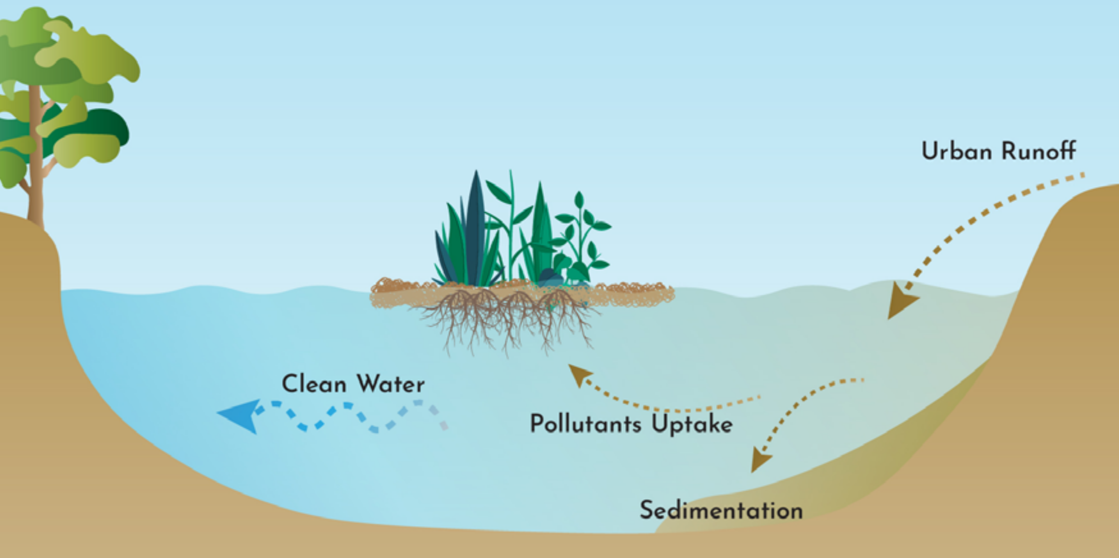
Guidebook

Floating Treatment Wetland System (FTWS)

Sustainable green technology to remediate polluted surface water bodies



Guidebook
Floating Treatment Wetland System (FTWS)

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Preface

Floating Treatment Wetland System (FTWS) is a sustainable green technology that can be used to remediate polluted surface water bodies. This guidebook provides theoretical and practical knowledge and tools for the installation and application of FTWS in the field.

FTWS project is a regional project led by The Small Earth Nepal (SEN), with funding support from the Asia-Pacific Network for Global Change Research (APN). The project is being implemented in three South Asian countries: Bangladesh, India, and Nepal.

The concept of FTWS is emerging in Southeast Asian countries, while in Nepal, it is in the introductory phase. This study is a collaborative work of national and international universities, NGOs, governmental bodies, and graduate researchers.

This guidebook is based on the experience of collaborative research on the FTWS project implementation in Nepal. The information and materials used can be customized for each country, site, and location.

The main objective of this guidebook is to provide researchers, scientists, and officers from governmental and non-governmental organizations with the knowledge and tools they need to conduct similar studies on FTWS.

Authors

Acronyms and Abbreviations

APN	Asia-Pacific Network for Global Change Research
APHA	American Public Health Association
BOD	Biological Oxygen Demand
cm	Centimeter
CURAJ	Central University of Rajasthan
DO	Dissolved Oxygen
DU	University of Dhaka
EC	Electrical Conductivity
FTWS	Floating Treatment Wetland System
HRT	Hydraulic Retention Time
L	Liter
Mg/l	Milligram per liter
N	Nitrogen
NGO	Non-Governmental Organization
NRC	National Research Council
PPM	Parts per Million
%	Percent
P	Phosphorus
pH	Potential of Hydrogen
PPE	Personal Protective Equipment
SEN	The Small Earth Nepal
STSC	Students, Teachers, Scientists and Communities
TDS	Total Dissolved Solids

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Glossary

Biochemical process

Biochemical process denotes the conversion of biomolecules, their synthesis, and their disintegration to produce new biomolecules, and processes (Manahan, 2023).

Biofilm in FTWS

Biofilm in FTWS represents a community of microorganism attached to the roots of the FTWS plants that may include bacteria, fungi, yeasts and other microorganisms.

Buoyancy

Buoyancy refers to the ability of any object to float freely in a fluid.

Community

A community is a group of people with different norms, religions, values, or identities living in the geographical area, near the study location that are directly or indirectly affected.

Eutrophication

Eutrophications refers to the production of undesirable changes and excessive production of algae like aquatic plants causing the deterioration of water quality due to excessive nutrient enrichment of water bodies.

Floating Treatment Wetland System (FTWS)

FTWS is an eco-technology that helps to remediate the polluted water through the application of floating rafts that supports shallow-rooted plants with their roots hanging freely into the water column (Headley & Tanner, 2008).

Floating wetland

Floating wetland represents a system with floating raft supporting phytoremediating plants and helps settle suspended sediments from water (Department of Environment, Science and Innovation, 2022).

Hydraulic Retention Time (HRT)

HRT also known as hydraulic residence time is a measure of average time a soluble compound resides within a constructed aeration tank. It has a significant impact on the quality of treated effluent water (Frankel, 2022).

Microcosm

A microcosm is a small ecosystem held in containers. They are useful for studying the way the ecosystem works and for the very practical purpose of determining what happens to the toxic substances in the ecosystems.

Monitoring

Monitoring is a process of observing and collecting information periodically. It also includes analyzing and using information to actively manage performance, maximize positive impacts, and minimize the risk of adverse impacts.

Perennial

Perennial word refers to the process of lasting for an indefinitely long time. For plants, it is the plants having a life cycle of more than two years.

Pollution

Pollution is contamination that results in or can result in adverse biological effects on resident communities.

Personal Protective Equipment (PPE)

PPE denotes the items worn to reduce the risk of severe injuries and health issues at the workplace that may be due to exposure to chemicals, physical forces, electricity, machinery, or other workplace threats. Some examples of PPE are gloves, safety goggles, earmuffs, helmets, vests, complete suits etcetera (OSHA, 2019).

Raft

A flat buoyant structure of timber or other materials fastened together used as a boat or floating platform. Rafts float on water and hold the plant freely in the water column.

Restoration

Restoration is the process of recovering any ecosystem that has been degraded, damaged, polluted, or destroyed.

Stakeholders

Stakeholders for a project are those institutions, individuals or organizations who are an essential part of the project and whose positive and negative interest affects the project outcomes.

Urbanization

Urbanization is the process of development in cities and the process of migration of higher populations from rural to city areas to live there for different facilities and reasons.

Wetlands

Wetlands denotes to the transistional areas between land and water. It may include wet environments, including marshes, swamps, wet meadows, floodplains (Council, 1995).

CHAPTER 1

Floating Treatment Wetland System

1.1 Background

The scarcity in availability of fresh water in urban areas is being the critical issue with urbanizational, industrial revolution, and high population growth (Bhattarai et al., 1970). With these, the rapid degradation of lake water is occouring (Pant et al., 2019). With increasing population, lots of nutrient pollutants increases in water causing the eutrophication of water. As, eutrophication of water is being observed as a significant water quality problem, it can be mitigated with the application of innovative, environmentally sustainable, cost effective technology (Rana Magar & Khatry, 2017; Greenway, 2005).

Floating Treatment Wetland System (FTWS) is an eco-technology that can be easily operated with low-investment and can mainly be suitable for developing countries (Mustafa, 2013; Kivaisi, 2001). FTWS is an innovative and emerging technique that helps to remediate the polluted water bodies (Zhang et al., 2014). It makes use of a freely floating mat that supports shallow-rooted plants with their roots hanging freely into the water column. The roots in the water develops microbial biofilms that helps in remediation process (Afzal et al., 2019). These microbes removes pathogenic microorganisms, absorb nutrients and degrades phytotoxic compounds in water (Ijaz et al., 2016).

Figure 1: FTWS on surface water body (Picture credit: Nazmoon N. Sumiya, DU)

1.2 Mechanism of FTWS

FTWS consists of a freely floating synthetic buoyant raft that supports phytoremediation plants with their roots hanging freely into the water column (Afzal et al., 2019). The floating roots absorb nutrients directly from the water column, accelerating the nutrient and element uptake into biomass (Tanner & Headley, 2011). The associated pollutant-degrading microbes that are present at the roots absorb nutrients and also remove heavy metals from the water (Ijaz et al., 2016). The microbes entrappes gasses on the root surface thus providing buoyancy to raft (Afzal et al., 2019). The buoyancy enables the rafts to tolerate large fluctuations in water depth and also help to manage a position of raft for the improvement of water quality of water body (Tanner & Headley, 2011).

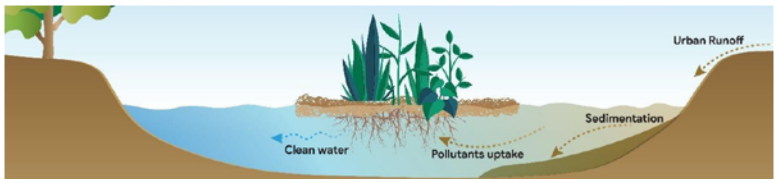

Figure 2: Mechanism of FTWS

1.3 FTWS: A low-cost and sustainable green technology

FTWS is a simple technology that can be prepared from locally available trash materials with minimal installation and operational expenses. Local communities provided with basic training can easily learn, prepare and install them in the field.

This technology requires minimal costs for construction and installation. So, it is an affordable and feasible solution, particularly in developing nations, for the remediation of pollutants in water bodies. FTWS does not hamper the storage capacity of the water body due to its buoyant capacity and also uses natural energy from sunlight to remediate water bodies. FTWS uses locally available plants for the remediation of polluted water that requires minimum maintenance and operational costs (Shahid et al., 2018).

1.4 Benefits of FTWS

1.4.1 Enhanced water quality

FTWS promotes the removal of excess nutrients, heavy metals, and pollutants through plant uptake and microbial processes. This will remediate the polluted surface water and help to restore the lake and pond ecosystem.

1.4.2 Protects the biodiversity and aquatic ecosystem

FTWS enhances the water quality of water bodies, making them more suitable as a habitat for aquatic ecosystems. FTWS provides a habitat for aquatic and migratory birds, thereby enhancing biodiversity.

1.4.3 Aesthetic value

Using plants helps enhance the aesthetic value of water bodies, contributing to the overall landscape.

1.4.4 Scenic beauty and design flexibility

FTWS can be made up of different designs ultimately enhancing the scenic beauty of the water body and adding value to the entire location. The flexibility in the design and the enhancement of scenic beauty help to increase the tourism and recreational value of the water body.

1.4.5 Suitability

FTWS is a suitable for use in existing ponds, lakes, slow-flowing waters, and polluted treatment ponds that need remediation. Pollutant concentration, sediment flow rate, and temperature affect the pollutant removal rates of FTWS. Different sites may have varying levels of pollutants and different types of water bodies, which can impact the treatment system's effectiveness (Department of Environment, Science and Innovation, 2022).

CHAPTER 2

Designing a Floating Treatment Wetland System

Different factors should be considered when designing a FTWS. Proper planning, selection of appropriate sites, seeking approval from local bodies, selection of materials for raft preparation, and selection of plants play a vital role in properly designing and implementing FTWS.

2.1 Site selection and preparation

Proper planning and a conceptual framework should be prepared for the selection of the study locations, microcosm study, selection of plants, implementation of field prototypes, and lab tests. A research/study design will provide an overall overview of conducting all the activities smoothly. The size of floating rafts and the dimension of surface bodies should be taken into consideration during the preparation phase.

2.2 Stakeholders and collaborators

A consortium of stakeholders and collaborators with similar interests can be formed to work together. This will help generate new ideas, share experiences, and produce a better conclusion. It can also make it easier to conquer the expected goals and objectives of the study. This can include community people, policy-makers and local representatives, NGOs, governmental organizations, students, and researchers. These stakeholders and collaborators can work collaboratively for the best outcomes from the study.

Figure 3: Polluted water body (Picture credit: Ayaswori Byanju, SEN)

2.3 Rapport building and taking approvals

Before implementing the project, one should build connections and trust with the local government and communities. The plan should be shared and discussed to create a mutual understanding. They can also be a part of different activities at their convenience. Approval for installing the floating rafts and their regular monitoring at the selected water body should be planned with local community and local government. Public consultation and discussions should also be conducted with community people and the local youth groups of the selected water body.

2.4 Public engagement and outreach

Community people's engagement in different project activities plays an important role in the smooth completion of the project and also creates awareness amongst the public. Community people could be engaged in raft layer construction, boating, plantation, and anchoring activities. Different meetings, workshops, trainings could be done as outreach activities.

2.5 Initial water quality test

Before sampling water bodies, it is essential that the government entities, local communities are informed and permission has been taken. Initial water samples are tested to evaluate the water quality status of the selected water source. Water samples could be taken from different directions/points of the lake e.g., East, West, North, and South, inlet, and outlet of the lake (as Figure 4). The water quality test can be done using available in-situ testing kits or laboratory analytical procedures. For the lab procedure, a standard water quality test method can be applied. Results can be compared against the aquatic water quality and/or drinking water quality standards to evaluate the level of pollution of the selected water body. This will provide insight to the water quality of the water body for establishing FTWS.

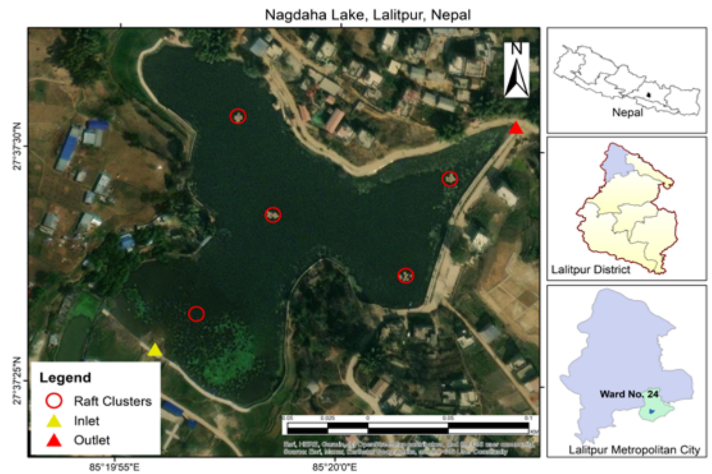

Figure 4: Water sampling sites in water body

2.6 Plant selection

FTWS mostly consists of shallow-rooted aquatic plants suitable for the wetland. These plants should be non-invasive, indigenous, adapted to the local climate, have high nutrient uptake capacity, and tolerate prolonged water inundation. A mix of emergent, submergent, and floating should be considered to enhance treatment efficiency. Terrestrial or aquatic plants of flowering, non-flowering, edible, and medicinal perennial plants are ideal for FTWS.

For the plants to insert in the rafts, saplings can be grown for 3 to 4 months before the start of the project in suitable climatic conditions to reduce the stress of finding the plants in large quantities. The plants can be ordered from plant nurseries. Preparing plant saplings in advance also reduces financial costs for impromptu plant purchases.

Figure 5: Examples of plant species (Picture credit: Ayaswori Byanju, SEN)

2.7 Microcosm study

Figure 6: Microcosm study of FTWS (Picture credit: Nazmoon N. Sumiya, DU)

A microcosm study is a small-scale experimental research work that

can be done before the field installation of the floating rafts. Microcosm studies provide insights into the suitability of selected raft materials, plants, and how plants interact with water. A small-scale study will act as a practical demonstration of the concept before field deployment. Such analysis will help identify any technological gaps. The treatment units for the microcosm study must have control units (polluted water only), and different treatment units (with raft only, with raft and selected plants).

2.7.1 Preparation of shed setup

For conducting the microcosm study, a structure more likely a greenhouse or any shed or laboratory room with proper ventilation can be prepared. If a favorable shed is already available with transparent roofing material and a half-wall room, it can also be used for installing the setup. Such sheds for FTWS can be prepared by utilizing iron bars, bamboo, and aluminum structures for the overall frame, and high-quality plastic sheeting to wrap the body section. Roofing can be done using

Figure 7: A sample of the shed for microcosm study (Picture credit: Nammy Hang Kirat, SEN)

high-quality polycarbonate roofing materials. For holding the experimental buckets/setup, a table of 3/4 ft. height with desirable length and width can be made. The table frame can be made of wood or iron material covered by a wooden plank. The buckets with an average of 30 to 40 liters capacity can be used to setup the treatment units. For the best result, each treatment unit can be prepared by combining three identical interconnected buckets and preventing possible back flow by clipping the tubes with appropriate valves. These buckets can be connected to the storage tank of desirable quantity. A mini submersible pump can be used to pump water upward from the stock tank to the initial bucket of the treatment unit.

CHAPTER 3

Field Installation of Floating Rafts

For proper construction and implementation of the floating rafts, various factors like plan preparation, local consultation, and selection of appropriate locations play a key role. So, these factors should be addressed with proper planning.

3.1 Preparation

3.1.1 Plan for field installation

For installation of the floating rafts, a detailed plan of each activity needs to be prepared, and the time frame to accomplish them. Detailed planning will help to accomplish the targeted work efficiently within a time frame.

3.1.2 Selection of suitable point for installation

The site for floating raft installation should be covered with water permanently throughout the year. Other studies have recommended measuring the water velocity and depth variation as high variations of water in the water body can affect the installed floating rafts. It is best to get the required materials from the local community and vendors and to involve the community in the rafts' planning, construction, and management (Department of Environment, Science and Innovation, 2022). The selected site should be easily reachable for monitoring and re-plantation on the installed rafts (whenever necessary). Strategically, the installation should be done to cover important parts of the water body. However, a single point of water body that seems best for the installation could be chosen, and the raft can be installed.

3.1.3 Construction materials and resources

Raft materials should be chosen as per the need of research to best meet its goals. The raft materials must be durable, non-toxic, and resistant to decay and degradation. Commonly used materials include recycled plastic, buoyant foam, or a combination of various materials, including hollow lightweight pipes, bamboo, bamboo mats, coconut fibers, etc. For the construction, polyethylene foam, styrofoam, bamboo frames, bamboo mats, and iron rod frames should be used as a scaffold layer of floating rafts. Circle or square holes of 2 X 2 cm^2 holes should be made using appropriate drill bits. Different layers of the rafts should be interconnected using cable ties, aluminium wires or stainless iron nails. If possible, it is best to use materials that are easily available as well as trash materials that are in good condition for re-use.

3.1.4 Sizing and layout of the field prototype

The size of FTWS system depends on factors such as the size of the water body, water volumes, and pollution load. Consider the hydraulic retention time, plant density, and desired treatment goals when determining the size and layout of FTWS. Ideally, the floating rafts

Figure 8: Example of the field prototypes (Picture credit: Ayaswori Byanju, SEN)

should cover 10 to 50% of ponds and lakes to create anoxic conditions for proper denitrification (Department of Environment, Science and

Innovation, 2022). Other studies have shown that minimum 5-8% of the surface area covered by floating wetlands is required to treat polluted water bodies (Pavlineri et al., 2017).

Before preparing the prototype, an appropriate space needs to be allocated for constructing and storing rafts. Raft prototype construction and implementation requires electricity and raw materials. There should be a need to communicate with team members, easy access to telecommunication is important. The floating raft should cover minimum of 5-8% of the surface area for the effective remediation of the pollutants from the selected water body.

The layers of different materials required for the raft need to be prepared, and then these floating platforms need to be stacked and interconnected with cable ties or aluminum wires (Figure 9).

The floating mat could be covered either by the bamboo mats from the upper side or be bound by the nets to make it more sustainable and to protect the plants and their roots from migratory birds, aquatic animals, and fluctuation of water velocity. As in Figure 8, the rafts are covered by the bamboo mat. In some cases, the floating rafts would need the coverage of nets to make it more durable and for external protection.

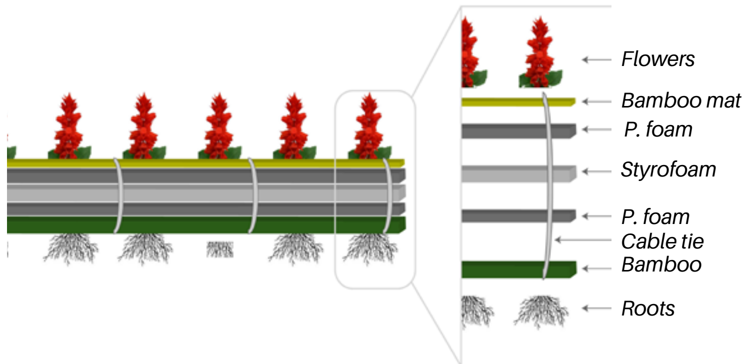

Figure 9: Example of the different layers of raft arrangements

3.2 Installation process

The floating prototype should be designed and installed so that the plant's root would interact with the water column, i.e., the plant root should always be wet and submerged in the water.

3.2.1 Plantation

For plantations, perforations (holes) must be made on the rafts in which growing media, such as coco peat and coconut fibers, can be used to support the plants in the rafts. If required, a jute net can be used in these holes to prevent the growth of media from being washed off in the water (Wang et al., 2015; Shahid et al., 2018; Arivukkarasu and Sathyanathan, 2023). Then the prepared prototype can be installed at the selected points of the water body by using boats.

3.2.2 Anchoring and mooring

FTWS rafts should be anchored or moored to fix their position at a point and to prevent them from being damaged by water level changes and flow velocity. The floating rafts could be anchored to the bank with ropes and wires. Alternatively, cement blocks can be tied up with a long rope for mooring, ultimately connecting with the floating rafts. Then the block could be submerged in the water to provide the weight for the floating raft to allow it to fix in a position (Greenway, 2005).

Figure 10: Raft installation (Picture credit: Samyak Prajapati, SEN)

CHAPTER 4

Operation and Monitoring

It is important to monitor the water quality to assess the effectiveness of floating wetlands in treating pollutants. Monitoring should be done at different phases of FTWS implementation.

4.1 Microcosm setup monitoring

The microcosm setup should be monitored for a certain time (3-6 months). The dead plants and the dried parts of the plants should be removed timely, and the root growth should also be monitored. While doing these activities, one shouldn't contaminate the sample water. All important activities and changes in the microcosm setup should be recorded in writing or digitally for future reference.

4.2 Installed raft monitoring

After implementing the prototypes, regular monitoring of the plant health and the root system is required to control weeds and pests around the prototypes. Regular monitoring should be carried out at least every 15 days or once a month. Additionally, removing debris, monitoring plant growth, controlling invasive species, trimming vegetation, and replacing plants should also be done as necessary. While undertaking these activities, PPE and safety gear such as life jackets should be used.

4.3 Water quality monitoring

Water quality monitoring is important to monitor the performance of microcosm studies and field prototypes in remediating pollutants. Initial tests of the sample water from both the experimental setup and the microcosm study should be done to determine the initial pollutant level of the sample water. Samples from the experimental setup should be taken and tested once a week or at least twice a month at a fixed frequency. In case of large sample numbers and time-consuming tests, the samples could be taken and tested once in every 15 days. The details of key parameters are included in Annex 3.

Figure 11: Field plant monitoring (Picture credit: Abir Mahmud, DU (Right) & Ayaswori Byanju, SEN (Left))

4.3.1 Things to be considered before and during water sampling

Before sampling, the sample bottles should be triple rinsed, first with tap water and then with deionized water. While sampling, the sample bottle should again be rinsed with the sample water once and then completely filled (without any air bubbles) and capped. Taking three samples is a standard size that provides accurate data and also represents the overall water condition of the bucket. However, one or two samples can be taken if three samples are not possible. Thus, collected samples should be packed in an ice box and then transferred immediately to the lab. Some of the parameters, such as DO, and BOD, fluctuate within some duration of time, so they should be immediately tested after sampling. At the same time, some of the water samples can be stored at the required temperature following American Public Health Association (APHA) standards and tested later.

Chapter 5

Safety Measures

Safety is the most important aspect of the human. So, it should be the foremost priority while conducting any activities. Safety measures should be taken to avoid any accidents and harm to the involved person. It is essential to follow all safety measures while conducting different activities of FTWS including microcosm setup preparation, water sampling, water quality testing at the lab, raft preparation, installation monitoring, and any other activities.

5.1 Microcosm setup preparation

During the microcosm setup preparation, hole saw, drill machine, and electric machineries need to be handled safely while interconnecting the buckets, arranging the electricity, and the electronic devices (like: sump pump). During these activities, PPE like gloves, masks, and precautions should be taken carefully.

5.2 Water sampling

For water sampling in a microcosm setup, masks and gloves should be used properly to avoid contamination of germs and bacteria. For some parameters, chemical reagents like acids need to be applied as preservatives. These chemical reagents should be handled properly. While collecting samples from water bodies, body-protecting suits like safety vests should be worn.

5.3 Water quality test at lab

Proper lab precautions should be applied including wearing a lab coat for working, using separate slippers for lab work, and handling the chemical reagents properly. While preparing the chemical reagents for the test, the acidic, basic nature of the reagents should be known and handled accordingly. While handling the concentrated acids and strong preservatives that produce fumes, one should wear eye protection wear, protective clothing and avoid spillage of the reagents. One should have experience in handling the electric machinery related to the water quality test to avoid accidents at the lab.

5.4 Raft preparation and installation

During the raft preparation, equipment like hammers, nails, wires, and electric machines such as drill machines should be handled appropriately and PPE such as gloves and masks should be used for safety. Safety vests are important while deploying the raft into the water.

5.5 Installed rafts monitoring

The entire development to deployment of FTWS is teamwork; hence, no field activity should be carried out individually. During the monitoring of rafts, one should have boats and a perfect boat skipper, wear a safety vest, have a couple of colleagues perfect in swimming, use PPE, and avoid accidental activities.

CHAPTER 6

Conclusion and Future Prospects of FTWS

FTWS is an eco-technology for the remediation of polluted water by applying floating rafts, and phytoremediation plants that can be applied in different water bodies like lakes, ponds, rivers, and treatment systems. In these systems, plant roots play an essential role in removing pollutants from the water. Different studies similar to this one could be done in future using reusable trash, locally available materials as raft materials.

Different methods and materials can be applied regarding plant selection, floating mat structure and size, plant density, hole size, harvesting and disposal procedures, and hydraulic retention times. Similarly, more microcosm studies can be launched to know the microorganism types, capacity for removal of pollutants, role in the growth of the plants, and etcetera in future. Studies on the time duration, need, and advantages of plant harvesting and its benefit in pollutant removal can also be interesting (Shahid et al., 2018).

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Annex 1: Microcosm setup plan

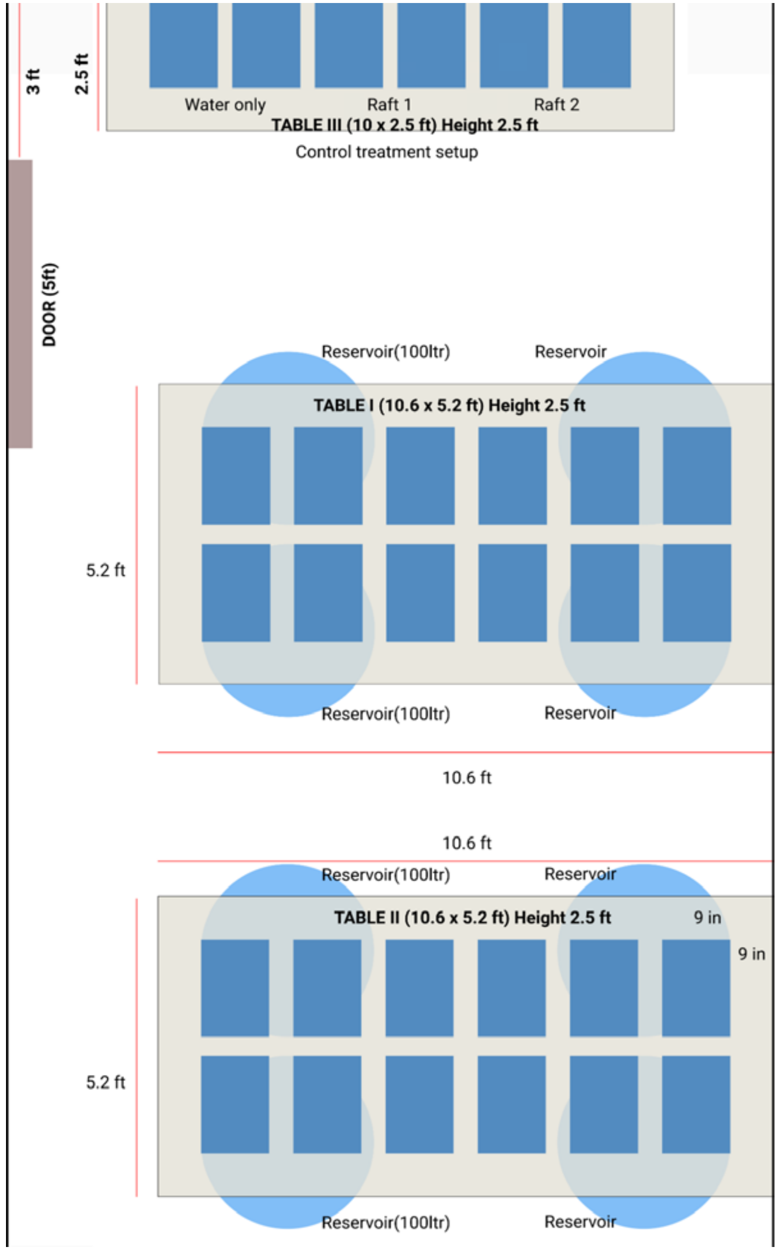


Figure 12: Technical drawing of microcosm setup plan

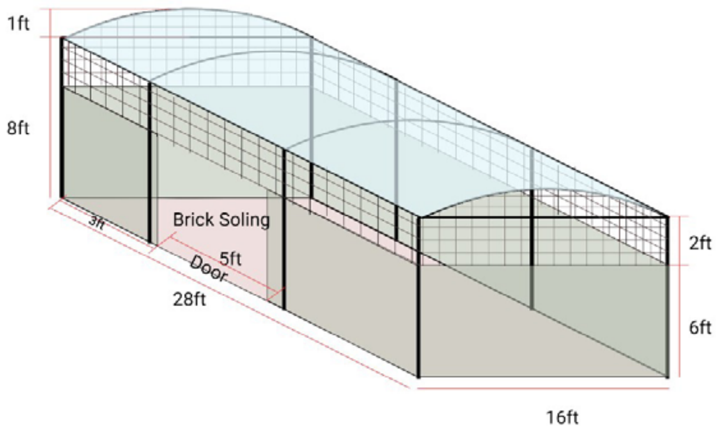


Figure 13: Design of experimental shed

Annex 2: Required materials for overall FTWS

S.N.	**Category**	Required materials
1	Shed preparation	Bamboo, aluminum wire, iron rods, bricks/ cement blocks, roofing materials, iron mess, polyethylene plastic sheets, aluminum rod
2	Experimental setup	Benches/table - can be made from wood, iron rod, aluminum rod, wood planks Units - 40 L water tank (can be of more capacity), pipes, stock tank (can be of 100 L or more), sump pump, electricity line
3	Raft preparation	Polyethylene foam, styrofoam, cable tie, aluminum wire, iron nails, hammer, drill machine, safety gloves, hollow plastic pipes, plastic bottles, rope, anchoring blocks, iron frame, wooden frame
4	Sampling	Sample bottles, ice boxes, chemical preservatives, sampling tools like buckets, samplers, boats, etc.
5	Water quality test at lab	Chemical reagents, lab apparatus, spectrophotometer and other required electric devices, apron, slippers, gloves, mask, protection goggles, sanitizer
6	Monitoring	Paper cutter, PPE, life jacket, boat, bucket

Annex 3: Methods used for FTWS study in Nepal

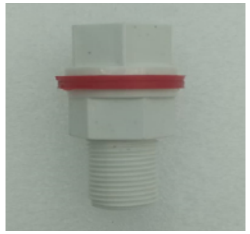
S.N.	Parameters	Methods
1	pH, EC, Temperature and TDS	Oaklon PCTS Testr 50
2	DO and BOD	Winkler's method
3	Ortho-phosphate	Ascorbic acid method (APHA, 2017)
4	Nitrate	UV Spectrophotometric screening (APHA, 2017)
5	Ammonia	Nessler reagent method
6	Iron	Phenanthroline spectrophotometer (APHA, 2017)

Annex 4: Components of Microcosm Setup

Water tank

Sump pump

Brass nozzle



Connectors

Pipes

Bucket

Figure 14: Required materials for microcosm setup (Picture credit: Ritu Singh, CURAJ)

The Small Earth Nepal (SEN)

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.

Floating Treatment Wetland System (FTWS)

FTWS is an innovative and eco-friendly approach to improve water quality and restore aquatic ecosystems of surface water bodies. It consist of floating platforms or mats that support various types of plants, which help to remove pollutants from the water. These are cost-effective, sustainable, and can be used in various water bodies, including ponds, lakes, stormwater retention basins, and wastewater treatment ponds.

The FTWS project has been 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:

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

The project is being implemented in three countries: Bangladesh, India, and Nepal. Project duration (October 2021-September 2024)

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