Study of the Use of Ion-exchange Porous Materials and Biofilms Established in Coconut Fibers as a Waterbody Restoration Alternative

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Introduction

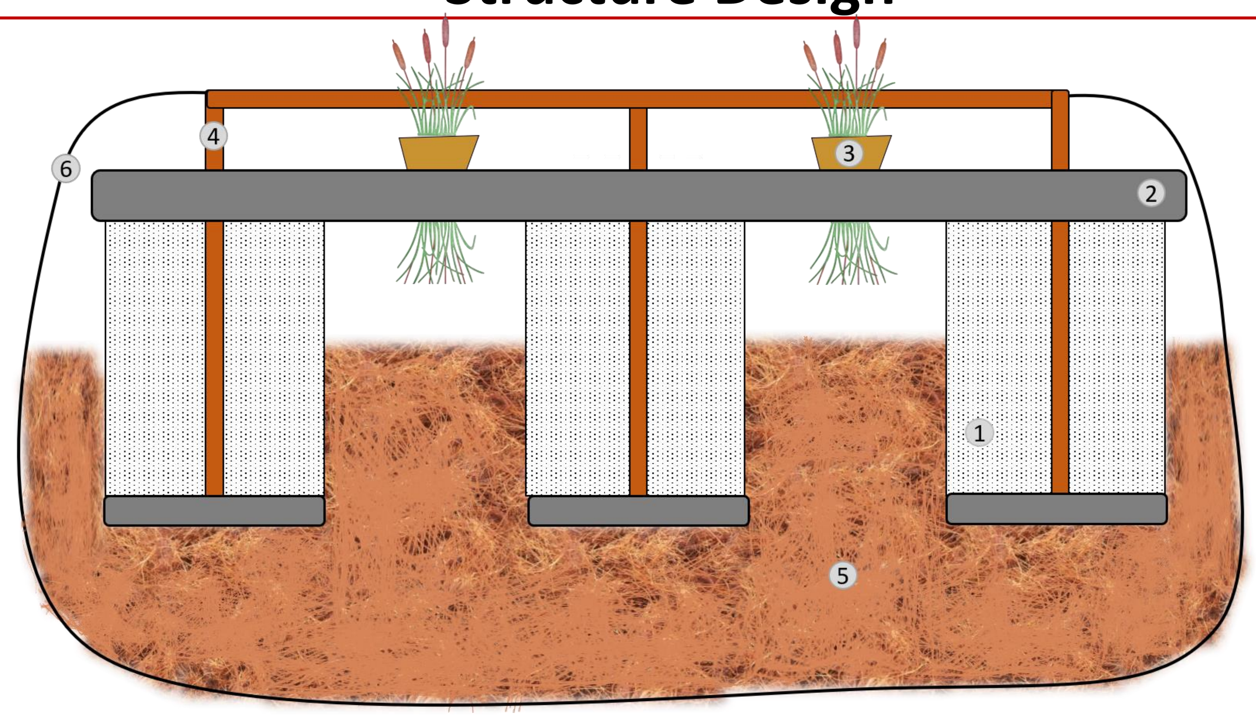
- When a water body is degraded, we lose many of the ecosystem services that are essential to society, such as nutrient cycling, water supply, food production, and recreation (TUNDISI, 2018).
- The restoration of water bodies aims to recover some of these losses and to do so in a more publicly acceptable way and at lower costs than through sewage treatment plants (BERNHARDT et al. 2007).
- Current waterbody restoration technologies have prohibitive implementation and maintenance costs, and there are limited real-scale studies about their effects (PAN et al., 2016).

Objective

Considering the limitations of current waterbody restoration methods and the increasing need for techniques that can improve degraded ecosystems, this research project had the objective of using residual materials (wood ash, coconut fibers, and used P.U foams) to develop and evaluate a new low-cost design of a floating waterbody treatment device, which follows the idea of constructed floating wetlands.

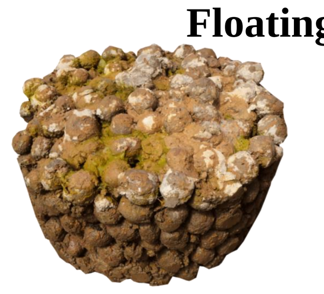
Floating Treating Structure

Structure Design



1 – Floating Purifier Concrete; 2 – P.U Foam; 3 – Macrophytes; 4 – PVC Pipes; 5 – Coconut Fibers; 6 – Nylon Mesh.

Base Constituents

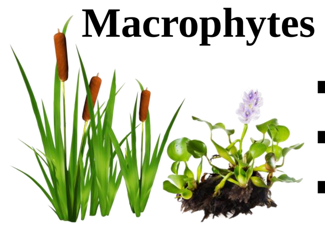


Floating Purifier Concrete:

- Made by recycling wood ash;
- Captures ionic pollutants through ion-exchange;
- Coagulates sediments;
- Serves as a host to phototrophic biofilms that oxygenate the water and degrade pollutants.

Coconut Fiber/Coir:

- The residual outer husk of the coconut;
- Serves as a host to biofilms that efficiently degrade pollutants;
- Captures nutrients by adsorption;
- Holds sediments with its fibrous aspect.



Macrophytes (*Typha domingensis* and *Eichhornia crassipes*) installed in P.U foam:

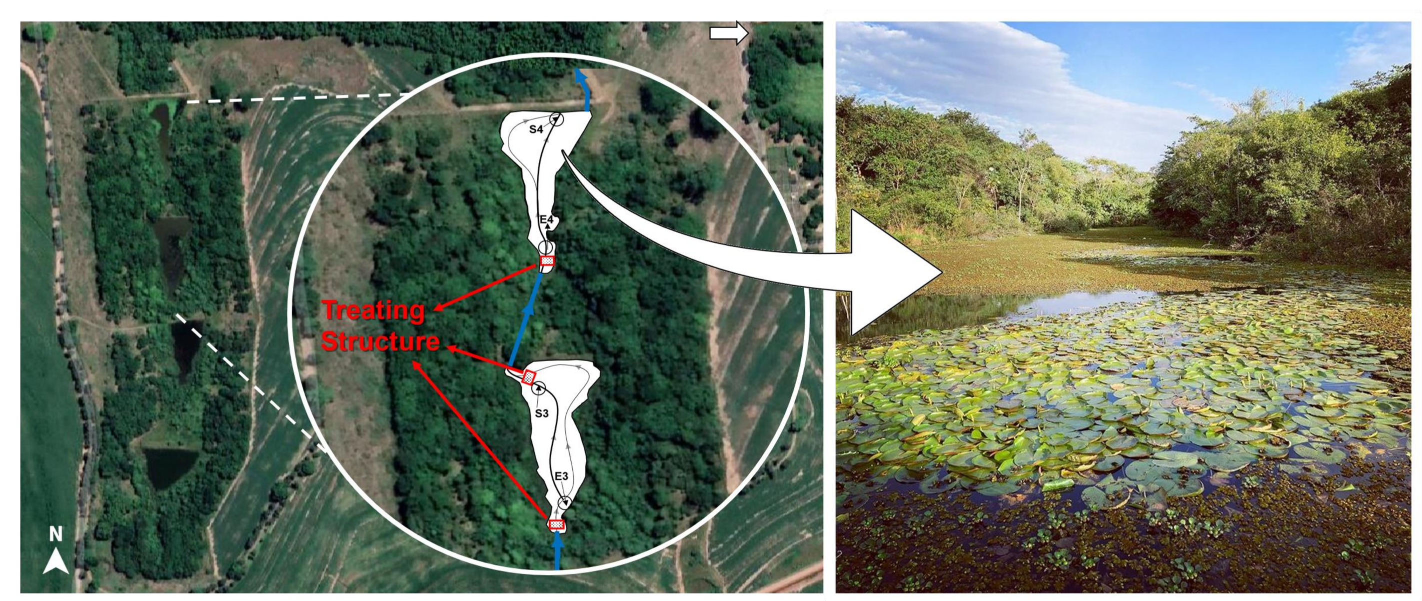
- Serves as a host to microorganisms that efficiently degrade pollutants;
- Captures nutrients by absorption in the roots;
- Holds sediments with its fibrous roots.

Study Design

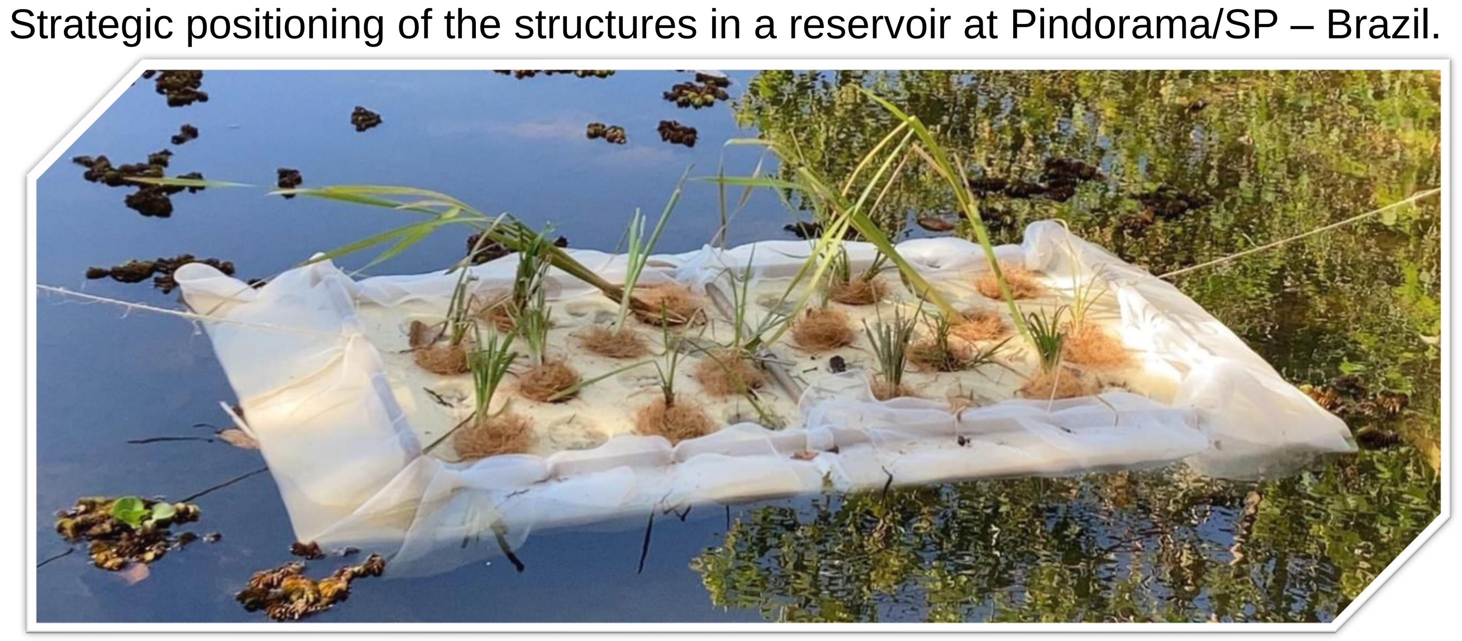
Phase I: Experiments in a Controlled Setting

Study of the structure's performance in treating a contaminated water.

Phase II: Experiments in a Contaminated Reservoir



Strategic positioning of the structures in a reservoir at Pindorama/SP – Brazil.



Structure Installed in a reservoir at Pindorama/SP – Brazil.

Results

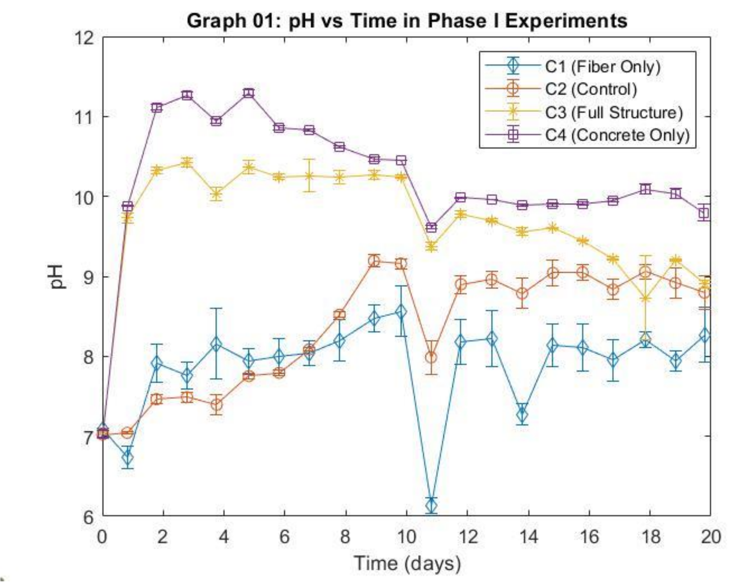
Phase I: Experiments in a Controlled Setting

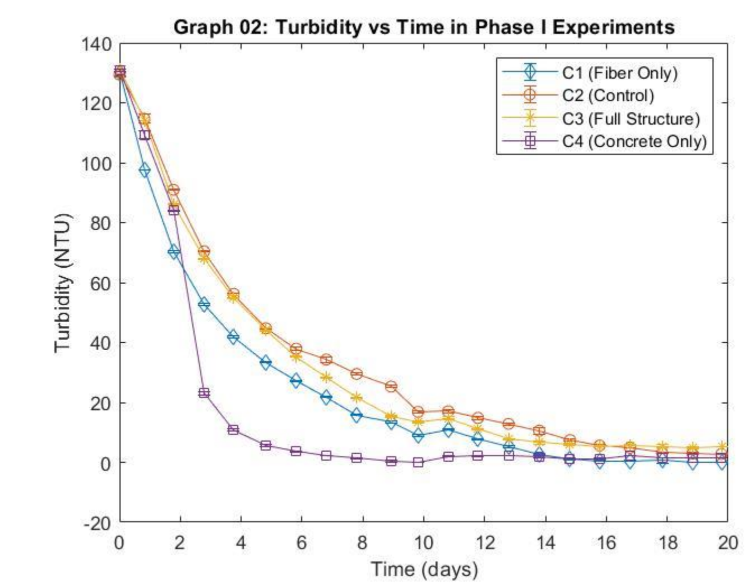
Table 01: Results of chemical parameters after 20 days of experimental treatment

	Raw Sample	Control	Full Structure	Coir only	Concrete only
Total Phosphorus (mg/L)	0.409	0.604	0.252	0.240	0.083
Kjeldahl Nitrogen (mg/L)	22.4	11.2	8.4	5.6	5.6
BOD (mg/L)	5.85	2.01	4.06	2.01	2.38

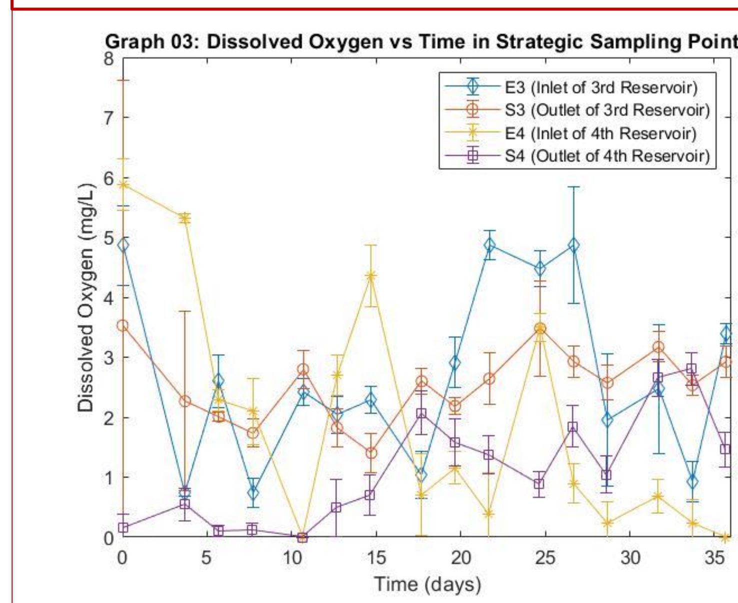
Results

Phase I: Experiments in a Controlled Setting





Phase II: Experiments in a Contaminated Reservoir



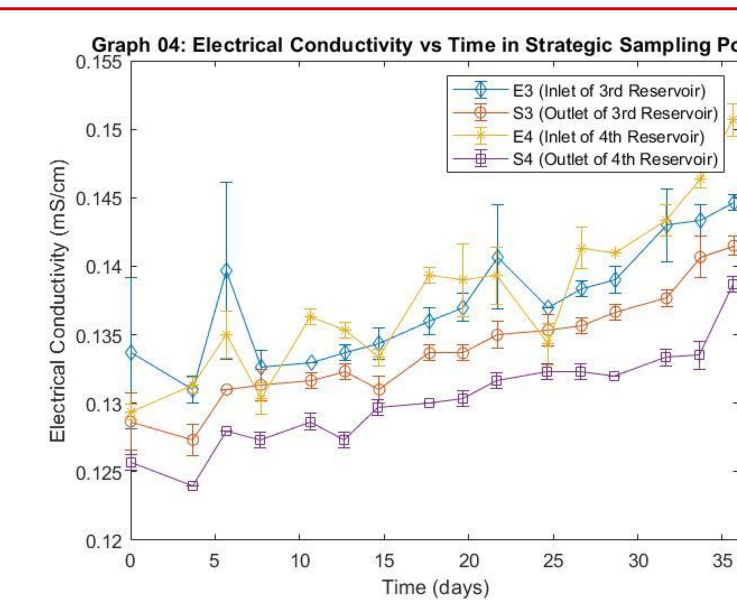


Table 02: Results of Total Phosphorus at Strategic Sampling Points

Total Phosphorus (mg/L)	E3 (Inlet of 3rd Reservoir)	S3 (Outlet of 3rd Reservoir)	E4 (Inlet of 4th Reservoir)	S4 (Outlet of 4th Reservoir)
June 08, 2021	-	-	2.152	0.072
July 22, 2021 (1st day of Phase II)	0.473	0.299	0.908	0.815
Aug 07, 2021 (16th day of Phase II)	0.063	0.044	0.097	0.043

Conclusions

- The results evidence that the structure studied reduces total phosphorus and nitrogen in the water, and this effect is increased with higher dissolved oxygen levels.
- The structure also reduces water turbidity and coloration at a faster rate than control samples.
- When installed in a reservoir, the structure considerably decreased total phosphorus concentration and increased dissolved oxygen at some points, thus improving the aquatic environment's ability to recover itself.
- This study provides data for future in-depth studies in which the structures could be further developed and applied to recover polluted water bodies.

References

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