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Wastewater Reuse Tariff for Agriculture in the Gaza Strip

تعرفة اعادة استخدام المياه العادمة للزراعة في قطاع غزة

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بسم الله الرحمن الرحيم

{ وَأَرْسَلْنَا الرِّيَاحَ لَوَاقِحَ فَأَنْزَلْنَا مِنَ السَّمَاءِ مَاءً فَأَسْقَيْنَاكُمُوهُ وَمَا أَنْتُمْ لَهُ بِخَازِنِينَ }

صدق الله العظيم

(سورة الحجر : الآية 22)

DEDICATION

To my father's soul, who in his life, spared no effort to help me pursue my education; and to my sincere Mother, for her kindness; to my wife for her support and encouragement; to my sons whose innocent energy was and still is a source of inspiration; To all of my Brothers and Sisters; to my friends, colleagues; to Every person who offers a useful science; I dedicate my research, hoping that I made all of them proud.

Ibraheem Abu Sultan

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ملخص الدراسة

يعتبر موضوع اعادة استخدام المياه المعالجة في الزراعة في قطاع غزة مدخلا جذابا لمعالجة موضوع ندرة المياه وذلك من اجل المحافظة على توفير المياه الصالحة للشرب من اجل المساهمة في إدارة متكاملة للمياه في قطاع غزة. ان تصميم تعرفة فعالة هو عنصر مهم لنجاح وديمومة أي مشروع لإعادة استخدام المياه المعالجة وذلك من اجل تغطية النفقات الكبيرة للمشروع. تتناول هذه الدراسة ايجاد تعرفة لاستخدام مياه الصرف الصحي المعالجة في الزراعة وذلك بناء"ا على منهجية دراسة احتساب قيمة الاسترجاع لتكلفة المشروع بالتوازي مع دراسة اراء المزارعين لمعرفة استعدادهم لقبول الدفع مقابل استخدامهم للمياه المعالجة في الزراعة. لقد تم دراسة احتساب قيمة الاسترجاع للتكلفة لعدة خيارات لنظام اعادة الاستخدام للمياه المعالجة في الزراعة والمقترح ضمن مشروع انشاء محطة الشمال في قطاع غزة لمعالجة مياه الصرف الصحي. كما تمت الدراسة من خلال استبيان علي 30 مزارع في منطقة الزيتون من مدينة غزة يستفيدون من مشروع تجريبي لإعادة استخدام المياه المعالجة في الزراعة وذلك بهدف تقييم الاثر الاجتماعي- الاقتصادي لإعادة استخدام المياه ومدى قبول المزارعين للدفع مقابل الخدمة. اوصت الدراسة ان يتحمل المزارع قيمة الاسترجاع لتكلفة التشغيل والصيانة لنظام اعادة الاستخدام على ان يبدا سعر المتر المكعب للمياه المعالجة بقيمة منخفضة 40 أغوره وذلك بهدف تشجيع المزارع على استخدام المياه المعالجة بدل المياه الجوفية على ان يتم تغطية الفرق في التكاليف من خلال دعم حكومي مع العمل على اعادة النظر ومراجعة الاسعار بعد ذلك بالتزامن مع رفع الاسعار بشكل تدريجي بموازاة تقليص الدعم الحكومي.

ABSTRACT

The reuse of the treated wastewater for the agricultural purposes in the Gaza Strip has become an attractive option for addressing water scarcity in order to conserve and expand available water supplies which can contribute toward a more integrated management of Gaza Strip water resources. Design a proper tariff system for treated wastewater services is an important component of the successful and sustainable implementation of the wastewater reuse in order to achieve effective treated wastewater service delivery to the users and to pay for operations, maintenance and the system management. In this study, the proposed of wastewater reuse tariff is based on the evaluation of the cost recovery of reclaimed wastewater and also on the farmers willingness to pay for using of the reclaimed wastewater. The cost recovery is calculated for five options using the present value method for the proposed reuse scheme that will be implemented as a part of North Gaza Emergency Sewage Treatment (NGEST) project. A social survey was carried out using a total of 30 questionnaire developed specifically for the purpose of evaluating the socio-economic impact of using the treated wastewater for agricultural purposes through pilot project in El Zitoon area in the Gaza city. The researcher recommended beginning the reuse of reclaimed tariff at low price 0.40 NIS where the farmers need to realize the value they can benefit from and to encourage the farmers acceptance to switch from using fresh water to reclaimed wastewater. In parallel a governmental subside is necessary at the early stage of reusing the reclaimed wastewater in irrigation and prices will be adjusted gradually to increase the tariff with removing the governmental subsides gradually.

LIST OF CONTENTS

LIST OF ABBREVIATIONS

BLWWTP	Beit Lahia Wastewater Treatment Plant
CM	Cubic Meter
CMWU	Coastal Municipalities Water Utility
GDP	Gross Domestic Product
GS	Gaza strip
IUG	Islamic University of Gaza
m^3/d	Cubic meter per day
MCM	Million Cubic Meters
MENA	Ministry of Environmental Affairs
mg/L	Milligram Per Liter
MOA	Ministry of Agriculture
MOH	Ministry of Health
MOP	Ministry of Planning
NIS	New Israeli Shekel
NWC	The National Water Council
O & M	Operation and Maintenance
PCBS	Palestinian Central Bureau of Statistics
PHG	Palestine Hydrology Group
PNA	Palestinian National Authority
ppm	Parts per million
PWA	Palestinian Water Authority
RO	Reverse Osmosis

SPSS	The Statistical Package for the Social Sciences
TDS	Total Dissolved Solids
TS	Total Solids
TSS	Total Suspended Solids
UN	United Nations
UNDP	United Nations Development Program
UNRWA	United Nations Relief and Works Agency
USAID	United States Agency for International Development
WHO	World Health Organization
WTA	Willingness to Accept
WTP	Willingness to Pay
WWTPs	Wastewater Treatment Plants

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

1.1 Background

Palestine as the majority of the Middle East countries suffers from water scarcity. The limited water resources pose severe constraints on economic and social development and threaten the livelihood of people. The over-pumping of groundwater, beyond natural recharge rates, has resulted in lowering the water table and causing an increase in groundwater salinity, ground water depletion, and ecological degradation (World Bank, 2009).

The current situation in the water sector in Gaza has been characterized by various parties as a humanitarian crisis. The primary source of fresh water is the underlying groundwater (the aquifer), that is grossly contaminated and at present yields almost no flow of acceptable quality for domestic use. The quantity of water available to the 1.7 million inhabitants of Gaza is also inadequate, and the quality of the water exerts major adverse impacts to public health. Most of the wastewater treatment facilities in Gaza fail at the present time to provide adequate treatment, and perpetuate the contamination of groundwater as a result. Almost no wastewater is available for reuse in the agricultural sector, which is one of the very few sources of employment in Gaza. The reuse of treated wastewater is a very important component because approximately half of the current fresh water use in Gaza is allocated to the agricultural sector. The introduction of treated wastewater reuse depends on the completion of high quality wastewater treatment facilities (PWA, 2011).

The wastewater sector in the West Bank and Gaza strip is characterized by poor sanitation, insufficient treatment of wastewater, unsafe disposal of untreated or partially treated water. The reuse of treated wastewater is practiced in a small scale and there is no comprehensive pricing policy or prices for reuse in Palestinian territories. Although finding the proper financial incentives is critical to cover at a minimum the operation and the maintenance costs of any reuse scheme, capacity building and assistance to farmers are also key to a achieving a rational pricing policy and to encourage the farmers to use treated wastewater for crop irrigation (World Bank, 2004).

In the Gaza Strip, pilot wastewater reuse schemes have existed for some years, and there are plans for these to be augmented shortly. The key requirement, however, is for the completion of the four major wastewater treatment plants scattered throughout Gaza, as reuse cannot be introduced at any significant scale in the absence of high quality wastewater treatment(Al-Dadah, 2013).

Pricing treated wastewater in the Gaza Strip is, however, a totally new phenomenon to the farmers and to all other stakeholders, since it has never been practiced in Palestine before. Experiences in these issues remain to be seen until the reuse of treated wastewater becomes a common practice in the coming years or decades(ÖZEROL, 2013).

1.2 Problem Statement

The reuse of reclaimed wastewater in Palestine is a major priority confirmed in the Palestinian Water Policy adopted by the PWA and the Ministry of Agriculture. Although various wastewater reuse projects are planned, only a few demonstration projects exist. The reasons for failing to promote reclaimed wastewater reuse in agricultural purposes have socio-cultural and due to the lack of funds(Zimmo & Petta, 2005).

An integrated vision for wastewater reuse issues is still missing, which should include political and institutional aspects, water policy, awareness, marketing, and tariffs (Samhan, 2008).

Due to shortage of water resources in the Gaza Strip, treated wastewater is the available resource to reduce consumption of the ground water where a new wastewater treatment plants are under construction and will provide suitable effluent for reuse. Many pilot projects were implemented for reuse in the Gaza Strip and the farmers are interested to use treated wastewater for irrigation. Design and implemented effective tariff is very important to sustain the reuse projects.

1.3 Research Aim

The overall objective of this research is to study the major factors on settings the system of the proposed tariff for the treated wastewater that should be built in Gaza Strip and to suggest an appropriate wastewater pricing in order to develop of a sustainable wastewater treated service in the Gaza Strip.

1.4 Research Objectives

The specific research objectives are:

- Investigate the farmers in Gaza strip knowledge of waste water reuse, their willingness to accept it.
- Measure the farmers willingness to pay for treated wastewater.
- Assess the socioeconomic farmers situation and its impact on treated wastewater pricing.
- Calculate the cost recovery of the reuse the treated wastewater in irrigation

1.5 Research Importance

The crisis of water scarcity looming on the horizon threatens the stability and security of the Gaza strip. The crisis will continue and increase with time, if no suitable actions are taken as soon as possible, therefore, the reuse of treated wastewater is well recognized for having a potentially significant role in alleviating the quantitative and qualitative stress on water resources in the region. To date, there is no any pricing for the reuse of the recycled water for irrigation purposes. Designing of proposed tariff will enhance the sustainability of the future reuse projects.

1.6 Brief Research Methodology

The research is conducted in three stages. The first stage includes identifying the research problem, research justification, setting out the research's aim and objectives. The second phase includes reviewing the relevant literature related to the concern subject and the factors affecting the tariff structure of reuse of treated wastewater in irrigation. The third includes developing semi structured interviews and designing questionnaire. The target group of the questionnaire is the farmers in El Zaiton area because they are served of a recently pilot reuse project in order to measure their willingness to pay for using treated wastewater. Statistical analysis for the questionnaires was made using Statistical Package for the Social Sciences (SPSS). Based upon the findings and discussion of the results, the model of reuse tariff was developed. Finally, conclusions of research and recommendations were then drafted.

1.7 Research Structure

The thesis is organized in seven chapters:-

Chapter one presents introduction about water and wastewater situation in the Gaza strip. It presents also the problem definition, goal and objectives of the study, the importance of the study and the thesis outline .

Chapter two reviews the literature related to the importance and the impact of the reuse. The type of tariff, the cost of treated wastewater, international tariff survey, willingness of farmers to pay and pricing principle for recycled water.

Chapter three describes the Gaza Strip as study area, its location, population, climate, hydrology, water resources , the quality of ground water, wastewater treatment situation , agriculture economy contribution and the experience in treated wastewater reuse.

Chapter four present various type of pricing methodology that used to find the reuse price of the treated wastewater and the research methodology used

Chapter five. Study and analysis the cost recovery for five options of the reuse scheme in the northern Gaza.

Chapter six present the results and discussion in order to study the socio-economic situation of the farmers in the Gaza Strip and its effect on the willingness and acceptance to pay for reclaimed wastewater.

Chapter seven state the conclusions and recommendations.

2 CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Water has a precious value and each drop must be accounted-for in water scarce regions. So wastewater has to be reclassified as a renewable water resource rather than waste as it helps increase water availability and prevents environmental pollution by treating and reusing it (Jhansi & Mishra, 2013).

In Palestine, wastewater reuse projects are associated with political obstacles, in addition to financial, social, institutional, and technical ones. “Wastewater reuse is still tied to the political issues concerning Palestinian water rights, since Israel considers reused wastewater as part of Palestinian total freshwater allotment (Samhan, 2008).

Wastewater effluent is the most readily available to provides a partial solution to the water scarcity problem, the agriculture sector is the second major consumer of groundwater in the Gaza Strip. Irrigated agriculture plays significant benefits in the sustainability of crop production to feed the rapid increasing population in the Gaza Strip (Al-Dadah, 2013).

2.2 Wastewater Reuse in the Agriculture

Reuse of treated, high-quality reclaimed wastewater for agriculture is important not only to protects human health but also consider a good conservation strategy to reduce the consumption of limited drinking water for irrigation and to reduce fertilizer costs in the agricultural sector of low-income countries (Zurita & White, 2014).

AHT GROUP AG (2009), reported that wastewater reuse for agricultural irrigation involves three major challenges:

1. Quality requirements, to limit all kinds of negative impact on human health and the environment/water cycle. This would necessitate appropriate treatment of water to be reused and the application of safe irrigation techniques.

2. Seasonal demand: wastewater is produced constantly, but irrigation is only needed seasonally, thus intermediate storage facilities would be required.

3. Location of production; the greatest amount of wastewater is generated in large agglomerations/cities, whereas agricultural areas are mostly located in rural areas. Consequently, long-distance transportation networks and pumping would be needed.

Treated wastewater reuse in agriculture is a strategic option for enhancing agricultural water supply in the West Bank and Gaza as well in arid and semi-arid areas. However, TWW reuse faces technical, legal, institutional and socio-economic challenges which could be overcome through participatory approaches in which farmers present their views and concerns for successful implementation of TWW reuse projects(Mizyed, 2013).

Wastewater reuse is important as a means to support the agricultural sector in Gaza because approximately half of the current fresh water use in Gaza is allocated to the agricultural sector. This will serve to reduce the abstraction pressure on the groundwater. Until recently it is reported that farmers in Gaza are opposed to the reuse of wastewaters, but now a lot of recent studies, suggest that the farmers in Gaza are willing to utilize treated wastewaters for irrigation . In the Gaza, pilot wastewater reuse schemes have existed for some years, the key requirement, however, is for the completion of the four main wastewater treatment plants throughout Gaza Strip, as reuse cannot be introduced in the absence of high-quality wastewater treatment (PWA, 2011).

According to NJDEP (2005), the two mostly common types of water irrigation are:

- Restricted irrigation

use of low quality effluents in limited areas and for specific crops (wooden, fodder and cocked), restrictions are imposed based on the type of soil, the proximity of the irrigated area to a potable aquifer, irrigation method, crop harvesting technique, and fertilizer application rate. It is simple and low cost so farmers must be trained to handle the low-quality effluent.

- Unrestricted irrigation

use of high quality effluents, instead of freshwater, to irrigate any crop (include also vegetables eaten raw) on any type of soil, which means without limitations as contact and even accidental drinking do not pose health risks.

2.3 Benefits of Wastewater Reuse

Wastewater treatment and reuse can play a significant role in alleviating the water problems of Palestine, both in the West Bank and the Gaza Strip. This is particularly valid for the Gaza Strip since groundwater pumping rate exceeds the replenishment rate of the aquifer and the quality of water continually decreases. The reuse of treated wastewater in irrigation will increase the water supply for agriculture, and the availability of freshwater resources for domestic and industrial uses (Nassar et al., 2009).

Nassar et al. (2010b) state that, the treated effluent from wastewater treatment plant that will use for irrigation must meet with appropriate quality standards to ensure adequate protection of human health, agricultural production and the environment.

Engineers who are evaluating project alternatives often compare only the financial costs of various alternatives and do not quantify the social domain. As a result, the true benefits and costs of many water reuse projects have never been properly evaluated. So the benefits of many water reuse projects would exceed the costs however, many utilities price this water below the cost of service in order to promote its use (Miller, 2006) .

The benefits of using treated wastewater must also be considered against the human health, economic, and environmental costs of not using it. For example, treating and using wastewater would reduce the discharge of untreated wastewater into the environment which reducing water pollution and the contamination of drinking water supplies and would improve the socioeconomic situation of farmers (Qadir et al.,2007).

Wastewater reclamation and reuse is well recognized for its ability to mitigate water shortage which is a major threat to sustainable development and political stability.. Reuse of wastewater has been practiced in many areas worldwide for thousands of years, the economic incentives to reuse reclaimed wastewater is the scarcity of water, and to avoid the cost of the deterioration of the water resources and the environment. (Abu-Madi & Al-Sa'ed, 2009).

Treated wastewater makes a significant contribution to the limited irrigation water supply and ensures the continuation of agriculture in parts of the country. Reclaimed water can contain substantial amounts of plant nutrients, thus reducing the amount of chemical fertilisers needed to obtain profitable crop yields (Carr et al., 2011)

Designing wastewater treatment plants for reuse in irrigation is a particularly underutilized opportunity that could potentially increase agricultural yields, conserve surface water, offset chemical fertilizer demand, and reduce the costs of wastewater treatment by eliminating nutrient removal processes (Murray & Ray, 2010).

Benefits of safely recovering and reusing human wastes include the reduction in effluents to bodies of water and the opportunity to re-build soil with valuable organic matter. The nitrogen in reclaimed water can replace equal amounts of commercial fertilizer during the early to midseason crop-growing period (Jhansi & Mishra, 2013).

In general, the benefits of this alternative source of water are:

• reducing the need for future water resource development (and associated economic and environmental costs) by substituting for (original source) potable and/or irrigation water in various uses;

• improving the health of aquifers by reducing extraction;

• reducing the negative environmental impacts that in some settings accompany discharges from treatment plants into waterways; and

• providing economic development opportunities based on utilisation of a previously unused resource (Woolston & Jaffer , 2005).

2.4 Impacts Of Reclaimed Wastewater Reuse

There are major real potential health, environmental and economic impacts as a result of poor sanitation, improper disposal of treated and untreated wastewater, and use of raw or partially treated wastewater to irrigate edible crops.

Özerol & Günther (2005) Mentioned that, although several potential benefits are expected from the wastewater reuse in agricultural irrigation there is a risk of using the wastewater which may cause serious health problems for the people exposed to wastewater and ecological problems due to contamination of both soil and water, hence also high economic costs.

The reality is that unplanned water reuse is happening all over the world in river basins with very few people being aware and concerned about it. People say that treated wastewater discharged to the natural system may be the most effective way to deal with some of the most problematic water health issues (Bixio D., et al., 2008).

The reclaimed water from domestic/urban origin presents hazards and risks. Both are elated to the presence of microbes and chemicals capable to cause illnesses and toxicity for human and animals and negative impacts on the environment(Salgot M., 2008).

2.5 Economics of Reclaimed Wastewater Irrigation

The most important aspect to take when studying the feasibility of reusing wastewater is the economic and financial viability. The cost effectiveness of a reuse project depends on the volume of reclaimed water used; where the more water utilized, the more the cost-effective the project (Urkiaga et al, 2008).

The valuation approach suggests that cost benefit analysis must incorporate socioeconomic, health related and environmental impacts of wastewater reuse in agriculture, for proper assessment. When evaluating wastewater reuse projects, the initial approach is to categorize all benefits into two groups, direct and indirect benefits. For the former, increased crop production, savings on fertilizer costs and on water supply as well as generating job opportunities, are just a few. For the latter they are minimized environmental damages ,controlled soil erosion and protection of groundwater which reduces waste and enhances water conservation (Al-Dadah, 2008).

Water reclamation and reuse is technically possible but often it is not a cheap option. The infrastructural requirements are usually high, in particular because of the need to construct and/or retrofit the distribution system (Bixio et al., 2008).

2.6 Wastewater Reuse Tariff

A tariff for water and wastewater services, which is the appropriate price a user of these services is expected to pay, may have several objectives: cost recovery and financial sustainability, efficient allocation of scarce sector resources, income distribution, or fiscal viability (Laredo D., 1991).

2.6.1 Types of Tariff Structures

Water and wastewater tariffs include at least one of the following components:

- a volumetric tariff, where water metering is applied, and

- a flat rate, where no water metering is applied.

Many utilities apply two-part tariffs where a volumetric tariff is combined with a fixed charge. The latter may include a minimum consumption or not. The level of the fixed charge often depends on the diameter of the connection.

Volumetric tariffs can

- be proportional to consumption (linear tariffs)
- increase with consumption (increasing-block tariffs)
- decrease with consumption (decreasing-block tariffs)

2.6.2 Water Reuse Costs

The capital and operating costs of treating wastewater to a standard suitable for its intended use will depend upon factors such as the quality of the influent, the quality of the recycled water required, the technology adopted or required for the appropriate level of treatment. Generally, the higher the level of treatment, the higher the cost. If the influent has particular characteristics (eg high levels of salt), costs of treatment to make the wastewater 'fit for purpose' will often be high (Woolston & Jaffer 2005).

The direct costs associated with recycled water schemes can vary widely, and depend on the nature of the scheme, its location, and the quality of the recycled water needed for specific end-uses. These costs can be grouped into capital, operating and administration costs:

• Capital costs include the costs of constructing additional treatment plants, trunk mains and reticulation systems and storage capacity where needed to match seasonal variations in production and demand;. Capital costs also include costs incurred by customers to access the recycled water, such as conversion of equipment, plumbing.

• Operating costs include the annual costs incurred in maintaining and operating the recycled water system, as well as any additional treatment and disposal costs incurred after the recycled water has been used. Operating costs also include ongoing monitoring and compliance with regulatory requirements.

- In addition, operating costs include administration costs, such as marketing, education and consultation programs, legal costs, and metering, billing and other customer related costs (IPART,2006).

Some analysts argue that economic calculations for reuse projects require that only the marginal cost of wastewater recycling (additional treatment, storage, and distribution) be considered, excluding the cost of wastewater collection and treatment (Lazarova et al. 2001).

The costs of wastewater treatment also depend on the technology that is used, the quality of water required. The other important cost of reuse, which will vary across supply alternatives depending on the relative distances to the reuse sites, is distribution of treated water back to demand locations; this varies from US$0.05-0.36/m3, and represents a lower bound on the cost of reuse in places where sewers and treatment are already in place (Jeuland,2011).

The Al-Beirah wastewater reuse system, is an example of water reclamation and reuse in Palestine. The construction cost of the wastewater reuse system is about 7 million €. The total cost for treating one cubic meter is 0,32 €(Salem *et al*., 2004).

An interesting case in Cyprus is the Larnaca wastewater reuse system, the total cost of the project is 50 million €, out of this, 9,3 million € is the cost of the tertiary treatment plant with the reuse network and pumping station. The cost for the production of tertiary treated water is around 0,5 €/m^3 (Hidalgo *et al*, 2004).

The direct costs of recycled water vary considerably from scheme to scheme, the direct per unit cost of recycled water is typically higher than the current usage charge for potable water. There are several reasons for this:

• Building recycled water schemes in new development areas involves constructing an additional pipe system to distribute the recycled water. This represents a significant proportion of the cost of supplying the service.

• The direct costs do not reflect avoided costs or external benefits associated with recycled water schemes. Some schemes will only become economic when recycled water is evaluated in the context of an integrated urban water system, and the value of these avoided costs or external benefits are taken into account (IPART,2006).

2.6.3 International Tariff Surveys

There is a real difficulty to give a range of prices for reclaimed water as they change very much form one country to another one.

Condom et al., 2012, believe that the price of treated wastewater is very different from one project to another. It ranges from “zero” to the price of conventional water. Setting a zero price on wastewater for users encourages acceptability of this innovation, hence reducing wastewater discharges into the environment.

Yemen and Syria do not charge farmers anything for recycled water (Baquhaizel and Mlkat 2006).

Wastewater reuse is provided free of charge in Australia to reduce wastewater discharges into sensitive water environments (Condom et al., 2012).

A study conducted in California in 2005 on 11 wastewater reuse projects shows prices for TWW range from 45 to 100 percent of the price of drinking water (77% in average) (American Public Works Association, 2005).

Table 2.1 indicate an international recycled water tariff for some countries

Table 2.1 International Recycled Water Tariff Surveys

Country	Conventional water tariff	Recycled water tariff	Original Sources for data
Israel	€0.346 to €0.504/m^3	€0.151 to €0.205/m^3	Feitelson & Laster, 2011
Kuwait		US$0.07/$m^3$	Fadlelmawla, 2009
Tunisia	€0.072/m^3	€0.0103 /m^3	AHT Group AG, 2009
Cyprus	€0.1/m^3	€0.1/m^3	Hidalgo and Irusta, 2005
Japan	\$3.73/m^3	\$2.99/m^3	Suzuki et al., n.d

2.7 Willingness of Farmers to Pay for Reclaimed Wastewater

AHT GROUP AG (2009), believe that the willingness to pay for using reclaimed wastewater depends on the following criteria:

- Scarcity of the resource: the more limited or less available conventional water resources are, the higher the price that is acceptable to users.
- Costs of conventional water resources: the higher the costs (pumping from wells), the more the consumer is willing to accept alternative sources at similar prices.
- Quality of the resource: the better the water quality provided, the more the consumer is prepared to pay for it.
- Service provision: farmers and other consumers of treated wastewater could be more willing to pay higher charges if there is a good prospect of improved services

The main problem when dealing with water reuse is the acceptation of the resource by the end users. Apart from the concept of risk, developed so far, it is necessary a willingness of the end user or/and customer that will buy the production (Salgot, 2008).

When willingness to pay is weak and charges on direct users are unlikely to recover costs, service providers and government authorities face limited choices. Transparent government funding of the gap as a community service obligation is an option (Centre for International Economics, 2010).

Although wastewater collection and treatment are a prerequisite for subsequent reuse, the related costs cannot be charged to the end user (e.g. the farmer) alone. For sewerage and treatment up to standards for discharge into the environment the ‘polluter pays’ principle has to be applied, meaning that the costs for decontamination have to be covered by the polluter, i.e. the freshwater consumer. The extent to which wastewater has to be treated before being discharged into the environment is country specific and the relevant interface between ‘polluter’ and ‘user’ has to be defined accordingly (AHT GROUP AG, 2009).

In Jordan and Tunisia, in principle, farmers are willing to apply reclaimed wastewater for agricultural irrigation with preference for unrestricted irrigation. Availability or accessibility to fresh water and concern for water quality and crop marketing are the major factors that make farmers reluctant or hesitant to irrigate with reclaimed wastewater. Farming profitability as well as the prices of fresh water and reclaimed wastewater significantly influence farmers’ willingness to pay. Farmers prove to be unwilling to pay more than 0.05$/m^3 of reclaimed wastewater primarily because of comparatively easy access to fresh water at low price. The water price that farmers are willing to pay hardly covers the operation and maintenance costs for conveyance and distribution of the reclaimed wastewater. Ambitious attempts to recover the full cost of treatment and conveyance and distribution might not succeed (Abu Madi et al. 2003).

Ghanem (2012) note that more than half of the respondents in wadi Nar area located in the southern region of the West bank are willing to pay for treated wastewater for irrigation and the majority of them believe that the fee should be less than that of fresh water. The average amount thought to be a suitable fee for treated water used in irrigation is 1 NIS/m^3 .

A study with sample of 30 farmers interest for using treated wastewater from Al-Zaitoun District and Khan Younis Governorate where most of the surveyed farmers were willing to use treated wastewater with average acceptance around 81%. The main reasons behind this high level of acceptance included increasing salinity level in local agricultural wells , increasing fuel prices, and maintenance costs. This is obvious in the acceptance of most farmers to pay for wastewater and the majority of the target group of farmers accept to pay with a maximum price of 0.5 NIS/m^3. It was noted that most farmers want to use reclaimed water to save on abstraction of ground water and use of fertilizers, and to increase crop production. Serious and actual implementation of reuse projects should be achieved. Most surveyed farmers cultivate citrus, olives, and guavas using reclaimed water for irrigation. Surveyed farmers mentioned an increase in crop production per tree and dunum. There was an average increase in citrus production of 25 kg/tree and 662 kg/dunum. There was an increase of 28.7 kg/tree and 670 kg/dunum for olive production, and 51.4 kg/tree for guava (Alimari et al. 2013).

A study with sample of 90 farmers from Gaza and Middle Governorates was conducted to measure the attitudes of farmers towards wastewater reuse and their willingness to pay for treated effluent. The result of acceptance using reclaimed wastewater for irrigation is very high 89.9% of all farmers. The results also show that 44.1% would pay up to 0.30 NIS/m^3, 46.6 % would pay between 0.30 and 0.50 NIS/m^3 .On the average, farmers would be willing to pay 0.36 NIS/m^3 (Nassar et al. 2010a).

In Tulkarem district, in the West Bank, the farmer's willingness to pay for TWW amounts to 50% of the cost of access to groundwater, or €0.65/m^3, provided no restrictions apply to irrigation (World Bank, 2004).

2.8 Experience in Treated Wastewater Reuse

There is absence of existing water reuse projects and practical reuse experience in the Gaza strip while the wastewater reuse in agriculture is currently limited to a small pilot scale.

A pilot project in the Gaza strip through a French program called "Strategy of agricultural water management in the Middle East", the duration of the project was three years initiated at the beginning of 2003 which consider an example for the

Palestinian practice of treated wastewater reuse in agricultural production. The contract has been signed between the French Government as a financier and the Palestinian Ministry of Agriculture and Palestinian Water Authority to start a project on using treated wastewater effluent in agricultural irrigation. Palestinian Hydrology Group and the Council of the Bedouin village has also been involved. Two areas were chosen for the implementation of the project the first was Beit Lahia area where the treated wastewater coming from the Beit Lahia WWTP was available in unlimited quantities to irrigate vegetation for animal consumption cultivated on an area of 20 dounums. The drip irrigation system was used with a wastewater filtration system consist of sand filter in order to avoid drippers clogging from time to time. Different types of fodder were selected as Alfalfa, Rye Grass and Sudan Grass which met the local market in the Bedouin Village where there is a number of sheep and cow keepers.

The second area of the project is in the Gaza Eshtiwi farm to irrigate citrus, olives trees and various fruits on a land of 12 dunums by the treated wastewater generated from the Gaza wastewater treatment plant . The system of irrigation was also drip irrigation.

According to Ghazali M., and Abu Aqleen A. (2003), the crop production quantity shows promising results. In addition, testing results of plant and soil contamination are within safe standards. Based on that these pilot projects can be expanded to larger scale plan and can be useful for changing crop pattern.

Another pilot plant funded through Austria in 2011 was construct in El Zaiton area, the site is in Gaza City within Sheikh Ejleen area, close to the existing WWTP. Apart of the effluent from Shiekh Ejleen treatment plant pump there where additional treatment occur through sand filter, because the post-wastewater treatment plant couldn't provide the water on demand, there is a pond 600 m3 capacity to store the treated wastewater from the infiltration system that needed for the irrigation the post treated water pump to the farmers through pipe network every farm has its own drip irrigation system that will be used for the growth of citrus and olives. The pilot plant should serve 176 dunums for 30 farmers where the effluent of the pilot post-treatment plant will be used for the growth of citrus and olives trees which would require class B water quality, according to the guidelines for wastewater reuse for irrigation in Palestine, the quality of the effluent as shown in table 3.3. The total capacity of the pilot post treatment system is 1,000 m3/d. The farmers in this part of Gaza are already convinced about the interest of reusing such water. However, the farmers are actually requesting more treated wastewater in order to irrigate more areas around the farm.

The proposed tariff for the reuse of the treated wastewater in this project is approximately 1 NIS/m3 which would be required to cover for only operational costs. The PWA articulates the tariff at the pilot stage to be about 0.5 NIS/m3 in order to incentives and encourage the using of treated wastewater. The actual collected price from the farmers in the pilot project per cubic meter is only 0.20 NIS because the farmers refuse to pay more (Almadina, Enfra & DHV, 2011).

2.9 Pricing Principles for Recycled Water

Setting a price for treated wastewater will depend on the characteristics of each project, in particular:

● Production costs for water services;

● Flexibility regarding the cost-recovery objective;

● Benefits drawn from TWW use;

● Users' willingness and capacity to pay for TWW, chiefly determined by: scarcity of conventional water resources, cost of irrigation with conventional water, the quality of TWW resources (willingness to pay will increase with higher levels of treatment of wastewater) and service quality (reliable supply with TWW vs. variable access to conventional water) (Condom et al., 2012).

The Essential Services Commission, (2011) in Victoria recently recommended to regulate recycled water by application of appropriate pricing principles

Principle 1: Flexible regulation

Light handed and flexible regulation (including use of pricing principles) is preferable, as it is generally more cost-efficient than formal regulation. However, formal regulation (e.g. establishing maximum prices and revenue caps to address problems arising from market power) should be employed where it will improve economic efficiency.

Principle 2: Cost allocation

When allocating costs, a beneficiary pays approach typically including direct user pay contributions should be the starting point, with specific cost share across beneficiaries based on the scheme's drivers.

Principle 3: Water usage charge

Prices should contain a volumetric component to address consumption based pricing

Principle 4: Substitutes

Regard to the price of substitutes (potable water and raw water) may be necessary when setting the upper bound of a price band.

Principle 5: Differential pricing

Pricing structures should be able to reflect differentiation in the quality or reliability of water supply.

Principle 6: Integrated water resource planning

Where appropriate, pricing should reflect the role of recycled water as part of an integrated water resource planning system.

Principle 7: Cost recovery

Prices should recover efficient, the full direct costs.

Principle 8: Transparency

Prices should be transparent, understandable to users and published to assist efficient choices. Subsidies and community service obligation costs should also be transparent.

Principle 9: Gradual approach

Prices should be appropriate for adopting a strategy of 'gradualism' to allow consumer education and time for the community to adapt.

2.10 Standards and Regulations

An important element in the sustainable treatment and reuse of wastewater is the formulation of standards and regulations that are achievable (AHT Group AG, 2009).

Most wastewater reuse standards in the Middle East and North Africa region "are based either on the United States Environmental Protection Agency (USEPA) or World Health Organization (WHO) guidelines" (WaDImena, 2008).

The Palestinian wastewater management strategy is to eliminate raw wastewater discharge to the environmental through implementation of collection and treatment systems and where possible to reuse wastewater for irrigation purposes and aquifer recharge. There is a Lack of unified planning laws and regulations concerning the wastewater reuse in Palestine ,in order for wastewater reuse to become an established resources a firm national water reuse regulations is needed. The key Palestinian regulation documents regarding wastewater treatment and reuse are the Palestinian water law No.3 of year 2002; the agreement with Israel particularly the MOU of Dec.2003; and the Palestinian Environmental law No.7 of year 1999 and recently the Palestinian water law No.14 of year 2014 . The detailed description of the Laws and Regulations is presented in detail in the Annex 1.

2.11 Conclusion

The reuse of treated wastewater for agriculture is consider a good strategy option to reduce the consumption of limited drinking water. The quality requirements for reclaimed wastewater is very important in order to limit all kinds of negative impact on human health and to comply with the farmers requirement for unrestricted irrigation.

The capital and operating costs of treating wastewater to a standard suitable for its intended use will depend upon the quality of the recycled water required and the technology adopted. There is a range of international prices for reclaimed water as they change very much form one country to another one which range from zero to the conventional water price.

The main problem when dealing with water reuse is the acceptation of the resource by the farmers. The willingness of the farmers to pay for reclaimed wastewater depends on many factors as Scarcity of the resource, costs of conventional water and the quality of the reclaimed water. Setting a price for treated wastewater will depend on Production costs for water services, flexibility regarding the cost-recovery objective and the farmers willingness to pay for using the reclaimed water in irrigation.

The pricing principles are very important and have to be considered as a guide in establishing the of wastewater reuse tariff.

3 CHAPTER 3: STUDY AREA

3.1 Introduction

The Gaza strip is part of the occupied Palestinian territories which is a narrow strip of land on the Mediterranean coast with an area of 365 km^2. The estimated population of Gaza strip is 1,672,865 (PCBS, 2013). Thus, Gaza holds the highest population density in the world with 4,583 persons per square km (PCBS, 2009). The farmers who use traditional ways of farming, compose 12% of Gaza economy (PCBS, 2011).

The Gaza Strip is bordered by the Mediterranean Sea in the west, Egypt in the south and the green line from the north and east which is approximately 41 kilometers long, and between 6 and 12 kilometers wide as shown in figure 3.1

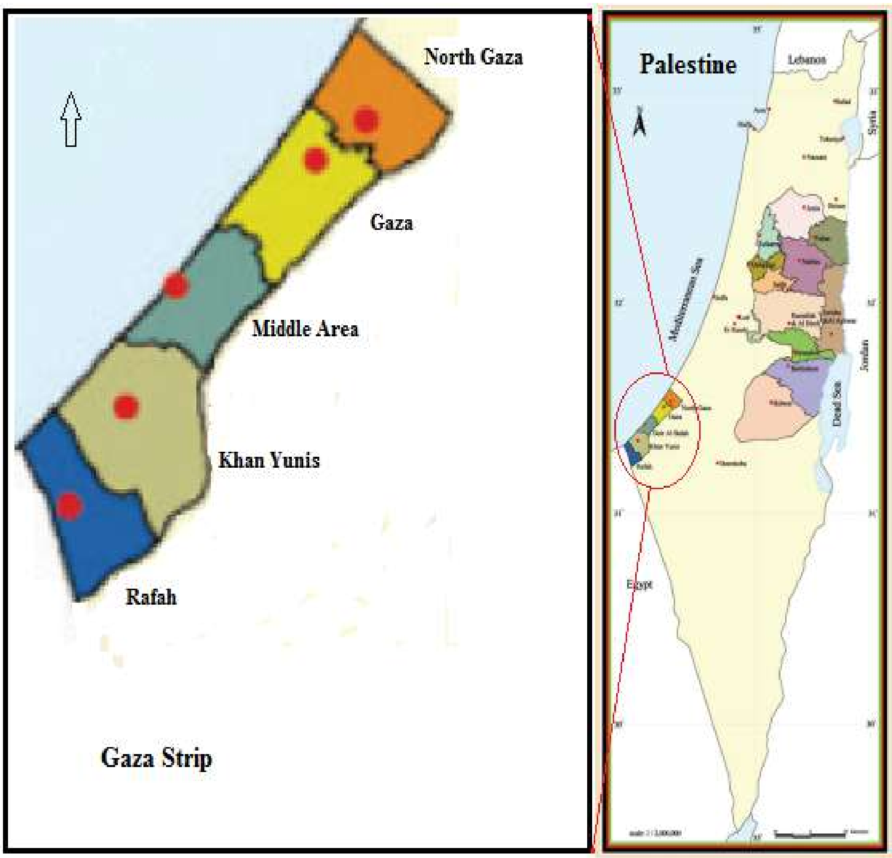

Figure 3.1: Map of Gaza Strip

The Gaza Strip has a temperate climate, with mild winters and dry, hot summers subject to drought. Rainfall in Gaza strip is unevenly distributed it varies considerably by governorates from the North to the South with long-term annual average rainfall of 372.1 mm (PWA, 2012a).

3.2 Water Resources in Gaza Strip

3.2.1 Ground water

Groundwater is the main source of water in the Gaza Strip where the Coastal Aquifer is the only source of water in the Gaza Strip, with the thickness of the water bearing strata ranging between several meters in the east and south-east to about 120-150 m in the western regions and along the coast. The aquifer consists mainly of sand, gravel and sandstone (Kurkar) intercalated by clay and silt. A hard and non-productive layer of clay and marl with low permeability has a thickness of about 800-1000 m situated below the coastal aquifer. The yearly recharge volume for this limited aquifer is in the range of 55-60 MCM/yr. the total abstracted volume is about 180 MCM, this means that the total recharge is only one third of total abstractions. These unsustainably high rates of extraction have led to lowering the groundwater level, the gradual intrusion of seawater and upwelling of saline groundwater (PWA, 2012b).

3.2.2 Non-conventional water resources

According to PWA (2013), Gaza cannot supply itself but must find new alternative sources of water as:

1-Purchased water (Mekorot)

Gaza currently imports some of its water from the Israeli water utility (Mekorot): 5 Mm^3/year. Israel is under an obligation to supply addition 5 Mm^3/year under the interim agreement and negotiations over the implementation of those obligations are ongoing with a tentative price agreed (PWA, 2013).

2- Desalination Plants

Desalination of brackish water to achieve acceptable levels of drinking water quality is an important option which were implemented at small scale. Around 2-3 MCM/yr is provided for drinking through about 100 private water vendors (brackish groundwater desalination) in addition to one public sea water desalination plant and around six pubic brackish water desalination plants operated by CMWU and Municipal Departments. The PWA recently finalized a study of water supply option for the short, medium and long term. At the short term, low volume (STLV) sea water desalination plant to be constructed with a total capacity of 13 MCM/y. In the long-terms regional seawater desalination plant will be constructed with a capacity of 55 MCM/y by the year 2017-2022 (PWA,2012b).

It is planned to construct large RO desalination plant to overcome the yearly groundwater deficit. The first phase supposed to start producing a quantity of 60,000m^3/d. Due to political constrains, this plant did not see the light (CMWU, 2010).

3- Treated Wastewater Reuse

Future of wastewater reuse seems to be promising in the Gaza Strip. The expected amount of wastewater to be used for irrigation will progressively increased on the coming twenty years saving more than half of groundwater needed for irrigation. (Tubail et. al., 2003).

There is a number of recent studies, all of which have suggested that the farmers in Gaza are willing to utilize treated wastewaters for irrigation, if flows of the relevant volume are made available. the reuse of treated wastewater is a very important because approximately half of the current fresh water use in Gaza is allocated to the agricultural sector. The reuse cannot be introduced at any significant scale in the absence of high-quality wastewater treatment (PWA, 2011).

3.3 Groundwater Quality

The Water quality in Gaza strip is very poor where the major problem is the high concentrations of salts and nitrates. Only about 5% of water supplied through the network meets drinking water standards (World bank, 2009).

In Gaza, the direct consequences of over pumping of the coastal aquifer are seawater intrusion and uplift of the deep brine water; as a result the water quality falls below the accepted international guidelines for potable water resources. Currently, several agricultural wells are also showing high salinity levels. The chloride concentration of the pumped water is in the range of 100-1000 mg/l, while the nitrate is in the range of 50-300 mg/l. A significant water salinity increase was generally observed as a result of continuous over-pumping where the trend of increase varies from well to well based on well location, abstraction rate and pumping duration (PWA, 2012a). Figure 3.2, 3.3 and 3.4 illustrate the chloride and nitrate concentrations over Gaza strip

Figure 3.2: Chloride Concentration in the Gaza Strip(PWA, 2014)

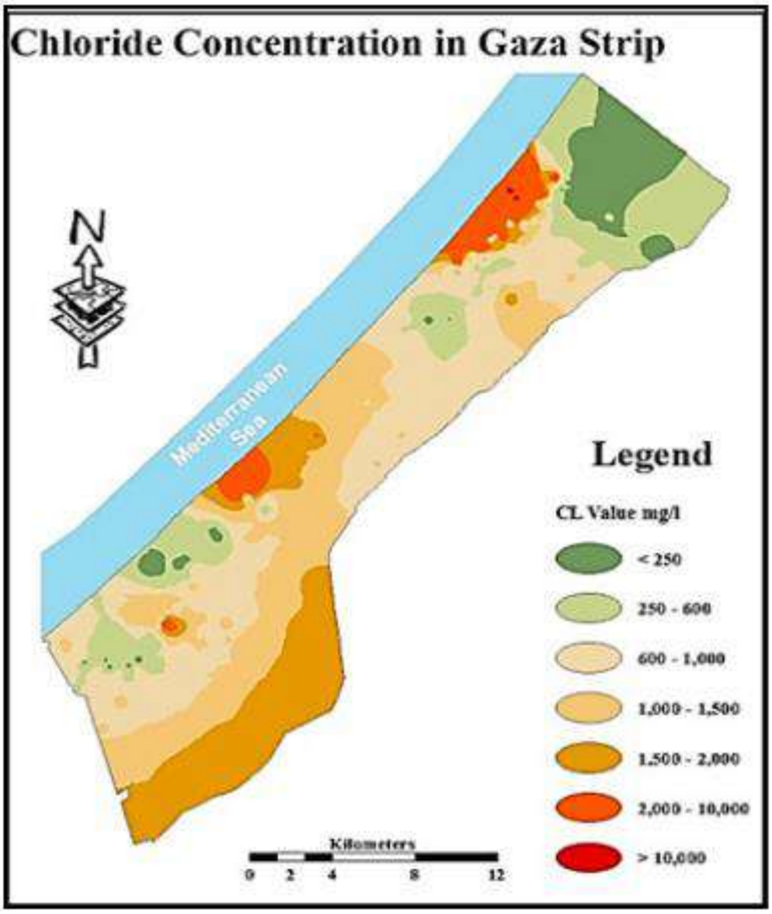

Figure 3.3: Chloride Contour Map in the Gaza Strip(PWA, 2014)

Through monitoring all municipal wells and some agricultural wells distributed all over the Gaza Strip it is notes that the nitrate ion concentration reaches a very high range in different areas of the Gaza Strip, while the WHO standard recommended nitrate concentration less than 50mg/L. The nitrate ion in the groundwater is a chemical components has resulted from different sources i.e. intensive use of agricultural pesticides beside the existence of septic tanks to dispose the domestic wastewater in the areas where there is no wastewater collection system. (CMWU, 2011).

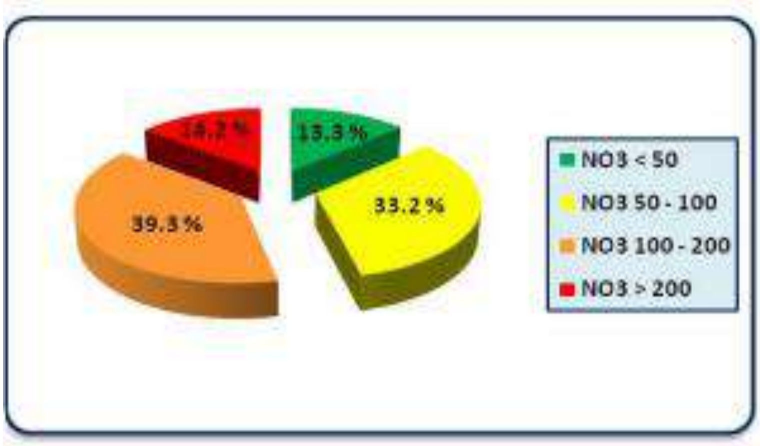

Figure 3.4: Nitrate Concentration in the Gaza Strip(PWA, 2014)

3.4 The Situation of Agriculture in Gaza Strip

The agriculture is an essential component of the Palestinian national, cultural, economic and social fabric The cultivated area is estimated at 1.854 million dunums, out of which 91% in the West Bank and 9% in the Gaza Strip (MOA, 2010).

Agriculture can create incomes and jobs, can provide independent food security, and contribute to poverty reduction. Agriculture is almost entirely irrigated, where the average water use of 400-500 m3/dunum. The main problem is the water quality which is rapidly deteriorating, and this can have an impact on agricultural yields. (World bank, 2009).

The agricultural sector in Gaza Strip in average consumes around 80 million cubic meters annually from the groundwater wells. There is absence of direct measurement of water withdrawal for agriculture as most of the agricultural wells distributed all over Gaza Strip are unmetered , not functioning well or not installed absolutely, All amounts of water used for this purpose come from groundwater wells. Table 3.1 shows the seasonal crop. It can be noticed that more than two thirds of the total cultivated areas are irrigated areas (PWA, 2012a)

Table 3.1 Seasonal crop in the Gaza Strip (PWA,2012a)

Crop	Cultivated Area dunum	% of total area	Irrigated Area dunum
Vegetables	59,601	36.8 %	45,712
Horticulture	62,871	38.8 %	57,339
Field Crops	39,066	24.1 %	15,430
Herbs	50	0.3 %	140
Total	161,909	100 %	118,621 (73%)

Figure 3.5 indicates the potential agricultural areas in Gaza. Typical for the Gaza strip is the high population density, small scale agriculture and the agricultural areas located nearby housing areas. Most farms are small, growing different kinds of crops (Al Madina & Enfra, 2011).

Agriculture is the prevalent sector Gaza's economy and contributes to 32% of its economic production. In addition, it is a politically sensitive sector as all of its inputs such as, seeds, fertilizers and pesticides are imported from Israel. Therefore, any political crisis influences it directly while the agricultural sector is considered to be a main part of Palestinian life, over the last five years it’s contribution to the national Gross Domestic Production (GDP) has reduced from 9.1% in 2000 to about 7.0% in 2005 (Al Najar, 2007).

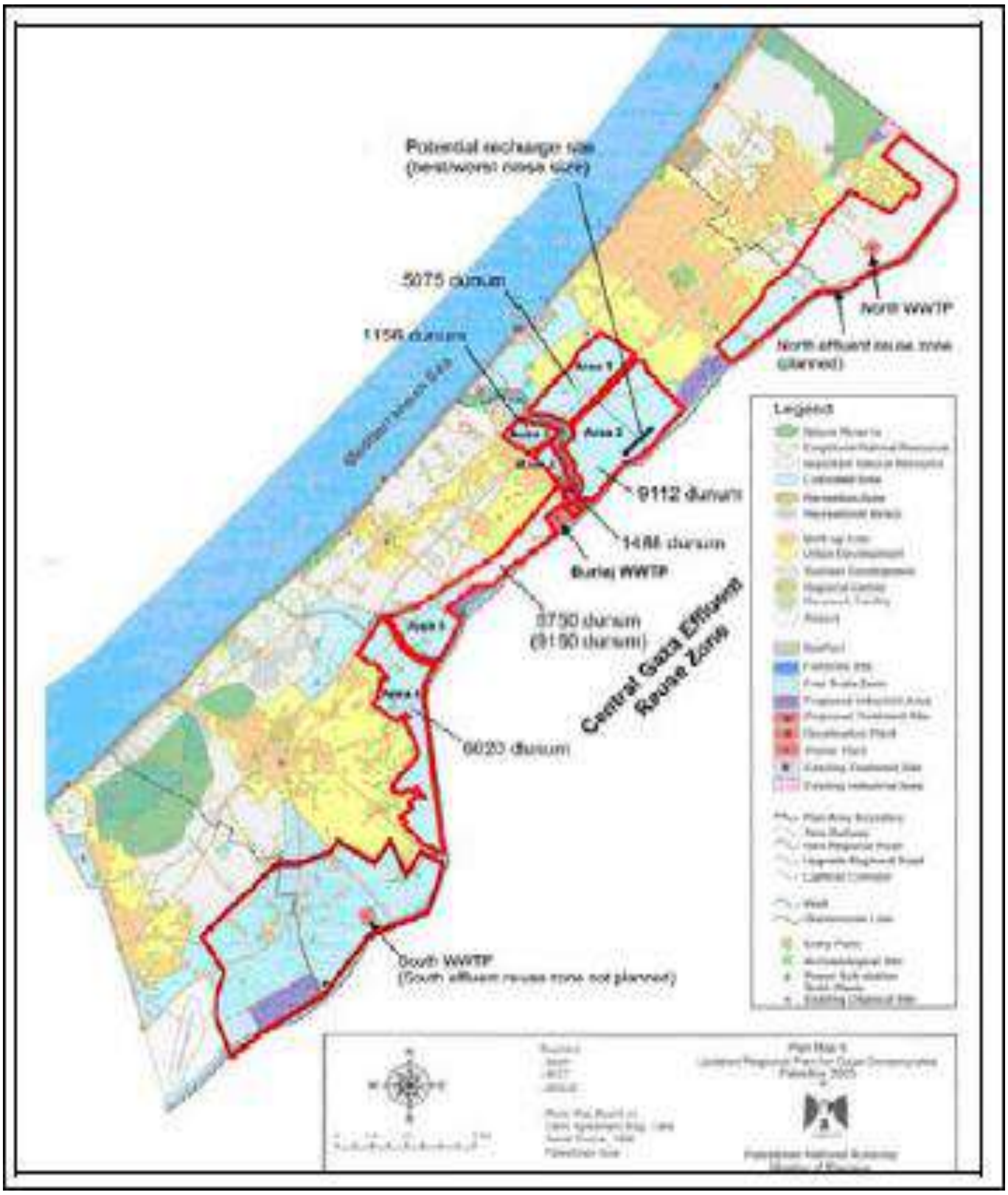

Figure 3.5: Potential areas for wastewater reuse (PWA, 2012)

3.5 Wastewater Treatments in Gaza Strip (GS)

Sanitation services in GS are also in crisis, the existing wastewater treatment plants function intermittently, so little sewage is being treated and most is returned raw to lagoons, wadis and the sea (World bank, 2009).

In Figure 3.6 the current and future WWTPs in Gaza Strip are indicated. Four WWTPs: Beit Lahia in the north, Gaza in the Gaza City, Khan Younis and Rafah in the south which are now operational, but are heavily overloaded as the actual flow far exceeds the design flow. The type of treatment, quantity and final disposal of each plant is summarized in table 3.2. It is planned that these four WWTPs will be replaced by three new WWTPs: North, Central and South. The North Gaza Emergency Sewage Treatment (NGEST) is under construction and this WWTP will replace the old plant at Beit Lahia. The design of the South and Central WWTPs is finalized, but funding for construction needs to be secured. In the meanwhile the old WWTP's Gaza, Khan Younis and Rafah will be rehabilitated.

Table 3.2 the status and condition of wastewater treatment plants in Gaza Strip (PWA, 2011)

Governorate	**Population Capita**	**Connection to Sewage network (%)**	**Sewage Production (m^3/day)**	**Treatment availability**	**Final Destination**
Northern	290,000	80%	23,000	Available partially treatment	100% Infiltration basins
Gaza	550,000	90%	60,000	Available 80% Partially Treatment, 20% Raw	100% to sea)
Middle	220, 000	75%	10, 000	Not Available	100% to Wadi Gaza and indirectly to the Sea 10,000 Raw
Khan Younis	280, 000	40%	10,000	Available Partially Treatment	100% to sea
Rafah	185, 000	75%	10,000	Available Partially Treatment	100% to sea
TOTAL	1,525, 000		41mcm /y		33 mcm /y To sea

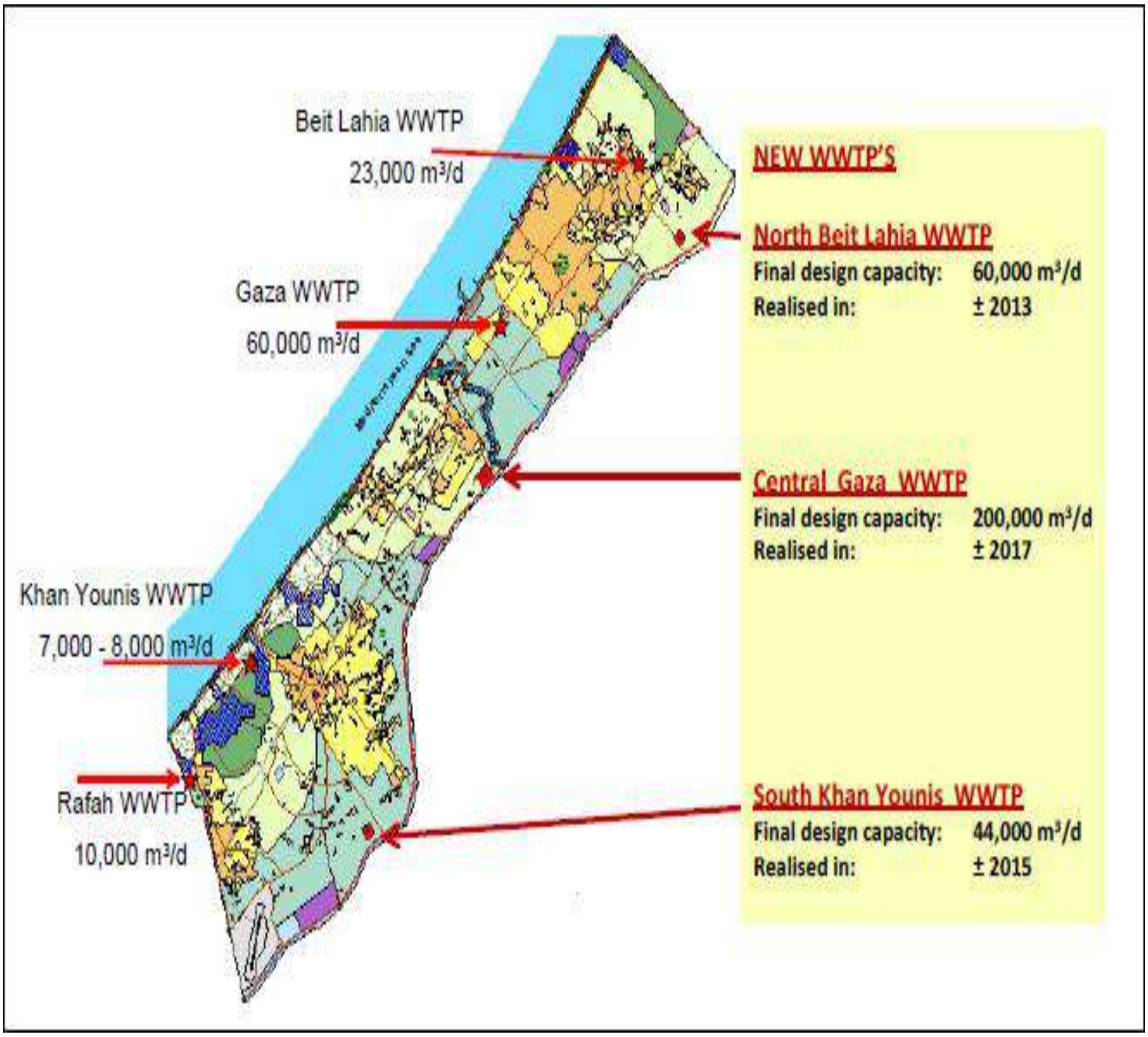

Figure 3.6 The current and future Treatment Plant in Gaza Strip (PWA,2012)

Table 3.3: Effluent wastewater quality in El Zitoon Pilot reuse project (Almadina, Enfra & DHV, 2011).

Parameter	Unit	Effluent Sheikh Ejleen	Outlet from sand filter
pH	-	7.8	7.43
E.C.	µS/cm	3970	3870
TDS	mg/l	2380	2320
TSS	mg/l	99	35
NO3	mg/l	1	<1
BOD5	mg/l	90	60
COD	mg/l	230	185
Fecal coliform	CFU/100ml	8×10^4	3×10^4

3.6 Water Supply Tariff in The Gaza Strip

There is no unified water supply tariff system in the Gaza strip. Although the socio economic conditions for the people along the GS is similar, there is many different water tariff applied as shown in table 3.4 (MAS, 2013).

Table 3.4: Water supply tariff in the Gaza strip (Jaber, 2006).

Municipality	**Fix fee**	**Consumption Category M³**					
		0-10	**11-20**	**21-30**	**31-40**	**41-50**	**>50**
Gaza	6	0.3	0.5	0.5	0.9	0.9	0.9
Rafah	20			1	1.5	1.5	2
KhanYounes	40					1.5	2
Beny Sohila	18		2	2	2.2	2.2	2.2
Big Abasan	18		2	2	2	2	2
Small Abasan	15		2	2	2	2	2
Khozaa	18		1.9	2	2.2	2.2	2.2
Qarara	25			1.2	1.2	1.2	1.2
Dier El Balah	15		1.7	1.7	1.7	1.7	1.7
Nusirat	16		1.8	1.9	2	2	2
Magazi	17		1.8	1.9	2	2	2
Buriej	17		1.8	1.9	2	2	2
Jabalia	40					0.8	0.8
Beit Lahia	30				0.8	0.8	0.8
Beit Hanon	30				0.8	0.8	0.8

4 CHAPTER 4: METHODOLOGY

There is a range of methods are currently used to establish prices for recycled water.

4.1 Pricing methods

According to Woolston & Jaffer (2005), a number of alternative approaches to pricing methodology of recycled water can be assessed

4.1.1 Willingness to pay

Under this approach, prices for recycled water are essentially set on the basis of "what the market will bear", rather than with reference to the cost of supply, other than the requirement to cover system incremental costs . In practice, discovering 'willingness to pay' is likely to be an iterative process. It is also likely that willingness to pay' will change over time in line with growing acceptance of recycled water, increases in the price and/or availability of potable water

4.1.2 Defined percentage of potable price

There are a number of variants of this approach.

1-Arbitrary percentage of potable price

One is to simply set the price for recycled water as some arbitrary percentage (eg 50%) of the current potable price, in recognition of the fact that users will generally require some discount for the usually lower quality and restrictions associated with recycled water. The problem with this approach is that it might result in prices outside the efficient price band. It is possible that the proportion will be set too high and it is also possible for the proportion to be set too low, encouraging excessive demand that does not cover its cost.

2- Subsidies and second best

A number of commentators have suggested that the use of recycled water has been impeded by the availability of subsidised potable and irrigation water alternatives. It is then argued that recycled water should also be subsidised in order that efficient choices between alternative sources of water are not distorted.

3-Risk of locking in inappropriately low prices

The alternative is to link the price of recycled water to the price of potable water, so that increases in the price of potable water automatically feed through into prices of recycled water. However, this may expose users to considerable risk given that the supply authority may have the ability to set its potable water price and/or future movements in price may become highly uncertain.

4.1.3 Full commercial return on project

This approach seeks a full economic return on the recycled water project in its own right (covering a commercial rate of return on all assets associated with the project, operating and maintenance cost etc) directly from recycled water users.

The ability to do so will depend heavily on the willingness of users to pay relative to the direct costs associated with the specific project. In practice, many recycled water projects have to date been unable to achieve this.

4.2 Research Methodology

This chapter mainly focus on the adopted pricing methodology that used in this research depending in both 'assessment of willingness to pay' and 'cost recovery analysis' to achieve the main research objectives by the following steps:

4.2.1 Literature review

Revision of accessible references as books, studies and researches relative to the topic of this research which may include: wastewater reuse, economics of reclaimed wastewater irrigation analytic , ..etc.

4.2.2 Data collection

Data gathering from relevant authorities such as Palestinian water authority, Coastal water utility, municipalities, Ministries and others about different parameters(land use , treatment process, crops types, irrigation system,) in Gaza strip.

4.3 The Questionnaire

The objectives from the questionnaire is to investigate the farmers knowledge of water recycling, their willingness to accept recycled water being incorporated in region's water management plans and to measure their affordability and the willingness to pay for treated wastewater

4.3.1 Questionnaire Design

The questionnaire are designed to support and verify the objectives in this research for investigating the socioeconomic situation in the Gaza Strip and its impact on treated wastewater and to measure the affordability and the willingness to pay for using treated wastewater in the agricultural purposes.

4.3.2 The Study Population

The population of this research involved the farmers in Al Zitoon area whom are benefit from the pilot reuse project in Gaza city.

4.3.3 Sample Size

The population is not high, so 35 questionnaires were sufficient and distributed to the farmers using the treated wastewater to irrigate their crops. The total number returned was 30 questionnaires and the overall response rate from the farmers was 85.6 %.

4.3.4 Research Location

The research was carried out in Gaza city where a pilot project in al zitoon area sereved about 35 farmers

4.3.5 Pilot Study

To examine the degree of understanding of the questionnaire from the respondents, five questionnaire was sent to the farmers. In general, the respondents agreed that the questionnaire is easily understood and some modification to the questionnaire was conducted to be clearer and the final questionnaire were prepared after taking the results of the pilot study into account and the questionnaire became ready to be distributed to the selected sample .

4.3.6 Questionnaire Contents

The questionnaire were designed to address the following information:

- General information about the age, sex, location and area cultivated.
- Social information about the farmer including education, agricultural experience, land ownership, size of family, number of family members working in agriculture and agricultural contribution in the income of the family.
- Irrigation quantities, cost, quality, irrigation methods, availability and pricing of agricultural water.
- Farmers concerns and knowledge about reuse of treated wastewater in agriculture including types of crops that could be planted,
- Existing agricultural practices by the farmer including types, areas, agricultural inputs, agricultural outputs and profitability of crops cultivated.
- Farmers concerns and willingness for reuse treated wastewater in agriculture and acceptable prices for treated wastewater .

4.4 Statistical Analysis

Quantitative statistical analysis for questionnaires were done using SPSS in order to draw the results

4.5 Cost Recovery Calculation

Different techniques were employed to collect the data necessary to achieve the objectives of this study. In addition to literature review, interviews, questionnaires , and cost recovery calculation.

To estimate the cost recovery of reuse the reclaimed wastewater in agricultural purposes, first we need to find a planed reuse project. The best example is the North Gaza Emergency project, where the treatment plant is the modern wastewater treatment plant in the Gaza strip with a high technology. The effluent of the plant quality is fit to aquifer recharge and unrestricted Reuse. Also there is a recently detailed design and tender documents of effluent recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment. From previous collecting data all capital and operation and maintenance costs incurred and associated with the withdrawal and transmission of water from its source to final delivery points will be considered. By using the present valve calculation method to compare the cost recovery between many proposed options in order to find the price of the cubic meter of using the reclaimed wastewater in the agricultural .

5 CHAPTER 5: RESULT AND DISCUSSION

5.1 Results of the Questionnaire

The results obtained from the field survey through the questionnaires filled by the farmers who benefited from a pilot reuse project in El Zitoon area in the Gaza city. The analysis was done by using Statistical Package for the Social Sciences (SPSS).

5.1.1 Socio-Economic Issues

The study sample consist of 30 farmers all of them are males, distributed between different age categories as indicated in table 5.1, where the largest percentage of respondents (40 %) lies in the age category (36-46 years).

Table 5.1: Distribution of farmers according to age group

Age of Respondent (years)	Frequency	Percent
25-35	6	20.0 %
36-46	12	40.0 %
47-57	7	23.3 %
58-68	2	6.7 %
69-79	3	10 %
Total	30	100%

Almost all of the respondent 93.3 % are married as indicated in figure 5.1

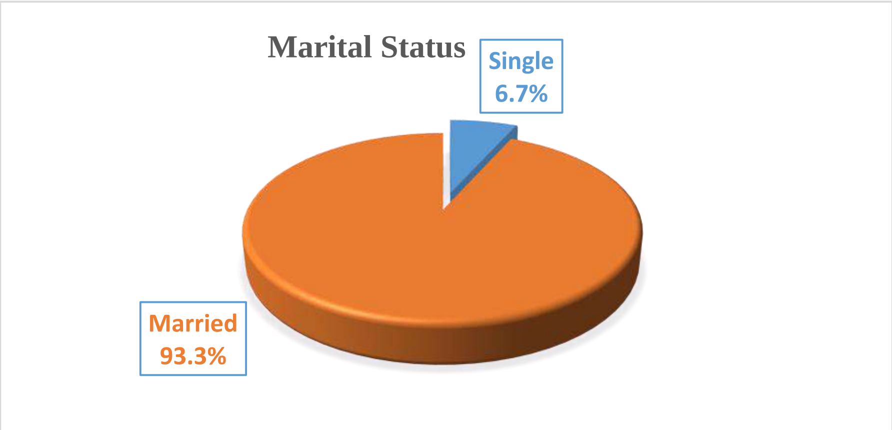

Figure 5.1: The marital Status of Respondent

The result shows that the farmers have different educational background, where 50.0% of the respondents were having Primary education, 20.0 % having secondary education , 23.3% having bachelor degree and 6.70 % are illiterate as indicated in figure 5.2

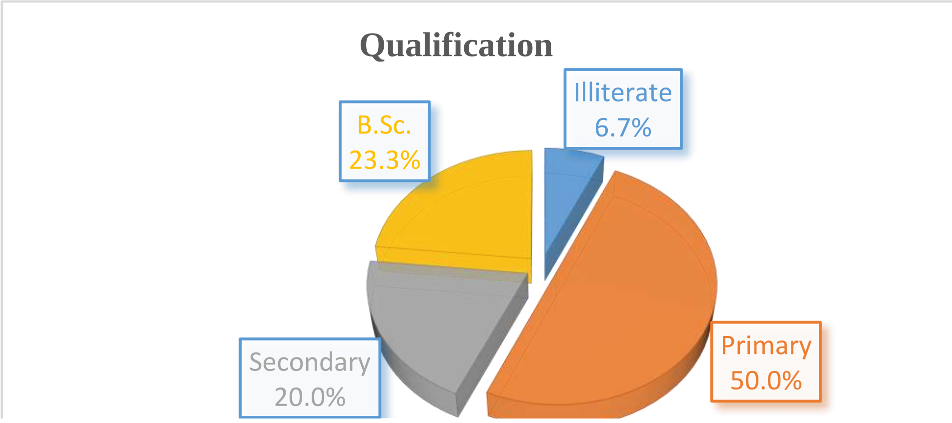

Figure 5.2: Category of Qualification

The result also show that the average family size was 7.5 persons and the average monthly farmers income was 500 NIS. 90.0% of the respondents reported that land they are cultivating in their own land, while 10 % of the respondents reported that land they are cultivating in renting land as indicated in figure 5.3. Also the result show that the average land area is 6.1 dunum per farmer with a total land area of 184 dunum.

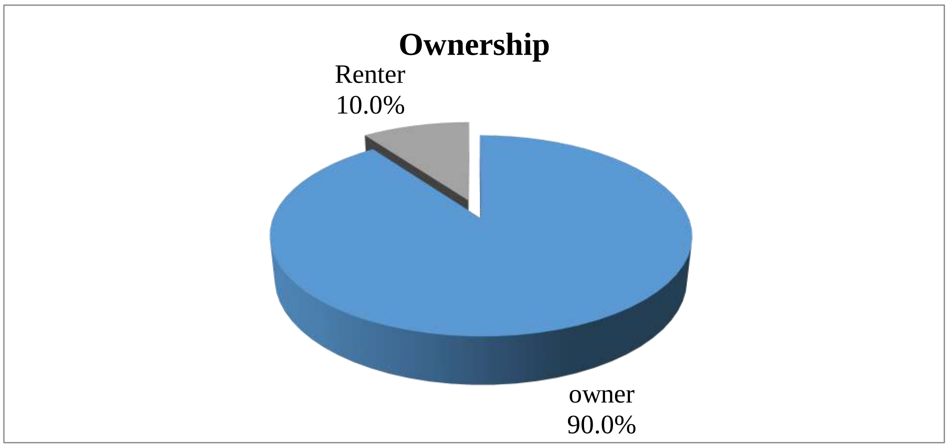

Figure 5.3: land Ownership

Figure 5.4 shows that the majority of the respondents 53.3% were purchasing the water from their neighbors before using the TWW and the others 46.7 % are owing private wells.

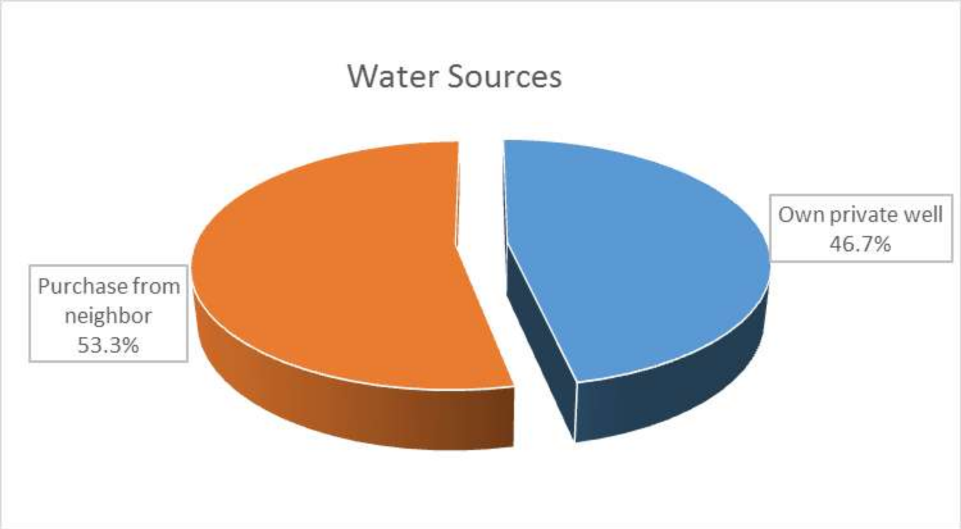

Figure 5.4: Irrigation water source before using TWW

All the respondent 100 % depending on the time method in measuring the quantity of purchased water used for irrigation. The purchased price per hour is 40 NIS where the pumping rate is about 50 m^3 per hour.

About 40.0 % of the respondent reported that the cost per cubic meter ranges from 0.80 to 1.0 NIS as shown in table 5.2. The cost of fresh water from agricultural wells depends on the method that getting the water from(owing private well or purchasing water) and the method that operating the wells by electricity or by diesel.

Table 5.2: The Price of agricultural water

Cost of Water (NIS)	Frequency	Percent
0.20 – 0.40	6	20.0 %
0.50 – 0.70	10	33.3 %
0.80 – 1.00	12	40.0 %
1.20	2	6.7 %
Total	30	100%

The majority of the respondent 60.0 % reported that the cost of the needed fertilize per dunum yearly is from 100 to 200 NIS, and about 33.3 % reported that the cost is about 220 to 300 NIS as indicated in table 5.3. The difference between them depend on the type of fertilize (organic as animal manure or chemical fertilize)

Table 5.3: The cost of needed fertilize per dunum yearly

Cost of fertilize (NIS)	Frequency	Percent
100 – 200	18	60.0 %
220 – 300	10	33.3 %
400 – 600	2	6.7 %
Total	30	100%

The result show that 50 % of the farmers are cultivating citrus and 43.3% of the farmers are cultivating olive. Drip irrigation is most frequently used 70 % while the flood irrigation is about 30 % .

5.1.2 Willingness to pay for of Reclaimed Wastewater Reuse

Almost all of the respondent 96.7 % know about the problems of the water in the Gaza Strip as indicated in table 5.4. The majority of them 50 % believe that the problem is related both quality and quantity of the water and 40 % believe that the problem is related to the quality of water.

Table 5.4: The knowledge about water problems in the Gaza Strip

Water problems knowledge	Frequency	Percent
Yes	29	96.7 %
No	1	3.3 %
Total	30	100%

Twenty percent of respondent pointed that the objective of treating wastewater is to save water for irrigation, 6.7 % is to avoid healthy risk, 3.3% is to protect the environment and 70.0% for all mentioned reasons.

Fifty percent of the respondent attributed the using of reclaimed wastewater in agricultural purposes for the low price of TWW, 30 % for the high price of water supply while 20 % for the shortage of water supply in the Gaza strip as indicated in table 5.5

Table 5.5: Concerns about Willingness to use Reclaimed wastewater

The cause of using TWW	Frequency	Percent
Shortage of water supply	6	20.0 %
High price of water supply	9	30.0 %
Low price of TWW	15	50.0 %
Total	30	100%

Almost all of the respondent 93.3 % are willing to pay for TWW to irrigate their crops as indicated in table 5.6.

Table 5.6: Willingness to pay for reclaimed wastewater

WTP	Frequency	Percent
Yes	28	93.3 %
No	2	6.7 %
Total	30	100%

The majority of the respondent 53.3 % mentioned that using treated wastewater in the agricultural purposes is very high saving the cost of fertilize and also 36.7 % of them mentioned that using treated wastewater in the agricultural purposes is high saving the cost of fertilize.

About three percent of farmers believe that harms from using treated wastewater for irrigation were healthy, also 3.3 % environmentally, 23.3 % pollute the soil but the majority 66.7 % believe that there isn’t any harm of using reclaimed wastewater.

The table 5.7 shows a high statistical significant difference between the farmers willingness to pay for TWW to irrigate the crops and both saving of fertilize and also for the bad effect due of using of treated wastewater (P value = 0.002 and 0.005 respectively).

Table 5.7: Willingness to pay versus fertilize saving & TWW impact

Variable		WTP		P- Value
		Yes %	No %	
Using of treated wastewater is saving the cost of fertilize	Very high	53.6	50	0.002 *
	High	39.3	0	
	Medium	7.1	0	
	Low	0	50	
	Very low	0	0	
Impact of using the treated wastewater in irrigation	Healthy	3.6	0	0.005 *
	Environmentally	0	50	
	Pollute ground water	3.6	0	
	Pollute the soil	25	0	
	None	67.9	50	

* Statistically Significant

However, the table 5.8 shows that there is no statistical significant difference between the farmers willingness to pay and the Age, Qualification and ownership of the land (P value= 0.759 , 0.66 and 0.626 respectively).

Table 5.8: Willingness to accept versus (Age , Qualification & Ownership of land)

Variable		WTP		P- Value
		Yes %	No %	
Age	25-35	17.9	50	0.759
	36-46	39.3	50	
	47-57	25	0	
	58-68	7.1	0	
	69-79	10.7	0	
Qualification	Illiterate	3.6	0	0.66
	Primary	0	50	
	Secondary	3.6	50	
	B.Sc.	25	0	
Ownership of land	Owner	89.3	100	0.626
	Renter	10.7	0	

The results also show that the majority of the respondent 67.7 % are willing to pay 0.20 NIS, while about 26.7 % of the respondent are willing to pay 0.10 NIS, Only 6.7 % of the respondent are willing to pay 0.30 NIS and none of them are willing to pay 0.50 NIS per a cubic meter for using treated wastewater for irrigation as indicated in table 5.9

Table 5.9: Max price the farmer willingness to pay for Reclaimed wastewater

Unit Price (NIS)	Frequency	Percent
0	1	3.3 %
0.10	7	26.7 %
0.20	20	67.7 %
0.30	2	6.7 %
0.50	0	0 %
Total	30	100%

All of the respondent 100 % are interesting in the quality of the reclaimed wastewater. Also all the respondent 100 % didn’t face any difficulty in marketing their product and finally all of them 100 % believe that sharing the farmer in decision making concern the reuse of reclaimed wastewater is very necessary.

5.2 COST RECOVERY ANALYSIS

5.2.1 Introduction

Project costs might include operation and maintenance of treatment and distribution facilities, annual debt service, and capital replacements and improvements. A financial analysis helps determine how much a reclaimed water project will cost and whether the entities involved will earn sufficient revenues from “paying customers” to cover their costs. The financial analysis alone does not account for all the values of the services that reclaimed water might provide. For example, a financial analysis focused on the wastewater utility would not typically reflect benefits to the region, such as the environmental and social costs avoided such as when using of reclaimed water it reduces effluent discharges to water bodies, recharges aquifers and providing for a more reliable water resource. A traditional analysis of reclaimed water projects starts from the assumption that the costs of all the components of the reclaimed water facilities from additional wastewater treatment through delivery to an end user should be attributed to the reclaimed water project as part of the project’s costs (King County, 2008).

5.2.2 North Gaza Emergency Sewage Treatment

The Palestinian Water Authority (PWA) is executing the Northern Gaza Emergency Sewage Treatment (NGEST). Because of financial constraints the NGWWTP project was be implemented through phases. Project initiated in 2004 and being implemented through World Bank, with co-financing from other donors has responded with a two-phase project.

5.2.2.1 Part A: North Gaza Emergency Sewage Treatment Project

In Part A of the project, nine infiltration basins with a total area of around 81 dunums of a total maximum infiltration capacity of 35,600 m3/day have been constructed around seven kilometers to the east of Gaza City, close to the eastern border. The effluent from Beit Lahia treatment plant is transferred through new terminal pumping station with maximum flow of 5,040 m3/h to the new basins via a pressure line of a ductile iron sewage pipe with 800 mm diameter and 8 kilometer length(EcoConServ & Universal Group, 2014).

The Investment Cost of part A is US$15.9 million and the operation and maintenance cost for the emergency phase is shown in table 5.10

Table 5.10: The O&M Cost breakdowns for the emergency phase (NGEST) (EMCC, 2006).

	Million US $/year
Sewage transfer and infiltration	2.08
Existing pumping station and sewer network	1.04
Total O&M Cost	3.12

5.2.2.2 Part B: North Gaza Wastewater Treatment Plant

Phase B of the project is to construct a new treatment plant near the infiltration basins with capacity of 35,600 m3 daily. The plant comprises of Primary treatment; Secondary treatment and Sludge treatment to bring the quality of the effluent to a standard that can be reused for Agriculture or for recharge of the aquifer. Part B is expected to be completed 2014 (EcoConServ & Universal Group, 2014).

The Investment Cost of part B is US$ 47.0 million and the operation and maintenance cost for the treatment plant is shown in table 5.11

Table 5.11: The O&M Cost breakdowns for the wastewater treatment (NGEST) (EMCC,2006)

	O&M Costs Thousand US$/year
Power	648
Power recovery	-381
Poly. electrolyte	123
Chlorine	9
Ferric Chloride	11
Transport	69
Labor	180
Maintenance	433
Total O&M cost	1091

5.2.2.3 Part C: The effluent recovery and reuse

Part C of the project is to recover and reuse the treated effluent after the new wastewater treatment is completed. The consultant has completed the design report and detailed engineering design of the reuse scheme which was based on the amount of recovered water about 35,600 m3/day This system is composed of a chain of 27 recovery wells surrounding the basins. The components of reuse scheme included two water storage reservoirs of a capacity 4000 m3 each, ten variable speed booster pumps with its associated facilities, and a distribution network for agricultural reuse. The recovered effluent is expected to irrigate around 15,000 dunums of adjacent agricultural land. The proposed agricultural area for reuse activities is divided into two zones (A and B) according to its location from NGWWTP. Zone A is the part located north of NGWWTP with about 10,100 dunum whereas, Zone B is located south of NGWWTP with about 5,000 dunum (EcoConServ & Universal Group, 2014).

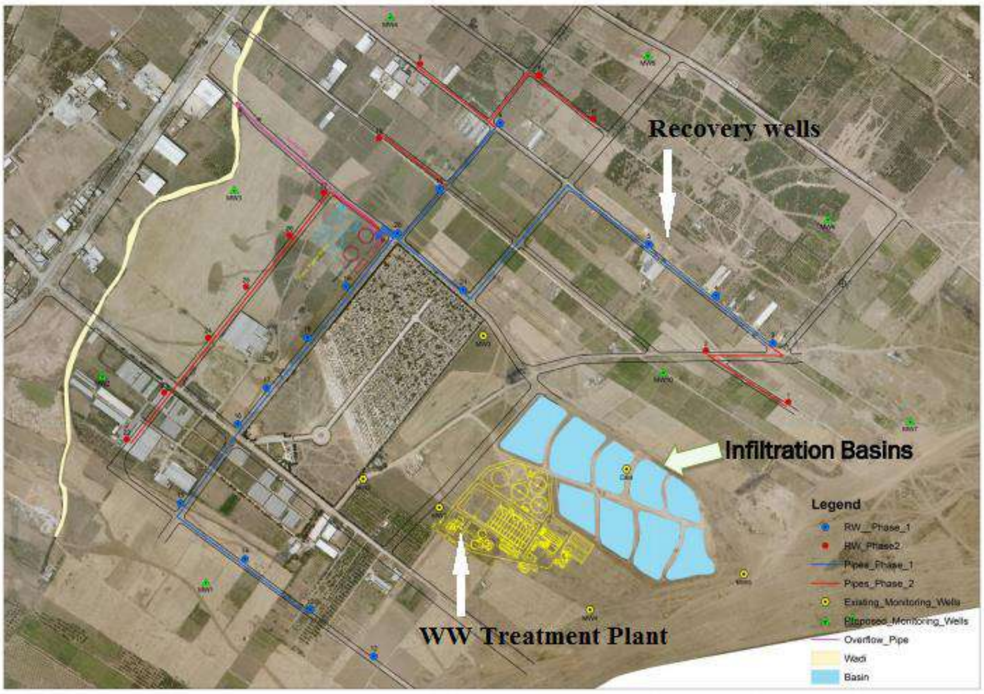

Figure:5.5Locations of the physical components for the recovery and reuse scheme (CEP & FCG , 2010).

The Investment Cost of part C consisting of recovery wells, collection pipes, observation wells and reuse water tanks, booster pumping station, irrigation water network and associated facilities as shown in table 5.12

Table 5.12 : Estimated Capital Cost for the reuse scheme (NGEST) (CEP & FCG , 2010)

	Capital Cost Million US$
Reservoir	0.90
Civil work	1
Pumps	2.5
Electrical	2.4
piping	9.1
Other equipment	3.5
Total capital cost	19.4

5.2.3 Present Value Calculations

Present value analysis is simply a method that can be used to compare alternatives that involve different cost components that are anticipated to occur at different times. All costs anticipated during the planning period will be converted to an equivalent present value in Year 0. The sum of all component present value for an alternative yields the total present value of that alternative . This type of analysis results in a comparison of all costs associated with each alternative stated in today's dollars; thus, removing the time impact of money.

5.2.3.1 Period of Analysis

According to DEP (1996), the planning period of analysis will be 20 years

5.2.3.2 Discount Rate

Interest rate varies depending on the kind of loan and the currency it is denominated in, but usually ranges between 7% - 9% on the dollar, 8% - 10% on the Dinar and 8.5% - 14.5% on the Shekel (The Palestinian Economic Policy Institute (Mas), 2008).

The interest rate used to reduce future sums of money in order to facilitate the comparison of alternatives in current dollars, the current discount rate to be used in the analysis will be 8% on dollar.

5.2.3.3 Calculation of Present Value

The present value (PV) is the discounted future value (either costs and benefits) at a fixed, predetermined discount rate. For a project, the PV is the sum of discounted future costs and benefits accruing throughout the life of the project. The formula used to calculate the present worth (Newnan et at., 2004).

For single payment, to find P given F, (P/F, i, n)

$$P = \frac{F}{(1+i)^n}$$

For Series Compound Amount, to find P given A, (P/A, i, n)

$$P = A * [\frac{(1+i)^n - 1}{i(1+i)^n}]$$

Where :

P = A present sum of money

A = Disbursement in a uniform series continuing for n periods

i = Interest rate

n = Number of interest periods

5.2.3.4 Salvage Values

Salvage Values are shown as a source of revenue at the end of the 20-year analysis period.

5.2.3.5 Depreciation method

The straight line method-of depreciation should be used in the present value' analysis. The useful lives' of certain equipment and facilities are provided as follows(DEP, 1996)

Storage ponds/reservoir	50 years
Transmission/Distribution pipes	50 years,
Steel and concrete structures	30 years
process equipment and pumps	15 years
Auxiliary equipment	10 years
land	permanent

5.2.4 Options of Cost Recovery

5.2.4.1 Option One

Recover only the Operation and Maintenance Cost of the reuse system (O&M in Part C)

The operation and maintenance cost is assumed to be 1.943 M$/year

The quantity of the recover water 35600 m^3/d

$$NPV\ (water\ deliver) = 35600 * 9.82 * 365 = 127.6\quad Mm3/year$$

The present value of O&M

$$P = 1.943 * [\frac{(1+0.08)^{20} - 1}{0.08(1+0.08)^{20}}]$$

$P_{O\&M\ part\ C}$ = 19.08 M$

One US dollar = 3.8 NIS at exchange date 1/1/2015

$$Cost\ per\ cubic\ meter = \frac{P\ of\ \ O\&M\ cost}{P\ (water\ deliver)} = \frac{19.08}{127.6} = 0.15\ \$ = \ 0.57\ NIS$$

As well as the cost of the scheme itself incremental administrative cost including billing , corporate overheads etc. also need to be added , assume the administrative cost about (15%) of the final cost.

The cost recovery of the reclaimed wastewater in this option is 0.70 NIS per m^3

5.2.4.2 Option Two

Recover the Capital cost, O&M Cost and depression of the equipment of the reuse system (all cost in Part C)

The cost of mechanical equipment 1.72 M$

The Cost for irrigation Network 11.40 M$

The total capital cost 19.43M$

1- Initial capital cost which already at present value

$P_{\text{capital cost}}$ = 19.43 M$

2- Replacement of capital cost of pumping equipment (in year 15)

The present value calculate

$$\boldsymbol{P = F * [\frac{1}{(1+i)^n}]}$$

Where F is a future sum of money

$$P = 1.72 * [\frac{1}{(1+0.08)^{20}}]$$

$P_{\text{pump replacement}}$ = 0.369 M$

1- Salvage value (SV) of initial pumping equipment (in year 20)

Where it is install at year 0 with a useful life = 15 years

SV = 0

2- Salvage value (SV) for the replacement of pumping equipment (in year 20)

$$SV = 1.72\ M\$ * \frac{15\ years}{20\ years} = 1.29M\ \$$$

The present value

$$P = 1.29 * [\frac{1}{(1+0.08)^{20}}]$$

$P_{\text{pump salvage}}$ = 0.277 M$

1- Salvage value (SV) for the pipes (in year 20)

$$SV = 11.40\ M\$ * \frac{20\ years}{50\ years} = 4.56\ M\ \$$$

$$P = 4.56 * [\frac{1}{(1+0.08)^{20}}]$$

$P_{\text{pipe salvage}}$ = 0.978 M$

The total present value of the option

$P_{\text{(all cost part C)}} = P_{\text{capital}} + P_{\text{replacement}} - P_{\text{salvage}} + P_{\text{O\&M cost}}$

= 19.43 + 0.369 -0.277 – 0.978 + 19.08 = 37.62 M$

$$Cost\ per\ cubic\ meter = \frac{Total\ P}{P\ (water\ deliver)} = \frac{37.62}{127.6} = 0.295\ \$ = \ 1.12\ NIS$$

Add administration fees 15%

The cost recovery of the reclaimed wastewater in this option is 1.3 NIS per m^3

5.2.4.3 Option Three

Recover the O&M Cost, and depression of the equipment of the reuse system plus O&M of infiltration system

O&M cost for sewage transfer and infiltration is about 2.08 M$/year

$$P = 2.08 * [\frac{(1+0.08)^{20} - 1}{0.08(1+0.08)^{20}}]$$

$P_{\text{O\&M part A}}$ = 20.42 M$

$P = P_{O\&M\ part\ C} + P_{O\&M\ part\ A}$

P = 19.08 + 20.42 = 39.50 M$

$$Cost\ per\ cubic\ meter = \frac{P}{P\ (water\ deliver)} = \frac{39.50}{127.6} = 0.31\ \$ = \ 1.18\ NIS$$

Add administration fees 15%

The cost recovery of the reclaimed wastewater in this option is 1.4 NIS per m^3

5.2.4.4 Option Four

Recover the O&M Cost, and depression of the equipment of the reuse system , O&M of infiltration system and O&M of the treatment plant.

O&M cost for wastewater treatment plant 1.09 M$/year

$$P = 1.09 * [\frac{(1+0.08)^{20}-1}{0.08(1+0.08)^{20}}]$$

$P_{O\&M\ part\ B}$ = 10.70 M$

$P = P_{O\&M\ part\ C} + P_{O\&M\ part\ A} + P_{O\&M\ part\ B}$

P = 19.08 + 20.42 + 10.70 = 50.20 M$

$$Cost\ per\ cubic\ meter = \frac{P}{P\ (water\ deliver)} = \frac{50.2}{127.6} = 0.39\ \$ = \ 1.50\ NIS$$

Add administration fees 15%

The cost recovery of the reclaimed wastewater in this option is 1.7 NIS per m^3

5.2.4.5 Option Five

Recover all the cost of the reuse system part C, also the O&M and the capital cost of the infiltration basin and treatment plant.

P capital part A + P capital part B = 15.9 + 47 = 62.9 M$

P (all cost part C) = 36.6 M$

P O&M part A + P O&M part B = 20.42 + 10.7 = 31.1 M$

P Total = 62.9 + 36.6 + 31.1 = 130.6 M$

$$Cost\ per\ cubic\ meter = \frac{P}{P\ (water\ deliver)} = \frac{130.6}{127.6} = 1.02\ \$ = \ 3.89\ NIS$$

Add administration fees 15%

The cost recovery of the reclaimed wastewater in this option is 4.5 NIS per m^3

5.2.4.6 Comparison between the options

The comparison between the options as shown in table 5.13

Table 5.13: The cost recovery for the five options

No.	Option No.	Cost Recovery items	Cost NIS/ m^3
1	Option 1	$P_{O\&M\ part\ C}$	0.70
2	Option 2	$P_{(all\ cost\ part\ C)} = P_{capital} + P_{replacement} - P_{salvage} + P_{O\&M\ cost}$	1.30
3	Option 3	$P = P_{O\&M\ part\ C} + P_{O\&M\ part\ A}$	1.40
4	Option 4	$P = P_{O\&M\ part\ C} + P_{O\&M\ part\ A} + P_{O\&M\ part\ B}$	1.70
5	Option 5	$P = P_{(all\ cost\ part\ C)} + P_{O\&M\ part\ A} + P_{Capital\ part\ A} + P_{Capital\ part\ B} + P_{O\&M\ part\ B}$	4.50

5.3 Discussion

The reuse of reclaimed water is essential to meet the water demands of the agricultural sector due to the water scarcity in the Gaza Strip. It is not feasible to manage any reuse project without a certain tariff system due to the high investment, operation and maintenance costs. To date there is no any pricing for the reclaimed wastewater in the Gaza Strip. The adopted pricing methodology that used in this research depending in both ‘assessment of farmers willingness to pay and cost recovery analysis to achieve the research aim by settings a proposed tariff for the reuse of treated wastewater in agriculture.

Through the pricing principles shown in the literature review, we setting the tariff of wastewater reuse as follow:

Principle 1: Flexible regulation

Successful wastewater reuse in agriculture can never be achieved without establish laws and flexible regulations to encourage the reuse of treated wastewater. The reuse of treated wastewater in Gaza strip is still relatively new and there is a Lack of unified planning laws and regulations concerning the wastewater reuse in Palestine ,in order for wastewater reuse to become an established resources a firm national water reuse regulations is needed. The key Palestinian regulation documents regarding wastewater treatment and reuse are the Palestinian water law No.3 of year 2002; the agreement with Israel particularly the MOU of Dec.2003; and the Palestinian Environmental law No.7 of year 1999 and recently the Palestinian water law No.14 of year 2014

There is a presence of interference in the powers and responsibilities among the competent authorities and the lack of a national strategy for the management of the sector so policies towards the reuse of waste water should be developed by governments and regulators and to built a legal organization of qualified personnel to be responsible of managing, operating and maintaining, all functions related to deliver the service in order to assure sustainability of the agricultural reuse water system

Principle 2: Cost allocation

It is appropriate for at least some of the costs of the reuse wastewater schemes to be recovered from parties as the community other than the farmers who's the direct users of the service where the wastewater reuse generate broader community benefits, such as environmental improvements, and improved visual amenity. It is assumed that agriculture will bear only the operations, maintenance, system management and depreciation of the reuse system and the municipal to bear the cost of wastewater treatment.

Although the result show that almost all of the respondent 93.3 % are willing to use and pay for reclaimed wastewater because they believe it will save money, and reduce the problem of water scarcity in the Gaza strip, they are not willing to pay much for the cubic meter as the majority of them 67.7 % are willing to pay only 0.20 NIS , 27.7 % are willing to pay 0.10 NIS, 6.7 % are willing to a pay 0.30 NIS and none of them are willing to pay 0.50 NIS. The average of willing to pay is about 0.20 NIS which lower than the lowest tariff concerning the first option. which reflect in general the farmers opinions of a high willingness to pay for treated wastewater if the unit price (tariff) is low. Such tariff can't recover the minimum cost of operation and maintenance of the reuse system.

It's important to mention that the farmers willingness to pay' is not necessarily a fixed with the time. The more benefits that get from switching to use reclaimed wastewater, it can often significantly increase the farmers willingness to pay.

The alternatives sources to recover the cost are from the municipal, the farmers, the government and the donors. Financing of investment in the Palestinian territories is typically by donors so the capital cost are rarely recovered so the options that include the capital cost of any assets of the treatment and reuse component is not visible because all the capital costs are covered through external donation.

There is no uniform tariff of potable water in the Gaza Strip where the tariff in the middle and south Governorate is about 2 NIS per the cubic meter while the tariff in the Gaza and northern governorate is about 0.80 NIS. The prices to users should reflect the fact that treating and reusing wastewater is an increasingly valuable water resource. The previous tariff is not reflecting the cost recovery for the treatment process which only recover the pumping and distribution of the municipal water. According to my study an additional 1.0 NIS per cubic meter have to be added to the municipal water price in order to recover the treatment process as mention in option 4 that will increase the gab between the potable water price and the proposed price for reclaimed wastewater

Principle 3: Water usage charge

The proposed tariff depends on recovering the costs through volumetric usage charges that the farmers are charged for each cubic meter of treated wastewater they consume. volumetric rates for recycled water is adapted to avoid perverse incentives (eg using the recycled water for inappropriate purposes. There are three type of the volumetric tariff, the first is the increasing block tariff , whereby per cubic meter charge increases in steps as additional water is consumed. that will not encourage of using more treated wastewater. The second type is the decreasing block tariff which mean the more quantities consume the price will be decrease which will encourage the more using of treated wastewater but the problem of this type is not equal between the farmers of having different areas that means the richer farmers who own the larger areas will consume the more quantities and the final result get the lower prices than the poorer farmers owing small areas.

The third type is the linear tariff that means the price is constant a long the quantity of the treated wastewater consume, this type is adopted in our study which consider more fair among the farmers for it's equity because there is a different in owner ship areas. From the survey study the range of the owner ship areas is from one dunum to 17 dunums and also there is a different types of cultivated crops which consume a different quantity of water.

Principle 4: Substitutes

Until now the ground water for irrigation is available with low cost alternative which consider the substitute for using treated wastewater. Since recycled water is typically of a lower quality than potable water so to make irrigation with reclaimed wastewater most economically attractive it must to be provided it to the farmers at lower price comparing with freshwater. Increasing in potable water prices as part of policies aimed to conserving water could be expected to increase willingness to pay for the reuse of the treated wastewater.

Principle 5: Differential pricing

Billing should account according to the quality of the treated wastewater, to reflect its true agricultural value. So the price for unrestricted irrigation is not equal to the price of restricted irrigation.

Principle 6: Integrated water resource planning

The Palestinian wastewater management strategy now is to eliminate raw wastewater discharge to the environmental to protect the environment and the quality of ground water resource through implementing treatment plants and to reuse wastewater for irrigation purposes where it possible and for aquifer to increase water for irrigation purpose especially in the Gaza strip which suffer from water deficit.

Principle 7: Cost recovery

The reuse projects need a high investment for capital, operation and maintenance costs. Table 6.10 show the summary result for the calculation of the five options for the cost recovery, the first option recover only the operation and maintenance of the reuse of reclaimed wastewater scheme, while the second option consider all the cost concerning the reuse scheme. The third option will recover the operation and maintenance of the reuse scheme in additional to the operation and maintenance cost of both the infiltration basin and pumping wastewater from BLWWTP to NGEST. The forth option will recover only the operation and maintenance of all the component or in other words the option three plus the operation and maintenance of the treatment plant itself. The last option will recover the whole system by considering the capital cost. The tariff price according to the five option is range from 0.70 NIS to 4.70 NIS where the lowest tariff concerning the first option of 0.70 NIS. If we exclude the capital cost recovery as it cover from external donation, the cost needed to recover is range from 0.70 to 1.70 according to the options 1,3 and 4. The farmers have to bear the 0.70 NIS as it consider belongs the additional treatment and the reuse system while the whole community will bear 1 NIS according to the polluter pay principle

Principle 8: Transparency

In setting the tariff of wastewater reuse, a consensus needs to be reached among all the stakeholders concern. Pricing arrangements for wastewater reuse services should be transparent , simple and easy for farmers to understand. Farmers will be more supportive if they feel that the water pricing is fair and according to the benefits they can be reap from switching to irrigation using the treated wastewater. The methodology of the research depends mainly in assessment the socio economic and willingness to pay from the farmers.

Principle 9: Gradual approach

At first step to get farmers to accept to switch from fresh water to reclaimed water , the price of reclaimed water needed to be provided at lower price where the farmers need to realize the value they can benefit from. and prices after will adjusted . step by step approach is recommended to put water reuse agenda forward.

By evaluation El Zaiton pilot reuse project recently, the consultant proposed tariff is approximately 1 NIS/m3. Although the PWA articulates the tariff at the pilot stage to be about 0.5 NIS/m3, the actual collected price from the farmers in the pilot project per cubic meter is only 0.20 NIS because the farmers refuse to pay more than this price. So the low price of the reuse of wastewater will encourages acceptability of this innovation, and reducing wastewater discharges into the environment.

From the literature reviews, the prices of the treated wastewater for irrigation in Jordan, Morocco , Tunisia, France and Spain is from 0.02 to 0.08 €/m3 and in Israel, the price of TWW for irrigation is between €0.151 and €0.205 per cubic meter.

A balance tariff must be achieved so at the first stage of implementation the reuse system, a governmental subsides is very important in order to encourage the farmers to switch using reclaimed wastewater instead of fresh water and to achieve reuse goals. In this stage I suggest to start the tariff at 0.40 NIS, then few years the farmers absolutely will convince and get good revenue from using TWW because farmers' income in general grows with using TWW by saving in both difference in the price of water and saving in fertilize and increasing in the productivity then gradually to increase the tariff with removing the governmental subsides gradually.

6 CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The reuse of reclaimed wastewater is a major priority to meet the increase water demands of the agricultural sector due to water scarcity in Gaza Strip so design and implement effective tariff is very important to sustain any reuse project.

According to the results obtained from this study, the researcher found that almost all of the respondent are willing to use and pay for reclaimed wastewater in the agricultural purposes. Although of very high acceptance of using the TWW, the maximum price that the farmers willing to pay is 0.20 NIS which is consider very low compared with the cost recovery needed only for operation and maintenance of the reuse system which about 0.70 NIS.

The reuse has a positive effects on the whole society as they benefit from the improved environmental , public health conditions and conserve the ground water resource for the domestic purposes . To encourage the farmers acceptance to switch from using fresh water to reclaimed wastewater, the price have to be accepted by the farmers. The researcher recommend beginning the reuse of reclaimed tariff at a price of 0.40 NIS where the farmers need to realize the value they can benefit and at the first stage of implementation the reuse system, a governmental subsides is very important because there is a deficit the actual cost recovery and price that will paid by the farmers and then gradually to increase the tariff with removing the governmental subsides gradually.

The municipal water price will be also increase by additional 1 NIS to recover the operation and maintenance of the wastewater treatment system according to the polluter pay principle.

6.2 Recommendation

Based on the achieved results of the study, the following points can be recommended in order to produce a suitable reuse pricing system of treated wastewater in the Gaza Strip

1. Built a legal organization of qualified personnel to be responsible of managing, operating and maintaining, all functions related to deliver the wastewater reuse service in order to assure sustainability of the agricultural reuse water system.
2. It's also recommended to increase the gap between freshwater and reclaimed wastewater tariffs by increasing the tariff of fresh water in order to make irrigation with reclaimed wastewater most economically attractive.
3. To start with low tariff could be necessary to encourage the farmers acceptance to switch from using fresh water to reclaimed wastewater.
4. Governmental subside is necessary at the early stage of reusing the reclaimed wastewater in irrigation and prices after will adjusted gradually to increase the tariff with removing the governmental subsides gradually.
5. A gradual tariff is recommend in order to let the farmers get accustomed to the new water tariff situation.
6. The tariff structure must be reviewed and adjusted frequently.
7. Conducting training and public awareness programs to inform the farmers dealing with using treated wastewater and how they could protect themselves from hazards.

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ANNEXES

ANNEX 1: PALESTINAN REUSE STANDARD AND REGULATION

The following are a summary of the Palestinian Legal framework includes the laws, regulations and guidelines related to reuse of wastewater.

1-Palestinian Environmental law 7, 1999

The Environmental Law of Palestine (PEL) includes a framework for environmental protection including reused treated water. The following are some of the important articles.

Chapter 1 (Article 5): To ensure the right of every individual to live in a sound and clean environment and stress on resource conservation and sustainable development including the protection of water resources, soil quality.

Chapter 3 (Articles 29): It is the responsibility of EQA to address the standards of water collection, treatment and disposing in environmentally sound way that preserve the environment

Chapter 3 (Article 30):To prohibit the discharge of any solid or liquid or other substance unless conforming to the regulations.

2-Palestinian Water Law 3/2002

This law comprises of all regulations that govern water in the Palestinian territory and Gaza Strip. The following are some of the important articles

Chapter 2 (Article 6) According to this law an organization should be established under the auspices of the Palestinian Authority in order to be responsible for water sector and should be named as Water Authority.

Chapter 2 (Article 7) discusses the responsibility of water authority which assume full responsibility for the management of water resources and sanitation in Palestine and the preparation of draft laws, regulations and instructions relating to water resources, implementation and provision of technical opinion in disputes concerning the sources of water.

Chapter 5 (Article 18-20) discussed the licenses and tariff mechanisms

Chapter 7 (Articles 25-27) that discusses the water utilities roles and responsibilities

3-Palestinian Water Law 14/2014

This law aims to develop and manage the Water Resources in Palestine, to increase their capacity, to improve their quality, to preserve and protect them from pollution

Chapter 1 (Article 3) All Water Resources in Palestine shall be considered public property, and the authority has the power to manage these resources

Chapter 7 (Article 37) a National Water Company shall be established and shall be fully owned by the State of Palestine. Its responsibilities is to extraction of water from Water Resources, desalination of water then supply and sale of bulk water to water undertakings, local authorities

4-Guidelines for Wastewater Reuse in the Gaza Strip, Palestine

This guideline is for reuse of treated wastewater from housing, municipality, industry and commercial enterprises in the Gaza Strip and to provide information for collection, additional treatment, and storage of treated effluent in such manner that the use of groundwater can be replaced, the aquifer can be enriched and the inflow of saline water into coastal aquifer can be reduced. (Article 1 and2).

Chapter I Article 6: Principles of the Water Reuse

- *Economic and financial principles*

Water is not a usual commercial product but a scarce natural resource which must be protected, defended and treated correspondingly and must be provided as a basic need by supplying safe water to all consumers. One of the important components for wastewater reuse is wastewater tariff charge and the incentives must be given to promote the widespread reuse. In addition, demand and supply management for treated wastewater has to be considered.

- *Environmental Principles*

Activities related to the reuse of wastewater need to be planned and implemented with due regard for all their environmental implications, including the protection of aquifer from pollution and over exploitation. In addition, the short- and long-term effects of the reuse of wastewater should be monitored so that the improvements can be encouraged and detrimental impacts minimized.

- *Institutional and management principles*

The role of the responsible authorities and all official bodies at all levels should be clearly defined and the areas of responsibility officially established. The structure and system of the wastewater reuse management should be designed in such a way as to facilitate the involvement by the responsible authorities at different levels with encouragement of private sector involvement. In addition, capacity building for all institutions for treated wastewater reuse has to be envisaged and intermediary bodies such as association, NGP and local councils has to be enhanced.

• Chapter II: Article 7: Technical Principles

- General Technical Principles

All wastewater shall be collected, treated and used according to these guidelines to minimize the deficit in the water balance. The treated wastewater reuse should comply with the standards and has to be transported in accordance to the guidelines (closed pipes). Dilution of the wastewater to reach the compliance standard and direct injection to the aquifer without treatment is forbidden. In addition, wastewater treatment operator shall provide information and test results of quality of wastewater or any other information as requested.

- Technical Principles for Irrigation and Recharge

Industrial and commercial wastewater is allowed to be used for irrigation and groundwater enrichment, only if the compliance with the standards is durably

guaranteed during operation. The use of wastewater for irrigation and ground water enrichment is forbidden in drinking water protection zones. The ground water enrichment by wastewater is only allowed in facilities that are operated with a license from the competent authorities.
The reuse of wastewater for irrigation is only allowed if it follows the regulations and standards according to the relevant type of cultivation and irrigation technique. The use of sprinklers is not allowed for irrigation.

All kinds of vegetables are not allowed to be irrigated by treated wastewater. Irrigation with treated wastewater has to be stopped two weeks before harvest. Fruits on the ground from trees that have been irrigated with treated wastewater are forbidden to eat, to process or to sell.

- Chapter III: Competent Authorities and Responsible Areas

Application and approval for wastewater reuse process is following EA administrative procedure as describes in the Palestinian Environmental Assessment Policy. Licenses and permission is prepared by PWA with coordination with MoA (Article 9).
Regarding wastewater reuse, PWA is responsible for technical, financial and operational issues, including compliances (chemical, microbial, samples, groundwater measures, and wells). MEnA is responsible for environmental issues supervision. MoH is responsible for the public health supervision in regards to the consumption of food products that are irrigated by wastewater reuse and employees working on the reuse system. (Article 10)
Monitoring of groundwater, wastewater quality, soil quality of product and human health is required to ensure proper treatment, avoiding environmental degradation, minimizing adverse health impacts and increasing the agriculture production in a sustainable manner. The monitoring of facilities and operation includes self-monitoring, compliance with regulations of facilities and operations and required control facilities and documentations. In addition, sampling analysis and conservation shall follow Annex 1 of this guideline (Article 11, 12 and 13)

Article 8: Competent Authorities and Responsibility Areas

**** National Water Council (NWC)***

NWC is responsible for:

a. Setting the policy for reuse of wastewater for Palestine and submitting it to the Council of the Palestinian National Authority for approval.

b. Reinforcing regional and international co-operation in reuse of treated wastewater.

c. Determining the budget required for investment in reuse of wastewater.

**** Palestinian Water Authority (PWA)***

PWA is responsible for:

The strategic planning for the reuse of treated wastewater, e.g., for setting up the water management plan .

a. Issuing licenses related to the operation of facilities for the groundwater recharge

b. Giving permission for the use of ground water and irrigation with treated wastewater.

c. Monitoring the quality and quantity of treated wastewater.

d. For the reuse of treated wastewater PWA is working in close cooperation with other stakeholders mainly the Ministry of Environmental Affairs, the Ministry of Health and the Ministry of Agriculture.

e. Instruct the Coastal Municipal Water Utility with special design tasks.

5-Technical Specification (TS) 34 / 2012

This Technical specification divide the quality of treated wastewater into 4 categories, high quality (A), Good quality (B), Moderate quality (C) and Poor quality (D). In addition, this specification regulate that the effluent quality of the treated wastewater for irrigation has to be approved by the Ministry of Irrigation and Ministry of Agriculture to use of the treated wastewater for irrigation in accordance to their standards and specification.

ANNEX 2: QUESTIONNAIRE (ARABIC FORM)

استبيان المزارعين

1- عمر المزارع : ( ) سنة

2- الجنس :

1- ذكر 2- انثي

3- الحالة الاجتماعية:

1-اعزب 2- متزوج

3- ارمل

4- الحالة التعليمية:

1- امي 2-اساسي

3- ثانوي 4- جامعي

5- عدد افراد الاسرة : (فرد)

6- عدد الاشخاص العاملين في المزرعة من العائلة: (فرد)

7- عدد الاشخاص العاملين في المزرعة من خارج العائلة: (فرد)

8-متوسط الدخل الشهري: (شيكل)

9-ملكية الارض :

1- مالك 2- مستاجر 3- غير ذلك (يرجى التحديد)....................

10-مساحة الارض المزروعة (دونم)

11-ما هي نوع المزروعات:

1- حمضيات 2- زيتون 3- لوزيات

4- اعلاف 5- غير ذلك(يرجى التحديد)...

12-مصدر المياه قبل استخدام المياه المعالجة:

1- بئر جوفي خاص 2- شراء من الجيران

3- من شبكة البلدية 4-مصادر اخرى (يرجى التحديد)..............................

13-في حالة امتلاك البئر الجوفي، ما هي التكلفة الشهرية للتشغيل والصيانة : (شيكل)

14-في حال شراء الماء ما هي طريقة قياس كمية المياه للري :

1- عداد مياه 2- قياس زمني

3- تقديرية حسب مساحة الارض 4-طرق اخرى (يرجى التحديد)..............................

15-تكلفة كوب المياه المستخدم لاغراض الري (شيكل)

16-متوسط كمية المياه الشهرية المستخدمة لاغراض الري في مزرعتك (م^3 لكل دونم)

17-ما هي طريقة الري المستخدمة في مزرعتك

1-التنقيط 2- رشاش

3- الغمر 4- طرق اخرى (يرجى التحديد)..............................

18-انواع السماد المستخدم :

1- فوسفات 2- امونتيا 3- سماد بلدي

19-متوسط تكلفة استخدام السماد سنويا (شيكل/ دونم)

20-هل تعرف عن مشكلة المياه في قطاع غزة :

1- نعم 2- لا

21-تعتبر مشكلة المياه في القطاع :

1- نقص في الكميات 2- جودة المياه 3- كل ما ذكر

22-ما الهدف من معالجة المياه العادمة :

1- الحفاظ على البيئة 2- تجنب مخاطر صحية

3-توفير مياه للري 4-كل ما ذكر

23-هل لديك الاستعداد للدفع مقابل استخدام المياه العادمة المعالجة في الزراعة :

1- نعم 2- لا

24-ما الذي يدفعك لاستخدام المياه المعالجة:

1-نقص كميات المياه وعدم توفرها 2- ارتفاع اسعار المياه 3-رخص ثمنها

25-استخدام المياه المعالجة يوفر السماد بصورة :

1- كبيرة جدا 2- كبيرة 3- متوسطة

4-قليلة 5- قليلة جدا

26-من وجهة نظرك ما هي الاضرار نتيجة استخدام المياه المعالجة في الزراعة

1-صحية 2- بيئية 3- تلويث الخزان الجوفي

4-تلويث التربة 5-لا توجد اضرار 6- كل ما ذكر

27-تعتقد ان السعر المناسب لكوب مياه الصرف المعالجة:

1- صفر 2 -10 اغورة 3- 20 اغورة

4- 30 اغورة 5- 50 اغورة

28-استخدام المياه المعالجة يشكل خطورة بصورة:

1-قليلة جدا 2-قليلة 3- متوسطة

4-كبيرة 5-كبيرة جدا

29-ماذا تفعل بالمحصول الزراعي:

1- يباع في الاسواق 2- استهلاك ذاتي 3-يباع لاغراض الصناعة

30-انتاجية المحاصيل المروية بالمياه المعالجة مقارنة بالمياه العادية

1-اقل بكثير 2- اقل 3- نفس الشئ

4- اكثر 5- اكثر بكثير

31-هل تجد صعوبة في تسويق المنتجات :

1-نعم 2- لا

32-هل انت معني بجودة المياه اللازمة للري

1-نعم 2- لا

33-كيف تعتبر اشراك المزارع في اتخاذ القرار

1-ضروري 2- غير ضروري

اى ملاحظات اخري ترغب قي كتابتها

ANNEX 3: CAPITAL COST BREAKDOWN FOR THE REUSE SCHEME

Cost Prediction for the Effluent Recovery and Irrigation Scheme of NGEST (CEP,2010)

Item No	Description	Total Rate ($)
1	**Circular Tank 4000 m^3 (2 Tanks)**	
	Civil Works (Concrete, Isolation, Water Stop etc)	900,000
	Mechanical & Piping	20,000
	Total Cost for Circular tank	**920,000**
2	**Mechanical Room**	
1	**Civil Works (440 m^2)**	**200,000**
2	**Mechanical Works (Pumps, Fittings, Crain, piping, .. etc)**	
2.1	Booster Pumps (n=10)	600,000
2.2	Fittings (for 10 pumps)	40,000
2.3	Crain Girder	50,000
2.4	Piping works	7,000
	Total for Mechanical Works	697,000
	Total Cost for Mechanical Room	**897,000**
3	**Electrical Building**	
1	**Civil Works (580 m^2)**	**200,000**
2	**Electrical Works**	
2.1	transformer station #1	70,000
2.2	transformer station #2	70,000
2.3	transformer station #3	80,000
2.4	MDB1	50,000
2.5	MDB2	50,000
2.6	MDB3	60,000
2.7	MCC	180,000
2.8	Cables	50,000
2.9	Miscellaneous	15000
	Total for Electrical Works	**625,000**
	Total Cost for Electrical Building	**825,000**
4	**Guard Room**	
	Civil Works (12 m^2)	5,000
	Total Cost for Guard Room	**5,000**
5	**Booster Site**	
1	**Civil Works** (Interlocking, Boundary Wall, Gates, Curb stones, Chamber, Supports, etc.)	**300,000**
2	**Mechanical & Piping System**	
2.1	Piping System & Flow meter Set	130,000
2.2	Fuel Tanks	40,000

2.3	Surge Tanks	20,000
	Total for Mechanical & Piping System	**190,000**
3	**Electrical Works**	
3.1	GENERATOR SET #1	250,000
3.2	GENERATOR SET #2	250,000
3.3	GENERATOR SET #3	250,000
3.4	Cables	100,000
3.5	Miscellaneous	15000
	Total for Electrical Works	**865,000**
	Total Cost for Booster Site	**1,355,000**
6	**Irrigation Network (around 103 KM)**	
1	**Piping Network (UPVC + Ductile Iron)**	
	DI 900	70,435
	DI 800	188,738
	DI 700	805,362
	DI 600	2,127,515
	UPVC 500	1,627,106
	UPVC 450	890,079
	UPVC 400	656,282
	UPVC 355	510,893
	UPVC 315	319,729
	UPVC 280	430,638
	UPVC 225	394,749
	UPVC 160	181,967
	UPVC 140	37,612
	UPVC 110	49,556
	UPVC 90	65,191
	UPVC 75	17,322
2	**Fittings (Tee, Gates, Chambers, Control .. Etc)**	**2,500,000**
	Total Cost for Irrigation Network	**10,873,174**
7	**Well Network (around 6 KM)**	
1	Piping Network and Fittings	
1.1	UPVC 450	230,000
1.2	UPVC 400	82,000
1.3	UPVC 355	39,000
1.4	UPVC 315	10,000
1.5	UPVC 280	36,000
1.6	UPVC 225	53,000
1.7	Fittings (Tee, Gates, Etc)	80,000
	Total Cost for Well Network (around 6 KM)	**530,000**
8	**Recovery Wells (27 Wells)**	
1	**Civil Works for 27 Wells**	

1.1	Gate, Fence..etc	216,000
1.2	Digging, Filter, S.S. Pipe, Gravel Pack, .. etc)	1,269,000
	Total for Civil Works	**1,485,000**
2	**Mechanical Works for 27 Wells**	
2.1	Pump	405,000
2.2	Manifold (Piping, Gates, Meter, Cyclone.. Etc)	256,500
	Total for Mechanical Works	**661,500**
3	**Electrical Works**	
3.1	GENERATOR SET #1	40,000
3.2	GENERATOR SET #2	40,000
3.3	GENERATOR SET #3	40,000
3.4	GENERATOR SET #4	40,000
3.5	GENERATOR SET #5	40,000
3.6	TRANSFRMER Station #1	45,000
3.7	TRANSFRMER Station #2	45,000
3.8	TRANSFRMER Station #3	45,000
3.9	TRANSFRMER Station #4	45,000
3.10	TRANSFRMER Station #5	45,000
3.11	MDB1	25,000
3.12	MDB2	25,000
3.13	MDB3	25,000
3.14	MDB4	25,000
3.15	MDB5	25,000
3.16	MCC 1~27	300,000
3.17	Cables	100,000
3.18	Miscellaneous	20000
	Total for Electrical Works	**970,000**
Total Cost for Recovery Wells (27 Wells)		**3,116,500**
9	**Monitoring Wells (10 Wells)**	
	Civil & Mechanical Works (Fence, Digging, Filter, Gravel Pack, Pump,. etc)	205,000
Total Cost for Monitoring Wells (10 Wells)		**205,000**
10	**Automation and Scada System**	
Total Cost for Automation and Scada System		**700,000**
Grand Total		**19,426,674**