



Ministry of Foreign Affairs of the
Netherlands



Participatory Action Research

Water Scarcity and Contamination in Duhok City

Greywater recycling and treatment

Prepared by:

Slav Hami Saleem (Group Leader)

Daveen Mishtaq Ahmed

Paiman Hashim Abdulrahman

Yassir Qassim Osman

Supervised by:

Dr. Walat Al-hamde

University of Duhok in collaboration with UNICEF

Dohuk Governorate, Kurdistan Region, Iraq

October 2024 - January 2025

Contents

Executive Summary	3
Introduction	3
Data collection Sample Size.....	4
Results	4
Discussion.....	5
Challenges and limitation.....	6
Recommendation	6
References.....	7
Conclusion.....	7
Appendices.....	7

Executive Summary

As members of the Blue Planet Group, we focused on graywater recycling to address water scarcity and promote sustainable water use. Graywater, generated from activities like laundry, dishwashing, and bathing, is often wasted despite its potential for reuse. Our project aimed to explore methods for recycling this resource to reduce water consumption and associated costs while ensuring environmental sustainability.

We employed three data collection methods: questionnaires, group discussions, and interviews. These approaches allowed us to gather insights from diverse sources, including hospitals, car washes, fire stations, and households. Our discussions with stakeholders highlighted existing water

usage practices and the challenges in implementing water-saving systems. Interviews provided in-depth perspectives on the feasibility and benefits of graywater recycling, while electronic surveys captured broader public opinions.

This research aligns with the progress of Duhok's wastewater treatment infrastructure, now 85% complete. By complementing these efforts, we aim to promote practical solutions, including physical, mechanical, biological, and chemical treatment techniques, to recycle graywater effectively.

Our findings emphasize the urgent need for public awareness, better management practices, and accessible recycling systems. These efforts could significantly reduce water wastage, protect resources, and enhance sustainability in the region.

Introduction

Water scarcity is an escalating global concern, with substantial volumes of water wasted in daily activities such as bathing, laundry, and dishwashing. Graywater, a byproduct of these activities, presents a valuable opportunity for recycling and reuse, reducing water consumption and alleviating resource stress [1, 2 and 3]. As members of the Blue Planet Group at the College of Science, we undertook a project to explore graywater recycling methods and their potential for sustainable water management.

This research focused on identifying practical solutions for graywater recycling through data collection via questionnaires, group discussions, and interviews. Our study encompassed diverse sectors, including households, hospitals, car washes, and fire stations, aiming to assess water usage practices and the feasibility of recycling systems. The findings align with the ongoing development of Duhok's wastewater treatment plant, which is 85% complete, showcasing the region's commitment to environmental sustainability.

Our project highlights four key techniques—physical, mechanical, biological, and chemical—for treating and reusing graywater. By implementing these methods, we can reduce water wastage, lower costs, and promote sustainable practices. This study also emphasizes the importance of raising awareness and improving water management systems to safeguard resources for future generations.

Data collection Sample Size

Data Collection Methods:

Data for this study on graywater recycling and water conservation were collected using three primary methods:

1. **Questionnaires:** A structured questionnaire was developed to capture quantitative data on water usage practices, awareness of water conservation, and willingness to adopt recycling systems.
2. **Group Discussions:** Focus group discussions (FGDs) were conducted with community members to gather qualitative insights, allowing for the exchange of ideas and perspectives about water conservation challenges and potential solutions.

3. **Interviews:** In-depth interviews were carried out with specific participants, such as farmers and teachers, to explore their unique experiences and understanding of water management issues.

Sample Size:

The study involved **50 respondents**, aged between 18 and 40 years. The sample included:

- **Illiterate participants (e.g., farmers):** Representing the majority of the sample, these individuals provided critical insights into the direct impacts of water scarcity and the importance of community-driven conservation efforts.
- **Literate participants (e.g., teachers):** A smaller portion of the sample, these individuals contributed their understanding of water conservation and the role of education in spreading awareness within their communities.

The diverse composition of the sample ensured a comprehensive understanding of the water conservation issue, integrating both practical experiences and educational perspectives to shape actionable solutions.

The respondents ranged in age from 18 to 40 years. Most of the participants were illiterate, eg farmers, and some of the participants were literate (Teacher These illiterate people, ie farmers, said that the water was decreasing in your own way He learned the importance of establishing a water protection system and raising awareness among the community Not a small one Understand water conservation and spread it to the community

Results

159 households including 862 individuals, participated in this survey. Figure 1 shows that 39% of respondents feel greywater recycling systems are affordable. However, 41% are unsure, indicating a lack of awareness about costs. 20% believe these systems are not affordable. Figure 2 illustrate the top benefit identified is saving money which is about (~26%), followed by saving water (~22%). Irrigation benefits and general support for the environment both received (~17%) each, while economic reduction was noted by (~13%).

Moreover, 23% of respondents simply said "yes" to concerns, while 11% mentioned issues like contaminated water, bad filtering, or incomplete filtration. Some respondents (11%) believe there are no risks, while others want systems to have guarantees to ensure safety as clear in figure 3.

Figure 4 and figure 5 gives information about **encourage people in our community to consider greywater recycling and greywater recycling as a practical solution for water conservation in our society**. Social (45%) and seminars (22%) and workshops (11%) can raise awareness. Involving the Ministry of Public Health (11%) could boost credibility. Offering home water tests (11%), personalized learning. A combined approach of social influence, education, and government support is most effective. (85%) see greywater recycling as a practical solution for water conservation due to its benefits like reducing water wastage, reusability, and irrigation use. However, 15% believe it is not practical, indicating some skepticism. Furthermore, 31% believe there are health or environmental concerns that could affect its acceptance, while another 31% see no concerns. 23% focus on environmental benefits, while 7% respondent highlights both health and environmental issues. 8% mentioned that acceptance depends on filtration quality.

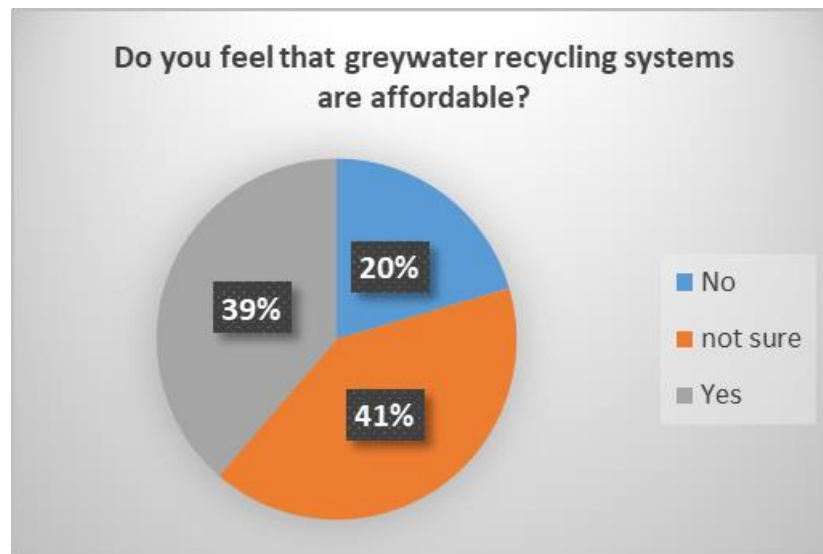
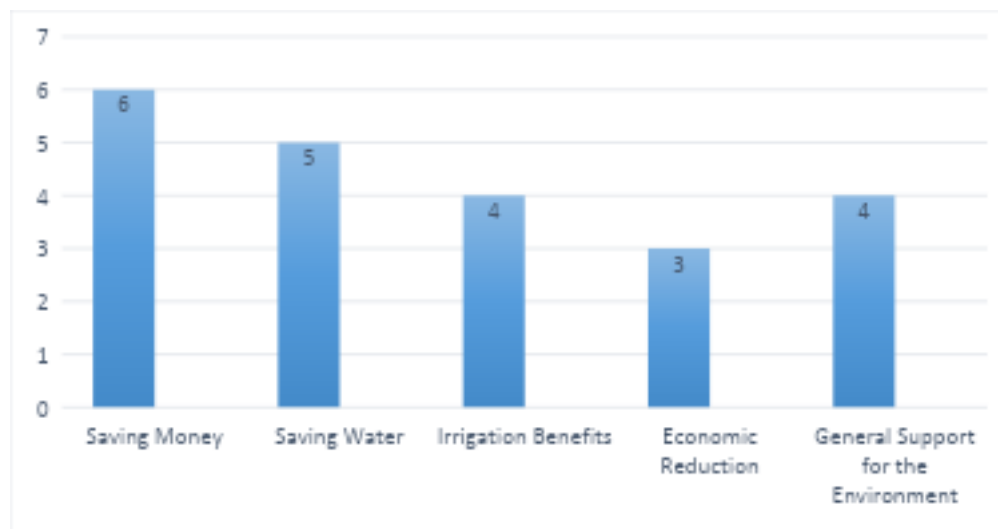


Figure 1:



Information of about greywater recycling systems affordable

Figure 2: Thinking of community about benefits graywater recycling bring our community

What concerns or reservations do you have about using greywater in your home?

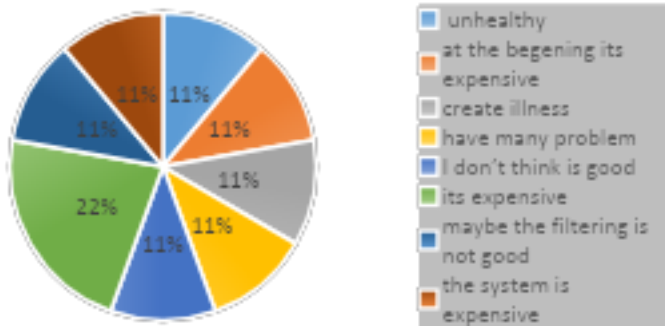


Figure 3: publication concerns about using greywater in your

home

In what ways do you think we can encourage more people in our community to consider greywater recycling?

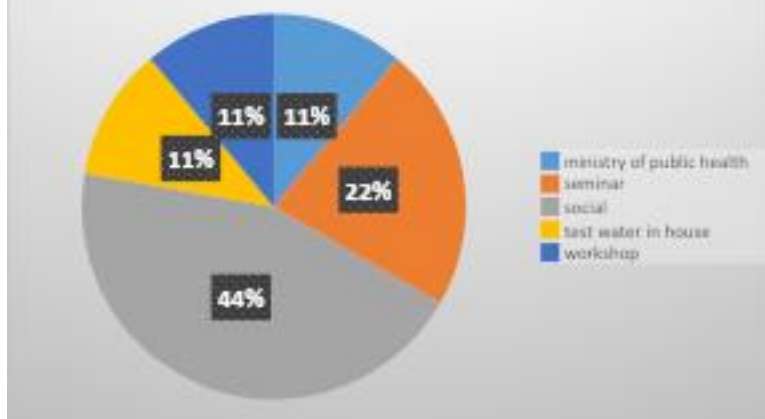


Figure 4: encouraging ways people in our community to consider greywater recycling?

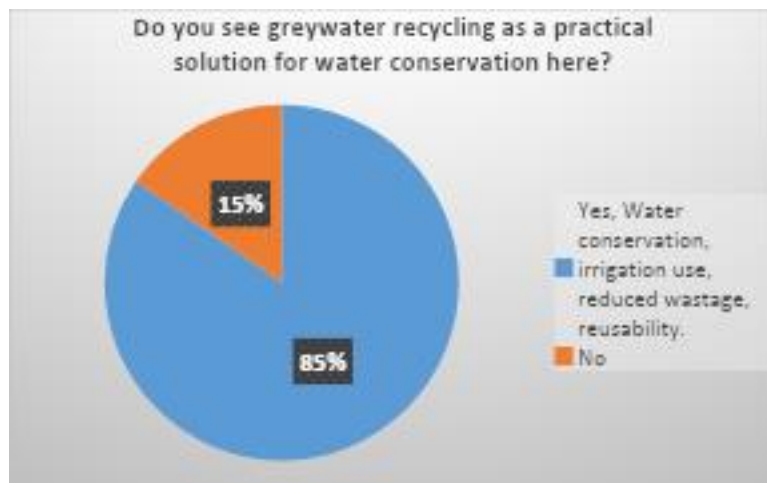


Figure 5: asking about greywater recycling as a practical solution for water conservation in Duhok

In other hand figure 6, 7 and 8 illustrate some another information about graywater recycling. 25% people indicating it is a good idea and 25% others affirming it is feasible. 8% expressed uncertainty about cost but suggested it might not be too high. Another 8% believes households will benefit and install it. However, there is some skepticism, with 9% stating it's not feasible, and 25% others suggesting that it might not be widely adopted. The majority of respondents live in a house (83%), while a smaller group resides in an apartment (17%).

from government (2 responses) and private organizations (1 response) could help reduce costs. Community efforts (1 response) and organizing (3 responses) could raise awareness and pool resources. Future recommendations (1 response) could simplify installation, while addressing cost concerns (1 response) would improve affordability for households.

High range (15,000–30,000 IQD) with (~33%), followed by Medium (5,000–15,000 IQD) at (~27%). Free or minimal cost was mentioned by (~20%). Fewer reported Low cost (under 5,000 IQD) at (~10%), and Very high cost (over 30,000 IQD) was noted by (~3%). Some provided qualitative responses (e.g., "High," "Medium") at (~13%), and a few mentioned other currencies or unknown values at (~3%).

The majority of respondents have heard of greywater recycling (53%), while 47% indicate they have not. This suggests that while greywater recycling is somewhat known, there is still a considerable portion of people who are unfamiliar with the concept

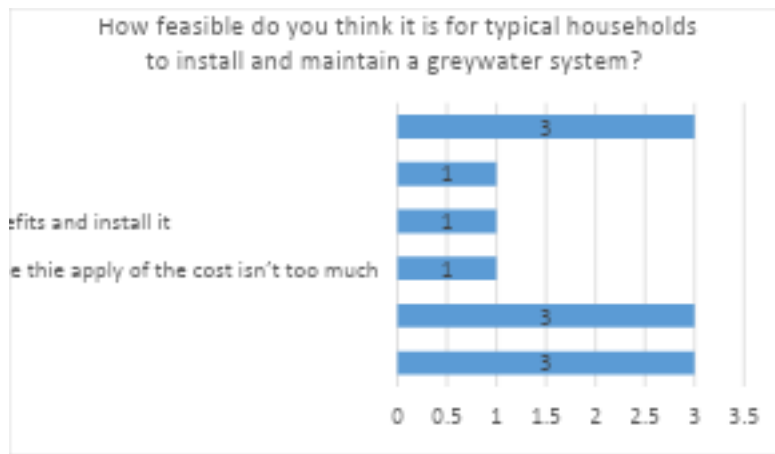


Figure 6: feasibility of thinking for typical households to install and maintain a greywater system

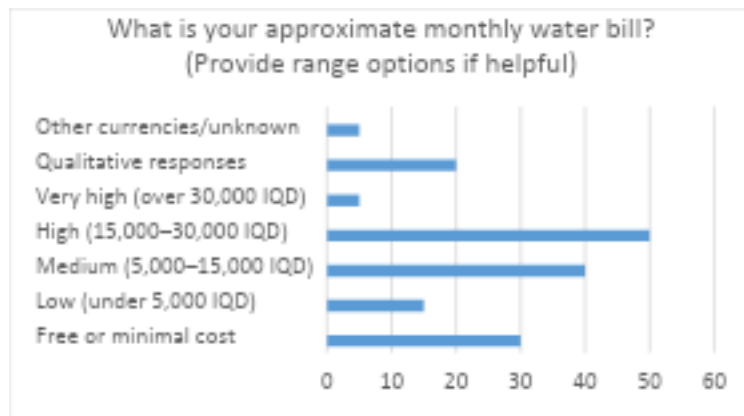


Figure 7: approximate monthly water bill in Duhok

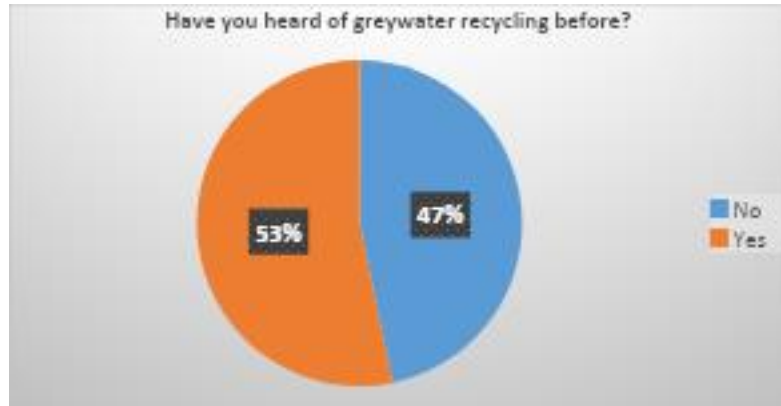


Figure 8: information about the knowledge of graywater

Discussion

Interpretation of Findings

Our study highlights significant public support for graywater recycling, with 68% of respondents believing it can reduce waste. However, 17% were uncertain, and 15% were skeptical due to misconceptions, indicating a need for better education on the benefits and effectiveness of the system.

Affordability remains a key barrier, as only 39% find graywater systems affordable. This suggests that cost transparency and financial incentives are necessary to make these systems accessible to a broader audience. Despite this, many participants recognized the benefits of recycling, with 26% citing cost savings and 22% highlighting water conservation. Irrigation (17%) and environmental support (17%) also emerged as important advantages, reflecting broader ecological awareness.

Concerns over contamination and filtration risks were noted by 11% of participants, underscoring the need for quality assurance in system design. Interestingly, 31% did not perceive any risks, indicating a potential gap in understanding.

The most popular use for recycled graywater was garden irrigation (56%), followed by cleaning and toilet flushing (33%). This aligns with the general goal of reducing potable water consumption for non-essential tasks.

While 85% viewed graywater recycling as practical, skepticism (15%) and feasibility doubts (25%) point to challenges in adoption that could be addressed through education and accessible solutions.

Challenges and limitation

A key challenge in the adoption of graywater recycling systems is the significant **awareness gap**, with 41% of respondents lacking clarity on the costs and benefits of the system. This lack of understanding hinders public willingness to invest in such technologies. Additionally, **safety concerns** regarding contamination and filtration quality remain prevalent, with many individuals worried about the safety of using recycled water, especially for non-potable applications like irrigation. Lastly, **cost barriers** continue to be a major limitation, as affordability remains a significant obstacle for many households and businesses. With only 39% of respondents finding the systems affordable, the high initial investment required for graywater recycling limits its widespread adoption. Addressing these challenges through education, improved safety standards, and cost-effective solutions will be crucial for the success of graywater recycling in the future.

Recommendation

To promote graywater reuse, it is essential to raise public awareness through workshops and campaigns, encouraging household-level systems for garden irrigation and toilet flushing while offering incentives for adoption. Policymakers should establish and enforce clear reuse standards, provide subsidies or tax incentives for graywater system installations, and mandate such systems in new developments. Future research should focus on understanding local

graywater composition to identify effective treatment methods, invest in affordable, low-maintenance technologies, and assess the long-term impacts of graywater reuse on water conservation. Successful implementation requires collaboration with governments, NGOs, and private sector partners, involving communities and experts in system design and maintenance. Capacity building is crucial, including training technicians and community members in installation and upkeep, as well as creating resource centers for support. Monitoring and scaling should begin with pilot projects, gradually expanding and using technology to optimize system performance, with regular inspections to ensure effectiveness.

References

- World Health Organization (WHO). (2006). *Guidelines for the Safe Use of Wastewater, Excreta, and Greywater*. WHO Press.
- Gleick, P. H. (2000). *The World's Water 2000-2001: The Biennial Report on Freshwater Resources*. Island Press.
- Lazarova, V., & Bahri, A. (2005). *Water Reuse for Irrigation: Agriculture, Landscapes, and Turf Grass*. CRC Press.

Conclusion

We have discussed this issue with our manager and we have analyzed the data and we have analyzed the problems and we have put this system to protect the water and we will try to communicate with people through social media, to give information about the benefits of this system, and about this system and its protection of the water. these methods are most widely used in wastewater treatment. Also many possible synergism of these techniques promise a good pollutant destruction rate that helps in maintaining the environment clean.

Appendices

Questionnaires:

1. What is your age?
2. What type of residence do you live in? (e.g., apartment, house, other)
3. How many people live in your household?
4. What is your approximate monthly water bill? (Provide range options if helpful)
5. Have you heard of greywater recycling before? (Yes/No)
6. How familiar are you with greywater recycling? (Not at all familiar - Very familiar)

7. Where did you first learn about greywater recycling? (Options: social media, school, government, friends/family, other)
8. How important is water conservation to you? (Not important - Very important)
9. Do you believe that greywater recycling can help reduce water waste? (Yes/No/Not sure)
10. Would you consider installing a greywater recycling system in your home?
(Yes/No/Maybe)
11. What motivates you most to conserve water? (Check all that apply: environmental protection, cost savings, personal responsibility, community impact, other)
12. Which of these benefits would encourage you to adopt greywater recycling? (Cost savings, reducing environmental impact, increasing self-sufficiency, other)
13. What concerns do you have about greywater recycling? (Check all that apply: cost, maintenance, health risks, lack of information, regulatory barriers, other)
14. Do you feel that greywater recycling systems are affordable? (Yes/No/Not sure)
15. Do you think greywater poses a health risk if used for non-potable purposes (e.g., garden irrigation)? (Yes/No/Not sure)
16. How often do you engage in water-saving practices at home? (Never - Always)
17. Which of the following water-saving actions do you currently practice? (Shorter showers, using water-saving fixtures, reusing water for plants, collecting rainwater. other)
18. Would you be willing to make adjustments to your home if it meant saving water?
(Yes/No/Maybe)
19. How likely would you be to attend a workshop or seminar on greywater recycling?
(Very unlikely - Very likely)
20. What resources would help you feel more comfortable about greywater recycling?
(Check all that apply: informational pamphlets, expert consultations, government incentives, installation guides, other)

Interview:•

1. How familiar are you with greywater recycling and its applications?
2. What do you think are the most important benefits of greywater recycling for our community?
3. Do you see greywater recycling as a practical solution for water conservation here? Why or why not?
4. Are there any current policies or regulations in place related to greywater use in this area?
5. How supportive do you think local government or regulatory bodies are towards greywater recycling?

6. What policies or incentives, if any, do you think could encourage wider adoption of greywater recycling?
7. What do you see as the main barriers or challenges to implementing greywater systems in homes or businesses?
8. Are there specific public concerns, such as health or environmental issues, that you think could affect acceptance of greywater recycling?
9. How feasible do you think it is for typical households to install and maintain a greywater system?
10. How aware do you believe the public is of greywater recycling as an option for water conservation?
11. What types of information or education do you think would be most effective in encouraging people to consider greywater recycling?
12. Have you seen any successful examples of greywater recycling in action that could serve as case studies for our community?
13. In your experience, how effective are greywater systems in terms of maintenance, cost, and operational performance?
14. What do you think could be done to make greywater systems more accessible or affordable for average households?
15. If given the choice, would you implement greywater recycling in your own facilities or recommend it to others? Why or why not?

•Focus group discussion (FGDs)

Opening Questions (to gauge awareness and initial thoughts)

1. Have you heard of greywater recycling before? If so, what do you know about it?
2. What are your initial thoughts or feelings about the idea of reusing household water for purposes like irrigation or toilet flushing?
3. What benefits do you think greywater recycling could bring to our community or environment?
4. How important is water conservation to you personally, and do you see greywater recycling as part of the solution?
5. If you were to install a greywater system, what would be your main motivation? (e.g., saving money, helping the environment, conserving water)
6. What concerns or reservations do you have about using greywater in your home?
7. Are there any health or safety concerns that you think need to be addressed before using greywater?
8. How do you feel about the cost and maintenance of greywater systems? Do you think they would be affordable and manageable?

9. in what ways would you be willing to reuse greywater? (e.g., garden irrigation, flushing toilets, cleaning)
10. What kind of support or resources would make you feel more comfortable about adopting greywater recycling?
11. Do you think it's realistic for average households in our area to implement greywater systems? Why or why not?
12. How interested are you in learning more about greywater recycling?
13. If there were workshops, demonstrations, or incentives available, would you be more likely to consider using greywater at home?
14. In what ways do you think we can encourage more people in our community to consider greywater recycling?
15. After our discussion, has your view on greywater recycling changed? If so, how?
16. What would you like to see happen next to promote or explore greywater recycling in our community?