Chapter 12

Social Perspectives on the Effective Management of Wastewater

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Additional information is available at the end of the chapter

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Abstract

The chapter discusses how adopting a holistic methodology that acknowledges sociological factors, including community participation, public involvement, social perception, attitudes, gender roles and public acceptance, would lead to improvements in wastewater management practice. It highlights the social dimension as a tool, a lens through which wastewater management and reuse can take on new dimensions. In this way, this chapter aims to shift the focus from perceiving wastewater as a nuisance that needs disposal, toward a resource not to be wasted, which can contribute to food security, human and environmental health, access to energy as well as water security.

Keywords: wastewater reuse, social dimension, community participation, public involvement, public acceptance, gender

1. Introduction

The global water crisis, the shortage of fresh water, contamination of water and increasing volumes of wastewater being produced have eventually necessitated the use of wastewater. A paradigm shift is therefore required not only to prevent further damage to the ecosystems, but also to emphasize that wastewater is a resource whose effective management is essential for future water security [1, 2].

Wastewater can be recycled and reused for a variety of water demanding activities such as agriculture, firefighting, flushing of toilets, industrial cooling, park watering, formation of wetlands for wildlife habitats, etc. [3]. Treated wastewater reuse can be seen as a sustainable way of addressing long-term imbalances between water dem and and supply, which makes sound economic sense also in view of increased imbalances due to climate change [4]. The

focus of most wastewater research has been on the technical aspects and improvements in terms of water quality and on minimizing the environmental and health impacts, without paying sufficient attention to their basic social and sustainability dimensions. Recent research has shown that ignoring broader social issues that impact the adoption of sustainable solutions prolongs global environmental problems as well as unjust public health and social conditions [5]. Thus, more attention is needed to the social aspects of wastewater management strategies.

2. The Global Demand for Water

The development of human societies is heavily dependent on the availability of water of suitable quality in adequate quantities. However, the demand for water is ever increasing due to population growth, technological advancement, industrial expansion, pollution and urbanization, which put great stress on the natural water cycle [1]. These demands were met by constructing ever-larger dams, which in turn affect both water quality and quantity [6]. Moreover, the available freshwater supplies are not evenly distributed, and there is a growing competition for water from different sectors, including industry, agriculture, power generation, domestic use, etc. As a result, one-third of the world's population is currently experiencing water scarcity. In water-scarce regions and countries, inequity in access to water resources is increasing because of competition for limited resources, and this particularly affects poor people [7]. However, the focus on freshwater without enough attention to its end products (wastewater) will exacerbate the water quality problem. It is therefore very important to consider wastewater management as a critical component in achieving future water security through integrated water resources management [8]. This is particularly true as wastewater is the only source of additional water that actually increases in quantity as population and water consumption grow.

3. Wastewater crisis

With increasing urbanization and changing lifestyles, increasing amounts of wastewater is being generated and where these are not sufficiently treated, freshwater bodies are continuously threatened [9]. Achieving the Sustainable Development Goal 6, which targets improved wastewater management, thus puts immense economic pressure especially on poor countries [10]. Inadequate infrastructure and sustainable management systems for the increasing volume of produced wastewater are at the heart of wastewater crisis in developing countries. As a result of inadequate infrastructure of wastewater treatment in most of the big cities where half of the world's population lives, the majority of wastewaters are discharged into the environment without any form of treatment, harming both the ecosystem and humans [9, 11]. Over half of the world’s hospital beds are occupied by people suffering from diseases caused by contaminated water, and more people die as a result of polluted water than are killed by all forms of war. In

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many developing countries, an estimated 1.8 million children under 5 years old die every year due to water-related disease [12].

Wastewater damages the ecosystem in many ways: For example, wastewater may contain high levels of nutrients such as nitrates and phosphates. When water bodies receive excess amounts of these nutrients, it may stimulate excessive plant growth, which may release toxins into the water bodies, leading to oxygen depletion and causing what is known as de-oxygenated dead zones. This phenomenon decreases biodiversity and changes species composition and dominance, as well as decreasing water quality for reuse [11, 13]. Another example is the impact of wastewater on the climate around the globe: Wastewater treatment-related emissions of methane and nitrous oxide (powerful global warming gases) could rise by 50% and 25%, respectively, between 1990 and 2020 [1].

According to the fourth World Water Development Report by UNESCO [14], only 20% of globally produced wastewater receives proper treatment. Treatment capacity typically depends on the income level of the country; thus, in high-income countries, the treatment capacity reaches up to 70% of the generated wastewater compared to 8% in low-income countries [15]. Meeting the wastewater treatment challenge is thus not a luxury but a prudent, practical and transformative act, able to maintain public health and secure ecosystem health.

While so far, wastewater has mostly been seen as a treatment challenge, a paradigm shift toward its recognition as a resource for sustainable development is emerging. In this sense, wastewater can be reframed from being a problem to be disposed of to being a resource with social and economic value [5]. This shift offers wastewater to become part of an integrated, full life cycle, ecosystem-based management system that operates across the three main dimensions of sustainable development, that is, its social, economic and environmental pillars [1, 16].

4. Wastewater as a resource

Depending on the treatment or lack of it, as well as the degree of dilution, wastewater can be rich in resources such as nutrients, inorganic and organic compounds as well as energy, making it worthwhile for recovery and reuse. On the other hand, it can also be rich in chemical and microbial contaminants, and the improper use of untreated wastewater can have adverse effect on both human health and environment [13]. Wise wastewater management can therefore be a positive addition to the environment with significant returns in terms of enhancing food security, creating livelihood opportunities, climate change adaptation and sustainable ecosystem [1].

Successful examples of this paradigm shift can be found around the globe. There have been dramatic successes in using treated water for drinking purposes; for example, in Namibia, 35% of all drinking water is treated wastewater, and in Singapore, 30% of all water used is reclaimed water (and this percentage is increasing) [17]. The United States of America has also been seen several successes in treating wastewater for drinking purposes.

Wastewater can also be treated to provide energy. Various forms of energy can be recovered from wastewater and its biosolids, with biogas being the most prominent. It can be combusted on-site for heat or electricity generation, cleaned and sold to local natural gas providers or as fuel for vehicles [18–20]. Wastewater treatment plants are increasingly generating their own energy, which is an important achievement because energy consumption is a major cost in treatment plants. Another example from low-income countries is the transformation of fecal sludge (and other organic waste) into dry fuel like briquettes [21, 22]. The most common materials, however, that are recovered from wastewater are the water itself, which can be used for irrigation and its crop nutrients and biosolids as fertilizer. The use of fecal sludge as fertilizer is a well-known practice, especially from septic treatment plants given the low contamination within household-based on-site sanitation systems, compared to biosolids recovered from wastewater treatment plants. Some treatment processes recover nutrients, such as the N- and P-rich struvite, from wastewater during treatment rather than from the final products of the treatment [23–25].

5. The overlooked social dimension

The focus of most wastewater-related research has been on the technical aspects of the problem and improvements in terms of water quality and in minimizing environmental and health impacts, with very limited attention to its basic social and cultural sustainability dimensions [5, 9]. While, with increasing urbanization, wastewater treatment has moved further away from the household and its social roots, three types of campaigns (i) against open defecation, (ii) for the promotion of water-saving dry toilets and (iii) for using reclaimed water for drinking made it clear that sanitation depends strongly on social habits and acceptance. Where treatment is not keeping pace with population growth, and environmental pollution is threatening public health, the social dimension of wastewater management becomes obvious. Recognizing the role of the social base for wastewater management from risk reduction to reuse can have major implications, for example, on the choice and effectiveness of the technologies employed. Yet, usually, only limited information is available on the social perspective [5].

Wastewater management strategies have been traditionally driven by considerations of efficiency, safety, and cost-effectiveness. Even technology choices are often made by finance institutions outside the country, especially in low-income countries, often favoring "Northern" technology options. The emphasis on costs and benefits in this context would be acceptable if, in addition, other relevant factors could be included in the decision-making process by adopting a holistic methodology that includes the voices of all stakeholders and an analysis of sociological factors. Unless a holistic methodology is adopted, even cutting-edge technology might impede progress toward sustainable development, as the example of Toowoomba shows (Box 1). Likewise, the Singaporean success story would have had a very different outcome if public buy-in for wastewater reuse for drinking purposes had not been secured [5].

http://dx.doi.org/10.5772/67312

Queensland's Toowoomba in Australia is an often cited case illustrating the strength of public opinion regarding wastewater use. A plan to turn wastewater into drinking water failed in Toowoomba at a referendum in 2006, although water scarcity in the community was severe, to the point that water use for gardening was completely prohibited in the "Garden City." With no major river nearby, the community water supply had to be pumped uphill. During several years of drought, the 140,000 residents of Toowoomba and surrounding areas endured tough water restrictions. Local officials considered that the city had no choice but to treat and use parts of its wastewater for drinking water, and given the water crisis, they expected the program would be acceptable. However, the proposal met with fierce opposition from the community. In 2006, the residents of Toowoomba voted strongly against treating and using 25% of the city's wastewater. They relied instead on water piped from Brisbane's Wivenhoe Dam, at a cost to ratepayers of nearly $100 million more than the reuse program would have cost.

The Toowoomba proposal was an indirect wastewater use program, in which highly treated wastewater would be passed through an environmental buffer before being treated again, as part of the drinking water system. The public poll was accompanied by two dynamic campaigns building on the "yuck" and "fear" factors on one side, and social and financial arguments on the other. In the end, 62% of those polled opposed the project.

Sources: Ref. [5].

Box 1: Community resistance to wastewater reuse

A primary shortcoming in wastewater reuse is the lack of a combined sociotechnological planning and design methodology to identify and deploy the most sustainable solution in a given geographic and cultural context. The best practice, once a treatment or reuse technology has been developed, is to get early stakeholder buy-in and identify the best way to implement the technology in a participatory manner that is socially acceptable from the local perspective [26–28]. Stakeholders can be included in the decision-making process in different ways, including facilitating positive social learning processes, minimizing and resolving conflicts and, most importantly, using local knowledge and community participation [4].

5.1. Community participation and public involvement

Successful employment of appropriate technologies requires deep understanding of the social dynamics of the community in which they are applied [29–31]. This is only achieved through effective public involvement and community participation. Public involvement is best achieved through participation and involvement of users in all parts of the project cycle, from planning and design to implementation and decision-making, which produces more efficient and sustainable projects/outcomes [32]. In a sense, when communities have influence and control over decisions that affect them, they have a greater stake in the outcomes and are more committed to ensuring success.

Public involvement is of particular relevance when it comes to wastewater reuse, which is associated with major social concerns, including impacts on public health and safety, impacts

on environmental quality as well as the benefits and risks of reuse. Thus, having an effective public involvement strategy from the planning phase to full implementation leads to greater acceptance and facilitates the implementation process of the wastewater reuse scheme. In other words, community participation can assure the social viability of the wastewater reuse practices [33–35]. Effective public involvement begins with early contact with potential users through the actual inclusion of all stakeholders and can involve educational and public awareness programs, the formation of advisory committees, and holding public workshops to discuss the benefits and risks of reuse [5, 36]. According to Ashley et al. [30], publicity, including advertisement in the media, education and inclusion of all stakeholders (politicians, experts and general public) in the decision-making process are the key elements for successful design and implementation of wastewater schemes. Gibson and Apostolidis [37] argue that the best way to involve the general public and to gain its support and acceptance is through successful demonstration projects.

For community participation to be as inclusive and effective as possible, the diversity of people within the same community should be acknowledged and dealt with. Communities are made up of individuals of different genders and groups of people who command different levels of power and wealth. Within each community, there are always competing interest groups. For example, there are rich and the poor, the farmers who have fields and livestock to water and the landless farmhands with children to care for, marginalized groups and members of socioeconomic minorities, housewives who need water for drinking and household and businessmen who own industries that require water. Thus, perception studies are a key component of any social analysis [26, 38].

5.2. Social perception and public acceptance

Even when wastewater is treated using advanced technologies and health risks are carefully addressed and controlled, irrespective of all scientific evidence, social perception remains the driver of the success or failure of wastewater reuse schemes. Depending on public perceptions, impressions and attitudes, the development of a wastewater scheme can be supported or constrained. Negative public perception can prevent well-planned projects from moving forward. On the other hand, positive public perception, which leads to greater acceptance, is the key element for successful implementation of wastewater recycling [5, 39]. Experience shows that the local communities have rejected a number of wastewater recycling projects by the governments and water boards around the world as a result of inadequate community consultation which led to negative public perception [40].

The degree of acceptance of wastewater reuse varies widely depending on the reuse purposes and is influenced by many factors, such as the degree of contact; expressions of disgust; education; risk awareness; the degree of water scarcity or availability of alternative water sources; calculated costs and benefits; trust and knowledge; issues of choice; attitudes toward the environment; economic considerations; involvement in decision-making; the source of water to be recycled; and experience with treated wastewater. Other factors that depend on the region and case include cultural, religious, educational and/or socioeconomic factors [5, 27, 35, 41–43].

Education and the level of physical contact (potable/no potable reuse) are the most influential factors that have been frequently associated with levels of acceptance of treated wastewater. In

http://dx.doi.org/10.5772/67312

Kuwait and Greece, for example, the willingness to accept recycled water increased with educational levels [44, 45]. However, as much as education and knowledge support public acceptance, nevertheless, direct exposure to the recycled water strongly influences its acceptance [46, 47]. For example, potable use is usually rejected due to health concerns. Wastewater use in agriculture generally is preferred to potable use, but more distant uses, such as landscape irrigation, are the most preferred [48, 49].

Several authors have investigated the association of sociodemographic descriptors with the acceptance of treated wastewater. The D'Angelo report [50] indicated that the acceptability of using recycled water in agriculture is higher for nonedible crops than for edible crops. For edible crops, the preference is for crops that must be peeled prior to human consumption, such as oranges and sweet corn. A relevant study [51] reported that the public's acceptance of reuse increases as the degree of human contact with the recycled water increases, with 97% and 96% of the public supporting wastewater reuse for irrigation and for toilet flushing, respectively, whereas only 20%–30% support potable reuse. Another study conducted by Friedler and Lahav [39] to determine the attitudes of the Israeli urban public toward possible urban reuse revealed that the majority of participants supported options perceived as low contact, such as irrigation of public parks (96%), sidewalk landscaping (95%) and use in the construction industry (94%), while higher contact reuse options, such as commercial launderettes (60%), found less support. According to Bruvold [52], the degree of human contact has a greater effect when people were asked about general use options, whereas when the specific use scheme was used, other factors such as health, environment, treatment, distribution and conservation had greater impact on people's perceptions. Therefore, he argues that it is essential to weigh the different objectives of the recycling options in coordination with people's/users' acceptability and preference and select the recycling projects which are most likely to be accepted by the community and therefore make the project implementation successful.

5.3. Gender roles and implications

As mentioned above, successful community participation is better achieved by acknowledging the diversity of people within the community. This includes gender, age, education level, power, wealth and so on [53]. In this context, it is very important to acknowledge the differences of interests and roles between men and women as different stakeholders. There are a number of gender aspects which influence how both genders are involved in and benefit from improvements to the water. In many developing countries, women have limited access to education and other resources and services, have heavier workloads, are more constrained by poor health, have a lower social status, and are poorly represented in decision-making at both household and community levels [54]. Thus, balanced attention is needed in the form of distinctions between what women and men know, do and decide and what the effects are for them, their families and communities (Box 2).

In general, women are most vulnerable to water-related disasters, including water scarcity and bad water quality. Many infectious diseases are associated with poor water quality, and these are reported as being among the fifth biggest killer of women worldwide, causing more deaths than AIDS, diabetes or breast cancer [55]. Dirty water and poor sanitation are also at the root of problems such as maternal and child mortality and sexual violence. Many women in developing countries give birth at home without access to clean water, exposing themselves

and their babies to infections. More than 50 million primary-school-aged girls in developing countries are not in school because they are required to fetch water and firewood [56]. Thus, it becomes a necessity to bring women frequently on the scene for consultation and allow their full participation in wastewater management. Implementing a gender-sensitive approach produces more effective, efficient and affordable outcomes. Including women in water and wastewater management planning often makes for fewer oversights in technical planning and improves resource and financial management, as well as allowing for greater transparency [54].

Acknowledging gender roles and differences not only contributes to the success of a project, but offers planning options to optimize the overall social and economic development and reduces competition and conflicts over water resources. In most societies, the provision of water for the fulfillment of fundamental human needs has always been women's responsibility, yet their participation in decision-making is very limited if there at all. To bring about constructive change, more efforts are needed to better understand the gender implications in water sector [57, 58].

Thoughtful safety interventions must be gender sensitive. In many cultures, women carry the main responsibility for hygiene and health, also vis-à-vis greywater or wastewater use as reported, for example, from Jordan, Vietnam and Tunisia. The strong connection between women and water use at household level offers significant potential for innovative training approaches to improve the social acceptance of safe water reuse, as recently demonstrated in Jordan. Also the use of protective clothing should be gender-specific. In Vietnam, women were observed wearing protective gloves and boots more consistently than men. The differences were attributed to the gendered work division on the farm, with men walking around the farms much more than women, and where protective clothing constrained men's movements. Sources [5, 59–61].

Box 2: Gender roles

6. Key improvement areas

There is little known about public perceptions of wastewater reuse in the literature, and it is mostly documented in a limited number of locations, that is, the United States, Australia and Western Europe. Still a lot of more studies are required at national and subnational context in order to avoid outcomes being transferred from one country to another, which is always inappropriate due to the range of factors that influence public acceptance from country to another, including culture, religion, economy, climate and water availability [40].

In general, public acceptance of reuse is not straightforward, but it is always easier when water scarcity is already affecting the public, so that they perceive wastewater reuse as a solution rather than a problem [5, 62]. However, for greater acceptance, public and private concerns and benefits must be aligned. Public concerns about risks are to be weighed against the benefits of using treated water. The dialogue should be built on mutual trust to provide the right climate for negotiation and conflict resolution [5].

http://dx.doi.org/10.5772/67312

Certain social factors have always been associated with poor acceptance of wastewater reuse, including the lack of coordination between the authorities involved in planning; inadequate community consultation; lack of trust in technology; social pressure and fear of social backlash; and fear of losing markets in case of wastewater reuse in irrigation [41, 63, 64]. Another factor is overlooking the gender dimension [65].

In order to fill the gap in knowledge regarding the social dimension of wastewater reuse, extensive social research into public perceptions of wastewater reuse is needed. Some of the priority areas to focus on are as follows (1) to understand judgment strategies that shape public decisions to support or reject wastewater reuse; (2) to identify factors influencing people's risk perceptions; (3) to investigate the role of trust in the authorities and the limits in scientific knowledge in people's decision-making processes to either accept or reject the reuse; (4) to examine how factors such as health, environment, treatment, distribution and conservation can affect people's willingness to use recycled water; (5) to examine people's sensitivity with regard to the disgust emotion or "yuck" factor; (6) to understand the impact of the source of wastewater on people's decisions; (7) to understand how the economic advantages in using recycled water can facilitate public acceptance; and (8) to identify possible environmental justice issues that may affect public acceptance [66, 67].

With regard to gender implications on community participation and public acceptance, greater women's participation is needed through effective gender mainstreaming strategies. Obstacles to women's participation generally include lack of confidence, family commitment including child care, heavy workload and time constraints, traditional values and stereotypes, fears of men and husbands who prevent women from participating (many women said that their husbands do not support their participation in public life) [68, 69].

Apart from the social and cultural issues, another reality with regard to gender mainstreaming is the lack of general awareness of the significance of gender factors in water and wastewater management, which applies to both leaders and decision-makers who work in water management programs. Another shortcoming is the lack of gender-disaggregated data, which is the only way to move forward from principles to practice in gender mainstreaming [70, 71].

In order to fill the gender gap in wastewater reuse, investing time and effort in awareness raising on the different needs and impacts for women and men at all levels is part of the necessary training for all professionals in the wastewater sector. Nevertheless, gender mainstreaming is a continuous process and a holistic approach, which cannot be achieved by a single training session.

Some of the key issues to focus on are as follows: (1) to acknowledge both men's and women's roles and responsibilities, energy, experience and knowledge in contributing to the effectiveness of wastewater reuse programs as well as identifying their different needs and priorities; (2) to mainstream gender throughout all projects' cycle from planning and design to implementation as well as related policy; (3) to ensure women's participation in consultation committees and educational workshops in terms of timing and allocation of these meetings by taking into consideration their family responsibilities (e.g., domestic work), otherwise,

women may choose not to participate to avoid conflict with their responsibilities; and (4) "at institutional level" to train the technical staff working in research and development to integrate gender dimensions into the socioeconomic aspects of research work, in order to address the differential impacts of structural interventions and the appropriation of new technologies [53, 54, 72].

7. Conclusions

With increasing pressures on water resources, wastewater recycling and reuse have rapidly become an imperative for integrated water management strategies. However, along with the technology advancement in wastewater treatment, societal factors such as public perception, public acceptance and the dimension of gender have great implications on the success of wastewater reuse.

Adopting a sociotechnological approach by means of considering all social factors together with technology in wastewater recycling results in great improvements in terms of effectiveness and efficiency as the infrastructure will be more widely used and optimally sustained by all user groups including women and men. It will also contribute to the overall development of the society by increasing consumption, production, income, environmental security, health and overall family welfare, along with securing water resources when addressing the societal issues of the service delivered. Another gain of the sociotechnological approach in water sector is the sustainability of the service, in the sense that equal participation of all stakeholders in research and project implementation can increase the potential, flexibility and creative innovation in responding to water insecurity.

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