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UNESCO-IWRA ONLINE CONFERENCE
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Emerging Pollutants: Protecting Water Quality for the Health of People and the Environment

Addressing Emerging Contaminant Removal in Hospital Wastewater Treatment using Algal-Bacterial Consortia

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INTRODUCTION

- The centralized scheme of wastewater treatment is hugely incompetent to treat nutrient pollutants, let alone emerging contaminants.
- 80% of wastewater containing these emerging contaminants flows back into the ecosystem without receiving any specialized treatment
- Also, in view of the pandemic, the wastewater is overloaded with myriads of epidemiological vectors.
- The Central Wastewater Treatment Plants (CWWTPs) are currently dependent on heterotrophic microbes for pollutant removal.
- Due to the incompetency of the CWWTPs, nutrients and persistent pollutants remain a large problem and could pose detrimental effects on the biosphere, if not catered to.
- To eliminate the problems of CWWTPs, decentralized wastewater treatment systems (DWWTS) are being greatly researched and developed, which could serve as point-of-care systems and thereby, be used for remote locations as well.

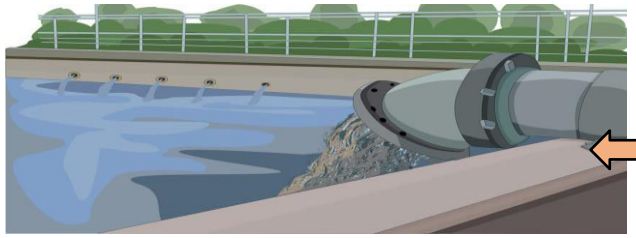
CURRENT SCENARIO

- In most developing countries including India, Hospital Wastewater (HWW) is mixed with Municipal Sewage.
- Daily wastewater discharge from hospitals is about 400 – 1200 L/capita/day.
- Hospitals discharge Persistent Organic Pollutants (POPs) like Pharmaceutical compounds, chemical compounds, surfactants and antibiotic-resistant bacteria (ARB).
- The volume of wastewater generated from hospitals depends on its size and type, patient intake capacity, technical facilities and miscellaneous services provided to patients.
- Mixing of Sewage and HWW chokes the treatment units and causes the release of these ECs into the environment.

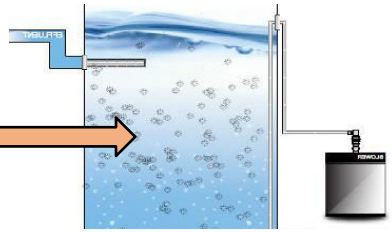
Hospital Wastewater scenario:
Increase in:

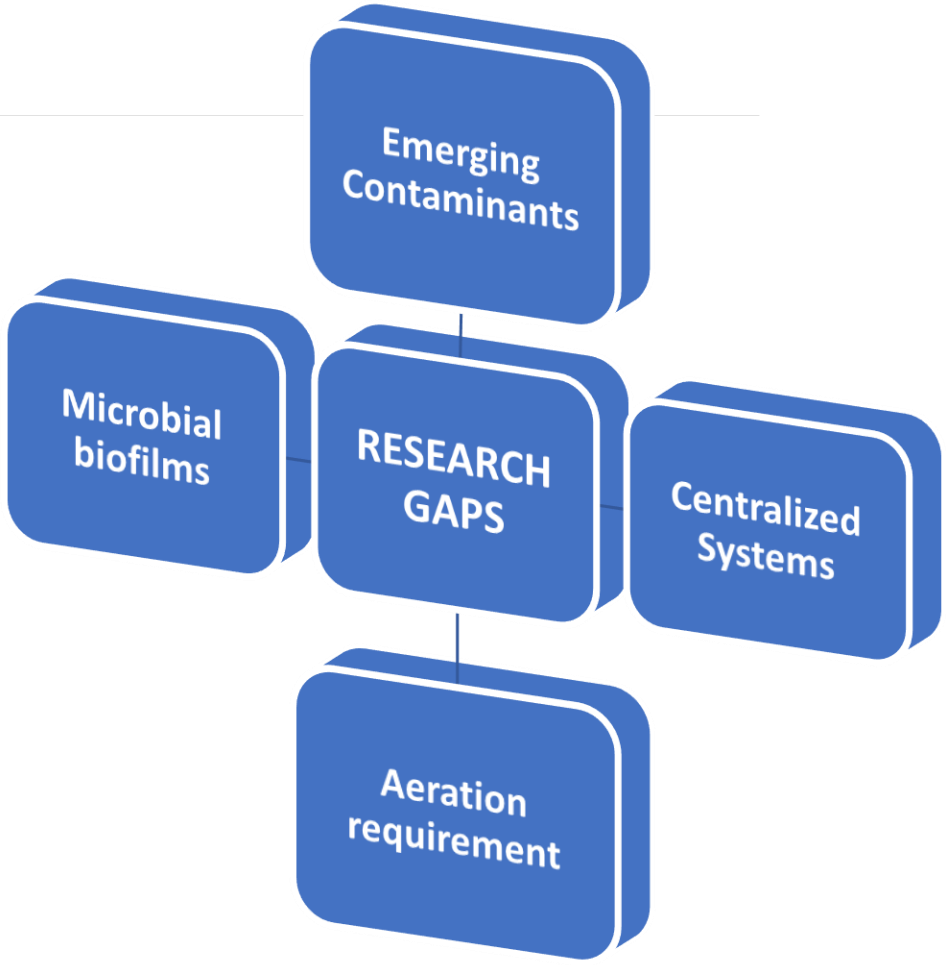
- Surfactants
- Disinfectants
- Pharmaceuticals

Centralized System



Decentralized System





HYPOTHESES

H1: The intrinsic availability of autotrophs in wastewater would be used such that a symbiotically functioning algal-bacterial community (ABC) is cultured. It is hypothesized that this would lead to a decrease in the treatment duration, a lowering of the HRT, and an increase the overall quality of treatment along with establishing appropriate emerging contaminant removal.

H2: Due to the well-established bio-accumulation, bio-disintegration and bio-adsorption characteristics of Algae, the resulting ABC system could be a promising sustainable and greener approach to wastewater treatment.

H3: Algae in the ABC being autotrophic in nature would produce oxygen and thereby help reduce the need for aeration. This reduction in aeration requirement may also be attributed to the development of an ABC biofilm on the Kaldness (K1) carriers which could further economize the MBBR treatment technology.

OBJECTIVES

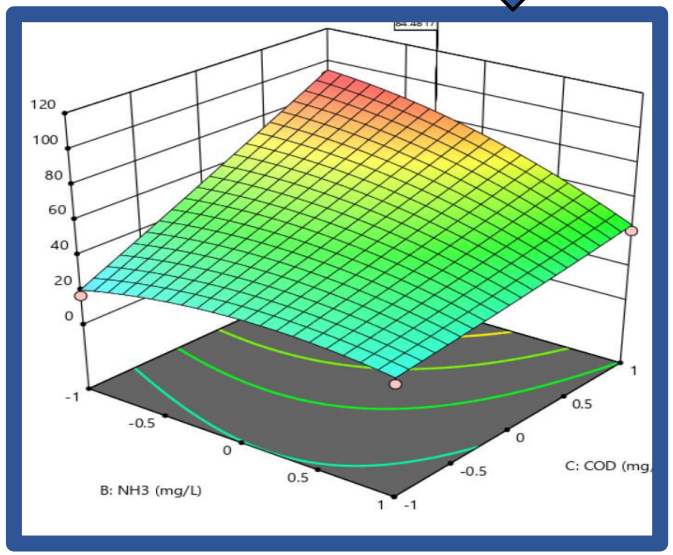
- To reduce the aeration requirement for the aerobic MBBR process by establishing a reliance on ABC.
- To achieve appreciable removal of antibiotics, surfactants and phenols.
- To study the removal rates of nutrient and ECs achieved using novel algal-bacterial consortia (ABC).
- To conduct ecotoxicological studies for the presence of ECs in wastewater and sludge component.
- To propose a modular, sustainable, economic, flexible and GREEN approach for HWW treatment.

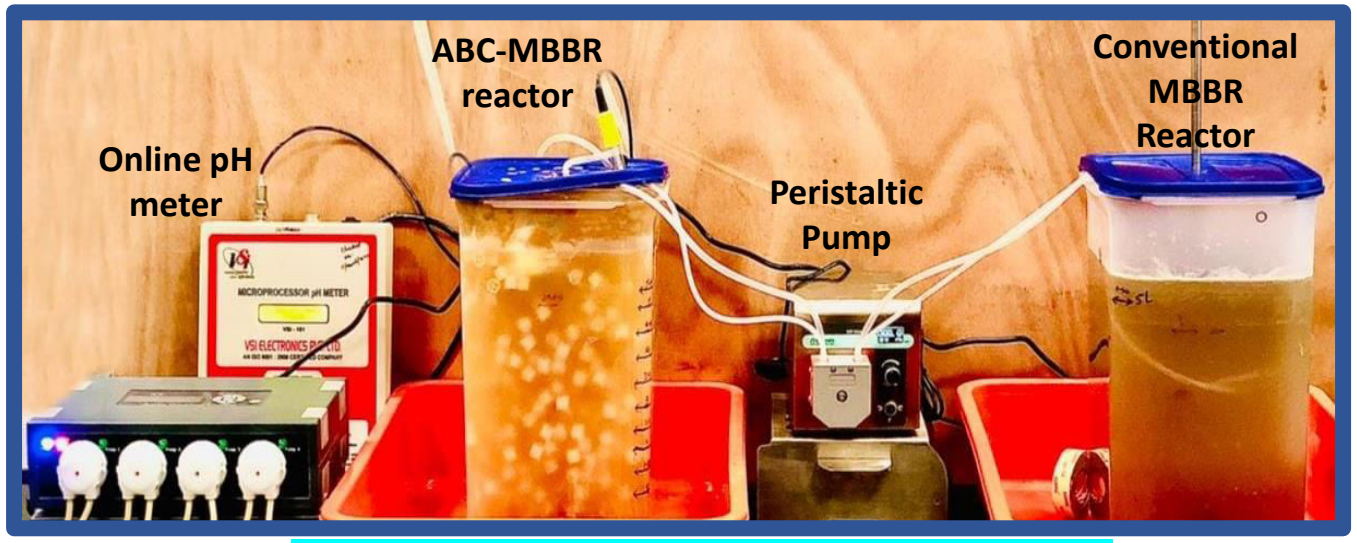
METHODOLOGY

Culturing of Algae

LEVELS	FACTORS
1. pH	3*3*3 = 27 outcomes
2. Ammonia Removal	6 Centre points
3. COD Removal	14 factorial points

Design of Experiment using CCD





Batch Operation for acclimatization

METHODOLOGY

- The acclimatized carriers and cultured algal-bacterial consortium will be studied for the removal of emerging pollutants in continuous operation (at least 45 days)
- Removal rates of the nutrients would also be studied in parallel.
- A comprehensive comparative assessment of native & conventional bacterial community-based MBBR vs. a novel and acclimatized ABC-based MBBR with respect to the anticipated emerging contaminant concentrations would be evaluated.

GPS-X™

Validation

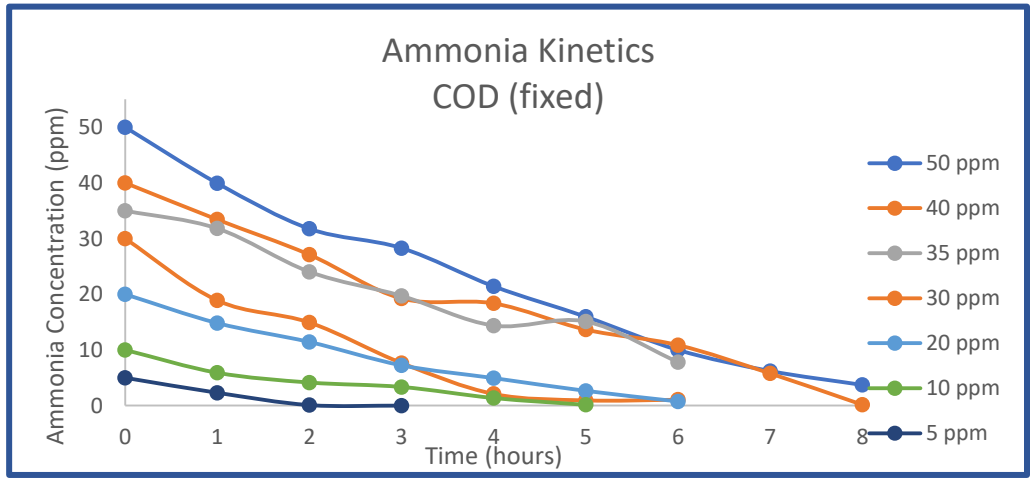
SUPERPRO DESIGNER

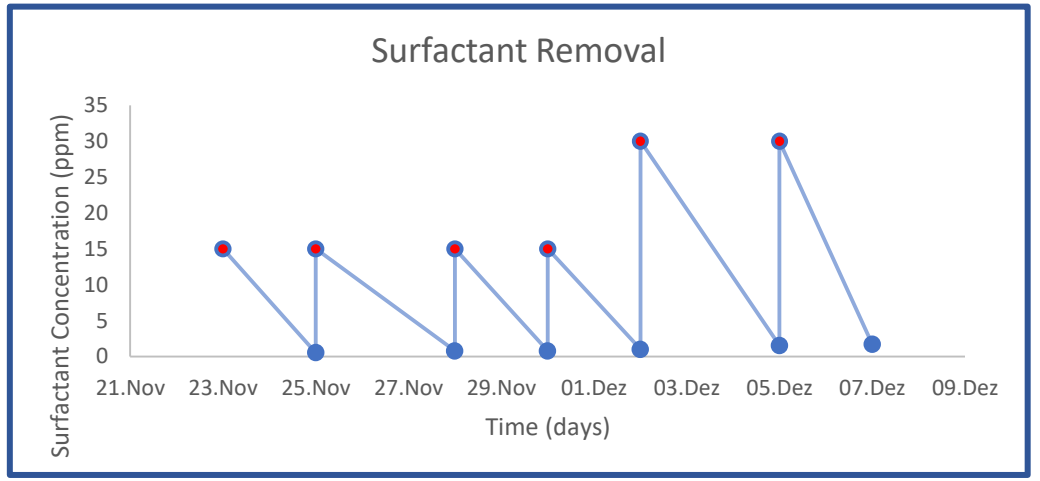
Techno-economic analysis

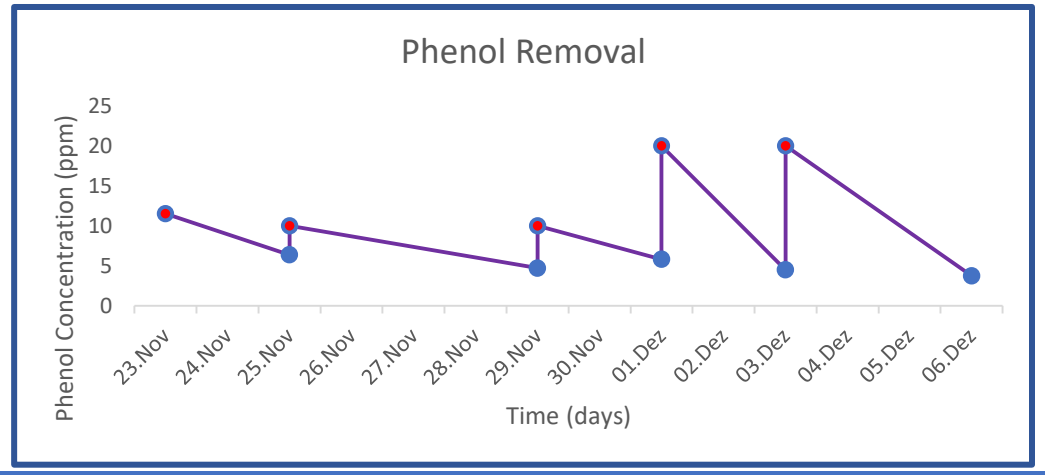
SimaPro

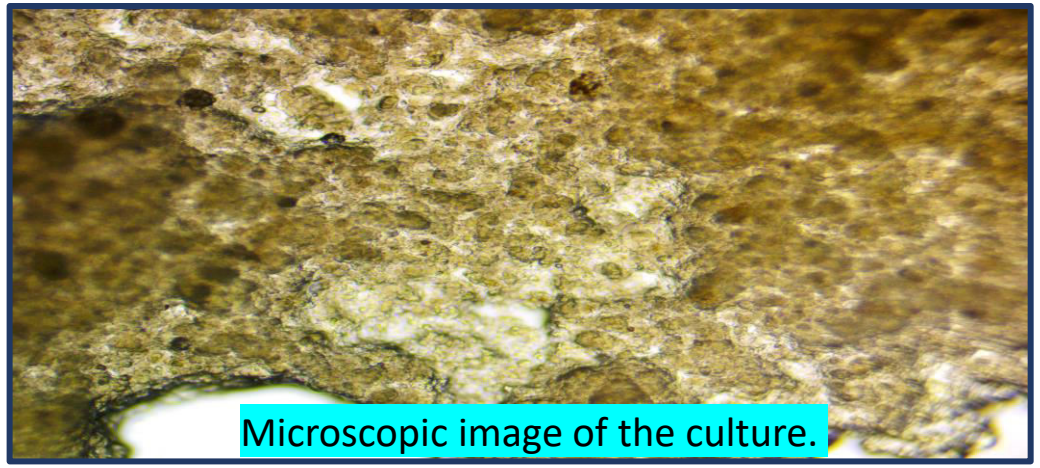
Life cycle assessment (LCA)

PRELIMINARY RESULTS








Microscopic image of the culture.

PRELIMINARY CONCLUSIONS

- The existing wastewater treatment facilities are incompetent to remove nutrient and organic pollutants, even in a HRT of 16 hours.
- The removal of Phenol and surfactants, i.e., the emerging contaminants (EC) was found to be highly appreciable.
- The novel algal bacterial consortia cultured in the lab is capable of removing the same in 6 – 8 hours.
- At least 70% removal for ammonia and more than 80 % COD removal has been observed.
- The continuous process would be used to simulate sewage treatment plant-like conditions at a pilot scale, along with observation of removal rates of conventional and emerging contaminants.

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