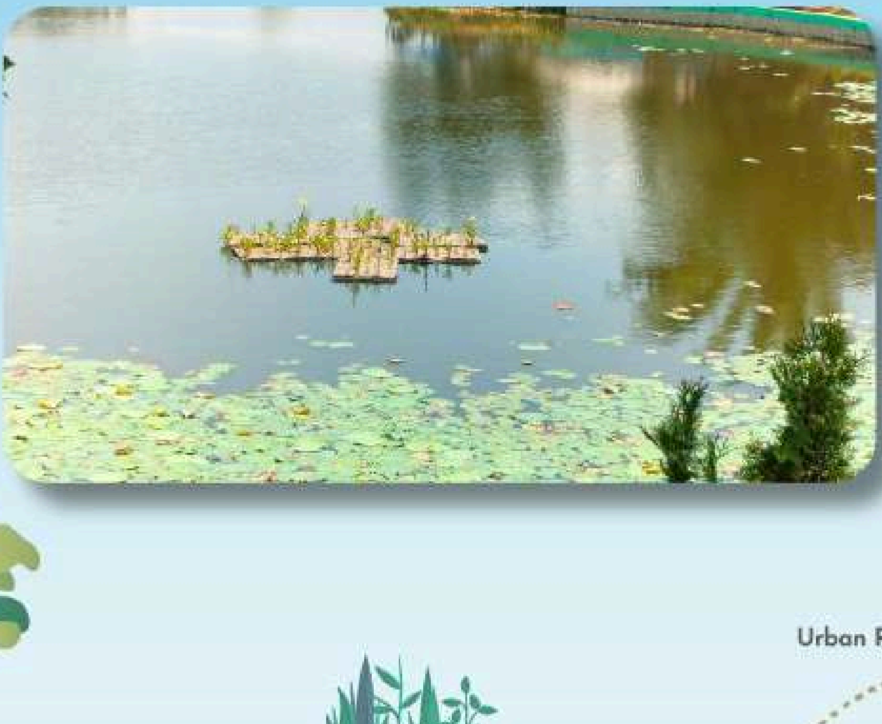
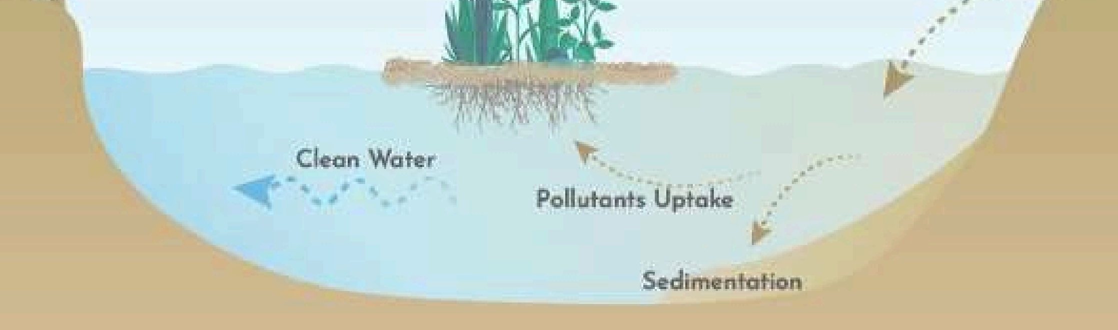
Management of Urban Lakes

Recommendations from Floating Treatment Wetland System (FTWS) Project

(Policy Brief)





Management of Urban Lakes

Recommendations from Floating Treatment Wetland System (FTWS) Project

Prepared by

Ayaswori Byanju
The Small Earth Nepal

Dhiraj Pradhananga
Tribhuvan University

Published by

The Small Earth Nepal (SEN)

Management of Urban Lakes
Recommendations from Floating Treatment Wetland System (FTWS) Project

Publisher: The Small Earth Nepal (SEN)

Prepared by: Ayaswori Byanju and Dhiraj Pradhananga

Layout and Designing: Tribikram Basnet

Edition: First

ISBN (Book): 9789937-1-6293-7

ISBN (Ebook): 9789937-1-6277-7

The Small Earth Nepal (SEN)
PO Box: 20533 (Kathmandu), Nepal
Email: info@smallearth.org.np
www.smallearth.org.np

ललितपुर महानगरपालिका
२४ नं. वडा कार्यालय
ललितपुर, बागमती प्रदेश, नेपाल

Executive Summary

Our urban lakes, once vibrant hubs of our cities, are struggling to survive. Pollution from settlements and human activities suffocates these vital ecosystems, transforming them into polluted shadows of their former selves. However, hope emerges in the form of the Floating Treatment Wetland System (FTWS), an innovative technology that cleans water naturally.

This policy brief empowers local governments, NGOs, and communities to take ownership of their lakes and ponds. It offers practical steps for sustainable management, equipping stakeholders with the knowledge and tools needed to revitalize these precious urban oases.

Abbreviations

APN	Asia-Pacific Network for Global Change Research
BOD	Biological Oxygen Demand
cm	Centimeter
CDHM	Central Department of Hydrology and Meteorology
CREEW	Center of Research for Environment, Energy and Water
CURAJ	Central University of Rajasthan
DO	Dissolved Oxygen
DU	University of Dhaka
ft	Feet
FTWS	Floating Treatment Wetland System
INGO	International Non-Governmental Organization
NGO	Non-Governmental Organization
KVWSMB	Kathmandu Valley Water Supply Management Board
L	Liters
NAST	Nepal Academy of Science and Technology
SEN	The Small Earth Nepal
TU	Tribhuvan University
URI	University of Rhode Island
UY	University of Yamanashi

Table of Contents

List of Figures

Background

Nepal's numerous lakes and ponds, covering about 3.2% of its land area (Bhuju et al., 2013), are crucial resources for both humans and aquatic life. However, unchecked pollution from agricultural runoff, settlements, and industries is steadily degrading their water quality. Direct discharge of pollutants accelerates eutrophication, leading to excessive invasive plant growth and transforming these once vibrant ecosystems into stagnant wastelands. This not only threatens aquatic biodiversity but also renders the water unsuitable for drinking, recreation, or other essential uses.

Seeking an effective and eco-friendly solution, the Floating Treatment Wetland System (FTWS) project was launched as a collaborative effort between national and international government agencies, non-governmental organizations, researchers, students, and communities. Spanning across three countries, including Nagdaha lake in Lalitpur, Nepal; Dhanmondi and Gulsan Lake in Dhaka, Bangladesh and Naya Goan Talai in Ajmer, India, the project aims to:

- Investigate the effectiveness of FTWS in improving surface water quality.
- Identify and test the suitability of locally available plant species for this purpose.
- Develop comprehensive technical guidelines for large-scale FTWS implementation.
- Communicate the project's findings and recommendations to relevant stakeholders and policy-makers.

By harnessing the power of nature through phytoremediation, the FTWS project aims to breathe new life into these critical freshwater resources.

Methods

To assess water quality issues, the project measured key parameters like pH, nitrate, BOD, and DO in the selected lakes. A microcosm study was conducted using containers filled with lake water and planted with *Canna indica* and *Tradescantia pallida*. Water samples were analyzed every 15 days to track pollutant reduction.

In the field study, rafts planted with *Canna indica* and *Salvia Splendens* were installed in Nagdaha. Water samples were collected monthly from seven points within the lake, including the inlet and outlet. Detailed design specifications for the microcosm and rafts are provided in Annexes 1 and 2.

Findings

The microcosm study showed significant reduction in various pollutants: nitrate (99%), iron (56%), BOD (41%), and ammonia (55%). DO levels also increased by 50%.

In the field study, *Canna indica* demonstrated the highest survival rate and contributed to reducing phosphate, nitrate, and ammonia levels compared to the lake inlet.

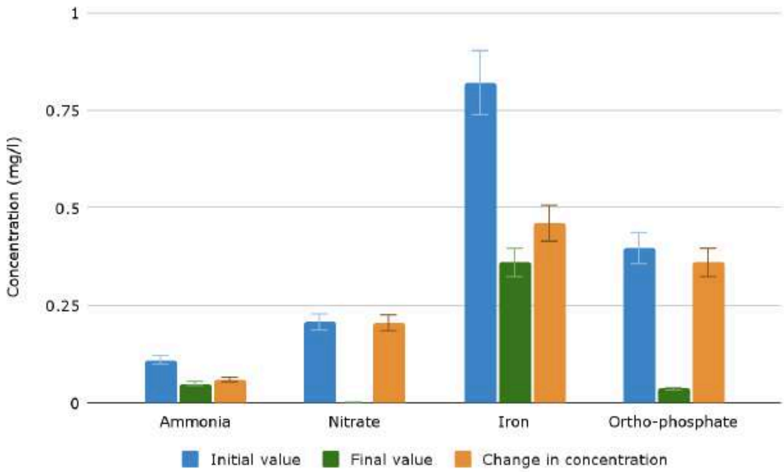


Figure 1 Concentration change of major nutrient pollutants

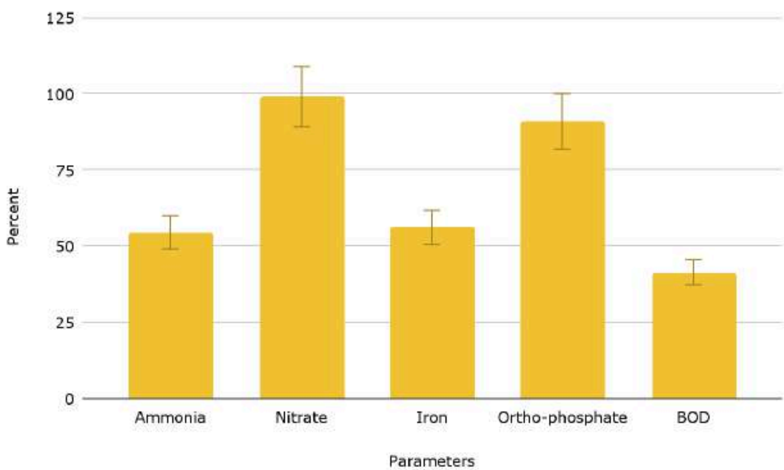


Figure 2 Percent change throughout the study

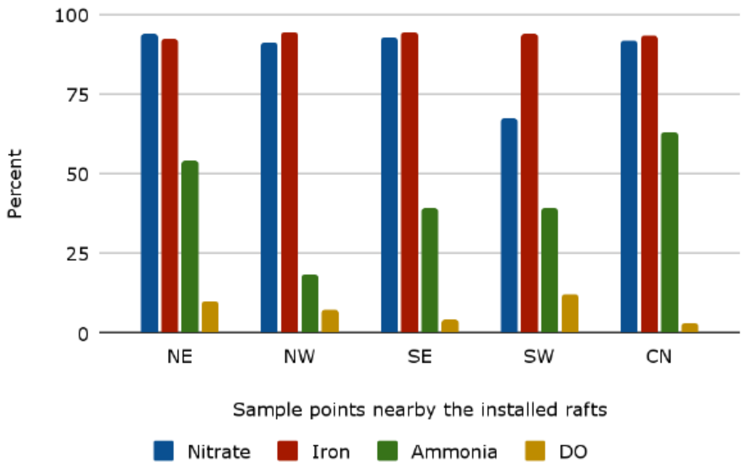


Figure 3 Percentage change of each installed point in terms of the inlet of the lake

The NE, NW, SE, SW, and CN denote the raft installed points of Nagdaha named as North East, North West, South East, South West, and Central respectively.

Community Engagement

Data were gathered through primary and secondary sources, including community surveys and local consultation workshops. Local governments, communities, and organizations actively supported the project. Capacity-building training was provided to stakeholders, researchers, and community members. Awareness-raising programs and knowledge-sharing workshops were held at local, national, and international levels.

Based on the project results and consultation workshops, the following recommendations are derived:

Recommendations for Sustainable Lake Management:

1. Collaborative Governance:

- **Establish a multi-stakeholder forum** involving government agencies, NGOs, community organizations, and private sector representatives to discuss lake management challenges and solutions.
- **Develop a framework for collaboration and coordination** between stakeholders, outlining roles and responsibilities.

2. Community Engagement and Awareness:

- **Conduct regular awareness campaigns** targeting local communities, farmers, and businesses to educate them about the importance of lake conservation and pollution prevention.
- **Empower local communities** through training and capacity-building programs to participate in lake management activities (e.g., clean-up drives, water quality monitoring).

3. Pollution Prevention and Control:

- **Implement strict regulations** prohibiting the direct discharge of pollutants into lakes, including wastewater, agricultural runoff, and solid waste.

- **Promote sustainable agricultural practices** around lakes, such as reduced fertilizer and pesticide use and buffer zone establishment.
- **Continue research and application of nature-based solutions** like FTWS for water quality improvement.

4. Sustainable Resource Management:

- **Develop a comprehensive watershed management plan** that addresses sediment control, water retention, and catchment area protection.
- **Explore innovative technologies** for sediment management, such as bio-product preparation from invasive plants and eco-hydrological approaches.
- **Promote water conservation practices** among all stakeholders, including rainwater harvesting and efficient irrigation techniques.

5. Enforcement and Monitoring:

- **Enforce existing laws and regulations** related to water resource use and lake protection.
- **Establish a monitoring system** to track water quality, identify pollution sources, and measure the effectiveness of management interventions.

Conclusion

The plight of our urban lakes and ponds is a stark reminder of the delicate balance between human activity and environmental health. The FTWS project offers a beacon of hope, demonstrating with impressive results from Nagdaha that this innovative technology can reclaim polluted waters and restore life to these vital ecosystems. But the journey to clean and thriving lakes is not a solo endeavor. It demands immediate action from all stakeholders.

By embracing the recommendations outlined in this brief - from resource mobilization and community engagement to pollution control and sustainable management - we can unlock the full potential of FTWS and transform our urban lakes from desolate wastelands into thriving oases once again. Now is the time for action. Let's work together to ensure a healthy future for our lakes and for ourselves.

References

Bhuju, D., Sharma, S., Jha, P., & Gaire, N. (2013). Scientific Discourse of Lakes in Nepal. Nepal Journal of Science and Technology, 13(2), 147–158.
https://doi.org/10.3126/njst.v13i2.7728

Additional Information

Asia-Pacific Network for Global Change Research (2021). Floating Treatment Wetland System (FTWS) – Sustainable green technology to remediate polluted surface water bodies in the COVID-19 era.
https://www.apn-gcr.org/project/floating-treatment-wetland-system-ftws-sustainable-green-technology-to-remediate-polluted-surface-water-bodies-in-the-covid-19-era/

Pradhanang, S, Boving, T, Meisinger, E. (2019). Floating Wetlands System: A viable alternative for water pollutants remediation. MATEC Web Conf., 280 DOI:
https://doi.org/10.1051/matecconf/ 201928005001 Floating Wetlands System: A Viable Alternative for Water Pollutants Remediation

The Small Earth Nepal (2020). An innovative Floating Treatment Wetland System (FTWS) using the microcosm study to remediate polluted waterbody: A case study of Nagdaha Lake https://www.smallearth.org.np/apn-ftws/

Annex 1: Methodological Details

1. Construction of Shed

A high tunnel-type shed was designed and constructed within the premises of Kathmandu Valley Water Supply Management Board (KVWSMB) at Bhaisepati. The structures of the shed were made up of bamboo and plastic sheeting. Brick soling was done to level the ground inside the shed. The microcosm units were set on three tables made from metal frame fitted with wooden boards. A banner was also placed at the location to display the project information.

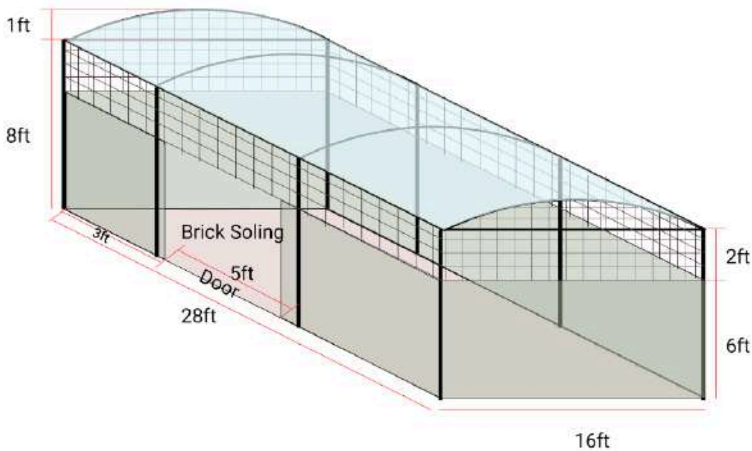


Figure 4 Design of high tunnel-type shed

Figure 5 Shed constructed within the premises of KVWSMB for the microcosm experiment setup

2. Experimental Setup

The experimental system was assembled at the high tunnel-type shed within the premises of KVWSMB. To mimic natural water systems, each treatment unit comprised three identical 40-liter plastic storage buckets with floating rafts and a 100 liters (L) stock drum. Holes were drilled 6 cm below the rims of the buckets to inter-connect the buckets through pipes. Each stock drum to each treatment unit was equipped with a submersible pump to enable water circulation. Three buckets of each treatment unit were arranged at a certain height to allow gravity flow of water from the first to the third bucket. Then the end point of the third bucket was connected with the 100 liters drum through the help of a pipe and the water from the 100 L of drum was again allowed to flow on the 1st bucket through the help of a sump pump. Each floating raft with selected plant species was allowed to float on the buckets. Floating rafts were prepared by polyethylene foam.

Figure 6 Experimental setup prepared at KVWSMB

The FTWS treatment units were set as:

1. **Control (C1):** Treatment units with polluted water only
2. **Treatment-1 (T1):** Treatment units with polluted water, and float raft
3. **Treatment-2 (T2):** Treatment units consist of polluted water, float raft, and plant-1 (*Tradescantia pallida*)
4. **Treatment-3 (T3):** Treatment units consist of polluted water, float raft, and plant-2 (*Canna indica*)
5. **Treatment-4 (T4):** Treatment units consist of polluted water, float raft, and plant 1 and 2

(**Note:** Treatments 2, 3, 4 and, 5 were again duplicated that was indicated as set 2/replicated set)

Sample from each microcosm was triplicated for further water quality tests. *Tradescantia pallida* and *Canna indica* were the plants selected for the microcosm study.

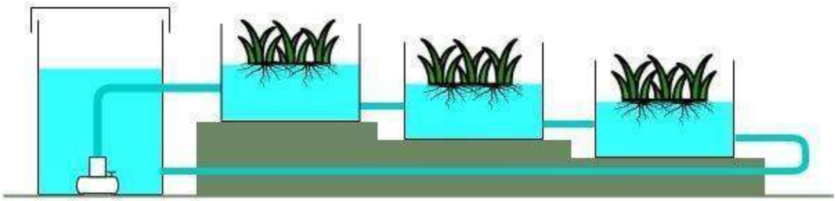


Figure 7 Each treatment unit of microcosm setup

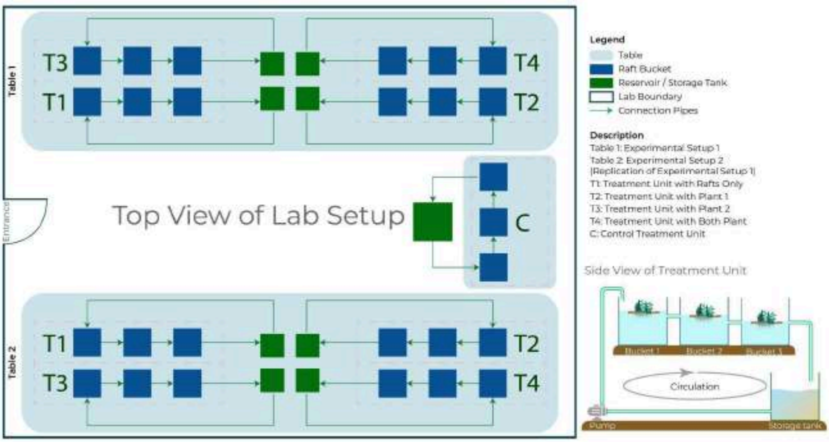


Figure 8 Technical drawing of microcosm setup plan

Figure 9 Preparation of the raft inserted with the plant

Annex 2: Sample Water Test

Samples collected from Nagdaha were transported to the KVWSMB. The water samples were then transferred to 9 drums each having the capacity of 100 L and to 24 buckets each of capacity of 40 L. Though the capacity of each bucket was 40 L, each bucket was only filled with 30 L of sample water, and the microcosm was set.

Altogether, 27 buckets were used for the experimental setup. Triplet samples were drawn from each bucket for test. Altogether (27*3) 81 samples were tested at a time in a 15-day time interval. The water quality test was carried out for 4 times.

The standard method for examination of water and wastewater by the American Public Health Association (APHA) 23rd edition was followed for the water quality test in the laboratory.

Methods used for water quality test in the lab

Parameters	**Methods used**
Ammonia	Nessler reagent method
DO and BOD	Winkler's method
Iron	1,10 Phenanthroline (APHA, 23rd edition)
Nitrate	UV Spectrophotometric screening (APHA, 23rd edition)

Ortho-phosphate	Ascorbic acid method (APHA, 23rd edition)
pH, EC, TDS, Temperature	Multiple parameter probes

Annex 3: Preparation of Floating Rafts

The floating raft was designed and prepared using the local materials that were bought from local vendors. Different layers of foam and bamboo frame were prepared using bamboo mat, styrofoam, polyethylene foam, bamboo frame, and zip tie. A total of 40 rafts of 4/6 ft. sq. were prepared and installed at five different direction points of the lake. Plants were adjusted in the 2 inches hole drilled 6 inches apart from each other. Each raft contained 55 plants from one of the two species selected, viz. *Canna indica* and *Salvia splendens*. Volunteers from different colleges, local youth club members, and the local people helped during the work.

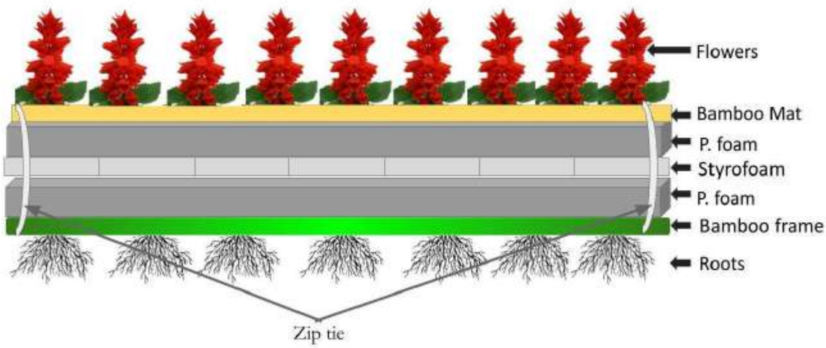


Figure 10 Schematic diagram of FTWS raft

Acknowledgments

The FTWS project CRRP2021-11MY-P.Kayastha is funded by the Asia-Pacific Network for Global Change Research (APN) and led by The Small Earth Nepal (SEN) in collaboration with the following institutions:

- Center of Research for Environment, Energy and Water (CREEW), Nepal
- Central University of Rajasthan (CURAJ), India
- University of Dhaka (DU), Bangladesh
- Kathmandu Valley Water Supply Management Board (KVWSMB), Nepal
- Nepal Academy of Science and Technology (NAST), Nepal
- Central Department of Hydrology and Meteorology (CDHM), Tribhuvan University (TU), Nepal
- University of Rhode Island (URI), USA
- University of Yamanashi (UY), Japan

Management of urban lakes:

Recommendations from Floating Treatment Wetland System (FTWS) Project

Published By: The Small Earth Nepal (SEN)

Prepared By: Ayaswori Byanju and Dhiraj Pradhananga

Layout and Designing: Tribikram Basnet

The Small Earth Nepal (SEN) stands as a distinguished non-governmental organization (NGO) dedicated to promoting sustainable lifestyles and reducing Nepal's global footprint. Since its inception in March 2001, SEN has been committed to advancing sustainable development and fostering choices that bolster system resilience.

SEN emphasizes research and effective science communication initiatives, spanning from grassroots school-level engagement to high-level policy discussions. Serving as a vital bridge between the public and private sectors, academia, and government agencies, SEN facilitates collaborative efforts in research, capacity building, awareness raising, and advocacy.

9789937162937

9789937162777