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PUBLIC ACCEPTANCE OF GREY WATER REUSE: A CASE STUDY & ANALYSIS IN THE UAE

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Abstract

Fresh water is considered a limited resource in the United Arab Emirates (UAE), with full reliance on ground water and desalinated saline water. Grey water reuse has been investigated as a solution to reduce the demand for potable water and to provide an alternative water resource. However, public perceptions and acceptance of treated wastewater is a significant factor for adopting grey water reuse on a wide domestic scale. This study aims to investigate the factors influencing public acceptance of grey water reuse. A stated preference survey is designed and distributed in the different Emirates of the UAE. The results of the study suggest that there is still a lack of awareness in the perception of fresh water availability among residents in the UAE. Moreover, 70 % of the surveyed sample agreed to use treated grey water in applications not involving direct contact. Factors influencing public acceptance were found to be health risk concerns, lack of confidence in the water quality, lack of scientific knowledge about the treatment process and the potential uses of treated grey water. The

results of this study demonstrate the potential for the public acceptance of grey water reuse, thus, its implementation in the UAE.

Keywords

Non-Conventional Water Resources, Grey Water, Reuse, Public Perception, United Arab Emirates

1. Introduction

Despite that around three-quarters of the surface of the earth is covered with water, fresh water is considered a scarce resource. This is because 97% of the volume of the water on earth is saline, and 2.5 % exists in the polar ice caps, glaciers, and atmosphere, which makes only 0.5 % of the water available for meeting human demands (Gude, 2017). Gude reported in 2017 the causes of water scarcity, which include drought, over consumption, physical distance, and political and social stress (Gude, 2017).

1.1 Fresh Water Resources

Fresh water is conventionally available in the form of surface water and ground water. However, in parts of the world where surface water is a limited resource, as is the case in the Middle East region, non-conventional water resources become essential for reducing fresh water consumption and demand. Non-conventional water resources include desalinated saline water, rain water harvesting, and treated waste water. The only fresh water resource in the United Arab Emirates is ground water, which is available in only finite reserves (Alsharhan & Rizk, 2020), (Chowdhury, 2009). Therefore, non-conventional resources such as desalinated water and treated waste water have been adopted in the UAE for reducing the consumption of ground water (Gude, 2017). In fact, the UAE is the leading producer of desalinated water in the Gulf region, contributing 35% of the worldwide seawater desalination capacity (Dawoud, 2012). Treated grey water is currently being used in a very limited capacity in the UAE; its use includes landscaping, car wash, and toilet flushing.

1.2 Grey Water Reuse

Greywater is defined as relatively clean waste water from baths, sinks, and washing machines (Amaris et al., 2020). According to Amaris, Dawson, Gironás, Hess & Ortúzar in 2020, grey water reuse has been emerging in recent years as a viable and sustainable water strategy due to a number of reasons (Amaris et al., 2020). Firstly, the volume of grey water that can be reused constitutes a significant proportion of the consumed water (Amaris et al., 2020). Secondly, grey water quality after treatment has reached high standards (Amaris et al., 2020). Moreover, utilizing treated grey water is

associated with lower water demands and reduced potable water losses; hence more efficient management of water resources (Amaris et al., 2020). However, public acceptance of grey water reuse is an essential factor influencing the domestic adoption of grey water reuse, especially if there are any associated additional costs or religious views. Although the environmental aspects of treated grey water are satisfied, the social factor is still an issue that needs to be addressed. Further studies are required to investigate the public perceptions and acceptance of treated grey water.

1.3 Factors Influencing Grey Water Reuse

A number of factors are associated with the public acceptance of grey water reuse. Numerous studies were previously conducted to investigate the factors influencing public acceptance of treated grey water utilization on a domestic scale. A literature review conducted by Po, Kaercher and Nancarrow, in 2003, revealed a number of factors including perceptions of health risks associated with utilizing reused water, psychological discomfort, the specific use of the treated grey water, perception of fresh water abundance and availability, confidence in the quality of the treated water, scientific knowledge about the treatment process, attitude towards the environment and socio-economic factors (Fu et al., 2018).

Domènecha and Sauría developed a framework in 2010 to analyze the factors influencing the public acceptance of grey water reuse, summarizing these factors as perceived cost, perceived health risk, operational regime, and environmental awareness (Domnech & Saurí, 2010). Maraqa and Ghoudi found that public acceptance directly declines with the level of physical contact with the water, with a higher agreement to toilet flushing than to washing clothes (Maraqa & Ghoudi, 2012). In other research, grey water rejection was attributed to religious, health, or safety concerns (Hyde et al., 2017). Nevertheless, social acceptance of utilizing treated greywater can be obtained by raising public awareness (Maraqa & Ghoudi, 2012).

1.4 Research Scope & Objectives

The purpose of this study is to investigate the overall public perception of greywater, to what extent greywater reuse is accepted in the UAE, public concerns regarding treated greywater, the public attitude towards investing in greywater treatment systems, and the factors influencing grey water acceptance in the UAE. Insight into this information can be used to improve the perception of the UAE population and to enhance the acceptance of grey water reuse. Descriptive statistics are performed to meet the objectives of the study.

2. Methodology

A survey was designed to investigate the public perception of water availability, and the acceptance of grey water reuse, in the UAE. The survey was distributed using an online format in all 7 Emirates of the UAE (Abu Dhabi, Dubai, Sharjah, Ajman, Fujairah, Ras Al Khaima, and Um Al Quwain). The stated preference approach was adopted for the formulation of the questionnaire. Most of the questions involved either asking the respondents to choose an answer from a list of choices, or to choose all applicable answers from the provided list. A few questions required open-ended answers to be provided by the respondents.

The survey is composed of five main sections and a total of 18 questions. In the first section of the survey (questions 1 to 5), demographic information where collected, including emirate of residence, gender, age group, nationality, and occupation. The second section addresses the public perception of water abundance locally and globally as well as the importance of water demand reduction. In the third section, public awareness and acceptance of grey water reuse are addressed. In the fourth section of the survey, the cost of installing greywater reuse systems is addressed. In the last section, public concerns about treated grey water and its perceived importance are investigated.

The survey was filled by 436 respondents residing in different Emirates of the UAE. The distribution of respondents to the survey is about 14% from Abu Dhabi, 26% from Dubai, 47% from Sharjah, and a total of 13% are from Ajman and the other Emirates. Almost 95 % of the survey respondents are between 18-45 years old, with 48 % of the respondents being male. 10% are UAE nationals, and 90 % are expatriates. 61% of the respondents are both graduate and undergraduate students, while 32 % are employed and 7 % are homemakers.

3. Results

The results of the study are divided into two main sections. The first section addresses the public perceptions of the availability of fresh water resources as well as the importance of water conservation. The second section is concerned with the public acceptance of grey water reuse and the concerns associated with using treated grey water. This is to reveal the different factors affecting the public acceptance of grey water reuse in the United Arab Emirates.

3.1 Public Perceptions: Water Abundance & Conservation

When survey participants were asked if they were aware of the increasing global water scarcity issue, 73% responded “yes”, while 27 % responded “no “or “not sure”. However, only 40% classified

the availability of fresh water in the UAE as “scare”. In the meanwhile, 40% considered fresh water resources in the UAE as “abundant” and 20 % were “not sure”. This shows that despite the public awareness of the global water resources condition, a significant percentage of UAE residents still lack awareness of the scarce fresh water resources in the UAE. This can be attributed to the abundant supply of desalinated water and bottled potable water. Despite that, 89% of the survey respondents were familiar with the importance of water conservation, and 78 % were familiar with the importance of recycling water.

Similar findings were documented by Maraqa and Ghoudi, who conducted a similar study in the UAE, and found that 48% of the respondents consider freshwater in the UAE as scarce, while 35% consider it to be abundant (Maraqa & Ghoudi, 2012). These findings reflect higher levels of awareness among the participants regarding the limited freshwater resources in the UAE. In contrast, Wait documented in 2014 a lower percentage of respondents, in the GCC region, considering fresh water to be scarce (15 %) (Wait, 2014). Participants considering fresh water to be abundant were also considered by Maraqa and Ghoudi to be confusing fresh water with the daily availability of desalinated water (Maraqa & Ghoudi, 2012). Maraqa and Ghoudi also found that 92% of the respondents considered that there is a need for water conservation, which is very similar to the findings of this study (Maraqa & Ghoudi, 2012).

3.2 Greywater Reuse: Acceptance & Concerns

Investigating the public familiarity and acceptance of grey water reuse showed that 38% of the participants were already aware of the term grey water, while only 33% heard of greywater reuse. Upon defining “grey water reuse”, 70% of the survey participants accepted using treated grey water in applications that do not involve physical contact, such as toilet flushing and landscaping. Figure 1 shows the uses of grey water included in the survey and the percentage of participants accepting it. As shown in Figure 1, 13% of the participants in the study did not accept utilizing treated grey water in any application. In addition, applications that do not involve physical contact with grey water had higher acceptance rates compared to high contact applications. For instance, toilet flushing, landscaping, and car wash were accepted by 83%, 77%, and 67%, of the respondents, respectively. Showering and cloth wash, on the other hand, was accepted by only 11% and 21%, respectively. The results shown in Figure 1 demonstrate that public acceptance of treated grey water declines with applications involving higher levels of physical contact with the water. Additional uses of treated grey water, as per the documented suggestions of the respondents are uses for water fountains, outdoor

cleaning, and construction purposes, and concrete mixing.

The results obtained in this study agree with the findings of Amaris, Dawson, Gironás, Hess, and Ortúzar; and Maraqa and Ghoudi (Amaris et al., 2020), (Maraqa & Ghoudi, 2012). Maraqa and Ghoudi found high acceptance levels for car wash, followed by toilet flushing, landscaping, and outdoor cleaning, compared to washing clothes and bathing, which were the least acceptable uses (Maraqa & Ghoudi, 2012). Amaris, Dawson, Gironás, Hess, and Ortúzar also concluded that there is an overall acceptance for using high-quality treated greywater for toilet flushing, laundry, garden irrigation, hand washing, and shower use (Amaris et al., 2020).

Chowdhury reported in 2009 that 70% of respondents in his study agreed that greywater can be reused for gardening purposes and about 10% agreed to reuse greywater for toilet flush purposes (Chowdhury, 2009). Compared to the results shown in Figure 1, it can be concluded that significant improvements have taken place over the past decade regarding the public acceptance of utilizing treated waste water among the residents of the UAE.

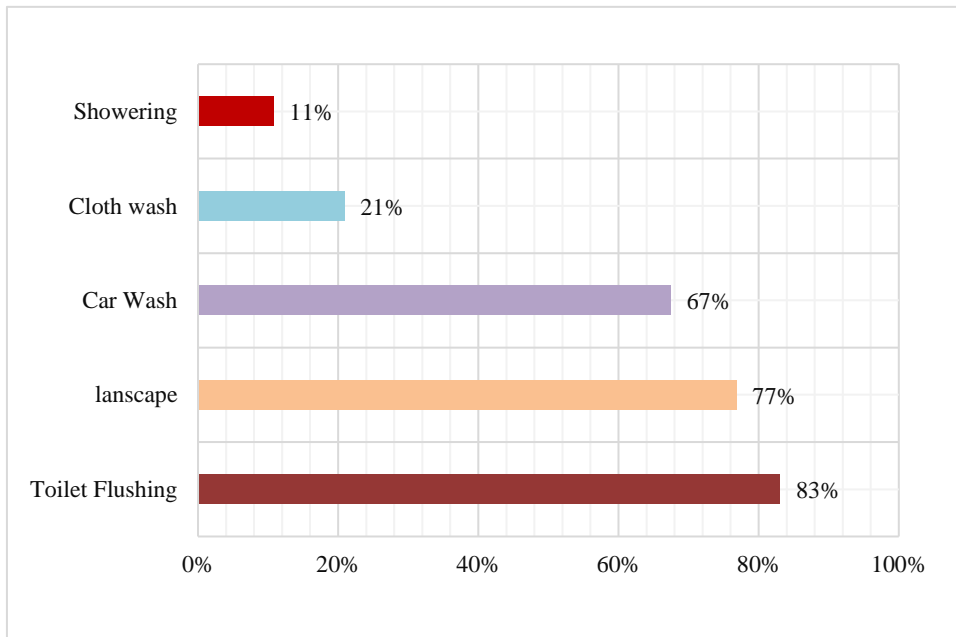


Figure 1: *Percentage of Respondents indicating Acceptable Uses for Treated Grey Water*

Participants in the survey were asked about their concerns with regards to using treated grey water. Figure 2 demonstrates a summary of the responses to this question. Only 8% of the participants consider the matter not significant enough for their contribution. However, diseases and water quality

concerns are the major causes of concerns, which agrees with the findings documented by (Fu et al., 2018) in their literary analysis. Social and psychological barriers concerned 27 % of the respondents, while 18 % rejected treated grey water for religious reasons as found by (Hyde et al., 2017). Few respondents noted in the comment box other reasons than those shown in Figure 2. Additional concerns are the presence of excessive treatment chemicals in the water, forming a risk on the human health and the environment, additional maintenance costs leading to rejecting the new system, and the anticipated presence of poor hygiene and unpleasant odor.

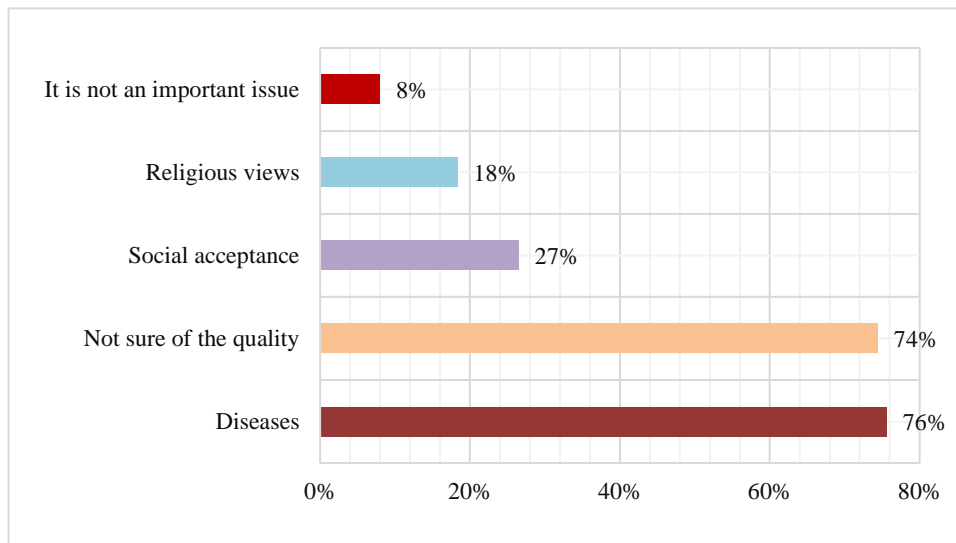


Figure 2: Grey Water Reuse Concerns

4. Conclusion

The results of this study were found to support the findings of similar studies conducted in the UAE (Maraqa & Ghoudi, 2012), (Wait, 2014), (Amaris et al., 2020), (Chowdhury, 2009), (Fu et al., 2018), (Hyde et al., 2017). In addition, the results agree with the factors identified in the literature to have an impact on the public acceptance of grey water reuse. The results revealed that despite the public environmental awareness, there is still a lack of awareness about the scarce fresh water resources in the UAE. Moreover, 70% of the survey respondents agreed to use treated grey water in applications not involving direct contact. However, utilizing treated grey water for applications that involve cloth wash and showering is still not widely accepted by the public. This is attributed mainly to health risk concerns, lack of confidence in the water quality, and lack of scientific knowledge about the treatment process. In conclusion, the results of this study demonstrate significant potential for the

public acceptance of grey water reuse, thus, its implementation. It is believed that public acceptance of grey water reuse can be enhanced by increasing awareness regarding the abundance of fresh water resources, providing education regarding the treatment process of grey water and the quality of the product water.

The results of this research demonstrate a significant limitation that will be addressed in future research. Despite that the size of the surveyed sample of the population is sufficient for statistically significant conclusions, the survey data is not broadly representative of the greater population of the United Arab Emirates with regards to age, occupation, and educational background. The majority of the survey respondents are undergraduate and graduate-level university students. Therefore, it is anticipated that the survey results are influenced by the attitudes and educational levels of this particular group. This group is expected to be familiar with water scarcity issues, sustainable practices, and water conservation necessities. This limitation will be addressed by expanding the size of the survey data to be a more broad representation of the United Arab Emirates Population.

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REFERENCES

- Alsharhan, A. S., & Rizk, Z. E. (2020). Water Resources and Integrated Management of the United Arab Emirates (Vol. 3). <http://link.springer.com/10.1007/978-3-030-31684-6>
- Amaris, G., Dawson, R., Gironás, J., Hess, S., & Ortúzar, J. de D. (2020). Understanding the preferences for different types of urban greywater uses and the impact of qualitative attributes. *Water Research*, 184, 116007. <https://doi.org/10.1016/j.watres.2020.116007>
- Chowdhury, R. K. (2009). Potable Water Saving by Reusing Greywater in the Al Ain City. 1–8.
- Dawoud, M. A. (2012). Environmental Impacts of Seawater Desalination: Arabian Gulf Case Study. *International Journal of Environment and Sustainability*, 1(3). <https://doi.org/10.24102/ijes.v1i3.96>
- Domnech, L., & Saurí, D. (2010). Socio-technical transitions in water scarcity contexts: Public acceptance of greywater reuse technologies in the Metropolitan Area of Barcelona.

Resources, Conservation and Recycling, 55(1), 53–62.

<https://doi.org/10.1016/j.resconrec.2010.07.001>

Fu, H., Liu, Z., Wang, M., & Wang, Z. (2018). Big data digging of the public's cognition about recycled water reuse based on the BP neural network. *Complexity*, 2018(December).

<https://doi.org/10.1155/2018/1876861>

Gude, V. G. (2017). Desalination and water reuse to address global water scarcity. *Reviews in Environmental Science and Biotechnology*, 16(4), 591–609. <https://doi.org/10.1007/s11157-017-9449-7>

Hyde, K., Smith, M. J., & Adeyeye, K. (2017). Developments in the quality of treated greywater supplies for buildings, and associated user perception and acceptance. *International Journal of Low-Carbon Technologies*, 12(2), 136–140. <https://doi.org/10.1093/ijlct/ctw006>

Maraq, M. A., & Ghoudi, K. (2012). Public Perception of Water Conservation, Reclamation and Greywater Use in the United Arab Emirates. *International Proceedings of Chemical, Biological and Environmental Engineering*, 32(1), 12–16. <https://doi.org/10.7763/IPCBE>

Wait, I. W. (2014). Consumer perception of water quality, abundance, and cost: comparison of drinking water source, attitudes, and preference. *International Journal of Environmental Engineering*, 6(4), 361. <https://doi.org/10.1504/ijee.2014.067006>