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Non Revenue Water in Palestine: Economic Drivers Diagnosis and Reduction Policies

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الاقرار

أنا الموقعة أدناه، مقدّمة الرسالة التي تحمل العنوان:

Non Revenue Water in Palestine: Economic Drivers Diagnosis and Reduction Policies

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Declaration

The work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

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Date: **التاريخ:** 26.12.2019

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List of Abbreviation

Abbreviation	Meaning
AFD	L'Agence Française de Développement
CMWU	Coastal Municipal Water Utility
CoM	Council of Minister
DOI	Digital Object Identifier
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
IBNET	International Benchmarking Network for Water and Sanitation Utilities
IWA	International Water Association
IWRM	Integrated Water Resources Management
JWU	Jerusalem Water Undertaking
KFW	Kreditanstalt für Wiederaufbau
MoLG	Ministry of Local Government
NRW	Non-Revenue Water
PWA	Palestinian Water Authority
UFW	Unaccounted for Water
UN	United Nation
UPWSP	Union of Palestinian Water Service Providers
WB	World Bank
WBWD	West Bank Water Department
WSP	Water Service Providers
WSRC	Water Sector Regulatory Council
WSSA	Water Supply and Sewerage Authority

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Abstract

In Palestine, natural resources are limited and under military control by the Israeli occupation. The Israeli occupation prevents drilling wells even if they are located within the Palestinian Authority areas, including major cities. Given these circumstances, the Palestinian people are suffering from a severe shortage of water especially in Hebron.

The conservation of natural resources especially the water will undoubtedly increase local economic development and raise the level of economic growth. Water is one of the most important resources which is considered an input for production process in different sectors, including agriculture & industry. Today, the concept of hydroponics is totally dependent on water. In addition, water enters as a production input in many important industries such as the production of juice and soft drinks, pharmaceuticals, ready-made concrete, stone and other products.

In Palestine, the water sector suffers from the accumulated financial losses, the interruption of water service from many Palestinian areas, and from the shortage of water to the minimum levels. While the World Health Organization (WHO) has determined that the minimum per capita

consumption is 120 liters per day, some areas suffer from water shortages, reach only 30 liters per day, which is very small quantity and does not meet basic needs. This condition is forcing the Palestinian people to purchase water tanks at double prices. In view of the importance of water, there is a real need to reserve the water and not waste it either through leakages in the main reservoirs or in networks or by thefts. The difference between the quantity of water supplied and invoiced is called the non-revenue water. The higher the water loss, the higher the cost of water to the people, there is also inequitable distribution due to thefts as well as lower revenues for the water service provider and the ability to sustain and expand the service.

To study this phenomenon, this study addressed the factors which increases water loss and also discussed the mechanisms that can lead to a reduction in this value. The data collection depends on secondary sources for previous five years from the performance indicators report in the Water Authority and the Water Sector Regulatory Council. This data has been analyzed using multiple regression. This study aims to give decision makers the importance of non-revenue water and to calculate the real cost of this loss.

Finally, the study recommends the necessity of working together by all stakeholders in order to reduce the non-revenue water and increase investment projects that lead to reduction non-revenue water quantities such as Jenin and Tulkarem. This study advises the need to update the bylaws and adapt them to the research results and scientific studies.

Chapter One
Introduction

Introduction

The 9th Arab Environmental Conference, which was held in Cairo states that most Arab countries will fall below the water poverty line between 2020-2025. The water problem is not only an Arab problem but a global problem as well. The relevant statistics indicate that the water quantity in the world is estimated at 1386 million billion cubic meters, of which fresh water is only a small percentage which is estimated only 2.5%, and the majority of water is salt water in the seas and oceans 97.5%. However, the relevant studies reveal that 68.9% of fresh water is frozen water, thus, available water for human use is approximately 31% of total fresh water. More than 1 billion people worldwide do not have access to clean water, and 1 billion people in developing countries suffer from lack of drinking water, and 80% of health problems in developing countries are due to inadequate water and sanitation, which kills 18 million children every year (Faraj, 2010).

The shortage water problem can be noted during the summer season, the visitor to the Palestinian southern municipalities such as Yatta, Dura and other villages in Hebron Governorate will find waiting list in the water department in those municipalities. The people in those areas, pay in advance to the financial department to buy water tanks. Each family shall wait many days or more than a week to have the chance of supplying the

requested water tanker. However, if the family has emergency and can't wait water tanker from the municipalities, the alternative way is to buy water tank from private water tanker at very high price.

Given the fact water shortage in Palestine especially in Hebron, and very high price due to private water tankers; the non-revenue water reaches about 35%. This means that for each 100 cubic meter purchased and produced by water service provider i.e. municipalities, there are 35 cubic meters not sold due to network leakage, thefts or illegal connections, metering inaccuracies, and unbilled consumptions (WSRC, 2015).

According to Water Sector Regulatory Council and Palestinian Water Authority, the minimum value of non-revenue water is only 4% and the highest value is 59%. The total value of non-revenue water for about 70% of Palestinians' service providers in year 2015 is $ 43,778,000. Most of this value is related to unaccounted for water i.e. commercial losses. The assumption that physical leakage is 6% as per sample taken from the water balance of some service providers. In descriptive statistic term, if this amount is divided by the number of Palestinian; then, at the end of the year, water utility will give to each person $12.7 i.e. $70 for each Palestinian family! (Tamimi, Samhan, et al). The question is why the Palestinian household shall pay to the water service providers against this lost amount? Expressed in other term, if a water service provider has water loss level of 50% of the system supply. The water utility will charge twice the price of water to recover the cost of this losses.

As a rule, water losses can be physical such as leakages in main pipes and distribution network. Much of the drinking water infrastructure in Palestine has been in service for many years and can be a significant source of water loss through leaks. The largest Palestinian water service provider is Jerusalem Water Undertaking JWU. This utility provides water services for near to 62,000 connections, as of more than 370,000 residents. JWU was established in year 1949, so the network was placed in service before 70 years. The non- revenue water for Jerusalem Water Undertaking is 28%, this means that replacement of some pipes will lead to decrease this percentage (JWU, 2017).

This research thesis investigates several variables that affect non-revenue water for Palestinian water service providers, based on data collected from all Palestinian water service providers. Given the ultimate goal of exploring those drivers; the purpose of this thesis is not to enrich our understanding of relationship between non-revenue water and those predictors, but also to measure the significance of those variables, and to provide the policy makers better understanding for the no revenue water from a non-technical point of view. The Palestinian Water Authority always sets strategic plans to decrease the non-revenue by given percentage during given period of time. The output of this thesis will be proposed to support these plans, policies and strategies.

Problem Definition

In Palestine, the average non-revenue water is near to 35% according to the performance monitoring report (WSRC, 2015). This percentage is near to 30% in West bank and 39% in Gaza. The extracted water during year 2015 was 29.8 million cubic meters in West Bank and 80 million cubic meters in Gaza for about 75% of the Palestinian Population. However, for those population, the purchases of water from Israeli Water Company was 25 million cubic meters. This means that total purchases and produced i.e. available for Palestinian people to consume was 135 million cubic meters. Given the fact that the average water loss is 35%, by this the total water loss is near to 47 million cubic meters!

In Palestine, some Palestinian areas especially in Hebron Governorate face water shortage. The average consumption per capita per day there, is 25 liters i.e. is too low. The international standards set 120 liters per day for basic needs. The average consumption per day is more than 220 litters per capita per day in Qalqilya and Jericho. But the PWA can't transmit the water to Hebron and other areas that have shortages without Israeli side approval that always rejects the concept.

So far, near 35% of Palestinian water being lost, considering the Palestinian people have the need for this water due to shortage problem especially in the summer and costing wise. The old water network in many of Palestinian cities, lack of periodic maintenance, accumulated losses incurred by water providers, lack water records, absent to main meters,

illegal connections in some area especially in summer season, and the old household meters, all those variables and others lead increasing directly the non-revenue water. This problem has many effects on the Palestinian people as they pay the cost of this loss and may be contaminated. The reduction of non-revenue water for instance has an economic value and a significant relationship to economic development. The availability of water has an essential effect on several sectors, especially the agriculture sector, which has begun to deteriorate in the recent period in Palestine. Water is also one of the most important factors that are necessary for the production in many industries, and therefore, supports the economic growth.

Research Hypothesis

In evaluating what factors contribute to overall non-revenue water quantity and how these factors affect positively or negatively on this responded variable; this thesis reiterates on the common notion that non-revenue water levels are affected by key aspects water economic parameters, that those contribute significantly and able to predict the level in the future. Therefore, following the null hypotheses that will be posed and evaluated with a significance level of 0.05.

$\boldsymbol{H_0}$**-1**: There is no significant relationship between NRW and Water Price.

$\boldsymbol{H_0}$**-2**: There is no significant relationship between NRW and Collection Efficiency.

***H_0*-3**: There is no significant relationship between NRW and Daily Consumption.

***H_0*-4**: There is no significant relationship between NRW and Energy Cost.

***H_0*-5**: There is no significant relationship between NRW and Provider Size.

***H_0*-6**: There is no significant relationship between NRW and Provider Location.

***H_0*-7**: There is no significant relationship between NRW and Provider Ownership.

Research Objective

In summary, the main purpose of this research thesis is to deliver model for the Palestinian decision makers. Those results and findings may be considered as tools for decreasing the non-revenue water in Palestine in the long run. In addition, this study aims to come up with understanding of how the water stakeholders could perform effectively and amalgamate their efforts to reduce the non-revenue water. The PWA may benefit from the proposed model to align its strategic plan and set rational target for non-revenue water percentage. In addition to PWA, other donation agencies that are supporting the water sector will be able to prioritize their interventions by many parameters as location, size, price and others. Therefore, maximizing the benefit from their investment.

Research Significance

The PWA may adapt and put some targets and milestones based on the empirical results and ratio of the variables in this thesis such as non-revenue water and other parameter variables. The governmental entities and local governmental units can prioritize policies and plans that represent the least cost to achieve water loss reduction. Such as installation of water meters and specific tools necessary to measure water quantities effectively in given area. Perform high level audit work as a result of this thesis parameters to assess the performance of water service providers.

Research Limitation

The study is limited by place to include the water service providers in the West Bank's towns, camps including Area C, some areas in East Jerusalem, and the Gaza Strip. The data examined for this research represents data collected for the year 2017. The Palestinian water service providers in this research have been selected and limited to those who under monitoring by Water Sector Regulatory Council. The database contains about 80 water service providers in the West Bank and the Gaza Strip, those water providers represent 80% of West Bank and Gaza Strip population. In this thesis the economic indicators and variables will be investigated to measure the non-revenue water and explain this phenomenon. Hence, there are other technical variables such as technology, GPS dedications, software monitoring, smart software and water meters, all those topics are out of scope of this research, because they require huge efforts and capabilities.

The researcher obtained from the Water Sector Regulatory Council user name and password to access to the database to import the available data. The researcher finds some difficulties to export all required data at the same due to the database performance, and because of the large number of variables and records, and their intertwined with each other. The researcher faced some difficulties in getting interviews with some water service providers to learn about practical methods to reduce water loss. For this reason, some interviews were limited to the telephone because the managers and staff were busy and have limited time.

Other difficulties in this thesis expected in obtaining scientific previous studies and references, since there are a limited number of books in this field. The researcher also noted that the focus in reducing non-revenue water is always performed through technical solutions, and therefore there is no special published materials on the role of economic policies in reducing those huge losses and the mechanisms lead to this reduction.

Chapter Two

Theoretical Framework

NRW Definition

Water is a necessary and very important resource. It is a rare and critical resource that needs to be maintained, rationalized, and used in the efficient manner. Millions of people including children die every year from diseases associated with inadequate water supply, sanitation and hygiene. Therefore, water management becomes particularly important in the region because these countries suffer from water shortage and the water is a determining factor for all social and economic development efforts. The PWA in Palestine develops and manages water resources to meet all Palestinians water needs (Water Law, 2014). In this context, PWA sets comprehensive, guidelines and strategies in order to make sure the actual water resources are adopted by the sustainable water policy that aimed reduction water losses, retaining those resources, as well as reserves drinking and domestic uses clean and far from pollutions (State of Palestine 2012).

Palestine has embraced this trend through its commitment to the Sustainable Development Goals set out to achieve clean, accessible water for all is an essential part of the world and there is sufficient fresh water on the planet to achieve. Through Integrated water resources management (IWRM) fresh water can be maintained and reserved. The IWRM is defined as a method that strengthens and supports management and development sustainable development of water resources, based on

ongoing process with incremental impacts taking into account other resources, in order to maximize economic and social benefits and achieve equitable distribution without prejudice to the environment and allow water stakeholders to participate in the decision-making process (UN Environment, 2018).

Rainfall does not occur in enough quantities in many countries of the world, and many other areas may be at risk of drought in a given year. This causes water crises in many countries of the world; therefore, forcing the people of those areas to take austerity measures in order to maintain water quantities at least for human use and drinking purpose. One of these correction measures is reduction the wasted water in the network pipes or what called is Non-revenue water.

To gain a comprehensive understanding of the elements and causes of water losses (non-revenue water, i.e. water that does not constitute any financial return for loss of networks or to use it illegally without reading the water meter) this research introduces the details of this item. The NRW is the difference between the total quantity of water produced or pumped in the networks to provide the subscribers, and the water consumed legally upon arrival to subscribers through their water meters. Thus, NRW has two main elements: the real losses and the apparent losses, which are also known as the technical losses that are lost through the fractures of the networks during the pumping and running of water. As well as the administrative losses resulting from the failure to read the real consumption

and illegal use of water. So, the quantity of water that is lost from the distribution system before it could be billed is simply the NRW (Perera, Mallawaarachchi, et al).

Generally, the non-revenue water may be expressed in terms of water loss. The International Water Association "IWA" focused on the concept of water loss for all treated water that is real lost, which is mostly from underground leaks on water-mains and water service pipes. However, those losses include any water that has entered the networks pipes after treatment, and not delivered to the end customers, thus real loss in the network (International Water Association, 2018).

NRW Components

Identifying the components of NRW has a primary role in directing efforts and funding towards solving this water loss and reducing the percentage of NRW generally.

Water Entering the System:

The quantity of water entering to the water system includes purchased water amounts, desalinization plants, and sources i.e. wells, springs, produced from local water all sources. Ideally the accuracy of the input meters is verified using portable flow measuring devices (Farley, et al). Expressed in details, the water entering to the water system (Water Supply) includes three sources. First through the production of water from wells owned by the water service provider directly. There are some water service

providers in Palestine producing water from underground wells, such as Qalqiliya, Anabta, Azzun Municipality, and other municipalities where water is available in their areas and they have ability to extract water from these wells. It is worth mentioning here that some of the underground wells are far deep from the surface, and therefore the service provider does not incur additional costs to extract water from these underground wells such as Zeta municipality in Tulkarm governorate. While there are some areas where the groundwater wells are located far from the surface, and therefore the cost of pumping water will cost more, Hebron municipality is an example of this type (WSRC, 2015).

Second: water source to the system from purchases. Most of water service providers in Palestine purchase their water needs from bulk provider (WSRC, 2014). These municipalities, regional water utilities and joint services councils purchase water from the wholesale water supplier from the West Bank Water Department. Which in turn buys water from the Israeli Water Company Micorot. Purchases always are made through pipe connections that are connected to the main reservoirs of the Palestinian water service providers. Some of these water needs to be pumped by the Palestinian provider and this leads to increase cost of sales of cubic meters. However, other Palestinian water providers do not need pumping due to gravity, therefore less cost. For example, the Joint Services Council for the villages of north-west Jerusalem purchases water by gravity from Israeli Water Company because of lack of groundwater wells in the area. Hence

the digging of wells in all Palestinian areas needs Israeli approval, which does not grant to the Palestinian.

Third source entering to the water systems is from desalination. Desalination exists only in the Gaza Strip and on a small scale with high costs due to electricity. The PWA has consistently emphasized the Desalination project as a priority infrastructure project in Gaza Strip to build Plant. Donors are very concerned with the long-term cost recovery of the desalination plant and its operation, they believe that will require an operational subsidy for the initial three years (PWA, 2015). But in all cases, it is considered a source of water entering the water supply network. Now it is clear that the quantity of water entering the water supply network is either produced or purchased water or desalinate or more of these sources together. Thorough water entering the system there may be leakage and thus lead to increase the non-revenue water quantity.

Physical Losses:

Physical losses are always result from leakage in the main pipe or national carrier, local network and in the reservoir and distribution.

The water carrier connects the produced water from underground wells with the internal water network or the reservoirs. National carrier can also connect between the cities. In Palestine there is no national carrier connecting the Palestinian cities because of Israeli control on water and land. The leakage in the main water pipe in Palestine always occurs

between the point of production and the reservoirs or the internal water network, it increases the quantity of water loss. Water leakage in the main reservoirs can lead to an increase in the quantity of water loss due to the fact that the produced quantity that entered to the water system has not been fully sold by the water service provider.

Finally, water can be leaked in the internal water network. Where the total quantity of water will not be delivered to the end consumer and therefore the water service provider would be unable to issue sales invoice to charge the final consumer. In general, WSP repairs the leakages as they occur to avoid waste of water from the first side, and to prevent the contamination of water from the other side. Many activities to reduce water losses include dividing large water distribution networks into District Metered Areas and monitoring of flow rates and water pressures (MUHAMMETOĞLU, et al). Studies have shown that water leakage repair costs an average of $ 550. Therefore, some water service providers do not repair the network if the leakage is simple and the cost of water is low. I.e. they consider the tradeoff principle of balance between costs and return (Liemberger. & Marin 2006).

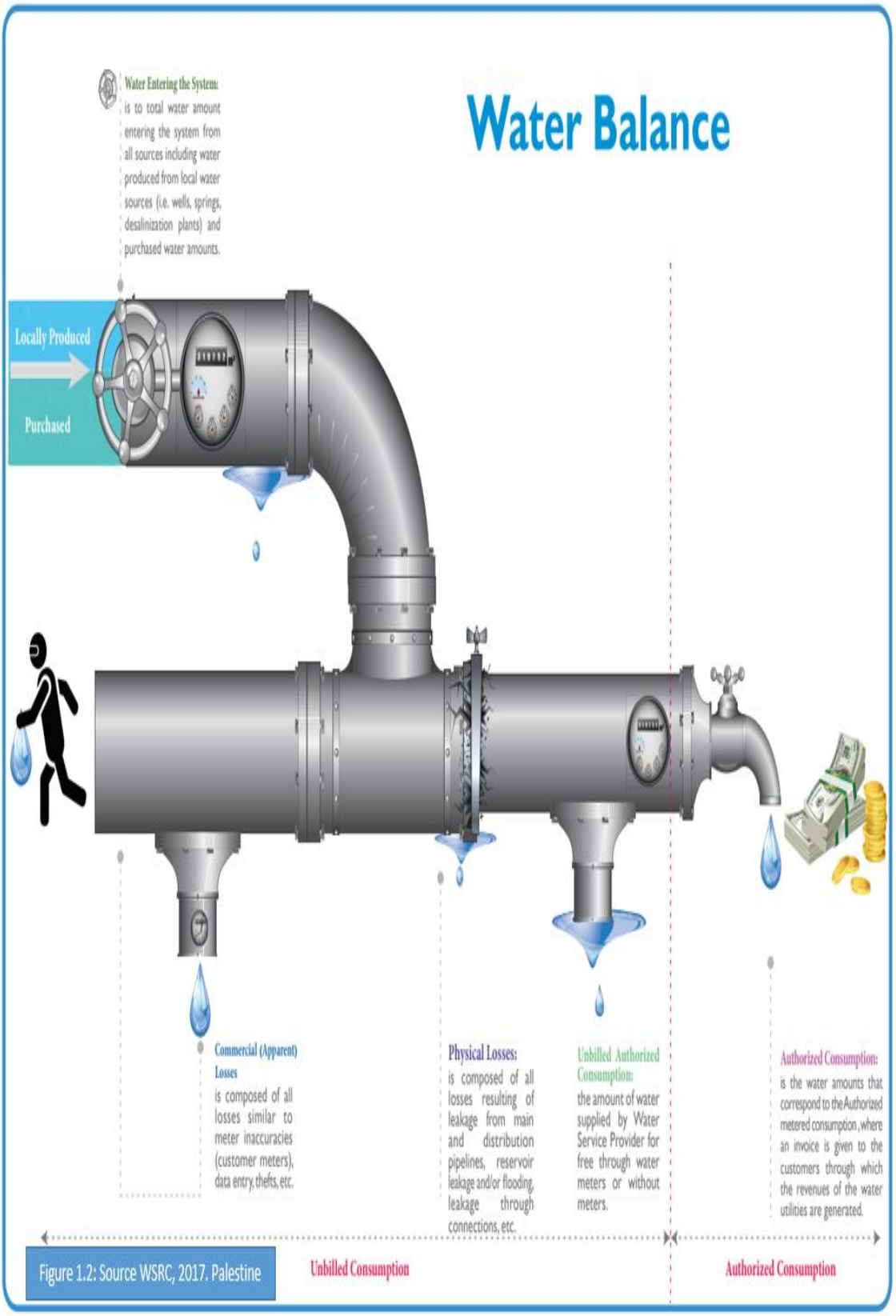

Figure 1: Source WSRC, 2017, Palestine

Apparent Losses:

It is called also commercial losses. It is composed of that are result from water meters' inaccuracies or deficiency, human error in data enter to the water records and thefts or illegal connections. (Vermersch, et al).

Water loss in the new water meters (when purchases at the first use) is about 5%. By using those meters and the inaccuracy of measuring the water consumption increased in high levels even higher than 15% because of deprecation (Couvelis & Zyl, 2015). Water loss as result from meters' inaccuracy depends on the type of meter. Some meters are old, mechanical, speedometers, all those types increase the inaccuracy of reading and therefore when the water providers' employee records the reading; the result would be different than those are actually consumed. The final consumer may have actually consumed 10 cubic meters let say, while the meter shows that the consumed water is only 8 cubic meters. Accordingly, the water supplier issues a bill of 8 cubic meters as according to the meter reading. May be the error occurs in the main water meters as well, which are installed on the wells and at the entrance of the water network. It may happen that the meters may properly register water consumption, but the water providers' officer reads the value incorrectly. i.e., thus, the issue sales invoices that do not represent the actual water consumption.

Other aspect of commercial water loss is water theft or illegal connections. They are usually actions such as encroach on the WSP network. Some people connect their home or gardens directly from water network or the

main line without knowledge of WSP management, and thus consume water without bills. In Jamaica for instance, 20 to 30 illegal connections removed on each patrol are used to irrigate fields for legal and illegal farming purposes (The National Water Commission, 2018). The service provider usually installs zone meters by area to determine the quantity of waste in each area and check the possibility of theft in a given area or actual leakage and take the action accordingly. In summary, it is clear that the commercial loss is water that is actually consumed by theft or human error in the registration, or inaccuracy in water meter. All these components increase water loss and are real financial losses the service providers incur.

Unbilled Consumption:

Some water providers deliver water quantity to authorized dealers in free of charge. For example, the public utilities such as schools, government entities, mosques, churches, police fire and other entities. On the other side, some of these entities already installed water meters but without issuing sales invoice, therefore, increase the non-revenue water. i.e. legitimate but not billed and therefore do not produce revenue (UN-Habitat, 2012).

The water provider should pay attention to this category of water loss because this category causes the significant part of non-revenue water in the water balance. There are many municipalities and service providers that provide the water to police stations, firefighters, and government institutions without meters installed to these locations. On the other side, some water service providers install meters on these institutions, mosques

and churches for example, but those meters are not read by the service provider. Sometimes the meters are read and recorded but the water provider do not issue sales invoice to those authorized dealers. All these cases cause non-revenue water and lost opportunity to generate revenue to the water service provider. One of the consequences of this category is the encouraging water thefts by different parties.

All these categories correspond to non-revenue water components. According to the water balance, the quantity of water that is pumped into the water system must be equal to that of the water quantity that is sold to the final consumer. The difference in this equation is non-revenue water and opportunity lost on the water service provider. NRW importance also lies in the possibility of water pollution due to damage to the infrastructure and water network, cracks in buildings, especially in reservoirs. As well as unfair water distribution, especially in the period of water shortage.

Authorized Consumption:

The authorized metered and billed consumption is water that consumed though the metering and invoicing process (Wegelin, 2014). Where an invoice is given to the customer through which the revenues of the water utilities are generated. It is worth mentioning here that issuing water sales invoices to the end water consumer does not mean that the water service provider has received in cash the amount of water sold. On the contrary, the amount remains due until it is collected and therefore transferred from receivables to cash.

Previous Studies

Many literatures have tackled the performance of water service providers, the financial sustainability and efficiency. Most the published papers that have been reviewed about non-revenue water consider the engineering side and physical leakages, therefore, it is necessary to touch this part for the beneficial of decision makers and other stakeholders.

(Tamimi & Samhan, 2017) studied the determinants of non-revenue water and financial viability for the Palestinian water service providers that deliver services in West Bank and Gaza. The researchers have collected many parameters that affect on non-revenue water and financial viability of the Palestinian water providers. Cross sectional data has been collected from Palestinian water provider's performance reports that were issued by Palestinian Water Authority and recently have been issuing by Water Sector Regulatory Council. The study shed the light on the average price as predictor of non-revenue water. In high non-revenue, low water prices, those conditions lead to insufficient amount of generated revenue, and therefore bad financial performance and no financial sustainability. The results of this research show high effect of price on non-revenue water and financial viability at the same time. The increasing price by one unit, results in decreasing the non-revenue water by.346 units, other things begin equal.

(Caroline van den Berg, 2014) analyzed the non-revenue water for water utilities in 68 countries for five years. Secondary and cross-sectional data has been extracted from International Benchmarking Network for Water and Sanitation Utilities (IBNET). According to the researcher, the IBNET is a database contains performance indicators and parameters for about 1,861 water providers in serving nearly 513 million people with water in 12,480 cities and towns. The author came up with a model that contains physical characteristics of the water infrastructure (P), management characteristics of the utility (M) and a vector of environmental factors (E). Further the country effects, where, each country has its own characteristics that may influence the water losses (e) and an error term (u), such as building standards, legal issues, levels of corruption, and so forth.

The findings of research indicated that some factors are out of control of water utilities management, such as population density, length of the network, and the type of network distribution. Those variables are resulted from pattern of population, and the water utilities can do nothing to fully control those issue. The author noted an important conclusion in the non-revenue water reduction programs and strategies. Where, it should consider the determinants of the non-revenue water and those to be delivered to the water providers' managers with a better understanding of what can be achieved in terms of non-revenue water reduction and whether the benefits of these reductions exceed their costs. The trading off between cost and benefit of non-revenue water reduction is to be considered since May the

cost of one maintenance of water leakage be more and higher than benefit from fixing the leakage.

(Murrar, 2017) studied the determinants of non-revenue water in Balkan countries. The data has been collected from the International Benchmarking Network for Water and Sanitation Utilities (IBNET). In addition to the site visit to the Balkan Water Conference by the researcher, a panel data for more than 10 years has been inserted into Statistical Package for the Social Sciences "SPSS" to find the significant parameters on the non-revenue water for about 180 water service providers in Albania, Bulgaria, Bosnia, Kosovo, Macedonia, Moldova, and Montenegro.

The researcher finds that increasing in metering level ratio and labor; lead to decrease the non-revenue water percentage. On the opposite side, more consumption per person, production per connection, number of populations, network connection density, operating cost per cubic meter sold and number of connections, all those variables raise the non-revenue water percentage. The researcher calls for coordination, amalgamations and multiple efforts to handle this high percentage. The researcher concluded that those countries are suffering from large physical leakages and high commercial losses. Therefore, the non-revenue water percentage reaches more than 50% and thus it requires amalgamations from international donation, decision makers, and all other stakeholder's efforts. This high percentage of non-revenue water was confirmed with (Gjinali & Giantris, 2014) who studied this phenomenon in Greater Balkans, such as Albania,

Kosovo, Montenegro, Bosnia-Herzegovina, Macedonia, and Moldova. The researcher finds that the volume of non-revenue e water is ranging between 40% and 70%. The researchers concluded that administrative issues have direct impact on the energy cost and continuing of water services. The staff skills, productivity, automated meters reading have high potential to reduce non-revenue percentage.

Another diagnosis methodology that the researcher concentrated is the corruption, political, awareness and other social factors. Some authors find that political issue beyond increasing the non-revenue water percentage. Those argue that the water utilities managers may interest to say that their non-revenue water is high, so they can attract the donation, maintenance the water networks, replace new water meters, and so forth. In some cities, high non-revenue water may have other reasons. (García-Rubio & Guardiola, 2011) studied those factors. They concluded that lack of incentive, corruption and personal interest for different stakeholders even on political level are main reasons for high non-revenue water. On the other hand, the authors found that lack of awareness for the customers about those losses may consider as direct reason for high non-revenue water, especially once the water tariff is low. Expressed in other term, the behavior of people where the price of cubic meter is very low will be of course different than the behavior of other people who purchase water at high price. When the water price is very low compare with the household income, his or her incentive toward illegal connections will be less.

Because of no caring from customers about non-revenue water problem, since they have no awareness about the importance of this problem. The result is by default no caring for utilities management to reduce those losses as a result of no caring from the customers! So since there is no accountability, the non-revenue water is high in some countries. In Colombia, fraud plays major reason of non-revenue water components. (Ramirez, 2008) estimated 30% of non-revue water is caused by fraud; where overall non-revenue water on national level reached up to 50%.

So far, many variables affect and lead to increase the non-revenue water percentage. Different researchers tacked different aspects i.e. financial, environmental, corruption, political, non-controllable factors and others. The other part of this thesis will cover the reduction strategies. The Palestinian Water Authority has the ministerial and planning role of Palestinian water sector has set non-revenue water reduction strategy as final draft. The strategy is simply incorporated with the strategic plan for the Palestinian Water Authority (PWA, 2012). The document specifies the non-revenue water in Palestine by 38% which equal to 285 litters per property per day. According to the PWA, this is not acceptable, and the efforts will be paid to decrease the percentage to minimum level by year 2020. The PWA follows the cost benefit from of reduction, since the cost is high and therefore, it estimates that decreasing the non-revenue water percentage from 38% to 35 % will lead to save 40 Million dollars over ten years.

PWA considers the reduction strategy as a methodology to initiate activities that cost less amount of money and have significant effect over the saving water, such as: Installing the metering into the water providers. Develop national and individual targets for water providers, this can be performed through benchmarking and therefore determine the priorities of interventions. PWA also interests to detail the type of non-revenue water as physical losses or commercial and apparent losses, this will lead to dramatically decrease the percentage since the diagnosis become known. Other directions from PWA are to encourage the large water providers to establish unit or section under water department called Non-Revenue Water Reduction Unit. The purpose of this unit is to manage the non-revenue water and monitored and then make significant reduction. The cost and benefit from this unit may need to be studied well to move into establishment.

(Farley, et al) has listed the benefit of non-revenue water reduction in the World. The decreasing non-revenue will lead to new business job creation, improve the customer services as the customer will feel fair and have the access to the water, and will also gain the access to additional cash flow into the water sector. The author concludes that the water reduction is the responsibility of everyone. It should be a financial allocation to finance the non-revenue water reduction program. Efficient management that will and the following up of the non-revenue water reduction program. Data and updated information about the pram of non-revenue water, customer

support and operating maintenance periodically to make sure that no new water loss appeared.

(Dighade, Kadu &Pande, 2015) studied the non-revenue water reduction strategies in India. The papers show that there is from 50 to 60 % of non-revenue water in India. This high percentage affects the cost and revenue recognition. The researchers have studied the relationship between the non-revenue water and the pressure, so their objective is to achieve maximum coverage considering the continuous supply. In addition to the objective. The authors explain and implement the tool which is the Water Balance or water Audit. The International Water Association "IWA". This table simply summarizes the components and provides accountability, as all of the water placed into a distribution system should metered and quantified, i.e. water input. The authorized consumption then may be billed or unbilled as per the case. In this issue the definition and quantification shall be performed to better analysis in the future. Only billed metered consumption and billed un metered can generate and transformed into real revenue for the water utility. However, the other categories such as unbilled authorized consumption will not generate revenue. Further to that, the apparent losses and real losses which include to leakage during the production and transmission, and in accuracy in meters, all those are lost without any revenue recognition.

Water Sector

The structure of the water sector differs from one country to another. Some countries have private companies that supply water to the water sector, while the central government provides the population, institutions and private companies with water services, such as electricity and communication services. There are also some countries in which the private sector is involved with the government in implementation of several water projects and the provision of water services. In Palestine, the situation is different, a reform has been conducted before some years. The Palestinian Council of Ministers approved the Action Plan for Reform towards the definition and implementation of a comprehensive program of institutional and legislative restructuring in the Palestinian water sector in 2009. The purpose of this reform was to restructure the water sector as a whole sector and its role and responsibilities for each entity that maximize the efficiency and deliver the quality of service (PWA, 2015). The water law simple has split policy actions from the regulatory functions. This actually appeared in Palestine and only in three different countries in the World at least Brazil and Portugal i.e. possibly the Palestine is the only country that has full regulatory function. To support the CoM reform plan, a new Water Law was approved in end of 2014. As a result, the institutional framework, role and responsibilities, definition, all those mandates of the water sector in Palestine have been defined by this Water Law 2014. The major player in the sector is Palestinian Water Authority PWA i.e. ministerial role to ensure better handling of the planning and developing policies of the water

sector. It is responsible for setting water sector policy, strategy, master planning, sector development, restructuring, water resources licensing, management, and monitoring. This means that on the national level, the PWA sets the plans of non-revenue water, and related targets. However, new entity has been created which is Water Sector Regulatory Council WSRC, it has the function of monitoring the performance of water services providers, approving water prices, water tariff to ensure that service is provided according to the standards; and with the aim of ensuring water and wastewater services quality and efficiency to customers in Palestine at affordable prices. The WSRC mandate is to monitor the non-revenue water for each water provider. Making sure that the percentage decrease gradually and also reports that to the PWA and other donors. In this regard, the PWA shall allocate the fund, projects and other support to match the reporting of WSRC for better enhancement of water service providers. The third party of water sector is water service providers that include municipalities, regional utilities, joint water councils, and the national water company (i.e. the bulk provider); those are in charge of water and wastewater services delivery to the customers (Palestinian water law 2014). There are other institutions in the sector as Union of Palestinian Water Service Providers “UPWSP”. International donors as World Bank, GIZ water Program, KFW, AFD and other donors that already have programs in water sector.

Water Providers

In Palestine, there are more than 280 water and wastewater service providers in the forms of water and wastewater utilities, undertakings, authorities, water departments within municipalities, village, joint service council's, cooperative associations, and private sector. According to the data bank of Palestinian Water Authority, which consists data about all water service providers in West bank and Gaza, and as per the performance report of water providers of Water Sector Regulatory Council (WSRC, 2014),

The ownership and legal structure are important in the performance of water provider and non-revenue water percentage. Regional utilities are semi-independent and report to their board of directors. The joint service councils are reporting to the ministry of local government directly; and the water department within the municipalities report to the mayor of the municipality, which at the end report to ministry of local government. In terms of number of population and services, the performance reports show that the three Palestinian water utilities deliver water services to more than half millions of people i.e. about 18% of the sample population. On the other hand, the municipalities deliver their services to more than 75% of total population; and the last part is served by the joint service councils. The data shows that there is difference in non-revenue percentage, average price, cost, surplus and all performance indictors among those intuitional water service providers (WSRC, 2015).

Performance Indicators

(Baietti, Kingdom and Ginneken, 2006) studied the characteristics of well-performing public water utilities. The researchers conclude that many performance areas water provider can enhance to be rated as good performance such as the non- revenue water reduction. According to the International Water Association, the non-revenue water is a core indicator to measure overall performance of water service providers. High volume percentage indicates poor management and not utilization of resources. Non-revenue water has major impact on water service providers. It mainly decreases the expected revenue from first side; as a result of illegal connections, metering inaccuracies, unmetered, and unbilled consumption. On other side, it increases the cost and expenses especially leakage in main pipes and distribution network.

According to the performance report of the Palestinian water service providers. There are three indicators that measure the non-revenue water. (1) Non-revenue water percentage, this equals the total billed quantities over the total supplied into the network. I.e. simply the differences between supplied and billed to the customers. It reflects the real loss of water due to physical leakages, illegal connections and other not metering quantities. This indicator is a common and always used by the water providers as vertical analysis i.e. compare with the performance with last years or more. (2) Non-revenue water per cubic meter per km in the network per year. It measures the efficiency in the water network i.e. water losses per km of the

network. By this indicator, another variable which the network is can be included in the analysis, so it will compare with other water service providers from first side, and also it compared with the same provider with previous years. (3) Non-revenue water per connection per day, which measures the non-revenue water per connection per day. The more the non-revenue per connection per day, the more the inefficiency of water service providers. in some cases, the large amount of non-revenue water per connection per day may equal the consumed quantity. Therefore, the reduction strategy shall be implemented to decrease this loss.

So far, there are performance indicators that measure different aspect of the water service providers. The technical indicators such as the non-revenue water, the consumption of water per day per capita, and the coverage of the water compare with the total population. On the other side, there are financial indicators for assessment the financial position of the water service providers. Such as the gross profit, average cost and average selling price, current ratio and other financial ratios. Those rations provide a diagnosis for the water service provider. There are other indicators and ratios that always measure other parts of the water utilities such as the customer satisfaction and number of complaints per each category. On the other hand, the water quality indicators which measure the chlorine and other elements concentration in the water. all those indicators are important and shall be lined with the non-revenue.

NRW Policy

In October 2017, the Palestinian Water Authority issued a non-account water policy as draft copy for review and comments (Palestinian Water Authority, 2017). A workshop was held on this issue which was called for by stakeholders and those concerned with water loss. This policy is to be implemented at the beginning of 2018. The overall objective from this policy is ensuring the reduction of non-revenue water, which is one of the most important factors for achieving water sustainability. The definition article states difference between unaccounted for water "UFW" and non-revenue water. According to the article, the unaccounted-for water is the difference between water supplied and water distributed to consumers and expressed as a percentage of water production. Whereas the non-revenue water is more general, it includes the UFW and adding unbilled invoices to authorized consumptions.

According to the policy preface, the average water loss for the year 2015 ranged from 24% to 36% in the northern governorates and in the southern governorates was from 41 to 46%, which is high percentage according to international standards. Note that the Palestinian National Water and Sanitation Policy (2012-2032) approved a maximum of 20% non-revenue water to be reached in both northern and southern governorates at end of year 2032.

The reasons for the increase in the proportion of non-accountant water in Palestine are set of interrelated factors such as network depreciation, illegal

connections, inaccuracy meters reading, poor maintenance programs. Also absent of legal, administrative and institutional framework for the water sector, as well as the ability to implement, technical, financial, development and operation programs for many water service providers.

The policy has set three main objectives in addition to reducing water losses: the sustainability of water resources and the provision of additional water resources that increase the citizen's access to adequate water supply. Reduce the cost and price per cubic meter of water and achieve the financial sustainability for water service providers.

The policy has called for identification the water consumers whether entities or households and to document those consumers in WSP financial and billing system. Installing water meters for all consumers, so that the water consumption would be measured, invoiced in billing and financial system of the service provider. The policy called also for the stop providing any exemptions on water consumption for any citizen or entity. For the water theft, it encourages for supporting the role of media (such as television, radio, newspapers, worships, awareness leaflets, etc.). In addition to the educational curricula in order to promote the concepts of values and good behavior for the students. As well as increased administrative control and the activation of legal sanctions.

The policy addressed the need to decrease the water loss that caused by meters' inaccuracy by ensuring the installation meters based on the required specifications, and the replacement of damaged meters within

programs planned based on the results of the periodic calibration test. The policy also called for ensuring the installation and maintenance of main meters on the beginning and end of the main water network lines and documenting the readings periodically to compare the losses in the main lines therefore reducing the loss resulting from leakage in the main network lines, internal networks, and the reservoirs.

Chapter Three

Methodological Approach

Data Collection

This thesis will mainly depend on the secondary data that have been collected from published performance indicator reports of Palestinian water service providers. The Performance Reports are mainly data collected from different Palestinian water providers. This data includes financial data such as average price, operating and maintenance cost, quantity sold in cubic meters, quantity produced, quantity purchased, discounts on sales, sales in amount, number of connections, number of population, size of water providers, account receivables, per capita and so forth. They are more than 19 indictors in financial, technical, quality, customer satisfaction and other variables.

It is good to mention here that those performance reports were published by Palestinian Water Authority (PWA) before year 2013; and currently are published by Water Sector Regulatory Council (WSRC); with full support as financial and technical advisors team by Deutsche Gesellschaft fuer Internationale Zusammenarbeit (GIZ) Water Program and World Bank.

To enhance the methodology especially in non-revenue water diagnosis and reduction strategies, site visits have been conducted to selected Palestinian water service providers. Some Palestinian water providers have high non-revenue water, where, others have minimum level i.e. Tulkarem

municipality is facing from high percentage which is about 50%, and Ellar municipality in the same governorate and a small town is less than 8% (WSRC, 2015). Therefore, it will be beneficial to record the lessons learnt from different categories of Palestinian water providers in the non-revenue issues.

During these visits, interviews have been conducted, to have full understanding of the water providers' procedures, and programs in different areas. On the other hand, to document some success stories in non-revenue water reduction, and how these success stories can be benefit others in Palestine and the region. Further, the visits will enhance the identifications and verification of variables.

Sample Size

According to the Water Sector Regulatory Council, the published data in 2017 report covers more than 80% of total Palestinian population. Thus, the sample size in this thesis will be included all water service providers that deliver water services to more than 80% of the Palestinian population in West Bank including some of east Jerusalem and Gaza, with considering that all Palestinian population in Gaza where there are 84 water service providers are included in this sample.

Those observations will be analyzed and tested using Statistical Package for Social Science (SPSS). Both descriptive and inferential analyses will be conducted. The purpose of this inferential test is to know which of those

variables can explain the non-revenue water significantly and by how much based on the data collected for this mission.

Model Design

Generally, the thesis will adapt quantitative research methodology. The data will be collected from secondary source. Primary data will also be collected about the procedures of water providers in non-revenue water reduction. The framework is adapted to reflect multiple regression analysis. The following diagram sketches this relation.

NRW = α+ ß1ce+ ß2dc+ ß3sp+ß4ec+ ß5ps+ ß6pl+ ß7po+…ε…….. (1)

Where:

α = Constant

ß1, ß2, ß3, ß4, ß5, ß6, ß7 = Coefficients of the model variables.

CE: Collection Efficiency, DC: Daily Consumption, SP: Sales Price, EC: Energy Cost, PS: Provider Size, PL: Provider Location, PO: Provider Ownership, and ε stands for errors and others.

Chapter Four

Results & Discussion

Descriptive Statistics

There are two sets of data that have been analyzed in this section. The first set is the sample data which represents previous years for water service providers which reflect the performance indicators reports that published by the Water Sector Regulatory Council. There are also water service providers' data included in the 2017 Performance Indicators report, which is the latest report issued by the Water Sector Regulatory Council, that report includes about 85 water service providers covering about 3.8 million people in the West Bank and Gaza Strip. This is a high percentage and therefore the results can be generalized.

In this section, descriptive statistic will be provided for each variable, and the correlation between the non-revenue water and the other variables, as well as explaining from the water sector environment. This section is supported by graphs and chart analysis to better understanding the variables and their relationship, as well as match the findings with the empirical section.

Non-Revenue Water Indicator

The randomized sample data, which have been covering the last five years of selected water providers, shows that the non-revenue water volume is

about 32%. Which is high if compared to the urgent need of water for the Palestinian population. According to the statistical data for water service providers in Palestine for the year 2017, it was found that non-revenue water volume has decreased to 28% as average of water providers in Palestine. This is a good indicator because recently the Palestinian Water Authority and many donors work to reduce the non-revenue water because of its importance and being one of the sources of water that can be relied upon as alternative source. The importance of non-revenue water quantity is that it is enough quantity especially that it constitutes about one third of the water available for consumption.

The non-revenue water volume varies between different governorates and Palestinian territories. The data for 2017 indicates that the rate of non-revenue in the cities and areas of the northern West Bank is on average 28%, the central regions about 29%, the southern areas 23%, and the Gaza Strip 33% (WSRC). This is due to the difference in water leakage between the governorates and regions, including the availability of water in the network in the south, where there is no water in the networks in Hebron areas and the water service may reach the consumer after 90 days especially in the summer season. As well as the depreciation of the water network in the Gaza Strip. The water providers in Gaza Strip are unable to make maintenance for the water network because of high financial losses and decreased the collection rate of debts. Further, there are no projects to reduce water losses and that is why Gaza Strip began to find alternative source which is the desalination. In the central and northern regions, water

is better than in other areas, especially Jericho, Al Ouja in Jericho, Qalqiliya and Azzun in the western areas of Qalqilia governorate, and others.

Some areas have experienced a decline in non-revenue water volume, especially in areas like Ellar and Tafuh. This is due to the fact that the municipality of Ellar works to measure the water on a daily basis and from various water meters. It also works to repair any faults in the water network from municipal sources. In addition, there is no water theft in this town. Where the mayor installed the water meters for the subscribers outside their houses to make sure that those meters can be seen from outside. Also, in this municipality, the average water prices cover service costs with a profit margin. Finally, debt collection efficiency is high and there is no accumulated debt substantially compared with other water service providers.

In contrast, data for 2017 shows an increase in water losses in other areas, like Anata in Jerusalem. The data of this town indicates that the non-revenue water volume reaches 70% it is very high compared with volumes in other areas. The reason for this increase is that there are thefts in this area, as this town is divided into the areas of Jerusalem which is under Israeli Occupation control; and the areas of the West Bank which is administrated by Palestinian and controlled by Israeli security, and therefore there are thefts and illegal connections. Due to these facts on the ground the municipality is unable to manage this condition and to protect

the network from theft. Generally, it has been noted that the non-revenue water in the areas that under Israeli security control, such as the town of Al-Eizariya in Jerusalem Governorate, are high. On other hand, there are other cities that always suffer from high non-revenue water volume such as Tulkarem and Jenin. The water loss rate in these cities is about 48%, which is high considering the need for water service. One of the reasons for this loss is the error in registration and metering accuracy in those cities, as well as the leaks in the water network despite the support from international donors who financed the project to decrease the non-revenue water. One of the causes of non-revenue water in Tulkarm is commercial losses. Where water is consumed for parties such as civil defense and public parks without recording the quantity of water consumed.

Economic Development

The collected data have been analyzed for all water service providers in Palestine those who covered by the Performance Indicators Report. A data for about 84 service providers in West Bank and Gaza Strip is investigated. Those water providers are providing water services to approximately 3.85 million people, or about 80% of the Palestinian population.

The records show that the water purchases from West Bank Water Department are about 70,620,997 cubic meters and the quantity of water produced from the main water sources is 109,948,803 cubic meters according to the data of year 2017 that is recently published . This means that the quantity of water entering the water service provider's network is

180,569,800 cubic meters, or 47 meters per person per year. Unfortunately, this quantity is not consumed by all Palestinian citizens, but some of these quantities go into the non-revenue water. Water service providers can account only for 67% of this quantity, or 121,722,497 cubic meters. The remaining 58,847,303 cubic meters are lost revenues and non-revenue losses to water service providers. The total water loss represents about 82% from total water purchases in all West Bank and the Gaza Strip areas. This is a very large quantity, especially when considering the water shortage problem in Palestine and the accumulated financial losses of water service providers in Palestine. (WSRC report, 2017)

According to these results, the discussion goes to fact that the non-revenue water has economic value because simply water has great benefits for human consumption, such as improving the public health of the individual and reducing many diseases. If the quality or quantity of water is not sufficient or enough for the entire population in a given country, the possibility of increasing diseases is high. Which will cost the Palestinian Authority treasury households or doubling the cost of water production. The impact of not having enough water quantity for the society will cause reduction of the productivity of the individuals, whether by work or education. In other words, decrease the economic development in all productive sectors in Palestine. The availability of water for industrial, agricultural and service industries has a significant positive impact on the economy and the GDP which results also in moving the productive sectors

in the various activities and more development and growth expanding (Ismail, 2009).

In Palestine, water is one of the most important resources, especially in light of the Israeli occupation, which controls all economic natural resources and hinders the development process. Water is an important economic resource in all aspects of life. Therefore, the Palestinian citizen must know that this resource has costs and cannot be provided free of charge. The increase in non-revenue water losses in this high volume as in Palestine will increase the cost of water paid by the Palestinian citizen. Moreover, the economic and social impact of its provision is more than double its costs. Therefore, the balance in its pricing, especially in terms of the segments, has a great positive impact on the water providers and on the customer side as well. In this regard, it should be noted that there are calls to reduce the production of materials that consume water, this science called and is known as water foot print. for instance, if it is said that milk production should be reduced because it consumes a lot of water, as well as some food or transformational products in order to save water, this is a significant decline in the productivity of goods that satisfy large percentage of domestic needs. Therefore, the solution is not to decrease the production to save the water, rather, the solution is requiring integrated planning between all parties and the first is to reduce the non-revenue water in Palestine and increase the production process in all economic sectors.

The non-revenue water has not only significant impact on the economic development process, but also has financial value and direct financial losses. The results of the water purchases show for year 2017 that 60% of the water in Palestine is purchased from the Israeli company Microot through the West Bank Water Department. The Israeli occupation sets the price of water, and the Palestinian Authority is forced to pay within certain categories and conditions. In general, the average price per cubic meter of water is about 3 NIS. This means that the West Bank Water Department buys water from the Israeli company at about NIS 2.11 billion annually. Increasing water production from the Palestinian wells, lead to the reducing purchases and dependence on Israeli occupation. On the other side reducing non-revenue water will lead also to decrease the dependency on the Israeli.

Generally, investment in water projects may be economically feasible, especially since water is necessary for all human beings. According to the United Nations and UNESCO data, based on the results of the studies carried out, they indicate a strong positive relationship between water-related investments on the one hand and economic growth on the other hand.

Investment in small enterprises that provide access to drinking water and basic sanitation in Africa for instance could have a return on investment of approximately $ 28.4 billion a year, which is equivalent to about 5% of the Africa GDP. These water investments have a positive impact on employment. In the United States for example, investment of $ 1 million in

the water supply and sanitation infrastructure is estimated to generate between 10 and 20 jobs. The Bureau of Economic Analysis of the US Department of Commerce has shown that every job opportunity provided in the water sector and wastewater treatment leads to 3.68 indirect job opportunities in the national economy. In Latin America also, another study showed that investment of $ 1 million in the development of water supplies and sanitation services led to the creation of 100,000 jobs (UNESCO, 2019).

Water Balance

One of the results in this study is the water balance and its classifications. The water balance is simply the different water sources and uses until the water reaches the end customer or user. In this study thesis, all the water balances of the water service providers in Palestine are collected and analyzed for results and recommendations that could result in improving the water service and reducing the water losses in Palestine. The water balance results show that the quantity of water entered into the water system is 180,569,800 m3 in 2017(WSRC report 2017). This water is divided into two types, the first is the water consumed, which amounted to 126,885,886 cubic meters. The second is the water loss or non-revenue water, which amounted to 53,774,598 cubic meters.(WSRC report 2017)

The water consumed is divided into two types. The first type is the water that was consumed and invoiced to the water consumers, it is called Billed Authorized Consumption. Thus, the water that generates revenues to the

water service provider is essentially 121,813,181 cubic meters. The second type is water consumed by known water consumers, but no bills have been issued to increase the revenues of water service providers, it is called Unbilled Authorized Consumption. This amount amounted to 5,072,705 cubic meters. (WSRC report, 2017)

The water that was invoiced to the consumers is also divided into two types. The first is the water that was measured and invoiced according to the water meters, which is the vast majority of consumers is called Billed Metered. It reached 121,228,932 cubic meters. The second section includes the water that was invoiced but not measured by meters. For example, some mosques, are received water invoice from the water service provider without being measured. This total amounted to 584,249 cubic meters. it is called Billed Unmetered. (WSRC report, 2017)

Back to the consumed water that has not been issued an invoice which is Unbilled Authorized Consumption. It is also divided into two parts, the first is the water that was consumed and measured but not invoiced, and the second is the water that has not been invoiced and not measured. In order to facilitate this mission here and due to insignificance, the total amount of these quantities is 5,072,705 cubic meters. (WSRC report, 2017)

Now, back to the total water losses, it is divided into main two parts, the first part is the apparent loss or what called commercial losses, which is water consumed and no revenue is generated to the water service provider as a result of this consumption. The quantity of water in this category is

totaled to 36,914,387 cubic meters. This category is divided into two categories. The first category is the water that was illegally consumed or stolen from the network, estimated at 23,401,116 cubic meters. it is called the Unauthorized Consumption. The second category is the water that resulted from the inaccuracy of water meters during the recording of real consumption. This quantity is totaled to 13,513,271 Cubic meters. it is called Metering Inaccuracies (customer meters). (WSRC report, 2017)

It is good to say that there is another component of water loss, which is actual losses. The actual quantity of water losses for 2017 was 16,860,210 cubic meters. It is called the Real (physical) losses. This quantity is divided into two types: the first is the quantity resulting from the leakage in the reservoirs, which has quantity about 873,762 cubic meters. The other quantity is the leakage resulting from the main lines and distribution network, which has total quantity of 15,986,448 million cubic meters.

These data generally indicate that the water loss or non-revenue water is very high. This gives a question mark about the sustainability of the water sector under these circumstances because of the loss of revenues for the water service providers. The inability of the service provider to register about one third of the revenue, while also increasing the costs and inequities in the distribution among people. In other words, the citizen should pay this cost i.e. the non-revenue water by more than 33% of the current price.

These data indicate that there is a real loss about 16 million cubic meters in the main and distribution lines. One driver of this amount is practically a difference between the Israeli meters and the Palestinian meters. The Israeli occupation imposes on the Palestinian Authority meter readings without any regard for the Palestinian water meters. the Palestinian authority should pay the amount accordingly and always these amounts are deducted from the Palestinian revenue taxes.

Non-Revenue Water & Per Capita

The per capita water consumption indicator is one of the most important economic indicators that measure the per capita consumption from water daily, annually or monthly. In general, in Palestine there is a water shortage problem in the quantity of consumption per capita because of the Israeli occupation control on water sources in Palestine. On the other hand, to make drilling of any well of water, the utility or municipality should gain Israeli approval, even if it is within the areas of the Palestinian Authority. For this reason, Palestinians subsidize the water by digging wells to collect and store the rainwater in the hope that they will continue to consume water during the summer season. Data shows that the per capita of water in Palestine generally is 78 liters per day. This quantity even lower because of several reasons. First, this quantity contains commercial, industrial and tourist consumption i.e. not all these liters are for household consumption. Second, this quantity includes water that is not for human drink, as in the

Gaza governorates. Thirdly, this quantity is intermittent and not continuous as water comes every few weeks in summer and winter.

There is a relationship between the per capita water consumption and non-revenue water. Some studies suggest that the higher the per capita consumption, the lower the non revenue water volume, because there is water availability and that the individual does not have to steal water. The water service is available at low prices so there is no real incentive to steal. Another point of view is that there is a direct correlation between per capita consumption and the non-revenue water. The water is available at a low price and consumption consumes more per capita consumption, but there is no incentive to save water. Thus, the relationship is a direct relationship between the share of the individual and the non-revenue water. Others do not see a significant relationship between the two indicators, where the value of the loss increases or decreases based on leakage reduction projects as well as network maintenance and also buy water meters that can accurately measure the water transfer and movement. However, this data for 2017 according to water service providers in Palestine shows that the per capita indicator varies from one region to another, and the per capita indicator does not go down and go up in relation to the percentage of water losses.

Non-Revenue Water & Price

The water price is the main driver and factor in increasing the revenues from water service. The higher the selling price per cubic meter, the higher

the revenues for the water service provider; therefore, the higher the net profit and the lower the percentage of total financial losses. In Palestine, water is sold according to the water tariff bylaw that issued by the Council of Ministers. Currently, the Palestinian Water Authority is working on issuing a new water tariff bylaw. According to the tariff bylaw and water law as well, the water should be sold incremental increase segments. The higher the per capita consumption, the greater the price per cubic meter. The reason for the incremental increase policy is to encourage consumers not to consume water because of the lack of water in Palestine. Second, to protect the low-level income family. Third, it is to increase the revenues of the water service provider, as some water consumers want to buy large quantities for other uses such as swimming pools and others.

Tariff by-law also calls for separate water connections according to the consumption categories. Where there must be a price for domestic that is different from the price of commercial consumption, industrial and tourism categories. This is due to the fact that companies and commercial factories must pay a higher price than the citizen because these companies use the water for profit purpose and trade rather than human consumption. For example, cola, juice, concrete and others commercial companies and factories.

Average water prices does affect non-revenue water. It is expected that the higher the price of water, the greater the incentive to steal water and illegal connections with the water network. At the same time, this will lead to an

increase in water losses. Other researchers conclude that the higher the price of water, the more the water service provider will have cash and revenue; thus, this water provider can hire staff to protect the network and can use this revenue to maintain the water network. Therefore, the relationship between the price of water and the non-revenue water is inverse relationship.

In Palestine, according to 2017 data for water service providers who providing water to more than 80% of the population of the West Bank and Gaza Strip, the average water price is about NIS 4. These are high prices if compared to third world countries. But the purchase price of the cubic meter water is about 2.85 shekels which is purchased from the Israeli Company Microt. this is cost of purchasing without the costs of transportation, pumping and maintenance. This means that the cost of water is already high and therefore it is necessary to setting the water price high to cover the basic cost.

Water prices in the northern West Bank on average totaled NIS 4.37 per cubic meter of water, while in the middle region area it is 5.16 shekels on average, the southern region area is NIS 5.70, while in the Gaza Strip it is NIS 1.81. The reason for the decline water sales price in Gaza Strip is that the water is high salinity and therefore is not suitable for drinking. the people in Gaza depend on desalination and thus purchase water at high price.

NRW & Cost

Water costs can be divided into several categories. All maintenance materials include services to provide water service such as oil, chlorine, workers' salaries, maintenance tools and others are within this category. There are also administrative costs such as accountants and department managers, and also purchasing costs, including water purchases from the West Bank Water Department, and also there are energy costs. These costs vary with non-revenue water. High maintenance costs in a given period can be explained by the fact that there is maintenance in the water networks and therefore the water loss is expected to decrease as a result of this maintenance. There may also be a positive relationship as the high maintenance on the network reflects the impression that the network is consumed and therefore suffers from high water loss rate. The same applies to staff, energy and other expense items.

The cost of maintenance and operation varies over time and from given region to another region in Palestine. In the northern West Bank for instance, it was NIS 4 to sell one cubic meter of water. Whereas in Jenin city it costs 7 shekels for cubic meter. The increase in costs is due to higher staff costs, as well as higher costs of water purchases from the West Bank Water Department. In central areas, water costs more, with an average cost of 5.7 shekels per cubic meter. This is a high amount compared to the citizen's ability to pay the water bill. In the town of Abu Dis for example the cost is about 7 shekels, Bitonia 6 shekels, Anata 10 shekels. One of the

main reasons for the increase in costs is the purchase of water from the West Bank Water Department or from another service provider, such as the purchase of water by the Municipality of Bitonia from the Jerusalem Water Undertaking. In the south areas however, the cost of water cubic meters of is about NIS 5. The main reasons for these high costs are the costs of purchases. The situation in the governorates of Gaza varies where the average cost per cubic meter is about NIS 3 and this is less cost compared to other areas. The reason for this decline is that Gaza produces water from its underground wells, but unfortunately, this water is not suitable for drinking or human consumption, which means that water is desalinated until it is consumed.

There is no significant relationship between the non-revenue water and water cost categories. However, there is a relationship between energy costs and non-revenue water. The higher the cost of energy the higher the water loss. The non-revenue water always increases in areas that need to be pumped more than the non-revenue water in the areas which rely on gravity. While the higher the water purchases, the lower the water loss. This can be explained as the non-revenue water is more in areas that produce water from areas that buy water from the main networks.

Non-Revenue Water & Collection

The Palestinian water sector suffers from the collection of accumulated receivables on large number of subscribers. The process of debt accumulation begins with the issuing of a monthly water bill by the water

service provider. Invoicing process means lower non-revenue water, more revenue, because non-revenue water means water consumption without bill or illegal consumption. When paying the bill, the citizen or the subscriber pays part of it and the remaining part remains accumulated to the next water cycle. When a small part of the water bill is collected, the water service provider cannot follow up the maintenance and expansion of the network and also pay the accumulated debt payable to its suppliers. Therefore, debt also accrues to the West Bank Water Department as is the bulk water provider. The total accumulated debts of the West Bank Water Department, which is required to be paid by the water service providers, is NIS 1.5 billion. Which is very high and puts the sustainability of the water sector at stake. The West Bank Water Department also pays the bills to the Israeli company Microt. But Microot does not wait for the transfers of the West Bank Water Department but instead pays the water from the clearing bills in what is known as net lending.

Therefore, this indicator is very important because it has to do with the sustainability of the water sector in Palestine. Debt collection is also linked to non-revenue water. The increase in debt collection will increase the cash flows to the water service provider, and then pay the West Bank Water Department and thus increase the quality of service and reduce the losses through periodic maintenance and preventive maintenance schedule.

The collection efficiency indicator is very important for the service provider. The indicator concept can be calculated by the sum of the

amounts of the accumulated debt to the water revenues generated during the year. The higher the percentage of collection efficiency, the greater the ability of the service provider to pay the water invoice to the bulk providers and cost dues, and the lower the ratio, the difficulty the service provider in payment its due amount and perform monthly payment salaries and maintenance.

Collection of receivables varies from region to region. The reasons for the increase in prepaid meters are in several areas. The percentage of collection efficiency in the northern West Bank for instance is averaged 84%, while in the central region it was about 69%. The reasons for this rate compare with the north regions is that the middle the areas there are postpaid meters rather than prepaid installation like in the north region such as Jenin and Tubas. While the average collection in the region of the south was 50%, which means that the subscriber pays only half the amount of water bill throughout the year and the other part will be accumulated to the second period. In Gaza, the percentage is also 50% due to low income, water quality issue, and wars.

Water loss data indicates in the above chart that there is an inverse relationship between non-revenue water indicator and debt collection. In other words, the higher the percentage of debt collection, the lower the non-revenue water. This is due to the fact that the increase in cash will lead to high quality maintenance and the renewal of the network from the water service provider own revenue.

Non-Revenue Water & Provider Size

The size and structure of water service providers in Palestine varies. There is a small size, those are often municipalities and small village councils serve a limited number of subscribers. These village councils are characterized by a short and expanded network because of the lack of population density in the villages. On the other hand, there are also joint services councils, as these councils provide water service to some areas such as many villages. These new institutions have been established by the Ministry of Local Government to reduce costs and increase the quality of water service. The councils may be in the medium size such as Joint Services Council in north-west Jenin, where the number of subscribers can reach up to 7000 connections and serves more than 10 villages.

It can also be in the middle size some municipalities and water associations such as Abu Dis water cooperative association. However, the large size of water providers is two types. The first is the large municipalities and these municipalities are usually in the large cities such as Hebron Municipality, Jenin, Tulkarm, Gaza, Qalqiliya, and others. The second type is the regional utilities, which are water entities with a board of directors and have some direct relation and coordination with the Water Authority and the Ministry of Local Government. While municipalities reported only to the Ministry of Local Government.

Water loss varies depending on size and ownership of the service provider. The large size usually attracts donors, has a number of departments and employees and thus has a greater ability to collect debt and reduce costs and increase the quality of service. However, the water distribution network is expanded and thus the non-revenue water can be more and that thefts can be increased because of the length of the network large number of subscribers. While in the small water providers, the network is short, but the water service is less quality due to the higher costs i.e. economy of scale.

The Water Law calls for the merging the water service providers into regional water utilities, thereby increasing the volume of water service providers so that costs are reduced. This will lead to the restructuring of water service providers. This will have economic implications for reducing costs due to the economy of scale in the future.

The merging will also reduce non-revenue water, increase quality of service, large economic investment, and hence comprehensive process in the economic development. The descriptive statistic results show that there is no significant relationship between the size of water service providers and non-revenue water. Although there is a positive relationship, the more the service provider, the greater the non-revenue water. This is because water losses are high in the water service provider in the city of Jenin and the city of Tulkarem by up to 50%. But also at the same time water losses are lower in medium-sized water service providers compared to small size

water providers. That is, when the size of the service provider increases, the water loss will be reduced.

Economic Value

Non-revenue water varies from region to region. But also, the components of the non-revenue water are different from one region to another as well. Water balance data indicates that water loss is 33%. This means that there is a quantity of 23,309,929 cubic meters of water relative to the quantity of total purchases. According to the water balance, the total non-revenue water quantity is 58,847,303 cubic meters. This amount has a financial and economic value. The financial value depends on the costs at the time of purchase and the selling price at the time of sale. This means that the amount of water, if calculated on the cost of purchase, the value financially equivalent to 176,541,903 shekels annually. Which is a very large amount and is equivalent to $ 49,039,417 per year. If the water loss is calculated based on the average cost of the cubic meter, including maintenance, operation, electricity and other expenses, the amount will rise to 294,236,515 shekels. Which is equivalent to $ 81,732,365. These amounts are very large and put a question mark on the economic importance of reducing water loss and its impact on sustainable development. Expressed in other term, the total value of non-revenue water is equivalent 77 NIS for each individual Palestinian during year 2017. This means that each family can receive the USD 21 each year as value of non-revenue water.

Water balance data shows that the non-revenue water in Palestine is mainly caused by water theft. As a result of theft, non-revenue water accounts for about 40% of total water loss. The thefts are concentrated in the Gaza governorate, especially in Nuseirat. The thefts are also concentrated in the central and southern West Bank, particularly in Anata, Jerusalem, Al-Azariya, Sawahreh Al-Sharqiya and Abu Dis. There is also a rise in illegal connections, especially in the Bethlehem governorate, as well as in the areas south of Hebron, especially Yatta and al-Dhahiriya. In the North West Bank, the illegal connections are concentrated in the Tulkarm governorate, specifically in Tulkarm municipality and Atil municipality.

The water thefts have value as well. The illegal connections in the northern West Bank amounted to about $ 1 million, while in the central West Bank they amounted to about $ 1.2 million. While in the southern regions. About three million and three hundred thousand dollars, which are about three times the central and northern West Bank. While in the Gaza Strip the highest percentage reached about ten million dollars. Thus, the total loss of water due to thefts based on the sales price of water reached in 2017 about 15 million and 500 thousand dollars. These amounts are very high if compared to the social justice of the Palestinian population and the shortage of water in some areas compared to other areas.

The other factor in the non-revenue water is the leakage in the network, whether the water network in the pipeline between cities or through the internal distribution network in the city or the town itself. The non-revenue

water due to this loss is about 27% of total water loss. About $ 16 million worth of losses as a result of this leakage from the networks. Deprecation is generally found in the main cities in the northern West Bank. The reason is that these cities have an old water network and are depreciated and need non-revenue water projects to replace. The highest water losses are due to the depreciation can be found in Tulkarem, Nablus, Jenin, Qalqiliya and other water service providers. While the amount of water leaking in the central West Bank is less than the north, the Jerusalem Water Undertaking has reached about 3 million cubic meters, which is a large quantity and is equivalent to about one million dollars annually. In the south, the leakage is further reduced to nearly one-third as compared to the north and center. This is due to the fact that the water networks are not used at a high rate and that the network usually does not have water. In the Gaza Strip, the leakage is about 4 million cubic meters of water per year, equivalent to about 8 million shekels based on the selling price per water cubic meter.

The lack of accuracy in the meters is also a major problem and one of the water loss factors of water service providers, which accounts for 23% of total water losses. The amount of water loss of this category is about 13.5 million cubic meters of water annually. It is noted that water meters are also connected to the water network, where the more leakage in the network the greater the leakage as a result of the meters. This is due to the fact that changing the meters is usually in conjunction with the change of the water network in water loss reduction projects. Other non-revenue water components such as unbilled water consumption, for which no bill

has been issued, such as consumption for gardens, mosques, churches and others. While only 1% of water loss goes as a result of leaking in reservoirs.

Therefore, there is a difference in non-revenue water components and that it is distributed among the various water service providers. More thefts were observed in the areas that are not under Palestinian security control as well as in the areas that are facing water shortage. There is also water loss due to leakage from the network or reservoirs or the network in the water meters, and this category is more located in areas where there is a quantity of water. In both cases, the non-revenue water of any component has financial and economic value and therefore its reduction helps economic development and social justice for the Palestinian people.

Regression Results

Multicollinearity Diagnostics

When independent variables are correlated, there will be possibility of multicollinearity.

NRW = α+ ß1ce+ ß2dc+ ß3sp+ß4ec+ ß5ps+ ß6pl+ ß7po+ …ε

As other research concluded, the multicollinearity has impact over the regression and it increases estimate of parameter variance, which yields high R Square (Ofir & Andre, 1986), (MELA & KOPALLE, 2002) Tolerance Levels and Variance Inflation Factor (VIF) both are widely used

in the multicollinearity, (O'BRIEN, 2007) tolerance level should be more than or equal to .01 and VIF value is above 10. In this research, all independents variables were examined to determine the existence of multicollinearity. According to Table 1.7 all independents variables have tolerance more than 0.1, on the other hand all of the (VIFs) are less than 10, therefore, this has implied that no multicollinearity exists in the model and all independent variables have been included in the regression. A histogram of standardized residuals shows a normally distributed residual error. However, the figure also shows approximately linear plots, as a result of observed cumulative probabilities of occurrence against expected cumulative probabilities.

Regression Model Fit

One of the good indicators of the model fit is the adjusted R square. It is a statistical measure of how close the collected data are to the fitted regression line that executed. This can be known as a percentage which indicates that the model explains none of the variability of the response data around its mean. A full percentage i.e. 100% indicates that the model explains all the variability of the response data around its mean. The adjusted R squared is a modified version of indicator R-squared that has been adjusted for the number of predictors in the non-revenue water model. In this research Table 1.5 the adjusted R squared equaled value of 0.557, this implies the goodness fit of the overall model, which the relationship between the non-revenue water and the predictors i.e. the independent

variables are good but not strong (Riesinger, 1997). According to the (Zou, 2003) the value of the 0.8 of correlation coefficient value is considered as strongly positive as in terms of direction and strength of correlation.

This thesis shows that the independent factors are able to explain the dependent variable by about 55%, which is a good ratio if we consider that these few factors and their ability to explain and predict the non-revenue water. Compared to previous studies, the adjusted R squared was about 37% in the study of water loss in Palestine, and that the same researcher delivered another research but the application in the Balkan countries. In that research the adjusted R squared was 81%. During that period the researcher relied on large data and visited the Balkan countries and investigated the situation there as part of his mission. in Balkan countries the non-revenue water is on average about 50% (Murrar, 2017).

Predictors & Coefficients

The regression has been developed to measure the non-revenue water in Palestine. Seven predictors have been included, which are: Population, Energy, Collection efficiency, Per Capita, Size, Average Price, HR Cost. The regression results show that Energy, Size, Average Price, HR Cost have significant impact on the non-revenue water. Therefore, based on this relationship, the hypothesis that stated there is no significant relationship between the non-revenue water and Energy, Size, Average Price, HR Cost are rejected. And the regression results show that there is significant relationship between the dependent variable and these predictors where

(Energy, t = 5.749, p = .000, Average Price, t = -4.919, p = .000, HR cost t = 2.466, p = .017, Size, t = 2.065 and p = .043). However, no significant relationship has been found between the non-revenue water and Collection efficiency, Per Capita, and Population.

NRW = α+ ß1ce+ ß2dc+ ß3sp+ß4ec+ ß5ps+ ß6pl+ ß7po+ …ε

The results of this thesis also show that there is a significant relationship between the expenditure of energy or energy cost and non-revenue water, with positive relationship. In other words, if energy cost increases, water losses will increase. This also applies to salary expenses as there is a significant relationship between increased salary expenses and non-revenue water. In fact, increasing the total costs will result in the inability of the water service provider to pay water dues, maintenance work or even periodic maintenance. The increase in electricity bills and employee salaries means that the water service provider must pay the value of these bills which cannot be deferred to the suppliers, and thus decrease the percentage of total profit and increase losses and decrease in cash in the service provider's treasury. Under such circumstances, the service provider cannot issue maintenance order for instance to repair the non-revenue water and reduce the loss rate. This result is consistent with previous studies, which indicated that there is a direct relationship between the costs of electricity, energy, pumping water and water loss (Murrar, 2017). Another explanation for this phenomenon in this research is that a service provider that relies on water pumping has more non-revenue water percentage than

the percentage of non-revenue water for the water provider that relies on gravity to deliver water to consumers. Because the pumping process lead to destroy the meters and pipes in some cases and high-pressure pumping process.

The PWA is seeking to merge water service providers based on a long-term plan to reduce water losses and increase economic efficiency. Hence, the results of this research reveal that the small-scale water service providers suffer from high non-revenue water volume, while the medium size is the lowest proportion in water loss compared to the large and small size. This is due to the fact that the high-water losses have been observed in large cities such as Jenin, Tulkarm, Nablus and others. The loss is expected to decrease due to water loss reduction projects.

The results of this study are also consistent with previous studies on the relationship between water consumption and non-revenue water. The results reveal that the higher the water consumption, the lower the non-revenue water. However, there is negative relationship between the collection efficiency and non-revenue water i.e. the debt collection ratio. The availability of cash with the water service provider will substantially help to pay maintenance fees and materials for reducing water losses that is why there is negative relationship is found in this issue.

Regression Results

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.324	.051		6.322	.000		
	Avg Price	-.036	.007	-.627	-4.919	.000	.400	2.499
	Energy	.085	.015	.548	5.749	.000	.716	1.397
	Collection efficiency	-.049	.042	-.115	-1.158	.251	.665	1.505
	HR Cost	.056	.023	.326	2.466	.017	.373	2.678
	Per Capita	.000	.000	-.113	-1.167	.248	.695	1.439
	Size	.039	.019	.236	2.065	.043	.497	2.013
	Population	-1.668E-7	.000	-.161	-1.470	.147	.540	1.851

a. Dependent Variable: NRW

Chapter Five

Conclusion & Recommendations

Conclusion Summary

The reservation of natural and economic resources is one of the most important factors that can help in economic development and economic growth. One of the important natural sources is water. Water is associated with many indicators with the economy. As water is one of the main raw material and input factor in the production process of many economic sectors. For example, agriculture and manufacturing, especially in water-based plants such as cola, juice and laundry, as well as cement and concrete. Therefore, water has an economic value and contributes to many job creation and economic expansion in many sectors. Investment in water projects are one of the most important projects that achieve high return on investment. Economic expansion needs political and social stability. Water is one of the most important variables for a society because the societies simply cannot live without water. The lack of water per capita will spread diseases and epidemics. The lack of adequate water will also impact the stability of society. Human beings are in high need of water and willing to pay a high price for water especially in the summer season.

In view of the importance of water and its close relationship with the economic activities, the central and local government must design policies to maintain this natural resource, and remove all obstacles that may cause

waste of water. One aspect of water conservation is to stop non-revenue water and thus reduce water loss. Non-revenue water is the unaccounted water quantity between the quantity of water produced and purchased, and the quantity of water invoiced to the final consumer. The reality of this ratio varies from one country to another. In developed countries for instance this percentage does not exceed 15% in all cases, in some European countries the non-revenue volumes do not exceed water 7%. In developing countries, water losses reach 50% even more. In fact, the greater the non-revenue water, the greater the waste of water, the greater the loss to society of this natural resource. One aspect that causes social injustice is water theft and illegal connections with the distribution network.

The results of this study reveal that the non-revenue water in Palestine has a real economic value. Water balance data indicates that water loss is 33% (Murrar, 2016). The total non-revenue water quantity is 58,847,303 cubic meters (Murrar, 2016). The financial value of non-revenue water depends on the costs at the time of purchase and the selling price at the time of sale. This means that the amount of water, if calculated on the cost of purchase is equivalent to 176,541,903 shekels annually. Which is equivalent to $ 49,039,417 per year. If the water loss is calculated based on the average cost of the cubic meter, including maintenance, operation, electricity and other expenses, the amount will definitely rise to 294,236,515 shekels. Which is equivalent to $ 81,732,365. These amounts are very large and raise a question on the economic importance of reducing water loss and its

impact on sustainable development. The results of this study reveal that the total value of non-revenue water is equivalent 77 NIS for each individual Palestinian during year 2017. This means that each family can receive the $ 21 each year as value of non-revenue water. (Murrar, 2016)

Water balance data shows that the non-revenue water in Palestine is mainly caused by water theft. As a result of theft, non-revenue water accounts for about 40% of total water loss. The water thefts have value as well. The illegal connections in the northern West Bank amounted to about $ 1 million, while in the central West Bank they amounted to about $ 1.2 million. While in the southern regions, it reached three million and three hundred thousand dollars, which are about three times the central and northern West Bank. While in the Gaza Strip the highest percentage reached about ten million dollars. Thus, the total loss of water due to thefts based on the sales price of water reached in 2017 about 15 million and 500 thousand dollars. These amounts are very high if compared to the social justice of the Palestinian population. (Murrar, 2016)

This study shows that other factor which impacts the non-revenue water is the leakage in the network, whether the water network is in the pipeline between cities or through the internal distribution network in the city or the town itself. The non-revenue water due to this loss is about 27% of total water loss. The amount $ 16 million worth of losses as a result of this leakage from the networks. Deprecation is generally found in the main cities in the northern West Bank. The reason is that these cities have an old

water network and are depreciated and need non-revenue water projects to replace it. The amount of water leaking in the central West Bank is less than the North, the Jerusalem Water Undertaking has reached about 3 million cubic meters, which is a large quantity and worth one million dollars annually. In the South, the leakage is about one-third of as compared to the North and Center. In the Gaza Strip, the leakage is about 4 million cubic meters of water per year, equivalent to about 8 million shekels based on the selling price per water cubic meter.

This finding indicates well to the lack of accuracy in the meters as also a major problem and one of the water loss factors of water service providers. This driver (inaccuracy) accounts for 23% of total water losses. The amount of water loss of this category is about 13.5 million cubic meters of water annually. Other non-revenue water components such as unbilled water consumption, for which no bill has been issued, such as consumption for gardens, mosques, churches and others. While only 1% of water loss goes as a result of leaking in reservoirs.

Based on these findings, this study tries to explain the factors that impact non-revenue water drivers. Therefore, a regression analysis has been utilized, data has been collected from secondary source for three previous years as cross-sectional data. Seven predictors have been included, which are: Population, Energy, Collection efficiency, Per Capita, Size, Average Price, HR Cost. The regression results show that Energy, Size, Average Price, HR Cost have significant impact on the non-revenue water.

Therefore, based on this relationship, the hypothesis that stated there is no significant relationship between the non-revenue water and Energy, Size, Average Price, HR Cost is rejected.

However, no significant relationship has been found between the non-revenue water and Collection efficiency, Per Capita, and Population.

The study shows that variable water sales price is one of the factors which is significantly associated with non-revenue water, with a negative relationship. This means, the higher the sales price of water, the lower the non-revenue water. The increase in price will lead to an increase in water revenues, which means there is more profit or less financial loss due to higher revenues. This will have a positive impact on the financial position of the water service provider and this enables the provider to make periodic maintenance work, employing engineers to reduce water losses, buying pipes, software, meters, and so on.

The results of this thesis also show that there is a significant and positive relationship between the expenditure of energy or energy cost and non-revenue water. i.e. if energy cost increases, water losses will increase. This also applies to salary expenses which shows a significant relationship between increased salary expenses and non-revenue water. This result is consistent with previous studies, which indicated that there is a direct relationship between the costs of electricity, energy, pumping water and water loss.

Policy Implications

It is clear that there is a difference in non-revenue water, thefts is important factor in the areas that are not under Palestinian security control as well as in the areas that are facing water shortage. There is also water loss due to leakage from the networks or reservoirs or the network in the water meters, and this category is more located in areas where there is a quantity of water. In both cases, the non-revenue water has financial and economic value and therefore its reduction helps economic development and social justice for the Palestinian people.

This finding is important for policy makers and all other stakeholders to work to decrease the nonrevenue water. However, based on suggested literature reviews and analysis, correlation, regression results and other site visits, suggested the recommendations for better performance and economic development in water sector and other related sectors that always affected by the water sector.

- The study recommends the need to reduce water losses in areas suffering from high water losses such as Jenin, Tulkarm, Anata, Sawahra, and Gaza Strip such as Nusseirat and others. The study recommends to start investigating the non-revenue water first in these areas and study the causes of non-revenue water. The thesis shows that there are several components of the water loss and it varies from one region to another. While there is a high percentage of thefts in areas such as Anata, Al-Dhahiriya and Yatta, the reason for the loss of water is the weakness in data recording.

Therefore, the study recommends the need to identify water loss projects based on an in-depth analysis before starting the process and implementation of these projects.

- This thesis recommends increasing the price in some areas of water providers in the hope of decreasing the accumulated financial losses, decreasing the non-revenue water, replacing the current old meters and increase the debt collections.

- The study recommends the need to build the capacities of the water staff members who work in water service providers, the necessity of giving them the required training in reducing water loss.

References

[1] Murrar (2017). ***The Determinants of Non-Revenue Water in Balkan Countries.*** **American Journal of Water Science and Engineering**. Vol. 3, No. 2, 2017, pp. 18-27. doi: 10.11648/j.ajwse.20170302.11

[2] Tamimi, Murrar, Samhan (2017). ***The Determinants of Non-Revenue Water & Financial Viability for the Palestinian Water Service Providers***. **Journal of Water Resources and Ocean Science**. Vol. 6, No. 2, 2017, pp. 35-45. doi: 10.11648/j.wros.20170602.12.

[3] Ismail A. (2009). ***Water is the economic and sustainable natural resource.*** **Aleqtisadi journal**.

http://www.aleqt.com/2009/05/01/article_13618.html. Access date 09/03/2019.

[4] MUHAMMETOĞLU et al. ***Management of Water Losses in Water Supply and Distribution Networks in Turkey***. **TURKISH JOURNAL OF WATER SCIENCE & MANAGEMENT**. http://dergipark.gov.tr/download/article-file/410298

[5] Baietti, Kingdom, Ginneken, (2006). **Characteristics of well-performing public water utilities**. Infrastructure Network of the World Bank Group. Note No. 9, May 2006. http://www.worldbank.org/watsan/bnwp

[6] Berg. Caroline van den (2014). **The Drivers of Non-Revenue Water How Effective Are Non-Revenue Water Reduction Programs? Water Global Practice Group**. World Bank. Policy Research Working Paper 6997

[7] Biswas & Tortajada, (2010). **Water Supply of Phnom Penh: An Example of Good Governance.** Water Resources Development, Vol. 26, No. 2, 157–172, June 2010.

[8] Ofir & Andre, (1986). ***Multicollinearity in marketing models: Diagnostics and remedial measures***. **International Journal of Research in Marketing** 3(3):181-205. DOI: 10.1016/0167-8116(86)90023-6.

[9] Dighade, Kadu &Pande. (2015). ***Non-Revenue Water Reduction Strategy in Urban Water Supply. System in India***. **International Journal of Research in Engineering and Applied Science**. Vol.03. Issue. 0,1 Jan 2015.ISSN Print 22499210- Online 23481862.

[10] FA Couvelis & JE van Zyl. (2015). **Apparent losses due to domestic water meter under-registration in South Africa**. Published under a Creative Commons Attribution Licence. http://dx.doi.org/10.4314/wsa.v41i5.13 Available on website http://www.wrc.org.za ISSN 1816-7950 (On-line) = Water SA Vol. 41 No. 5 October 2015.

[11] Fanner P., Sturm R., Thornton J., and Liemberger R. (2007) **Leakage Management Technologies**. Awwa Research Foundation, American water Works Association, IWA Publishing. 2007 Awwa RF.

[12] GJINALI E., Giantris P. (2014). ***Non-Revenue Water and Some Simple Economics for Developing Counties***. **Online International Interdisciplinary Research Journal,** {BiMonthly}, ISSN2249-9598, Volume-IV, Nov 2014 Special Issue.

[13] González-Gómez F., García-Rubio M. & Guardiola J. (2011). ***Why Is Non-Revenue Water So High in So Many Cities?*** **International Journal of Water Resources Development** Volume 27, 2011 - Issue 2.

[14] International Water Association. (2018). **Water Loss. IWA Publishing**. http://www.iwa-network.org/groups/water-loss/. Access date 28/12/2018.

[15] Jerusalem Water Undertaking (2016) Foundation of JWU. **Historical Background**. Published on May 23, 2016. http://www.jwu.org/jwu/?p=1698&lang=en. Jan 28, 2018.

[16] Kingdom. B, Liemberger. R, & Marin P. (2006). **The Challenge of Reducing Non-Revenue Water (NRW) in Developing Countries How the Private Sector Can Help: A Look at Performance-Based Service Contracting.** THE WORLD BANK GROUP Washington, DC. PPIAF. Water Supply and Sanitation Sector Board Discussion Paper Series no.8.

[17] Malcolm Farley et al. **The Manager's Non-Revenue Water Handbook. A Guide to Understanding Water Losses**. Ranhill Utilities Berhad and the United States Agency for International Development (USAID) jointly funded the publication of this report. AECOM International Development provided assistance under USAID contract 486-C-00-05-00010-00. 23 June 2008

[18] Mela & Kopalle, (2002). **The impact of collinearity on regression analysis: the asymmetric effect of negative and positive correlations**. Applied Economics, ISSN 0003±6846 print/ISSN 1466±4283 online # 2002 Taylor & Francis Ltd 2002, 34, 667±677

[19] Vermersch, (2016). **Guidance Notes on Apparent Losses and Water Loss Reduction Planning.** IWA Water Loss Specialist Group. http://www.leakssuite.com/wp-content/uploads/2016/09/AL-Guidance-Note-Final-15th-Sep-2016.pdf

[20] O'BRIEN. (2007). **A Caution Regarding Rules of Thumb for Variance Inflation Factors.** Quality & Quantity (2007) 41:673–690. DOI 10.1007/s11135-006-9018-6

[21] Palestinian Water Authority. (2015). **Desalination Facility Project: Necessity, Politics and Energy**. Gaza Strip http://www.pwa.ps/userfiles/file/DesalinationReportEnglish.pdf

[22] Palestinian Water Authority. (2017). **Non-Revenue Water Policy**. Draft 2. July 2017.

[23] Perera, Mallawaarachchi, Jayasanka & Rathnayake, (2018). **A Water Management System for Reducing Non-Revenue Water in Potable Water Lines: The Case of Sri Lanka**. ENGINEER - Vol. LI, No. 02, pp. [53-62], 2018. DOI: http://doi.org/10.4038/engineer.v51i2.7295

[24] PWA et al. Water Governance in Palestine. **SECTOR REFORM TO INCLUDE PRIVATE SECTOR PARTICIPATION**. NATIONAL REPORT 2015. Governance & Financing for the Mediterranean Water Sector

[25] Ramirez, J. C. B. (2008) **Non-Revenue Water Reduction Programs in Colombia: Methodology Analysis using a System Dynamics Approach, M. Phil.** Thesis in System Dynamics, University of Bergen

[26] Richards, Gregory L.; (2010***). Apparent Losses Caused by Water Meter Inaccuracies at Ultralow Flows***. **Journal - American Water Works Association.** Volume / Number: 102, Number 5. Page(s): 123-132. JAW_0071985.

[27] Golfinopoulos , B. Arhonditsis (2002). **Multiple regression models: A methodology for evaluating trihalomethane concentrations in drinking water from raw water characteristics**. Elsevier Science Ltd. Chemosphere 47 (2002) 1007–1018.

[28] State of Palestine (2012). **Non-Revenue Water Reduction Strategy. Palestinian Water Authority**. 2012. Final Draft Document. http://www.pwa.ps/userfiles/server/policy/NON-REVENUE WATER REDUCTION STRATEGY.pdf. February 02, 2018.

[29] State of Palestine (2014) Decree No. **14 for Year 2014 Relating to the Water Law.** Palestinian Water Authority.

[30] Bartfuss et al. **Accuracy of In-service Water Meters at Low and High Flow Rate.** Water Research Foundation. ISBN 978-160573-148-3. USA.

[31] The National Water Commission. (2018). **Illegal connections affecting water supply**. http://jamaica-star.com/article/news/20180824/illegal-connections-affecting-water-supply. Access Date 28.12.2018.

[32] UN Environment. (2018). **Progress on Integrated water resources management. Global Baseline for SDG 6 indicators**. Clean Water and Sanitation 6. http://www.un.org/waterforlifedecade/iwrm.shtml. Access date 28/12/2018.

[33] UN-Habitat. (2012). **Water Audit Manual. Utility Management Series for Small Towns.** United Nations Human Settlements Programme 2012. ISBN (Series) 978-92-1-133404-3 ISBN (Volume) 978-92-1-132534-8. Volume 4.

https://www.zaragoza.es/contenidos/medioambiente/onu//newsletter15/966-eng-v4.pdf.

[34] Brown (2017). ***Water Theft and Water Smuggling: Growing Problem or Tempest in a Teapot? Foreign Policy at Brookings Water Theft and Water Smuggling.*** **JPMorgan Chase, and is part of the Global Cities Initiative.** March 2017.

[35] WA Wegelin, RS McKenzie, Z Siqalaba. (2014). **Guideline for the preparation of an IWA water balance to determine Non-Revenue Water and Water losses.** Republish of South Africa. http://mfmamirror.s3.amazonaws.com/RegulationsandGazettes/MunicipalRegulationsOnAStandardChartOfAccountsFinal/Documents/Position%20papers%20(exposure%20drafts)/07b.%20Water%20Balance%20Guideline%202014-09-10%20compressed.pdf

[36] Water Sector Regulatory Council (2013) **Water Services Providers Performance Report 2013.** Water Sector Regulatory Council. 2013.1. www.wsrc.ps.

[37] Water Sector Regulatory Council (2014) **Water Services Providers Performance Report 2014**. Water Sector Regulatory Council. http://www.wsrc.ps/

[38] Water Sector Regulatory Council (2015) **Water Services Providers Performance Report 2015**. Water Sector Regulatory Council. http://www.wsrc.ps/

[39] Kelly H. Zou, (2003). **Statistical Concepts Series Correlation and Simple Linear Regression.** Radiology 2003; 227:617– 628. 10.1148/radiol.2273011499

Appendix

Table 1.1: Variables Descriptive Statistics

	Mean	Std. Deviation	N
NRW	.3175	.11562	69
Avg Price	3.8493	2.03204	69
Energy	.691043	.7491374	69
Collection efficiency	.6384	.27107	69
HR Cost	1.0217	.66983	69
Per Capita	87.4280	46.26435	69
Size	2.217	.7044	69
Population	91867.935	111854.9948	69

Table 1.2: Correlations

		NRW	Avg Price	Energy	Collection efficiency	HR Cost	Per Capita	Size	Population
Pearson Correlation	NRW	1.000	-.284	.585	-.280	.159	.079	.104	-.028
	Avg Price	-.284	1.000	.178	.465	.663	-.513	.202	.140
	Energy	.585	.178	1.000	-.074	.404	-.064	-.027	-.048
	Collection efficiency	-.280	.465	-.074	1.000	.435	-.086	.156	.131
	HR Cost	.159	.663	.404	.435	1.000	-.300	.370	.265
	Per Capita	.079	-.513	-.064	-.086	-.300	1.000	-.133	-.149
	Size	.104	.202	-.027	.156	.370	-.133	1.000	.672
	Population	-.028	.140	-.048	.131	.265	-.149	.672	1.000
Sig. (1-tailed)	NRW	.	.009	.000	.010	.095	.260	.197	.409
	Avg Price	.009	.	.071	.000	.000	.000	.048	.125
	Energy	.000	.071	.	.273	.000	.300	.411	.349
	Collection efficiency	.010	.000	.273	.	.000	.240	.100	.142
	HR Cost	.095	.000	.000	.000	.	.006	.001	.014
	Per Capita	.260	.000	.300	.240	.006	.	.138	.111
	Size	.197	.048	.411	.100	.001	.138	.	.000
	Population	.409	.125	.349	.142	.014	.111	.000	.
N	NRW	69	69	69	69	69	69	69	69
	Avg Price	69	69	69	69	69	69	69	69
	Energy	69	69	69	69	69	69	69	69
	Collection efficiency	69	69	69	69	69	69	69	69
	HR Cost	69	69	69	69	69	69	69	69
	Per Capita	69	69	69	69	69	69	69	69
	Size	69	69	69	69	69	69	69	69
	Population	69	69	69	69	69	69	69	69

Table 1.3: Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.777[a]	.603	.557	.07692	.603	13.235	7	61	.000

a. Predictors: (Constant), Population, Energy, Collection efficiency, Per Capita, Size, Avg Price, HR Cost

b. Dependent Variable: NRW

Table 1.4: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.548	7	.078	13.235	.000[b]
	Residual	.361	61	.006		
	Total	.909	68			
a. Dependent Variable: NRW						
b. Predictors: (Constant), Population, Energy, Collection efficiency, Per Capita, Size, Avg Price, HR Cost						

Table 1.5: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.324	.051		6.322	.000		
	Avg Price	-.036	.007	-.627	-4.919	.000	.400	2.499
	Energy	.085	.015	.548	5.749	.000	.716	1.397
	Collection efficiency	-.049	.042	-.115	-1.158	.251	.665	1.505
	HR Cost	.056	.023	.326	2.466	.017	.373	2.678
	Per Capita	.000	.000	-.113	-1.167	.248	.695	1.439
	Size	.039	.019	.236	2.065	.043	.497	2.013
	Population	-1.668E-7	.000	-.161	-1.470	.147	.540	1.851
a. Dependent Variable: NRW								

Table 1.6: All Variables Correlations

		NRW	Cap	Price	OC	HR	Purch	Energy	Other	Dbt Co	Wk ratio	Staff Indx	Population	Size	Post PD	Prepaid	Metrs	Location	PP %	Year
NRW	Pearson Correlation	1	.079	-.284*	-.071	.159	-.515**	.585**	.243*	-.280*	.197	.117	-.028	.104	-.076	-.700*	-.099	.285*	-.268*	-.117
	Sig. (2-tailed)		.520	.018	.561	.191	.000	.000	.044	.020	.105	.338	.817	.394	.534	.016	.421	.018	.026	.337
	N	69	69	69	69	69	69	69	69	69	69	69	69	69	69	11	69	69	69	69
Per Capita	Pearson Correlation	.079	1	-.513**	-.531**	-.300*	-.510**	-.064	-.168	-.086	-.043	.075	-.149	-.133	-.149	-.242	-.158	.125	-.099	-.008
	Sig. (2-tailed)	.520		.000	.000	.012	.000	.601	.167	.480	.727	.539	.222	.275	.222	.473	.196	.305	.416	.951
	N	69	69	69	69	69	69	69	69	69	69	69	69	69	69	11	69	69	69	69
Avg Price	Pearson Correlation	-.284*	-.513**	1	.833**	.663**	.650**	.178	.370**	.465**	-.285*	-.188	.140	.202	.335**	.125	.347**	-.589**	.111	.142
	Sig. (2-tailed)	.018	.000		.000	.000	.000	.143	.002	.000	.018	.122	.251	.097	.005	.713	.004	.000	.362	.246
	N	69	69	69	69	69	69	69	69	69	69	69	69	69	69	11	69	69	69	69
Operating Cost	Pearson Correlation	-.071	-.531**	.833**	1	.802**	.675**	.301*	.633**	.380**	.184	-.158	.198	.266*	.370**	-.166	.373**	-.409**	.000	.108
	Sig. (2-tailed)	.561	.000	.000		.000	.000	.012	.000	.001	.131	.195	.102	.027	.002	.626	.002	.000	.998	.376
	N	69	69	69	69	69	69	69	69	69	69	69	69	69	69	11	69	69	69	69
HR Cost	Pearson Correlation	.159	-.300*	.663**	.802**	1	.235	.404**	.754**	.435**	.103	.003	.265*	.370**	.442**	-.326	.439**	-.471**	-.076	.187
	Sig. (2-tailed)	.191	.012	.000	.000		.052	.001	.000	.000	.398	.978	.028	.002	.000	.328	.000	.000	.536	.124
	N	69	69	69	69	69	69	69	69	69	69	69	69	69	69	11	69	69	69	69
Purchase Cost	Pearson Correlation	-.515**	-.510**	.650**	.675**	.235	1	-.382**	-.009	.283*	.074	-.262*	.154	.134	.239*	.277	.252*	-.176	.144	.002
	Sig. (2-tailed)	.000	.000	.000	.000	.052		.001	.941	.018	.544	.030	.207	.273	.048	.410	.037	.149	.239	.984
	N	69	69	69	69	69	69	69	69	69	69	69	69	69	69	11	69	69	69	69
Energy	Pearson Correlation	.585**	-.064	.178	.301*	.404**	-.382**	1	.478**	-.074	.055	.078	-.048	-.027	.008	-.352	-.002	-.138	-.133	-.007
	Sig. (2-tailed)	.000	.601	.143	.012	.001	.001		.000	.545	.653	.526	.697	.823	.946	.288	.990	.257	.277	.956
	N	69	69	69	69	69	69	69	69	69	69	69	69	69	69	11	69	69	69	69

Other Cost	Pearson Correlation	.243*	-.168	.370**	.633**	.754**	-.009	.478**	1	.260*	.320**	.029	.088	.263*	.232	-.389	.223	-.360**	-.152	.209
	Sig. (2-tailed)	.044	.167	.002	.000	.000	.941	.000		.031	.007	.810	.470	.029	.055	.237	.065	.002	.213	.085
	N	69	69	69	69	69	69	69	69	69	69	69	69	69	69	11	69	69	69	69
Collection efficiency	Pearson Correlation	-.280*	-.086	.465**	.380**	.435**	.283*	-.074	.260*	1	-.104	-.093	.131	.156	.298*	.142	.311**	-.551**	.142	.264*
	Sig. (2-tailed)	.020	.480	.000	.001	.000	.018	.545	.031		.395	.446	.283	.201	.013	.676	.009	.000	.244	.028
	N	69	69	69	69	69	69	69	69	69	69	69	69	69	69	11	69	69	69	69
Working ratio	Pearson Correlation	.197	-.043	-.285*	.184	.103	.074	.055	.320**	-.104	1	.016	-.035	-.161	-.074	-.629*	-.080	.306*	-.078	-.045
	Sig. (2-tailed)	.105	.727	.018	.131	.398	.544	.653	.007	.395		.898	.773	.187	.547	.038	.512	.011	.525	.715
	N	69	69	69	69	69	69	69	69	69	69	69	69	69	69	11	69	69	69	69
Staff productivity	Pearson Correlation	.117	.075	-.188	-.158	.003	-.262*	.078	.029	-.093	.016	1	.104	.137	.028	-.423	.024	.153	-.058	-.112
	Sig. (2-tailed)	.338	.539	.122	.195	.978	.030	.526	.810	.446	.898		.393	.261	.817	.195	.846	.209	.638	.361
	N	69	69	69	69	69	69	69	69	69	69	69	69	69	69	11	69	69	69	69
Population	Pearson Correlation	-.028	-.149	.140	.198	.265*	.154	-.048	.088	.131	-.035	.104	1	.672**	.883**	-.151	.883**	.121	-.064	.098
	Sig. (2-tailed)	.817	.222	.251	.102	.028	.207	.697	.470	.283	.773	.393		.000	.000	.657	.000	.323	.603	.423
	N	69	69	69	69	69	69	69	69	69	69	69	69	69	69	11	69	69	69	69
Size	Pearson Correlation	.104	-.133	.202	.266*	.370**	.134	-.027	.263*	.156	-.161	.137	.672**	1	.626**	-.159	.626**	-.005	-.050	.206
	Sig. (2-tailed)	.394	.275	.097	.027	.002	.273	.823	.029	.201	.187	.261	.000		.000	.640	.000	.968	.683	.090
	N	69	69	69	69	69	69	69	69	69	69	69	69	69	69	11	69	69	69	69
Post Paidconnections	Pearson Correlation	-.076	-.149	.335**	.370**	.442**	.239*	.008	.232	.298*	-.074	.028	.883**	.626**	1	-.283	.997**	-.084	-.118	.179
	Sig. (2-tailed)	.534	.222	.005	.002	.000	.048	.946	.055	.013	.547	.817	.000	.000		.399	.000	.493	.333	.141
	N	69	69	69	69	69	69	69	69	69	69	69	69	69	69	11	69	69	69	69
Prepaid	Pearson Correlation	-.700*	-.242	.125	-.166	-.326	.277	-.352	-.389	.142	-.629*	-.423	-.151	-.159	-.283	1	-.158	-.106	.941**	.179
	Sig. (2-tailed)	.016	.473	.713	.626	.328	.410	.288	.237	.676	.038	.195	.657	.640	.399		.642	.756	.000	.598

	N	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Connections	Pearson Correlation	-.099	-.158	.347**	.373**	.439**	.252*	-.002	.223	.311**	-.080	.024	.883**	.626**	.997**	-.158	1	-.096	-.051	.207
	Sig. (2-tailed)	.421	.196	.004	.002	.000	.037	.990	.065	.009	.512	.846	.000	.000	.000	.642		.432	.677	.088
	N	69	69	69	69	69	69	69	69	69	69	69	69	69	69	11	69	69	69	69
Location	Pearson Correlation	.285*	.125	-.589**	-.409**	-.471**	-.176	-.138	-.360**	-.551**	.306*	.153	.121	-.005	-.084	-.106	-.096	1	-.142	-.154
	Sig. (2-tailed)	.018	.305	.000	.000	.000	.149	.257	.002	.000	.011	.209	.323	.968	.493	.756	.432		.246	.207
	N	69	69	69	69	69	69	69	69	69	69	69	69	69	69	11	69	69	69	69
PP Percenage	Pearson Correlation	-.268*	-.099	.111	.000	-.076	.144	-.133	-.152	.142	-.078	-.058	-.064	-.050	-.118	.941**	-.051	-.142	1	.325**
	Sig. (2-tailed)	.026	.416	.362	.998	.536	.239	.277	.213	.244	.525	.638	.603	.683	.333	.000	.677	.246		.006
	N	69	69	69	69	69	69	69	69	69	69	69	69	69	69	11	69	69	69	69
Year	Pearson Correlation	-.117	-.008	.142	.108	.187	.002	-.007	.209	.264*	-.045	-.112	.098	.206	.179	.179	.207	-.154	.325**	1
	Sig. (2-tailed)	.337	.951	.246	.376	.124	.984	.956	.085	.028	.715	.361	.423	.090	.141	.598	.088	.207	.006	
	N	69	69	69	69	69	69	69	69	69	69	69	69	69	69	11	69	69	69	69
*. Correlation is significant at the 0.05 level (2-tailed).																				

Table 1.7: All Variables Descriptive Statistics for data 2017

	N	Range	Minimum	Maximum	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
NRW	84	.70	.02	.72	.2845	.01391	.12748	.016
Capita	84	214.33	18.10	232.43	78.5667	3.67577	33.68898	1134.947
Price	84	8.29	1.00	9.29	4.0144	.20876	1.91334	3.661
Operating Cost	84	10.53	.84	11.37	4.3576	.23731	2.17500	4.731
HR Cost	84	3.52	.15	3.67	.8727	.06376	.58433	.341
Purchase Cost	84	9.3990	.0010	9.4000	2.276679	.2235196	2.0485914	4.197
Energy	84	2.4890	.0010	2.4900	.417262	.0542346	.4970683	.247
Other Cost	84	2.64	.10	2.74	.7939	.05595	.51281	.263
Collection	84	1.51	.06	1.57	.6296	.03360	.30798	.095
Working ratio	84	2.72	.31	3.03	1.1331	.05787	.53039	.281
Staff productivity	84	20.35	1.16	21.51	4.6071	.32456	2.97462	8.848
Population	84	597654.0	2000.0	599654.0	45636.244	9372.6275	85901.5497	7379076238.642
Size	84	2	1	3	1.68	.074	.679	.462
Post Paid	84	66754.0	7.0	66761.0	5495.940	1240.7238	11371.4214	129309224.153
Prepaid	84	7603.0	.0	7603.0	480.655	147.8395	1354.9712	1835947.048
Connections	84	66561.0	200.0	66761.0	5976.595	1235.5319	11323.8370	128229285.111
Location	84	3.0	1.0	4.0	2.548	.1327	1.2164	1.480
Year	84	.0	2017.0	2017.0	2017.000	.0000	.0000	.000
PP Percentage	84	428.571	.000	428.571	10.19296	5.419971	49.674853	2467.591
Persons Connection	84	15.4	3.4	18.8	7.572	.3191	2.9243	8.552
Valid N (listwise)	84							

جامعة النجاح الوطنية

كلية الدراسات العليا

فاقد المياه في فلسطين / المحددات الاقتصادية وسياسات التخفيض

إعداد

ولاء مصطفى محمد أيوب

إشراف

أ. د. جهاد ياسين

قدمت هذه الأطروحة استكمالاً لمتطلبات الحصول على درجة الماجستير في إدارة السياسة الاقتصادية، بكلية الدارسات العليا، في جامعة النجاح الوطنية، نابلس- فلسطين.

2019

فاقد المياه في فلسطين / المحددات الاقتصادية وسياسات التخفيض

إعداد

ولاء مصطفى محمد أيوب

إشراف

أ. د. جهاد ياسين

الملخص

في فلسطين، المصادر الطبيعية الاقتصادية محدودة بسبب سيطرة الاحتلال الإسرائيلي على هذه المصادر. لا تستطيع السلطة الفلسطينية التنقيب عن النفط والغاز لان الاحتلال سبق وان منع ذلك. اما المياه فهي عصب الحياة، فان الاحتلال الإسرائيلي يمنع بتاتاً حفر الابار حتى ولو كانت في مناطق سيطرة السلطة الفلسطينية مثل المدن الرئيسية. امام هذه الظروف، فان المواطن الفلسطيني يعاني من نقص شديد في المياه، بل ان طوابير المواطنين تصطف في محافظة الخليل لتسجيل أسمائهم لشراء تنكات المياه في فصل الصيف بواقع اضعاف سعر متر المياه المكعب.

ان الحفاظ على الموارد الطبيعية واهمها المياه سيؤدي بلا شك في زيادة التنمية الاقتصادية المحلية ورفع مستوى النمو الاقتصادي. ان الماء هو أحد اهم عوامل الإنتاج في العديد من القطاعات الإنتاجية ومثالها الزراعة، كذلك أصبح اليوم مفهوم الزراعة المائية والذي يعتمد كلياً على المياه. بالإضافة الى ذلك، فان المياه تدخل كعامل انتاج في العديد من الصناعات الهامة مثل صناعة العصائر والمشروبات الغازية، صناعة الدواء، الباطون الجاهز والحجر وغيرها. بل ان المياه يدخل في تركيبة العديد من المنتجات الصناعية وتشغيل العديد من الصناعات لغايات متعددة.

أصبح هناك توجه في بعض الدول على الاستثمار في المشاريع الاقتصادية التي تدر عائد على الاستثمار وان احدى فئات هذه المشاريع هي المشاريع المائية. يشير تقرير الأمم المتحدة إلى أن الاستثمار في المشاريع الصغيرة لتوفير خدمات المياه المأمونة ومرافق الصرف الصحي في قارة أفريقيا يمكن أن يوفر عائدا اقتصاديا على الاستثمار يقدر بحوالي 28.4$ مليار دولار في السنة،

أو ما يقارب 5٪ من الناتج المحلي الإجمالي للقارة. وهو مبلغ مرتفع جدا وعائد مجدي بالنسبة الى الاستثمار الاقتصادي في هذا القطاع.

وليس الامر مرتبط في الدول النامية، بل ان ذلك أيضا في الدول المتقدمة. حيث يشير تقرير الأمم المتحدة الى أن لمثل هذه الاستثمارات أيضا تأثير مفيد على العمل والحد من البطالة. ففي الولايات المتحدة يخلق كل استثمار بمليون دولار في البنية التحتية للمياه ما بين 10 و20 وظيفة إضافية في نفس القطاع وبشكل مستدام. ويتشابك قطاع المياه مع القطاعات الإنتاجية الأخرى بحيث تخلق كل وظيفة يتم إنشاؤها في قطاع المياه والصرف الصحي في الولايات المتحدة 3.68 فرصة عمل غير مباشرة في القطاعات الإنتاجية الاقتصادية الاخرى. اما في أمريكا اللاتينية أظهرت دراسة أخرى أن استثمار بليون دولار في توسيع خدمات المياه والصرف الصحي يخلق 100 ألف وظيفة بشكل مباشر. وهذا يدل على أهمية قطاع المياه في التنمية الاقتصادية وانتهاج السياسات المائية الاقتصادية لزيادة عملية التنمية وان تكون شاملة لكافة القطاعات الاقتصادية.

في فلسطين، يعاني قطاع المياه من الخسائر المالية المتراكمة، انقطاع خدمة المياه عن العديد من المناطق الفلسطينية، نقص كمية المياه الى المستويات الدنيا، وغيرها العديد من المؤشرات الاقتصادية الهامة. ففي الوقت التي حددت فيه منظمة الصحة العالمية ان الحد الأدنى للاستهلاك الفرد هو 120 لتر في اليوم، فان بعض المناطق في محافظة الخليل والتي تعاني من نقص في المياه لا تصل الكمية للفرد الواحد في اليوم سوى 30 لتر، وهي نسبة ضئيلة جدا ولا تلبي الحاجات الأساسية. مما يضطر المواطن الفلسطيني الى شراء تنكات المياه بأسعار مضاعفة. ونظرا لأهمية المياه، فانه من الاجدر المحافظة عليها وعدم هدرها سواء من خلال التسرب في الخزانات الرئيسية او الشبكات او التعدي على الشبكات والسرقات. يسمى الفرق بين كمية المياه التي دخلت الشبكة بهدف الاستهلاك وبين الكمية التي تم بيعها بفواتير الى المستهلكين بفاقد المياه. كلما زادت نسبة فاقد المياه، كلما زادت تكلفة المياه على المواطن، أصبح هناك ايضا عدم عدالة في التوزيع بسبب السرقات وكذلك انخفاض الإيرادات لمزود خدمة المياه وما يمكنه من استدامة والتوسع في الخدمة.

ولدراسة هذه الظاهرة، تناولت هذه الدراسة العوامل التي تؤدي الى زيادة فاقد المياه وأيضا تم التطرق الى الاليات التي يمكن ان تؤدي الى انخفاض هذه القيمة. حيث تم اتباع نهج جمع البيانات من مصادر ثانوية لخمس سنوات سابقة من بيانات مؤشرات الأداء في سلطة المياه ومجلس تنظيم قطاع المياه. وقد تم تحليل هذه البيانات باستخدام الاقتران المتعدد. وقد تم الاطلاع على الدراسات السابقة هنا في فلسطين وعدد من الدراسات الدولية. وهدفت الدراسة الى إعطاء صانعي القرار أهمية موضوع فاقد المياه واحتساب التكلفة الحقيقية لهذا الفاقد.

بينت الدراسة أن فاقد المياه في فلسطين له قيمة اقتصادية حقيقية. تشير بيانات الميزان المائي في هذه الدراسة إلى أن نسبة فاقد المياه هي 33٪. وتبلغ الكمية الإجمالية لفاقد المياه 58,847,303 متر مكعب. تعتمد هذه القيمة على التكاليف في وقت الشراء وسعر البيع في وقت البيع. وهذا يعني أن كمية المياه، إذا ما تم احتسابها على أساس تكلفة الشراء، فإنها تعادل مالياً 176,541,903 شيكل سنوياً. اي 49,039,417 دولارًا سنويًا. إذا تم حساب فاقد المياه على أساس متوسط تكلفة المتر المكعب، بما في ذلك الصيانة والتشغيل والكهرباء والنفقات الأخرى، فإن المبلغ سيرتفع بالتأكيد إلى 294,236,515 شيكل. وهو ما يعادل 81,732,365 دولارًا. هذه المبالغ كبيرة جدا وتضع علامة سؤال كبيرة حول الأهمية الاقتصادية للحد من فقدان المياه وتأثيرها على التنمية المستدامة. أن القيمة الإجمالية لفاقد المياه بتعبير اقتصادي اخر هي ما يعادل 77 شيكل لكل فرد فلسطيني خلال عام 2017. وهذا يعني أن كل أسرة يمكن أن تحصل على 21 دولارًا أمريكيًا كل عام كقيمة فاقد المياه.

بينت الدراسة ان عامل سعر بيع المياه هو أحد العوامل التي ترتبط بطريقة جوهرية مع فاقد المياه بعلاقة سالبة. أي انه كلما زاد سعر المياه كلما انخفض فاقد المياه. ويتناسب ذلك مع الدراسات السابقة في فلسطين والبلقان. ان زيادة السعر سيؤدي الى زيادة إيرادات المياه. أظهرت نتائج الدراسة أيضا ان هناك علاقة جوهرية بين مصاريف الطاقة وفاقد المياه، وان هذه العلاقة هي موجبة. أي انه إذا زادت مصاريف الطاقة ارتفعت نسبة فاقد المياه، وينطبق ذلك أيضا على مصاريف الرواتب حيث ان هناك علاقة جوهرية بين زيادة مصاريف الرواتب وأيضا فاقد المياه.

في الواقع، ان زيادة التكاليف اجمالا سيؤدي الى عدم قدرة مزود خدمة المياه على تسديد مستحقات المياه وعمل صيانة مانعة او حتى صيانة دورية. ان زيادة فواتير الكهرباء ورواتب الموظفين يعني ان مزود خدمة المياه يجب عليه ان يدفع قيمة هذه الفواتير التي لا يمكن تأجيلها الى الموردين، وبالتالي انخفاض نسبة مجمل الربح وزيادة الخسائر وانخفاض النقد في خزينة مزود الخدمة. عند هذه الظروف لا يستطيع مزود الخدمة اصدار مصروفات لتصليح فاقد المياه وتخفيض نسبة الفاقد. ان هذه النتيجة تتناسب مع الدراسات السابقة والتي اشارت ان هناك علاقة طردية بين تكاليف الكهرباء والطاقة وضخ المياه وبين نسبة فاقد المياه. هناك تفسير اخر لهذه الظاهرة وهي ان مزود الخدمة الذي يعتمد على ضخ المياه سيؤدي الى زيادة فاقد المياه بنسبة أكبر من مزود الخدمة الذي يعتمد على الجاذبية لإيصال المياه الى المستهلكين، وذلك لان الاعتماد على ضخ المياه سيزيد ضغط المياه في الشبكة والعدادات، مما يسبب بتقصير العمر الافتراضي.

تناغمت نتائج هذه الدراسة مع الدراسات السابقة والخاصة بوجود علاقة قوية وطردية بين حجم مزود الخدمة بين نسبة فاقد المياه. حيث بينت نتائج الدراسة انه كلما زاد حجم مزود خدمة المياه في فلسطين، كلما زادت نسبة فاقد المياه. أي ان نسبة فاقد المياه تتواجد في مزود خدمة والمياه الذي لديه شبكة مياه كبيرة وعدد اشتراكات كبير. في حين ان نتائج هذه الدراسة تتعارض مع نتائج دراسة أخرى والتي بينت انه هناك علاقة جوهرية وعكسية بيمن فاقد المياه وبين حجم مزود الخدمة كما هو الحال في دول البلقان.

تطابقت نتائج الدراسة هذه مع الدراسات السابقة والخاصة بالعلاقة بين نسبة استهلاك المياه وبين فاقد المياه، وبينت النتائج، انه كلما زاد استهلاك المياه كلما اتخفض نسبة فاقد المياه. ويرجع السبب الى ان زيادة الاستهلاك يعني تخفيض السرقات وتحويل من استهلاك غير قانوني الى استهلاك قانوني. اما بالنسبة الى زيادة نسبة تحصيل الديون، فان توفر النقد لدى مزود خدمة المياه يساعد بشكل جوهري على دفع مستحقات الصيانة والمواد الخاصة بتخفيض فاقد المياه.

أخيرا، اوصت الدراسة بضرورة العمل من كافة الشركاء على تخفيض فاقد المياه واستخدام الأموال في زيادة الاستثمارات التي تساهم في الحد من الفاقد وذلك عن طريق المشاريع التي تؤدي الى

تخفيض فاقد المياه وان تستهدف هذه المشاريع المناطق التي تعاني من ارتفاع فاقد المياه مثل جنين وطولكرم. أيضا، اوصت الدراسة بضرورة العمل من كافة المنظمات الدولية والمحلية للضغط على الاحتلال الإسرائيلي لكي يخفف من قبضته على ابار المياه ومصادرها في فلسطين والسماح بحفر الابار وكذلك نقل المياه من قلقيلية الى مناطق أخرى بحاجة ماسة اليها. كذلك اوصت الدراسة الى ضرورة متابعة القوانين وموائمتها مع نتائج الأبحاث والدراسات العلمية. كذلك اوصت الدراسة الى تكثيف رسائل الماجستير من تخصصات مختلفة مثل هندسة المياه والطاقة ومختلف تخصصات الهندسة لعمل أبحاث تخص المياه مثل البرامج الذكية لتخفيض فاقد المياه وغيره.