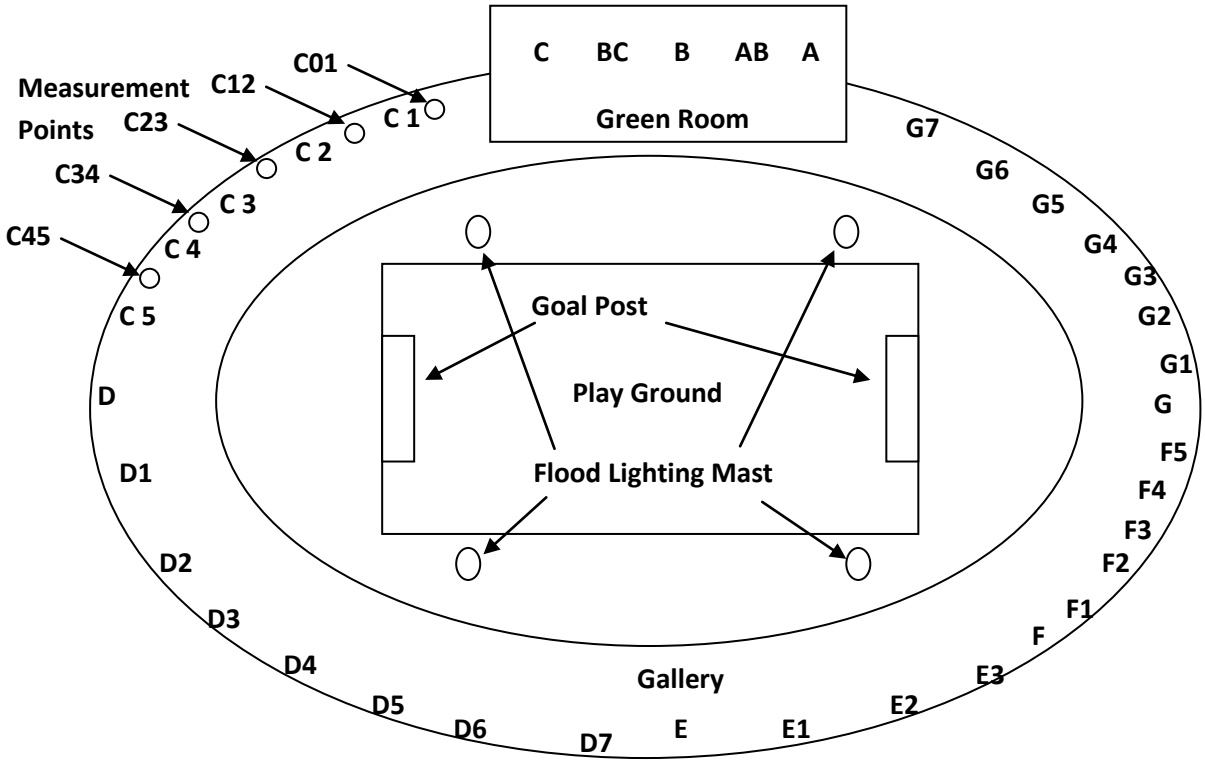

Figure 9.1. Schematic diagram of measurement points in the stadium

Appendix – 1

Vertical **illuminance values measured on the black light guard from the gallery**

Measurement Taken on 18/02/2017

Time	Measurement point	Vertical Illuminance values (Lux)
5-50 pm	**A**	**163**
5-54 pm	**B**	**152**
5-58 pm	**C**	**172**
6-03 pm	**C1**	**192**
6-02 pm	**C2**	**163**
6-04 pm	**C3**	**173**
6-05 pm	**C4**	**169**
6-06 pm	**C5**	**174**
6-07 pm	**D1**	**136**
6-08 pm	**D2**	**145**
6-09 pm	**D3**	**144**
6-10 pm	**D4**	**128**
6-11 pm	**D5**	**143**
6-12 pm	**D6**	**140**
6-13 pm	**D7**	**228**
6-14 pm	**E1**	**224**
6-15 pm	**E2**	**234**
6-16 pm	**E3**	**212**
6-17 pm	**F1**	**241 (max)**
6-18 pm	**F2**	**203**
6-19 pm	**F3**	**203**
6-20 pm	**F4**	**181**
6-21 pm	**F5**	**150**
6-22 pm	**G1**	**128**

6-23 pm	**G2**	**120**
6-24 pm	**G3**	**112 (min)**
6-25 pm	**G4**	**142**
6-26 pm	**G5**	**135**
6-27 pm	**G6**	**187**
6-28 pm	**G7**	**188**

Measurement Taken on 28/02/2017

Time	Measurement point	Vertical Illuminance values (Lux)
5:45 pm	**C5**	**198**
5:45 pm	**C45**	**193**
5:45 pm	**C4**	**191**
5:45 pm	**C34**	**213 (max)**
5:50 pm	**C3**	**63**
5:50 pm	**C23**	**65**
5:50 pm	**C2**	**90**
5:50 pm	**C12**	**76**
5:50 pm	**C1**	**59**
5:50 pm	**C01**	**49 (min)**
6:00 pm	**C**	**192**
6:00 pm	**BC**	**160**
6:00 pm	**B**	**145**
6:00 pm	**AB**	**141**
6:00 pm	**A**	**130**

Illuminance values (in lux) measured at the play ground outside the stadium at a height of five feet from ground level during the football match measured on 18th February, 2017.

	A		B		C		D		E	
	H	**V**	**H**	**V**	**H**	**V**	**H**	**V**	**H**	**V**
1	12	43	13	47	11	38	13	33	9	27
2	13	51	12	51	9	39	6	32	7	28
3	15	51	12	47	13	47	10	37	6	34

H – Horizontal Illuminance level

V – Vertical Illuminance level

Appendix – 2

Horizontal light level measured on the pathway surrounding the stadium.

Illuminance Values are in Lux

	A	**B**	**C**	**D**
1	25	27	27	23
2	21	24	25	22
3	14	17	17	15
4	12	12	11	9
5	8	8	7	7
6	7	7	7	7
7	7	10	8	4

	A	**B**	**C**	**D**
1	40	42	35	23
2	35	39	37	25
3	29	37	38	30
4	25	28	30	30
5	21	28	28	28

6	20	29	31	28
7	6	26	28	30

Layout of the illuminance level measurement grid points upon the road surface between two street lighting poles.

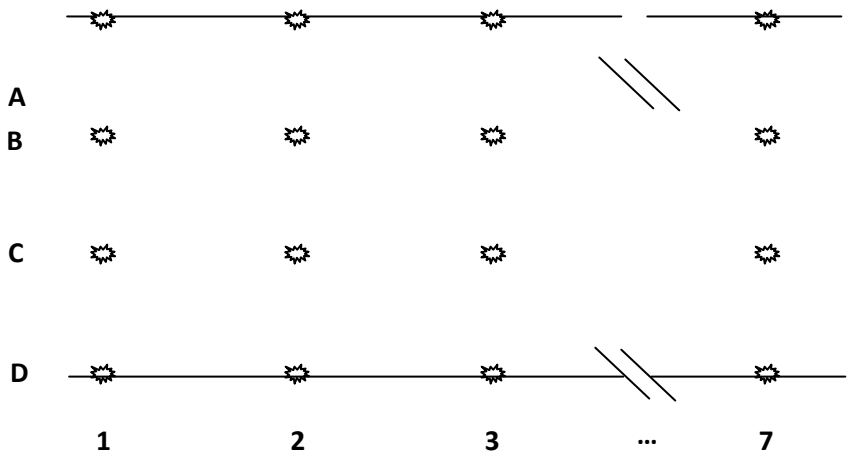

Figure 9.2. Schematic diagram of the grid points on the road surface for illuminance measurement

10.0. Trophic status of the lake

Trophic status is a useful means of classifying lakes and describing lake processes in terms of the productivity of the system. An oligotrophic lake has low nutrient concentrations, low level of phosphorus enrichment, clearer water, low algal growth, and has low productivity; a eutrophic lake has high concentration of nutrients, depleted oxygen in bottom layers, murky or less clearer water due to planktonic and algal growth and has high phosphorus enrichment; whereas mesotrophic lakes have characteristics somewhere in between eutrophic and oligotrophic lakes.

Eutrophication, being of autocthonous and/or allocthonous origin, the progress of a lake toward a eutrophic condition, is often discussed in terms of lake history and management. A typical lake is said to age naturally from a young, oligotrophic state to an older, eutrophic state. Besides natural change of trophic status, presently cultural eutrophication of lakes by anthropogenic acceleration of their natural rate of nutrient inflow are seen globally as major cause of loss of lakes' ecological equilibrium. In the present study, the trophic status of Rabindra Sarobar is being investigated.

10.1. Materials and methods

The hydrophytes and colour of the water were studied during the visits to the Rabindra Sarobar. Phytoplankton/ algal samples were collected and studied. The trophic status of the lake was studied based on the calculation of Trophic State Index (TSI) of three parameters of Secchi disk depth, Chlorophyll-a content and total phosphorus content of the lake water following Carlson (1977). For calculation of Secchi disk depth, the instrument was immersed in 6 sampling sites (SU1-SU6) (fig. 1) of lake water body until the black and white areas of the disk were indistinguishable and the depth was measured. Water samples collected from 6 sampling sites (SU1-SU6) (fig. 1) and were analyzed for Chlorophyll-a content using UV-VIS spectrophotometer (Model LASANY double beam LI-2800). The data on the total phosphorus of the water during the study period (SU1,SU2,SU6 and SU7) were provided by West Bengal Pollution Control Board. The trophic state classification of lake based on TSI as adopted by (KDHEKS, 2000) was followed. Methodology adopted for sampling and analysis of water were developed in-house with the methods published in the manual of American Public Health Association for analysis of water and wastewater. For Dissolved Oxygen (DO) profiling, the measurements were made at a single point (Near Bengal Rowing Club), where the water samples were collected from 1 foot depth every 2 hours from 1200 hrs. of 07 April to 1000 hours of 08 April, 2017. As the ambient temperature on this date the air temperature was 32˚C and the water temperature was 30˚C. Water quality analysis was performed on the collected fresh water within 2 hours of the collection. The equation for calculation of TSI (Carlson, 1977) was put in MS Excel with following representation:

TSI(SDD)=10(6-ln(SDD)/ln2)

TSI(Chl-a)= 10(6-(2.04-0.68*ln chl-a/ln2))

TSI(TP)=10(6-(ln(48/TP)/ln2)

Where SDD= Secchi Disk Depth in meter, Chl a=value of Chlorophyll a in mg/m^3, TP=value of total phosphate in mg/m^3

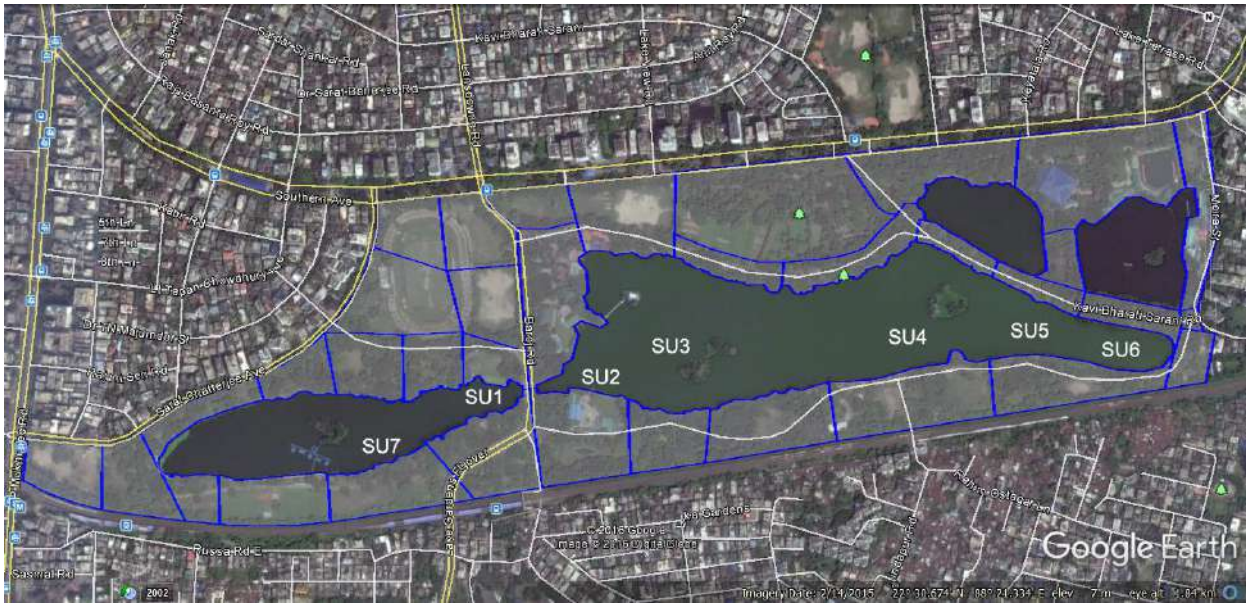

Fig. 10.1. Sites for collection of water samples for calculation of Trophic State Index (TSI) of Rabindra Sarobar water body (Image source: Google Earth).

Results and discussions

Rabindra Sarobar water body has diverse submerged aquatic macrophytes like *Hydrilla verticillata*, *Vallisneria spiralis* in the littoral zones of the lake. Sometimes *Ceratophyllum demersum* was found to be suspended sporadically in the lake. Among floating ones, *Lemna perpusilla* along with *Spirodela polyrrhiza* and *Azolla pinnata* are also distributed sporadically in the entire lake but sometimes clumped at the edge region. Interestingly *Wolffia arrhiza* is also dominant in certain region of the water body, indicating nutrient enrichment.

The present study reveals presence of 87 species of phytoplankton and other algal components in Rabindra Sarobar, distributed under 52 genera, 40 families and 10 classes. The most species rich genera was *Scenedesmus* (11 species), followed by *Aphanocapsa*, *Euglena* and *Merismopedia* (4 species each); *Coscinodiscus*, *Gomphonema* and *Tetrastrum* (3 species each); *Chodatella*, *Encyonema*, *Lyngbya*, *Navicula*, *Pediastrum*, *Pseudanabaena*, *Schroederia*, *Spirogyra*, *Tetraëdron* and *Trachelomonas* were represented by 2 species each and rest 35 genera were represented by single species only. The most diverse families were Scenedesmaceae (14 species), Merismopediaceae (8 species), Euglenaceae (6 species), Gomphonemataceae and Hydrodictyaceae (5 species each) and Coscinodiscaceae (3 species), while, rest 12 families had two species and 22 families had one species. Amongst the classes, the most diverse was Chlorophyceae (36 species), followed by Cyanophyceae (18 species), Bacillariophyceae (12 species), Euglenophyceae (7 species), Trebouxiophyceae (5 species), Coscinodiscophyceae (4 species), Conjugatophyceae (Zygnematophyceae) (2 species), while Dinophyceae, Mediophyceae and Xanthophyceae were represented by single species only.

Quantitative samples were used to calculate density and frequency class of Phytoplankton. Phytoplankton community of the lake reveals that maximum population was attained by the members of Cyanophyceae (58.3 no./l) and Chlorophyceae (50.7 no./l) followed by Bacillariophyceae, Coscinodiscophyceae, Trebouxiophyceae, Euglenophyceae, Conjugatophyceae and Mediophyceae.

Table 10.1. The density of phytoplankton studied was found to be as follows.

Class	**Density (no./l)**
Cyanophyceae	58.3
Chlorophyceae	50.7
Bacillariophyceae	4

Coscinodiscophyceae	3.56
Trebouxiophyceae	2
Euglenophyceae	0.86
Conjugatophyceae	0.73
Mediophyceae	0.2

Members of Cyanophyceae are reported to dominate in eutrophic water, whereas Chlorophyceae are less tolerant of nutrient overload (Rawson, 1956). Inspite of maximum population contributed by Cyanophyceae, most of the Chlorophycean members have also good population size in Rabindra Sarovar. Among the members of Cyanophyceae, *Merismopedia punctata* and *M. convoluta* were most common.

Rawson (1956) opined that the presence of *Melosira*, *Fragilaria* of Diatomaceae are indicative of eutrophic condition, and their presence in Rabindra Sarovar hints towards the same. The phytoplanktonic population of Rabindra Sarovar reveals that the density of two Cyanophycean members - *Merismopedia punctata* (141 no./l) and *M. convoluta* (109.6 no./l) are among the phytoplankton indicating the eutrophic nature of the lake which is corroborated by the study of Caljon (1983).

The levels of Secchi Disk Depth (SDD) was found to be 0.762 m (2.5 ft) AMRI towards gate side to 1.397 m (4.58 ft) towards Calcutta University Rowing Club (Table 2). As per NHDES (2017), SDD value of <10 ft is considered to be eutrophic. Trophic State Index based upon values of SDD **(**Table 3) also points towards the water body of Rabindra Sarobar to be very eutrophic to fully eutrophic based upon the trophic status classification by KDHEKS (2000) (Table 4-5).

Chlorophyll-a content was found to be 44.1 mg/m^3 towards Calcutta University Rowing Club to 166.4 mg/m^3 towards AMRI gate (Table 2). As per NHDES (2017), a water body where Chlorophyll-a content is >5 mg/m^3 is regarded to be eutrophic. Trophic State Index based upon values of level of Chlorophyll-a (Table 3) also pointed out that Rabindra Sarobar is a hypereutrophic as per trophic status classification of KDHEKS (2000) (Table 4-5).

Total phosphorus (TP) was found to be in the range of 80 mg/m^3 towards Calcutta University Rowing Club and 220 mg/m^3 towards AMRI gate (Table 2). As per NHDES (2017), a water body where TP level is found to be above 12 mg/m^3, then it is considered to be eutrophic. Trophic State Index based upon values of level of TP (Table 3) also points towards the water body of Rabindra Sarobar to be hypereutrophic based upon the trophic status classification by KDHEKS (2000) (Table 4-5).

Table 10.2. Showing Secchi Disk Depth (SDD), Chlorophyll 'a' content (Chl a) and total phosphorus content (TP) of water body of Rabindra Sarobar from the present study. (SU=Sampling Unit)

	SU1	SU2	SU3	SU4	SU5	SU6	SU7
SDD (m)	1.397	1.016	0.7874	0.9144	0.762	0.9144	N.A.
Chl a (mg/m3)	44.1	125.2	125.2	67.5	165	166.4	N.A.
TP (mg/m3)	80	220	N.A.	N.A.	N.A.	200	220

Table 10.3. Showing Trophic State Index based upon values of SDD, Chl 'a' and TP in Rabindra Sarobar from the present study. (SU=Sampling Unit)

	SU1	SU2	SU3	SU4	SU5	SU6	SU7
TSI(SDD)	55.18	59.77	63.45	61.29	63.92	61.29	N.A.
TSI(Chl a)	76.77	86.98	86.98	80.93	89.69	89.77	N.A.
TSI(TP)	67.37	81.96	N.A.	N.A.	N.A.	80.59	81.96

Table 10.4. Table showing various levels of TSI with corresponding trophic status (KDHEKS, 2000).

Sl. No.	**Trophic status**	**TSI level**
1	Oligotrophic	TSI < 40
2	Mesotrophic	TSI: 40 - 49.99
3	Slightly Eutrophic	TSI: 50 - 54.99
4	Fully Eutrophic	TSI: 55 - 59.99
5	Very Eutrophic	TSI: 60 - 63.99
6	Hypereutrophic	TSI>64

Table 10.5. Showing trophic status of sampling sites at Rabindra Sarobar based upon the corresponding TSI based upon (KDHEKS, 2000).

Parameter	SU1	SU2	SU3	SU4	SU5	SU6	SU7
SDD	Fully Eutrophic	Fully Eutrophic	Very Eutrophic	Very Eutrophic	Very Eutrophic	Very Eutrophic	N.A.
Chl a	Hypereutrophic	Hypereutrophic	Hypereutrophic	Hypereutrophic	Hypereutrophic	Hypereutrophic	N.A.
TP	Hypereutrophic	Hypereutrophic	N.A.	N.A.	N.A.	Hypereutrophic	Hypereutrophic

Oxygen dissolved in water ensures the supply of oxygen to all aquatic living organisms. Higher dissolved oxygen in water bodies indicate less pollution by organic degradable materials. Bhatnagar and Devi (2013) have mentioned that the Dissolved Oxygen of 5.0 mg/l or more is a compulsory requirement for healthy fish growth, whereas, when this level falls below 3.0 mg/l, the survival of fish becomes difficult.

The diurnal behavior of the DO in lake water is a very important parameter which indicates environmental health of the Rabindra Sarovar lake. During the late noon (16:10 hours), the DO value of highest 11.1 mg/l was recorded, when the Photo-Synthesis reached its maximum, along with the respiration. But during the sunset, the DO value was found to drop to the level of 5.2 mg/l. Later, during the night and early morning hours before the sunrise on the following day, the DO value remained below 4.0 mg/l, reaching below 3.0 mg/l for more than 6 hours between morning 02:00 and 08:00 hours. The low DO is also indicative of ill health of the lake.

Samal et. al. (2009, 2014) have studied DO profiles very recently and they have found out that the Rabindra Sarobar lake exhibits anoxic (DO < 1ppm or 1 mg/l) conditions only during the peak summer and generally to a height of 0.5-0.75 m from the bottom sediment-water interface. The oxic conditions (DO: >5 mg/l) usually occur up to a depth of 2-2.5 m from the water surface with hypoxia (DO: 1-5 mg/l) in between. The hypoxic conditions in general exist within the oxycline layer of the water column.

Samal et. al. (2009, 2014) have noted that Rabindra Sarovar undergoes thermal stratification (from March to mid-June: summer period) which is the result of energy exchanges between water and the surrounding environment, particularly the atmosphere. During this phenomenon, a thermal/density barrier to oxygen transfer between the epilimnion and hypolimnion of a lake is created, thus inhibiting reoxygenation of hypolimnetic waters. Low value of dissolved oxygen near the sediment-water interface develops the hypoxic condition (DO < 5 mg/l) and it gradually extends upward throughout the summer, until early winter, which leads to cutting-off of bottom layer atmospheric oxygen. Further, in the chain of events, the rate of oxygen consumption is rapid in the thermocline zone due to high temperature gradient leading to loss of more DO which might be necessary for chemical oxidation in the band of hypolimnion, resulting in increase in toxicity of the water. The DO value was found to drop below 1.0 mg/l at Rabindra Sarobar from the depth of 3.5 m to the bottom (Samal et al., 2009), which may account for a sudden fish die off. The decreasing DO level (<1.0 mg/l) with hypolimnion depth is indicative of hypolimnetic DO depletion which also suggests a case of eutrophication as per NHDES (2017).

Considering all trophic state indices [TSI(SDD, TSI(Chlorophyll-a and TSI(TP) the trophic status of Rabindra Sarovar lake is highly eutrophic-hyper eutrophic.

10.2. References

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11.0. PUBLIC OPINION

(1) Kolkata Improvement Trust

Several meetings were held with the Secretary, KIT to discuss the responsibilites performed by KIT in the management of R. S. During the meetings the queries raised by the Rabindra Sarobar Monitoring Committee constituted by the Hon'ble Calcutta High Court were also discussed. Later a questionnaire was given to the Secretary, the reply for which is enclosed.

As per the version of the Secretary, KIT is serious in their duties but sometimes due to some unwanted reasons lapses are noticed in maintenance of Rabindra Sarobar.

(2) Rabindra Sarobar Monitoring Committee

The Expert Committee discussed with the members of the Monitoring Committee twice on the matter related to mismanagement of Rabindra Sarobar.. The Expert Committee handed

over a detailed questionnaire to the Monitoring Committee and their reply was received and enclosed.

(3) Authority of the Clubs in the Rabindra Sarovar Premises

The Expert Committee convened a meeting for discussion of the complaints against the clubs in R. S. raised by the Monitoring Committee. Out of 15 clubs 8 attened the meeting and a detailed discussion was held with them. Later a questionnaire based on the discussion was sent to all the clubs and reply from seven clubs have been received and enclosed.

Most of the club authorities denied the complaints against the clubs except a few who sportingly accepted some of the allegations and agreed to not to do the same in future.

(4) Morning & Evening Walkers in the Rabindra Sarovar Premises

Some of the members of the Expert Committee met a few morning and evening walkers in Rabindra Sarobar and asked them about the facilities, problems and environmental changes, if any, in the Sarovar.

Most of them are not aware of the environmental problems there and only mentioned about the amenities urgently required. According to them sufficient arrangement of drinking water, toilets and cleanliness are urgently needed. Some of them also mentioned about entry of antisocials who sometimes cause problem to the visitors.

(5) Rabindra Sarovar Security Staff

While visiting the Rabindra Sarobar premises the Expert Committee members talked to the security staff regarding problems in the Rabindra Sarobar. They mentioned about problems created by some young neighbour.

(6) The neighbouring residents

The Expert Committee members once visited neighbouring houses and discussed the present state of Rabindra Sarobar. None of the residents have any complaints against the maintainance of of Rabindra Sarobar and are satisfied with the management of Rabindra Sarobar by KIT.

(7) Visit in the Clubs and interaction with the staff members there

The Expert Committee members visited four clubs in one evening and interacted with the officials and other staffs there. They were very cordial with the expert members and replied to the queries relating to the club activities, etc. A report on the said visit is prepared and enclosed.

12.0. RECOMMENDATIONS

Flora:

- Green areas and landscaping may be developed with the trees. Indigenous plants should be given importance while introducing plants in the lake premises. Rabindra Sarovar area can be a live repository of indigenous and rare plant species of West Bengal or of Eastern India along with ornamental and avenue trees. For selection of plant species to be introduced in the Sarovar area the authority should consult with prominent Botanist/Botanical Institutes, Taxonomist/Plant conservationist and others.
- Wild indigenous fruit trees having larger canopy to give shelter and food for small animals and birds as well should be introduced.
- There must be regular awareness programmes in the Rabindra Sarovar area to educate people and make the aware about nature, plants, animals and biodiversity. Authority can take up "Lake merchandise/ conservation" measures to make awareness among the masses.
- There need to be set up one interpretation center or at least one small Herbarium with the specimens of plants from Rabindra Sarovar to educate about Biodiversity the students visiting the Lake.
- The area with *Saraca asoca* (Ashok Tree) individuals may be demarcated as **"Ashok Kunja"** and more Ashok saplings may be planted there, and such areas should not be altered for any other purpose.
- As *Pongamia pinnata* (Karanja tree) has good population with old trees and the representative of back mangrove marshy places/ riverine system indicating the ecological history of Kolkata's original habitat, a *Pongamia* zone as **"Karanja Kunja"** may be created in some open places.
- Like the *Pongamia pinnata*, *Barringtonia acutangula* (Hijol tree) is also the indicator of riverine marshy woodland vegetation/ back mangrove swamp having a good lineage of Kolkata's ecological history. So, *Barringtonia acutangula* may be regenerated much more at the bank site or other open places of the premises.
- *Heritiera fomes* (Sundari tree) is growing well in this soil (as evidenced), some more Sundari plants may be planted with some other mangrove associates.
- Trees should be labeled with scientific name and other necessary information in consultation with the experienced botanists/ botanical institutes as part of awareness programme.
- It was observed that, there are many Rain Trees (*Albizia saman* (Jacq.) Merr.) which have died due to some infection without felling. Following due procedure these trees should be removed and new seedlings to be planted in those places. The deasd trees may in near future be the abode of various pest species.
- Drip irrigation/ low-volume, angle sprinkler system shall be used.

Fauna:

- The land and water bodies forming open space of Rabindra Sarovar play a very important role in the metropolitan city of Kolkata. The environmental imbalance that

has occurred in the Rabindra Sarobar deserves special consideration and steps have to be taken by the Rabindra Sarobar authority to control the situation and to restore the original ambience as well as aquatic and terrestrial biodiversity of the Sarovar area.

- It is recommended that the three islands in the middle of the lake which are the nesting habitats of many water-birds be kept as such and no kind of developmental activities be allowed on them.
- Tree species like *Pongamia pinnata*, *Barringtonia acutangula*, *Albizia saman*, *Pithecellobium dulce*, *Sterculia foetida, Ficus religiosa*, *Azadirachta indica*, *Syzygium cumini* etc. were observed as vital trees where birds were making nest for breeding. Hence these plants should be given priority in introduction and conservation.
- By conserving plant diversity around Rabindra Sarovar, the variety of insect life will also be conserved. The bottom of the lake should be cleaned of garbage and pollutants as the lake water is vital for the survival of aquatic animals like turtles, amphibians and fishes.
- A Butterfly park with their host and nectar plants may be established.

Air Quality:

- The results obtained in the present study suggest that the Sarovar's air quality is impacted by events like football matches in the Stadium as indicated by rise in level of PM10 by 11-32 mg/m^3 compared to non-event days, while other parameters like PM 2.5, SO_2 and NO_2 of Rabindra Sarovar were well below the Kolkata city average.
- The rise of PM 10 in Stadium area compared to Kolkata city average is 20 mg/m^3 during event days, strongly suggests the regular air quality control measures should be undertaken, and should specially be focused on control of PM 10, especially in Stadium premises.

Water Quality of the Sarovar (Lakes):

- Sewage should be strictly discharged into underground drainage line of the municipality. Any sewage or garbage generated in clubs and/or in other areas should never be discharged /deposited in the lakes.
- Water from water bodies should be recycled completely atleast in every six months after treating it using automatic/ semi-automatic self –cleaning high velocity filters and chlorination/ chemical free ozonation system.
- As the **lake water is highly eutrophic**, the source of nutrient enrichment both allocthonous and autocthonous must be regulated through regular monitoring. The organic matter deposited at bottom sediment along with other solid waste like plastics, broken glass etc. should be removed immediately to check the anoxic condition of the bottom sediment *vis a vis* the maintenance of oxygen oscillation which would be helpful for sustaining the biodiversity of the lake.
- The lake bottom is should be cleaned immediately. All the broken glass, plastics and concrete debris should be removed and the soil bottom to be exposed. Dredging should not be done.

- Nutrient ingress in the lake water from the Club eateries should be restricted, and to restrict this any open air eating, in whatsoever manner, organized by the clubs or taken by the lake visitors should be restricted. In such cases stringent actions should be taken as per Rules.
- pH of lake water was very high which indicated unhealthy status of the lakes. KIT authority should take measures to ascertain the causal factors for such unusually high pH value of the Sarovar water, and go for its remediation on war footing.
- Phasing out of chlorination for disinfection of the swimming pool water may be practiced and introduction of ozonization should be introduced in that place.

Lake sediments and sub-surface soil

- Anthropogenic activities in the lake area should be restricted.
- Choking and ageing of lake must be restricted by checking the eutrophication.
- Desiltation practice should be maintained periodically to lessen the eutrophication/algal bloom.
- Slum dwellers from the neighboring area should be restricted for using the lake water.
- Bathing and washing clothes and utensils in the bank should be completely stopped.
- Toxic metal in the lake water which enters through the bright paints and colors varnish of the idols which are immersed in the lake during the festive season must be completely stopped.
- To maintain the pristine quality of the lake water and for the long term sustainability of the lake, anthropogenic activities have to be controlled to a large extent and retrieval strategies to remove immersed idols need to be undertaken to prevent the loading of toxic metal ions into the lake water.

Noise:

- Acoustic enclosures should be installed at all noise generating equipments such as DG sets, air conditioners, etc. to mitigate the impact of noise.
- The overall noise level in and around the project area (stadium Nazrul Manch) should be kept well within the prescribed standard by providing noise control measures including acoustic insulation, hoods, silencers, enclosures, vibration dampers, etc. on all sources of noise generation, the ambient noise levels should confirm to the standards prescribed under the Environment (Protection) Act and Rules.
- Based on observed continuous sound levels before, during and after football matches and also on event (football match held) and non-event days (no football match) at Rabindra Sarovar Stadium and reported effects of sound on birds in available literature, it is pertinent to consider that football matches are held occasionally in this stadium and for about 2 hours only per day when organized. The matches could indeed cause disturbances or affect some behavioral shifts and physiological changes in birds in the immediate vicinity of the ground and therefore the effects may be transitory. Since there is no previous data available on bird population in the immediate nearby areas when no football match was held or if at all there are other

factors that could be responsible for birds' death or decline in population (if at all found so) in this area, **it is premature to conclude at this point of time that football matches must be banned to restore bird's habitat, nesting and behaviour in the Rabindra Sarovar area.** However, considering the significant augmentation of noise level during foot ball matches and associated activities, use of loud-speakers (other than required for PA system), having only amusement value to selected population during the match period, before and after may be discontinued or be used at regulated noise level as per the Rules.

Illumination:

- The height of the black light guard installed during the last ISL match should be increased at least to six feet.
- If the matches end before 6.30 pm, the light pollution will be minimum.
- Similar type of light source with low mounting heights may be used for pathway/street lighting luminaires.
- Different types of bollards and street lights (as per in Appendix 3 of chapter on Illumination) may be used to illuminate the pathways to reduce light pollution.

Mega events like Cricket and Football matches:

- No mass eatery and/or canteen should be allowed in the stadium premise during Football match, nor should the spectators be allowed to carry food material inside the lake premise. Organizers should arrange for safe drinking water for the spectators as well other professionals (technicians, commentators, journalists etc.).
- As per the observations mentioned by the scientists in their reports (see above), it would be better if such megaevents are banned. But considering the urgent need, the events can be organised preferably in day time. If at all night matches are to be organised, the match should be strictly completed by 6.30 / 7.00 p.m. to avoid disturbances to the biodiversity due to high intensity noise and light. Bursting of crackers during and after making should be completely banned. Other conditions noted above under 'recommendations' should be strictly followed. Further, the recommendations noted in the Order No. PRO/NGT/EZB/KOL/2016/422, dated 06.10.2016 issued by the Hon'ble NGT (EZB) should be followed.

Chhat Puja festival & Picnic:

- During Chhat Puja festival, as reported, 40000 – 50000 people enter the Sarovar premises. This causes massive loss of biodiversity. Further the rituals pollute lake water with flowers, and also the soil is polluted and wasted due to ghee, oil, etc. Cracker bursting and emission of high intensity noise also greatly disturb biodiversity.
- From the observations mentioned above, it is clear that the activities during Chhat Puja pollute the Sarovar and land areas. It is, therefore, suggested that KIT along with appropriate public institutes should first make the people who practice Chhat puja in the R.S. premises aware of the problems resulting from Chhat Puja there. This awareness generation programme should be started a month before Chhat Puja and

convince them not to come to R.S. and go to River Ganges or any other suitable water body. Picnic inside the R.S. premises is to be banned completely.

- The complaints made in the appeal are addressed in the respective chapters and recommendations.

Rabindra Sarovar Lake:

- The results relating to the trophis status of the lake as above clearly show that the lake is in very bad state in respect of pollution. Immediate actions should be taken by KIT to save the lake. For details please see the 'recommendation' part above.

Clubs:

- The Clubs are never be turned into social clubs. It is reported that some of them are regularly holding social functions which cause disturbances to the biodiversity in the R. S. premises due to high intensity noise and bright light. KIT should make a Form which is to be filled in and submitted by the clubs for permission for prior to holding any such functions in the club.

- A fresh agreement between KIT and club should be made mentioning the purpose of establishing the club and commitment towards functioning of the club as per the basic purpose. Besides, each club should get approval from KIT to undertake any other activity which is not befitting with the basic purpose of the club.

- Bar & open eatery in the club houses is against the very purpose of establishing the clubs there in R.S. KIT is therefore advised to look upto the matter seriously and urgently.

- Clubs authority should take care of parking cars by their members / guests outside the R.S. premises.

Others:

- Common utilities like drinking water facility, toilets etc. should be adequately provided with adequate signage thereof.
- Ozone Depleting Substances (Regulation and Control) Rules should be followed. The existing air conditioning system in the Sarovar should be modified, if required.
- No further expansion/ construction/ modifications in the Sarovar likely to cause environmental impacts shall be carried out without obtaining prior approval from the concerned.
- It should be mandatory for the KIT to submit annual compliance report in respect of the stipulated prior environmental clearance terms and conditions in hard and soft copies to the regulatory authority concerned i.e. West Bengal Pollution Control Board.
- The generators, transformers, motors used in the Sarovar area should have minimum efficiency of 85%.

- Necessary self-explained display boards depicting information on the Sarovar, biodiversity therein, dos and don'ts at all appropriate places should be provided to create awareness among the visitors.
- Fire safety should be implemented with appropriate monitoring system.
- The solid wastes should be properly and regularly collected and segregated at source. The garbage should be disposed in nearby municipal bins. The recyclable material shall be sold to vendors.
- The rain water harvesting and non-conventional energy generation practices should be undertaken by the clubs.
- No hazardous wastes should be allowed to generate.
- The number of tea vendors should be restricted to five and identity card should be issued to them. They should use large-sized thermo flask containing ready-made tea to stop use of Kerosene stove.
- All types of plastic (throwaway water bottle, food packets & others) should be banned totally in the Rabindra Sarovar premises by the authority and every visitor should be checked at the entry points. Littering of lake premises and dumping of degradable and non-degradable materials into water should be banned. Authority can impose fine to those visitors who don't comply with the rules. Time to time peripheral cleaning of the lake can make it plastic and pollution free.
- Repeated exposure to vehicular emission due to vehicular movement for parking and other reasons inside the park is hampering the general wellness of the plants. Movement of vehicles and car parking inside the Rabindra Sarovar premises must be banned, except the extra special cases.
- Exposure to short day plants for longer period of light due to different activities like matches, fun programmes may hamper the physiology of the short day plants. **It is therefore required to use light for short period only.**
- **Dumping of plastics and other material in the peripheral zone of the Lake destroy the aquatic vegetation and animal lives of the Lake. Special attention is to be paid on this aspect.**
- Excessive addition of lime into the lake for cleaning of the lake water may lead serious danger to the aquatic community of the lake. **Lime should not be used in excess.**
- The pathways in side the Sarovar premises may be named after plants & animals like Ashok Path , Sundari Avenue, Hijol Path, Karanja Path, Chhatim Path, Barun Pakha (name of a butterfly recorded from R.S.), Basanta Bouri (a bird), Muniya (a bird). The lakes may also be named after eminent persons who were regular visitor.
- Near the Ashok trees a concrete tank is found in an abandoned state. It may be transformed into a water-filled tank with lotus. The tank is to be covered with net to avoid leaf-fall in the tank.
- The boundary wall near Gobindapur Busti should be completed to check entry of unwanted persons.
- Once famous Lili pool should be properly beautified.
- Lady security guards should be engaged.

- Entry by paying nominal fee.
- Entry pass should be issued to the morning and evening walkers.
- As the health of the lake is very bad, fish death may occur. Immediate measures to be taken by KIT.
- Meeting between KIT and the Monitoring Committee should be held at regular interval.

REPORT ON FISH KILLS IN RABINDRA SAROVAR DURING JUNE 2016

The Rabindra Sarovar (22'34'N, 88'23'E), a small and shallow, but highly eutrophic lake is located in the southern part of the metropolis of Kolkata spread over an area of 780,700 m^2 having water area of 295,400 m^2 (or about 38 % of the land area). It is an artificial lake, a major recreational centre of the city. The lake (formerly Dhakuria Lake) was renamed by Kolkata Improvement Trust (KIT) in May 1958 as Rabindra Sarovar in honour of Rabindranath Tagore. The maximum depth and the mean depth of the lake are 5.7 m and 3.5 m, respectively.

It was on 16.6.2016 (Thursday morning) news that hundreds of fish were found dead under mysterious circumstances in the Rabindra Sarobar in Kolkata. As morning walkers took a stroll around the lake, they spotted hundreds of dead fish floating on the surface of the water and informed the authorities (POOJA MEHTA | Thu, 16 Jun 201605:00 pm. Kolkata, dna webdesk). Fish deaths were first reported on Monday (i.e., 13.6.16). Since then, more than 100 fish of varying size and species have been found dead in the waters of Rabindra Sarobar. The dead fish include rohu, katla and khoyra and have been found across the 70-acre water body. There are small fish just a couple of inches long and also large ones that could weigh up to 15 kg. (The Telegraph, Dead fish flotsam swamps Sarobar, Friday, June 17, 2016). Similar fish kills were also noticed in the water bodies of the Victoria Memorial, Kolkata during the same time.

Dead fish floating in the waters of Rabindra SarobarDead Catla catla with typical signs of haemorrhage and scale protrusion Source: The Telegraph, Dead fish flotsam swamps sarobar, Friday, June 17, 2016.

From the published reports, we came to understand that Scientists from the West Bengal Pollution Control Board (WBPCB), Department of Fisheries (DF) and Jadavpur University, Kolkata visited Rabindra Sarobar on Thursday (16.6.16) and Friday (17.6.16) to collect water samples on request from the KIT. The WBUAFS, Kolkata received the request from KIT on 20.6.16/24.6.16 and a team of fish health specialists and research scholars visited the site on 25.6.16 for onsite analysis of fish and collection of fish and surface water samples for laboratory analysis. The detailed results of the surface water quality parameters (samples collected on 25.6.16) are furnished below:

Parameter	Physico-chemical parameters Padma pukur site	Hanging Bridge site
Sampling Time	10.20 a.m	11.00 a.m
Optimum level for fish Water surface	Thin oil-like layer	scum Colour Greenish brown to

		Light green
Odour	Odd offensive smell	No bad smell
Transparency (cm.)	86.0	90.0
pH	8.82	8.29
DO (ppm) (Surface)	5.30	6.00
Total alkalinity (ppm)	235.2	236.0
TDS (ppm)	370.0	370.0
BOD (ppm)	1.44	2.0
COD (ppm)	60.0	33.0
Carbonate (ppm)	24.0	8.0
Total Alkalinity (ppm)	114.0	114.0
Total Hardness (ppm)	87.2	88.0
Total Ammonia (ppm)	BDL	BDL
Nitrate (ppm)	BDL	BDL
Available Phosphorous (ppm)	0.082	0.085
On-site observations made at the lake vicinity	Dead silver carp and floating lab-lab Dead carp, Eichhornia, water hyacinth Thin oil-like layer or scum on the water surface	

On-site observations made at the lake vicinity are furnished below:
Dead silver carp and floating lab-lab Dead silver carp and floating lab-lab
Dead carp Dead carp

Observations and Impression:

- Water quality parameters: Most of the water quality parameters were well within the optimal levels recommended for fish.
- The pH was always above 8.0 and the range of pH observed was 8.20 – 9.15.
- Low dissolved oxygen (below 4.00 ppm) was recorded in certain sites by the Department of Fisheries on 17.6.16 (Report appended).
- The water was almost clear and the Sacchi disc reading was in the range of 86-90 cm, indicating poor productivity.
- The levels of ammonia and nitrate were below detectable level (in all case studies by WBPCB, DF and WBUAFS), thus ruling out the toxic effects of ammonia, nitrite and nitrate for fish kills (report appended).
- Analysis of pesticides by WBPCB, Kolkata revealed no traces of pesticide residues in water, thus ruling out their involvement in fish kills (report appended).
- No conclusion could be drawn from the above water quality parameters, as they were determined from the surface water samples.
- Water quality parameters especially temperature and dissolved oxygen from the bottom water samples would have thrown some light on the observed fish kills.
- It is because of the fact that: Fish kill in tropical regions are frequently attributed to low dissolved oxygen concentrations; however the circumstances causing these events vary considerably.
- The fish kills in ponds and small lakes usually occur during summer and winter stratification and are specially related to critically low oxygen levels; however, pollution, fish diseases and a phenomenon known as turnover can also kill fish.
- It has been observed by Samal et al. (2009) that the lake Rabindra Sarobar exhibits anoxic (DO < 1 ppm) conditions only during the peak summer and generally to a height of 0.5-0.75 m from the sediment-water interface. The oxic conditions (DO: >5

ppm) usually occur up to a depth of 2-2.5 m from the water surface with hypoxia (DO: 1-5 ppm) in between. The hypoxic conditions in general exist within the oxycline layer of the water column.

- Over the years, the lake Rabindra Sarobar shows hypoxic conditions of dissolved oxygen except during the summer season. The Rabindra Sarobar remains completely mixed (about 8 months) frommid-June to February until .the onset of thermal stratification (from March to mid-June: summer period).
- The available scientific data revealed the development of thermal stratification and dissolved oxygen stratification in Rabindra Sarovar (Samal et al., 2009, 2014). The thermal stratification is the result of energy exchanges between water and the surrounding environment, particularly the atmosphere. Low value of dissolved oxygen near the sediment-water interface develops the hypoxic condition (DO < 5 mg/l) and it gradually extended upward throughout the summer. As a result of thermal stratification the bottom layer is cut-off from atmospheric oxygen and oxygenproducing plants.
- The rate of oxygen consumption is rapid in the thermocline zone due to high temperature gradient and contribute to the development of minimum DO and is continued throughout the summer and fall and persisted until thickening of the mixed layer destroyed it in early winter. Low value of DO cannot enhance other chemical oxidation processes in the band of hypolimnion, resulting in increasing the toxicity of the water and the water quality becomes unfit for the sustenance of the aquatic life in the water body.
- The tolerable limit of DO has been prescribed as 40% saturation level or 3.0 mg/l for fish. In a study by Samal et al. (2099), the DO value was found to drop below 1.0 mg/l at Rabindra Sarobar from the depth of 3.5 m to the bottom, which may account for a sudden fish die off. Lake stratification creates a thermal/density barrier to oxygen transfer between the epilimnion and hypolimnion of a lake, thus inhibiting reoxygenation of hypolimnetic waters. The decreasing DO level with depth is indicative of hypolimnetic DO depletion.
- The depletion of dissolved oxygen in the hypolimnion and the variability in water column temperature may be highly dependent and the variability over time series is an indicator of climate change both in tropical and temperate weather conditions
- Formation of a hypolimnion oxygen minimum is of great importance for fishery management.

Source:
Samal et al., 2009: Aquatic Ecosystem Health & Management 12(2): 215-225

Note: Thermocline: an abrupt temperature gradient in a body of water such as a lake, marked by a layer above and below which the water is at different temperatures. Hypolimnion: The lower layer of water in a stratified lake, typically cooler than the water above and relatively stagnant. Epilimnion: The upper layer of water in a stratified lake. Lab-lab: A mass of microscopic algae chiefly of the Myxophyceae found on the mud in fishponds and used as food

The necropsy analysis made on morbid fish such as (i) mrigal carp, Cirrhinus mrigala, (ii) Murrel, Channa sp. (iii) Pangas catfish, Pangasius pangasius and (iv) Catla carp, Catla catla, (v) freshly dead big head carp, Aristichthys nobilis (vi) dead silver carp Hypophthalmichthys molitrix are furnished below:

Argulus infested Cirrhinus mrigala Argulus infested Cirrhinus mrigala with pale gills Gas filled intestine of Argulus infested Cirrhinus mrigalaKidney of Argulus infested Cirrhinus

mrigala Putrid silver carp Hypophthalmichthys molitrix Pangasius pangasius with mouth haemorrhage Pangasius pangasius with pale and comb-like gills Pangasius pangasius with damaged gill filaments Channa sp. with saddle back Channa sp. with saddle back Big head carp, Aristichthys nobilis with haemooragic caudal region Big head carp, Aristichthys nobilis with comb-like gill and mucus secretion Aristichthys nobilis with while patches on gills Emaciated big head carp, Aristichthys nobilis Necropsy of Aristichthys nobilis Necropsy of Aristichthys nobilis Necropsy of Aristichthys nobilis Discoloured kidney Healthy Catla catla Water turbidity measurement with Sacchi disc Disease diagnosis Sl no Fish species examined Clinical signs Diagnosis and Remarks 1 Mrigal carp, Cirrhinus mrigala Ectoparasite (Argulus) infestation, pale gills and kidney, and gas filled intestine Argulosis, respiratory problem/disorder 2 Murrel, Channa sp. Saddle back Columnaris (suspected) 3 Pangas catfish, Pangasius pangasius Mouth haemorrhage, pale and comb-like gills and damaged gill filament Cutaneous haemorrhage, respiratory problem/ disorder 4 Catla carp, Catla catla Healthy Healthy 5 Big head carp, Aristichthys nobilis Haemorrhagic caudal peduncle, emaciation, pale and white patches on gills Columnaris, haemorrhagic septicemia 6 Silver carp, Hypophthalmichthys molitrix Putrid Putrid Detection and confirmation of columnaris Fish species: Aristichthys nobilis (Big head carp) Diagnosis method: Culture independent metagenomic approach using Flavobacterium columnare specific PCR Primers used: Flavobacterium columnare specific primers as below Primers Sequence (5'-3') Amplification size Reference Col-72F GAAGGAGCTTGTTCCTTT 800-1000 bp Triyanto et al., 1999 Col-1260R GCCTACTTGCGTAGTG

Diagnosis: Columnaris disease caused by Flavobacterium columnare

Conclusion: The observed fish kills in Rabindra Sarovar during the mid June 2016 could be attributed to the thermal stratification, dissolved oxygen stratification and associated hypolimnetic dissolved oxygen depletion. The respiratory stress on fish due to low dissolved oxygen has led to secondary infection by Flavobacterium columnare in big head carp and opportunistic Aeromonas spp. as has been observed in catla with typical signs of haemorrhage and scale protrusion. Mortality due to Argulus infestation, a blood sucking crustacean parasite, could not be ruled out as Argulus infestation can cause huge mortalities in fish. It, however, needs to be observed on more number of fish and it cannot be detectable in dead fish.

References:

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ICAR-Central Inland Fisheries Research Institute (Indian Council of Agricultural Research) Barrackpore, Kolkata, India- 700 120

Report of investigation of fish mortality in Rabindra Sarobar

ICAR –CIFRI received a request form Kolkata Improvement Trust to examine the water quality and to find out the reason of sudden fish death in Rabindra Sarobar, Kolkata. Based upon the request from Kolkata Improvement Trust, a team of ICAR-CIFRI immediately visited the Rabindra Sarobar to investigate the sudden fish death in the lake. Secondary data obtained from the Sarobar officials present during the team visit revealed that Rabindra Sarobar has an area of 73 ha. Rowing by the club members is a common feature in the lake. It is also a place for picnic & recreation by tourist and morning and evening walkers. The lake is of national importance and was covered under national lake conservation plan. The team had a detailed discussion with the official members of Rabindra Sarobar available on 25th June during the visit. During the discussion, some interesting facts came to the knowledge of the team: • Fish death is a common feature every year immediately after the first monsoon rain. • Death of khaira (Gudusia chapra) is highest among the fish species present in the lake. • However, fish mortality is higher this year in comparison to other years. • Fishing is strictly prohibited in this lake, however stocking is done every year, mostly for the religious purpose. • Death of fish in terms of quantity was Gudusia chapra (khaira)> Silver carp> Grass carp> Catla > Rohu respectively. • Visitors of the lake were found to feed the fish from a suspension bridge. • Fish density in the lake is unknown.

The team had taken water samples from two locations (Sampling site-I and Sampling site-II) of the lake. There is a mosque in the lake's islands, which is connected to the southern shore by a iron suspension bridge and that was one of the sampling sites (Sampling site-I). Lake side near the Buddha temple on the southern fringe was sampling site –II. The water quality parameters at both the sampling sites:

Parameter	Site-I (Near Mosque)	Site-II (Near Buddha Temple)
Sampling Time	4.45PM	5.30 PM
Temperature (Air) °C	35.5	35.00
Temperature (Water) °C	34.6	33.2
Transparency (cm.)	61	55
Depth (feet.)	30.2	31.5
DO (ppm)	12.8	6.6
pH	8.82	8.5
BOD (ppm)	8.1	5.2
COD (ppm)	24.0	24.4
Free CO_2(ppm)	0.00	0.00
Carbonate (ppm)	24.0	8.0
Total Alkalinity (ppm)	114.0	114.0
Total Hardness (ppm)	88.0	92.0
Specific Conductance (mS/cm.)	318.0	316.0
Total Ammonia (ppm)	0.1684	0.24
Nitrate (ppm)	0.01129	0.0128
Phosphate (ppm)	0.1	0.1
Silicate (ppm)	11.73	11.52
Phytoplankton abundance	2125 nos./ml	2125 nos./ml
Zooplankton abundance	9 nos./ml	9 nos./ml

During the visit the team could not find any dead fish in the lake, since mortality occurred around 10 days before the visit. By the time the team visited, dead fishes were removed from the lake and lake was disinfected with lime and potassium permanganate. The lake administration has applied 80 bags of lime (400 kg approx.) and 25 kg Potassium permanganate in the lake. It was also observed that there was excess growth of filamentous green algae (Spirogyra) on bottom sediment towards the bank of the lake (lentic zone) and the growth was very high at the sampling site-II Near to Buddha mandir. Interestingly, the lake bottom (at least up to about 10-15 feet from banks where this study was limited) was devoid of typical soil/sediment, and instead was full of rocks and bricks. With much difficulty only few grams of sediment could be collected by the Lake personnel which was insufficient for detailed study. The hard lake bottom, especially towards the Buddha Temple, was covered with decomposed filamentous algae. The water quality showed analysis showed high BOD and COD levels, more oxygen consumption for decomposition of organic matter in the lake, as well as, presence of ammonia. Biological Oxygen Demand (BOD) level of the lake is more than 6 PPM, indicating the lake is not good health condition. High BOD may create low dissolved oxygen level for the aquatic animal in early hours and this when combined with rainfall might be the reason for recurrent seasonal fish mortality. It was remarkable that DO at site-II (measured at 5:30 pm) (with much decomposed algae at bottom) was only the half of that in site-I (measured at 4:45 pm), suggesting very rapid oxygen depletion from the system.

Inference:

- The lake water has high BOD and COD levels.
- Water is transparent favouring massive growth of filamentous algae/ submerged macrophyte.
- Lack of bottom soil does not allow complexation/binding of deposited organic matter, allowing its fast decomposition, especially during summer.
- Water temperature was high even during late afternoon hours disfavouring oxygen solubility in water, as well as, enhancing organic matter decomposition.
- Presence of rocky/metallic soil bottom may favour excess heat trap in the lake.

Suggestions:

1. Periodic physical removal of the filamentous green algae from lentic and lotic zones of the lake, at least before and during summer.
2. Removal of semi-decomposed filamentous green algae from the lake bottom
3. Prohibiting feeding the fish by visitors and dumping of waste food matter, discharge of waste water etc. in the lake.
4. The team found numerous plastic materials along the bank. The lake administration may place waste bins at different location of the lake and strictly monitor the use of dustbin for waste disposal by tourists.
5. Density of fish in the lake may be assessed. This was only one-time study, after few days of fish mortality in the lake. Hence season wise detailed limnological and fisheries study is recommended for finding out solution for recurrent fish mortality and long term management of the Sarovar.

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Dr. P. K. Parida, Scientist, ICAR-CIFRI, Barrackpore
Dr. Sanjay Bhowmick, CTO, ICAR-CIFRI, Barrackpore
Mr. L. R. Mahaver, STO, ICAR-CIFRI, Barrackpore
Sk. Rabiul, TA, ICAR-CIFRI, Barrackpore

Report compiled & Submitted by
(Sanjib Kr. Manna, Pr. Scientist)
https://mail-attachment.googleusercontent.com/attachment/…0_7EYxmpLRTA2vQQUKsCqFu

Annexure

WEST BENGAL POLLUTION CONTROL BOARD
10A, Block – LA, Sector – III, Salt Lake, Kolkata – 700098
Ph: (033) 2335 9088/6731/0261, Fax: (033) 2335 8073/2813

No: Dated:

Fish Death incident in Rabindra sarobar ::::: 16 JUNE 2016

Water quality parameters determined on 16th JUNE 2016 yielding the following data.

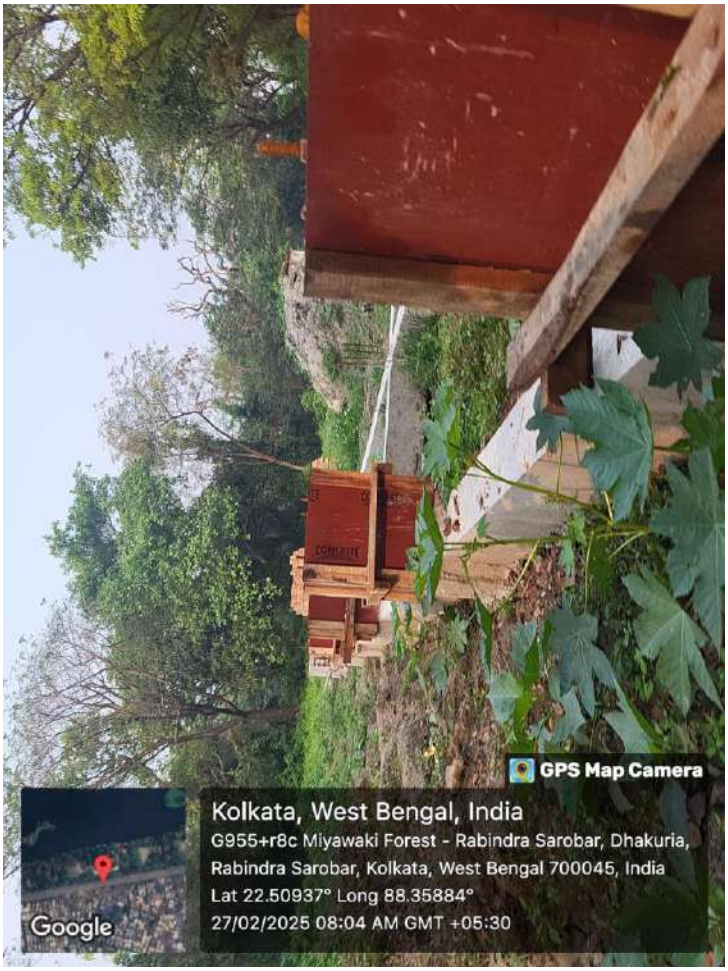
Sampling Location	pH	Dissolved Oxygen (DO) (in mg/l)	Biochemical Oxygen Demand (BOD) (in mg/l.)	Ammoniacal Nitrogen (in mg/l.) (DL = 0.1 mg/L)
Near RC Side	8.97	11.70	4.70	BDL
Near Padma Pukur	9.00	12.40	5.70	BDL
Near Buddha Mandir	9.15	14.50	5.95	BDL
Permissible Standard for use of water for Outdoor Bathing (Organised)	6.5-8.5	5 mg/L or more	3 mg/L or less	1.2 mg/L

Analysis for Pesticide Residues				
Sl.	Pesticides	Near RC Side	Near Padma Pukur	Near Buddha Mandir
1	a-BHC	NT	NT	NT
2	g-BHC	NT	NT	NT
3	MP	NT	NT	NT
4	MALATHION	NT	NT	NT

5	CPS	BDL	BDL	NT
6	Aldrin	BDL	NT	NT
7	ENDO I	NT	NT	NT
8	DIALDRIN	NT	NT	NT
9	Endo II	BDL	NT	NT
10	2,4 DDT	NT	NT	NT
11	p,p-DDT	NT	NT	NT
12	ANILOPHOS	NT	NT	NT
Results are expressed in ppb.				
BDL: Below Detectable Limit (DL - 0.05 ppb)				
NT: Not Traceable				


GPS Map Camera
Kolkata, West Bengal, India
G955+r8c Miyawaki Forest - Rabindra Sarobar, Dhakuria, Rabindra Sarobar, Kolkata, West Bengal 700045, India
Lat 22.509447° Long 88.358598°
27/02/2025 08:02 AM GMT +05:30
Google


GPS Map Camera
Kolkata, West Bengal, India
G955+r8c Miyawaki Forest - Rabindra Sarobar, Dhakuria, Rabindra Sarobar, Kolkata, West Bengal 700045, India
Lat 22.509312° Long 88.358654°
27/02/2025 08:03 AM GMT +05:30
Google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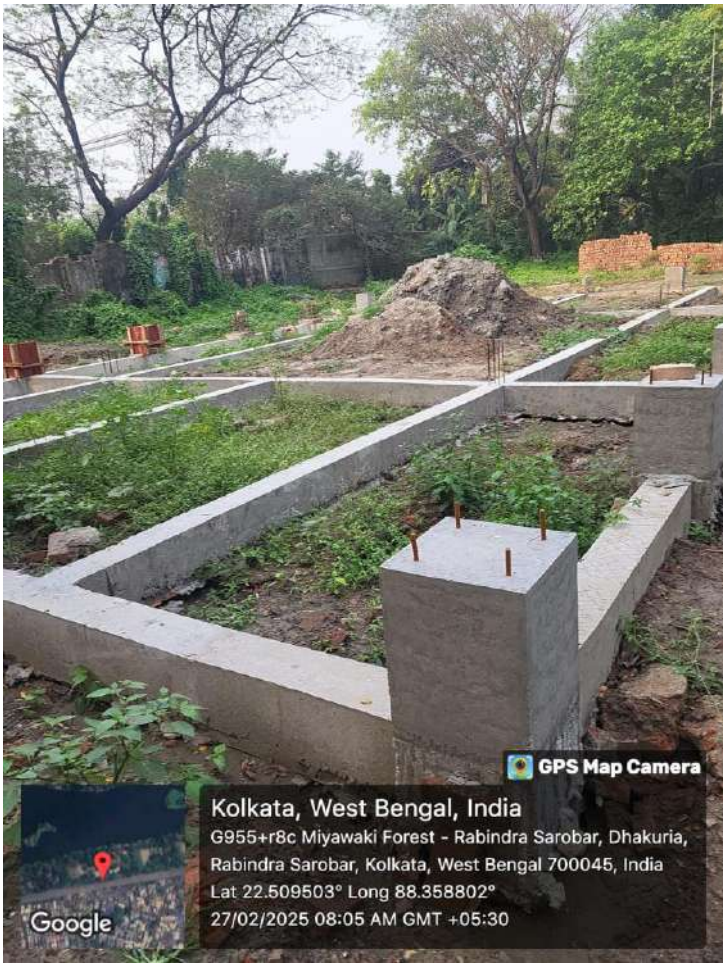
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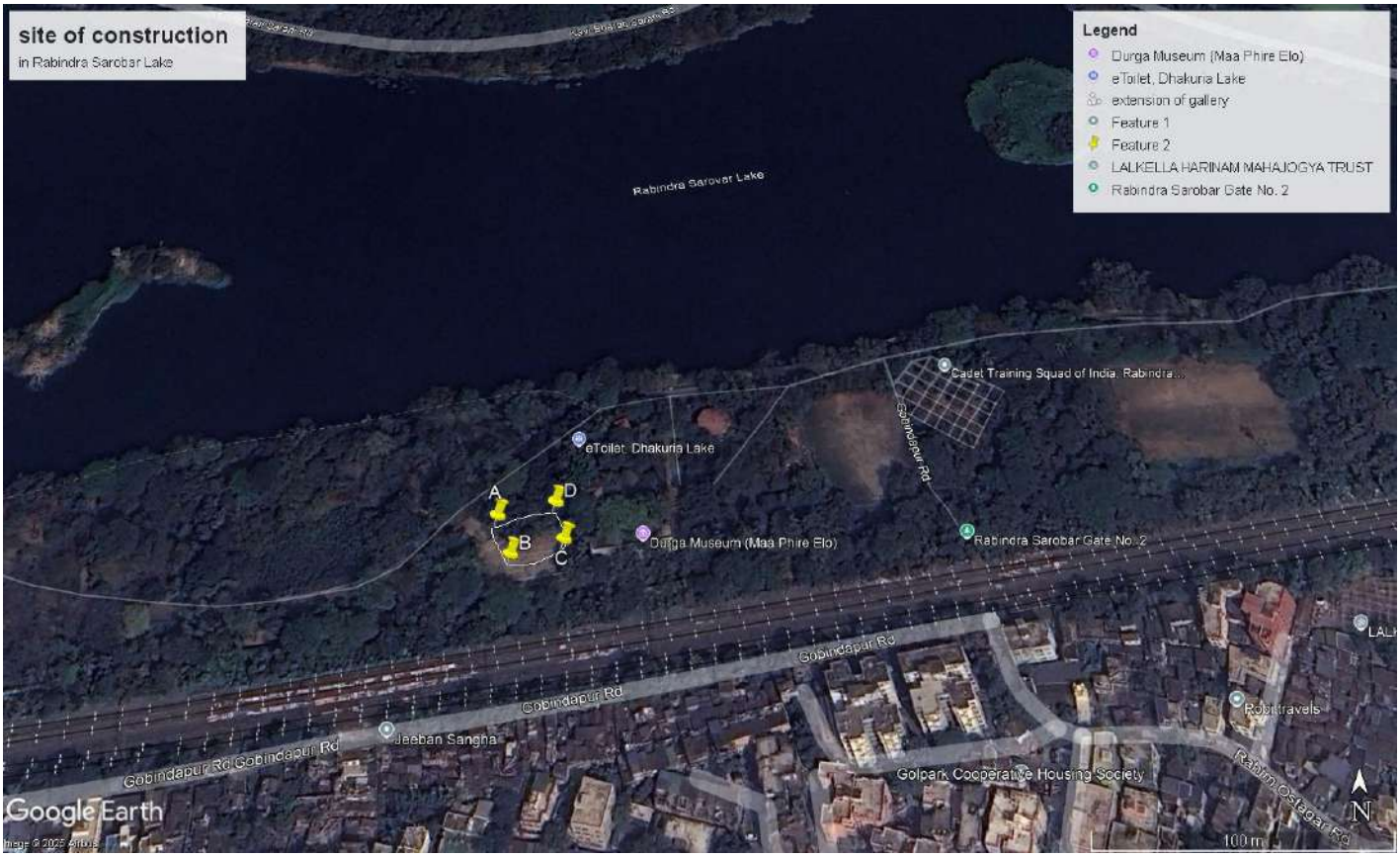
site of construction
in Rabindra Sarobar Lake
Legend
Durga Museum (Maa Phire Elo)
eToilet, Dhakuria Lake
extension of gallery
Feature 1
Feature 2
LALKELLA HARINAM MAHAJOGYA TRUST
Rabindra Sarobar Gate No. 2
Rabindra Sarovar Lake
Cadet Training Squad of India: Rabindra...
eToilet: Dhakuria Lake
Durga Museum (Maa Phire Elo)
Rabindra Sarobar Gate No. 2
A
B
C
D
Gobindapur Rd
Jaeban Sangha
Golpark Cooperative Housing Society
Robi travels
Google Earth
100 m
N