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Evaluating the Social and Psychological Factors about the Public Acceptance of Treated Wastewater Reuse: A Review

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Abstract: *To address water scarcity, treated wastewater has been demonstrated to be a more practical and environmentally beneficial solution than untreated wastewater. Nowadays, it is well acknowledged that social marketing and advocacy are inefficient at getting people to use recycled water. It is widely understood that the key components of any reuse project's success are public attitudes and acceptance of water reuse. This paper aims to present a summary of the literature on water reuse, with a focus on issues that may influence how the public perceives water reuse. In this study, a variety of social, psychological, and demographic variables are linked to higher levels of public support for wastewater use. The level of knowledge in this field is included in the conclusion, along with advanced suggestions and policy implications for improving our understanding of the socio-psychological and technological forces behind water reuse for multiple applications.*

Keywords: negative emotion, public acceptance, risk perception, trust, wastewater reuse

1. INTRODUCTION

Water challenges have become a major source of concern on a global scale due to the increased demand for water and the resulting strain on freshwater resources. As a practical solution to the rising water demand and limited freshwater supply, water conservation, desalination of seawater, and reuse of treated wastewater are widely investigated and acknowledged as being effective [1,2]. Given the increasing demand for freshwater reserves from population increase, pollution, and climate change, it is crucial to consider and use such strategies [3]. Wastewater that comes from industrial, commercial, or agricultural operations that have been treated to a level that is suitable for reuse is referred to as treated wastewater. Other sources of water reuse, such as domestic wastewater, stormwater, and rainfall collection, will be particularly highlighted when relevant. The use of treated wastewater is expanding, not just as a substitute for freshwater but also as a tool to slow down environmental deterioration. Reusing wastewater is an important tactic for protecting limited water supplies. Significant recent advancements in wastewater reuse technology imply that highly treated wastewater may eventually play a significant role in environmentally sound water security solutions [4].

1.1 Wastewater reuse status of different countries

In many parts of the world, including Singapore, Israel, Namibia, the United States of America, Australia, and many European nations (Fig.1), successful direct and indirect reuse projects have been implemented in response to emerging water scarcity challenges, current and future water shortages, and growing pressure on global water resources [5]. While there were systems for indirect potable reuse in existence in the USA, the first direct potable reuse was implemented in Windhoek, Namibia in 1968. (e.g. California) [6]. In USA, the main sectors of wastewater reuse are agriculture, landscape irrigation and groundwater recharge. In Europe, treated wastewater is reused in irrigation, groundwater recharge, industrial, indirect potable use, and recreational areas. In South Africa, the industry and agriculture sectors use recycled water. In Japan, water reuse is implemented for multipurpose uses such as agriculture and industrial use, stream flow augmentation, toilet flushing, recreational activities, heat source, and emergency water resources of towns. In Greece, the reuse system is executed in agricultural and landscape irrigations as well as firefighting [7–9].

1.2 Ecological impact of Untreated Wastewater

The main source of hazardous substances, pathogenic bacteria, and heavy metals is in wastewater treatment plants.

It gathers wastewater from several sources, including sewage from homes, businesses, hospitals or clinics, and urban runoff [10]. Heavy metals such as cadmium, lead, mercury, copper, and iron are categorized as harmful elements. Exposure to these heavy metals in excess amounts could have harmful effects on the environment and human health [11–13]. Wastewater should never be used improperly for irrigation as this endangers the environment. Heavy metals are transferred to the soil by irrigation with a variety of wastewater types, including industrial wastes, urban and agricultural wastewater, and sewage fluid sludge, which results in accumulation in crops because of poor farming techniques. This has been noted as a key pathway for heavy metals to enter aquatic resources [14,15].

Advantages of wastewater reuse are frequently highlighted in the literature [4,8]. The most significant advantages include offering a new water supply source that can be used for various water demands and uses, using less energy than existing water use alternatives, and lowering the amount of pollutants released into the environment [16,17].

Researchers still need to better understand how the public reacts to reclaimed water. According to some previous studies [17,18], existing information gaps make it difficult to fully comprehend the particular circumstances in which the society is responsive to alternate water sources and the patterns in which public acceptability can

vary across locations. The determinants of water reuse acceptability are strongly interconnected and highly complex. When trying to separate and hierarchically scale this, researchers face significant conceptual and methodological problems.

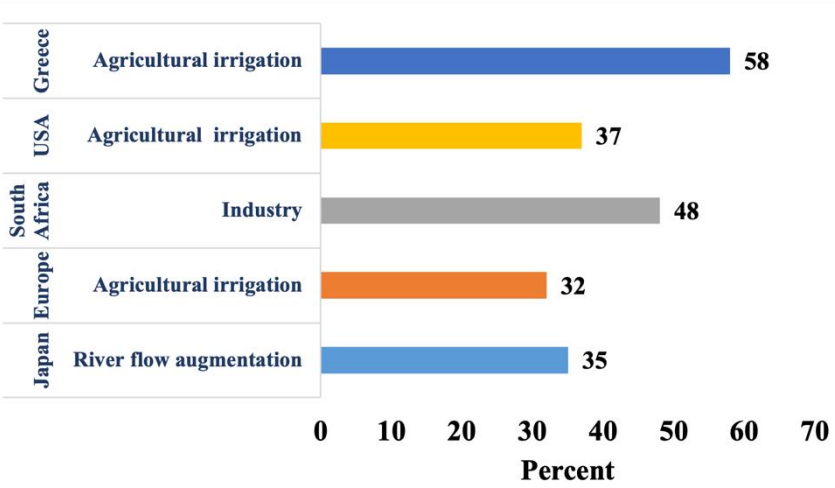

Fig. 1. Major sector for reuse the treated wastewater of different regions.

2. REVIEW APPROACH

Using Google Scholar, Scopus, and Web of Science, an extensive literature analysis was carried out to get a contemporary perspective on wastewater reuse. The theme, keywords (such as "water reuse," "recycled water," "public acceptance," "public attitudes," "risk perceptions" and "attitude"), as well as the summary, were all examined for the entire sample of articles (n = 100), and only those articles (n = 55) that were pertinent to the study's goals were selected. Most of the papers that were picked focused on finding and explaining determinants and success factors, and they also frequently drew attention to knowledge gaps and inconsistencies. All 55 of these papers were then further evaluated for inclusion. To find an additional relevant empirical study on recycled water, we searched the reference section of publications. Consequently, 30 papers in total were used as the basis for the analysis.

3. FACTORS BEHIND PUBLIC ACCEPTANCE BEHAVIOR

Although the usage of recycled water is logical, some are nevertheless hesitant to do so. The following is a review of the various components discussed in the literature that may affect how socially acceptable a reuse scheme is on a behavioral level (Fig.2).

Negative emotional reactions: The immediate psychological response of aversion associated with recycled wastewater is described as a negative emotion or disgust [18]. How disgust is formed and the measure to which disgust can be recognized as a significant and independent predictor of public acceptance are crucial issues for researchers as people's decisions about reusing water are influenced by their emotions and cognitive abilities [3]. The sense of disgust that is triggered by the idea of using recycled water appears to represent this psychological barrier. Some people claimed they were stuck in their own sewage-related mental images and couldn't get out of them [19].

Environmental risks: In some cases, nutrients (phosphorus, nitrogen, zinc, potassium, and Sulphur) in treated wastewater are over what plants need and can result in issues like abnormal plant development, delayed maturity, or decreased quality [20]. Important biological pollutants that can be conveyed by wastewater and concentrated in soil include human and animal pathogens, phytopathogens, and antibiotic- resistant microorganisms and their genes. Other pollutants in wastewater include active residues from personal care items, metals, metalloids, organic chemicals, and endocrine disruptors [21,22].

Health risks: The only risk factor that was discovered to have an immediate impact on intended behavior was health risk. Human contact with reclaimed water is perceived as having higher health concerns [23]. Food security is a key public concern since polluted food sources can result in a variety of serious health issues, such as the body's immune system being weakened due to a lack of critical nutrients [24]. Additionally, numerous studies have shown that treated wastewater contains significant amounts of bacteria and enteric viruses, which can be transported into the atmosphere and survive there for a long time [25,26].

The particular uses of wastewater: More individuals are against using recycled water, specifically the closer it is to human touch or consumption. The public was open to the idea of reusing non-potable water for sports fields, parks, and businesses. It was recognized practice for agricultural production. Research revealed that utilizing recycled water on crops that were either not directly consumed by humans was highly acceptable [6].

The issue of choice: A significant factor in determining whether the public will accept water reuse is the matter of choice. People were observed to readily adopt water reuse in areas with water shortage difficulties due to the increased knowledge of the need to preserve water [27]. There must be a true need for using recycled water, and it should only be taken into consideration if

other options proved unworkable and financially unprofitable.

Trust: Public acceptance of water reuse may be greatly influenced by public trust in government to deliver safe recovered water. People's perceptions of the quality of the water have been found to be mostly influenced by their trust in the water authorities. Higher levels of trust are thought to be linked to lowered risk perceptions, which in turn improve the likelihood of acceptance, according to several modelling-based studies [28].

Fig. 2. Social, psychological, and demographic factors of acceptance the treated wastewater reuse

Attitude: People's approval of using recycled water may be greatly influenced by their attitudes about the environment [29]. Individuals who had reclaimed water supplied to their residence for use in flushing toilets and watering gardens shown a high level of awareness and positive attitude towards water resource conservation through water reuse [30]. Some residents took into account the numerous environmental advantages of employing recycled water in certain research [31].

Knowledge: Public acceptance is also influenced by people's knowledge of water challenges and their willingness to support supply plans that employ recycled water. Participants who were more knowledgeable or more aware about the water situation and its effects on humanity were more receptive to using recycled water from various sources for different purposes [32,33].

Cost: Since recycled water is commonly thought to be of questionable quality, people typically expect to pay less for it. A poll of households in dual supply developments revealed that most respondents anticipated paying less for recycled water use due to the resource's limits and high quality. Some individuals believed that the reduced cost was required to promote acceptance and investments in the initial costs [6].

Socio-demographic Factors: Finally, several demographic variables that affect how the public views water reuse have been revealed in some studies. Some research claimed that males with higher levels of education, low change aversion, and no prior exposure to unfavorable reuse information were more inclined to approve potable reuse [34,35]. Age, gender, and income had no appreciable influence on whether potable reuse was accepted or rejected globally throughout the several study areas.

4. RESEARCH SUGGESTIONS

Given the importance that literature in environmental science contributes to our knowledge of the reuse of treated wastewater, it is also obvious that the current body of literature has some limitations. The first is the failure to understand that wastewater reuse usually demands the actions of the entire society and, as a result, takes place in a collective setting. So, the behavior of using recycled water will be greatly influenced by social support. Furthermore, to properly comprehend the consequences of the drivers and barriers, longitudinal studies of wastewater reuse operations are needed. Researchers can distinguish between causality and correlation using longitudinal investigations. Last but not least, there hasn't been much research on how to promote reuse behavior, including how to employ effective communication techniques, how to shape and how success is influenced by belief in the source of information, etc. To fulfill both short- and long-term water safety goals, a detailed and accurate treated wastewater reuse model is needed. This model could help water managers create sensitive and effective water management plans.

5. POLICY IMPLEMENTATIONS

Adoption of modern water resource management policies is required due to water shortage and the deterioration of water resource quality. This job needs to be the focus of the use of cutting-edge technologies and techniques. Without awareness, it will be extremely challenging to encourage a change in behavior toward practical and beneficial water reuse techniques. Greater water savings can be achieved through water reuse programs as people become more familiar with the technologies and generally aware of the associated benefits of increasing water reuse. Increased acceptance can be attained through education and awareness-raising initiatives on the importance of conserving water and the advantages of reusing treated wastewater. Identification of potential environmental justice concerns that might influence people's willingness to use recycled water Regular and sufficient monitoring of the treated wastewater is necessary to guarantee consistent water quality for reuse. The media and various organizations can increase public

awareness of the value of wastewater reuse. For the public to use treated wastewater for specific purposes, appropriate financial incentives can also be provided.

6. CONCLUSION

The reuse of treated wastewater has been linked to a variety of social and psychological difficulties, which have been reviewed in this study. Public acceptance of reuse is a result of emotion, attitude, control over the water supply, environmental knowledge or awareness, associated dangers, trust in the authority, specialized usage, cost, and water shortage. These elements have been researched separately or in combination in numerous locations where water reuse programs have been established or are being proposed. This knowledge will serve as a reminder for future study that examines strategies for promoting wastewater reuse to different extents. We still have a long path to go before we can reliably determine how people will react to initiatives for consumer preferences and motivations-based wastewater reuse programs and education. With consumer preferences and motivations considered, we still have a long path to go before we can reliably determine how people will react to initiatives to raise awareness of and educate about wastewater reuse.

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