

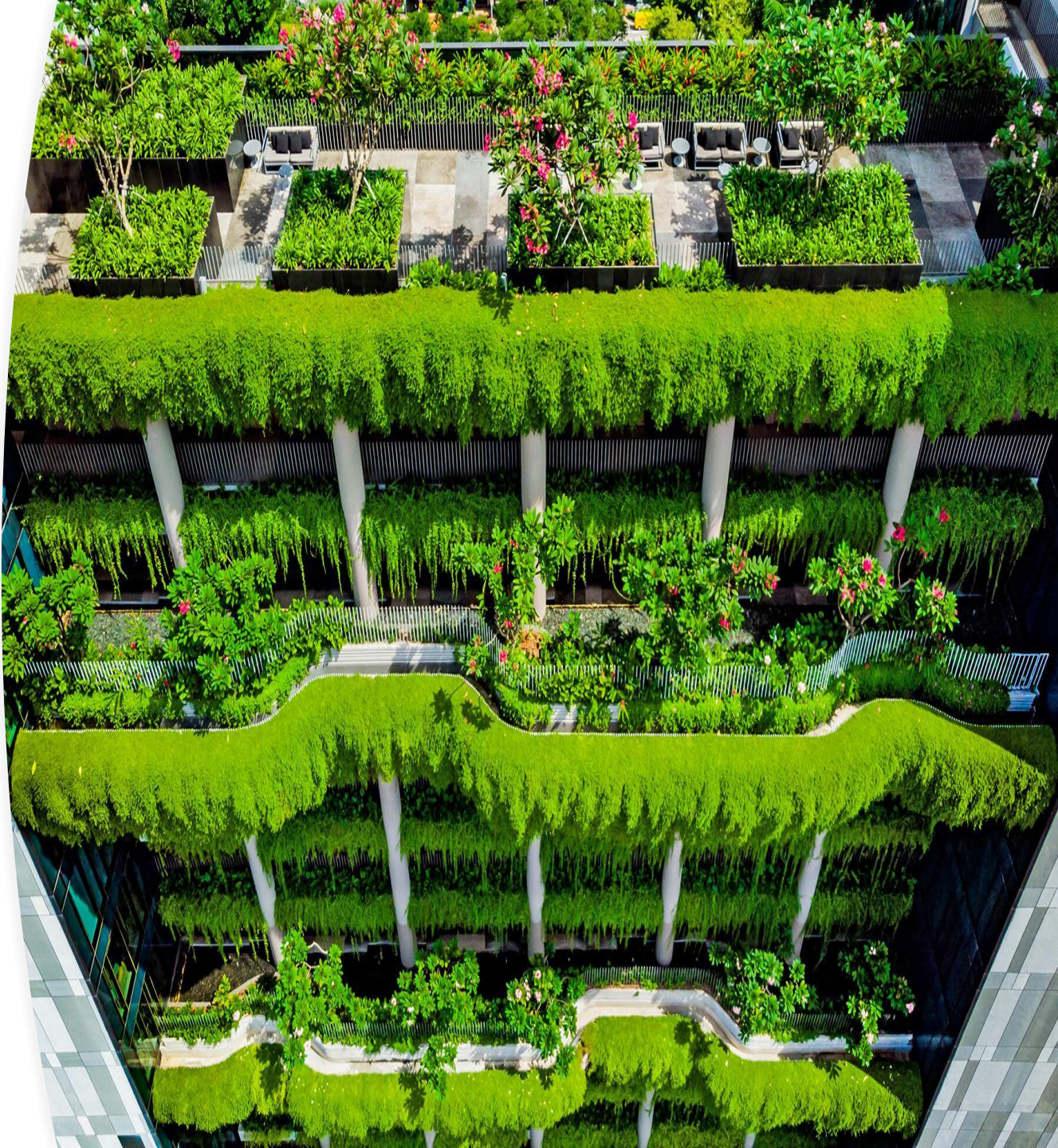
# Exploring the Potential of Green Walls in the Urban Desert Environment for Sustainable Water Management

Dr. Jayaprakash Saththasivam

QEERI

معهد قطر لبحوث البيئة والطاقة  
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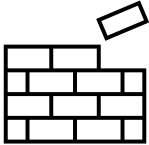


جامعة حمد بن خليفة  
HAMAD BIN KHALIFA UNIVERSITY





# Rising Water Table in Urban Areas



SWTR Risks			
Flooding	Structural Damage	Env. Impact	Contaminant Transport
			








# LIVING GREEN WALLS

**Bridging Nature and  
Urban Infrastructure**





# LIVING GREEN WALLS: An Urban Greening Approach

-  Water Conservation
-  Natural Filtration
-  Stormwater Management
-  Sustainable Solution
-  Aesthetic Improvement
-  Urban Resilience
-  Community Benefits







# Green Walls and Climate Change

## Mitigation

*Reduces energy use,  
lowering emissions*

## Adaptation

*Addresses  
groundwater and  
stormwater issues  
for urban resilience*

## Biodiversity Enhancement

*Supports urban  
biodiversity, enhancing  
ecosystem resilience*

## Temperature Regulation

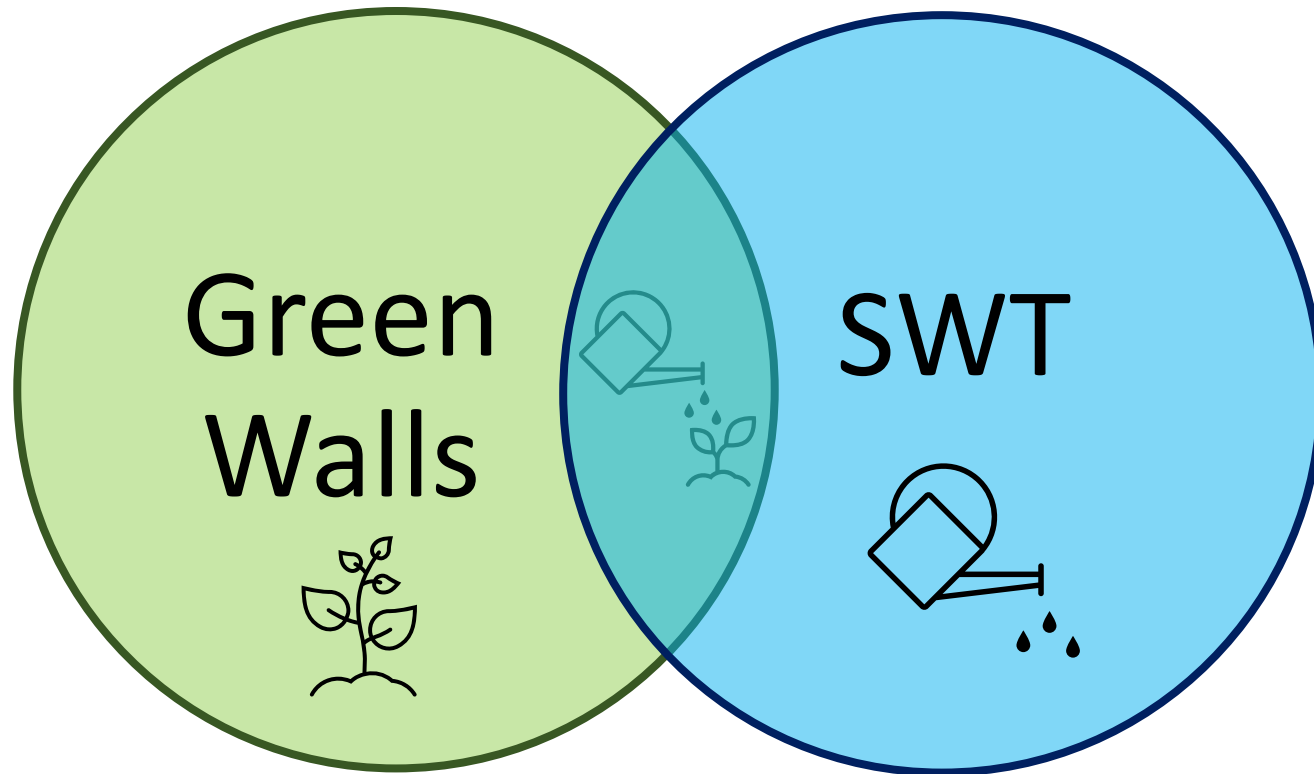
*Cools urban areas,  
reducing heat risks  
from climate  
change.*

## Community Engagement

*Engage communities  
in climate  
adaptation, building  
shared responsibility.*

# SWTR & Green Walls Synergy

❖ Green Walls issue: High Water Demand in hyper-arid environment



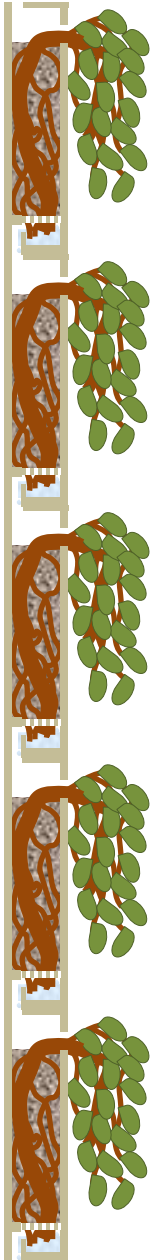
Pump and Treat SWT



Circular Water Economy

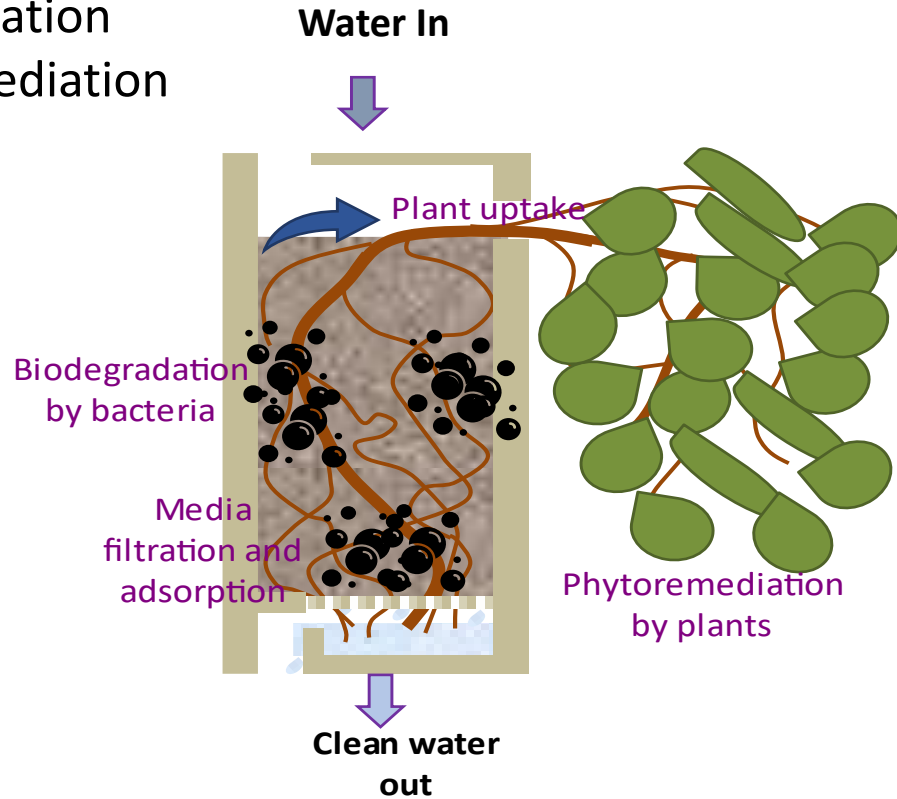
**Solution:**  
**Integrated Irrigation, Treatment and Reuse**



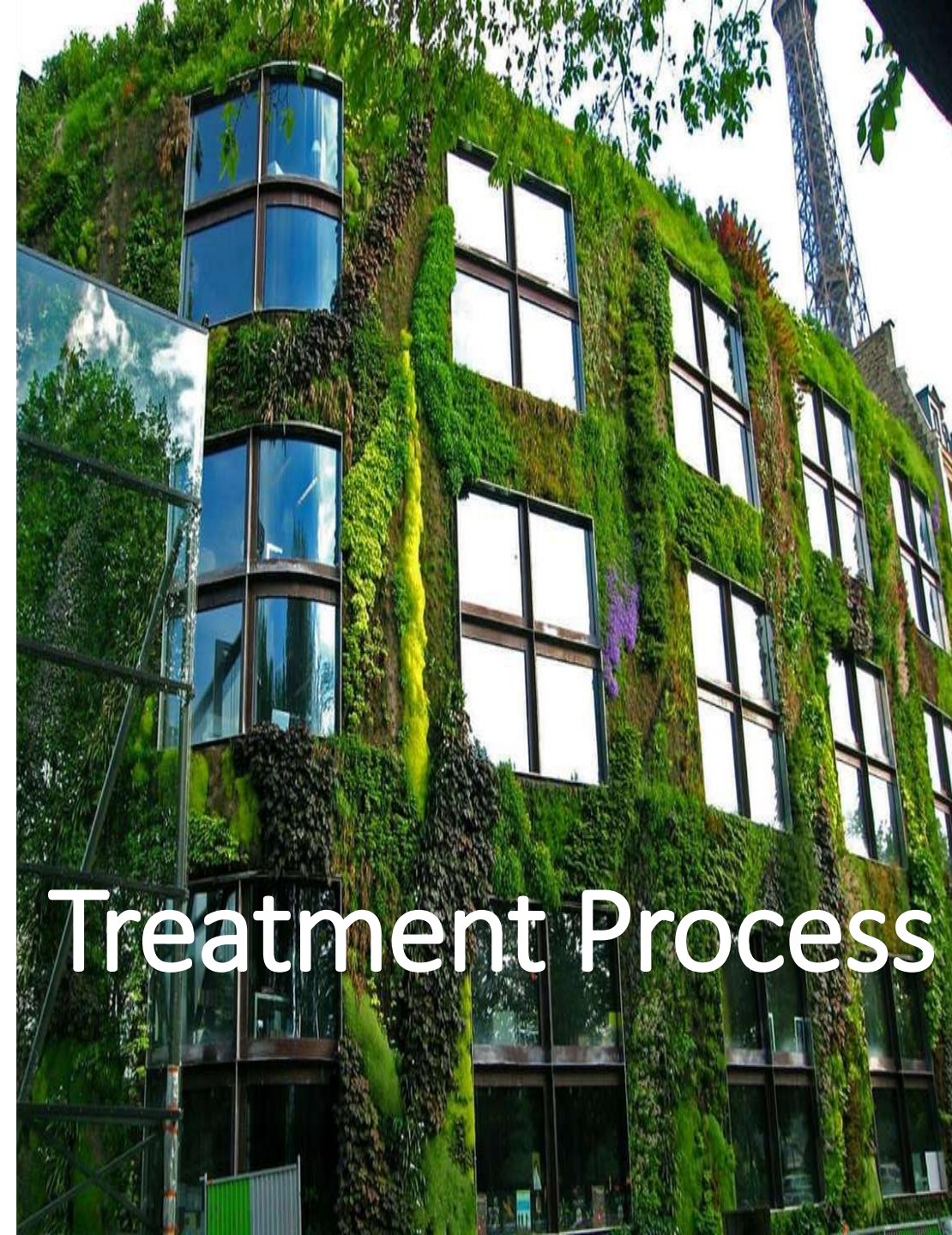


## WATER TREATMENT PROCESSES:

- Filtration
- Adsorption
- Biodegradation
- Phytoremediation



- ▶ Reduce the freshwater use in urban greening
- ▶ Recover water for further use (toilet flushing, further landscaping, outdoor cleaning)



# Treatment Process



# Project Novelty

NPRP12S-0226-190160

- One of first reported studies in a hyper-arid climate – for adaptation
- Reusing real greywater from student housing unit – pilot scale
- Study with suitable plants that grows easily and can be adopted in Qatar climatic conditions
- Study involving the integration of waste derived medias





# Results: Media Characterization

Parameters	pH	ECE ( $\mu\text{S}/\text{cm}$ )	Zeta potential (mV)	Moisture content <sup>(a)</sup> (%)	BET ( $\text{m}^2/\text{g}$ )	Bulk density ( $\text{g}/\text{cm}^3$ )	Porosity (%)
Coffee Biochar	7.58	25.53	-16.9	5.11	21.58	0.35	78
Zeolite	7.82	4.41	-47.3	14.6	0.67	0.84	85
Perlite	6.97	4.13	-21.9	8.94	1.39	0.08	90
Date stone	5.72	11.14	-45.9	9.64	0.01	0.82	63
Bone	7.02	10.64	-25.0	21.90	2.53	0.67	76
SCG	6.61	6.06	-29.0	68.55	0.04	0.49	61
Coco coir	6.28	45.04	-15.8	60.20	1.69	0.15	82

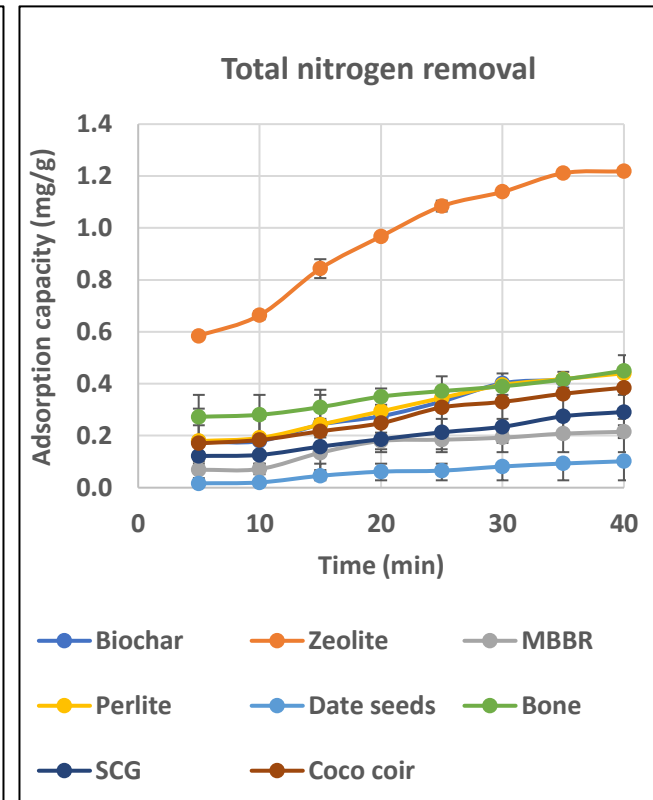
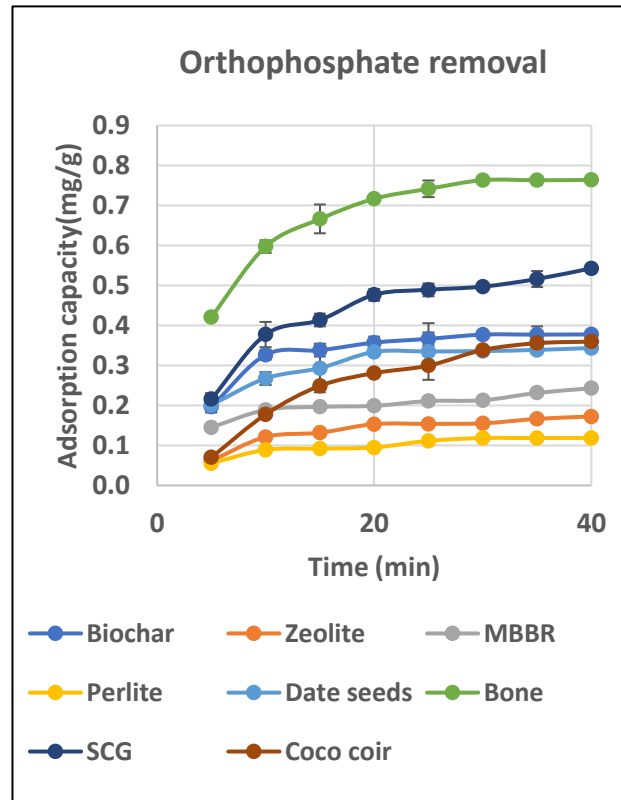
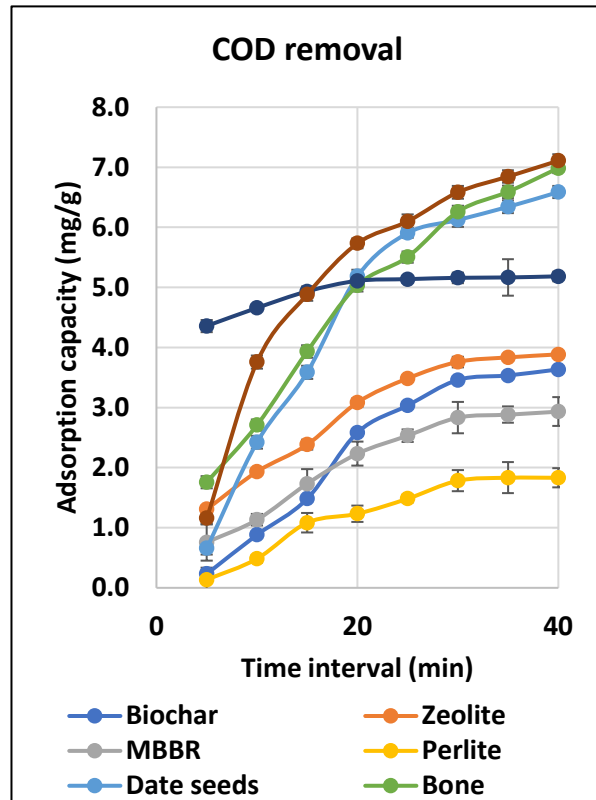
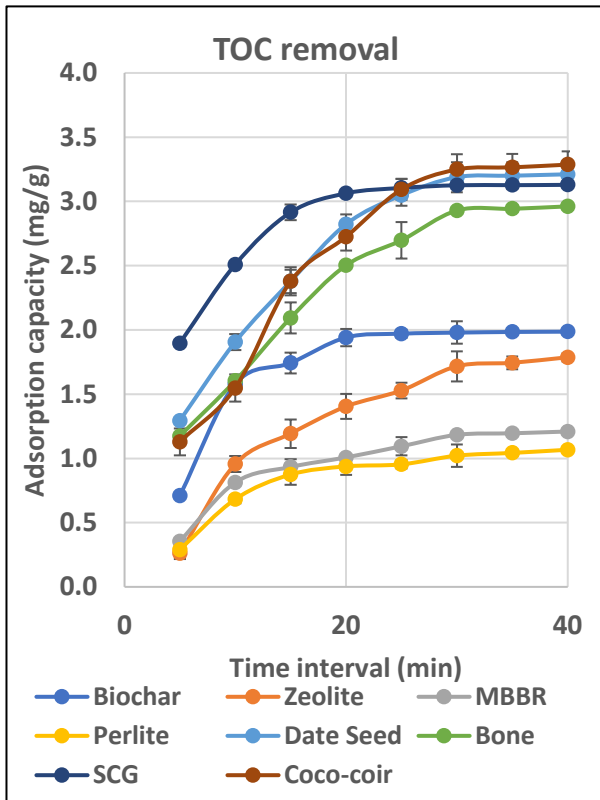


Media	Ultimate analysis (% w/w)				
	Carbon	Hydrogen	Nitrogen	Sulfur	Oxygen
Biochar	72.31	1.14	6.30	0	17.73
Date seed	48.95	7.23	3.35	0	39.68
Bone	14.33	1.31	8.60	0	23.62
SCG	26.91	2.14	5.54	0	65.26
Coco coir	44.24	5.31	4.57	0	31.99

Media	Proximate analysis*** (% w/w)					
	Moisture	Volatile matter	Ash	Fixed carbon	(H: C)	(O: C)
Biochar	5.42	9.12	2.52	82.94	0.02	0.25
Date seed	5.86	73.46	0.79	19.89	0.15	0.81
Bone	4.45	32.06	52.14	11.35	0.09	1.65
SCG	7.99	52.59	0.16	39.25	0.08	2.43
Coco coir	6.44	29.25	13.89	50.42	0.12	0.72



# Results: Nutrient Removal using Different Media





# Results: Column Studies



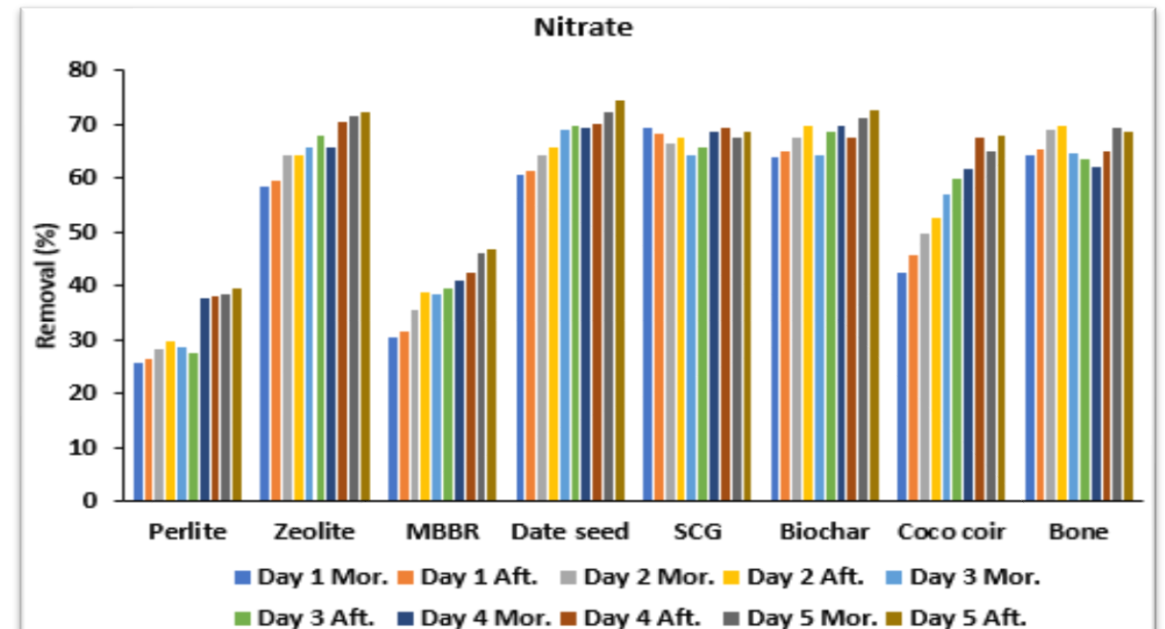
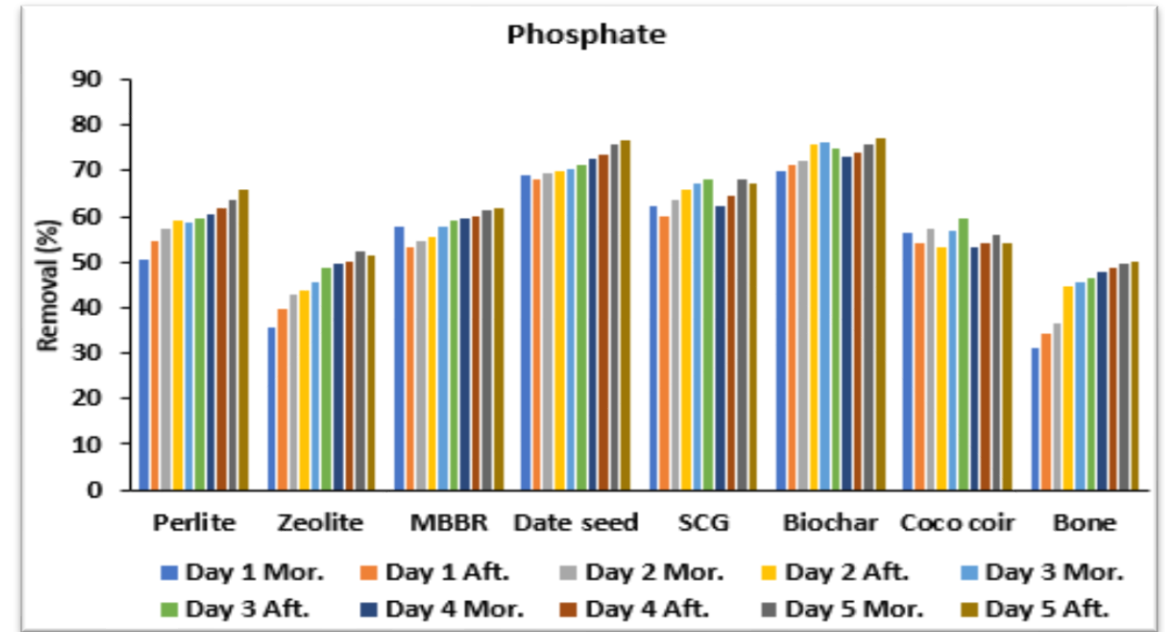
## Semi continuous flow

- 12.6ml/min for 3 hrs. continuous

## Intermittent flow

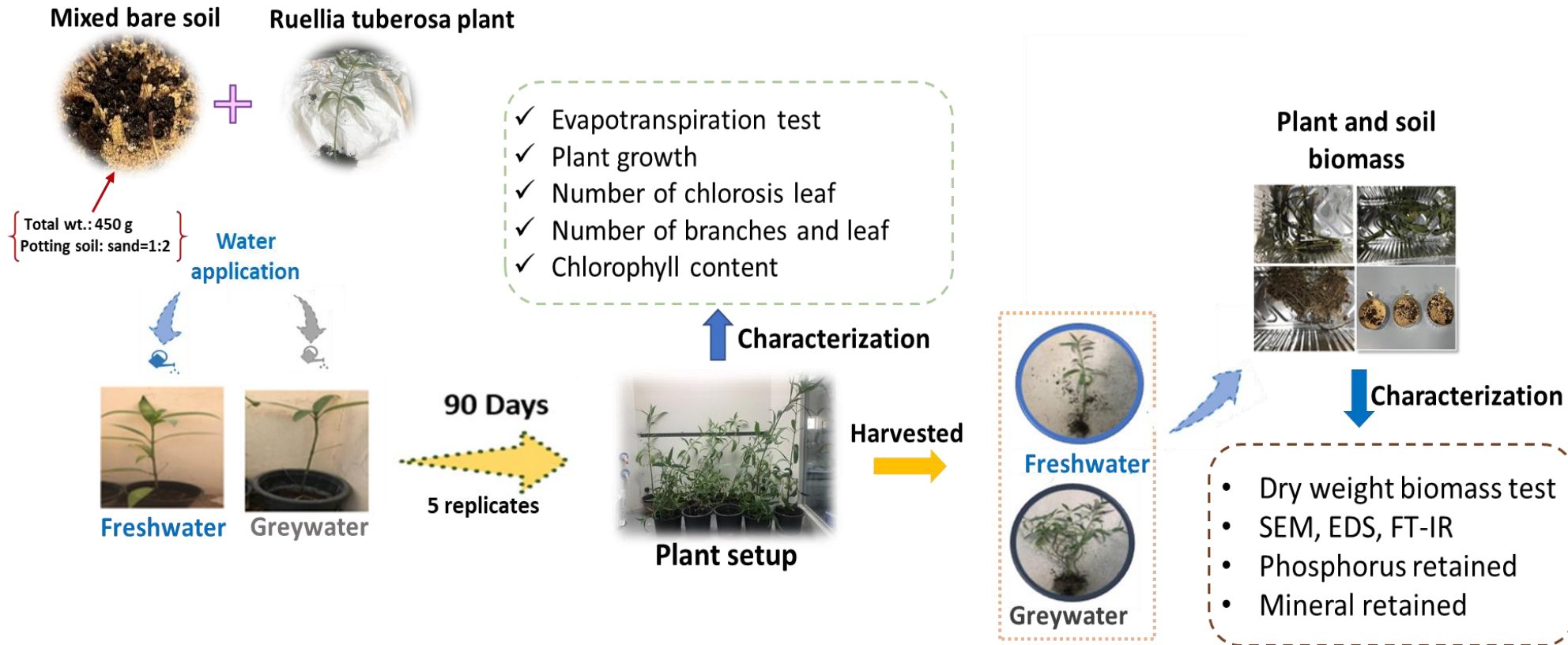
- 12.6ml/min for 1.5 hrs. in morning and 1.5 hrs. in afternoon

SL NO:	PARAMETERS	VALUES (RGW)	VALUES (mixed RGW:SGW)
1	pH	7.25	7.89
2	ECE	287 $\mu\text{S}/\text{cm}$	380.7 $\mu\text{S}/\text{cm}$
3	COD	19 mg/l	280 mg/l
4	TOC	6.6mg/l	114.3 mg/l
5	UV <sub>254</sub>	0.06	0.856
6	PO <sub>4</sub> <sup>3-</sup>	0.13 mg/l	10.45 mg/l
7	Nitrate	1.72 mg/l	33.87 mg/l

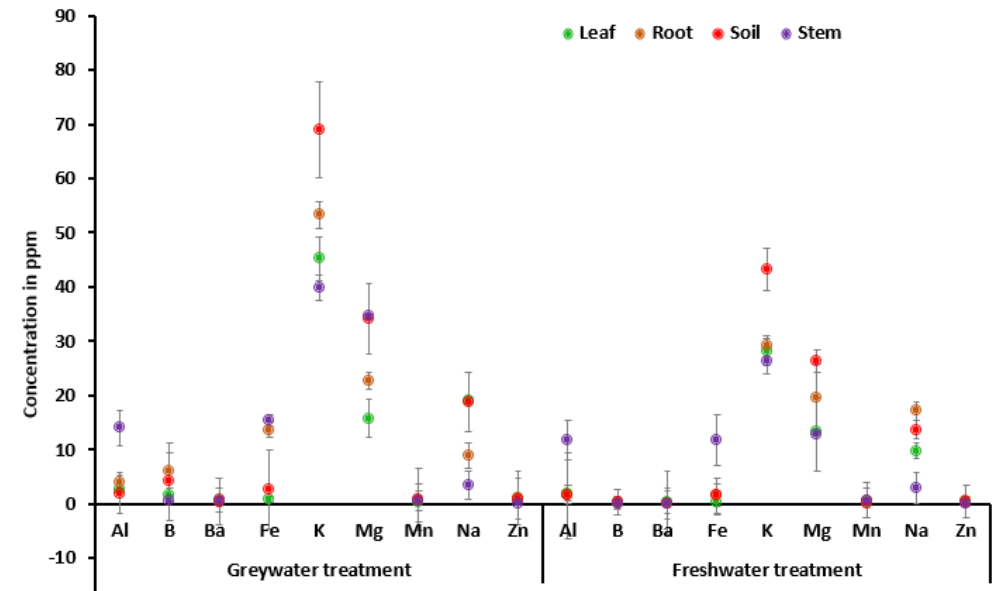
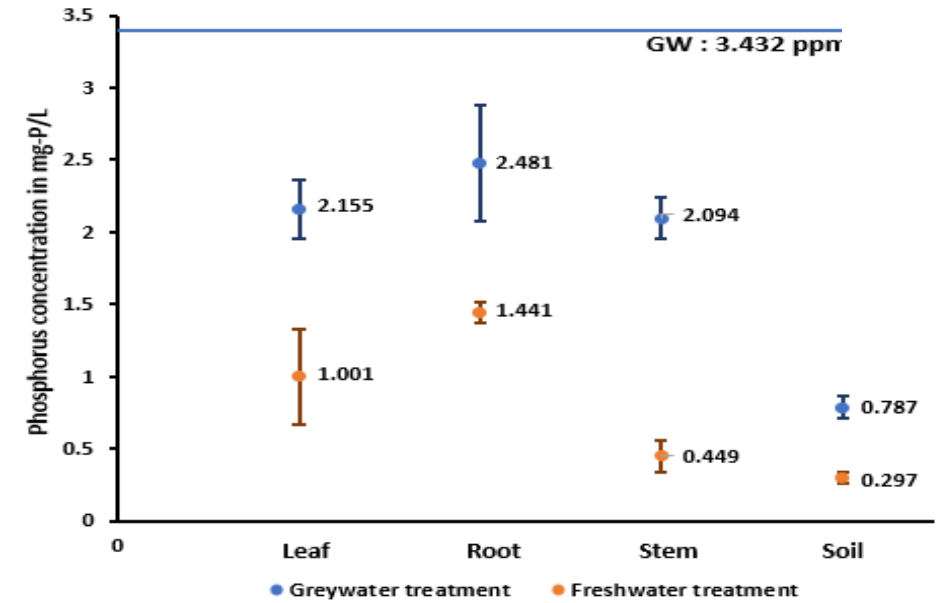
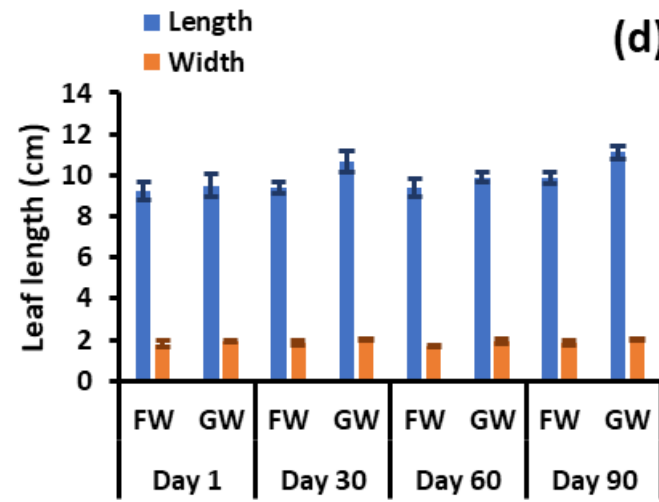
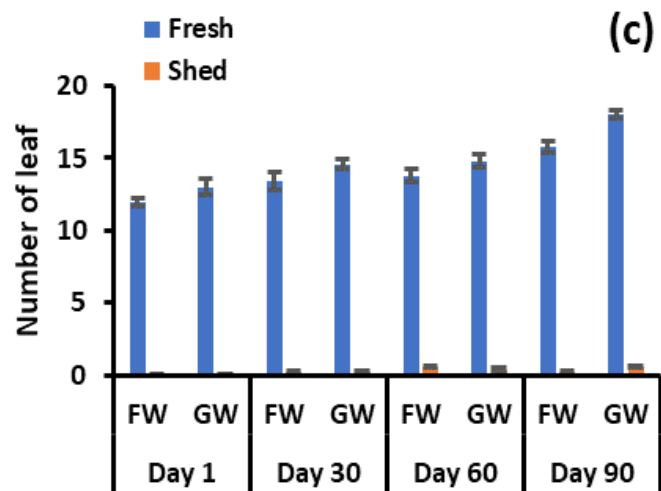
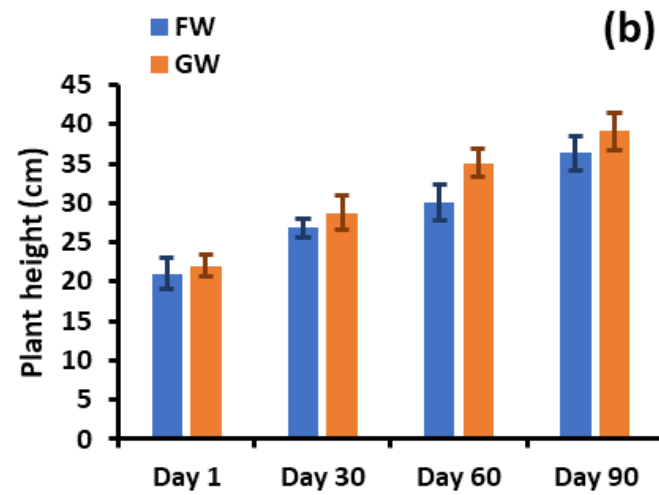
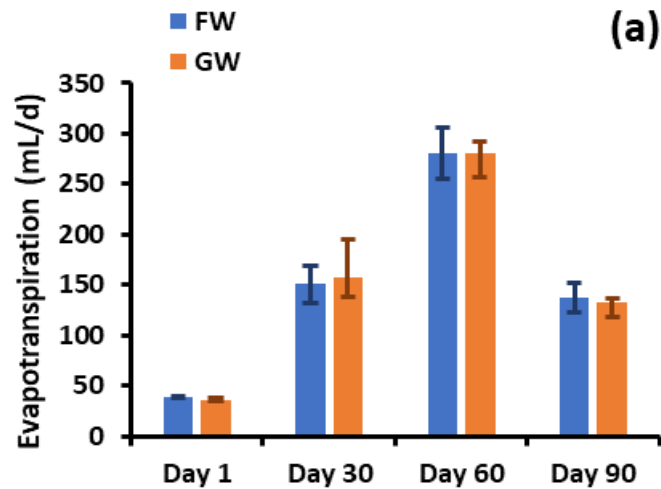




# Results: Lab/Indoor Studies

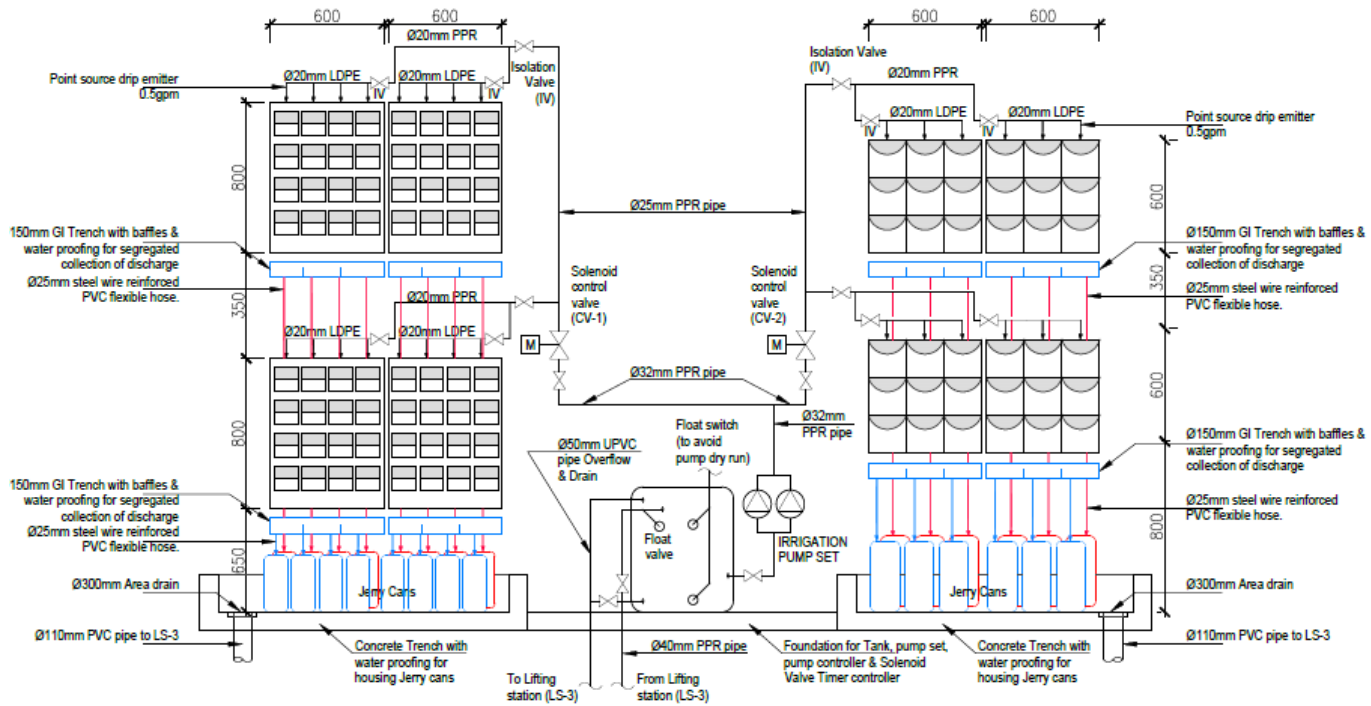


# Results: Lab/Indoor Studies

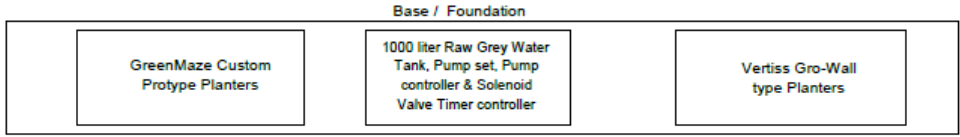




# Pilot Scale: Work in Progress



Green Wall - Elevation View



Green Wall - General Plan





# Pilot Scale: Work in Progress



*A. dentata*

*P. oleracea*

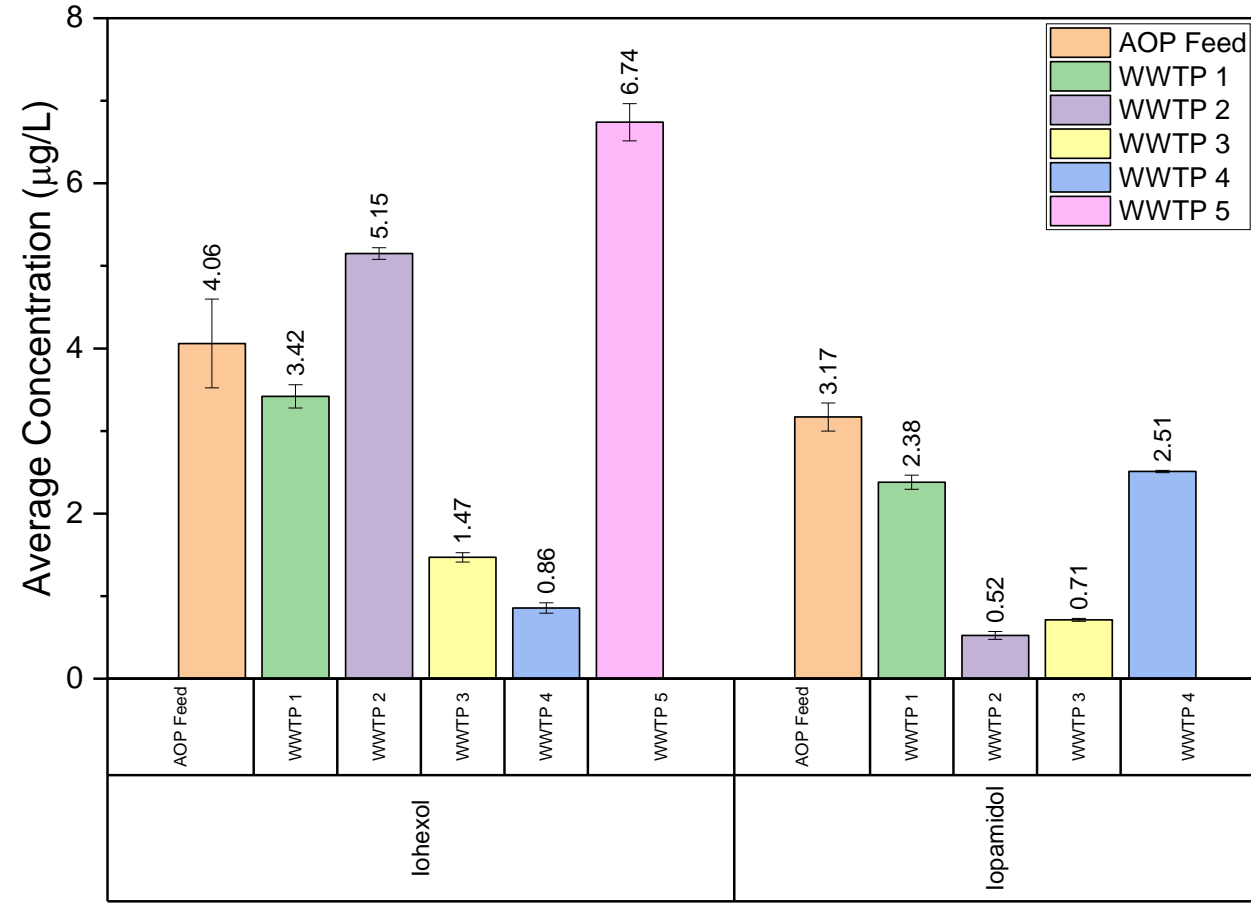
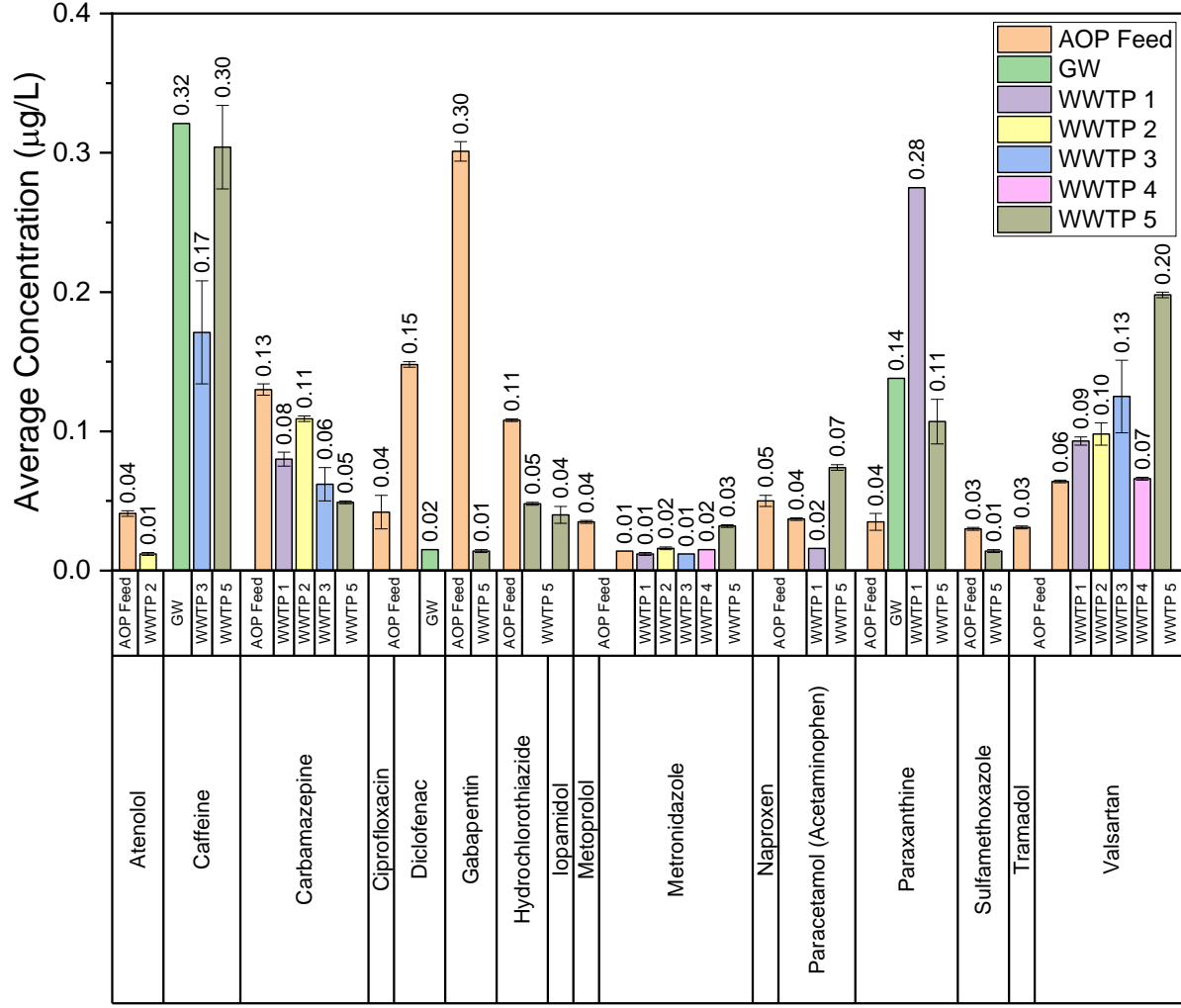


*P. Rubrum*

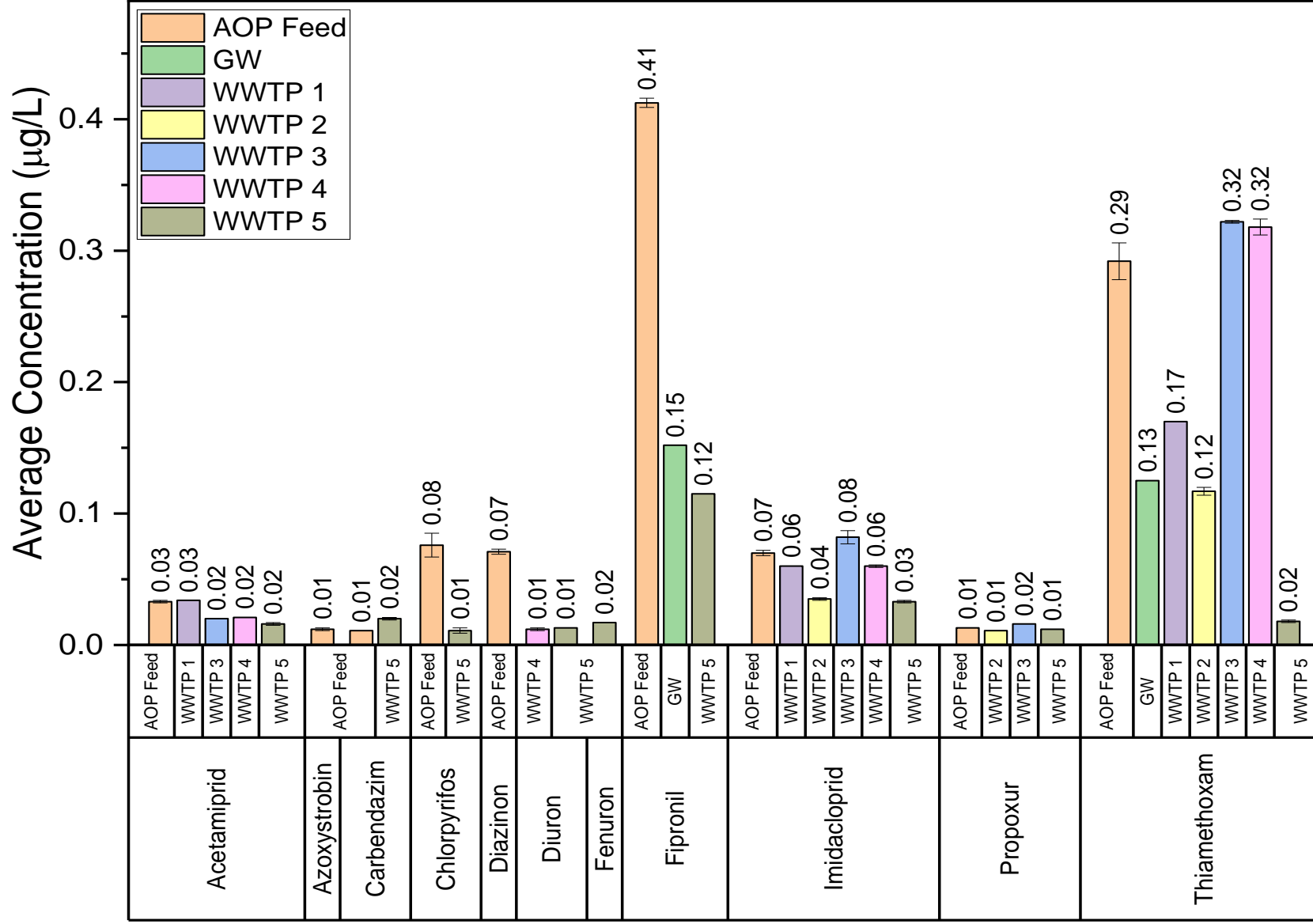
*Wedelia*



# Pharmaceuticals in Treated Sewage Effluent



# Pesticides in Treated Sewage Effluent





# Xenobiotic Removal (UNSW Team)

<https://doi.org/10.1016/J.WATRES.2022.118774>

- Investigated the performance of different light weight green wall media for the removal of XOCs from domestic greywater
- Two natural minerals (zeolite and perlite) and three carbonaceous waste materials (date seeds, coffee grinds, and coco coir)

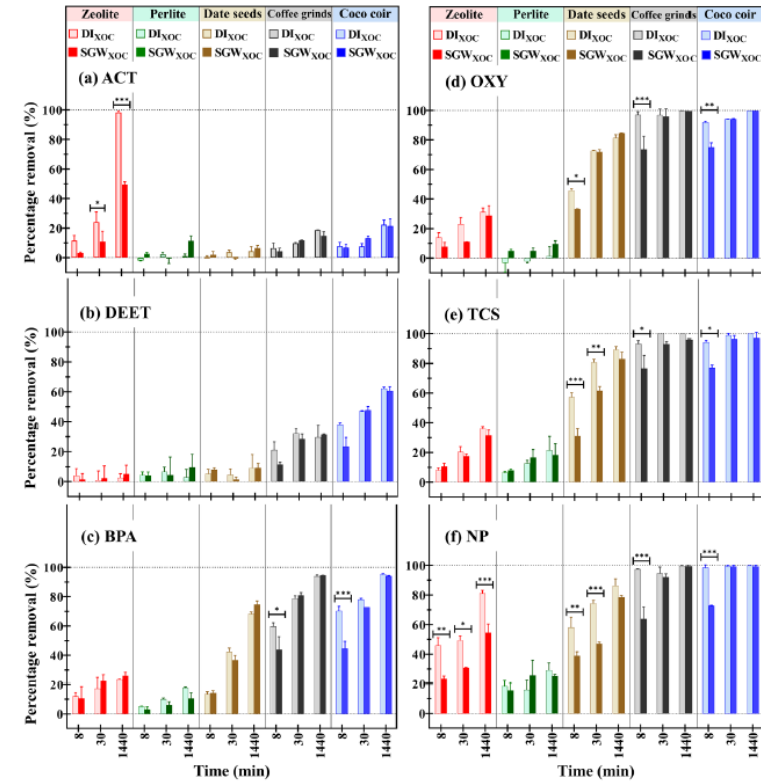
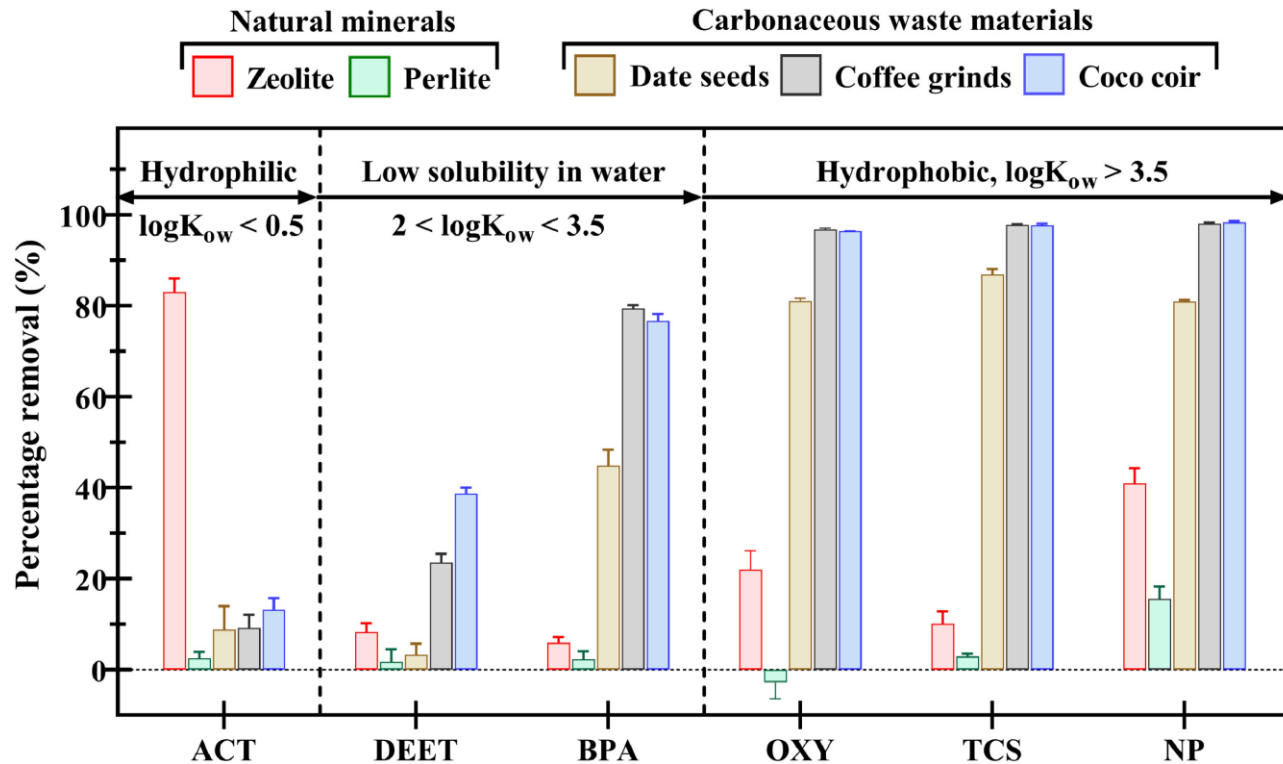


Fig. 7. The comparative removal of (a) acetaminophen (ACT), (b) diethyltoluamide (DEET), (c) bisphenol A (BPA), (d) oxybenzone (OXB), (e) triclosan (TCS), and (f) nonylphenol (NP) from DIxoc and SGWxoc by using different media types. The initial concentration of all XOCs was 5 µg/L. The statistical significance is presented using star (\*), where \* represent  $p < 0.05$ , \*\* represent  $p < 0.01$ , and \*\*\* represent  $p < 0.001$ .

# Key Questions

## SWT –Green Wall Integration

- Feed water quality
- Plant resiliency
- Selection of right light weight media
- Maintenance and Nutrient Balance
- Water availability and demand
- Infrastructure and System Design
- Long-term Viability
- Post treatment of effluent





# Recommendations

## Integrated Green Wall and Groundwater Management Strategies

- ✓ Develop Comprehensive Urban Strategies
- ✓ Identify Strategic Installation Sites
- ✓ Foster Interdisciplinary Collaboration
- ✓ Promote Holistic Urban Sustainability

## Incentives and Funding Mechanisms

- ✓ Establish Municipal Financial Incentive
- ✓ Facilitate Accessible Funding



# Acknowledgement

- QNRF (NPRP12S-0226-190160)
- Ms. Shaheeda Marakkur Anangaden (HBKU-CSE PhD Student)
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Thank you