Supplementary information

Green wall system coupled with slow sand filtration for efficient greywater management at households

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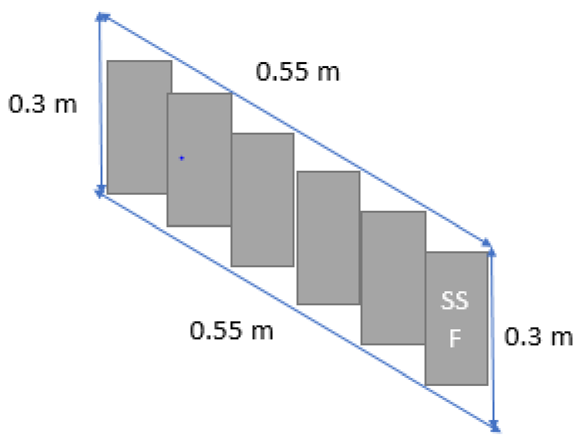
Supplementary Figure 1: Formation of Schmutzdecke layer on the top of the slow sand filter



Supplementary Figure 2: Measured dimension of a green wall system coupled with a slow sand filter demonstrated in this study

Supplementary Table 1: DO, pH, and fecal coliforms in the final effluent produced by slow sand filter at different tested HLRs

Parameter	Hydraulic loading rate (HLR)			
	187 cm d^{-1}	**374 cm d^{-1}**	**562 cm d^{-1}**	**749 cm d^{-1}**
pH	7.8 ± 0.2	7.75 ± 0.2	7.7 ± 0.3	7.9 ± 0.2
DO	6.6 ± 0.3	6.85 ± 0.3	6.8 ± 0.2	6.9 ± 0.2
Fecal coliforms (# per 100 ml)	$(0.8 \pm 0.4) \times 10^2$	$(2.6 \pm 0.6) \times 10^2$	$(2.5 \pm 0.7) \times 10^2$	$(4.6 \pm 0.6) \times 10^2$

Supplementary Table 2: Cost estimation of the green walls coupled with slow sand filter system.

Item used in system fabrication	~30 L d^{-1} system demonstrated in this study		Proposed 400 L d^{-1} treatment capacity system	
	Quantity used	**[1]Cost INR (USD)**	**Quantity required**	**Cost INR (USD)**
PVC pipes	2.5 m	320 (3.9)	10 m	1500 (18.4)
PVC end cap	12 nos.	480 (5.9)	40 nos.	2000 (24.6)
Flexible pipes	3 m	300 (3.7)	10 m	1000 (12.3)
Connectors and valves	variable	350 (4.3)	variable	750 (9.2)
Cocopeat	2 kg	210 (2.6)	10 kg	1000 (12.3)
Granular activated carbon	1.5 kg	100 (1.2)	10 kg	750 (9.2)
Sand	3 kg	-	10 kg	200 (2.5)
E. aureum sapling	8 nos.	-	40 nos.	200 (2.5)
Reservoir/tank with valve	1 no.	500 (6.1)	1 no. (500 L)	2000 (24.6)
Submersible water pump	1 no. (40W)	400 (4.9)	1 no. (0.5 hp)	2000 (24.6)
PVC Glue	100 ml	190 (2.3)	250 ml	400 (4.9)
Clamps	10 nos.	200 (2.5)	40 nos.	800 (9.8)
Manpower cost for system assembly	1 day	500 (6.1)	2 days	1000 (12.3)
Total capital cost	**3,550 INR or 43.6 USD**		**13,600 INR or 167.1 USD**	
[2]Recurring cost	**-**		**~1,000 INR or 12.3 USD**	

Note: No cost is included for Sand and *E. aureum* saplings for the demonstrated system, as these were arranged locally free of cost in this study.

[1]For currency conversion, US Dollar (USD) = 81.4 × Indian Rupees (INR)

[2]In recurring cost, the cost of replacing bed material is considered, which is expected to be on an annual or biannual basis. For the demonstrated system, the recurring cost was not estimated since no clogging issue occurred during the 8-month long experimental duration, which alleviated the cocopeat replacement requirement.

Supplementary Table 3: Comparison of the quality of reclaimed water from this study with the quality requirements or specifications for toilet flushing wastewater reuse of different countries or international standards mentioned in literature[1].

Parameter	Range of requirements
pH	6-9.5
Chemical oxygen demand (mg L^{-1})	50-100
Total nitrogen (mg L^{-1})	1.6-7.8
Total phosphorus (mg L^{-1})	0.2 max.
Turbidity (NTU)	0.5-10
Total coliforms (MPN per 100 ml)	0-240

Supplementary Note 1: Calculations for daily energy consumption

The actual time taken by a 40 W submersible water pump to lift 58 L of greywater to the reservoir during the experiment was ~ 5 min or 0.083 h.

Hence, energy consumption during study = 40×0.083 = 3.3 Wh or 0.003 kWh

Expected flow rate of the water pump (0.5 hp) for the reservoir placed at 2 m height = 30 L min^{-1}

Time needed to pump 400 L of greywater = 400/30 = 13.3 min or 0.22 h

Energy consumption of 0.5 hp (or 367.75 W) pump operated for 0.22 h = 367.75×0.22 = 80.905 Wh

Hence, the electricity consumption of the proposed 400 L d^{-1} treatment capacity system = ~ 0.080 kWh or units.

Supplementary Note 2: Calculations for Carbon or CO_2 footprint

Daily average COD fed to a system = COD of influent × Volume of greywater fed to a system = (0.26 g L^{-1}) ×10 L = 2.6 g

Total COD fed during the study period (i.e., 240 days) = 2.6 × 240 = 624 g

Net COD contributing to CO_2 release in the environment (considering the average 85% COD removal during the study period) = 530.4 g

TOC contributing to CO_2 release (considering the COD:TOC ratio of 2.5 as per literature[2]) = 530.4/2.5 = 212.2 g

CO_2 release from the completion conversion of 212.2 g TOC (considering CO_2/C ratio of 3.67) = 212.2 × 3.67 = 778.8 g

Total fresh weight of green (leaves and stem) biomass of *E. aureum* harvested from one green wall system (i.e., 4 plants) after 8 months of study = 190 g

Measured dry weight of *E. aureum* harvest (at 80 ^{0}C) = 28.5 g

Carbon content in herbaceous plant *E. aureum* (as per literature[3]) = 45%

Hence, carbon content in 28.5 g biomass = (28.5 × 45)/100 = 12.83 g

CO_2 consumed by a plant to accumulate 12.83 g C biomass = 12.83 × 3.67 = 46.9 g

Hence, reduction % of CO_2 release in the environment = (46.9 × 100)/778.8 = 6%

Supplementary References

1. Reynaert, E. *et al.* Practical implementation of true on-site water recycling systems for hand washing and toilet flushing. *Water Res. X* **7**, 100051 (2020).
2. Barzegar, G., Wu, J., Ghanbari, F. Enhanced treatment of greywater using electrocoagulation/ozonation: Investigation of process parameters. *Process Saf. Environ. Prot.* **121**, 125–132 (2019).
3. Ma, S., *et al.* Variations and determinants of carbon content in plants: a global synthesis. *Biogeosciences* **15**, 693–702 (2018).