From Living Systems to Clean Water:

Polycultures for Decentralized Water Remediation

Rita Morais[1], Marcos Cruz[2], Brenda Parker[1]
[1]VaxHub Sustainable, Dept of Biochemical Engineering, UCL, London, UK
[2]Bartlett School of Architecture, UCL, London, UK

Abstract

Water is a vital resource that supports all life forms and protects our communities and ecosystems. However, pollution from industrial processes and urban activities is threatening this essential resource. Additionally, traditional water treatment methods are often centralized, costly, and resource-intensive.

This project proposes a decentralized, nature-based approach to urban water remediation by integrating algal and bacterial polycultures into building surfaces. Using porous ceramic substrates designed for bioreceptivity and controlled water retention, the system fosters biofilm development that both treats greywater and sequesters CO2.

Objectives

01. To develop and test a ceramic-based, decentralized water treatment system that uses algae and bacterial consortia to remediate greywater and sequester carbon.

02. To design architectural surfaces that support biofilm development through controlled porosity and morphology.

03. To scale up the system to an architectural facade solution

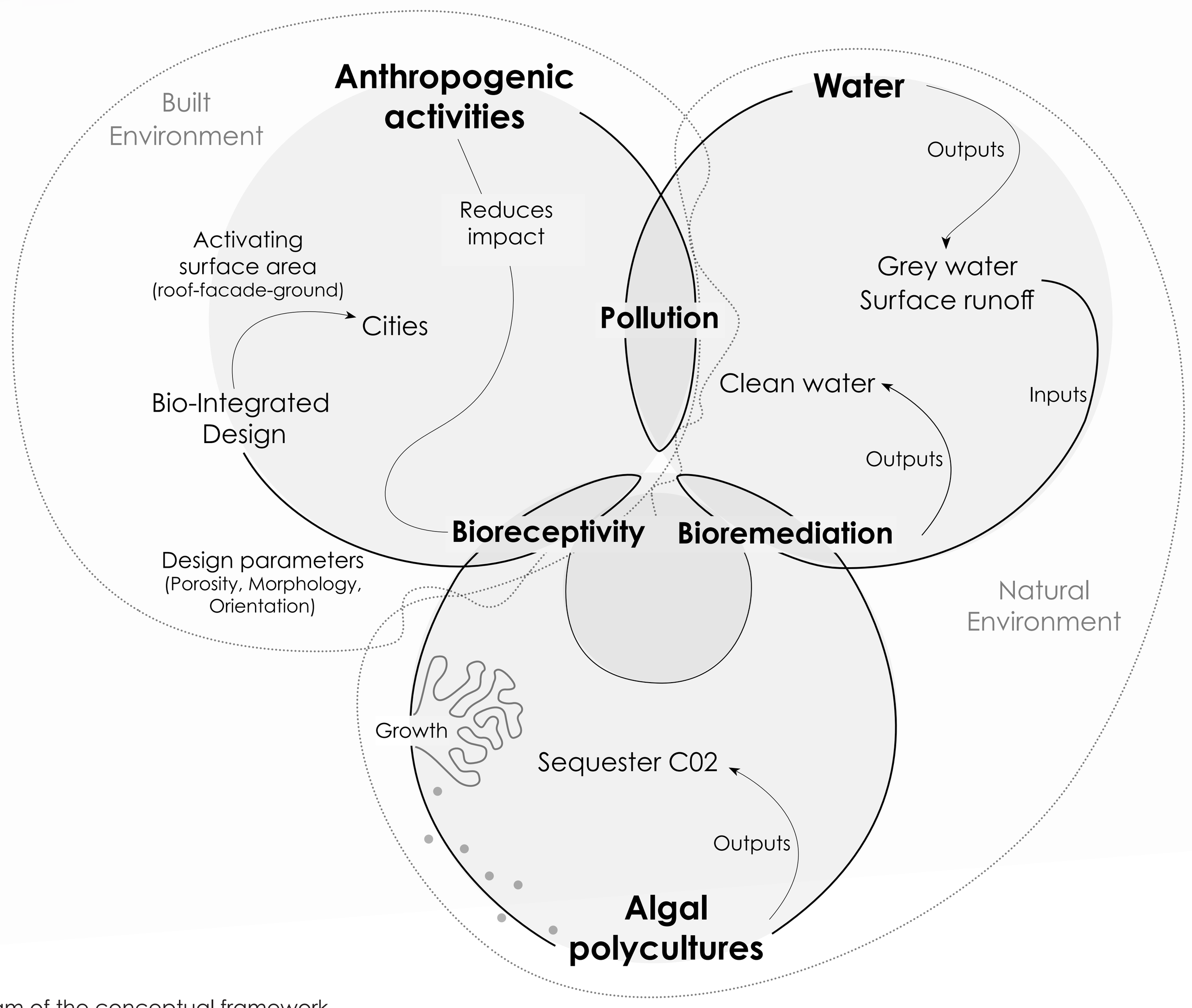


Diagram of the conceptual framework

Approach

Case Study 1: Augmented Polycultures

Augmented Polycultures (2024) by Studio Biocene is a vertical, gargoyle-like installation designed to grow algal polycultures by combining bioreceptive materials with advanced manufacturing. Made from porous ceramic via robotic extrusion, the structure is engineered to retain water and nutrients, promoting algae and bacteria growth.

Water circulating system

Ceramic tiles designed with computational methods and non-planar robotic extrusion

3D geometries that increase water retention

Cistern for controlled water flow and recycling

Water Pressure exhibition at the Museum of Arts and Crafts, Hamburg, March 2024

0 months

Main results

Museum für Gestaltung Zürich as part of the Water: Designing for the Future exhibition, November 2024

8 months

- Achieved stable growth of algae and bacteria on ceramic surfaces.
- The cistern system managed water circulation effectively, reducing run-off and improving treatment.

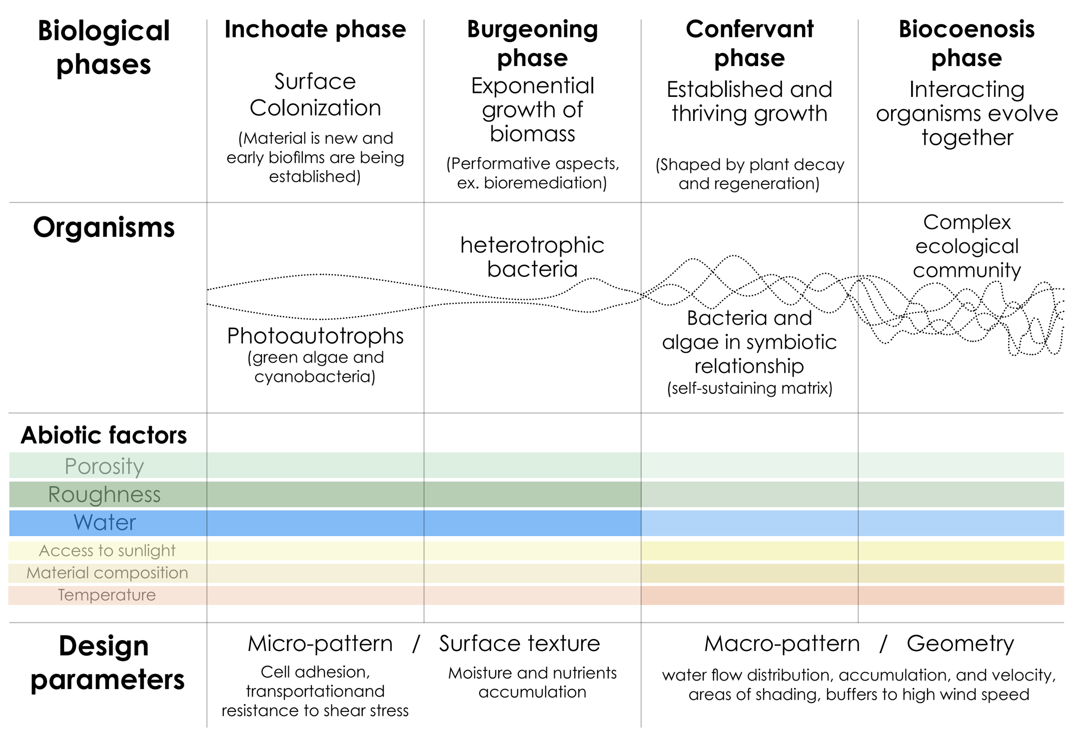


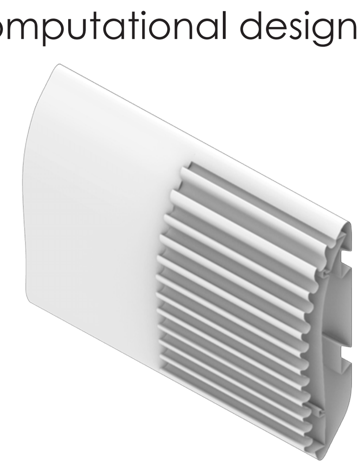
Diagram of series of biological phases identified through the lifespan of a design (Parker and Cruz, 2024), equivalent to Guillitte's bioreceptivity stages.

Continuation of the research

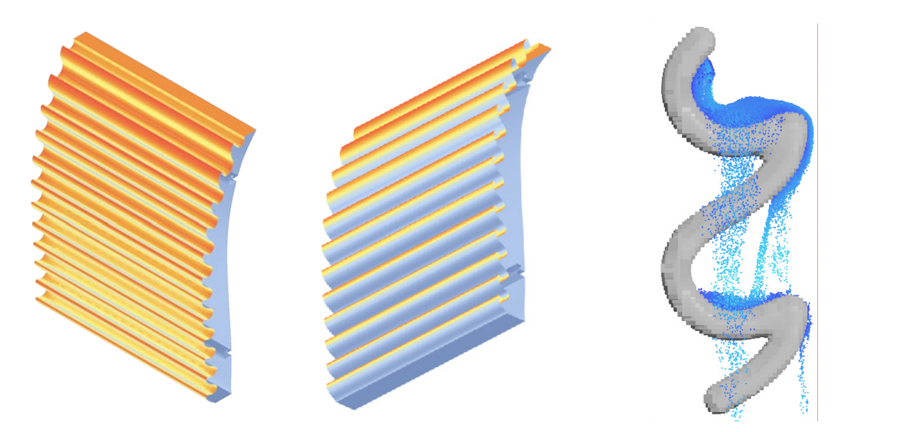
- Iterative workflow based on environmental simulations and fabrication.
- Scale up for architectural application.

Workflow:

01. Computational design



02. Environmental simulations of solar radiation and fluid flow



03. Robotically extrusion of clay

04. Physical testing and algae innoculation

Main results of initial algae inoculation on 3D printed ceramic tiles, which proven to be sucessful in supporting algae growth.

Conclusions

This project demonstrates how bio-integrated architectural systems can contribute to urban sustainability by embedding ecological function within the built environment. This project embraces a time-based model of biological succession, positioning microbial growth and material transformation as integral to a dynamic design language. Ongoing research will focus on testing hypotheses related to surface texture and geometry, with the aim of refining and scaling the system for application across architectural applications.

References

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