

Environmental Management

Water Reuse as an Incentive to Promote Sustainable Agriculture in Lebanon: Stakeholders' Perspectives

May A Massoud,*† Malakeh Terkawi,† and Rima Nakkash‡

†Department of Environmental Health, Faculty of Health Sciences, American University of Beirut, Beirut, Lebanon

‡Department of Health Promotion and Community Health, American University of Beirut, Beirut, Lebanon

ABSTRACT

While technical and economic feasibility of water reuse projects is requisite for implementation, issues in relation to cultural values, public acceptability, and perceptions should not be marginalized. This research focuses on examining the Lebanese stakeholders' knowledge, perception, and attitude toward the reuse of treated wastewater and on exploring potential enabling factors. Accordingly, in-depth interviews were conducted with stakeholders from concerned ministries, Lebanese Farmers Syndicate, farmers, and religious figures. The reported perceived barriers are categorized into ethical, religious, social, and economical. Various enabling factors that can ameliorate the management of potential perceived barriers are recommended, including enforcing laws, setting new regulations and quality standards, involving the public all through the project process, ensuring regular monitoring and evaluation, and developing financial policies and mechanisms. *Integr Environ Assess Manag* 2019;15:412–421. © 2019 SETAC

Keywords: Water reuse Agriculture sector Stakeholders' perspectives Lebanon

INTRODUCTION

Globally, several geoclimatic areas are facing an intensifying pressure on freshwater supply owing to the limited available water resources and the increase in water demand. It is estimated that water demand will surpass supply by 40% within the next few decades, exacerbated by the fact that about 85% of the population resides on the driest half of the world (WRG 2009; World Bank 2013). The World Resources Institute reported that it is projected that 33 countries globally would suffer severe water stress by the year 2040, with nearly half of them in the Middle East region. Lebanon is considered an extremely highly stressed country, primarily as a result of declining and deteriorating water resources in addition to long-lasting mismanagement (Gassert et al. 2013). Consequently, countries are compelled to improve the efficiency of the water supply system and to support the available water resources with more sustainable alternatives. The reuse of treated wastewater has been among the sustainable water management practices to augment water supply and reduce the demand for fresh water, particularly in the agricultural sector, due to environmental and economic motives (Petousi et al. 2015). Figure 1 exhibits the various sectors that reuse water at the global level after advanced or tertiary treatment (Lautze et al. 2014). Despite the explicit benefits of reusing treated wastewater, several projects faced

public resistance irrespective of the intended use (Hartley 2006; Dolnicar et al. 2011; Molle et al. 2012). This resistance is attributable to various sociocultural factors, including but not limited to trust in authorities, availability of fresh water, availability of information, risk perception, and religious prohibition (Saldas et al. 2016; Goodwin et al. 2017; Fielding et al. 2018).

Trust in authorities has always been a major global factor influencing the public acceptance to use treated wastewater (Chang et al. 2012; Wu et al. 2012; Ross et al. 2014). Concerns over the monitoring of implemented projects to maintain a safe effluent and concerns over public involvement from early stages of project planning are major factors expressed in several quantitative studies (Jeffrey and Jefferson 2003; Hartley 2006; Hurlimann and McKay 2007; Hurlimann 2009; Dolnicar et al. 2011; Peters and Goberdhan 2016). In addition to the aforementioned aspects, qualitative studies done in developing countries have shown that the public are also worried about the control of specific political bodies over wastewater treatment and reuse projects. Such control would not ensure equal service delivery to the public but would target the community that reflects political support (Carr et al. 2006; Wilson and Pfaff 2008; Carr et al. 2011; Mizyad 2012). Concerns were also raised regarding the fair and acceptable distribution of fees among the beneficiaries of the project (Wilson and Pfaff 2008).

The availability of safe fresh water and the quality of the received treated wastewater have been major factors affecting public acceptance to use treated wastewater in

* Address correspondence to may.massoud@aub.edu.lb

Published 29 January 2019 on wileyonlinelibrary.com/journal/ieam.

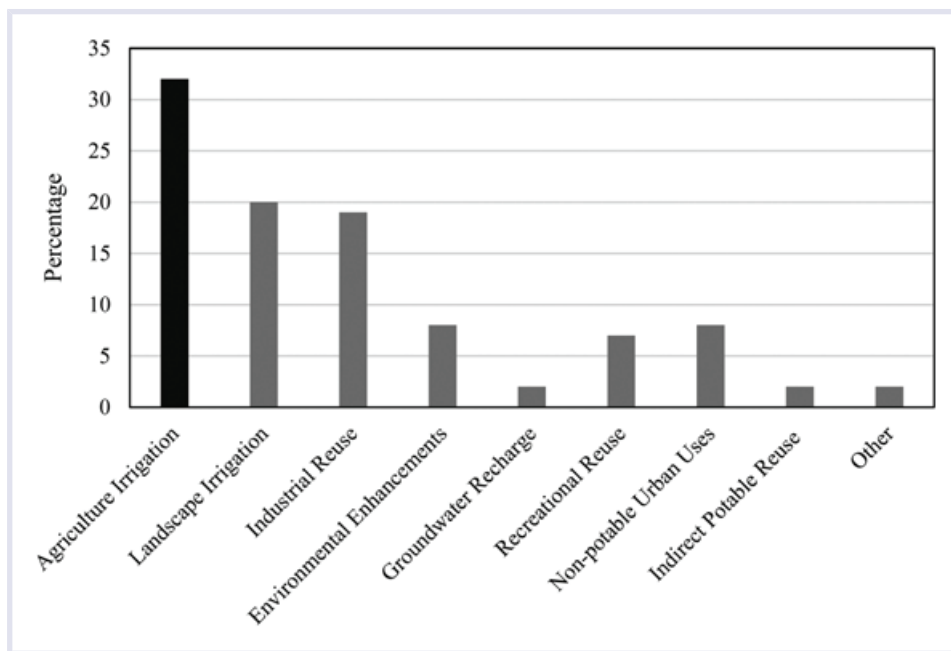


Figure 1. The various sectors reusing water globally after advanced or tertiary treatment (based on Figure 2 in Lautze et al. 2014).

both developed and developing countries. Risk perception is normally related to public health issues as associated with the quality and safety of using recycled water, perceived dirtiness or filthiness, and the fear of contamination from using the water (Po et al. 2003). Studies (Baggett et al. 2006; Hurlimann and McKay 2007; Menegakia et al. 2007; Peters and Goberdhan 2016) have found that the public's satisfaction with the available freshwater quantities affected their acceptance of using treated wastewater. Other studies revealed that water scarcity is the main determinant of public acceptance to use treated wastewater for irrigation, thus reaching the deduction that apprising the public of the existing water shortages would increase acceptability (Al-Mashaqbeh et al. 2012; Madi et al. 2017). The availability of information is a major factor affecting the stakeholder and public acceptance of wastewater reuse (Tsagarakis and Georgantzis 2003; Hartley 2006; Menegekia et al. 2007; Dolcinar et al. 2011; Peters and Goberdhan 2016).

Religious prohibition has been a major sociocultural factor investigated by various authors, primarily in the Arab countries. Generally, farmers tend to show less support for the reuse of treated wastewater for both potable and nonpotable practices due to religious aspects (Abu-Madi et al. 2008; Alhomoud et al. 2010; Aitkens 2014). Certain studies (Wilson and Pfaff 2008; Carr et al. 2011) revealed that religion is not a limiting factor when continuous monitoring over the quality of the delivered treated wastewater occurs. Apart from sociocultural factors, some demographic variables have an effect on the public's acceptance to use treated wastewater. Yet no significant global relationship could be formed between age, gender, and income in accepting treated wastewater reuse over different study locations (Po et al. 2003; Boberg 2005; Jain et al. 2014;

Fielding et al. 2018). Figure 2 shows the relationship among the various factors affecting the reuse of treated wastewater.

In Lebanon, water resources are under intense and escalating pressures. It is expected that by 2040, the temperature in Lebanon would increase by 1 to 2°C, the annual rainfall would face a 10% to 20% reduction, and the drought periods would increase by 9 d (IFI 2014). This would lead to a 10% decrease in the water supply by 2050 and to a possible conflict with neighboring countries over the scarce resources (IFI 2014). Thus, the treatment of wastewater and its reuse in agriculture—which consumes more than 60% of the available freshwater resources—would be considered a sustainable supplementary source for water management. Given that factors influencing acceptance of water reuse projects vary according to the context, the present research will assess the stakeholders' knowledge, perception, and motivation regarding the reuse of treated wastewater, analyze the perspectives of various stakeholders toward the usage of treated wastewater, explore respondents' views regarding wider participation of the public and other stakeholders in the planning and implementation of water management projects, and define the main concerns that should be addressed through implementing public information campaigns.

Water reuse projects are typically planned and implemented on the basis of only technical and financial feasibility. Issues in relation to beliefs and values of a culture that principally determine the perceived need for water reuse and the level of acceptability of reuse tend to be marginalized. The present research will lay down the foundations for further in-depth research to better design appropriate strategies, measures, policy reforms, and incentive schemes needed to implement and manage water reuse projects.

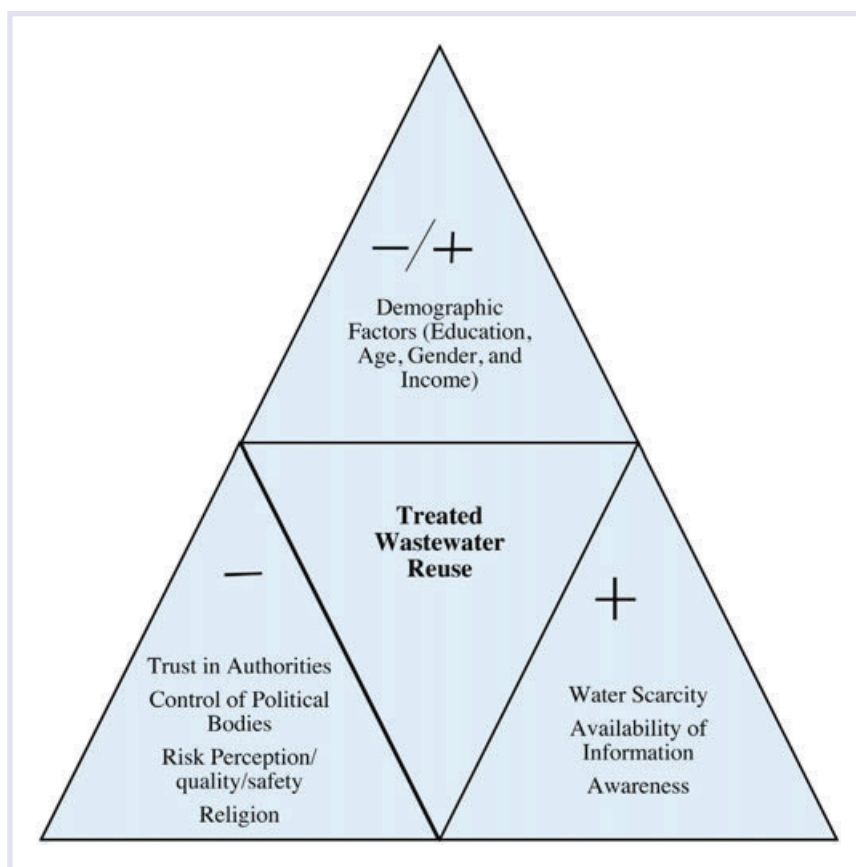


Figure 2. Relationship among the various factors affecting the reuse of treated wastewater.

METHODOLOGY

Study design and recruitment of participants

The qualitative research method, in particular the in-depth interview approach, was adopted in order to gather insights and more detailed information about the subject. This method provides a depth of information through the use of open-ended questions to collect nuanced information in a short period of time. A total of 14 stakeholders were interviewed, including 1 representative of each of the Ministries of Agriculture, Environment, and Energy and Water, 1 representative from the Syndicate of Farmers, 8 farmers, and 2 religious figures (Muslim and Christian). The number of farmers to be interviewed was selected on the basis of the distribution of agricultural land per district (Table 1). Other stakeholders were selected on the basis of their capability to influence treated wastewater reuse projects in agriculture. Farmers who are

owners of their lands were reached and selected conveniently through conducting field visits to the different Lebanese agricultural areas. The purpose of the present study was explained to each farmer, and the informed consent was read and explained clearly, followed by oral acceptance.

Governmental officials were reached through contacting the director general of each ministry by phone and through email. The director general was asked to discuss with the employees the purpose of the study and to select—without imposing pressure—an employee interested in participating. An interview date that fit the employee's schedule was assigned and consent was sought. A nongovernmental organization (NGO) was contacted through email in order to facilitate a scheduled interview with 2 religious figures from the Muslim and Christian religions at its site. Each religious figure was interviewed individually in a private room at the NGO, and oral approval was taken. Interviews were

Table 1. Selected number of farmers based on irrigated areas by district in Lebanon

District (Mohafaza)	Irrigated area (ha)	Irrigated area (%)	Nr farmers
Beqaa, Baalbeck, and Hermel	61 569	55	3
North	24 849	22	2
South	17 142	15	2
Mount Lebanon	9395	8	1

conducted in Arabic, based on an interview guide that supports the interviewer because it resembles the objectives of the study. Data were collected through note-taking and recording, followed by analysis. The interview took 40 min to be completed. Table 2 summarizes the in-depth questions of the interview guide in relation to the objectives of the present study.

Data analysis

All notes and voice recordings were combined and organized. Thematic analysis was employed to thoroughly examine and evaluate the transcripts comprehensively, following the set objectives of the research. The interviews were categorized and coded into topics where transcripts were sorted out according to the study questions. Codes were established from the research questions and from the issues emerging from the data analysis. This procedure ensured that spread parts of information on the same topic are consolidated for a complete review. Also, trends and patterns that reappeared among different interviews were identified. Data analysis was conducted by hand, using grids and matrices to summarize themes and organize findings. Furthermore, direct quotes from participants were used to support common themes. Figure 3 summarizes the data analysis process.

RESULTS AND DISCUSSION

Knowledge, perception, and motivation on the reuse of treated wastewater

Predictably, representatives from the ministries and the Syndicate of Farmers showed high levels of awareness of the water shortage problem and the need to rely on supplementary water sources. This is in agreement with other studies

that showed water shortage is a major factor affecting stakeholders' acceptance and motivation to rely on a supplementary water source (Baggett et al. 2006; Menegekia et al. 2007; Peters and Goberdhan 2016). The respondents disfavored the reuse of treated wastewater in the irrigation of raw vegetables and showed concerns about the potential perceived barriers of wastewater reuse in the domestic sector. The preference of the interviewed stakeholders to use treated wastewater at the agricultural sector rather than the domestic and industrial sectors has been reported by various studies (Dolnicar et al. 2006; Marks 2006; Ormerod et al. 2012; Peters and Goberdhan 2016), with a decrease in the level of acceptability as the degree of human contact increases.

Generally, farmers who have minimal knowledge about the possibility of water reuse praise the idea as a model for dealing with water shortages. Farmers in regions that have prior experience with treated wastewater reuse raised concerns about the treated water's physical characteristics, including turbidity, color, and odor. As such, they expressed hesitation in the future use of treated wastewater. Negative experience with treated wastewater and dissatisfaction with the service are reported among the factors that increase the reluctance to use treated wastewater (Dolnicar et al. 2011). Religious figures also showed awareness of the water shortage problem and their openness to adopting a water treatment model that provides supplementary water source to fresh water as long as the water quality meets the requirements of human consumption.

Stakeholders' perspectives toward the usage of treated wastewater in agriculture

Ethical perspective. Social justice, primarily equal distribution of the treated wastewater to residents of villages living at

Table 2. Summary of the interview questions linked to the study objectives

Objectives	Questions
Assess the stakeholders' knowledge, perception, and motivation on the reuse of treated wastewater.	1) What do you know about wastewater reuse? 2) What do you think about the option of treated wastewater reuse in different sectors as a part of water management plan in Lebanon?
Analyze the ethical, social, economic, and religious viewpoints of various stakeholders toward the usage of treated wastewater.	3) What do you think are the risks associated with implementing a water reuse project for irrigation in Lebanon? 4) How do you think the "trust in authorities" factor would be affecting the success of water reuse project in Lebanon? 5) What do you think are the steps that should be taken by the authorities to maintain transparency and accountability throughout the implementation of a water reuse project? 6) What do you think should be done to maintain equal and regular collection of fees from different stakeholders utilizing treated wastewater?
Explore respondents' views regarding wider participation of the public and other stakeholders in the planning and implementation of water resource management projects. Define the main concerns that should be addressed through implementing public information campaigns.	7) Communication with the public is always needed to ensure the success of a project; from your different backgrounds, how would you suggest the communication with the public to be when implementing this type of project? 8) What concerns would you have regarding public engagement in project implementation in the Lebanese context?

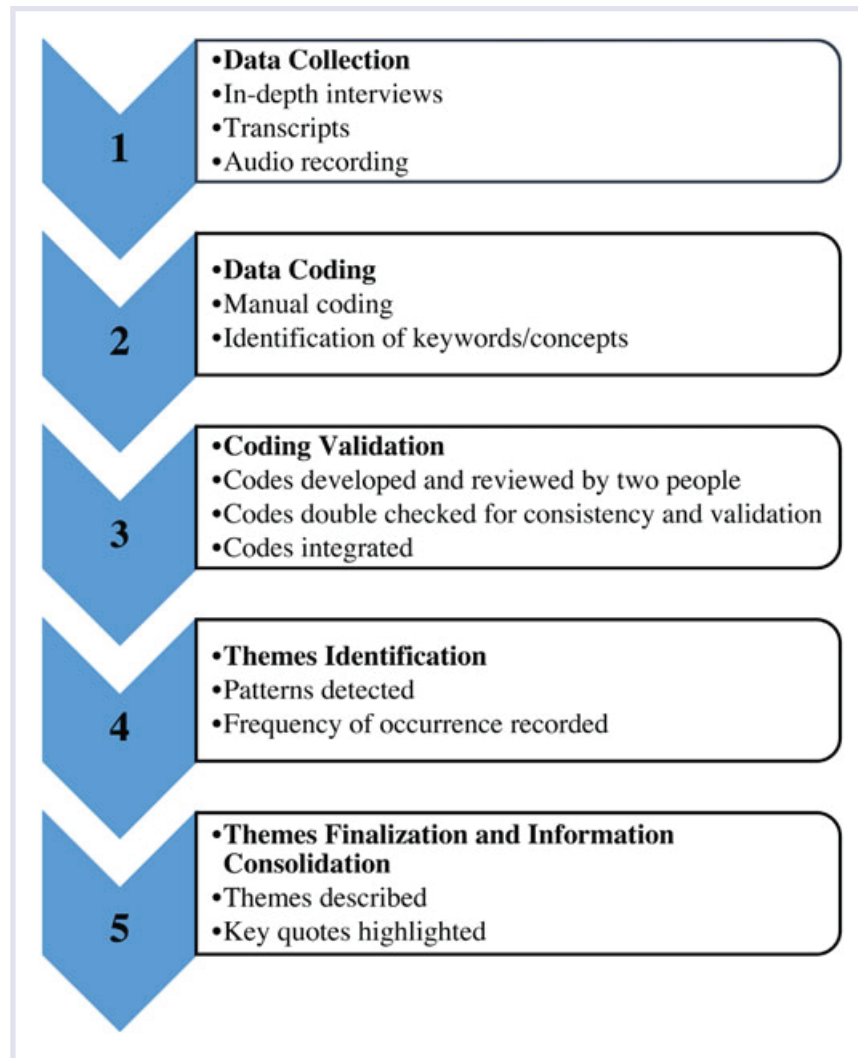


Figure 3. The process of thematic data analysis.

various topographies, has been a factor causing worry for the respondent from the Ministry of Agriculture as well as for interviewed farmers. Considering that wastewater treatment plants are sited in low-lying areas due to the natural flow of wastewater downhill, it is typical to distribute treated wastewater to the nearby surroundings because the distribution to areas at a higher altitude is more taxing. A farmer who had a previous experience with treated wastewater expressed this:

In a previously implemented project, various objections arose due to the utilization of treated wastewater originally flowing from uphill locations by residents living downhill; residents from the uphill locations have been deprived from using the treated wastewater.

The issue of social justice and equity are being increasingly addressed in projects, primarily during site selection (King County 2015). Another ethical concern raised by the respondent from the Syndicate of Farmers is developing

sustainable plans for wastewater treatment and reuse to cover the gradual population growth over years. All stakeholders expressed their distrust in governmental authorities, predominantly because of the continuous disruption in various public services such as electricity shortage and solid waste mismanagement. A respondent from the Ministry of Environment mentioned this:

Power outage has become a way of life in Lebanon. How can the government guarantee the quality of treated wastewater with continuous electricity cutoffs and the resulting equipment failures and operation errors?

The waste crisis in Lebanon erupted in July 2015 after authorities closed the primary landfill for the capital, Beirut, and the surrounding coastal governorates without providing an alternative. The Lebanese government's lack of a contingency plan to deal with waste management, lack of funds, and weak technical expertise have intensified public

distrust. A respondent from the Syndicate of Farmers mentioned this:

The main reason for the failure of various proposed developmental projects at the national level is the control of political bodies over the projects, their personal interests, and the unfair distribution of funds over the project implementation and monitoring.

Other qualitative studies (Wilson and Pfaff 2008; Carr et al. 2011) alluded that the control of political bodies over water reuse projects to deliver the service to their supporters is a major distrust factor that instigates public reluctance to use treated wastewater. The majority of the interviewed stakeholders asserted that the competency of concerned authorities is critical for the success of wastewater treatment and reuse projects in Lebanon. Setting standards for treated wastewater quality, enforcement of laws, and effective monitoring and evaluation of services were underscored.

The hardest job is succeeding at transforming a polluted (low-quality) raw material to end up with a high-quality product; the success of this procedure cannot be ensured without effective monitoring and evaluation.

Studies have also reported that standards related to treated wastewater are imperative for water quality management and a requirement to keep the population safe (Salgot and Folch 2018). Applying realistic standards and enforceable regulations is requisite for sustainable wastewater reuse strategies. Generally, developing countries lack wastewater reuse guidelines and standards, particularly with respect to operational guidelines, or they are not flexible enough to take local conditions into account (Condom et al. 2012; Wichelns et al. 2015).

The issues of trained and qualified personnel as well as transparent and accountable procedures during and after the project implementation were also highlighted. One farmer mentioned the following:

A major risk related to operating a wastewater system is having unqualified personnel, with minimal technical skills, working at the operational level.

Farmers expressed that previously implemented wastewater treatment plants either were not properly functioning or were operational but ineffective and consequently hardly achieved any treatment. Given the limited technical and financial resources of most small and rural communities, even with the availability of funding to build wastewater treatment plants, often technologies prove to be difficult and costly to maintain. One farmer mentioned this:

Following the project inauguration, which was in the presence of international bodies, minimal local

professional staff visited the plant to check for the system functionality.

Although developing countries are being encouraged to implement wastewater treatment and reuse projects with the promise of financial aid from developed nations, it is important that local conditions be considered carefully to make full use of any aid (Massoud et al. 2009). Development of appropriate policies and legislation, institutional strengthening and training, as well as effective monitoring and evaluation are crucial to overcoming the constraints to sustainable wastewater management and reuse projects. Several treatment facilities in developing countries are afflicted by inadequate technical expertise and skills and are operated beyond their design capacity, leading to failure in meeting the required wastewater reuse quality for irrigation (Choukr-Allah and Hamdy 2003; Jagannathan et al. 2009; Wichelns et al. 2015).

Religious perspective. Perceived barriers associated with the quality of treated wastewater were of primary interest to the interviewed religious figures. The Islamic scholar stated that in Islam the condition for using treated wastewater in any sector is based on the quality of the effluent:

The treated wastewater should have no smell, taste, or color associated with the presence of impurities after treatment. Stages of treatment and monitoring over the quality of treated wastewater are key factors to maintain the production of accepted treated wastewater.

The Christian clergyman stated that Christianity refuses subjecting the human being to trials. He mentioned this:

God grants His creations with water as a sign of His care. This water should be of best quality.

Farmers and government officials reported that religious prohibition is not a major concern and expressed their worry about getting in contact with the treated effluent or having unacceptable effluent quality. This opposes other studies that indicate religious prohibition is a factor limiting farmers' acceptance to use treated wastewater (Abu-Madi et al. 2008; Alhomoud et al. 2010). A study conducted in the West Bank revealed that the main concerns with using treated wastewater are safety and religious beliefs. Although the aforementioned issues were not of concern in Tunisia, soil degradation surfaced as a major concern, particularly after several years of experience using treated wastewater (Dare and Mohtar 2018).

Socioeconomic perspective. Farmers and governmental officials considered the selection of appropriate sites for wastewater treatment plants as essential because failure to do so will result in public opposition and an unsuccessful reuse project. In a study done in the United Kingdom, "nuisance from odor" has also been considered a societal

factor that affects the sustainability of wastewater reuse projects (Muga et al. 2008). Farmers also have been worried about the consumers' willingness to buy products irrigated with treated wastewater. Yet, due to the shortages of water resources, farmers are sometimes buying water for irrigation from trading brokers or opting to use untreated wastewater. Interviewed stakeholders recommended that having a safe water supplement at a reasonable price would encourage farmers to use the treated effluent for a fixed fee or charges. The respondent from the Ministry of Agriculture mentioned that in order to ensure credibility and encourage the end users to pay the imposed yearly charges, financial visibility, transparency, and accountability of operation and maintenance costs of the wastewater treatment plant are essential. Responding farmers suggested being given a trial period of 6 mo to 1 y before committing to certain charges. A summary of the perceived barriers discussed by the different stakeholders is presented in Table 3.

Enabling factors

Farmers, syndicate representatives, and religious figures considered recruiting professional staff at the concerned ministries to manage a wastewater treatment and reuse project as a key step needed to ensure transparency and accountability throughout the project implementation. The respondent from the Ministry of Agriculture and some farmers have expressed that sharing data with the public at the early stages of project implementation is important. Several studies reported that public acceptance of wastewater reuse requires active public involvement from the planning stages to the full implementation (Choukr-Allah and Hamdy 2003; Wichelns et al. 2015). Data such as various wastewater treatment technologies, values and interest, and site-specific characteristics would play a role in shaping the

perception of the farmers about the use of treated wastewater. Farmers suggested having a system of feedback to give manageable complaints about the quality and quantity of the supplementary source of water. This is in agreement with other studies (Matos et al. 2003; Ross et al. 2014), which recommended a system of feedback that reflects the farmers' complaints about the delivered treated wastewater quality and quantity. The respondent from the Ministry of Energy and Water focused on enhancing the research capabilities of the ministries. Research accompanied with site assessment would help in the selection of a proper site for a wastewater treatment plant, and in figuring out the means needed to facilitate equal service delivery to all project beneficiaries at varying locations.

The responding religious figures and farmers have insisted on having regular water quality assessment and machinery maintenance to minimize the occurrence of associated perceived health barriers and to ensure the sustainability of the project. Other studies (Jeffrey et al. 2003; Hartley 2006; Hurlimann 2009; Hurlimann and McKay 2007) considered quality control through regular water tests and machinery maintenance to be essential to maintaining the production of treated wastewater with minimal associated perceived health barriers and has also been a major factor affecting the acceptance of the public to reuse treated wastewater. At the economic level, some farmers suggested considering the financial capabilities of treated wastewater end users prior to imposing a specific yearly rate. Other farmers suggested that the Ministry of Agriculture provide financial assistance to farmers through a system of loans that could help in covering the farmers' agricultural needs, as well as the imposed charge for using treated wastewater. A summary of the enabling factors suggested to manage probable perceived barriers is presented in Table 4.

Table 3. Perceived barriers discussed by the different stakeholders

Aspect		Risks	Ministries	Syndicate of Farmers	Farmers	Religious figures
Ethical	Social justice	Equal service distribution	√	—	√	—
		Future planning		√		
	Trust in authorities	Minimal solutions to existing problems	√	√	√	√
Control of political bodies		—	√	√	—	
Religious	Water quality	Associated health risks	√	—	√	√
Social	Location of treatment plant	Nuisance from odor and air pollutants	√	—	√	—
	Feeling of disgust	Consumer acceptability	—	—	√	—
Economic	Fixed yearly charges	Transparency regarding the cost of operation and maintenance prior to collection of charges	√	√	√	—
	Trial period	Acceptability of water quality prior to payment commitment	—	—	√	—

Table 4. Enabling factors suggested by stakeholders to manage probable perceived barriers

Aspect	Risks	Enabling factors	Ministries	Syndicate of Farmers	Farmers	Religious figures
Ethical	Social justice	Enhancing research capabilities	√	—	—	—
	Trust in authorities	Recruitment of qualified staff	—	√	√	√
		Information management	√	—	√	—
Religious	Water quality	Quality control	—	—	√	√
Social	Location of treatment plant	Research	√	—	—	—
	Feeling of disgust	Information management and awareness	√	—	√	—
Economic	Fixed yearly charges	Financial assistance	—	—	√	—

Public involvement

All respondents indicated that public participation is a major factor influencing the success of water reuse projects in Lebanon. Stakeholders suggested diverse means of public involvement, including regular informative sessions, training, and workshops facilitated by municipalities and/or public cooperative organizations (PCOs). Farmers and the syndicate representative favored having public involvement that is enabled through NGOs. Their choice is based on their previous experience with local agricultural NGOs, which proved to be positive and constructive. The respondent from the Syndicate of Farmers mentioned this:

Lebanese farmers have different levels of knowledge about treated wastewater, so we need to ensure that the used methods of communication would target and reach all farmers.

The respondent from the Ministry of Agriculture asserted that the farmers should be involved at the early stages of project planning.

Considering the farmers as part of the system rather than being end users would influence their acceptance of the project and would put fewer burdens on the ministries to convince the farmers about the project at later stages.

Religious figures have also praised the concept of public involvement that could be facilitated through media networks. Both religious figures mentioned that integrity is insured through continuous communication with the public about a project. The means of actively involving farmers in the different stages of wastewater reuse projects as expressed by the stakeholders is depicted in Figure 4.

Few qualitative studies have been done to thoroughly reflect the stakeholders' perspectives on water reuse in developing and developed countries. Most studies involve

quantitative surveys that target specific indicators without exploring in more depth the respondents' views toward the implementation of water reuse projects in their countries. The availability of qualitative studies would present more substantial literature material and discussion in relation to the Lebanese context. Moreover, the interviewed stakeholders' views have been based on their educational background, professional experience, or acquaintance with water management in Lebanon. Thus, the responses would vary with the variation of the background and experience of responding stakeholders. Due to the nature of research questions 4 and 7 (Table 2) in the interview guide, the interviewer might have influenced the respondents' answers. This research limitation can be addressed in the future by

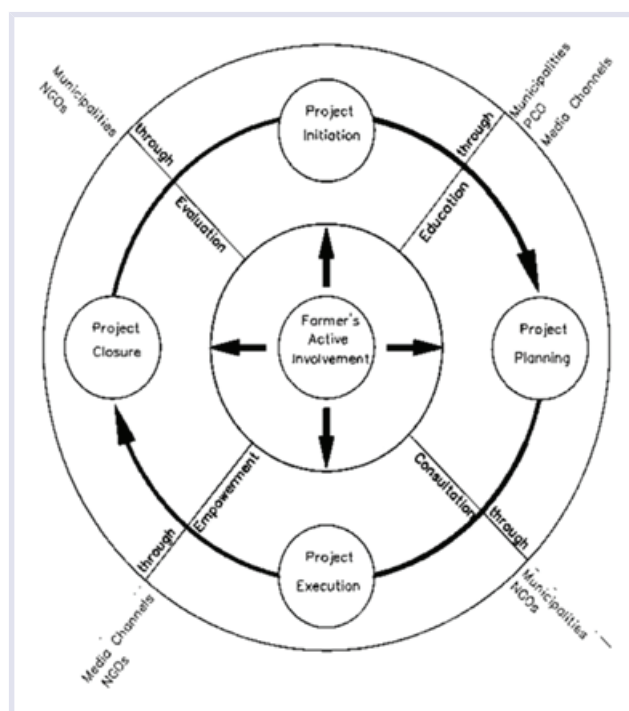


Figure 4. Means of actively involving farmers throughout the wastewater reuse project.

modifying or rephrasing the aforementioned questions in order to reduce bias.

CONCLUSIONS

The present study revealed various potential perceived barriers associated with the reuse of wastewater in agriculture. The continuous disruption in various public services for many years in Lebanon and the control of political bodies over water reuse projects resulted in distrust in governmental authorities. Although the interviewed stakeholders consider the implementation of water reuse projects a sustainable solution for water management, the success of a project relies mostly on effective and efficient planning, operation, and monitoring. The stakeholders also underscored the proper breakdown of operation and maintenance costs as well as financial visibility, transparency, and accountability. Perceived barriers associated with the quality of treated wastewater and the concerns regarding the risk to human health and the environment were accentuated by the stakeholders.

Considering that community acceptance plays a significant role in the uptake and implementation of alternative water systems, the impediments and enabling factors with regard to reuse schemes should form the basis for establishing the future potential of such schemes. Therefore, building public confidence, ensuring transparency and accountability, and encouraging public participation via proper communication channels throughout the implementation of a wastewater reuse project are fundamental. The present study pointed out various enabling factors to efficiently plan, operate, monitor, and evaluate wastewater reuse projects. At the legislative level, stakeholders suggested enforcing existing treated wastewater laws and setting new context-related guidelines and regulations, as well as achievable effluent quality standards. From a technical perspective, stakeholders suggested having qualified personnel at the operational level, and stressed the need to apply regular monitoring and evaluation procedures. Developing financial policies and mechanisms to enhance the success of wastewater reuse projects is equally important. Moreover, effective public involvement that could be facilitated through the joint effort of ministries, PCOs, NGOs, and media channels would be important means to ameliorate potential perceived barriers by the public.

Acknowledgment—Special thanks are extended to the American University of Beirut Research Board for funding this research project.

Data Accessibility—Data used in this research are not publicly available but may be requested, while maintaining confidentiality, from the corresponding author (may.massoud@aub.edu.lb).

REFERENCES

- Abu-Madi M, Al-Sa'ed R, Braadbaart O, Alaerts G. 2008. Perceptions of farmers and public towards irrigation with reclaimed wastewater in Jordan and Tunisia. *Arab Water Council J* 1(2):18–32.
- Al-Mashaqbeh O, Ghrair A, Megdal, S. 2012. Grey water reuse for agricultural purposes in the Jordan Valley: Household survey results in Deir Alla. *Water* 4(3):580–596.
- Boberg J. 2005. Liquid assets: How demographic changes and water management policies affect freshwater resources. Pittsburgh (PA): RAND. 154 p. https://www.rand.org/content/dam/rand/pubs/monographs/2005/RAND_MG358.pdf
- Carr G, Potter R, Nortcliff S. 2011. Water reuse for irrigation in Jordan: Perceptions of water quality among farmers. *Agric Water Manag* 98:847–854.
- Condom N, Lefebvre M, Vandome L. 2012. Treated wastewater reuse in the Mediterranean: Lessons learned and tools for project development. Valbonne (FR): Plan Bleu. 68 p. Blue Plan Papers 11.
- Choukr-Allah R, Hamdy A. 2003. Wastewater recycling and reuse in Mediterranean region as a potential resource for water saving. *Options Méditerranéennes: Série B. Etudes et Recherches* 44:89–101.
- Dare A, Mohtar R. 2018. Farmer perceptions regarding irrigation with treated wastewater in the West Bank, Tunisia, and Qatar. *Water Int* 43(3):460–471.
- Dolnicar S, Hurlimann A, Grun B. 2011. What affects public acceptance of recycled and desalinated water? *Water Res* 45:933–943.
- Fielding K, Dolnicar S, Schultz T. 2018. Public acceptance of recycled water. *Int J Water Resour Dev* doi: 10.1080/07900627.2017.1419125
- Gassert F, Reig P, Luo T, Maddocks A. 2013. A weighted aggregation of spatially distinct hydrological indicators. Washington (DC): World Resources Institute. 28 p. Working paper.
- Goodwin D, Raffin M, Jeffrey P, Smith H. 2017. Evaluating media framing and public reactions in the context of a water reuse proposal. *Int J Water Resour Dev* 34(6):848–868. doi: 10.1080/07900627.2017.1347085
- Hartley T. 2006. Public perception and participation in water reuse. *Desalination* 187(1-3):115–126.
- Hurlimann A. 2009. Water supply in regional Victoria Australia: A review of the water cartage industry and willingness to pay for recycled water. *Resour Conserv Recycl* 53:262–268.
- Hurlimann A, McKay J. 2007. Urban Australians using recycled water for domestic non-potable use – An evaluation of the attributes price, saltiness, colour and odour using conjoint analysis. *J Environ Manage* 83(1):93–104.
- [IFI] Issam Fares Institute for Public Policy and International Affairs. 2014. Impact of population growth and climate change on water scarcity, agricultural output and food security. Climate Change and Environment in the Arab World Program. Beirut (Lebanon). 57 p. [accessed 2016 Mar 16]. https://website.aub.edu.lb/ifi/public_policy/climate_change/Documents/20140407_IPG_CC_Report_summary.pdf
- Jain M, Lim Y, Arce-Nazario J, Uriarte M. 2014. Perceptual and socio-demographic factors associated with household drinking water management strategies in rural Puerto Rico. *PLOS One* 9(2):e88059.
- Jeffrey P, Jefferson B. 2003. Public receptivity regarding “in-house” water recycling: Results from a UK survey. *Water Sci Technol: Water Supply* 3(3):109–116.
- King County. 2015. Fair and just facilities – Being a good neighbor to all communities. Seattle (WA): Department of Natural Resources and Parks, Wastewater Division. [accessed 2018 Dec 14]. <https://www.kingcounty.gov/depts/dnrp/wtd/about/fair-and-just.aspx>
- Lautze J, Stander E, Drechsel P, Da Silva AK, Keraita B. 2014. Global experiences in water reuse. Colombo (LK): International Water Management Institute (IWMI). CGIAR Research Program on Water, Land and Ecosystems (WLE). Resource Recovery and Reuse Series 4. 31 p. doi: 10.5337/2014.209
- Marks J. 2006. Taking the public seriously: The case of potable and non-potable reuse. *Desalination* 187:137–147.
- Massoud MA, Tarhini A, Nasr J. 2009. Decentralized approaches to wastewater treatment and management: Applicability in developing countries. *J Environ Manage* 90(1):652–659.
- Matos R, Cardoso A, Duarte P, Ashley R, Molinari A, Schulz A. 2003. Performance indicators for wastewater services—Towards a manual of best practice. *Water Sci Technol: Water Supply* 3(1–2):365–371.
- Menegakia A, Hanleya N, Tsagarakis K. 2007. The social acceptability and valuation of recycled water in Crete: A study of consumers’ and farmers’ attitudes. *Ecol Econ* 62:7–18.
- Mizyad N. 2012. Challenges to treated wastewater reuse in arid and semi-arid areas. *Environ Sci Policy* 25:186–195.

- Molle B, Brelle F, Bessy J, Gatel D. 2012. Which water quality for which uses? Overcoming over-zealous use of the precautionary principle to reclaim wastewater for appropriate irrigation uses. *Irrig Drain* 61(Suppl 1):87–94.
- Peters E, Goberdhan L. 2016. Potential consumers' perception of treated wastewater reuse in Trinidad. *West Indian J Eng* 38(2):33–43.
- Petousi I, Fountoulakis MS, Saru ML, Nikolaidis N, Fletcher L, Stentiford I, Manios T. 2015. Effects of reclaimed wastewater irrigation on olive trees. *Agric Water Manag* 160:33–40.
- Po M, Kaercher J, Nancarrow B. 2003. Literature review of factors influencing public perceptions of water reuse. Canberra (AS): CSIRO Land and Water. 44 p. Technical Report 54/03.
- Ross V, Fielding K, Louis W. 2014. Social trust, risk perceptions and public acceptance of recycled water: Testing a social-psychological model. *J Environ Manag* 137:61–68.
- Saldás C, Speelman S, Van Koppen B, Van Huylbroeck G. 2016. Institutional arrangements for the use of treated effluent in irrigation, Western Cape, South Africa. *Intern Water Resour Dev* 32(2):203–218. doi: 10.1080/07900627.2015.1045970
- Salgot M, Folch M. 2018. Wastewater treatment and water reuse. *Curr Opin Environ Sci Health* 2:64–74.
- Tsagarakis K, Georgantzis N. 2003. The role of information on farmers' willingness to use recycled water for irrigation. *Water Sci Technol: Water Supply* 3(4):105–113.
- Wichelns D, Drechsel P, Qadir M. 2015. Wastewater: Economic asset in an urbanizing world. In: Drechsel P, Qadir M, Wichelns D, editors. *Wastewater: Economic asset in an urbanizing world*. Dordrecht (NL): Springer. p 3–14. doi: 10.1007/978-94-017-9545-6_1
- Wilson Z, Pfaff B. 2008. Religious, philosophical and environmentalist perspectives on potable wastewater reuse in Durban, South Africa. *Desalination* 228:1–9.
- World Bank. 2013. As climate change threatens, water cooperation becomes vital. Washington (DC). [accessed 2017 Oct 26]. <http://www.worldbank.org/en/news/feature/2013/03/20/climate-change-water-cooperation>
- [WRG] 2030 Water Resources Group. 2009. Charting our water future: Economic frameworks to inform decision-making. 198 p. [accessed 2017 Oct 23]. <http://www.2030wrg.org/wp-content/uploads/2014/07/Charting-Our-Water-Future-Final.pdf>
- Wu Z, McKay J, Keremane G. 2012. Issues affecting community attitudes and intended behaviours in storm water reuse: A case study of Salisbury, South Australia. *Water* 4(4):835–847.