

AMERICAN UNIVERSITY OF BEIRUT

STAKEHOLDERS' PERSPECTIVES ON WATER REUSE IN
THE AGRICULTURAL SECTOR IN LEBANON

by
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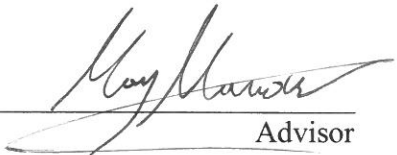
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AN ABSTRACT OF THE PROJECT OF

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The increasing population and the high levels of water pollution that lead to the shortage of available freshwater sources in Lebanon, necessitates the reliance on supplementary water sources. The reuse of treated wastewater is considered one optimal supplementary source for fresh water, especially at the agricultural sector which utilizes more than 70% of the freshwater resources. Accordingly, this study focuses on examining the Lebanese stakeholders' knowledge, perception, and attitude towards the reuse of treated wastewater at the agricultural sector in Lebanon. An in-depth interview was conducted with stakeholders from concerned ministries, Syndicate of farmers, farmers, and religious figures. Results were contextually and comprehensively analyzed, examined, and evaluated. Findings revealed that most of the respondents acknowledged that treated wastewater could be used as a supplement for fresh water. The risks that were found to be associated with the implementation of a water reuse project in Lebanon are: ethical (social justice and trust in authorities), religious (delivering safe water quality), social (location of the treatment plant and consumers' acceptance to utilize treated wastewater), and economical (commitment of end users to pay imposed charges). The respondents suggested various key steps that could be done to enhance the governmental transparency and accountability throughout the work flow. The respondents also suggested various enabling factors that could help in managing the risks associated with implementing a wastewater treatment project in Lebanon. Respondents stressed on public involvement and its facilitation through legal authorities, non-governmental organizations, and media channels.

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ABBREVIATIONS

CDC: Centers for Disease Control and Preventions

GWP: European Council for Environment

IFI: Issam Fares Institute for Public Policy and International Affairs

Public Cooperative Organizations (PCOs)

UN: United Nations

UNEP: United Nations Environmental Program

CHAPTER 1

INTRODUCTION

Many countries around the world are facing an increasing pressure on fresh water supply with the limited available water resources, and the increase in the water demand. A recent UN report reveals that by 2050, at least one in four people is likely to live in a country facing chronic or recurring shortages of freshwater (UN, 2016). Escalating pressure is due to various factors including population growth, industrial development, and expansion of peri-urban irrigated agriculture (Dolnicar et al. 2011). Inadequate water management, including the depletion of available surface and groundwater resources and the deterioration of water quality, has been a major factor affecting the availability of fresh water resources. Climate change with its effect on rainfall patterns, droughts, and flood cycles has also put pressure on the available water resources (Kirby, 2016).

Thus, this has compelled countries to improve the efficiency of water consumption and to support the available water resources with more sustainable alternatives. Among various available approaches, wastewater treatment and reuse has been one of the most sustainable water management practices, used mostly at the agricultural sector, due to environmental and economic reasons (Petousi et al.2015). Wastewater treatment and reuse in agriculture reduces the demand for freshwater, and the discharge of pollutants into surface waters (Petousi et al.2015).

In Lebanon, water resources are under a heavy and increasing stress, especially that part of the Lebanese fresh water resources-Wazzani, Hasbani, and Litani rivers- have been exploited by Israel (Stork, 2015). It is expected that by 2040, the temperature

in Lebanon would increase by 1-2°C, the annual rainfall would face a 10-20% reduction, and the drought periods would increase by 9 days (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 about 64% of the available freshwater resources (CDC, 2011) - would be considered a sustainable solution for water management in Lebanon.

Globally, the key points for the success of sustainable wastewater treatment and reuse projects include technical, financial, and institutional support resulting in low risk treated wastewater (UNEP, 2005). Yet, these key elements could not guarantee the success of a wastewater treatment project without public involvement and acceptance; especially that many countries faced public resistance to water reuse projects for various reasons (Dolnicar et al., 2011; Hartley, 2006; Molle et al., 2012). To avoid resistance, public participation has been increasingly integrated into the international agenda on environment and sustainability. This concept has been introduced to improve resource management, and promote more democratic decision making (GWP, 2014).

Since conclusions drawn on factors affecting the public acceptance of water reuse projects vary from one context to another, different Lebanese farmers' as well as other stakeholders' views need to be studied and investigated to reflect on how some factors including religious views, social factors, and other ethical considerations would be affecting the implementation of water reuse project in agriculture in the Lebanese context.

Accordingly, this research project will:

- Assess the stakeholders' knowledge, perception, and motivation, on the reuse of treated wastewater.
- Analyze the ethical, social, economic, and religious viewpoints 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 resource management projects.
- Define the main concerns that should be addressed through implementing public information campaigns.

This study is considered essential, since no studies have been done in Lebanon to assess stakeholders' perception of the reuse of treated wastewater in agriculture. It reflects on the farmers' knowledge about water reuse, and their worries from stakeholders' attitude toward implementing wastewater reuse for irrigation. Moreover, the interviews done with various stakeholders would present a comprehensive identification of the local factors that affect the implementation of water reuse in Lebanon.

CHAPTER 2

LITERATURE REVIEW

A. Public Acceptance of Water Reuse Projects

1. Importance of Public Acceptance

Public acceptance has affected the success of various water reuse projects worldwide. Examples of successful projects which insured the public integration from early stages of project planning include the first water reuse project proposed in Bora Bora , French Polynesia which stressed on educating and consulting the stakeholders and end users prior to project implementation, and the "Goreangab Water Reclamation Plant" in Windhoek, Namibia which was characterized by the high level of public acceptance (Ooi et al., 2014).Comparatively, other projects proposed in US including "California's Bay Area Water Recycling program" and "San Diego Wastewater Treatment plant" (Ooi et al., 2014), and projects proposed in Australia including "Western Corridor" and "Toowoomba, Queensland" (Demoware, 2014) were unsuccessful due to lacking the public involvement component.

2. Factors Affecting Public Acceptance of Water Reuse in Developing vs. Developed Countries

a. Socio-cultural Factors

Various socio-cultural factors have been found to be affecting the public acceptance of wastewater reuse worldwide.

i. Trust in authorities

Trust in authorities has always been a major global factor influencing the public acceptance to use treated wastewater (Ross et al., 2014; Wu et al. 2012; Chang et al. 2012). In developed countries, various concerns have been raised in regards to trust in public authorities. 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 quantitative studies done in the US(Hartley, 2006), Trinidad (Peters et al. 2015), Australia (Hurrilman et al. 2007; Hurrilman, 2007) and the UK (Dolnicar et al. 2011; Jeffrey et al. 2003). In addition to the aspects stated above, qualitative studies done in developing countries including Palestine, Jordan, and South Africa have shown that the public are also worried about the control of specific political bodies over wastewater treatment and reuse projects. The control of political bodies, as expressed by the stakeholders interviewed in the studies, would not ensure the equal service delivery to the public, but would be targeting the community reflecting political support (Mizyad, 2012; Carr et al. 2011; Carr et al. 2006; Wilson et al. 2008). In South Africa, worries have also been present regarding the fair and acceptable distribution of fees over the beneficiaries of the project (Wilson et al. 2008).

ii. Perception of Water Quality and Availability

The availability of safe fresh water and the quality of received treated waste water have been major factors affecting the acceptance to use treated wastewater in both developed and developing countries. Studies done in the UK (Baggett et al.2006), Trinidad (Peters et al, 2015), Australia (Hurrilman, 2007), and Crete (Menegakia et al. 2007) have found that the public's satisfaction with the available received fresh water

quantities, affected their acceptability to use treated wastewater. Farmers from developing countries including Gaza strip, Jordan, and Tunisia have expressed that the quality of received treated wastewater would affect their acceptance to use the delivered water as a supplementary source (Abu Shaban et al. 2006; Abu-Madi et al. 2008). A study done in rural Jordan has as well revealed that water scarcity is the main determinant of public acceptance to use treated wastewater for irrigation (Al-Mashaqbeh et al., 2012). Abu Madi et al. (2007) suggested that if developing countries are better informed about the existing water shortages in their countries they will be more accepting to use treated wastewater.

iii. Economic Feasibility

The fact that treated wastewater costs less than fresh water has always led to accepting its usage. In a quantitative study done in Australia, participants accepted to pay 76% of the amount they pay for available fresh water resources (Hurrilman et al. 2007). Similarly, in studies done in Israel (Freideler, 2006) , Greece (Menegakia et al., 2007) , Trinidad (Peters et al., 2015) and the UK (Baggett et al., 2006) the perceived financial gain from using treated wastewater has been the most important reason for accepting to use this alternative water source. In developing countries, studies done in Palestine, Jordan, Tunisia, and South Africa have revealed that saving money would be one of the major factors affecting the acceptance of the public to use treated wastewater (Mizyad et al., 2012; Abu Madi et al., 2008; Adewumi et al., 2008). Accordingly, as Mizyad (2012) mentioned, suppliers have to offer recycled water at concession prices in order to be accepted by the public.

iv. Knowledge/ Information

Results from quantitative studies done on public perception of wastewater reuse in the US have continuously revealed that the availability of information is a major factor affecting the stakeholders/public acceptance of wastewater reuse (Dolcinar et al. 2011; Peters et al., 2015; Hartley, 2006). Studies done in the EU (Tsagarakis et al. 2003; Menegekia et al., 2007), and Australia (Hurilman, 2007) have all concluded that availability of information and awareness on wastewater reuse would lead to a positive attitude from the public. The knowledge factor has been minimally assessed in studies done in developing countries. Results from a quantitative study done in Gaza strip, revealed that the minimal knowledge consumers have about wastewater reuse and its benefits has been a major factor hindering the acceptance of water reuse (Abu Shaban et al., 2006). Arafat (2012) states that improving farmers' knowledge and awareness on the benefits of reusing treated wastewater is a key determinant for the success of a water reuse project.

v. Religious Prohibition

Religious prohibition has been one major socio-cultural factor investigated by various authors primarily in the Arab countries. In Palestine, the majority of responding farmers believe that the reuse of treated wastewater is permitted under Islamic laws (Al-Khatib et al. 2001). In Jordan , a study done to assess the farmers' knowledge, perception and attitude towards the usage of treated wastewater, revealed that 87% of the interviewed farmers do not view religion as a factor limiting the reuse of treated wastewater in agriculture (Carr et al. 2011). In another study done in Jordan, and Tunisia, religion has been a factor inhibiting the farmers from using treated wastewater

for irrigation (Abu-Madi et al., 2008). Moreover, in a study done in Kuwait, 29% of the respondents refused the usage of treated wastewater for religious reasons (Alhomoud et al. 2010). In South Africa, interviewed religious figures expressed that Islam permits the use of treated wastewater under the condition of continuous monitoring over the quality of the delivered treated wastewater (Wilson et al., 2008). In a study done in England, the Muslim community showed less support to the reuse of treated wastewater in both potable and non-potable practices (Aitkens, 2014).

b. Demographic Factors

Apart from socio-cultural factors, some demographic variables have an effect on the acceptability of the public to use treated wastewater. Some common results are presented below.

i. Education

Most studies have revealed that individuals with college education are more knowledgeable about wastewater reuse than those with high school education (Peters et al. 2015; Rock et al., 2012; Owusu et al., 2011; Abu-Madi et al. 2008; Menegakia et al. 2007; Al-Hamoud et al. 2010; Hurlimann, 2007; Hurlimann et al. 2007; Robinson et al 2005; Tsagarakis et al. 2003; Arafat 2012; Abu Shaban et al. 2006; Freidler et al. 2006). These individuals viewed the internet as a major tool that facilitates their access to more research about wastewater reuse (Owusu et al., 2011; Robinson et al 2005). People with lower education rely more on television and newspapers to acquire information related to wastewater reuse (Owusu et al., 2011; Robinson et al. 2005). Individuals, who rely on media channels including television and newspaper to acquire information, are

sometimes exposed to incredible information presented by the channels in order to serve those who are against a reclaimed water scheme (Owusu et al. 2011; Robinson et al. 2005).

ii. Age

Studies have shown that age has an effect on the acceptability of using treated wastewater. People with age above 50 tend to be less knowledgeable about treated wastewater and thus less acceptable to use it (Al-Hamoud et al. 2010; Dolnicar et al. 2011; Menegakia et al. 2007; Hurlimann et al. 2007; & Owusu et al. 2011). This age group relies solely on traditional sources of information including television and newspaper (Robinson et al 2005). People with ages ranging between 35-49 show the highest acceptability rate of wastewater reuse (Owusu et al. 2011). This age group has broader sources of information – including internet- , and is more concerned in knowing about wastewater reuse especially if it is an available alternative solution present in their communities (Owusu et al. 2011). People with the age group below 35, show less interest in participating in studies related to wastewater reuse, and thus show insignificant statistical results (Owusu et al. 2011; Chang et al. 2012). Their low interest in participation could be related to having a less decision making role at the social and household level in comparison with elder people (Chang et al. 2012).

iii. Gender

Some studies have shown that gender also has an effect on the acceptance to use treated wastewater, whereby males tend to be more accepting to use this alternative source than females (Wester et al. 2015; Owuso et al. 2011; Al-Hamoud et al. 2010;

Hurlimann 2007; Hurlimann et al. 2007). Studies show that men rely on more sources of information than women, and women show higher concerns over health risks associated with the use of treated wastewater (Wester et al., 2015; Owuso et al. 2011; Hurlimann et al., 2007).

iv. Income

Some studies have shown that people with lower income tend to be more accepting to use treated wastewater (Robinson et al., 2005; Tsagarakis et al., 2003). This has been associated with the economic benefit of wastewater reuse in comparison with the price of available freshwater sources (Robinson et al., 2005; Tsagarakis et al., 2003). Comparatively, studies done in China (Chen et al., 2015), and San Diego (San Diego County Water Authority, 2015) revealed that people with higher levels of income showed higher willingness to use treated wastewater due to having more knowledge about the water profile of their country, and their higher water consumption. Other studies done in US, UK and Australia found no significant effect of demographic factors on the public acceptance of treated wastewater reuse projects (Jain et al. 2014; Aitken et al., 2014; Jeffrey, 2002; Fielding et al. 2015). Accordingly, no significant global relationship could be formed between age, gender, and income in accepting treated wastewater reuse over different study locations (Jain et al., 2014; Boberg, 2005; Po et al., 2003).

3. Stakeholders Engagement in Water Reuse Project

a. Traditional Forms of Engagement

i. Decide, Announce, Defend

The traditional approach includes the “decide, announce, defend” policy which includes educating the public about the project after decision making (Ogelvie et al. 2010). This approach has not been effective whereby two projects have failed in Australia due to having a debate with the public after the project implementation (Ogelvie et al. 2010). Walesh (2007) reported that water professionals nowadays face two major challenges primarily finding solutions to increasing water problems and interacting effectively with the public especially that the public are having more knowledge and expectations related to water science and technology projects.

ii. Social Marketing and Public Involvement

Effective public involvement does not include social marketing as some organizations tend to do under the name of public involvement. Social marketing is based on satisfying the needs of the people through a certain service/product that is promoted through the creation of a campaign which persuades the audience to change their attitude and/ or behavior (Ogelvie et al. 2010). In San Diego, social marketing for a wastewater reuse project has been used as a tool to involve the public. News was spread about the project through TV shows, magazines, and phone calls. People against the project implementation relied on an opposing media campaign that kept the people hesitant from using this alternative water source. Accordingly, the project failed since the residents have not been fully aware and knowledgeable about the project from early planning stages (Ogelvie et al. 2010).

b. The Public Owns the Project (POP) Approach

The traditional forms of interaction through “decide-announce-defend” and social marketing are no longer applicable. Walesh (2007) proposes a much better approach that needs to be considered; this approach is called "the public owns the project-(POP)". The objectives of the POP approach are spreading awareness, gathering data and information, and building a base of support. Walesh (2007) explains that the public has to be involved in identifying the problem, and in finding an adequate solution to the problem. Thus, he suggests involving the public in an integrated approach to prepare and implement a sustainable water plan. The approach is composed of 8 steps which are (Walesh, 2007):

- Setting objectives and standards
- Conducting Inventory
- Analyzing Data
- Formulating alternatives
- Comparing alternatives and selecting a recommended plan
- Preparing plan implementation program
- Implementing the plan
- Operation

c. Stakeholders Identification – Social learning and Knowledge Sharing

An important element considered in public involvement is the identification of stakeholders to be involved. Bagett et al. (2006) proposes an identification of the concerned stakeholder groups to be involved while planning for a wastewater treatment project. The stakeholder groups are: Management, Research, Regulatory, and Lay

community. Researchers move through the cycle of acquiring knowledge; management through the cycle of applying knowledge; lay community through the cycle of acquiring information that affect their attitude and influence their actions; and regulatory bodies through the cycle of setting guidelines that would minimize the impact of the pressure societies put on the environment. Thus, the joint work of the four independent cycles would power knowledge transfer and understanding leading to the clarification of: livelihoods, management strategies, research questions and governance which are individual issues relevant to the four stakeholder groups (Baggett et al., 2006).

d. Studying Site Specific Factors and Risk Communication

When considering the POP approach, the factors affecting the public's acceptance to use treated wastewater in a specific context should be studied; especially that stakeholders' responses vary with the variation of location, demographics, and social norms (Abu-Madi et al., 2008). Afterwards, risk communication would be necessary to back up the concept of integrated social learning. To maintain effective risk communication, the project management team shall take into consideration some key issues which include: Ensuring honesty, frankness, and openness, listening to public concerns, coordinating with credible sources, and meeting the media needs.

CHAPTER 3

METHODOLOGY

A. Study design

The qualitative research method was used through conducting in-depth interviews with various stakeholders. In-depth interviews include open ended questions that give the respondents the chance to thoroughly express their opinion toward the reuse of treated wastewater in various sectors.

B. Recruitment of Stakeholders

The total number of interviewed stakeholders is 14. Number of farmers to be interviewed is selected based on the distribution of agricultural land per Mohafaza. Table 1 shows the number of farmers selected based on the distribution of agricultural areas per Mohafaza. Data on the area of irrigated land by Mohafaza is extracted from the “Census of Agriculture” conducted in Lebanon during 2010 (FAO, 2010).

Table 1: Selected number of Farmers Based on Irrigated Areas by Mohafaza

Mohafaza	Irrigated Area (Ha)	Irrigated area (%)	Number of Farmers
Beqaa, Baalbeck , and Hermel	61,569	55%	3
North	24,849	22%	2
South	17,142	15%	1
Mount Lebanon	9395	8%	1

Other stakeholders to be interviewed are selected based on their capability on influencing the success of usage of treated wastewater in agriculture. These stakeholders include:

- Representative from the Ministry of Agriculture
- Representative from the Ministry of Energy and Water
- Representative from the Ministry of Environment
- Two representatives from the Syndicate of Farmers
- Muslim Religious Figure
- Christian Religious Figure

C. Data Collection

Farmers which are owners of their lands were reached and selected conveniently through conducting field visits to the different Lebanese agricultural areas. The purpose of the study was explained to each farmer reached, and he was asked whether he accepts to participate. If yes, the informed consent was read and explained to him clearly to be followed by his oral acceptance. Ministries were reached through contacting the director general of each of the three mentioned ministries by phone and through email. The director General was asked to discuss with the employees the purpose of the study, to select -without imposing pressure- an employee interested in participating. A date that fits the employee's schedule was assigned to perform the interview. The face to face interview with the employee was conducted in a closed room at the ministry with the investigator. The informed consent was explained clearly, followed by the employee's oral consent. The Syndicate of farmers was contacted through the phone and email for permission and for the allocation- without posing pressure- of a representative to

conduct the interview with at the syndicate. A scheduled interview was done in a closed room at the syndicate including the representative and the investigator. “Adyan” NGO was contacted through the phone and email in order to facilitate a scheduled interview with two religious figures from the Muslim and Christian religions at its site. Each religious figure was interviewed individually, in a private room at the NGO. The informed consent was explained to each religious figure, and his oral approval was taken. Interviews were conducted in Arabic based on an interview guide that supports the interviewer as it resembles the objectives of the study. Data was collected through note taking, and taping followed by analysis. The interview took 40 min to be completed. To ensure confidentiality, all collected data was stored in a locked drawer that could only be accessed by the investigator. Table 2 discusses the in-depth questions of the interview guide which reflect on the objectives of the study.

Table 2: Summary of the Interview questions that were addressed 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 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 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.	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?

D. Data Analysis

Thematic data analysis method was used. Data was analyzed inductively starting from organizing all the notes acquired from the interviews with farmers and other stakeholders.

The data from the interviews was examined and evaluated based on the study objectives. Data from the farmers' interviews was categorized based on the responses of

farmers per Mohafaza. Codes were given to reoccurring ideas between farmers to develop major concepts that were evaluated among farmers from all districts/Mohafazas. Thus, general themes were formed to reflect on the factors that affect the farmers' use of treated wastewater for irrigation.

As for the other stakeholders, their responses to the questions were compared. Codes were given to reoccurring ideas between various stakeholders to develop major concepts which lead to the formation of themes related to views of stakeholders on the reuse of treated wastewater in agriculture.

Data was analyzed by hand through using grid and matrices to organize the findings and summarize the themes. Comparison between the farmers and other stakeholders' views was done. Analysis of data was finally reported to reflect on the farmers' and other stakeholders' perception of water reuse.

E. Ethical Considerations

The interviews are intended for academic research purpose only. No sensitive information related to subject's reputation or insurability was gathered. Likewise, no information was gathered that causes psychological harm if disclosed outside the research. Responses were aggregated and the results were only reported in total. There are no perceived direct or indirect risks or benefits associated with humans' participation in the project and respondents' participation is voluntary.

CHAPTER 4

RESULTS

A. Knowledge, Perception, and Motivation on the Reuse of Treated Wastewater

Representatives from the three ministries: Ministry of Agriculture, Ministry of Environment, and Ministry of Energy and Water and those from the Syndicate of Farmers showed high levels of awareness of the water shortage problem and the need to rely on supplementary water sources. Respondents' acceptance and support of wastewater reuse as a supplementary source for fresh water has been directly impacted by the respondents' level of awareness of the existing water shortage problem in the country. Whereby the respondent from the Ministry of Energy and Water expressed:

"A supplementary water source is needed to cover the agricultural needs especially that the water demand at the domestic level is increasing."

Responding stakeholders from the three ministries and from the Syndicate of farmers preferred the use of treated wastewater at the agricultural sector particularly with regards to the irrigation of crops such as olive trees. The respondents disfavored the reuse of treated wastewater in the irrigation of raw vegetables and showed concerns about the potential risks of wastewater reuse in the domestic sector.

Respondents from the syndicate of farmers referred to greater environmental concerns in relation to the necessity of wastewater treatment as this would protect the water bodies from the discharge of polluted wastewater.

Religious figures, from the Islamic and Christian faiths, also showed awareness of the water shortage problem and their openness to adopting a water treatment model that provides supplementary water source to freshwater. An Islamic scholar stated that it is permissible to use treated wastewater in the industrial, agricultural, and even domestic sectors as long as the water quality meets the requirements of human need.

Additionally, a Christian clergyman mentioned:

“Treated wastewater is used due to the shortage in fresh water supplies. In the wastewater treatment process, chemicals are applied to kill bacteria, and then water passes through different filtration stages to end up with treated wastewater that has no taste or smell.”

Generally, farmers who have minimal knowledge about the possibility of water re-use praise the idea as a model for dealing with water shortages. However, farmers in the North and Bekaa region, who have previously used secondary-treated wastewater at the agricultural and domestic level, raised concerns about the treated water physical characteristics including turbidity, color, and odor. As such, they expressed reluctance in the future use of treated wastewater. The farmers’ previous experience with treated wastewater has negatively impacted their acceptance to use treated wastewater.

B. Stakeholders’ Perspectives toward the Usage of Treated Wastewater in

Agriculture

1. Ethical

a. Social Justice

The equal distribution of the treated wastewater service over residents of villages living at various topographies has been a factor causing worry for the respondent from

the Ministry of Agriculture and some responding farmers. Their worry has been present since wastewater treatment plants are designed to be located in low-lying areas due to the natural flow of wastewater downhill; this makes it easier to distribute treated wastewater to the nearby surroundings, and harder to distribute treated wastewater to locations of higher altitude. A farmer who had a previous experience with treated wastewater expressed:

“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.”

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. The respondent explains that planners should take into consideration the gradual population growth, and the right of future generations to benefit from provided environmental services.

b. Trust in Authorities

All stakeholders expressed their complete distrust in governmental authorities especially after the continuous disruption in various provided public services including the electric shortage and the solid waste management crisis. The electricity crisis which has been present since the 1990s is mainly linked to the government's inept capabilities in addressing the country's energy shortfall due to budget constraints, aging infrastructure, and resistance to change by various interest groups, and low quality bill collection service. A respondent from the Ministry of Environment mentioned:

“Power outages have become a way of life in Lebanon. How can the government guarantee the quality of treated wastewater with continuous electricity cut-offs and the resulting equipment failures and operation errors?”

The trash crisis has emerged since July 17, 2015, and is mainly linked to the Lebanese government’s lack of a contingency plan to deal with waste management; lack of funds and weak technical know-how. This has caused the distrust of all stakeholders in assigning governmental authorities the responsibility of undertaking serious environmental projects such as a wastewater treatment and reuse. A respondent from the Syndicate of Farmers mentioned:

“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”.

i. Governmental Transparency and Accountability

When asked about the steps that should be taken by the authorities to maintain transparency and accountability to gain the public trust throughout the implementation process of the project, the stakeholders expressed based on their role and experience various concerns related to implementing a wastewater treatment and reuse project in Lebanon.

Respondents from the three ministries, Syndicate of farmers, farmers and religious figures asserted that the competency of ministerial bodies is critical for the success of wastewater treatment and reuse projects in Lebanon. The institutional performance is considered one key factor that has a significant impact on the management of a wastewater reuse system. Ministerial capabilities at the legislative and technical levels are discussed below.

Respondents from the ministries have stressed on the importance of enforcing available water quality laws and designing new laws for treated wastewater with reference to human health. Religious figures have also assured that law enforcement is necessary for the provision of a safe and high quality treated wastewater for the community. The respondent from the Ministry of Agriculture mentioned:

“We should construct a flexible legal framework focusing less on issues of potential liability and more on the successful functionality of the treated wastewater system.”

Respondents from the ministries, Syndicate of farmers, and some farmers, stressed on applying transparent and accountable procedures during, and after the project implementation stage. At the operational level, respondents from the ministries have stressed on having trained operating personnel at the plant in order to insure the safe quality of treated wastewater. One farmer mentioned:

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

Respondents from the ministry of Energy and Water and Syndicate of farmers expressed their worry over effective monitoring and evaluation of wastewater treatment projects. The respondent from the Ministry of Energy and Water mentioned:

“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”.

Farmers expressed that previously implemented wastewater treatment plants suffered from the discharge of polluted effluent after a short period of project implementation; this has been linked to the minimal monitoring of the project. One farmer mentioned:

“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.”

2. Religious

Risks 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; in that sense, he mentioned:

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

It is interesting to note that farmers assured that they don't have any religious concerns in the use of treated wastewater.

3. Social

One major concern raised by farmers and one representative from the Ministry of Energy and Water is the selection of the geographical location appropriate to build a wastewater treatment plant. The farmers have expressed their concern about the location of the treatment plant due to their previous experience with treatment plants implemented in their regions. A farmer expressed that the location of the treatment plant is important since:

“The odors from a wastewater treatment plant located near a residential area would annoy the residents, and affect the kids’ health.”

Farmers have been also worried about the consumers’ acceptance to buy products irrigated with treated wastewater.

4. Economic

Responding stakeholders suggested various methods that could be used to maintain equal and regular collection of fees from the end users of the treated wastewater.

The respondents from the ministries, Syndicate of farmers, and religious figures suggested imposing affordable fixed yearly charges on farmers to be paid through local municipalities. The responding Islamic scholar explained that, due to the freshwater shortage, farmers from different agricultural areas in Lebanon buy the water needed for irrigation from trading brokers. Accordingly, religious figures view that offering a safe water supplement at a reasonable price would encourage the farmers to be committed to pay a yearly fixed fee. The respondent from the ministry of agriculture mentioned that

in order to ensure credibility, and encourage the end users to pay the yearly imposed charges, a clear identification of the costs needed for operation and maintenance of the wastewater treatment plant per year should be shared with the public.

Most of the responding farmers showed their willingness to pay for treated wastewater at affordable prices, under the condition of the delivery of safe treated wastewater. Responding farmers suggested being given a trial period of 6 months to 1 year in order to examine the produced treated wastewater. After being satisfied with the received water quality, the farmers would take the decision of committing to payment of fees associated with the utilization of the treated wastewater.

A summary of the risks discussed by different stakeholders is presented in Table 3.

Table 3: Risks discussed by different stakeholders

Aspect	Risks		Ministries	Syndicate of Farmers	Farmers	Religious Bodies
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	Discharged Odor and Air Pollutants			✓	
	Feeling of Disgust	Consumer Acceptability			✓	
Economic	Fixed Yearly Charges	Clear Identification of the cost of operation and maintenance prior to collection of charges		✓		
	Trial Period	Acceptability of water quality prior to payment commitment			✓	

C. Enabling Factors

Based on the discussed risks, responding stakeholders presented various factors that could enhance the success of a treated wastewater project in the Lebanese context.

Respondents from the Syndicate of farmers, farmers, and religious figures have viewed recruiting professional staff at the three 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 from early stages of project implementation is important. The respondent from the Ministry of Agriculture explained that sharing data with farmers related to science and technologies, values and interest, local knowledge, and site-specific characteristics would play a role in shaping the perception of the farmers about the use of treated wastewater. Farmers have also suggested having a system of feedback after the delivery of treated wastewater. They mentioned that they may have concerns about the received water quality or quantity. Thus, the decision of the farmers to rely on treated wastewater as a supplementary water source for irrigation, would be based on their right to give manageable complaints about this source.

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 an adequate wastewater treatment plant location, and in figuring out the means needed to facilitate the equal service delivery to all project beneficiaries at varying locations. Research would also help in estimating the needs of future generations.

The responding religious figures and farmers have insisted on having regular water tests and machinery maintenance to minimize the occurrence of associated health risks, and maintain the sustainability of the project.

At the economical level, some farmers suggested that an assessment of the financial capabilities of treated wastewater end users should be done prior to imposing a specific yearly rate. Other farmers suggested that the ministry of Agriculture provides financial assistance to farmers through a system of loans that could help in covering the farmers' agricultural needs, as well as, the utilized treated wastewater imposed charge.

A summary of the enabling factors suggested to manage previously discussed risks is presented in Table 4.

Table 4: Summary of enabling factors suggested by stakeholders to manage associated risks

Aspect	Risks	Enabling Factors	Ministries	Syndicate of Farmers	Farmers	Religious Bodies
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/Awareness	✓		✓	
Economic	Fixed Yearly Charges	Financial Assistance			✓	

D. Public Involvement

In addressing the third objective of the study, which reflects on the respondents' various views over the wider public participation in water resource management projects, all respondents indicated that public participation is a major factor affecting the success of water reuse projects in Lebanon. The Stakeholders suggested various means of public involvement as discussed below.

Respondents from the three ministries and some farmers have shed light on the importance of public involvement that is facilitated through municipalities, and public cooperative organizations (PCOs). Farmers expressed that representatives from concerned authorities should be in direct contact with the farmers to inform them about

the treated wastewater. In addition, the respondent from the Ministry of Agriculture has asserted that the farmers should be involved from early stages of project planning. The respondent mentioned:

“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.”

Respondents from ministries have also assured that regular informative sessions, trainings, and creative methods of marketing and communication should be implemented to influence the farmers’ choice of using treated wastewater. The respondent from the Syndicate of farmers mentioned:

“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”.

In order to facilitate communication, the respondents from the Syndicate of farmers, and other responding farmers preferred having public involvement that is enabled through non-governmental organizations. Their choice has been based on their previous experience with local agricultural NGOs that satisfy some of the farmers’ requirements. The work of public authorities could be enhanced through the involvement of NGOs that have employed efficient ways to deliver messages to the farmers.

Responding 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 the project. The responding Christian Clergyman has stated that:

“Clear and honest answers and updated results should be shared with the public throughout the project.”

A diagram of the means of farmers' active involvement as expressed by the stakeholders is presented in Fig.1.

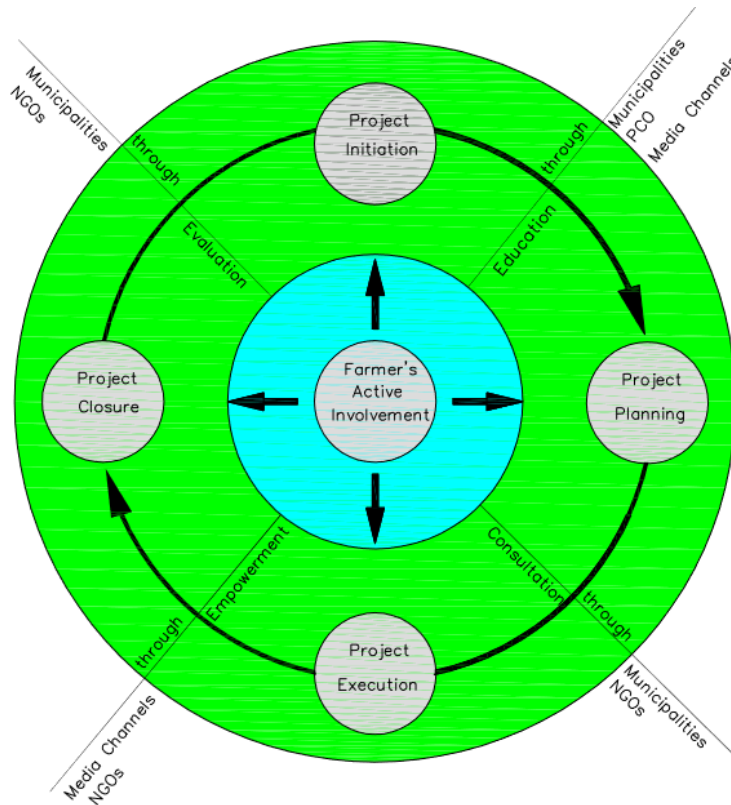


Figure 1: Means of Farmer’s Active Public Involvement throughout a Waste Water Treatment Project Life Cycle

CHAPTER 5

DISCUSSION

A. Knowledge, Perception, and Motivation on the Reuse of Treated Wastewater

Water shortage which has been a major factor affecting the stakeholders' acceptance and motivation to rely on a supplementary water source in Lebanon, has also been found to affect the acceptance of stakeholders to use treated wastewater in Trinidad, UK, and Greece (Peters et al, 2015; Baggett et al. 2006; Menegekia et al., 2007). Hence, 90% of the responding farmers in Trinidad (Peters et al., 2015), and 56% of the responding farmers in Greece (Menegekia et al., 2007) expressed their willingness to use treated wastewater for irrigation due to problems faced with freshwater.

The preference of the interviewed stakeholders to use treated wastewater at the agricultural sector rather than the domestic and industrial sectors has been expressed by various studies done in Trinidad, UK, and US (Peters et al., 2015; Ormerod et al., 2012; Dolnicar et al., 2006; Marks et al., 2008). Generally, the acceptability decreases as the users come into closer personal contact with treated wastewater. For instance, users have been found to support using treated wastewater for flushing toilets, meeting irrigation needs, and public yards. In contrast, they showed less support to using treated wastewater for indoor uses including drinking, cooking, and bathing.

Previous experience with treated wastewater which has negatively impacted the acceptance of some responding farmers to use treated wastewater, has been a factor encouraging responding farmers in a study conducted in the UK to utilize treated

wastewater , due to their satisfaction with a previously provided service (Dolnicar et al. 2011).

B. Stakeholders' Perspectives toward the Usage of Treated Wastewater in Agriculture

At the ethical level, the concern over ensuring social justice while implementing a wastewater treatment project which has been a worry to various Lebanese stakeholders was controlled at the wastewater treatment division present at King County, in the state of Washington by involving the principles of social justice and equity in their strategic plan. Special focus has been given to how to site, build, operate, and maintain the facilities in relation to the neighborhood demographics of the service area (King County, 2015).

In addition, control of political bodies over wastewater treatment projects which has been expressed by various stakeholders as a factor affecting their trust in authorities, was also a factor expressed by various interviewed farmers in a qualitative study done in South Africa; the study revealed that the responding farmers have been worried about the control of political bodies over water reuse projects to deliver the service to their supporters (Wilson et al. 2008). In another qualitative study done in Jordan, the responding farmers expressed the need of ensuring minimal political control over water reuse projects in order to give the farmers the capacity to discuss their water quality concerns with the project managers prior to service delivery (Carr et al. 2011).

The steps suggested by the stakeholders to ensure the transparency and accountability throughout the implementation of a wastewater treatment project, which include designing new flexible water quality laws that apply to the Lebanese context,

and applying monitoring and evaluation measures, have been considered in various studies as important elements to be involved in the implementation of a wastewater treatment project. Studies stressed on having achievable and enforceable standards whereby unrealistic standards or guidelines would be unachievable in practice, and would not have a significant effect on the background level of disease (Chang et al. 2012; Choukr-Allah, et al. 2004). Studies have also focused on the importance of the effective monitoring of a wastewater treatment plant whereby the “New Mexico Environmental Finance Center” discussed in a guide for water and wastewater system management that a wastewater treatment system is made up of assets- the physical components of a wastewater treatment plant- which lose value over time. Thus, proper operation and maintenance of a wastewater treatment plant, is essential for the production of safe treated wastewater with minimal associated health, and environmental risks (Environmental Finance Center New Mexico Tech, 2006). Another study has also stressed on having technical and organizational measures that would systematically give warnings of breakdowns in a wastewater treatment plant operations in order to avoid the flow of untreated wastewater into the distribution system (Choukr-Allah, R. 2010).

At the religious level, water quality which has been a major concern to responding religious figures, has also been a concern to interviewed religious figures- Muslim and Christian- in a qualitative study done in Africa; the interviewed religious figures encouraged the use of treated wastewater under the condition that the quality of delivered treated wastewater is acceptable (Wilson et al., 2008). The interviewed Muslim religious figures in Africa referred that Islam does not reject the use of treated wastewater, and emphasized that Islam acknowledges about the change of state of water

from impure to pure as long as it meets the “color, smell, and taste” principles (Wilson et al., 2008).

As some of the responding farmers in Lebanon expressed their worry about getting in contact with treated wastewater, some responding farmers in a qualitative study done in Jordan gave the same comment about being aware of getting in contact with the treated wastewater since it contains spiritual impurities (Carr et al. 2011).

Thus, results of the conducted study done in Lebanon reveals that religious prohibition is not a major concern to responding stakeholders in Lebanon in comparison to studies done in other countries such as Jordan, Tunisia, and Africa, where religious prohibition has been a factor limiting the farmers’ acceptance to use treated wastewater (Abu-Madi et al., 2008; Alhomoud et al., 2010).

At the social level, the concern of some stakeholders about the construction of a treatment plant near a residential area was discussed further in a study done in Kuwait to monitor the levels of air pollutants-including: VOCs and other gaseous pollutants such as methane, ammonia, and hydrogen sulphide- released from wastewater treatment plants. The study revealed that the location of a municipal wastewater treatment plant near an urban area will introduce new contaminants that will not only negatively impact the environment of the surrounding area, but also pose a threat on the public health (Hamoda, 2006). In a study done in the UK, “Nuisance from odor”, has also been considered a societal factor that affects the sustainability of wastewater reuse projects (Muga et al. 2008).

At the economic level, the suggestion of the farmers to get a trial period prior to being committed to yearly charges, has been supported by a quantitative study done in UK which concluded that techniques that allow people to experience treated wastewater

for a trial period lead to more public acceptance and commitment to pay for treated wastewater than official announcements about the availability of charged treated wastewater services.

C. Enabling Factors

Based on enabling factors suggested by interviewed stakeholders, a system of feedback which reflects on the farmers' complaints about the delivered treated wastewater quality and quantity has been considered an important performance indicator of wastewater services in a manual published by the American Society of Civil Engineers (Matos et al., 2002), and in a study done in Australia (Ross et al., 2014). Quality control through regular water tests and machinery maintenance, has also been a major factor affecting the acceptance of public to reuse treated wastewater as expressed in quantitative studies done in US (Hartley, 2006), Australia (Hurrilman et al. 2007; Hurrilman, 2007), and UK (Jeffrey et al. 2003). The studies revealed that quality control is essential to maintain the production of treated wastewater with minimal associated health risks.

CHAPTER 6

LIMITATIONS

Few qualitative studies have been done to thoroughly reflect on the stakeholders' perspectives on water reuse in developing and developed countries. Most studies involve quantitative surveys that target specific indicators without exploring more on the respondents' views towards the implementation of water reuse projects in their countries. The availability of qualitative studies would present a richer 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.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

The conducted project reflects that the Lebanese stakeholders show their motivation and acceptance to implement a wastewater treatment project in Lebanon specifically at the agricultural sector. The interviewed stakeholders involved in the implementation of wastewater treatment and reuse project in Lebanon anticipated many risks that can stand in the way of the project, including: trust in authorities, water quality, location of the treatment plant, consumer's acceptance of utilizing food products irrigated with treated wastewater, establishing efficient water quality assurance procedures prior to financial commitment by end users, and proper breakdown of operation and maintenance costs. Thus, to ensure transparency and accountability throughout the implementation of a wastewater treatment project, the stakeholders expressed various key elements that should be implemented at the legislative and technical levels to enhance the capabilities of ministerial bodies. At the legislative level stakeholders suggested enforcing available treated wastewater laws, and designing new applicable laws. At the technical level stakeholders suggested having qualified personnel at the operational level, and stressed on applying regular monitoring and evaluation procedures.

Accordingly, based on the conducted study, the implementation of a wastewater treatment project at the agricultural sector would be a sustainable solution for water management in Lebanon; yet, the success of the project relies mostly on the trust in authorities to professionally manage planning for, operating , and monitoring the

project. In addition, as the stakeholders stated, effective public involvement that could be facilitated through the joint effort of ministries, public cooperative organizations, NGOs, and media channels would be an important mean to manage various risks perceived by the public.

B. Recommendations

The interviewed stakeholders recommended various enabling factors to manage the risks associated with the implementation of a wastewater treatment project in Lebanon. Enabling factors include: Qualified staff recruitment, information management, quality control, and financial assistance.

Furthermore, the government has to provide undisrupted public services including continuous electric flow, and an integrated solid waste management plan prior to implementing any proposed developmental project; this will help in regaining the public's trust in the Lebanese authorities. The government should also seek the guidance of international staff experienced in the planning and implementation of wastewater treatment projects. The government should also set an effective legal framework which involves formulating achievable effluent quality standards, and establishing strategic plans for law enforcement and monitoring in order to maintain the production of safe treated wastewater.

APPENDIX 1: INTERVIEW GUIDE

Qualitative In-Depth

INTERVIEW GUIDE

- 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?
- 3- What do you think are the risks associated with implementing 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 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?
- 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?

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