3rd International Conference on Advances in Civil and Environmental Engineering (ICACEE-2024)

University of Engineering & Technology Taxila, Pakistan

Conference dates: 21st and 22nd February 2024; ISBN: 978-969-23675-2-3

Nature-Based Solution for the Treatment of Wastewater using Wetlands

Babar Abbas[1,*], Saimar Pervez[1], Talha Ahmad[1], Farwa Zafar[1], Adil Khan[1], Ahsam Masood[2], Muhammad Ahmad[2], Adil Khan[2]

[1] Department of Environmental Engineering, University of Engineering and Technology, Taxila, Pakistan

[2] World Wildlife Funding (WWF), Pakistan

*Corresponding author: babar.abbas@uettaxila.edu.pk

ABSTRACT

Pakistan has been blessed by nature with enough surface and groundwater resources but due to urbanization, industrialization, and rapid population growth, it might lean towards water stress conditions. Pakistan has 70% water supply but only 36% population have access to safe drinking water including 41% of urban and 32% of rural areas. According to the International Monitoring Fund (IMF), Pakistan ranks third out of all the countries that have insufficient water resources and sanitation problems. Pakistan is shifting from a water-stressed to a water-scarce country. Wastewater treatment is the need of an hour. Wastewater can be treated by using conventional wastewater treatment technologies like plant membrane bioreactors, sequencing batch reactors, and constructed floating and wetlands. Constructed Floating Wetland has been selected in this research, it has the advantage of being simple, requires less energy demand, and low skilled operation. This research investigates the role of three aquatic plants i.e., Lotus plant, Canna Indica, and Typha domingensis. Many parameters of water treatment are fulfilled during this treatment i.e. BOD, COD, TSS, TDS Ortho-Phosphate, Ph, Turbidity, Total Bacteria, Coliform, and E-Coli. Treated water from constructed floating wetlands can be used for non-potable purposes like agricultural activities and groundwater recharge.

KEYWORDS: Wastewater treatment, Nature-based solutions, Wetland

1 INTRODUCTION

Clean water scarcity is a major issue nowadays in the world of 7.7 billion people. The strain will grow from 22% to 34% in 2050 when the population will reach 9.4 to 10.2 billion. This population growth is expected in developing countries where water scarcity is the utmost rising issue. Water scarcity first hit Africa, then Asia and according to WWF in 2025, two-thirds of the world's population may face water shortage (Boretti & Rosa, 2019a).

According to the International Monitoring Fund (IMF), Pakistan ranks third in countries that have insufficient water resources and sanitation problems (Perveen & Amar-Ul-Haque, 2023). Pakistan produces 962,335 million gallons of wastewater every day, out of which only 5% of wastewater is treated. The supply of polluted water to the people is the result of poor management, lack of knowledge, and poor sanitation, especially for people in rural areas.

Different technologies are used nowadays to treat wastewater like RBCs ASP membrane-based wastewater treatment Trickling filters etc. But these processes require space, and they are cost-effective operation maintenance is also required and these technologies cannot be installed in rural areas because people do not know, and their operation and maintenance are also difficult.

Constructed wetlands are considered a more feasible option for treating wastewater in rural communities due to several advantages they offer in terms of cost-effectiveness, low energy requirements, and environmental benefits. In rural areas, where access to centralized wastewater treatment facilities may be limited, constructed wetlands present a sustainable and adaptable solution for wastewater management.

One of the primary reasons why constructed wetlands are a feasible option is their cost-effectiveness. Compared to conventional treatment plants, the capital and operational costs of constructed wetlands are relatively lower, making them more affordable and manageable for rural communities with limited financial resources (Kadlec & Wallace, 2008). The construction and maintenance of constructed wetlands often utilize natural processes and local materials, further reducing expenses. Additionally, constructed wetlands have low energy requirements, which is advantageous in rural settings where access to electricity may be limited or unreliable. The treatment processes in wetlands, such as microbial degradation and plant uptake, occur naturally and do not rely heavily on energy-intensive mechanical systems (Vymazal, 2011). As a result, they are less dependent on electricity and can operate efficiently with minimal energy input.

2 METHODOLOGY

The project was completed in a rural area of the Haripur region which helps in reducing the area's water demand by recycling their wastewater as well as aesthetically pleasing. The total population of Bandi Mueeem village is 2819 and per capita water consumption is 1000m^3. The village received an average rainfall of 131.65 mm.

2.1. Construction and Installation

As the selected site had a pound in a depression where all the wastewater can be collected easily, after the characterization of wastewater and selection of the buoyant mat these sheets were to be installed on the pound there are 110 sheets on a single mat with the size 6feet*4feet =24sq.ft It was ensured that the mats were attached securely to prevent drifting or damage during the installation, finally the mats were carefully placed over the water surface and it was ensured that all the sheets were evenly distributed over the surface of the water.

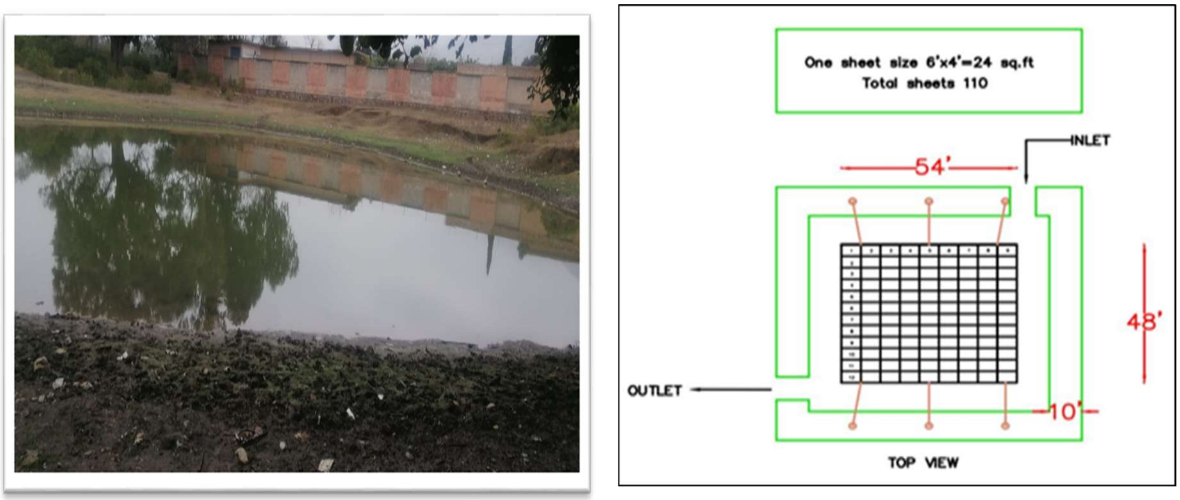

Figure 1. Selected site for Wetland (Left; Wastewater Pond, right; Design of wetland)

Based on the project's requirements and characterization of the wastewater we selected 3 plants for the floating treatment wetlands. The selected plants were Canna Indica, Lotus Plants, and Typha domingensis. These plants work fine in temperature variations and have effective removal efficiency.

Figure 2: Installed setup of a wetland

3 RESULTS AND DISCUSSION

After analysing the flow in our wetlands, the results speak volumes, neatly laid out in the tables. Reassuringly, our data aligns seamlessly with the benchmarks set by the National Environmental Quality Standards (NEQs). These findings not only signify compliance but underscore our unwavering commitment to preserving the delicate balance of our environment. In essence, our diligent scrutiny affirms a harmonious synchronization of inflow and outflow within the defined parameters, a testament to our dedicated approach to environmental stewardship.

Table 1: Wastewater characteristics at inflow and outflow

Parameter	Inflow Values	Outflow Values	NEQs
TDS (Total Dissolved Solids)	5000 mg/l	2695 mg/l	3500 mg/l
Turbidity	524.5 NTU	0.075 NTU	<1 NTU
COD (Chemical Oxygen Demand)	108 mg/l	97 mg/l	150 mg/l
5-Days BOD (Biochemical Oxygen Demand)	162 mg/l	54 mg/l	80 mg/l
pH	8.5	7.99	6-9 N/A
Orthophosphate Phosphorus	30 mg/l	0.059 mg/l	1 mg/l
TSS (Total Suspended Solids)	349 mg/l	88 mg/l	150 mg/l
E. coli (Escherichia coli)	438 CFU/100ul	0.001 CFU/100ul	0 CFU/100ul

4 CONCLUSION AND RECOMMENDATIONS

In conclusion, this constructed wetland project not only effectively addressed the identified problem statement but also exceeded expectations in terms of meeting NEQ standards, garnering community satisfaction, enhancing aesthetics, and reviving the contaminated food chain. This comprehensive approach has had a lasting and positive impact on the rural community in Haripur, providing them with a sustainable and improved wastewater treatment solution and the treated water can be used for non-potable purposes.

5 ACKNOWLEDGEMENTS

We would like to acknowledge the World Wildlife Fund (WWF) for their financial and technical support throughout the project for the betterment of the community.

6 REFERENCES

1) Aydin, A., & Kentel, E. (2006). Environmental and economic performance evaluation of rural wastewater treatment systems: A case study from Turkey. Water Science and Technology, 54(3), 27-36.
2) Boretti, A., & Rosa, L. (2019a). Reassessing the projections of the World Water Development Report. Npj Clean Water, 2(1). https://doi.org/10.1038/s41545-019-0039-9
3) Boretti, A., & Rosa, L. (2019b). Reassessing the projections of the World Water Development Report. Npj Clean Water, 2(1). https://doi.org/10.1038/s41545-019-0039-9
4) Karungamye, P. N. (2022). Potential of Canna indica in Constructed Wetlands for Wastewater Treatment: A Review. Conservation, 2(3), 499–513. https://doi.org/10.3390/conservation2030034
5) Maduelosi, J. N., & Ezuluofor, M. U. (2023a). Education as a Vaccine Against Girl Child Bullying. British Journal of Multidisciplinary and Advanced Studies, 4(3), 1–8. https://doi.org/10.37745/bjmas.2022.0207
6) Mahfooz, Y., Yasar, A., Guijian, L., Yousaf, B., Sohail, M. T., Khan, S., Tabinda, A. B., Rasheed, R., Mahmood, S., & Khan, M. (2020). An assessment of wastewater pollution, treatment efficiency management in a semi-arid urban area of Pakistan. Desalination and Water Treatment, 177, 167–175. https://doi.org/10.5004/dwt.2020.24949
7) Perveen, S., & Amar-Ul-Haque. (2023). Drinking water quality monitoring, assessment, and management in Pakistan: A review. In Heliyon (Vol. 9, Issue 3). Elsevier Ltd. https://doi.org/10.1016/j.heliyon.2023.e13872
8) Shahid, M. J., Arslan, M., Ali, S., Siddique, M., & Afzal, M. (2018). Floating Wetlands: A Sustainable Tool for Wastewater Treatment. In Clean - Soil, Air, Water (Vol. 46, Issue 10). Wiley-VCH Verlag. https://doi.org/10.1002/clen.201800120
9) World Water Assessment Program (United Nations). (n.d.). Wastewater: the untapped resource: the United Nations World Water Development Report 2017.