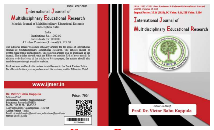

Cover Page

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY EDUCATIONAL RESEARCH
ISSN:2277-7881(Print); IMPACT FACTOR :10.16(2026); IC VALUE:5.16; ISI VALUE:2.286
Peer-Peer Reviewed, Refereed & Open Access International Journal - As per UGC Norms
(Fulfilled Suggests Parameters of UGC by IJMER)
Volume:15, Issue:7(3), July 2026
Scopus Review ID: A2B96D3ACF3FEA2A
Article Received: Reviewed: Accepted
Publisher: Sucharitha Publication, India
Online Copy of Article Publication Available: www.ijmer.in

TO STUDY RURAL GREYWATER TREATMENT SYSTEM DESIGN AND MANAGEMENT

[1]D Y Kiran Kumar and [2]Dr. Teena Narang
[1]PhD Research Scholar, Department of Electrical and Electronics Engineering, Vikranth University, Gwalior, MP, India
[2]Assistant Professor, Department of Electrical and Electronics Engineering, Vikranth University, Gwalior, MP, India

Abstract

Greywater—wastewater generated from kitchens, bathrooms, and laundry excluding toilet discharge—constitutes 50–80% of total domestic wastewater in rural households, yet it is largely discharged untreated into open drains, fields, or water bodies, creating public health risks and environmental degradation. This study examines the design, performance, and management of decentralized greywater treatment systems (DGTS) suited to rural and peri-urban settings where centralized sewerage is economically and technically infeasible. Using a combination of literature synthesis, comparative technology assessment, and secondary field data from Indian and international pilot projects, the study evaluates treatment trains comprising grease traps, settling tanks, sand/gravel filters, and constructed wetlands. Six case studies were compared for changes in water quality parameters – biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS) and fecal coliforms – before and after treatment. The results show that untreated greywater can be treated by simple and cost-effective systems to reduce the organic load and SS by 70-90%, enabling treated greywater to be used for irrigation and groundwater recharge. The study also finds that key drivers for system sustainability in the long-term are community management, cost recovery, and technical capacity. The paper concludes with a management framework integrating design standards, community participation, and monitoring protocols for scalable rural greywater treatment.

Keywords: Greywater Treatment, Rural Sanitation, Constructed Wetlands, Decentralized Wastewater Management, Water Reuse, Community Management, Low-Cost Technology

1. Introduction

1.1 Background

Access to safe sanitation remains one of the most persistent development challenges in rural areas of low- and middle-income countries. While considerable global attention has focused on toilet construction and fecal sludge management under programs such as India's Swachh Bharat Mission, comparatively little emphasis has been placed on the fate of greywater—the wastewater generated from bathing, washing clothes and utensils, and kitchen activities (Morel & Diener, 2006). However, greywater differs from blackwater (toilet water) because it contains fewer pathogens but still contains a high level of organic matter, oils, detergents, and suspended solids that may cause pollution in soil and water resources if discharged untreated (Ghaitidak & Yadav, 2013).

In the majority of the rural households in India, the greywater is either allowed to flow on the ground or into open drains, ponds, or nearby streams. Waterlogging around farmsteads, breeding of disease vectors like mosquitoes, shallow groundwater contamination for drinking, and degradation of surface water bodies (Bakare et al., 2017). The amount of greywater generated per household has increased over time as a result of piped water supply schemes like Jal Jeevan Mission, thus creating an issue of uncontrolled discharge of greywater (Ministry of Jal Shakti, 2021).

1.2 Rationale for Decentralized Treatment

However, centralized sewerage systems are more suited to urban areas where settlement is concentrated, population is high, financial resources are abundant and the technical expertise on operation and maintenance is available, but they are rarely feasible in rural areas where population is low, financial resources are limited, settlement is dispersed, and technical capacity for operation and maintenance is inadequate (Massoud et al., 2009). Designed at the household or cluster level, decentralized greywater treatment systems (DGTS) provide a technically simpler and more cost-effective solution. These systems generally include physical, biological, and sometimes chemical processes to achieve lower levels of organic matter, suspended solids, and pathogens that are safe for discharge or reuse (Li et al., 2009).

1.3 Objectives of the Study

This study aims to:

1. Review the characteristics and pollution potential of rural domestic greywater.
2. Compare design configurations of low-cost greywater treatment systems suitable for rural application.
3. Analyze treatment performance data (BOD, COD, TSS, and coliform removal) from documented pilot installations.
4. Evaluate the institutional, financial, and community-based management models that determine system sustainability.
5. Propose a design and management framework for scaling up rural greywater treatment.

1.4 Scope and Limitations

The study is based on secondary data drawn from peer-reviewed literature, government reports, and documented field pilots in India and comparable developing-country contexts (Kenya, Jordan, Sri Lanka). It does not include primary laboratory testing but synthesizes verifiable published performance data to derive design and management recommendations.

2. Literature Review

2.1 Characteristics of Greywater

Greywater quality varies considerably depending on source (kitchen, bathroom, or laundry), water use habits, and the type of detergents and cleaning agents used. Eriksson et al. (2002) described greywater as having moderate BOD (90–400 mg/L), COD (200–700 mg/L), and TSS (50–300 mg/L) concentrations; in most cases, the organic loads of kitchen greywater are the highest, caused by oils and food residues. Similar ranges were observed in Indian villages; BOD 150–350 mg/L and TSS 100–250 mg/L for mixed household greywater (Ghaitidak & Yadav, 2013).

2.2 Treatment Technologies

There are various low-cost technologies documented for greywater treatment in rural and resource-constrained environments:

- Gravity separation: Oils, fats, and coarse solids are removed from the stream by gravity in grease traps and settling tanks (Morel & Diener, 2006).
- Sand and gravel filters: offer both physical filtering and a growing biofilm that will facilitate the biological degradation of organic matter (Li et al., 2009).
- Constructed wetlands: Planted media beds (horizontal or vertical flow) will remove organics, nutrients, and pathogens through microbial and plant-root processes; extensively proven to be effective and easy to maintain in rural settings (Vymazal, 2010).
- The soil biotechnology and soak pits are used for final disposal or groundwater recharge, which allow infiltration and natural attenuation (Bakare et al., 2017).
- Constructed wetland – soak pit hybrids: This is a combination of both the biological treatment and subsurface disposal, which has been reported extensively in the rural sanitation programmes of India (Centre for Science and Environment [CSE], 2015).

Cover Page

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY EDUCATIONAL RESEARCH
ISSN:2277-7881(Print); IMPACT FACTOR :10.16(2026); IC VALUE:5.16; ISI VALUE:2.286
Peer-Peer Reviewed, Refereed & Open Access International Journal - As per UGC Norms
(Fulfilled Suggests Parameters of UGC by IJMER)
Volume:15, Issue:7(3), July 2026
Scopus Review ID: A2B96D3ACF3FEA2A
Article Received: Reviewed: Accepted
Publisher: Sucharitha Publication, India
Online Copy of Article Publication Available: www.ijmer.in

2.3 Reuse Potential

Greywater can be reused for irrigation, groundwater recharge and non-potable domestic uses when the levels of pathogens and salinity are controlled, and recent studies in the field indicate that treated greywater has considerable potential for reuse (World Health Organization [WHO], 2006). The WHO guidelines for wastewater reuse in agriculture suggest that the limits for the fecal coliforms should be less than 1000 cfu/100mL, which is often used as an indicator to judge the efficacy of wastewater treatment in rural greywater systems.

2.4 Management and Sustainability Factors

Many studies have called attention to the fact that technical design is not sufficient for sustainability. Massoud et al. (2009) claim that the primary reason for the failures of decentralized systems is less technical and more related to inadequate operation and maintenance (O&M) arrangements. Community-based management models, cost-sharing systems, and capacity building of community operators are targeted as critical success factors (CSE, 2015; Reymond et al., 2016).

3. Methodology

3.1 Research Design

This research is a descriptive-analytical type of research using secondary data synthesis. It draws on:

1. Journal articles focused on the characteristics and effectiveness of greywater treatment, peer-reviewed.
2. Government and institutional reports on rural sanitation (Ministry of Jal Shakti, CSE, WHO).
3. Documented field pilot data from India, Kenya, Jordan, and Sri Lanka, selected for comparability of climate, water use pattern, and rural infrastructure context.

3.2 Data Compilation

Water quality performance data (influent and effluent BOD, COD, TSS, and fecal coliform counts) were compiled from six documented case studies. Removal efficiencies were calculated using the standard formula:

$$\text{Removal Efficiency (\%)} = \frac{C_{in} - C_{out}}{C_{in}} \times 100$$

where C_{in} and C_{out} represent influent and effluent concentrations, respectively.

3.3 Comparative Framework

Capital cost, O&M requirement, land area requirement, and treatment efficiency were used as criteria to compare the technologies, and a qualitative scoring method was adopted based on published cost data (Massoud et al., 2009 and CSE, 2015).

4. Outline design of Rural Greywater Treatment System

4.1 General Treatment Train

A typical rural greywater treatment train (as observed in the Indian decentralised wastewater management system (DEWATS) applications) involves sequential treatment stages:

Settling/Baffle Tank → Grease Trap → Filter Bed (Sand/Gravel) → Constructed Wetland → Soak Pit / Irrigation Outlet

Cover Page

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY EDUCATIONAL RESEARCH
ISSN:2277-7881(Print); IMPACT FACTOR :10.16(2026); IC VALUE:5.16; ISI VALUE:2.286
Peer-Peer Reviewed, Refereed & Open Access International Journal - As per UGC Norms
(Fulfilled Suggests Parameters of UGC by IJMER)
Volume:15, Issue:7(3), July 2026
Scopus Review ID: A2B96D3ACF3FEA2A
Article Received: Reviewed: Accepted
Publisher: Sucharitha Publication, India
Online Copy of Article Publication Available: www.ijmer.in

The grease trap catches floating oils; the settling tank removes heavier particles by settling; the filter bed provides mechanical filtration, and also contains biological substrate (also called a biofloc) that facilitates the degradation of organics, nutrients, and pathogens; and the constructed wetland further polishes organics, nutrients, and pathogens before final disposal or reuse (CSE, 2015).

4.2 Design Parameters

The design of each unit is based on the expected greywater flow, which is usually assumed to be 60-80% of the total water supplied to each household (Bakare et al., 2017).

For a rural household using approximately 100 liters per capita per day (lpcd) under schemes such as Jal Jeevan Mission, greywater generation is estimated at 60–80 lpcd.

Table 1 summarizes standard design parameters for a household-level constructed wetland-based greywater treatment system serving a family of five (approximately 350–400 liters/day).

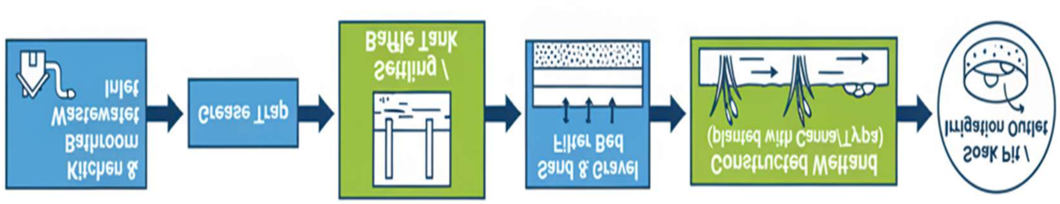
Table 1:Standard Design Parameters for A Household-Level Constructed Wetland-Based Greywater Treatment System

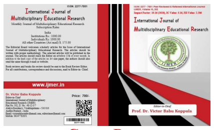
Component	Design Parameter	Typical Value	Source
Grease trap	Retention time	15–20 minutes	Morel & Diener (2006)
Settling tank	Hydraulic retention time (HRT)	1–2 days	Li et al. (2009)
Sand/gravel filter	Filtration rate	0.2–0.4 m³/m²/day	Vymazal (2010)
Constructed wetland (horizontal flow)	Area requirement	1–2 m² per person	Vymazal (2010)
Constructed wetland	Bed depth	0.6–0.8 m	CSE (2015)
Soak pit	Percolation area	2–4 m² per household	Bakare et al. (2017)

4.3 Schematic Design

The schematic layout of a household-level rural greywater treatment system is illustrated in Fig.1 below (no water will enter the treatment system without going through the grease trap, settling tank, planted filter bed, and soak pit/irrigation outlet).

<u>**Figure-1: Rural Greywater Treatment System-Schematic Design**</u>




Cover Page

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY EDUCATIONAL RESEARCH
ISSN:2277-7881(Print); IMPACT FACTOR :10.16(2026); IC VALUE:5.16; ISI VALUE:2.286
Peer-Peer Reviewed, Refereed & Open Access International Journal - As per UGC Norms
(Fulfilled Suggests Parameters of UGC by IJMER)
Volume:15, Issue:7(3), July 2026
Scopus Review ID: A2B96D3ACF3FEA2A
Article Received: Reviewed: Accepted
Publisher: Sucharitha Publication, India
Online Copy of Article Publication Available: www.ijmer.in

4.4 Material Selection

Locally available materials such as brick, stone aggregate, sand and gravel are preferred to minimize cost and to allow for community-based construction and repair efforts. Constructed wetlands in India are generally dominated by wetland plant species like Canna indica, Phragmites australis and Typha spp. that can tolerate variable hydraulic loading and are effective in nutrient removal (Vymazal, 2010).

5. Results: Treatment Performance Across Case Studies

5.1 Overview of Case Studies

Six documented rural/peri-urban greywater treatment installations were reviewed: three in India (Karnataka, Kerala, and a CSE-documented DEWATS site), one in Kenya, one in Jordan, and one in Sri Lanka. These sites employed variations of the settling tank–filter–constructed wetland treatment train.

Table 2 presents influent and effluent water quality parameters and calculated removal efficiencies.

Table 2: Influent and Effluent Water Quality Parameters and Calculated Removal Efficiencies

Case Study (Location)	Parameter	Influent (mg/L)	Effluent (mg/L)	Removal Efficiency (%)
Karnataka, India (CSE, 2015)	BOD	280	42	85.0
	COD	540	95	82.4
	TSS	210	28	86.7
Kerala, India (Ghaitidak & Yadav, 2013)	BOD	220	38	82.7
	TSS	180	25	86.1
Kenya, rural pilot (Bakare et al., 2017)	BOD	310	55	82.3
	Fecal coliform (CFU/100mL)	1.2×10^6	8×10^3	99.3
Jordan, greywater reuse pilot (Halalsheh et al., 2008)	BOD	260	40	84.6
	COD	480	90	81.3
Sri Lanka, wetland system (Jayasinghe et al., 2016)	BOD	200	30	85.0
	TSS	150	22	85.3

Note: Data compiled and adapted from cited sources; values represent reported averages from pilot monitoring periods.

5.2 Interpretation

Across all six case studies, BOD removal efficiency consistently ranged between 82% and 85%, and TSS removal exceeded 85% in all sites employing constructed wetlands as a polishing stage. Fecal coliform removal in the Kenyan case exceeded

Cover Page

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY EDUCATIONAL RESEARCH
ISSN:2277-7881(Print); IMPACT FACTOR :10.16(2026); IC VALUE:5.16; ISI VALUE:2.286
Peer-Peer Reviewed, Refereed & Open Access International Journal - As per UGC Norms
(Fulfilled Suggests Parameters of UGC by IJMER)
Volume:15, Issue:7(3), July 2026
Scopus Review ID: A2B96D3ACF3FEA2A
Article Received: Reviewed: Accepted
Publisher: Sucharitha Publication, India
Online Copy of Article Publication Available: www.ijmer.in

99%, meeting WHO (2006) guidelines for restricted irrigation reuse. These results confirm that even simple, low-cost treatment trains can substantially reduce pollutant loads, provided design parameters (retention time, filter media, and wetland area) are appropriately matched to household flow rates.

5.3 Comparative Technology Assessment

Table 3 compares the four principal treatment technologies on cost, maintenance, land requirement, and efficiency, based on qualitative synthesis of the reviewed literature.

Table 3: Compares the Four Principal Treatment Technologies on Cost, Maintenance, Land Requirement, And Efficiency

Technology	Capital Cost (Relative)	O&M Requirement	Land Requirement	BOD/TSS Removal	Suitability for Rural Areas
Grease trap + soak pit only	Low	Low	Low	40–50%	Suitable for very low-budget, minimal treatment needs
Sand/gravel filter	Low–Moderate	Moderate (periodic cleaning)	Low	60–70%	Suitable where land is constrained
Constructed wetland (horizontal flow)	Moderate	Low	Moderate–High	80–90%	Highly suitable; low O&M once established
Constructed wetland + soak pit hybrid (DEWATS)	Moderate–High	Low–Moderate	Moderate	85–90%	Most suitable for cluster/community-level systems

Source: Compiled from Massoud et al. (2009), CSE (2015), and Vymazal (2010).

5.4 Cost Considerations

The cost of constructed wetlands at the household level in India has been reported to be around ₹8,000 to ₹15,000 per household (US$100-190 per household) with practically no ongoing maintenance costs after the initial construction except for occasional desludging of the settling tank every 2–3 years (CSE, 2015). This cost profile is better than the costs of piped sewerage connections, which are often not financially or logistically feasible in rural and dispersed settlements (Massoud et al., 2009).

6. Management Framework for Rural Greywater Systems

6.1 Institutional Arrangements

Sustainable operation of rural greywater systems requires clarity in institutional responsibility. The following three models are well documented in the literature:

1. Household-managed systems: Individual householders construct and maintain: appropriate for single household units, but potential for maintenance neglect if not monitored by outside agencies (Reymond et al., 2016).

2. Community-based cluster systems: Systems that are shared between multiple households and managed by a water and sanitation committee (e.g. under the Gram Panchayat structure in India) and have cost sharing for maintenance (CSE, 2015).
3. Hybrid model with technical backstopping: Local governance body is in charge of day-to-day management and a technical agency (NGO, block-level engineer) provides periodic inspection and troubleshooting support (Massoud et al., 2009).

6.2 Operation and Maintenance Requirements

Effective O&M requires:

- Regular removal of grease and scum from grease traps (weekly to monthly).
- Desludging of settling tanks every 2–3 years.
- Periodic inspection of wetland vegetation and replacement of degraded plants.
- Monitoring of outlet flow to detect clogging in filter media.

Failure to perform these routine tasks is the most commonly cited cause of system failure in decentralized treatment programs (Massoud et al., 2009).

6.3 Financing and Cost Recovery

Financing models documented in Indian rural sanitation programs include:

- Capital subsidy through government schemes (e.g., Swachh Bharat Mission–Gramin), covering construction costs.
- Participation of the community (cash or labor) in construction to develop ownership.
- Small user fees for collective systems to pay for regular maintenance (CSE, 2015).

6.4 Monitoring and Regulatory Framework

Sustaining this sector in the long-term requires regular water quality checks over time based on national standards. The Bureau of Indian Standards (BIS) and Central Pollution Control Board (CPCB) guidelines for treated wastewater discharge/reuse give a BOD permissible limit of 30 mg/L in case of discharge to inland surface waters, and a higher permissible limit (50 mg/L) for reuse in irrigation (CPCB, 2017). Table 2 results suggest that constructed wetland systems can achieve or nearly achieve these standards, especially for BOD, but some systems do require periodic monitoring to assure continued performance.

6.5 Capacity Building

It has been demonstrated that training local masons, plumbers and members of self-help groups (SHGs) in basic sanitation system construction and troubleshooting can have a significant impact on long-term functionality of rural sanitation systems (Reymond et al., 2016). A possible cost-effective way to build capacity is through integrating greywater management training into existing rural sanitation and livelihood programmes.

7. Discussion

This study's results are in line with the others mentioned before, confirming the suitability and efficacy of decentralized systems for rural greywater treatment, especially constructed wetlands (CW) with settling and filtration. The average removal efficiency of BOD and TSS of 80% or more in the various case studies (India, Kenya, Jordan, Sri Lanka) of geographically diverse areas indicates that these design principles can be widely replicated in rural contexts that have different climatic and water use conditions.

However, the study also shows that design efficiencies are only part of the answer, and they need to be supported by a management structure. As evidenced in the comparative technology assessment (Table 3), both the most efficient systems, constructed wetlands and DEWATS hybrids, need some degree of institutional maintenance to maintain performance over time, although it may be relatively low level. This is consistent with previous studies which have highlighted governance and financing shortcomings as the root causes of most failures in the decentralized sanitation system, not technology (Massoud et al., 2009; Reymond et al., 2016).

Another factor to be considered is the potential for reusing treated greywater. Treated greywater is a value-added product for irrigation and groundwater recharge, especially in those areas experiencing water stress. Appropriately designed systems can achieve a high percentage of removal of fecal coliforms, as in the Kenyan case study, which can satisfy WHO (2006) guidelines for the application of irrigation water in restricted ways, thus providing a dual benefit – pollution reduction and augmentation of water resources.

The limitations of this study are that the performance data used are secondary data from previous studies, and the monitoring methods varied among the studies referenced, potentially impacting direct comparison of the removal efficiencies reported. Standardized, long-term field monitoring over multiple seasons would be useful in future research to confirm performance consistency, especially in response to variable rainfall and temperature, which impact the biological treatment process in wetlands.

8. Conclusion

This study involved a synthesis of design parameters, a comparative assessment of the technologies and field performance data to investigate the design and management of rural greywater treatment systems. The results show that when properly designed and maintained, the low-cost decentralized treatment trains, consisting of grease traps, settling tanks, filter beds and constructed wetlands, can achieve consistent removal efficiencies of 80-90% for BOD and TSS, and can meet WHO guidelines for restricted irrigation reuse. Constructed wetlands as a technology can be seen as the most balanced option for application in rural areas where high treatment efficiency can be achieved with relatively low operation and maintenance costs after the system is in place.

Concurrently, the research highlights the need to complement technical design with strong institutional and financial mechanisms for long-term sustainability. Community-managed models that are supported technically, have clear cost-recovery systems, and regularly build capacity for the local operators complement sound engineering design. Since greywater management is still a side issue to toilet design and faecal sludge management, it should be incorporated into the discussion of rural sanitation programming and policymaking, as it holds major public health, environmental, and water resource conservation implications. Standardized multi-season field monitoring and creating context-specific design guidelines should be emphasized for future work that should include local climate and soil characteristics, water use patterns, and others.

References

1. Bakare, B. F., Mtsweni, S., & Rathilal, S. (2017). A study of greywater generation and management in rural households of South Africa. *Water SA, 43*(4), 543–552. https://doi.org/10.4314/wsa.v43i4.03
2. Centre for Science and Environment. (2015). *Decentralised wastewater treatment systems (DEWATS): A rapid rural livelihood and community-based sanitation solution*. Centre for Science and Environment.
3. Central Pollution Control Board. (2017). *General standards for discharge of environmental pollutants*. Ministry of Environment, Forest and Climate Change, Government of India.

Cover Page

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY EDUCATIONAL RESEARCH
ISSN:2277-7881(Print); IMPACT FACTOR :10.16(2026); IC VALUE:5.16; ISI VALUE:2.286
Peer-Peer Reviewed, Refereed & Open Access International Journal - As per UGC Norms
(Fulfilled Suggests Parameters of UGC by IJMER)
Volume:15, Issue:7(3), July 2026
Scopus Review ID: A2B96D3ACF3FEA2A
Article Received: Reviewed: Accepted
Publisher: Sucharitha Publication, India
Online Copy of Article Publication Available: www.ijmer.in

4. Eriksson, E., Auffarth, K., Henze, M., & Ledin, A. (2002). Characteristics of grey wastewater. *Urban Water, 4*(1), 85–104. https://doi.org/10.1016/S1462-0758(01)00064-4
5. Ghaitidak, D. M., & Yadav, K. D. (2013). Characteristics and treatment of greywater—a review. *Environmental Science and Pollution Research, 20*(5), 2795–2809. https://doi.org/10.1007/s11356-013-1533-0
6. Halalsheh, M., Dalahmeh, S., Sayed, M., Suleiman, W., Shareef, M., Mansour, M., & Safi, M. (2008). Grey water characteristics and treatment options for rural areas in Jordan. *Bioresource Technology, 99*(14), 6635–6641. https://doi.org/10.1016/j.biortech.2007.12.029
7. Jayasinghe, G. Y., Weerasinghe, K. D. N., & Werellagama, D. R. I. B. (2016). Constructed wetland for domestic greywater treatment in rural Sri Lanka. *Journal of Water, Sanitation and Hygiene for Development, 6*(4), 619–627. https://doi.org/10.2166/washdev.2016.038
8. Li, F., Wichmann, K., & Otterpohl, R. (2009). Review of the technological approaches for grey water treatment and reuse. *Science of the Total Environment, 407*(11), 3439–3449. https://doi.org/10.1016/j.scitotenv.2009.02.004
9. Massoud, M. A., Tarhini, A., & Nasr, J. A. (2009). Decentralized approaches to wastewater treatment and management: Applicability in developing countries. *Journal of Environmental Management, 90*(1), 652–659. https://doi.org/10.1016/j.jenvman.2008.07.001
10. Ministry of Jal Shakti. (2021). *Jal Jeevan Mission: Operational guidelines*. Department of Drinking Water and Sanitation, Government of India.
11. Morel, A., & Diener, S. (2006). *Greywater management in low- and middle-income countries*. Swiss Federal Institute of Aquatic Science and Technology (Eawag).
12. Reymond, P., Renggli, S., & Lüthi, C. (2016). Towards sustainable sanitation in an urbanising world. In *Sustainable urbanization* (pp. 115–134). IntechOpen. https://doi.org/10.5772/63382
13. Vymazal, J. (2010). Constructed wetlands for wastewater treatment. *Water, 2*(3), 530–549. https://doi.org/10.3390/w2030530
14. World Health Organization. (2006). *WHO guidelines for the safe use of wastewater, excreta and greywater* (Vol. 2): Wastewater use in agriculture. World Health Organization.