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Impacts of Desalination Plants on Surrounding Environment and Public Health in Gaza city, Palestine

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Dedication

I would like to dedicate this work to my beloved parents whom gave me an endless support.

Also, this work is dedicated to my wife who supported and encouraged me.

Finally, this work is dedicated to my family and friends.

ACKNOWLEDGMENTS

First, all the thanks to **Allah** for helping and blessing to achieve this study, also I would like to express my deep gratitude to the donated institutions that facilitate this study and made it possible including the Palestinian Water Authotity**(PWA)**and The Middle East Desalination Research Center**(MEDRC).**

I would like to express my deep appreciation to my supervisor **Dr.Zeyad Abu Heen** for his advice , strong support and great help, I have learned from him in many ways, professionally and personally. Thank you very much.

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Finally, I would like to thank everyone who helped me to complete this study.

ABSTRACT

Gaza Strip is an area suffers from sharp deterioration in the water situation (both in terms of quality & quantity) due to high growth of population, industrial and agricultural activities.

The bad situation leads to establish a lot of commercial desalination plants, in order to contribute in the solution of water problems.

The goal of the research is to evaluate the effects of desalination plants on the surrounding environment and human health, by analyzing the desalinated water chemically, bacteriology and physically, measuring the level noise and air quality, the social effects of the desalination plants and providing some suggestions contributing in the mitigation of these effects.

The results indicated that there is growth in the number of desalination plants in the last seven years, about half of the desalination plants located in the west of Gaza City. All of these plants depend on private wells as water source but there were large number of these wells not closed and also not protected well.

There are 70 % of the desalination plants located in inappropriate sites (near facilities like schools, factories...). The pipe of discharge was fixed well in 72% of the trucks and the location of the generator was suitable in 76% of the trucks. Brine water disposal in 63% of the plants was in sewage. Most of the desalination plants were not disinfect the tanks, while 40.7% of the plants add chlorine to the water tanks.

There is no any problem in the physiochemical parameters of the desalinated water where all the samples were according to the WHO standards. The problem were present in the brackish water, where all the samples have physiochemical parameters higher than the WHO standards.

There was bacteriological contamination in 27% of the plants with FC, 28.3% were contaminated of E coli bacteria because of the absence of disinfection.

The air quality were not affected with the operation of the desalination plants. The air quality was affected during the operation of the delivery trucks. Differences between the concentrations of CO and CO_2 before and during the operation of the trucks are observed and measured. The desalination plants cause noise pollution as a result of the operation of pumps and the delivery trucks. All of the measured values of noise levels during the operation of the plant and the trucks were higher than the WHO standards.

There were weakness of monitoring and follow up which must be conducted by competent authorities. This weakness is in the technical issues and in the terms of conditions, hygiene, medical certificates and safety factors.

There is a clear absence of the periodic maintenance. There is an excellent follow up for the water quality results from the desalination plants through conducting periodic tests. Most of people who work in the desalination plants, have low

qualifications. There is no awareness activities targeted the workers in the desalination plants because they need such activities in order to be more qualified.
Desalination plants cause a lot of problems like noise, dust, crowd, accidents. But there is acceptance from the people for the presence of these plants near their houses.
Key Words: (water, drinking water, contamination, desalination)

المستخلص

يعاني قطاع غزة من تدهور حاد في الوضع المائي والوضع في مدينة غزة صعب جدا، لأن قطاع غزة يعاني من مشاكل المياه (سواء من حيث الجودة والكمية) وذلك بسبب النمو المرتفع في عدد السكان، والأنشطة الصناعية والزراعية هذا أدى إلى إنشاء الكثير من محطات التحلية التجارية، من أجل المساهمة في حل مشاكل المياه .

الهدف من هذا البحث هو تقييم آثار محطات التحلية على البيئة المحيطة وصحة الإنسان، من خلال تنفيذ تحليل كيميائي و بكتريولوجي للمياه قبل و بعد التحلية، وقياس مستوى الضوضاء وجودة الهواء، و كذلك مدى قبول التواجد لمحطات تحليه المياه في المجتمع وتوفير بعض المقترحات التي تسهم في التخفيف من هذه الآثار .

أشارت النتائج إلى أن هناك زيادة في عدد محطات تحلية المياه في السنوات السبع الماضية، وحوالي نصف محطات تحلية المياه تقع في غرب غزة، كل هذه المحطات تعتمد على الآبار الخاصة كمصدر للمياه ولكن كان هناك عدد كبير من هذه الآبار غير محكمة الإغلاق و غير محمية من مصادر التلوث.

هناك 70 ٪ من محطات تحلية المياه موجودة في مواقع غير ملائمة (بالقرب من المرافق مثل المدارس و المصانع) ، و فيما يتعلق بخرطوم المياه الموجود على الشاحنة التي تقوم بتوزيع المياه لوحظ أنه مثبت بشكل جيد في 72 ٪ من الشاحنات وكان موقع المولد الكهربائي مناسب في 76 ٪ من الشاحنات. التخلص من المياه المالحة في63 % من المحطات يتم في مصارف المجاري . معظم محطات التحلية لا تقوم بتعقيم خزانات المياه المحلاة، و 40.7 ٪ من المحطات تضيف الكلور إلى المياه المحلاة .

لم تكن هناك أي مشاكل في المعايير الفيزيائية و الكيمائية للمياه المحلاة، وجميع العينات كانت حسب معايير منظمة الصحة العالمية،كانت المشاكل موجودة في المياه المالحة،وجميع العينات كانت أعلى من المعايير.

كان هناك تلوث بكتريولوجي في 27٪ من المحطات بالبكتيريا القولونية البرازية و 28.3 ٪ بالبكتيريا القولونية بسبب غياب التعقيم.

و فيما يخص جودة الهواء لم يتأثر مستوى تركيز أول و ثاني أكسيد الكربون قبل و أثناء تشغيل المحطة و لكن زاد التركيز بشكل ملحوظ أثناء عمل شاحنات التوزيع حيث ارتفع لمستويات أعلى من المسموح بها و كذلك مستويات الضوضاء كانت أعلى من المستويات المسموح بها.

كان هناك ضعف في المتابعة التي يجب أن تتم من قبل الجهات المختصة، ولكن هذا الضعف في الجوانب التقنية وشروط الترخيص، والنظافة وعوامل السلامة .

هناك غياب واضح للصيانة الدورية في المحطات و هناك متابعة دورية لجودة المياه حيث يتم أخذ عينات بشكل دوري من المياه المحلاة.

معظم العاملون في محطات التحلية يحملون مؤهلات علمية منخفضة، حيث هناك عدد كبير منهم يحمل فقط الشهادة الابتدائية، أظهرت الدراسة أنه لا توجد أنشطة توعوية نفذت لاستهداف العاملين في محطات التحلية لأنهم بحاجة إلى مثل هذه الأنشطة.

محطات تحلية المياه تسبب الكثير من المشاكل مثل الضوضاء والغبار والزحام،والحوادث،ولكن هناك قبول من قبل السكان لوجود هذه المحطات بالقرب من بيوتهم.

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Abbreviations:

APHA	American Public Health Agency
EPA	Environment Protection Agency
EC	Electrical Conductivity
FC	Faecal Coliforms
MOH	Ministry of Health
MOLG	Ministry of Local Governance
PCBS	Palestinian Central Bureau of Statistics
PHG	Palestinian Hydrology Group
PWA	Palestinian Water Authority
WHO	World Health Organization
TDS	Total Dissolved Solids
MCM	Million Cubic Meters
MCM/Y	Million Cubic Meters per year
UNEP	United Nation Environmental Programme
TC	Total Coliform
EQA	Environment Quality Authority
MW	Mega Watt
PENRA	Palestinian Energy & Natural Resources
Km	Kilo Meter
RO	Reverse Osmosis
M3 /hr	Cubic Meter per Hour
P.V.C	Polymer Venyle Chloride
Km^2	Kilo Meter Square
mg/L	Milligram Per Litre
WWTP	Wastewater Treatment Plant
IUG	Islamic University of Gaza
pH	Potential Hydrogen
UV	Ultra Violet
MF	Membrane Filter
µm	Micro Meter
h	Hour
°C	Celsius Degree

CHAPTER(1)

INTRODUCTION

1.1Background

Gaza Strip suffers from a sharp deterioration in drinking water resources (both in quality &quantity) due to many factors such as location (semi-arid), growth of population, occupation, agricultural activities and untreated wastewater.

Baalousha (2005) reported that the projected water demand will be sharply increased from 213 MCM in the year 2010 to 262 MCM in the year 2020.The deficit will be increased from 76 MCM in the year 2010 to 107 MCM in the year 2020.

According to PWA(2012), average decline of groundwater in Gaza Strip up to about 50 cm annually, rate of sea water intrusion of groundwater in Gaza Strip up to about 40m/year. Currently the estimated deficit in water balance in Gaza Strip is about 80-100 MCM. Per capita consumption in Gaza Strip about 80 l/p/d that is half recommended by WHO (150 l/p/d). Occupation country stealing about 50 MCM from (Wadi Gaza water, groundwater flow normally from the eastern region and water traps).

Aish (2010) concluded that in the year 2005 approximately 150 MCM/y of water was pumped from about 4100 wells, 60 MCM were pumped for domestic and industrial and 90 MCM for irrigation.

In addition, Gaza Strip suffer from a sharp deterioration in water quality, according to CMWU (2010), 65% of wells contaminated with nitrate, 57%contaminated with chloride, water tests have shown some wells with high values of fluoride (EWASH, 2010).

(El-Naeem et al., 2009) showed that most of the groundwater is unsuitable for domestic uses because polluted wells increased from (72 %) to (78.5%) and (85.5 %) through the three stages 1994/1995, 1999/2000 and 2003/2004 respectively.

(Al-Yaqubi, 2006) showed that the major water quality problems are high salinity and high nitrate concentration in the aquifer. According to (PWA, 2012) Chloride concentration in the municipal wells ranges from 250 to more than 5000 mg/l. 25% of them had chloride concentration less than 250 (WHO allowable limit) while the remaining (75%) exceeds the WHO chloride level as shown in figure (1.1). Also Nitrate concentration in the municipal wells ranges from 50 to more than 300 mg/l. 21.5 % of them had Nitrate concentration less than 50 mg/l (WHO allowable limit) while the remaining (73.5%) exceeds the WHO nitrate level as shown in figure (1.2).

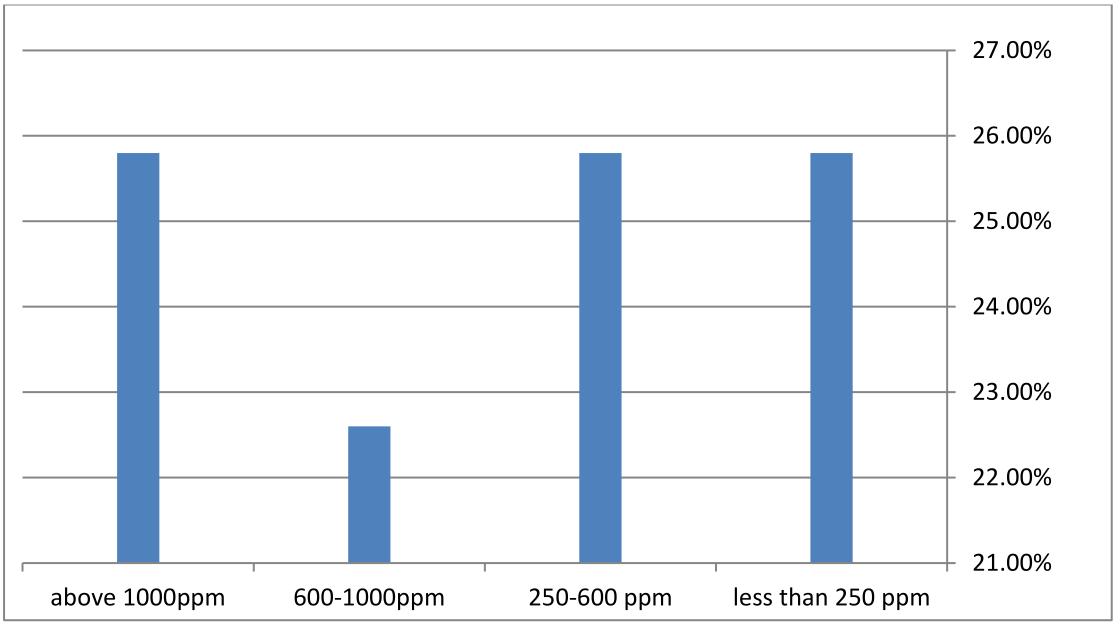


Figure (1.1): Chloride concentrations of domestic municipal wells in Gaza Strip (PWA, 2013).

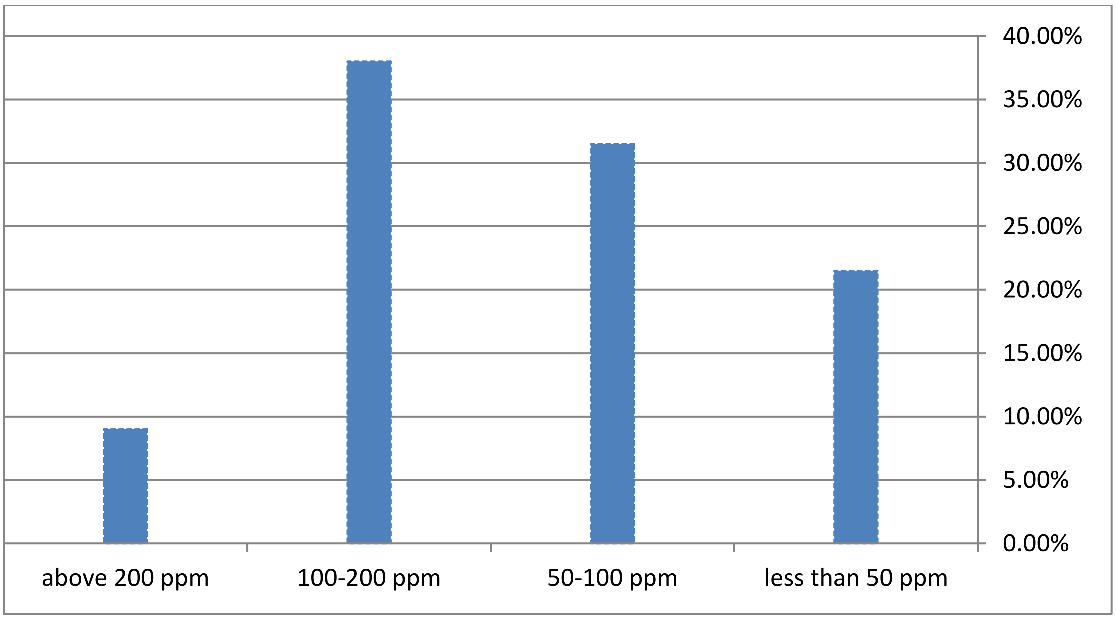


Figure (1.2): Nitrate concentrations of domestic municipal wells in Gaza Strip (PWA, 2013).

(Al-Khatib 2009) showed that the main source of microbiological contamination is microorganisms of human or animal excreta, which reaches humans through wastewater , landfills causing serious health problems e.g. according to the UN, diarrhea accounts for 80% of all diseases and over one third of deaths in developing countries which are caused by the patients consumption of contaminated water.

Based on the above information, the difficult situation in drinking water, a lot of desalination plants were built in Gaza Strip to contribute in solving drinking water problems.

1.2 Study Area

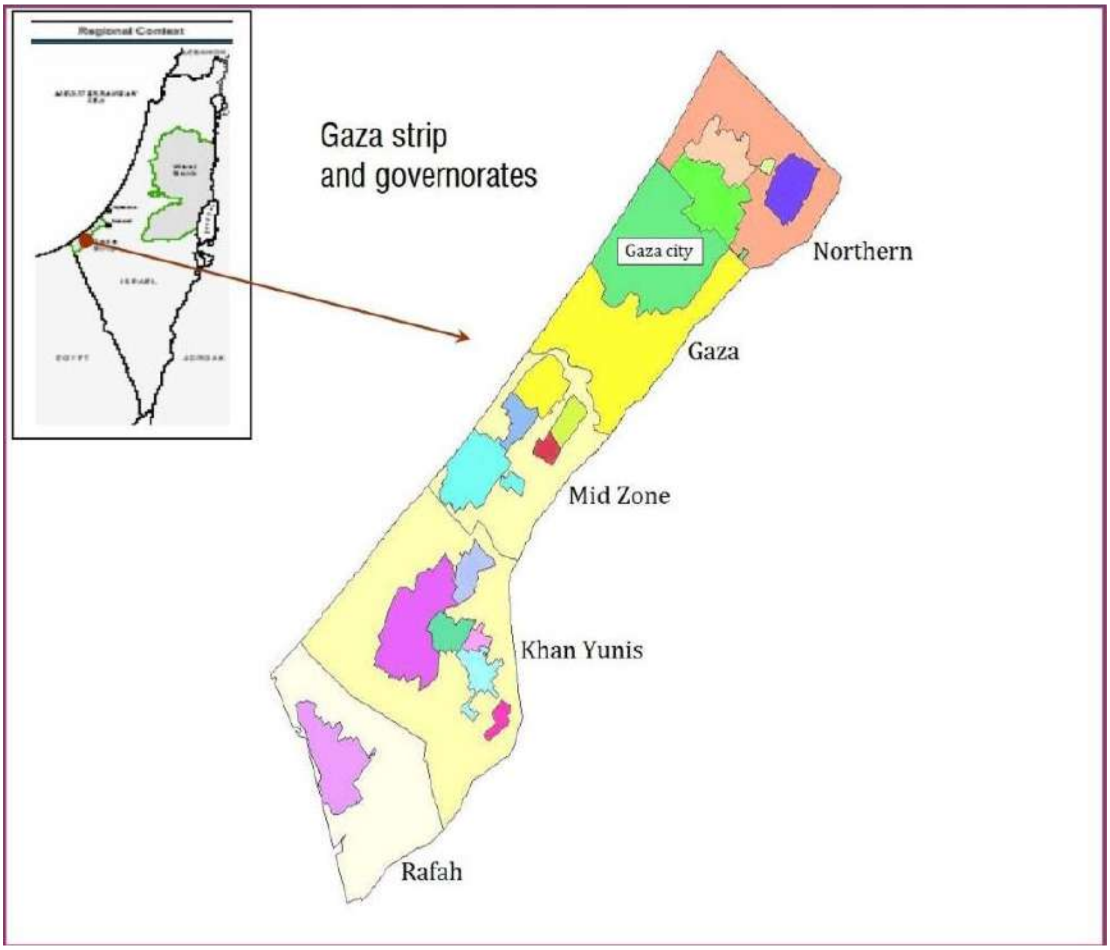


Figure (1.3) : Gaza governorates map

Gaza is located on the eastern coast of the Mediterranean Sea. It is bounded from the south by Egypt, from the east and the north by historical Palestine, and from the west by the Mediterranean sea. The total area of Gaza strip is 365 km^2, with approximately 40 km long and the width varies from 8 km in the north to 14 km in the south (PCBS, 2014)**.**Gaza Strip is divided geographically into five governorates: Northern, Gaza, Mid Zone, Khan Yunis, and Rafah as shown in Figure (1.3).
According to **(PCBS, 2014)** the number of estimated population in the Gaza Strip is about 1,760,037. This number representing about 38.3% of the population of the Palestinian territories. Gaza governorate ranked first in terms of population between the governorates of Gaza, where a population of about 570 thousand people, including 13.3% of the total population in the Palestinian territories as in figure (1.4).

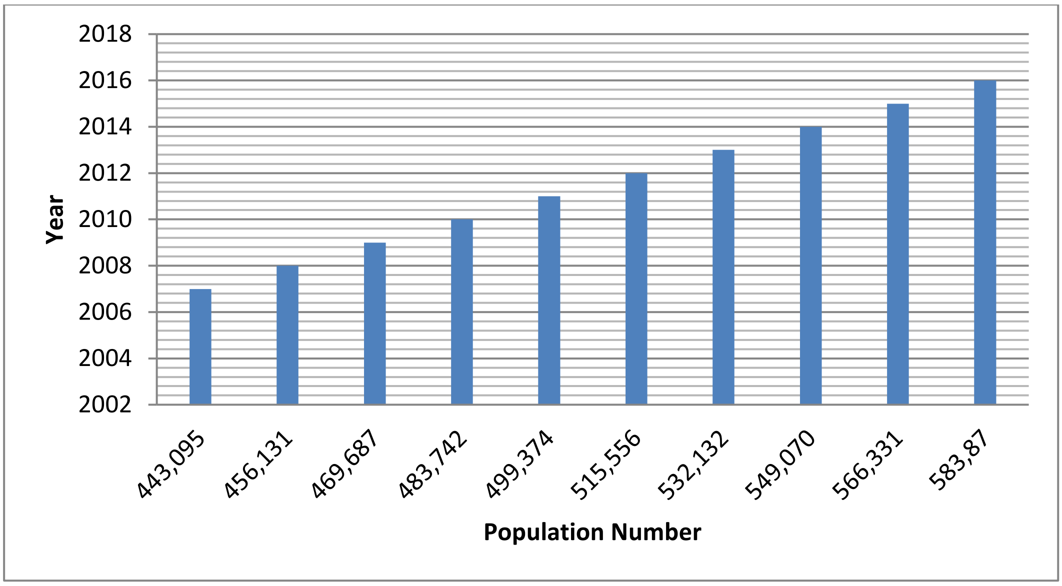


Figure (1.4): Population and Estimated population in Gaza (2007-2016).(PCBS, 2012)

1.3 Research Problem

Despite of providing healthy and safe drinking water, desalination plants have some bad effects on the environment and on human health. Some of desalination plants have inappropriate sites, near facilities or institutions as well as the land consumption. And the high consumption of both energy and groundwater. The chemical parameters of desalinated water results from the plants are below the standards of WHO and the Palestinian standards, especially fluoride, nitrate and chloride. Water analyses indicate that 5% of water samples were contaminated by fecal coliform (FC). The study showed that 25% of product water samples were contaminated by total coliform, and about 15% of water samples were contaminated by fecal coliform **(Aish, 2010)**. Also some desalination plant deliver contaminated water to the consumers, therefore; the desalination plants may be the source of this contamination, because they don't disinfect the water. Another problems associated with desalination plants such as, noise during the operation of the plant, delivery trucks and the air pollution results from the trucks. Also a lot of people are not satisfied of the presence of the plant near their homes.

1.4 Research Goal

The goal of the research is to evaluate the effects of desalination plants on the surrounding environment and human health. By analyzing both brackish and desalinated water chemically. And implementing microbiological assessment for both brackish and desalinated water. Measuring the level noise and air quality. Evaluating the social effects of the desalination plants and providing some suggestions contributing in solving these effects.

1.5 Research Objectives

- To determine the quantity and quality of desalinated water resultant from the desalination plants.
- To determine energy uptake of the desalination plants.
- To check the presence of microbiological contamination.
- To estimate the level of noise result from the desalination plants.
- To evaluate the social and natural impact of desalination plants.

1.6 Thesis Organization

The research contains of the following chapters that cover the subject as the following:

Chapter 1: is an introduction which covers the study area, research problem, research goal and research objectives.

Chapter 2: literature review, which presents the importance of desalination globally, the significance of desalination in Gaza by reviewing water pollution in Gaza after that there is a historical review of desalination in Gaza followed by the current desalination plants with their addresses.

After this part the chapter explain the role of supervisory authorities like, PWA, municipality of Gaza and the ministry of health and finally the effects of desalination plants on the environment and public health. These effects like ground water depletion, power consumption, land consumption, noise and air pollution, social acceptance and the chemical and bacteriological parameters of water like, fluoride, chloride, nitrate, pH, TDS, fecal coliform and E coli.

Chapter 3 focused on the adopted methodology in this thesis, the tools were used to achieve the study, the preparation and the design of questionnaires, the chemical and bacteriological analysis and finally the equipment and devices were used in this work.

Chapter 4 this chapter will involve the results and the discussion of these results.

Chapter 5: in this chapter, a number of valuable recommendations is mentioned.

Chapter 2
LITERATURE REVIEW

2.1 Introduction

Miller (2003) mentioned that water shortages affect 88 developing countries. In these places, 80-90% of all diseases and 30% of all deaths result from bad water quality. Furthermore, over the next 25 years, the number of people affected by water shortages is expected to increase fourfold.

The Gaza Strip is the most populous country of the world, where about 1.8million people in a very small area, Gaza Strip has very limited sources of water. Ground water is the main source of water in this area.

Because of human activities, high population growth, this led to high deterioration in quality of drinking water. It became unsuitable for human use. In order to overcome this problem many desalination plants were established in Gaza.

2.2 Desalination in the world

Access to sufficient quantities of safe water for drinking and domestic uses and also for commercial and industrial applications is critical to health and well being, and the opportunity to achieve economic development. People in many areas of the world have historically suffered from inadequate access to safe water. Some must walk long distances just to obtain sufficient water to sustain life (WHO, 2007).

According to (UNEP, 2008), the combined production of all desalination plants worldwide was 44.1MCM/day by the end of the year 2006.

The desalination market has been growing rapidly at a compound average rate of 12% a year over the past five years. The rate of capacity growth is expected to increase even further, reaching 64 MCM per day by 2010 and 98 million by 2015(GWI 2006).As of the beginning of 2006, more than 12,000 desalination plants are in operation throughout the world producing about 40 million cubic of water per day. About 50% of the capacity exists in the West Asia Gulf region. North America has about 17%, Asia apart from the Gulf about 10% and North Africa and Europe account for about 8 % and 7%, respectively, and Australia a bit over 1%(GWI 2006).

(USGS, 2012) reported that the scarcity of fresh water resources and the need for additional water supplies is already critical in many arid regions of the world, and will be increasingly important in the future. It is very likely that the water issue will be considered, like fossil energy resources, to be one of the determining factors of world stability. Many arid areas simply do not have fresh water resources in the form of surface water such as rivers, lakes, etc, but have only limited underground water resources that are becoming more brackish as abstraction of water from the aquifers continues. The world-wide availability of renewable energies and the availability of mature technologies in this field make it possible to consider the coupling of desalination plants with renewable energy production processes, in order to ensure the production of water in a sustainable and environmentally friendly scheme for the regions concerned.

Based on the mentioned above, it is clear why the world now direct towards desalination and in some countries desalination became necessary.

2.3 Importance of Desalination Plants in Gaza City

2.3.1 Current situation of drinking water wells in Gaza City

At this time there are 70 drinking water wells under the supervision of the municipality of Gaza, about 50 % of drinking water wells are located in the western area of Gaza city on 1-2 kilometers far from the beach of the sea. Before the year 2006 the number of wells was 30 well only, during the last six years the number of wells increased in rate of seven wells annually. Because of the low efficiency of the network, high population growth in the city. Figure 2.1 illustrates the number of wells historically (PWA, 2012).

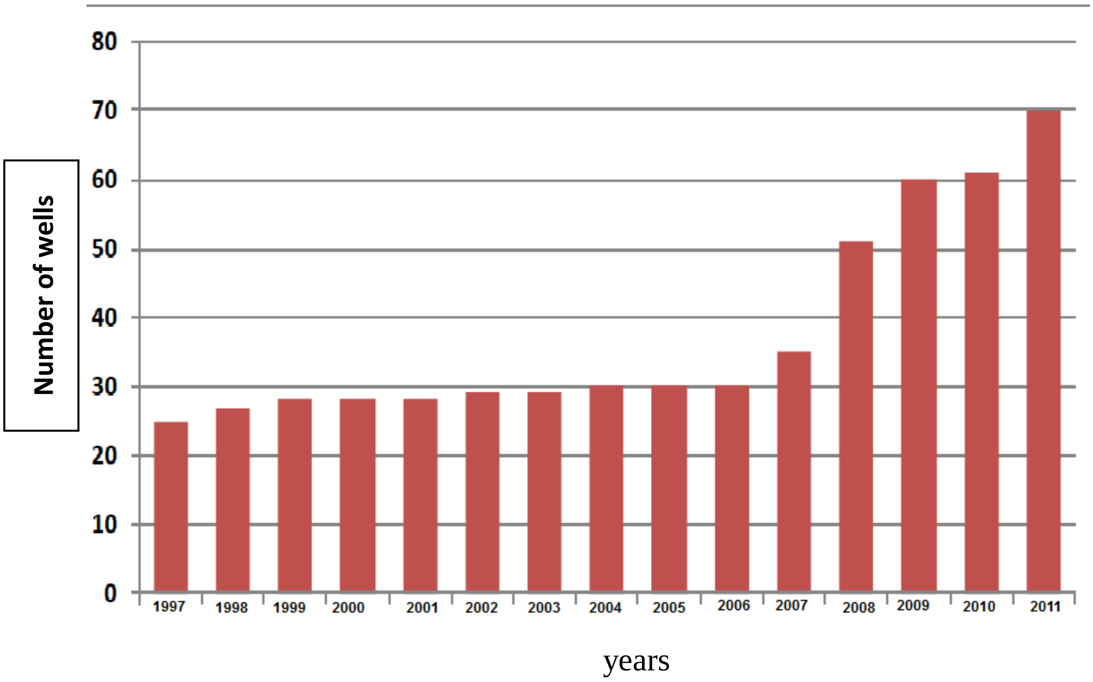


Figure (2.1): The number of wells in Gaza city (PWA,2012)

According to PWA about 36 MCM have been produced by the municipality of Gaza in the year 2011, while in the year 1997 the produced quality was 23MCM.This means that the average of productivity of the municipality wells increased about 1MCM annually(PWA2012).

The loss of the distributed water about 45% of the produced water because of the low efficiency of the network and the illegal networks in some areas in the city.

According to the (WHO) the average consumption per capita per day is 100 -150 L/C/day but in Gaza the average consumption is 90 L/C/D.

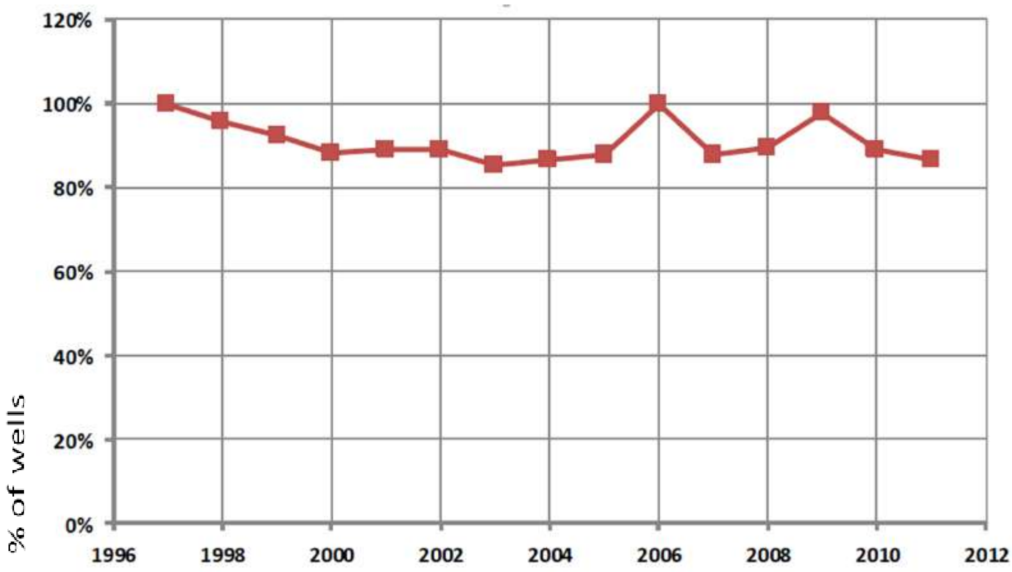
2.3.2 drinking water pollution in Gaza city

Groundwater is the only source of water in the Gaza Strip. The results of a ten-year monitoring program revealed that more than 90% of the available water is unsuitable for drinking purposes as a result of elevated chemical contaminants as well as micro-biological organisms(shomar,2010). Paper of Dr. Mohammed Alagha (2005)reported that about90% of the groundwater is unacceptable for drinking as a result of contamination by nitrate and chloride.

Abu maila (2005) showed that Nitrate was analyzed in 100 wells (47 agricultural and 53 domestic) in five governorates. The results showed that 90% of the tested wells have nitrate far beyond the allowed values set by the (WHO).

During the last few decades, groundwater quality has deteriorated to a limit that the municipal tap water became brackish and unsuitable for human consumption in most parts of the strip(el Nakhal,2004).

PWA (2012) reported that, 98% 0f drinking water wells of Gaza are not compatible with WHO drinking water standards (chloride&nitrate). as shown in the figure 2.2.



Years

Figure (2.2): Percentage of number of wells not compatible with WHO standards in concentration of Chloride, Nitrate.(PWA, 2012).

(MOH, 2012) records showed that there are about 85% of wells are suffering of high concentrations of nitrate, due to human, agricultural activities which depend on nitrogen fertilizers and leakage of waste water.

Also the concentration of nitrate in the western area of Gaza is higher than the eastern area, because of type of the soil, sand in the west and clay in the east(PWA, 2012).

Gaza suffers of sea water intrusion along the coast with a width of 1-2km from the beach of the sea. This led to high concentrations of chloride in water wells in Gaza city, it reaches to 1000-5000 ppm, these wells represent about 25% of the total number of the wells in Gaza (PWA, 2012).

Al-khatib (2009) showed that 25% of ground water samples have fluoride concentrations exceeding the allowable limits.

El-Mahallawi (1999) detected Total and Fecal Coliform contamination of tap water and roof tanks in Deir El-Balah, Gaza Strip, where disinfection processes were not fully implemented. Sharif, (2003) found various concentrations of Total and Fecal

Coliforms in water samples from 20 groundwater wells located in the surrounds of the wastewater treatment facility of BeitLahia, Gaza Strip. Yassin et al., (2006) revealed that Total and Fecal Coliform contamination exceeded (WHO) limits for water wells and networks in Gaza Strip. Alkhatib (2009) showed that 15.5% of water samples taken from water networks are contaminated of TC.

2.4 Desalination Plants in Gaza Strip

2.4.1 historical review

The first Reverse Osmosis plant in the Gaza Strip was built in 1993 in Deir Al Balah city by EMS, a subsidiary of Mekorot Company. This plant is constructed to desalinate brackish water and has a capacity of $45M^3$/hr at recovery rate of 75 % (El sheikh, 2003).

In May 1997 The Italian cooperation (CISS) has designed and built a RO brackish water desalination plant nearby the existing municipal well in Khan Younis city. The total capacity of this plant is estimated at $55m^3$/hr.

In July 1998, Khanyounis municipality had received another grant from Italian Government through Italian Developing Program. The Italian cooperation (CISS) also designed and built a RO brackish water desalination plant nearby the existing municipal well. The total capacity of the plant is estimated at $80M^3$/hr (Ismail, 2003).

The plant of the north area, designed to two phases, the first phase (I) is to produce 1250 M^3/day to be increased to $5000M^3$/day in phase (II). According to the contract between the PWA and Degremont (French company), the total production cost was estimated at US$ 0.94 per cubic meter, the plant now is not working (R Thaher, 2006).

In July 2000, the plant of the Deir elbalah was designed by the Austrian consultant (Trugina). It was built by specialist Austrian company(GWT).The plant use RO technology. The brine water is discharged to the sea. It produce 1200 M^3/day (Ismail, 2003).

The high salinity, high concentrations of nitrate, bad quality of drinking water supplied by the municipality led to look for another alternatives that can provide safe drinking water. This was a strong motivation at the end of the year 2000 for people to establish commercial desalination plant. Ismail, (2003) mentioned that between 1999 and 2003, the total number of RO private desalination plants for commercial use was 25 in Gaza Strip, in addition to seven vendors.

2.4.2 current situation in Gaza city

According to (PWA,2009) the number of private desalination plants in Gaza city was about 21.

This number has been increased to become 30 desalination plant in the year 2012, this large number due to the bad quality of water of the municipality. Most of these plants are located in the western area of Gaza city because of the high salinity of water in the these areas. The reason of this salinity is the sea water intrusion in these areas. Figure 2.3 and appendix **A** show the plants locations in Gaza city.

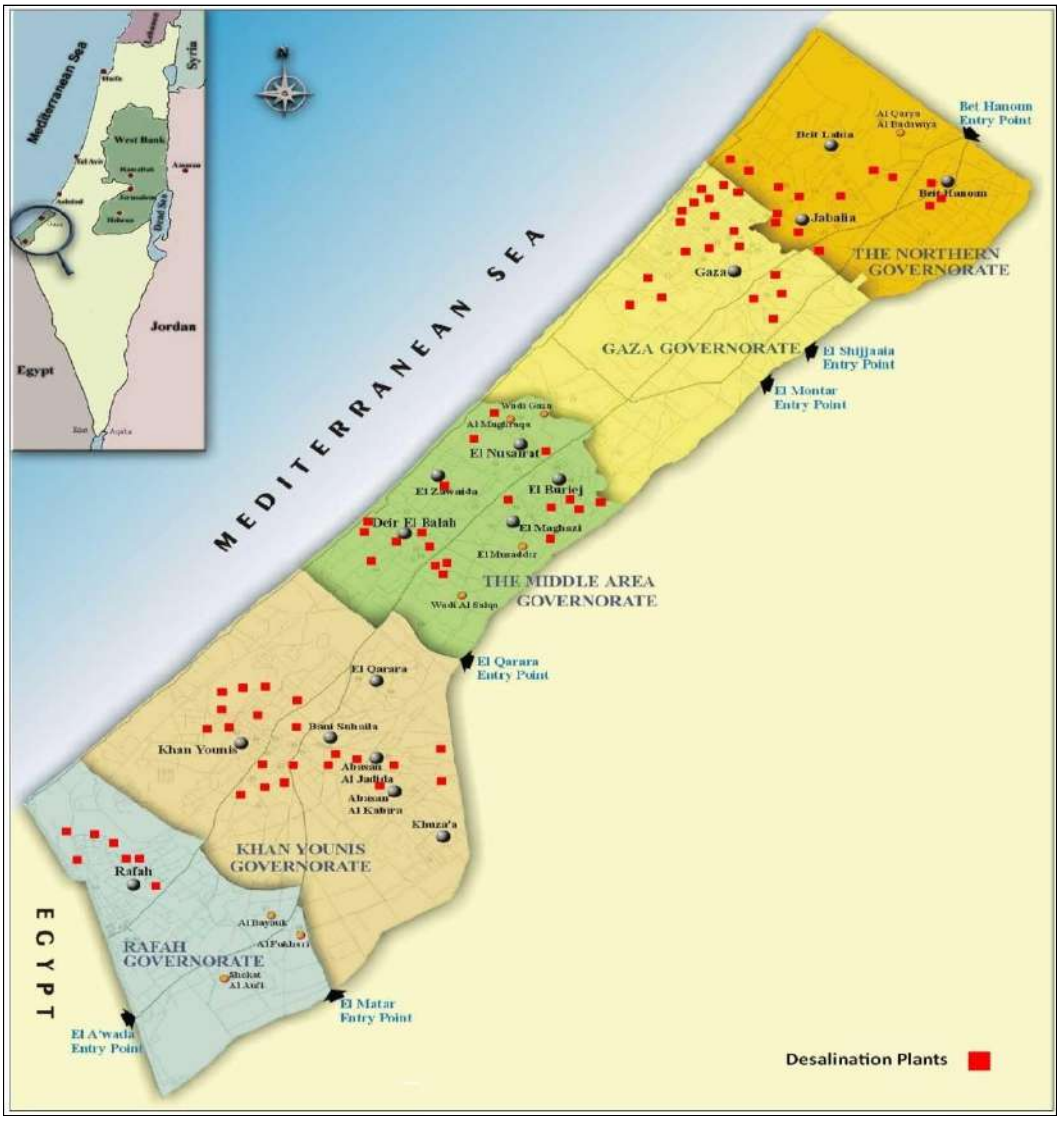


Figure (2.3): Desalination plants distributed in Gaza strip (PWA, 2012).

2.5 Competent Authorities

Desalination plants in Gaza provide safe drinking water for the people. These plants should be as requested environmentally, healthy and regulatory standards. So many authorities have a supervisory role on the desalination plants, and when licensing any desalination project, the agreement of these authorities is a basic condition.

2.5.1 PWA Licensing Conditions

The regulatory directorate in PWA is responsible for issuing licenses desalination plant or facility to sell water through the Department of Licenses and after fulfillment of all required procedures.

Also the follow up and inspection department at the same directorate, is responsible for coordination with the other relevant authorities to monitor the compliance terms of licensing, follow up the periodic tests of water samples to insure that the samples are compatible with drinking water standards. The department of consumer affairs is responsible for receiving compliance from consumers or water producers and solve the problems relevant to these compliances.(PWA, 2003).

2.5.1.1 PWA licensing procedure

- ✓ Submitting the application to president of PWA.
- ✓ License to practice the work from the municipality.
- ✓ Licenses for the cars and apparatus used in the plant of desalination.
- ✓ List of staff and their certificates.
- ✓ Determination the mechanism, place of disposal of brine water.
- ✓ Approval from, MOH, EQA and ministry of economy.

2.5.2 Municipality License Conditions

The preventive health department in the municipality is responsible for the monitoring of drinking water to insure that it is free from any contamination, conduct periodic tests to water samples from desalination plants and delivery trucks. Also the municipality conduct tests for water systems and wells to ascertain the extent of safety of the water that reaches out to people and that such networks do not any contamination, and sterilization of water wells by a system of "chlorination", and supervising the operations of washing and sterilizing new water networks (mogaza,2013).The municipality of Gaza imposes a set of conditions on licensing desalination plants or water sale facilities as follows:

2.5.2.1 Conditions of licensing

- ✓ The ceiling must be from concrete.
- ✓ walls from blocks, its forbidden to use metal or asbestos.
- ✓ Walls should be tiled with ceramic or painted with oil paint.
- ✓ General color of the place should be white with some blue lines.
- ✓ The ground must be tiled, easy to clean, have enough slopes to dispose easily from water.
- ✓ The tanks must be from stainless steel, with height from the ground not less than 40 CM, should have a drainage hole for cleaning, another hole on the top of the tank must be well closed.
- ✓ Tanks must be disinfected by using safe substances periodically.
- ✓ The pipes must be made from P.V.C, taps must be from plastic or stainless steel.
- ✓ The plant must have W.C connected to public sewage system, good aeration.
- ✓ The source of water must be safe, licensed, the produced water free from contamination**.**

2.5.3 MOH License Conditions

Ministry of health play a big role in this field. The department of preventive medicine in the ministry conduct periodic checking on the water before and after desalination, these tests are chemical, physical and bacteriological.

There are some healthy conditions are imposed by the ministry. These conditions related to the location, the building, treatment and packaging, monitoring and quality and the workers. Its allowable and permitted of the location of the plant to be in the industrial areas, commercial or residential after obtaining regulatory approval from the competent authorities. The ground of the plant must be tiled of ceramic, free of cracks and so the walls, the place must have good aeration and light, the interface of the plant should be from glass, the place must contain W.C, it should be always clean. All stages of processing of water must be fully automatically, substances and devices in the plant must be healthy approved. The owner of the plant must conduct the main chemical and physical tests in the plant(TDS,ph,CL_2) to insure the safety of water.

Also the microbiological tests should be conducted at least once monthly in a licensed laboratory. A records of the results must be kept in the plant. The desalinated water must be compatible with the healthy standards.

The solid and liquid wastes must be disposed in a correct and safe place, all the staff of the plant must have free of diseases certificate, should wear a special uniform, should keep on personal cleanness (MOH, 2012).

2.6 Effects of Desalination Plants on Environment

The majority of the available researches and studies related to the desalination plants focused on seawater desalination plants. The present study focuses on brackish water desalination plants. Although desalination plants contributed significantly and clearly in providing safe drinking water, it has many damages and negative effects on the surrounding environment and public health. These effects can be summarized as the following:

2.6.1 Groundwater Depletion

It is clear and known that Gaza Strip suffers of the groundwater aquifer deterioration as mentioned above. There is a clear growth in desalination plants from the past years until now. The private desalination plants have no sources of water except the ground water. This will contribute significantly in the depletion of the aquifer because of the continuous withdrawal of huge amounts of water used daily.

According to (PWA 2012) the amount of groundwater used by the private plants for desalination is about 4.2 MCM yearly.

Assaf (2001) mentioned the problems related to the groundwater depletion .These problems are: Depleting the underlying aquifer of its water due to continuous withdrawal, thereby lowering the water table and/or possibly causing further saltwater intrusion. Causing possible upcoming of underlying brackish waters of higher salinity. And Continuous withdrawal from the groundwater by brackish water desalination plants can delay the positive effects of Mother Nature's rehabilitation of the aquifer by natural recharge.

2.6.2 Power Consumption

Gaza Strip suffers of many problems in power. There are many sources provide power to Gaza. These are 120 MW from the Israeli company, 22 MW from Egypt, about 75 to 80MW from the power plant in Gaza which destroyed in 2006. So the total available power is 217MW, but the actual need of power is 270MW.This means that there is a deficit of about 60MW (PENRA 2012).

The general electricity network is the main source of energy that the desalination plants is depend on.

This led to overload on the network, especially there is a lot of pumps in the plants need high power to work, also the rate of consumption of energy proportional to the production capacity of the plant.

Because of the deficit of the power, there is frequent interruption of the electric current, so the desalination plants depend on alternative sources of electric power. Most of them use electric generators which work by fuel. This led to a consumption of large quantities of fuel.

2.6.3 Noise Pollution

A lot of noise can be produced by the desalination plants, especially the vast majority of them are located inside populated areas or near facilities such as schools and hospitals.

The sources of noise which caused by the plants are: noise result during the operation of the pumps and the trucks and the staff during the work. The frequent exposure to noise for long times can cause a lot of health problems.

EPA, (2012) reported that problems related to noise include stress related illnesses, high blood pressure, speech interference, hearing loss, sleep disruption, and lost productivity. Noise Induced Hearing Loss (NIHL) is the most common and often discussed health effect, but research has shown that exposure to constant or high levels of noise can cause countless adverse health effects.

The Palestinian environmental law (1999) in chapter 2, article 25 states that "the ministry in cooperation with the specialized agencies shall work on the establishment of standards, instructions and conditions to reduce environmental nuisance generated by general activities, every facility owner entity or individual shall be forbidden to cause any nuisance to others". Also article 26 states that " All parties and individuals undertake, upon the operation of any machines, equipment or utilization the horns, microphones, or practicing any other activities, not to exceed the permitted limit for the intensity of the voice and vibration.

2.6.4 Air Pollution

During the operation of the desalination plants, a variety of air pollutants can be resulted from the trucks that transfer water, especially carbon monoxide and carbon dioxide, also the unpaved roads can produce a large quantities of dust.

According to **(WHO 2008)**, air pollution continues to pose a significant threat to health worldwide. According to a WHO assessment of the burden of disease due to air pollution, more than 2 million premature deaths each year can be attributed to the effects of urban outdoor air pollution and indoor air pollution (caused by the burning of solid fuels). More than half of this disease burden is borne by the populations of developing countries.

The Palestinian environmental law (1999) in chapter 2, article 19 states that " the ministry in cooperation with specialized agencies, shall specify standards to regulate the concentration of pollutants in the air which may cause harm or damage to public health, social welfare and the environment" also article 21 states that " it shall be prohibited to utilize machines, engines or vehicles that generate exhaust that does not comply with the standards specified in accordance with the provision of this law"

2.6.5 Social Acceptance

Desalination plants can affect the life quality of the society, the well-being of the life. It can cause a lot of risks such as accidents , jam traffics. Some people cannot accept the plant to be near them because of many problems can be resulted like, noise, water result from leakage of the pipes and dust.

The (WHO) define the health as "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity"

The Palestinian environmental law (1999) in chapter 2 title 1, article 5 states that" this law shall guarantee the right to every individual to living in a sound and clean environment and to the best possible of health care and welfare.

2.6.6 Land Use

The total area of Gaza strip is 365 Km^2 while the area of Gaza city is 56 Km^2 **(MOG, 2012).** According to **(MOLG, 2015)** the area of Gaza strip is divided into industrial, agricultural, build up areas ….. etc as in the figure 2.4.

Gaza city contains about 30 desalination plants located in populated areas. The city area is very narrow so these plants consume areas of land in the city proportional to the total area.

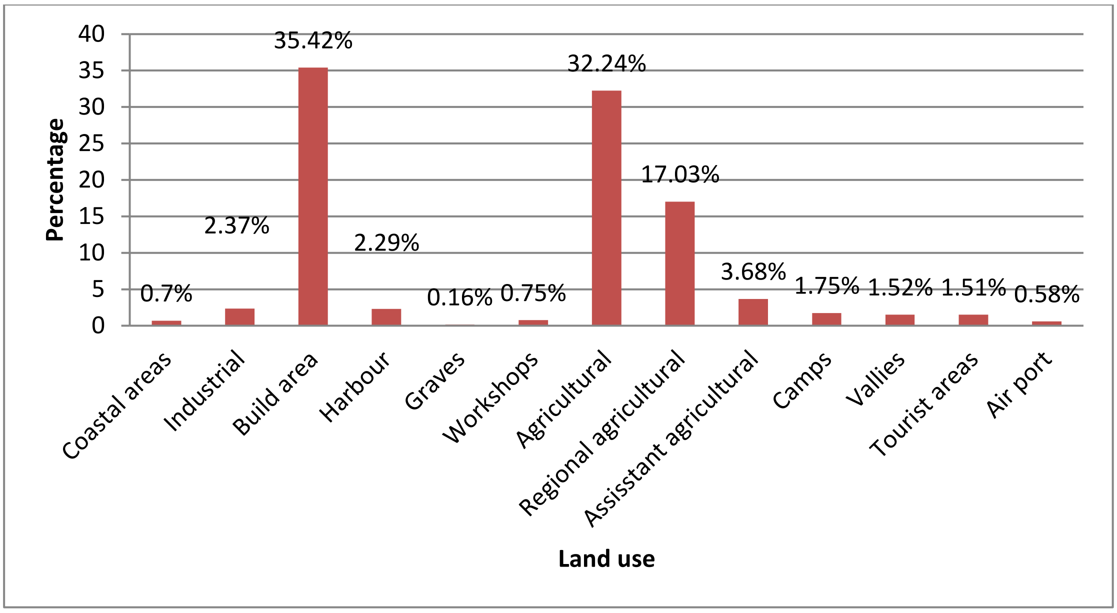


Figure (2.4): Major land use sectors in the Gaza Strip (MOLG, 2015) .

2.7 Potential Effects of Desalination Plants on Public Health

2.7.1 Chemical Parameters of Desalinated Water

2.7.1.1 Fluoride

Fluorides enter the human body mainly through the intake of water and, to a lesser extent, foods. Among the foods rich in fluorides are fish, tea, and certain drugs (EPA 1997). Ingested fluorides are quickly absorbed in the gastrointestinal tract, 35–48% is retained by the body, mostly in skeletal and calcified tissues, and the balance is excreted largely in the urine. Chronic ingestion of fluoride-rich fodder and water in endemic areas leads to development of fluorosis in animals e.g. dental discoloration, difficulty in mastication, bony lesions, lameness, debility and mortality (Patra et al. **2000).**

According to **(Hileman, 1988)**, fluoride has many adverse health effects, fluoride is known to cause dental fluorosis, a defect of the tooth enamel caused by fluoride's interference with developing teeth, fluoride is associated with Alzheimer's disease and other forms of dementia. Fluoride enters the brain and enables aluminum to cross the blood-brain barrier, resulting in increased risk for these diseases. Fluoride has also been associated with low Intelligence Qution and mental retardation in children, Fluoride can cause a crippling bone disease called skeletal fluorosis.

Al-Khatib, (2009) showed that 25% of groundwater samples, had fluoride content exceeding the allowable limit, compared to 5% only in desalinated water.

Results of the RO desalinated water samples show low fluoride concentrations. These results can be stressed by RO sample analysis, which indicate that 100% of RO desalinated water samples have fluoride concentration < 0.5mg/L **(El Tibi, 2010).**

2.7.1.2 Chloride

There are numerous sources of chloride in water such as, the use of inorganic fertilizers, landfill leachates, septic tank effluents, animal feeds, industrial effluents, irrigation drainage, and seawater intrusion.

Chloride is an essential element and is the main extracellular anion in the body. It is a highly mobile ion that easily crosses cell membranes and is involved in maintaining proper osmotic pressure, water balance and acid-base balance **(Honey field, D.C, 1985)**. In humans, 88% of chloride is extracellular and contributes to the osmotic activity of body fluids. The electrolyte balance in the body is maintained by adjusting total dietary intake and by excretion via the kidneys and gastrointestinal tract **(WHO, 1996)**.The WHO standards for drinking water recommended that chloride concentration must not increase about 250 ppm, there is no determination to the minimum concentration of chloride.

Chloride concentrations in the body are well regulated through a complex interrelated system involving both nervous and hormonal systems. Even after intake of large quantities of chloride through food and water, the chloride balance is maintained, mainly by the excretion of excess chloride via the urine **(health Canada, 2012)**.

According to **(Elttibi, 2010)** the effect of water with low concentration of chloride may be expected to have a negative or have no effect at all.

2.7.1.3 Nitrate

Nitrate is a colorless, odorless and tasteless compound that present in water, it can be expressed as NO_3 (J.R.self 1998).

Nitrate can reach both surface water and groundwater as a consequence of agricultural activity (including excess application of inorganic nitrogenous fertilizers and manures), from wastewater treatment and from oxidation of nitrogenous waste products in human and animal excreta, including septic tanks **(Lee Haller, 1999).**

The toxicity of nitrate to humans is mainly attributable to its reduction to nitrite. The major biological effect of nitrite in humans is its involvement in the oxidation of normal Hb to metHb, which is unable to transport oxygen to the tissues. The reduced oxygen transport becomes clinically manifest when metHb concentrations reach 10%

of normal Hb concentrations and above; the condition, called methaemoglobinaemia, causes cyanosis and, at higher concentrations, asphyxia. The normal metHb level in humans is less than 2%; in infants under 3 months of age, it is less than 3% **(WHO, 2012).**

Abu Maila et. al, (2004) reported that Nitrate represents one of the major pollutants of groundwater in the Gaza Strip. Several cases of blue babies disease were reported in the last couple of years.

According to Baalousha (2008), there are two main sources of nitrate pollution in Gaza, the first is point source presented in Waste Water Treatment Plants. Approximately 70-80 % of the domestic wastewater produced in the Gaza Strip is discharged into the environment without treatment through leakages and overloaded treatment plants. In addition to leakage from treatment plants, leakage of wastewater by other means is very common in the Gaza Strip. Only 60% of the urban areas are connected to sewerage network.

This means that there are many areas discharging the wastewater using cesspits, especially in the densely populated refugee camps. Sewage collected from cesspits is very often discharged to open fields without treatment, and thus, destroying the upper soil and increasing the aquifer pollution.

The other source which is non point source is the agricultural activities which usually considered as "the nonpoint sources of nitrate pollution". different types of fertilizers and pesticides are usually applied. Organic, including manures, and inorganic types of fertilizers are used in the Gaza Strip.

2.7.2 Microbiological Properties

The most common and widespread health risk associated with drinking-water is contamination, either directly or indirectly, by human or animal excreta, particularly faeces. If such contamination is recent, and if those responsible for it include carriers of communicable enteric diseases, some of the pathogenic microorganisms that cause these diseases may be present in the water. Drinking the water, or using it in food preparation, may then result in new cases of infection **(WHO, 1996)**.

2.7.2.1 Total Coli forms

Coliform bacteria belong to the family Enterobacteriaceae but are further defined by functional characteristics rather than systematic genus and species. All of the Enterobacteriaceae are rod-shaped, non-spore-forming, and gram-negative Bacteria as illustrated in figure 2.5 (**Clifford C. Hach, 1990).**

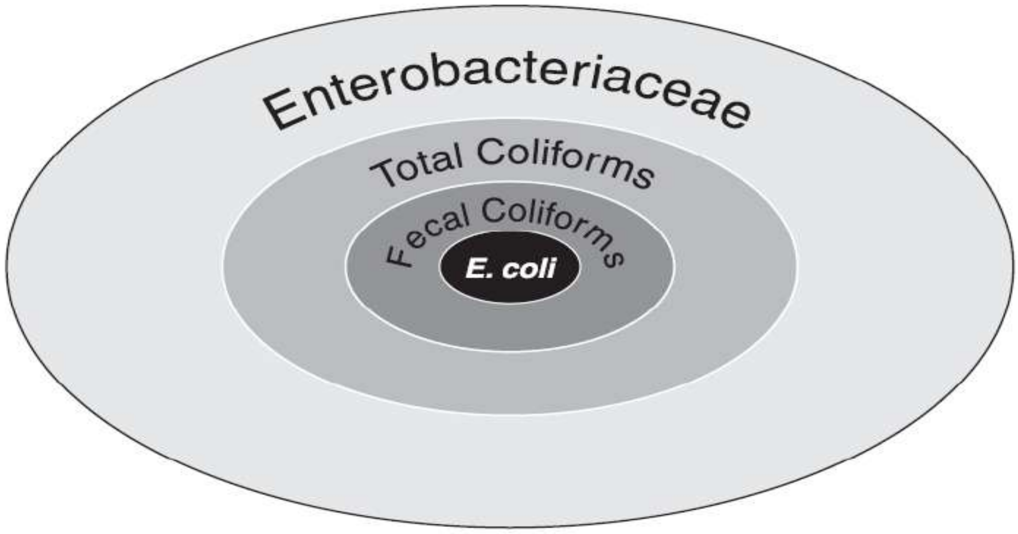


Figure (2.5): Relationship of Bacteria in Enterobacteriaceae Family (WHO)

World Health Organization has defined Coliforms as any rod-shaped, non-spore-forming, gram-negative bacteria capable of growth in the presence of bile salts or other surface-active agents **(WHO, 1985).**

Coliforms have been used extensively as a basis for indicating the microbial quality of drinking-water. Initially total coliforms were used as indicators of fecal contamination and hence of the possible presence of enteric pathogens. However, many species of bacteria in the total coliform group survive and grow in the environment, and theirvalue as an indicator of fecal contamination has been questioned by many regulatory agencies. Strains of total coliform bacteria may colonies surfaces within systems and become part of a biofilm **.**

The presence of coliform bacteria in potable water indicates unsuitable sanitation practices. Such occurrences may be a result of poor water treatment, plant design problems, improper water storage, inadequate hygienic practices in plant operation, or after growths in the distribution system Local authorities should ensure microbiological quality of treated drinking water. Coliform bacteria are not innate inhabitants of water, they can be found in water contaminated by domestic sewage or other sources of human and/or animal waste **(Geldteich, 1996).**

According to **(Eqa, 2011)** drinking water must be free from, Total coliform, Fecal coliform, Fecal streptococci, Clostridium perfringens and Pseudomonas aeruginosa.

2.7.2.2 Fecal coliforms

It is a sub-group of total coliform bacteria, They appear in great quantities in the intestines and feces of people and animals. The presence of fecal coliform in a drinking water sample often indicates recent fecal contamination, meaning that there is a greater risk that pathogens are present than if only total coliform bacteria is detected **(Connecticut Department of Public Health, 2010)**.

Coliform bacteria are described as facultative anaerobes (organisms which can survive in the absence of oxygen), gram-negative, non-spore forming, rod-shaped bacteria that ferment lactose (a type of sugar), producing gas and acid within 48 hours when cultured at 35C. Their lack of ability to form spores makes them more susceptible to destruction by environmental conditions **(APHA, 1999)**.

2.7.2.3 Escherichia coli

E. coli is found in large numbers in the faeces of humans and of nearly all warm blooded animalsas such it serves as a reliable index of recent faecal contamination of water **(WHO, 1996).**

Escherichia coli is a taxonomically well defined member of the family Enterobacteriaceae, and is characterized by possession of the enzymes galactosidase and glucuronidase. It grows at 44-45ºC on complex media, ferments lactose and mannitol with the production of acid and gas, and produces indole from tryptophan.

E. coli is widely preferred as an index of faecal contamination. It is also widely used as an indicator of treatment effectiveness although, as with the other coliform indicators, it is more sensitive to disinfection than many pathogens (in particular viruses and protozoa). The detection of *E. coli* in water leaving a treatment works is of the same significance as any other coliformorganism, but its absence does not necessarily indicate that pathogens have beeneliminated **(Payment, 2003).**

E. coli can cause serious disease, such as urinary tract infections, bacteraemia and meningitis. A limited number of enteropathogenic strains can cause acute diarrhea **(WHO, 2008).**

CHAPTER 3
MATERIALS AND METHODS

3.1 Introduction

The major goal of this research is to determine the effect of the desalination plants on environment and human health in Gaza city ,Palestine. In order to achieve this goal an observation card and questionnaire were used, the first to collect data about the desalination plants in Gaza city like, general information about the plant, physical, chemical and bacteriological parameters of both brackish and desalinated water, environmental, health and safety factors in the plant and the surrounding area and finally the awareness of the staff members of the plant about water issues. The second questionnaire was used to measure the social acceptance of the desalination plants.

3.2 Methodology of the Study

The information used in this study were gathered from the literature review and actual field investigation. The literature review obtained from many sources such as review of relevant books, reports, journals, articles, water experts and internet websites. Collection of the water samples was conducted in Gaza City, during the period from 20-10-2012to 1-12-2012. The chemical (chloride, fluoride, nitrate, TDS and EC) and microbiological (fecal coliform, E coli) analysis were conduct in the laboratories of environmental and earth science department at the Islamic University, some measures (pH) were conducted in the field. After that the questionnaire was applied to collect the required information about the plants from 1-12-2012 to 30-1-2013, SPSS software was used to analyze the collected data.

3.3 Sample Size

In Gaza City there are about 30 desalination plant, 27 desalination plant were targeted in this study, 27 observation cards were filled by the researcher to evaluate the targeted plants. 140 questionnaire were filled by the neighbors of the desalination plant, the distance from the plant was taken into account during filling the questionnaire. The questionnaires distributed on the people who live near the plant and far from it (0m -100m).

The total number of samples were collected and analyzed was 162 sample for chloride, fluoride and nitrate tests as the following:

81 samples were collected from the brackish water of the 27 desalination plants which targeted in the study , a sample were collected in each visit, where three visits were implemented for each plant, the total number of the collected brackish water samples become 81 . The same was done for the desalinated water samples.

Also 81 sample were collected to bacteriological analysis (FC, E coli) for the brackish water, and 81 samples from the desalinated water were collected to conduct the mentioned bacteriological tests.

3.4 Sample Collection

Sampling process was achieved according to Standard Methods for the Examination of Water and Wastewater 20th edition **(APHA, 1999)**. The following points were taken into account:

Sampling duration:

Samples collection process take time from 20-10-2012 to 25-11-2012, samples were collected from 27 desalination plant during the mentioned period.

Sample containers

250 ml plastic bottles were used to collect samples for chemical analysis. The bottles have been cleansed and rinsed very well with a final rinsed of distilled water and sterilized. while 100 ml sterilized plastic cups were used for bacteriological examinations, a cup of 100 ml also used to the measures that have been taken in the field.

Sampling Procedures

The samples were collected from the tap which connected to the desalinated water tank in the desalination plant. The tap was opened in order to let water run to waste for 2-3 minutes, after that the tap was closed to apply disinfection (inside and outside) using 70% Ethanol then was disinfected again by flame for a minute. After that water was run for additional 2-3 minutes. Then water flow was reduced to permit filling bottle without splashing. While the sample is collected, air space was left in the cup to facilitate mixing by shaking. Samples package was delivered in ice box to the laboratory immediately or in less than 6 hours.

3.5 Sample Analysis

In this study the laboratory procedures were used as follows:

3.5.1 Physiochemical Parameters

1- pH value

In order to measure the pH value for the samples, a portable pH pen meter was used (from the laboratory of IUG), To determine the pH value, the probe of the meter was washed with distilled water and dried prior to immersing the electrode in the sample to be tested, the pH values were recorded.

2- Total Dissolves Salts (TDS)

In order to measure the TDS value for the samples, a portable TDS pen meter was used (from the laboratory of IUG) ,The electrode of the meter immersed in the sample to be measured, after each reading the electrode was rinsed with distilled water and dried.

3- Electric Conductivity (EC)

A portable EC meter was used to measure the EC value(from the laboratory of IUG),The electrode of the meter immersed in the sample to be measured, after each reading the electrode was rinsed with distilled water and dried.

4- Chloride

Chloride concentration was determined by using argentometric method. In this method potassium chromate can indicate the end point of the silver nitrate titration of chloride. Silver chloride is precipitated quantitatively before red silver chromate is formed **(APHA, 1999).**

5- Fluoride

In order to determine the concentration of fluoride in drinking water SPADNS method was used. In the SPADNS (sodium 2- (parasulfophenylazo)–1,8–dihydroxy–3,6–naphthalene disulfonate) colorimetric method, fluoride reacts with the dye lake, dissociating a proportion into a colorless complex anion (ZrF6 2–) and the dye. As the amount of fluoride increases, the color produced becomes progressively lighter. After preliminary distillation, the distillate is reacted with the zirconium- dye lake and measured colorimetrically at 570 nm in a spectrophotometer **(WHO, 2006).**

6- Nitrate

In order to determine nitrate concentration in drinking water, ultraviolet Spectrophotometric method was used, Measurement of UV absorption at 220 nm enables rapid determination of NO_3^- (APHA, 1999).

3.5.2 Microbiological Analysis

1- Fecal Coliform

All water samples were tested using the standard membrane filtration (MF) method for estimation of FC bacterial populations. In brief, the MF method is based upon a selective medium (mFC agar) and incubation of filters at 44.5oC ±0.5°C for 24 h. All colonies that were blue color colonies were recorded as "Fecal coliform colonies". Practically, a sterile forceps was used to transfer a 0.45μm Millipore membrane on the filter support assembly. The funnel portion was place fitted (magnetic fitting). A 100 ml of water sample was transferred into a sterile magnetic funnel for filtration and, the membrane filter was then transferred to a Petri dish containing mFC Agar and incubated at 44.5oC ±0.5°C for 24 h. After incubation, all colonies that were blue color colonies were recorded as "Fecal coliform colonies". (APHA, 1998).

2- Echrecia coli

All water samples were tested using the standard membrane filtration (MF) method for estimation of E coli bacterial populations. In brief, the MF method is based upon a selective medium (MacConkey agar) and incubation of filters at 37.5oC ±0.5°C for 24h. All colonies that were red color colonies were recorded as "E coli colonies". Practically, a sterile forceps was used to transfer a 0.45μm Millipore membrane on the filter support assembly. The funnel portion was place fitted (magnetic fitting). A 100 ml of water sample was transferred into a sterile magnetic funnel for filtration and, the membrane filter was then transferred to a Petri dish containing MacConkey Agar and incubated at 37.5oC ±0.5°C for 24 h. After incubation, all colonies that were red color colonies were recorded as "E coli colonies". (APHA, 1998).

3.5.3 Air Pollution Measurements

In order to measure the level of carbon monoxide, carbon dioxide ,kanomax meter was used device for this purpose.

After turning the power ON, the meter was left for 20 minutes before starting the measurement. After that the measurement were started, five minutes were left between one reading and the other. Three readings were taken in each place, then the average was taken.

The measurements were taken before the operation of the desalination plant, during the operation of the desalination plant, before and during the operation of trucks.

3.5.4 Noise Measurements

The level of noise was measured by kanomax meter, three readings were taken in every position, before and after the operation of the desalination plant, before and after the operation of the trucks.

3.6 Research Tools

3.6.1 Questionnaire Design

An observation card and questionnaire were designed, the first to evaluate the desalination plant elements as follows:

- General information about the plant.
- Physiochemical and bacteriological parameters.
- Health, environment and safety factors.
- Assessment for the staff of the desalination plant.

The other questionnaire was designed to measure the social acceptance of the presence of the desalination plant. It was targeted the neighbors of the desalination plant in different locations, the following elements were covered:

- Personnel data e.g., age, sex level of education.

- Distance between the neighbor and the plant.
- Quality of water result from the plant.
- Problems result from the presence of the desalination plant.

Questionnaire used in current study is adopted from a questionnaire used by **PWA, (2009).** Both of the observation card and the questionnaire are present in appendix **D** and appendix **E.**

3.6.2 Media and Chemicals

Hydrochloric acid (35%), Ethanol (90,70%), potassium dichromate, silver nitrate, SPADNS, sodium hydroxide, rosalic acid, sodium fluoride, sodium arsenate and zirconyle chloride. Some of these reagents were available at laboratories in IUG, some were bought by the researcher. mFC Agar and MacConkey Agar were prepared according to manufacturer recommendations.

3.6.3 Equipments

In order to achieve the research, many equipments and devices were used. These are:

pH meter, Ec meter, TDS meter, Digital titration unit, Water bath, Incubator 44$_{\circ}$C, Incubator 37$_{\circ}$C,Autoclave, Balance, Hot plate and magnetic stirrer, Automatic pipette, Vacuum Pump, Refrigerator, spectrophotometer, Petri dish, sterilized cups 100 ml, Water bath, funnels, carbon monoxide meter and Computer, software SPSS and excel.

3.6.4 Data Organization and Analysis

The questionnaire was coded numerically in order to entering on excel table, the entered data was checked and reviewed, after that the excel software was used to analyze some data, the SPSS was used also to analyze some data.

CHAPTER (4)

RESULTS AND DISCUSSION

4.1 General Overview

The goal of the research is to evaluate the impacts of desalination plants on the surrounding environment and human health, by analyzing the desalinated water chemically, bacteriology and physically, measuring the level noise and air quality, the social effects of the desalination plants and providing some suggestions contributing in solving these problems.

The adopted methodology, in this thesis, depends on many approaches that were used in an integrated manner to achieve the objectives of this research. Data was collected by filling an observation card for the desalination plant, a questionnaire for the neighbors of the plants.

4.1.1 Geographical distribution of desalination plants

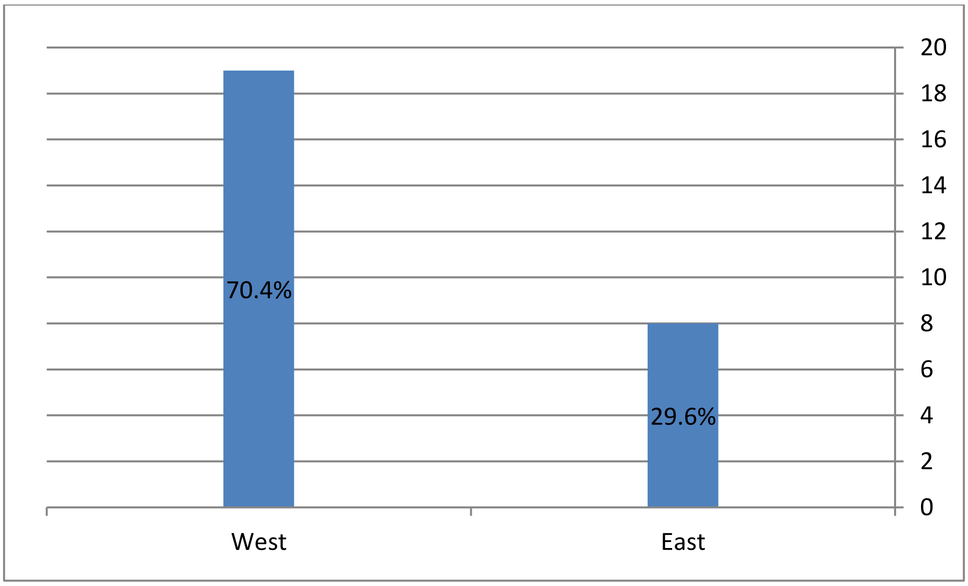


Figure (4.1): Geographic Distribution of desalination plants in Gaza City**.**

As shown in figure 4.1, The majority of the desalination plants are located in the western areas of Gaza City (from the east of Salah Eldien Road), where about 70.4% in the west and 29.6% in the east. This may regards to the high population density in the western area of Gaza City. And to the high water salinity in the west groundwater wells regards to sea water intrusion, and salinization of the ground water (PWA 2013).

4.1.2 Year of establishing of desalination plants

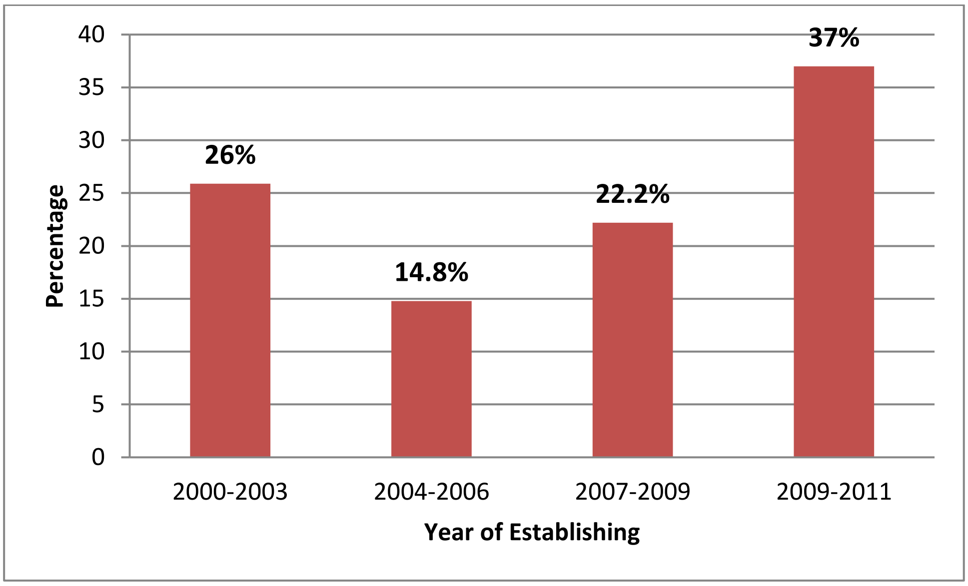


Figure (4.2): Year of establishing of desalination plants

It is clear that about (59%) of the desalination plant were established in the last six years as in the figure 4.2. This because of the bad quality of the water provided by the municipality. Also because of the rapid growth population which led to increasing the rates of demand on safe drinking water (UNRWA 2012).

4.1.3 Protection of Water Source Used in the Desalination Plant

All of the desalination plants targeted in this study were depend on private wells to desalinate water. This has a great adverse effects on the level of groundwater in the aquifer.

Figure 4.3 shows that 15 desalination plants (55.6%) have sources of water closed well and protected from any contamination and there is no any dangerous materials around it, while 12 desalination plant (44.4%) are not closed well and not protected from contamination and there is dangerous materials (fuel, chemicals, ….) around it.

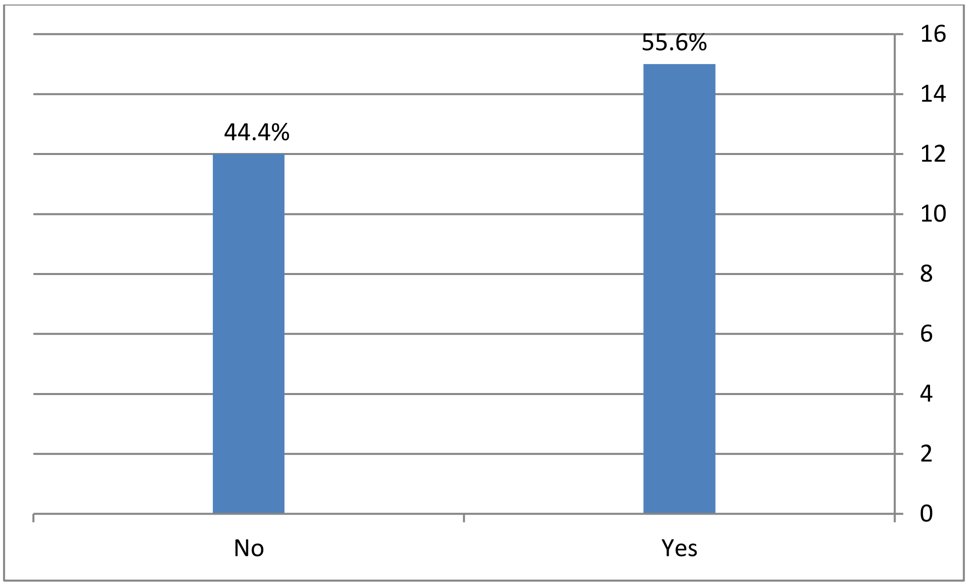


Figure (4.3): protection and closing well for the source of water

4.1.4 Water and Energy Consumption of Desalination Plants

According to table 4.1, the total consumption of desalination plants in Gaza City is 2378.5 m^3/day, 59462.5m^3/month and 713550 m^3/year. This means that yearly there is 713550$m^3$from the aquifer pumped to the desalination processes in Gaza City. According to PWA(2012), the amount pumped from the aquifer is 140 MCM yearly. Gaza City desalination plants consume 0.5% of this amount.

The power consumption of the desalination plants reaches to 60975 Kilowatt per month (60.975Mw per month), according to PENRA(2013), Gaza strip needs from(300-350 Mw), but the available from the different sources is about 217MW. There is a deficit about 100 Mw. So the desalination plants in Gaza city consume about 28% of the available energy. This means that desalination plants contribute in the present deficit in energy.

Table (4.1): Total water and energy consumption of desalination Plants

plant	Desalinated water M^3/H	Brine water M^3/H	Work of plant H/D	Total water consumption M^3/D	Total desalinated water M^3/D	Power consumption Kw/month
1	10	3	8	104	80	3000
2	10	6	7	112	70	2625
3	5	2	5	35	25	937.5
4	12	8	5	100	60	2250
5	5	2.5	6	45	30	1125
6	4	1.5	8	44	32	1200
7	20	13	10	330	200	7500
8	5	2	9	63	45	1687.5
9	5	2	9	63	45	1687.5
10	5	2	9	63	45	1687.5
11	6	2	4	32	24	900
12	8	3	5	55	40	1500
13	6	2	10	80	60	2250
14	10	2	3	36	30	1125
15	6	2	7	56	42	1575
16	11	7	8	144	88	3300
17	15	6	7	147	105	3937.5
18	4	3	6	42	24	900
19	7	4	6	66	42	1575
20	4	3	5	35	20	750
21	30	10	6	240	180	6750
22	6	3	6	54	36	1350
23	6	4	8	80	48	1800
24	30	10	5	200	150	5625
25	5	2.5	6	45	30	1125
26	6	2	5	40	30	1125
27	5	2.5	9	67.5	45	1687.5
Total	246	110		2378.5	1626	60975

4.1.5 Land Consuming

The total area of Gaza City is (56 km²), table 4.2 shows that the total area of desalination plants is 2787 m² (2.787 km²).This means that desalination plants in Gaza city occupate 0.05% of the total area of the city, this means that the small scale plants are not consume large area from the total area of the Gaza City.

Table(4.2): Total area of desalination plants

Plant	1	2	3	4	5	6	7	8	9	Total m^2
Area m^2	220	100	70	200	125	90	30	60	50	2787 m^2
Plant	10	11	12	13	14	15	16	17	18	
Area m^2	50	30	100	60	90	500	60	160	170	
Plant m^2	19	20	21	22	23	24	25	26	27	
Area	40	32	100	70	70	150	70	40	50	

4.1.6 Location of the Desalination Plants

The location of desalination plants is very important. The desalination plant must not represent a danger for people beside it. Because desalination plants produce noise, dust ,air pollution, jam traffic, cars accidents and water accumulation so it must not locate in populated buildings.

Figure 4.4 shows the location of desalination plants. It is shown that 14 desalination plant (51.9%) locate in separated building, while 13 desalination plants (48.1%) locate in shared building.

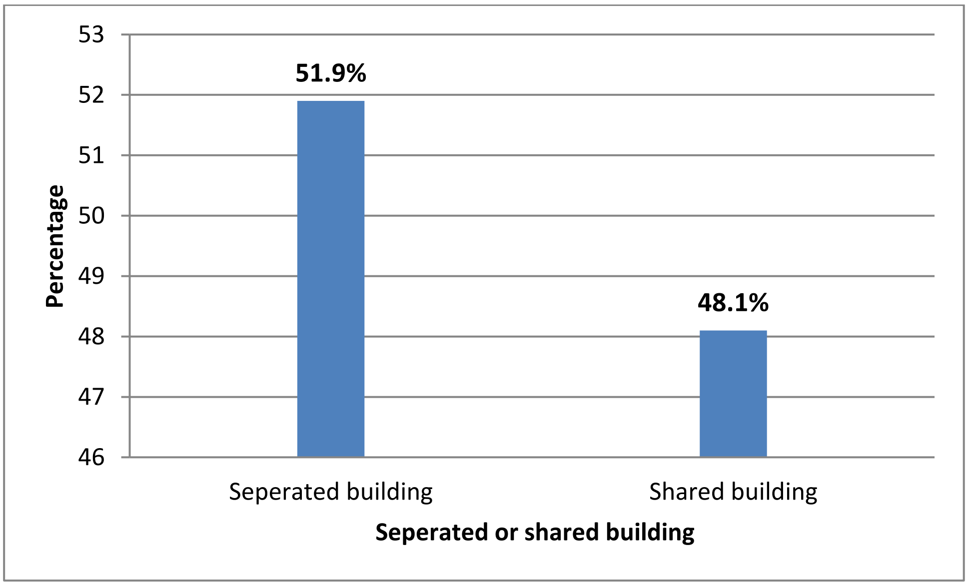


Figure (4.4): Desalination plants location

4.1.7 Impact of Street Width

Figure 4.5 shows the widths of streets which the desalination plants locate. According to the figure about (29.6%) desalination plants locate in street less than 10 meters in width. This can contribute in car accidents and jam traffics. About (33.3%) plants locate in streets with widths 10-15 meters. And about 37% plants locate in streets more than 15 meter in width. As the width of the street increase the chance of crowding and car accidents decrease.

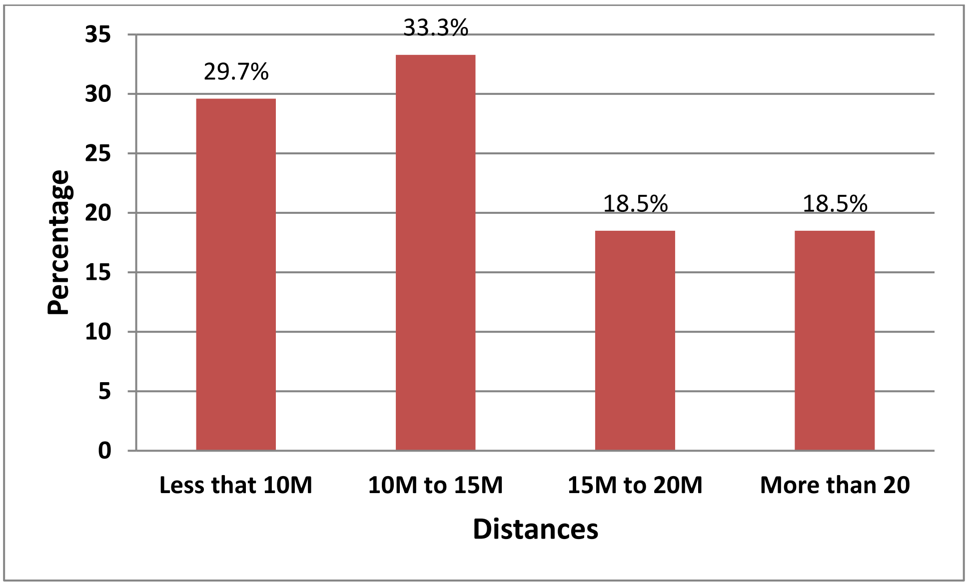


Figure (4.5): The widths of streets which the desalination plants locate.

4.1.8 Impact of Ground Street Type

Figure 4.6 shows the type of the street. It is observed that the majority of desalination plants are located at asphalt streets (59.3%), while (14.8%) locate in tailed streets. This can contribute in accumulation of water and 25,9% of the plants locate in sand streets, that leads to produce a big quantities of dust during the operation of delivery trucks.

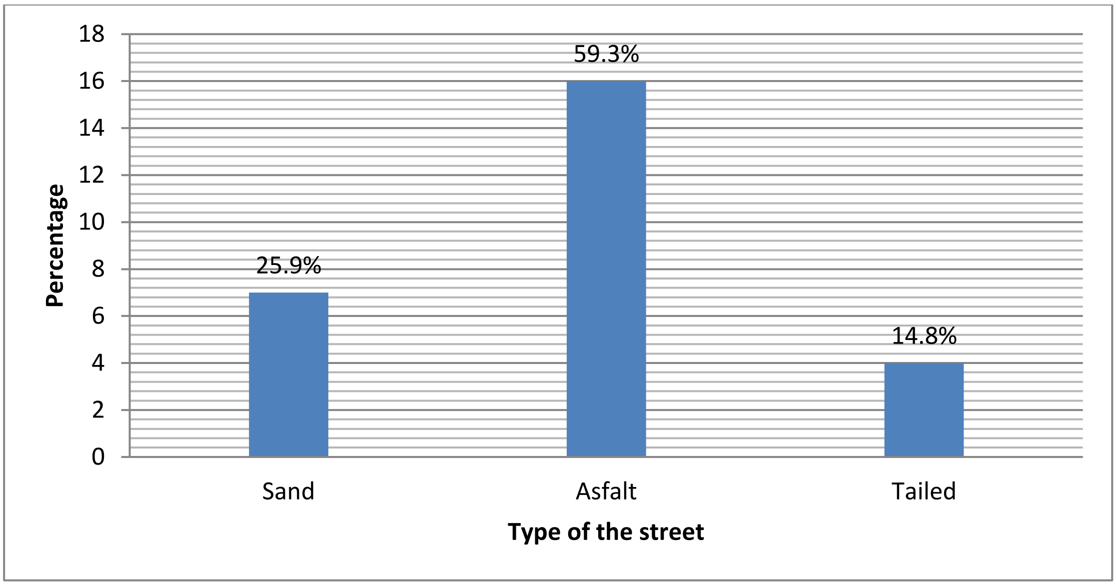


Figure (4.6): Type of the street

4.1.9 Impact of Desalination Plants to Surrounding Facilities

Data analysis shows that there are (70.4%) of the desalination plants locate near facilities, while (29.6%) are not locate near any facilities.

Figure (4.7) shows the types of facilities. It is clear that about(53%) of the plants are locate in industrial and workshop areas which represent a big danger if the owner of the plant not follow the rules of safety and also cause contamination of water. There are (32%) of the plants locate near schools , this can present danger for pupils because of car accidents and noise which affects the concentration of students. In addition (15%) locate near mosques, hospitals and farms.

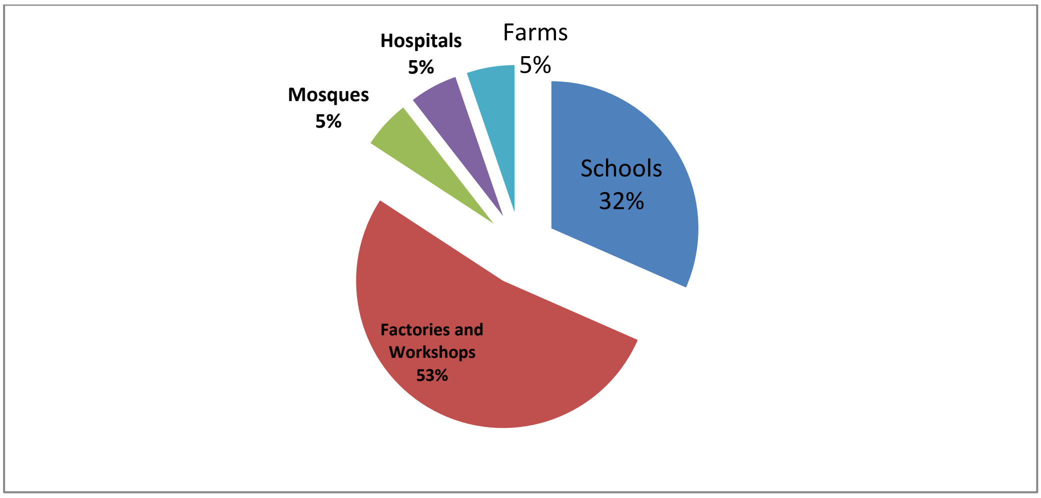


Figure (4.7): Facilities near the desalination plants and their types

4.1.10 Status of Delivery Trucks

The number of delivery trucks work in the plants in Gaza city was 79 truck, this can contribute in increasing of noise level, air pollution and the crowd.

The number of the evaluated trucks in this study was 25. Figure 4.8 shows the year of manufacture of used trucks. The vast majority of the targeted trucks were manufactured in the period from 1992 to 2002. They are old and need maintenance and represent risk to the driver and to the water.

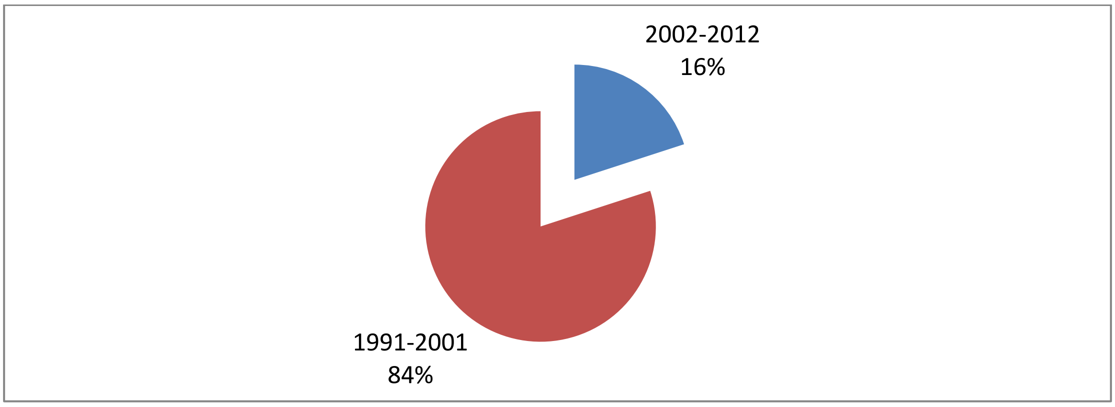


Figure (4.8): The year of manufacture for the delivery trucks**.**

4.1.11 State of Discharge Pipe

Figure 4.9 illustrates that (62.2%) of the delivery trucks have pipes fixed well and not exposed to any pollution, While (30.2%) of the delivery trucks their pipes are not fixed well so they exposed to pollution because they are always on the flour and in contact with sand and accumulated water. This can contribute in reaching pollutants to the water, so it could be reach the consumer polluted.

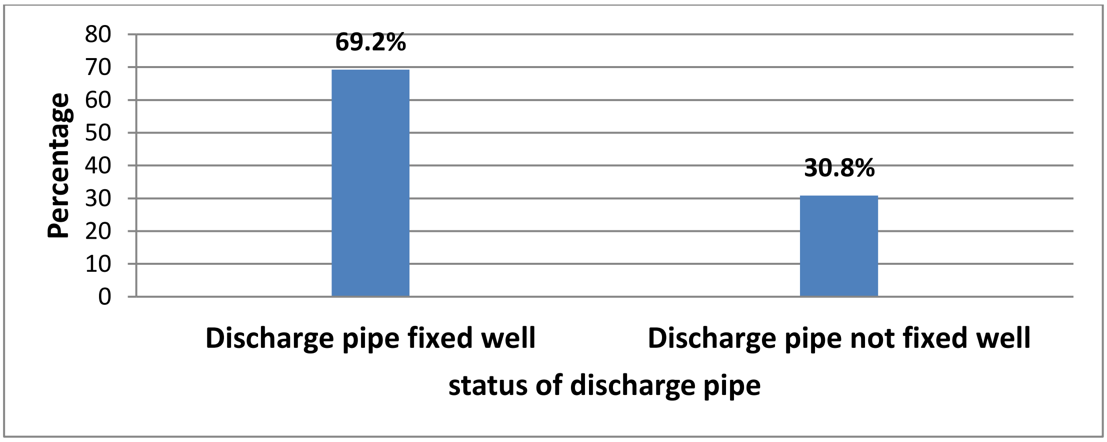


Figure (4.9): Situation of pipe discharge .

4.1.12 Brine Water Disposal

Brine water result from desalination process has a very high content of salts. This water should be disposed in a suitable manner because of its great risks. It can cause corrosion of pipes, increase salinity of the soil.

Disposal water uses are presented in figure (4.10). It is illustrated that about (63%) dispose the brine water in sewage which cause a load on the treatment plant and corrosion of sewage pipes, while (22%) used for agricultural irrigation purposes, that increase soil salinity and (15%) sold to be used for multi purposes like constructions (concrete).

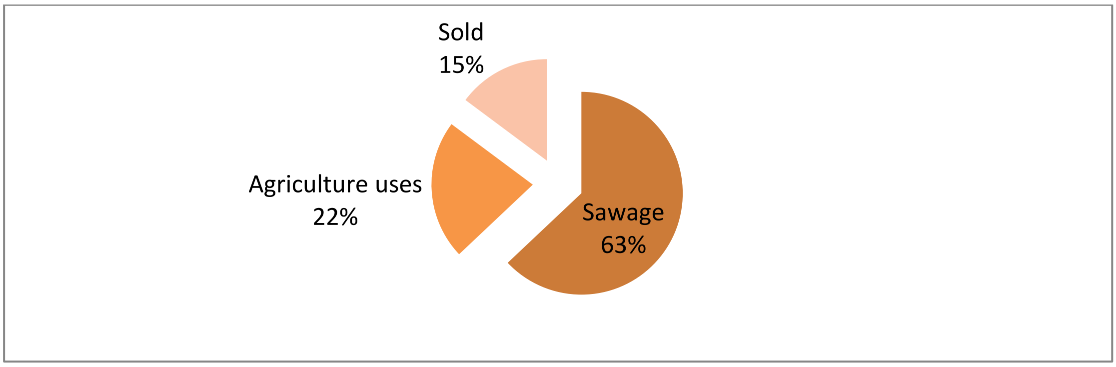


Figure (4.10): Disposal of brine water

4.1.13 Disinfection of Tanks

Disinfection of the desalinated water tanks is very important to prevent the presence of any contaminants in the water. Data result analysis in the figure (4.11) shows that (40.7%) disinfect the tanks by using chlorine, while (59.3%) not disinfect the tanks in order to keep the water taste accepted to their consumers. Absence of disinfection increase the probability of the presence of pathogens. Also the disinfection process is a necessary condition to license the desalination plant.

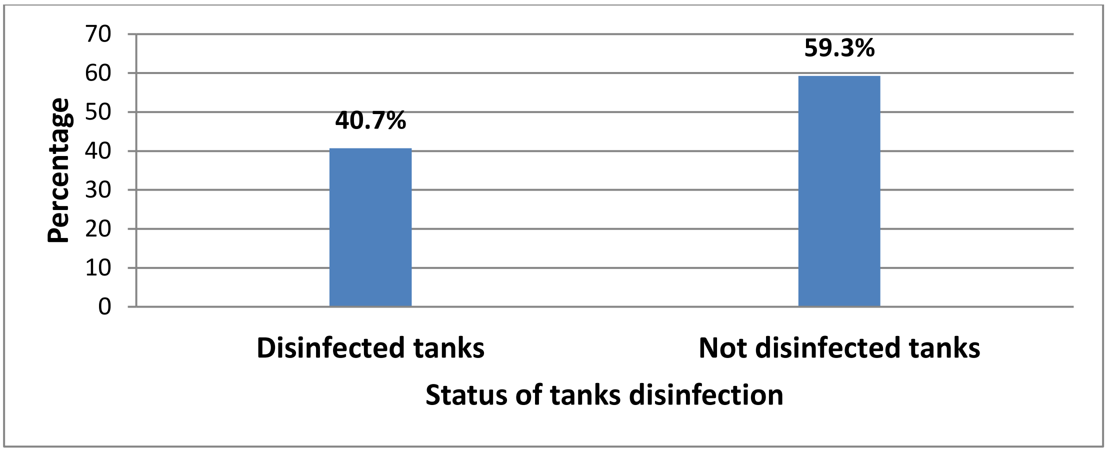


Figure (4.11): Disinfection of the tanks

4.2 Physico-chemical Characteristics of Water

The summary of the analytical results of both brackish and desalinated water in the study area is presented in Table (4.3), which shows the average maximum, minimum, mean and standard deviation values for the parameters. Also the table (4.4) shows a comparison of physico-chemical properties of brackish and desalinated water samples with Palestinian and (WHO) drinking water standards. Also the appendix **B** shows the raw data for the samples.

Table (4.3): physico-chemical properties of brackish and desalinated water samples.

Parameter	Type of water	Values from collected samples			
		Minimum	Maximum	Mean	Std. Deviation
EC	Brackish	230	6720	3051.6	1650
	Desalinated	35	475	158.7	116
pH	Brackish	6.8	8	7.6	0.34
	Desalinated	6.3	7.8	6.8	0.37
TDS ppm	Brackish	760	3700	1871.8	741.18
	Desalinated	45	210	110	38.39
CL ppm	Brackish	128	1205	594.5	311.11
	Desalinated	25	100	47.6	20.51
NO_3 ppm	Brackish	75	310	173.6	62.95
	Desalinated	11.5	90	29.4	14.49
F ppm	Brackish	2.10	7	4.4	1.38
	Desalinated	0.3	2	0.5	0.30

Table (4.4): Comparison of physico-chemical properties of brackish and desalinated water samples with Palestinian and (WHO) drinking water standards**.**

Parameter	Type of water	Values from collected samples				Standards	
		Min	Max	Mean	Std. Deviation	WHO	Local
EC µs/cm	Brackish	230	6720	3051.6	1650	1200 µs/cm	1500 µs/cm
	Desalinated	35	475	158.7	116		
pH	Brackish	6.8	8	7.6	0.34	6.5-8.5	6.5-9.5
	Desalinated	6.3	7.8	6.8	0.37		
TDS ppm	Brackish	760	3700	1871.8	741.18	1000 ppm	1000 ppm
	Desalinated	45	210	110	38.39		
CL ppm	Brackish	128	1205	594.5	311.11	250 ppm	600 ppm
	Desalinated	25	100	47.6	20.51		
NO_3 ppm	Brackish	75	310	173.6	62.95	50 ppm	70 ppm
	Desalinated	11.5	90	29.4	14.49		
F ppm	Brackish	2	7	4.4	1.38	1.5 ppm	1.5 ppm
	Desalinated	0.3	2	0.5	0.30		

4.2.1 Electric Conductivity

Brackish and desalinated water EC analysis is shown in figure (4.12).According to the figure, the values of EC in most of the plants are higher than the Palestinian standards (1500µs) and higher than the WHO standards(1200 µs). This reflects the bad quality of the water that supplied by the municipality, and the need of the desalination processes.

The values of EC for the desalinated water range from 35 - 475 µs\cm. This reflects that the desalination process produce unbalanced water because these values less than the recommended standards. Also this means that there is a need for a uniform standards for all the desalination plants. Also there is a big differences between the values of EC before and after desalination process, this reflects high efficiency of desalination plants.

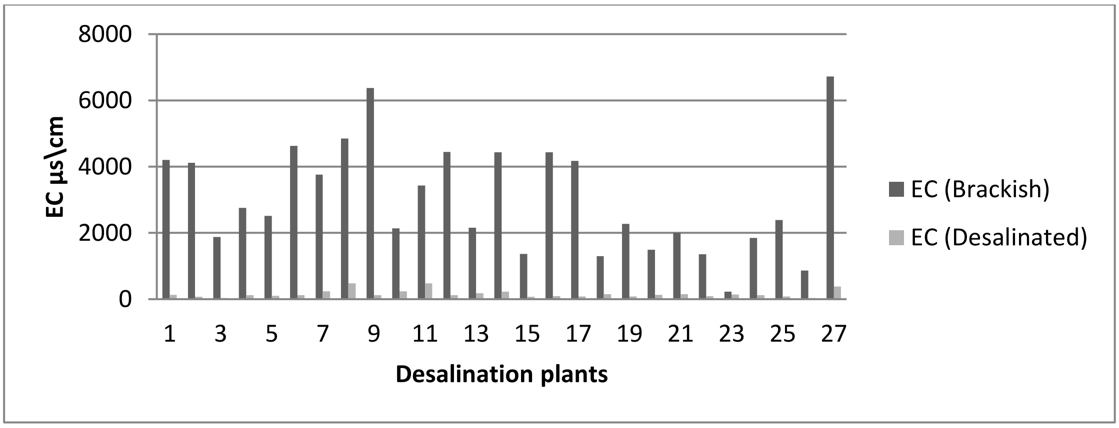


Figure (4.12): EC values for brackish and desalinated water.

4.2.2 pH value

According to (WHO 1996), The pH of water is a measure of the acid–base equilibrium and, in most natural waters, is controlled by the carbon dioxide–bicarbonate–carbonate equilibrium system.

In this study, the pH values for all brackish water samples are within the recommended standards (6.8 - 8) as in the tables above. But after the desalination process the values of pH of the desalinated water became less (6.3 - 7.8), this is due to the removal of elements. But the values of pH in both brackish and desalinated water samples are within the recommended standards.

The differences of pH values of desalinated water reflects the need to a uniform standards for all the desalination plants.

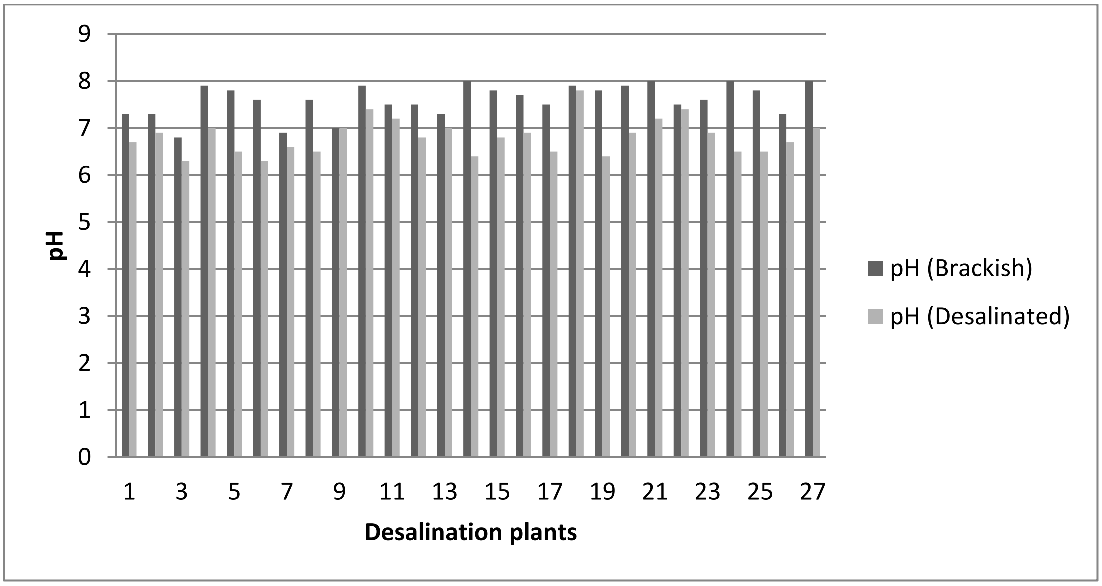


Figure (4.13): pH values for brackish and desalinated water

4.2.3 Total Dissolved Solids (TDS)

Figure (4.14) shows the results analysis for the TDS. According to the data analysis results, the TDS for brackish water for most of the plants (93 %) is higher than the recommended standards (1000ppm), while the rest (7 %) of the samples are less than 1000 ppm.
But the data result analysis of the TDS for the desalinated water are within the accepted range, the TDS ranges from (45-210 ppm).
This reflects the absence of the uniform standards that should be exist, and all the desalination plants must adhere to them. Also this reflects high efficiency of desalination process.

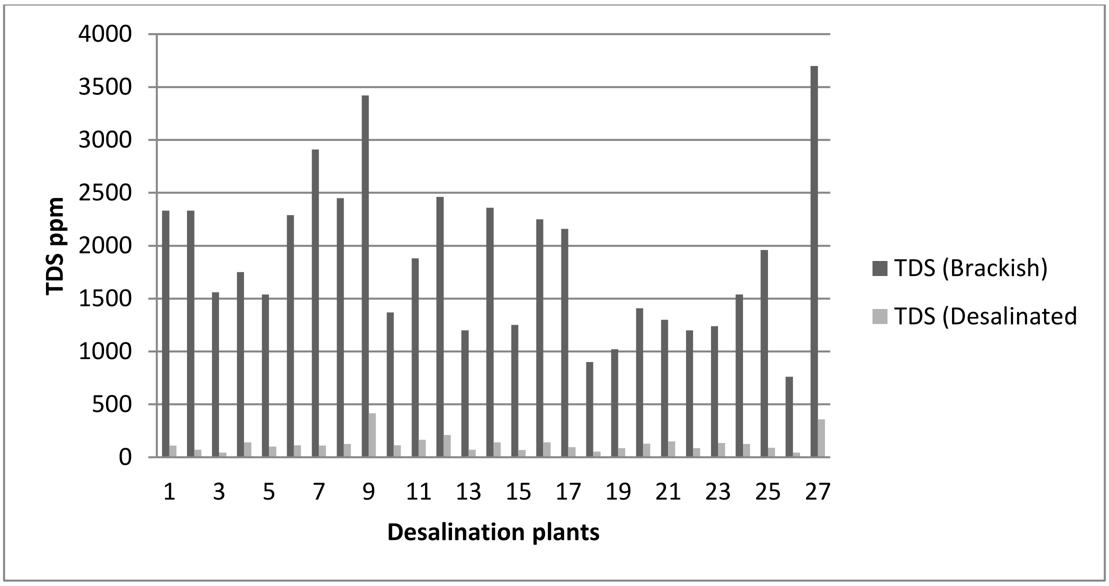


Figure (4.14): TDS values for brackish and desalinated water

4.2.4 Chemical Parameters

4.2.4.1 Chloride

The result analysis of chloride concentrations are shown in the figure (4.15).The majority of Cl concentrations for brackish water range between 128- 1205 mg/l. This is due to the sea water intrusion, continuous pumping (PWA 2013). Also this can show the differences of chloride concentrations in the different areas in Gaza city.

The concentrations of Cl for the desalinated water ranges between 25-100 mg/l. This means that they are in compliance with the recommended standards for drinking water, because all of the samples are under the Palestinian and WHO recommended standards.

The differences in chloride concentrations between brackish and desalinated water samples reflects the high efficiency of desalination plants. But the differences in chloride concentrations in the desalinated water reflects the need for uniform standards to all the plants.

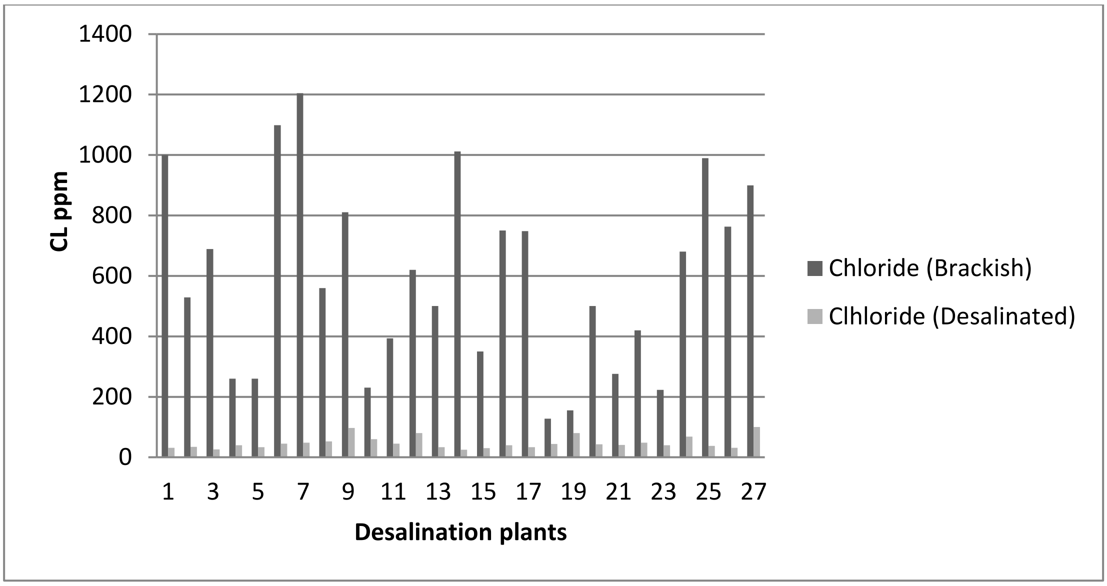


Figure (4.15): Concentrations of Cl for brackish and desalinated water

4.2.4.2 Nitrate

The nitrate concentration of brackish water in all the desalination plants is higher than the Palestinian and WHO recommended standards. As in the figure (4.16), the NO_3 concentrations range from (75-310 mg/l).

The high concentrations of NO_3 in brackish water in Gaza due to the application of fertilizers, pesticides. In addition to agricultural activities, nitrogen released from wastewater discharge plays a big role in aquifer pollution of nitrate (WHO 2013).

According to the data result analysis for the desalinated water samples, nitrate concentrations are under the recommended standards in all the plants, except the plant (27), the nitrate was 90 ppm. This may due to the location of this plant (near a basin for collecting water in Alsheikh redwan area).

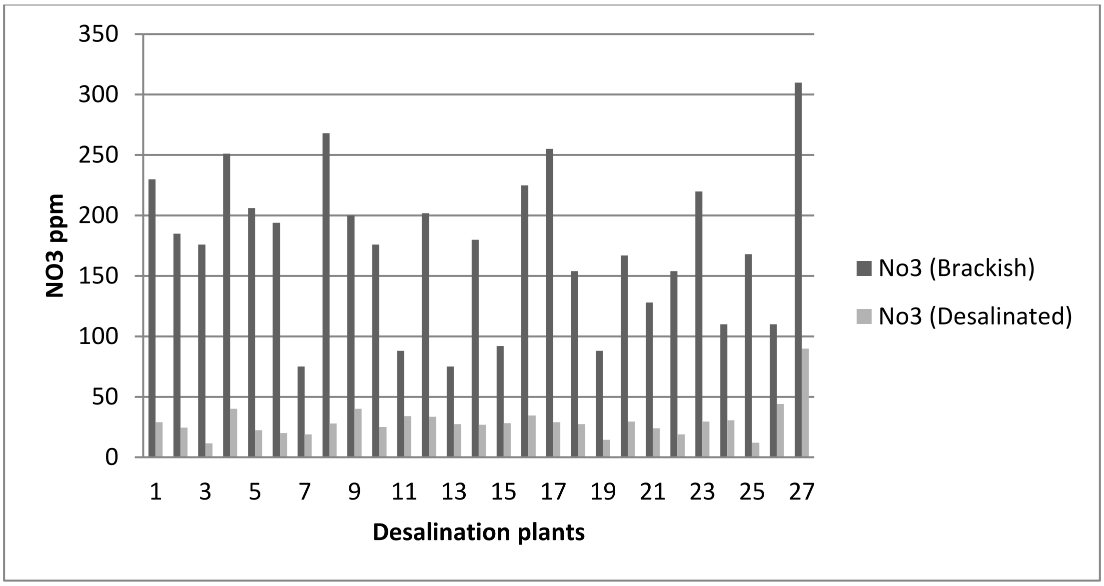


Figure (4.16): Concentrations of NO_3 for brackish and desalinated water

4.2.4.3 Fluoride

Fluoride concentrations for both brackish and desalinated water are shown in the figure (4.17). Fluoride concentrations all the brackish water samples are higher than the recommended (1.5 ppm), they range from (2.1-7. ppm).

Fluoride concentrations of all desalinated water samples are less than the recommended standards (1.5 ppm). Except the plant (27) due to its location as mentioned.

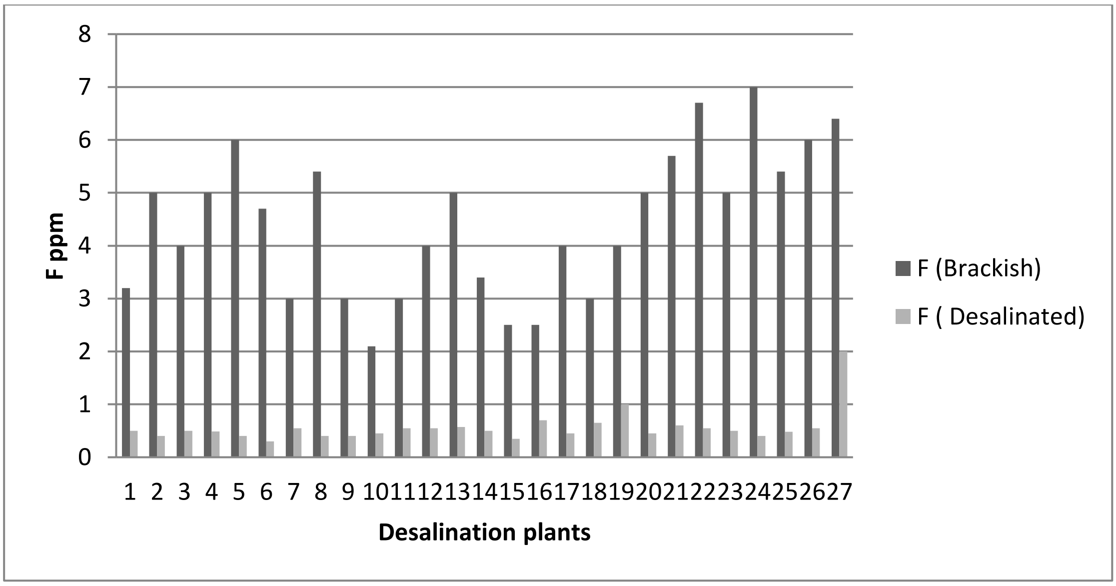


Figure (4.17): Concentrations of F for brackish and desalinated water

4.2.5 Efficiency of the Desalination Plants

According to the data result analysis and the figures above, there is a big differences between the concentrations of elements in both before and after the desalination process. The table in appendix **C** shows the percentage efficiency for each parameter in the targeted desalination plants. According to the table, most of the desalination plants have high efficiency in removing salts. The efficiency of the plants in removing TDS ranges from (88.5-97.1%), while the efficiency of the plants in removing Cl, NO_3 and fluoride range from (48-96.3%), (61.4-93.5 %) and (80-92%) respectively.

The average of the efficiencies for the desalination plants shows the difference between the plants. According to the table (4.5), the average of the efficiencies for the desalination plants range from (81.3 - 93.6%). This may be due to many factors like: quality of water in each area, the periodic times of changing the membranes, the manufacturing of the membranes and the periodic maintenance in the desalination plant.

Table(4.5): Average of % efficiency of the desalination plants

%Efficiency average(EC)	%Efficiency average(pH)	%Efficiency average(TDS)	%Efficiency average(Cl)	%Efficiency average(NO_3)	%Efficiency average(F)
92.3%	89.9%	93.6%	88.3%	81.3%	87.4%

4.3 Bacteriological Properties

The table (4.6) shows the results of bacteriological analysis of the targeted desalination plants. The first test shows that (37 %) of inlet of the targeted desalination plants are contaminated of Fecal coliform bacteria. And (18.5 %) are contaminated with E coli bacteria. The second test shows that (33 %) of inlet of the targeted desalination plants are contaminated of Fecal coliform bacteria. And (18.5 %) are contaminated with E coli bacteria.

The third test shows that (29.6 %) of inlet of the targeted desalination plants are contaminated of Fecal coliform bacteria. And (14.8 %) are contaminated with E coli bacteria. This may be because the source of the water (well) is not closed well and not protected from the sources of contamination.

But with regard to the desalinated water, the table shows that (22 %) of outlet of the targeted desalination plants are contaminated of Fecal coliform bacteria. And (29.6 %) are contaminated with E coli bacteria. The second test shows that (29.6 %) of outlet of the targeted desalination plants are contaminated of Fecal coliform bacteria. And (29.6 %) are contaminated with E coli bacteria. The third test shows that (29.6 %) of outlet of the targeted desalination plants are contaminated of Fecal coliform bacteria. And (25.9 %) are contaminated with E coli bacteria.

As in the table, the contamination of both FC and E-coli in some plants still present even after desalination process. This may due to the absence of disinfection process. Some plants are contaminated after desalination, this is a serious indicator and could be due to there is no disinfection to the tanks of the desalinated water and to the disinfection of the desalinated water, also may due to the closing of the desalinated water tanks in a good method.

Table 4.6 : A snapshot of the Excel table which was used to show the microbiological contamination of Desalination plants.

Plant	Date of the test	FC(In)	FC(Out)	E-coli(In)	E-coli(Out)	Plant	Date of the test	FC(In)	FC(Out)	E-coli(In)	E-coli(Out)	Plant	Date of the test	FC(In)	FC(Out)	E-coli(In)	E-coli(Out)
1	20-10-2012	0	0	0	0	1	10/11/2012	0	0	0	0	1	01/12/2012	0	0	0	0
2	20-10-2012	1	0	0	0	2	10/11/2012	0	0	0	0	2	01/12/2012	0	0	0	0
3	20-10-2012	3	0	0	0	3	10/11/2012	6	0	0	0	3	01/12/2012	1	0	0	0
4	20-10-2012	0	0	0	0	4	10/11/2012	0	0	0	0	4	01/12/2012	0	0	0	0
5	20-10-2012	0	0	0	0	5	10/11/2012	0	0	0	0	5	01/12/2012	0	0	0	0
6	20-10-2012	2	7	1	2	6	10/11/2012	5	1	3	1	6	01/12/2012	5	2	2	2
7	20-10-2012	1	0	0	0	7	10/11/2012	1	0	0	0	7	01/12/2012	1	0	0	0
8	20-10-2012	0	0	0	0	8	10/11/2012	0	0	0	0	8	01/12/2012	0	0	0	0
9	20-10-2012	0	0	0	0	9	10/11/2012	0	0	0	0	9	01/12/2012	0	0	0	0
10	20-10-2012	2	2	0	1	10	10/11/2012	4	1	0	1	10	01/12/2012	3	1	2	1
11	20-10-2012	0	0	0	0	11	10/11/2012	0	0	0	0	11	01/12/2012	0	0	0	0
12	20-10-2012	0	6	0	4	12	10/11/2012	0	6	0	4	12	01/12/2012	0	1	0	2
13	20-10-2012	0	2	0	1	13	10/11/2012	0	2	0	2	13	01/12/2012	0	2	0	1
14	20-10-2012	6	2	0	1	14	10/11/2012	2	1	0	3	14	01/12/2012	3	1	0	0
15	20-10-2012	0	0	0	0	15	10/11/2012	0	0	0	0	15	01/12/2012	0	0	0	0
16	20-10-2012	0	0	0	0	16	10/11/2012	0	0	0	0	16	01/12/2012	0	0	0	0
17	20-10-2012	0	0	0	0	17	10/11/2012	0	0	0	0	17	01/12/2012	0	0	0	0
18	20-10-2012	4	0	2	0	18	10/11/2012	1	0	1	0	18	01/12/2012	4	0	2	0
19	20-10-2012	0	0	0	0	19	10/11/2012	0	0	0	0	19	01/12/2012	0	0	0	0
20	20-10-2012	0	0	0	0	20	10/11/2012	0	0	0	0	20	01/12/2012	0	0	0	0
21	20-10-2012	0	0	0	0	21	10/11/2012	0	0	0	0	21	01/12/2012	0	0	0	0
22	20-10-2012	0	9	0	2	22	10/11/2012	0	5	0	2	22	01/12/2012	0	9	0	2
23	20-10-2012	0	2	0	0	23	10/11/2012	0	0	0	0	23	01/12/2012	0	0	0	0
24	20-10-2012	0	0	0	0	24	10/11/2012	0	0	0	0	24	01/12/2012	0	0	0	0
25	20-10-2012	21	0	10	0	25	10/11/2012	14	0	6	0	25	01/12/2012	0	0	0	0
26	20-10-2012	6	9	4	3	26	10/11/2012	2	1	3	1	26	01/12/2012	4	2	2	1
27	20-10-2012	7	2	1	0	27	10/11/2012	8	1	2	0	27	01/12/2012	3	1	1	0

4.4 Air Quality

4.4.1 Carbon Monoxide and Carbon Dioxide Inside the Desalination Plant

Figures 4.18 shows the concentration levels of CO before and during the operation of the desalination plant. It is observed that the levels of CO before the operation of the plant range from (0.2-4.8ppm), with average (2.5ppm). while the concentration levels of CO during the operation of the plant range from (0.2-4.7 ppm) with average (2.7ppm).The simple differences due to the presence of electric generators and to the ventilation of the plants. Also the concentration levels in the two cases were not represent a risk because they were less than the recommended standard of WHO (9ppm/8h).

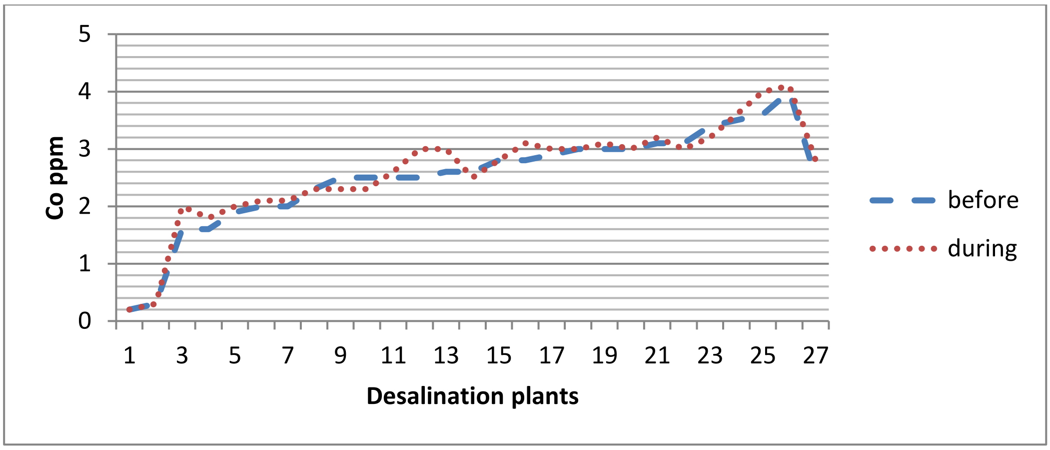


Figure (4.18): Concentrations of CO before and during the operation of the desalination plant.

The figure 4.19 shows the concentrations of CO_2 before and during the operation of the desalination plants. The concentration of CO_2 before the operation of the plants range from (240-475 ppm) with average (373 ppm).The concentrations of CO_2 during the operation of the plant range from (250-480 ppm)with average (385 ppm). There is no big differences between the two cases, this small differences due to quality of aeration and the operation of electric generators.

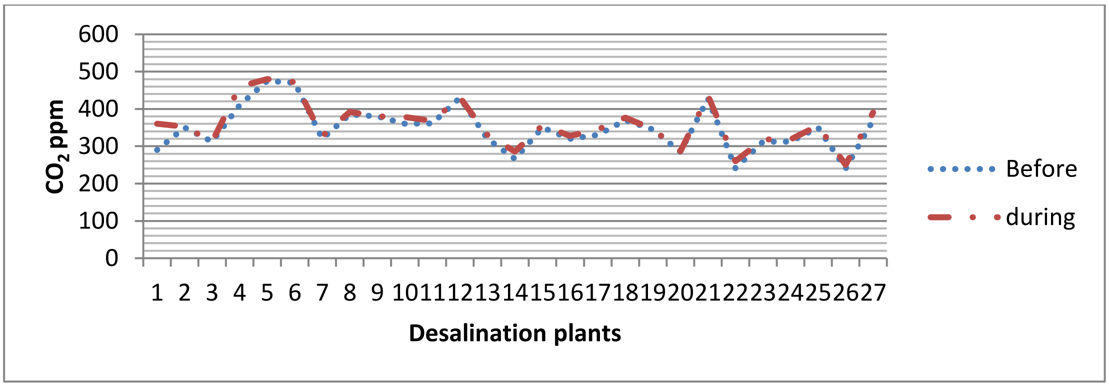


Figure (4.19): Concentrations of CO_2 before and during the operation of the desalination plant.

4.4.2 Carbon Monoxide and Carbon Dioxide Outside the Desalination Plant

Figure 4.20 shows concentrations of carbon monoxide before and during the operation of the delivery trucks on 5m and 10 m apart from the plant. Concentrations of CO before the operation of the trucks range from (1-4 ppm on 5m), with average(2.5 ppm) and (1-3 ppm on 10 m)with average(2.2 ppm).There is a slight difference between the two distances, but it is less than the recommended standards (9 ppm/8 hr) in both cases.

The concentrations of carbon monoxide were increased during the operation of the trucks to range from (4.7-6 ppm on 5m) with average (4.5 ppm), while it decreased to range from (2.9-4) ppm on 10 m)with average (3.8 ppm). This means that the concentration of CO reduced as we move away from the plant.

differences between the concentrations of carbon monoxide in both before and during the operation of delivery trucks may be due to many factors like: wind direction, width of the street, population density, location of the plant, case of the truck and the traffic situation in the street.

But here the exposure time is not enough. According to the recommended air quality standards of EPA and WHO (9 ppm/8hr). the measurements must be averaged during 8 hours, while it takes 20 minutes only, because the plants not work 8 hours continuously.

According to EQA there is no approved guidelines and standards for air quality and motor vehicle exhaust.

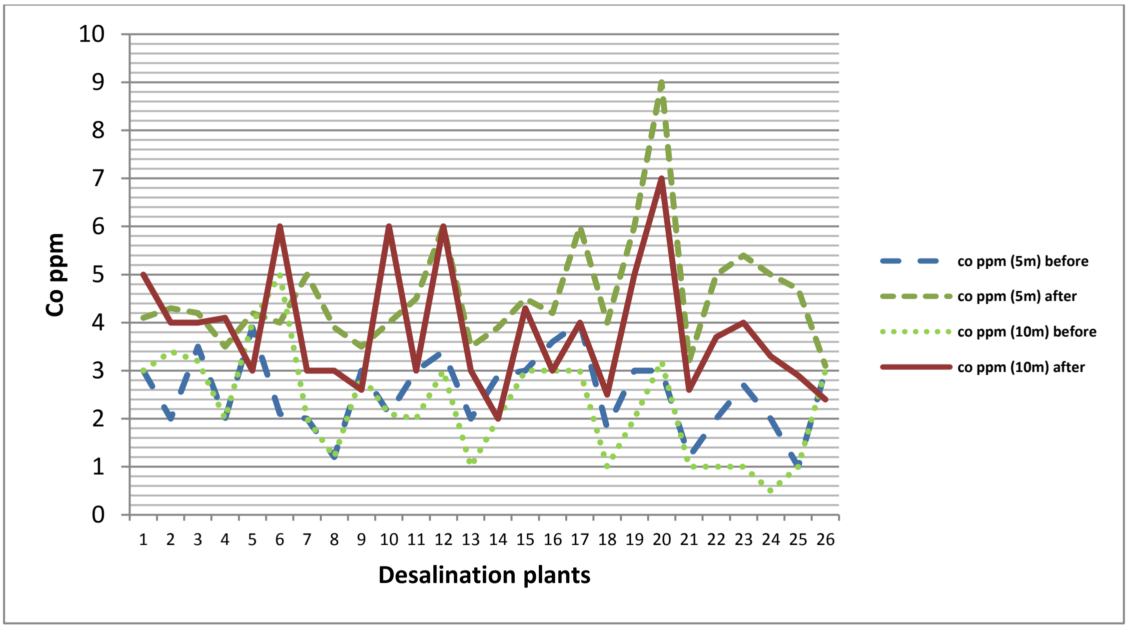
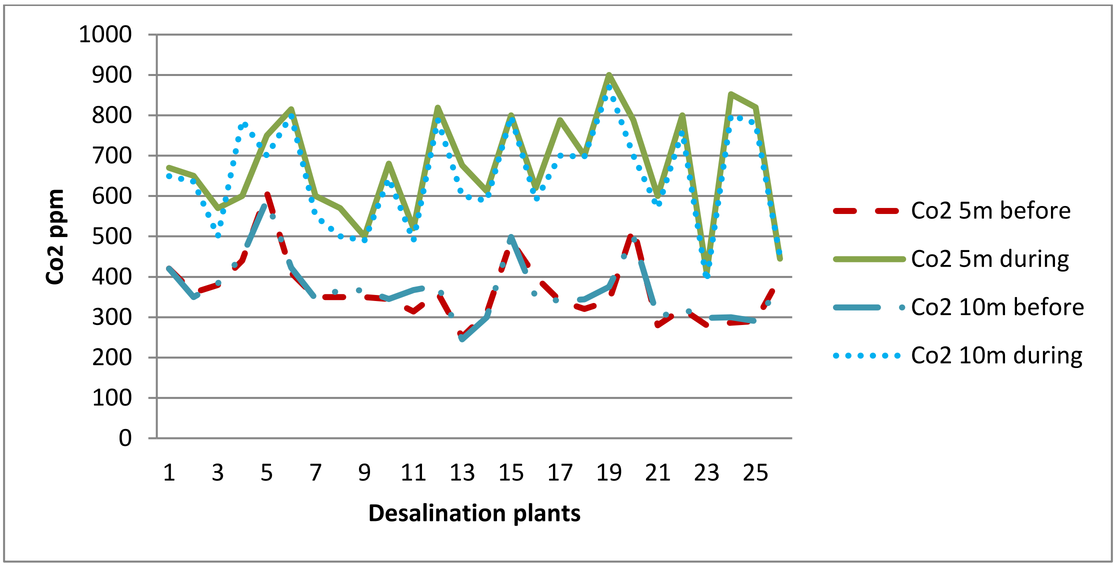


Figure (4.20): Concentrations of CO before and during the operation of the delivery trucks.

Figure 4.21 shows concentrations of CO_2 before and during the operation of the delivery trucks on 5m and 10 m distances apart from the plant. Concentrations of CO_2 before the operation of the trucks range from (251-608 ppm on 5m) with average (366ppm), while it range from (245-590 ppm on 10 m) with average (370ppm).

But the concentrations of CO_2 were increased during the operation of the trucks to range from (676-750 ppm on 5m) with average (975 ppm), while it decreased to range from (600-700 ppm on 10 m) with average (647 ppm). This means that the concentration of CO_2 reduced as we move away from the plant, the concentration of CO_2 is higher than the recommended standard (600ppm).

Differences between the concentrations of carbon dioxide in both before and during the operation of delivery trucks may be due to the following factors: wind direction, width of the street, population density, location of the plant, case of the truck and the traffic situation in the street.



Figure(4.21): Concentrations of CO_2 before and during the operation of the delivery trucks.

4.5 Noise Level

Figure 4.22, illustrates the values of noise before and during the operation of the plants and the trucks. The level of noise before the operation of the plant ranges from (31-80 dB). Some plants recorded high level of noise because different sources of noise affected the measurements.

The level of noise increased during the operation of the plant to range from (76-90 dB), all the desalination plants recorded levels of noise higher than the recommended standard of WHO (70 dB). During the operation of the plant and delivery trucks the level of noise increased again to range from (85-100 dB). This high level of noise can cause disturbance to the people near the plant, and cause health problems to the workers.

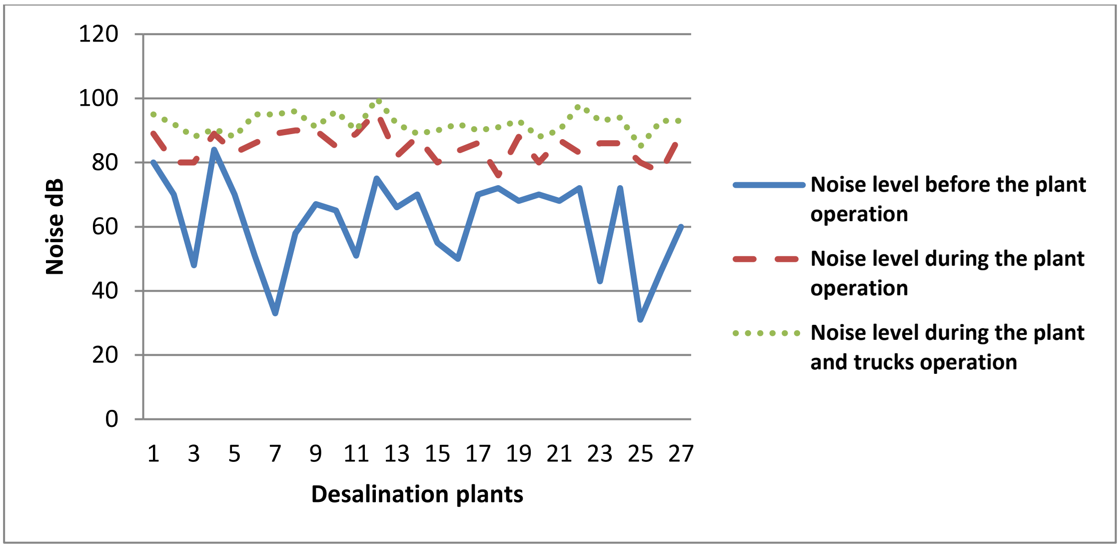


Figure (4.22): Noise levels before & during the operation of the desalination plant

4.6 Health and Environmental Situation

4.6.1 Ground of the Plant

According to MOH and the municipality of Gaza, the ground of the plant must be tailed and free of any cracks and holes. Figure 4.23 shows that 56% of the plants have tailed and free of cracks ground, 44% have no tailed and not free of cracks ground. This situation reflects the commitment of the owners of the desalination plants. This may lead to health problems like presence of insects and rodents. This may due to the absence of periodic maintenance of the plants.

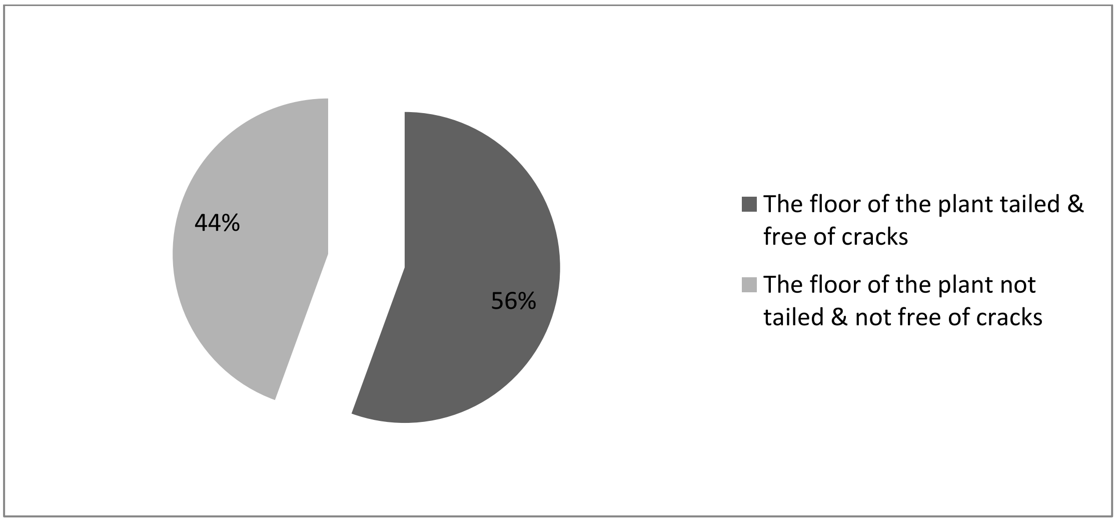


Figure (4.23): The status of the ground in the desalination plant

4.6.2 Walls of the Plant

Figure 4.24, illustrates the status of the walls of the desalination plants. There are 18.5% of the targeted plants have tailed walls and free of cracks, 81.5% of the plants have walls that are not tailed and free of cracks. this reflects the absence of commitment of the plants owners in the conditions of ministry of health.

Also this reflects the need of implementing periodic maintenance for those plants by the owners.

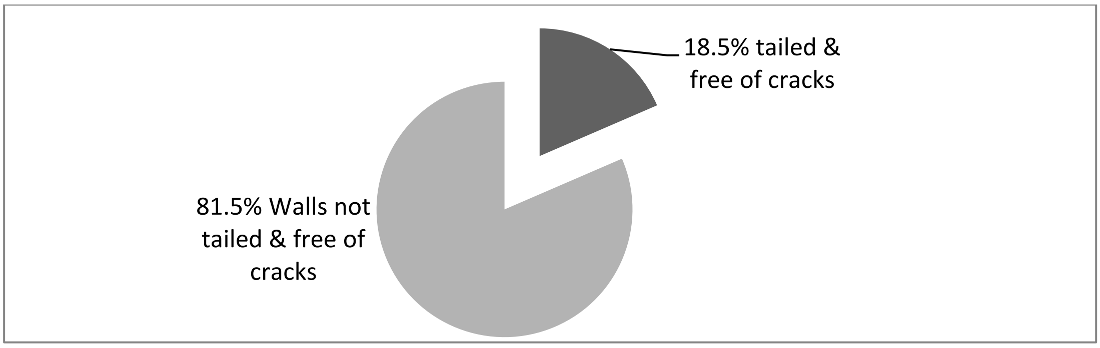


Figure (4.24): Status of the walls in the desalination plant

4.6.3 Plant Interface

Figure 4.25, shows the status of the interface of the plant. According to the figure about 40.7% of the targeted plants committed to the conditions of MOH, which state that the interface of the desalination plants should be from glass. 59.3% of the targeted plants are not committed to the conditions. This means that these plants will be presented to dust, sand and other pollutants and contaminant. Also this situation reflects the need of continuous follow up and monitoring from the competent authorities.

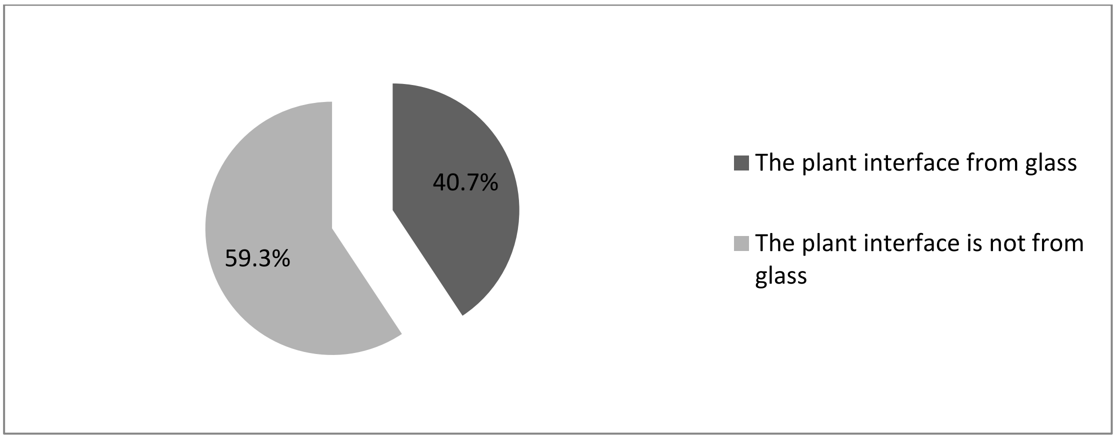


Figure (4.25): Status of the interface of the desalination plant

4.6.4 Sewage System

According to MOH and the municipality conditions and rules, the sewage system in the desalination plants must be separated of the brine water disposal system. In order to ensure that there is no any connection between the two systems.

Figure 4.26, shows the situation of the sewage system in the desalination plants.About three quarter (74.1%) of the desalination plants are not committed to the conditions of MOH. This can allow the pathogens and contaminants to reach to the water.

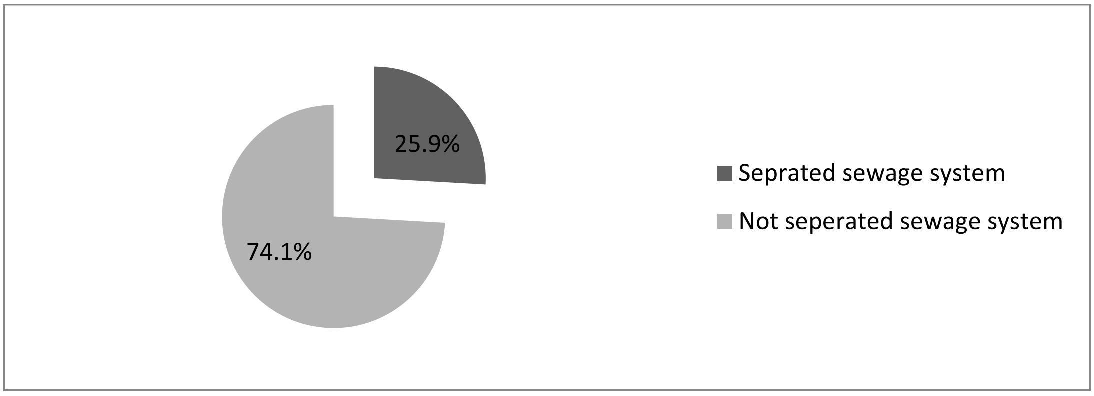


Figure (4.26): Status of the sewage system of the desalination plant

4.6.5 Cleanliness of Toilets

Figure4.27 shows the cleanliness level of toilets in the desalination plants. There are 25.9% of the targeted plants have toilets clean and there a soap in the toilet, 74.1% have lower cleanliness level and have no soap in them. This means that workers are presented to risks like diseases result from low level of hygiene and the desalinated water also presented to risks.

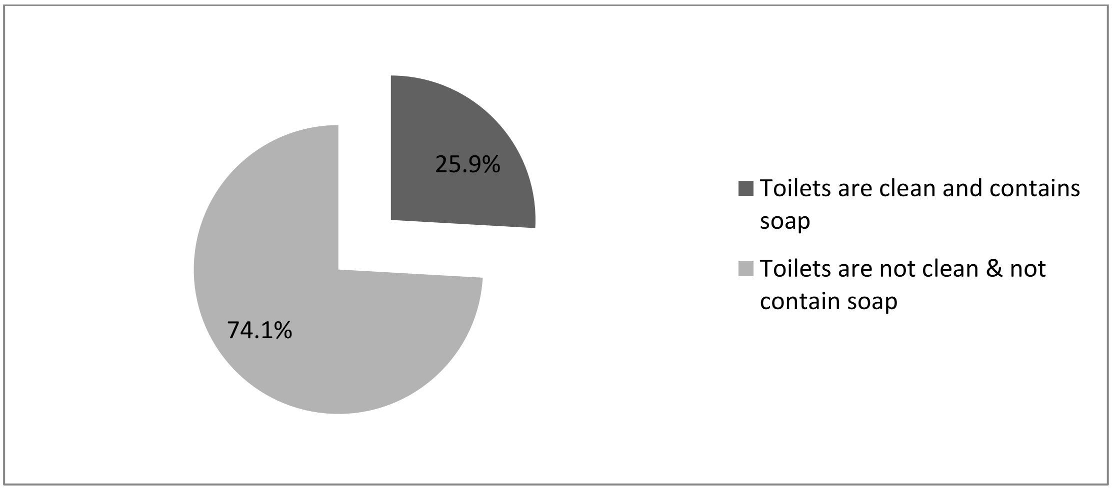


Figure (4.27): Status of the cleanliness of toilets in the desalination plant

4.6.6 Periodic Times of Cleaning the Plant

Figure 4.28, represents periodic times of plants cleaning of the targeted plants. It shows that 51.9% of the targeted plants being cleaned daily, 37% weekly and 11.1% monthly. Low level of cleanliness can lead to health problems to the workers and may reach to water. Also there were 66.7% of the plants disposed of their solid wastes in a correct and safe method, 33.3% do not dispose their solid waste in correct and safe method. This can lead to health problems risks.

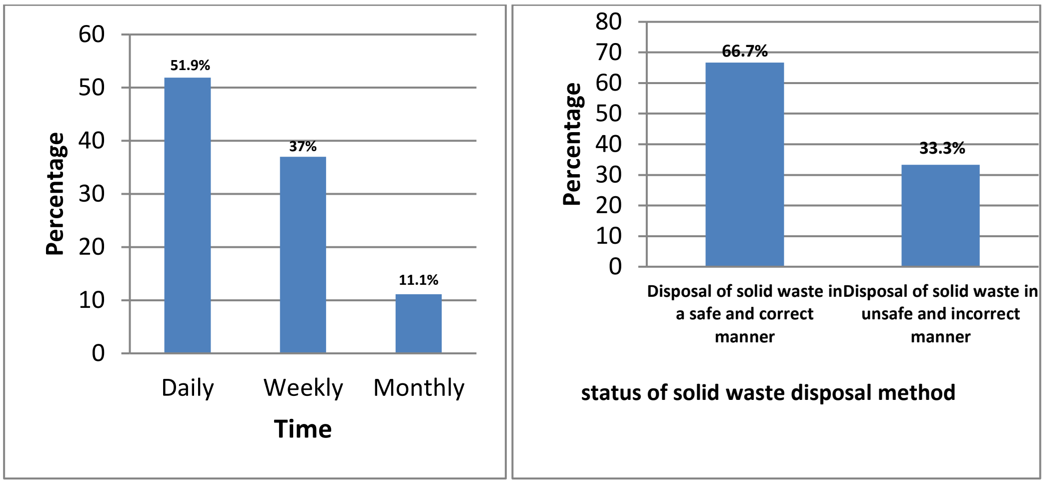


Figure (4.28): Times of cleaning the desalination plant& disposal of solid waste

4.6.7 Accumulation and Leakage of Water

Leakage of water from the pipes in the desalination plants can lead to many problems such as waste a large amounts of water and can affect the level of safety of the workers. Data analysis result shows that about 85.2% of the targeted plants suffer from leakage of water from the pipes, while 14.8% have no any leakage in the pipes.

The accumulation of water which result during filling the tanks of the trucks also can cause problems. It can cause disturbance to the people, waste large amounts of water, cause traffic accidents and can make damage to the roads. The results showed that 53.8% of the targeted plants have leakage and water accumulation during filling the tanks. This indicates that the competent authorities is not follow up these plants, and the owners of these plants need an intensive awareness campaigns.

4.6.8 Storage of Chemicals

Figure 4.29, shows the case of storage of chemicals which used in the desalination process. According to the figure there are about 52% of the plant not keep the chemicals in a safe place or safe containers. This reflects the absence of commitment of safety procedures, while there are 48% keep the chemicals in safe place and containers. This result from low level of awareness for the owners of the plants, and lead to health risks and problems.

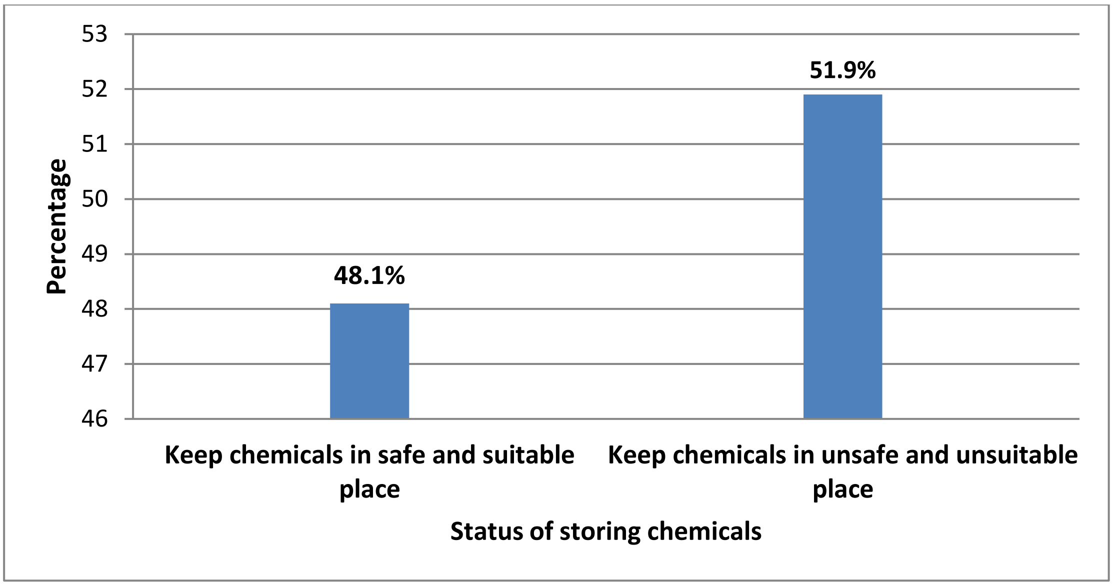


Figure (4.29): Storage of chemicals in a safe place**.**

4.6.9 Implementing Periodic Tests

Implementing periodic bacteriological and chemical tests is necessary in order to prevent contamination of water. Table 4.7 shows the percentage of plant owners which conduct periodic tests to the desalinated water. According to the table there are 74.1% of the owners not implement periodic chemical or bacteriological tests to the water, which can increase the presence of pathogens in the water, and increase the opportunity of the presence of problems.

According to the table, the vast majority of the targeted plants (85.2 %) have been followed up by the competent authorities, this means that the competent authorities doing its role in following up the quality of water in a large number of plants. But the remaining plants(14.8 %) need more follow up.

Table (4.7): Implementing periodic tests by the owners and competent authorities

implementing periodic tests by the owner			implementing periodic tests by competent authorities	
Yes/No	Number	Percent	Number	Percent
Yes	7	25.9%	23	85.2%
No	20	74.1%	4	14.8%
Total	27	100%	27	100%

Table (4.8): Time of implementing the periodic tests

Time of test implemented by the owner			Time of test implemented by the competent authority	
Time	Number	Percent	Number	Percent
Weekly	0	0%	0	0%
Monthly	6	85.7%	23	23%
Annually	1	14.3%	0	0%
Total	7	100%	23	100%

4.6.10 Plant documentations

Figure 4.30, displays the percentage of desalination plants that have records and documents to keep the results of the tests. The figure shows that 85.2% of the targeted plants do not have records, 14,8% of the plants have records. keeping the results of the tests in records is important to use it as reference.

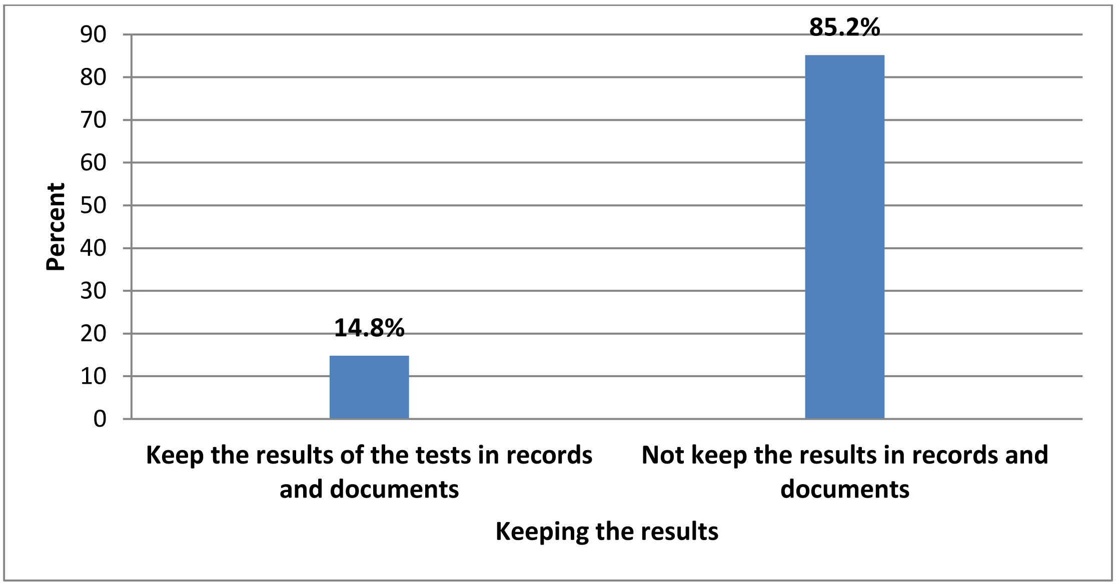


Figure (4.30): Keeping the results in records and documents

4.6.11 Workers health situation

According to ministry of health, the workers of the desalination plants must have free of disease certificate. Figure 4.31 shows the percentage of workers that have free of disease certificate. The figure shows that 59.3% of the workers not have free of disease certificate, this reflects the absence of commitment of the terms of the license. And can lead to health problems especially when we deal with infectious diseases may reach to the other workers or to the water.

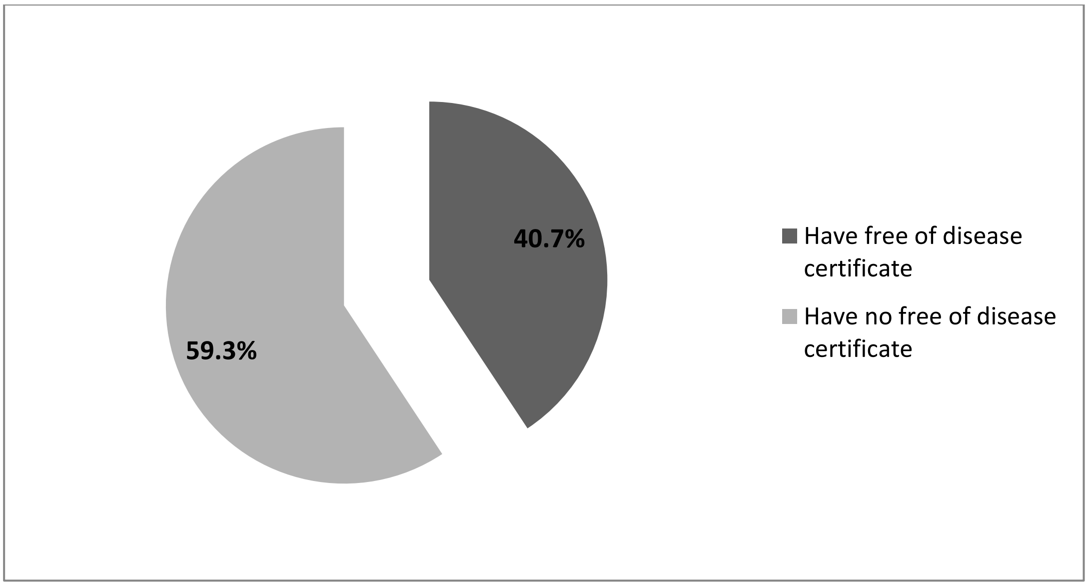


Figure (4.31): Percentage of staff members who have free of disease certificate

4.6.12 Workers & Hygiene

Figure 4.32 shows the percentage of workers who keep their personal hygiene. There are about 70% of the workers keep their personal hygiene, 30% of them are not keep their personal hygiene. Low level of hygiene and cleanness can lead to health problems.

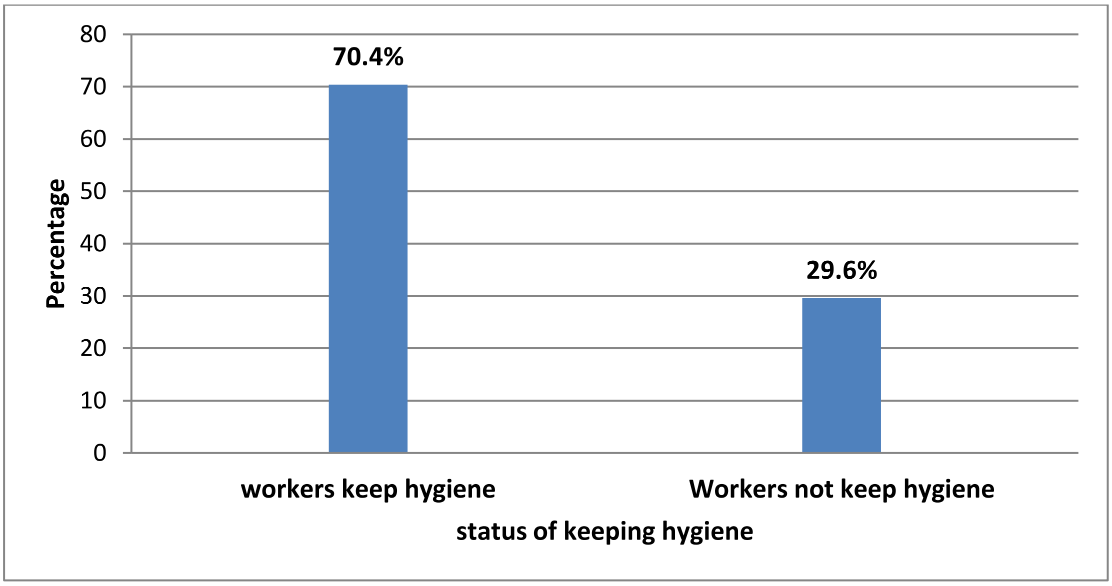


Figure (4.32): Percentage of staff members keeping on hygiene

4.7 Knowledge of workers to Water Issues

4.7.1 Age of the Workers

Table 4.9 shows the age distribution in the study population, From the table the highest percentage age group recorded was 41 % at group (31-40 years), the lowest percentage of age group recorded was 4 % at group (less than 20 years).

Table (4.9) : Distribution of worker's age

Total	Age group				
	Less than 20	**21-30**	**31-40**	**41-50**	**older than 50**
	4%	18%	41%	18%	19%
	100%				

4.7.2 Qualifications of Workers

Figure 4.33 shows the qualifications of the workers in the desalination plants. According to the figure there are 55% of the workers finished the primary school only, about 30% finished the secondary school only. This reflects the low qualification of the workers in this important sector.

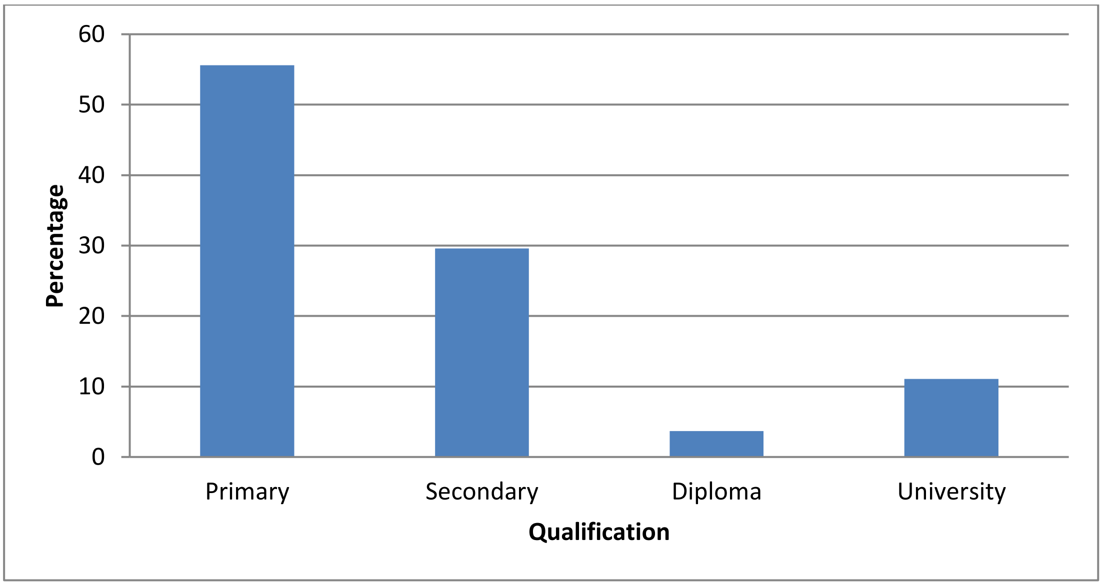


Figure (4.33): Qualifications of workers in the desalination plants

4.7.3 knowledge of Workers About Water Contamination

Figure 4.34 shows the knowledge of workers about contaminated water and diseases, it shows that 63% of the workers know that contaminated water can cause diseases, 37% do not know. This means that an efforts are needed in order to raise the awareness of the workers in this sector.

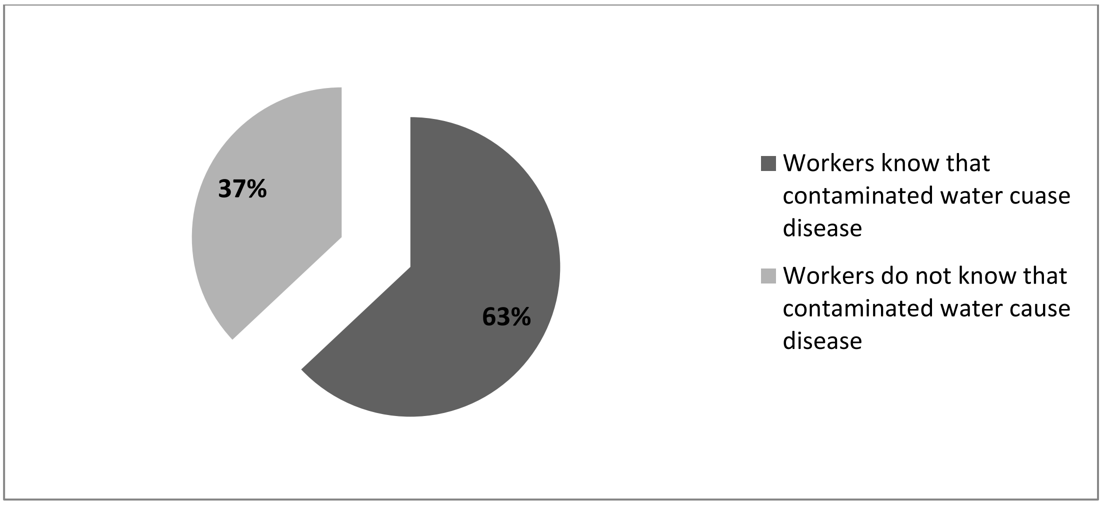


Figure (4.34): Knowledge of workers in the relation between water contamination& disease

4.7.4 Awareness of Workers

Figure 4.35 shows the percentage of workers who have read or heard about water contaminants. The figure shows that 22% have read or heard about water contaminants, 78% don't have read or heard about water contaminants. This means that the awareness level of the workers in this issue is low.

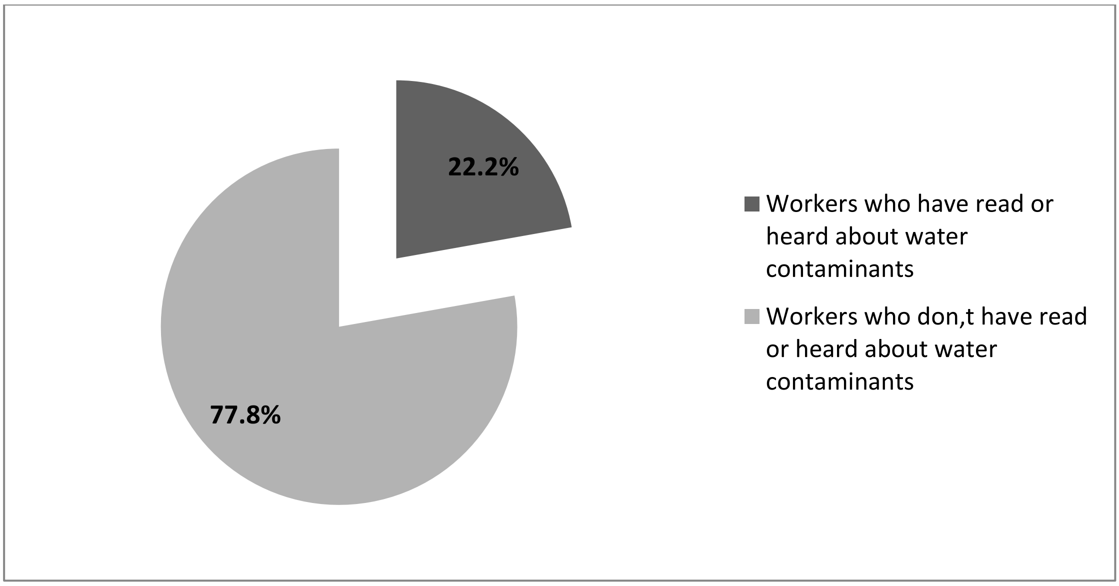


Figure (4.35): Awareness of workers about water contaminants

4.7.5 Source of Information

Figure 4.36 shows the sources of information about water and contamination that the workers have obtained. It shows that 50 % of them obtained the information from TV, 33% from the internet and 17% from the newspaper. This reflects that there is no any governmental or private institutions conduct awareness activities.

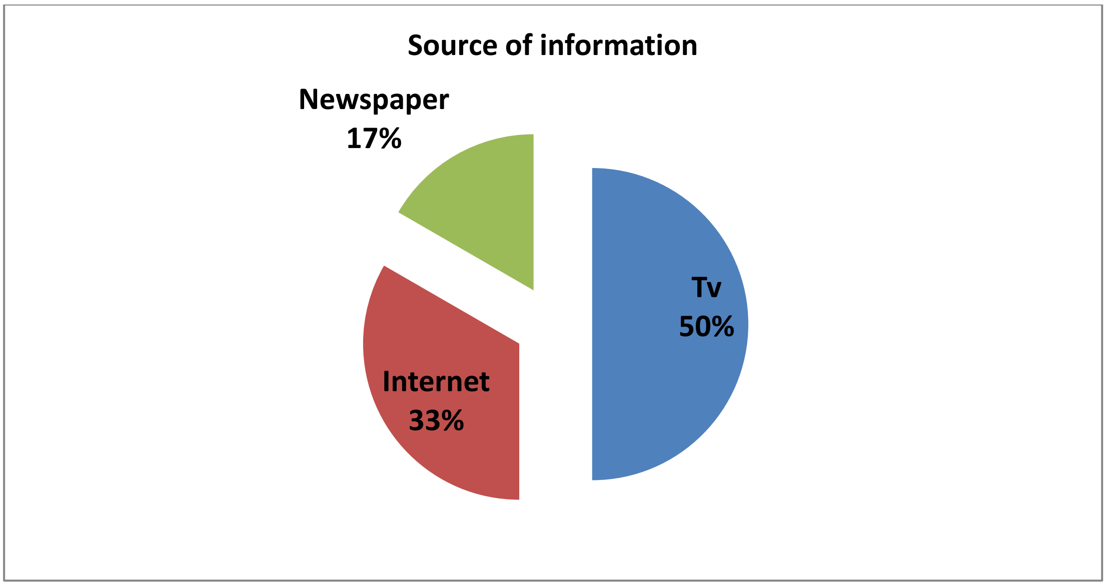


Figure (4.36): Source of information about water

4.7.6 Conduction of Awareness Activities

Figure 4.37 shows the percentage of institutions that conducted awareness activities for the workers. There are 92.6% of the workers told that there is no any awareness activities have been conducted by the institutions. Which reflects the urgent need for the awareness activities.

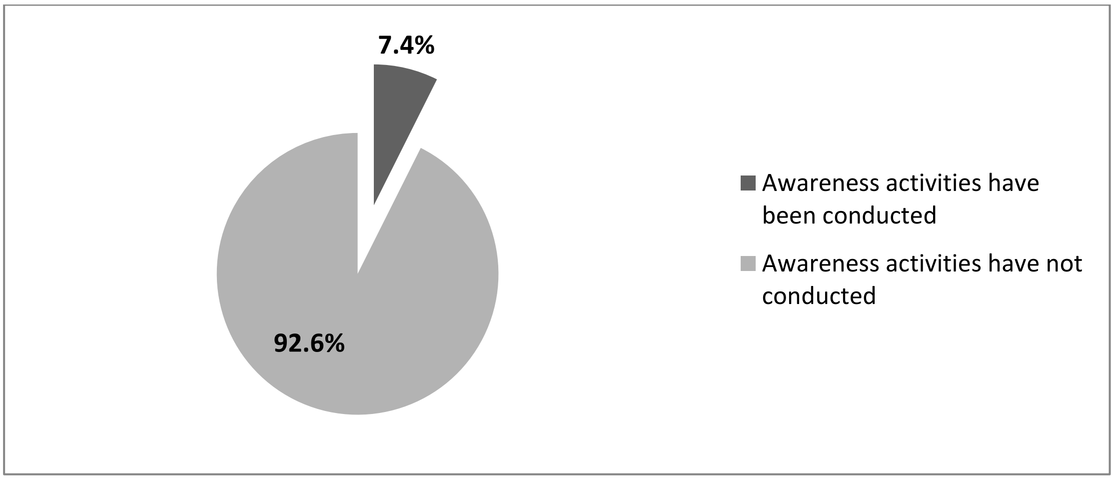


Figure (4.37): Conduction of awareness activities by institutions

4.7.7 Subjects needed to be Learned

Figure 4.38 shows the topics that needed to be learned to workers. There are 30% of them need to learn about contamination , 14% need to learn about salts and diseases, 30% need to learn all the previous subjects. This means that there is a large sector of the workers in the desalination plants need to be targeted in these subjects.

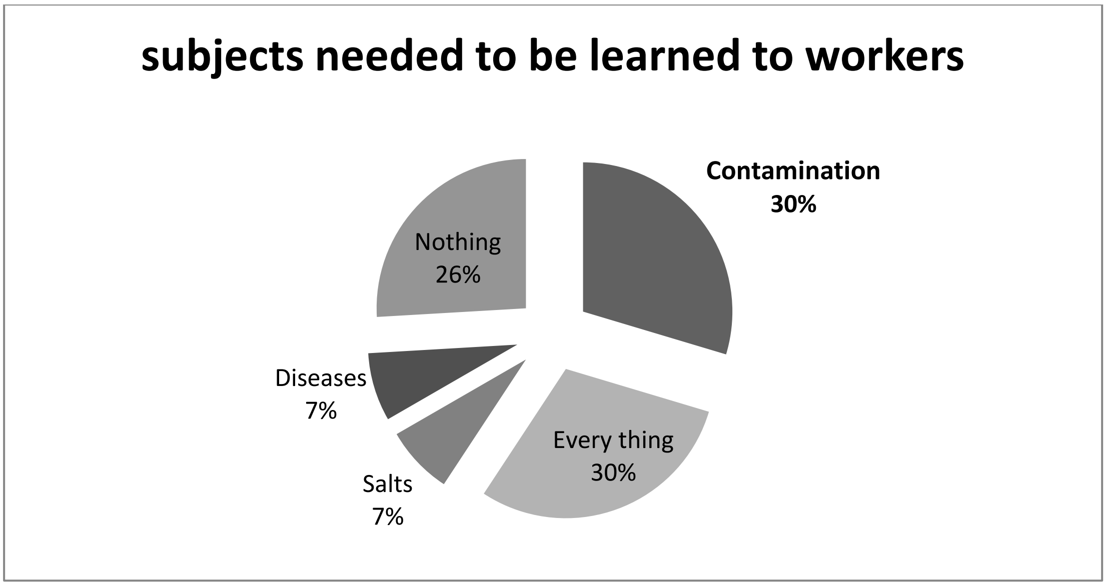


Figure (4.38): Related subjects to be learned to workers

4.8 Social Acceptance

In this part one hundred and forty persons were interviewed during the period from 1-12-2012 to 30-1-2013. Table 4.10 shows the age and sex distribution in the study population, according to the table the highest percentage age group recorded was 58.8 % at group (36 - 45 years), the lowest percentage of age group recorded was 1 % at group (less than 18 years).Males were higher than females.

Table (4.10): Distribution of age and sex in the study population

Total	Age						Sex	
	Less than 18	**19-24**	**25-35**	**36-45**	**46-55**	**Older than 55**	**Male**	**Female**
	1%	11.3%	5.2%	58.8%	14.4%	9.3%	73.2%	26.8%
	100%						100%	

The table 4.11 shows the distribution of qualifications in the study population. The highest percentage of education group was 42.3% at group (primary school), the lowest was of education group was 9.4% at group (uneducated).

Table (4.11): Qualifications of study population

Total	**Uneducated**	**Primary school**	**Secondary school**	**University**
	9.4%	42.3%	33%	15.3%
	100%			

4.8.1 Location and Distance From the Plant

According to table 4.12, the highest percentage distance group recorded was 35.7% (less than 10m) which represents the very closed cycle, the lowest percentage was 12% (51-70m).

Table (4.12): Distance and locations of study population from desalination plants

Distance	Less than 10m	11-30m	31-50m	51-70m	71-90m	Larger than 90m
Sample #	50	35	15	12	14	14
Percentage	35.7%	25%	10.7 %	8.6%	10%	10%
Total	100%					

4.8.2 Problems Result From the Plants

Table 4.13 displays the distribution of the problems result from the presence of the desalination plants. The highest percentage of problems was recorded 32.1% (all of these problems), the noise problem was recorded (17.9 %), the dust problem was recorded (12.9 %). The accidents problem was recorded (6.4 %), the water accumulation was recorded (10.7%), the choice none of these problems was recorded (12.9 %). And finally the lowest was 2.9 % (crowd).

Table (4.13): Problems caused by the plants

Problem	Noise	Dust	Accidents	crowd	water accumulation	Exhaust	All of these problems	None of these problems
Number	25	18	9	4	15	6	45	18
Percentage	17.9%	12.9%	6.4%	2.9%	10.7%	4.2%	32.1%	12.9%
Total	100%							

4.8.3 Relation between distance and problems

Figure 4.39 shows the relationship between the distance and the problems which caused by the presence of the desalination plant. The figure shows that as the distance from the plant increased the problems are decreased.

In the first location, which represents the very closed cycle of the desalination plant (less than 10 m), all the problems were recorded, the highest record was for the choice (All the problems) this means all the problems are exist. Also there are problems recorded like, noise, dust, water accumulation, accidents and exhaust.

In the second location (11 - 30 m) the effect of the problems decreased, all the problems recorded but the number is less. Some problems also recorded like: noise, noise, dust, accidents, water accumulation and exhaust. But in this location the number of the recorded problems is less than the problems that recorded from the first location.

In the third location(31-50 m), the problems decreased as we move away from the plant, all the problems recorded but in numbers less than both the first and the second locations. Also the noise and accidents problems were recorded.

In the fourth location (51-70 m), there is no problems recorded, the highest record was for the choice (None of the problems).

In both the fifth and sixth locations there were no any problems recorded, the highest record was for the choice (None of the problems).

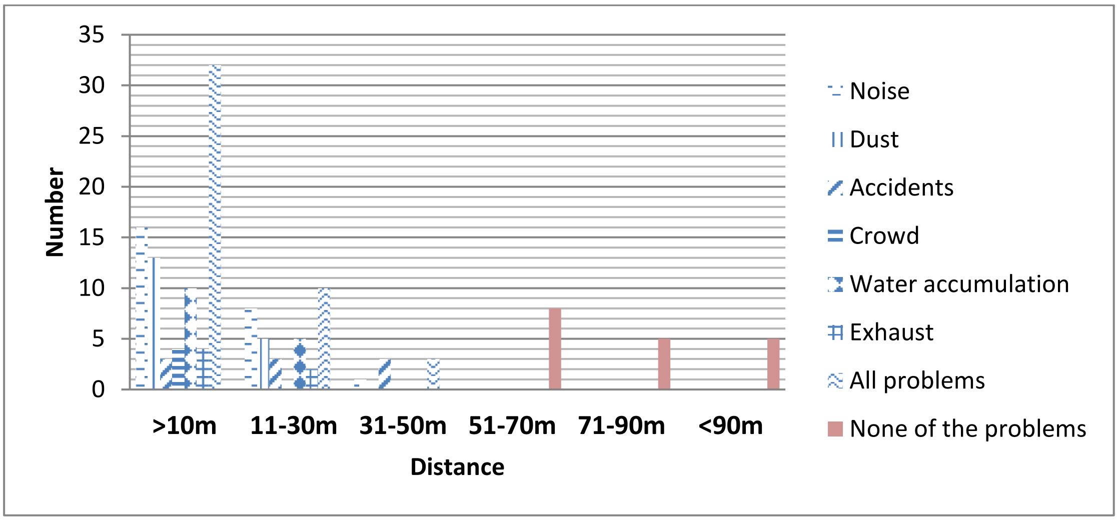


Figure (4.39): Relationship between distance and problems

4.8.4 Satisfaction for the Presence of the Plant

Figure 4.40 shows the satisfaction of the study population for the presence of the desalination plants .According to the figure there were 60.6% satisfied for the presence of the plant near them, 39.4 % were not.

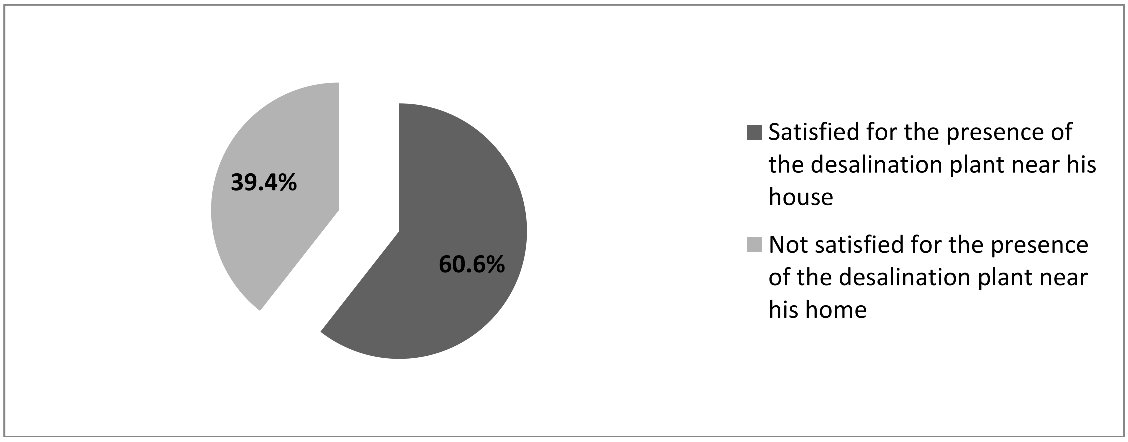


Figure (4.40): Satisfaction for the presence of the desalination plant

4.8.5 Water Quality

Figure 4.41 shows the percentage of people who satisfied about water quality (desalinated water).According to the figure, 90.4% of the people are satisfied for the quality of water, 9.6% are not satisfied but they don't give reasons to this.

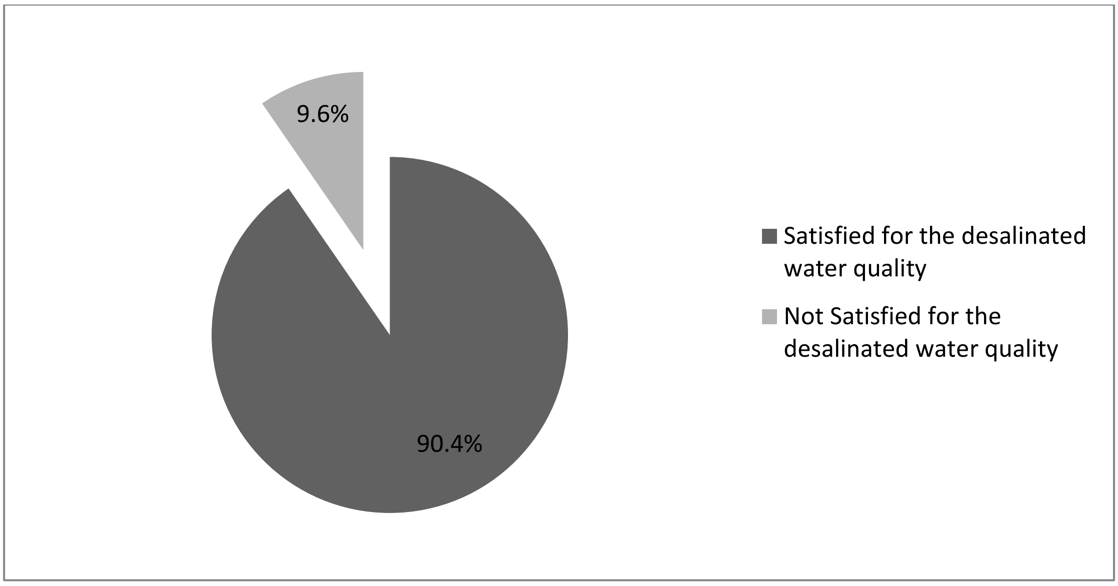


Figure (4.41): Satisfaction of people on water quality

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

1. The western areas of Gaza city have larger number of desalination plants than the eastern areas.
2. Three quarter of the desalination plants were established in the last seven years.
3. All of the desalination plants depend on private wells.
4. There were large number of these wells not closed well and protected well from contamination.
5. The desalination plants in Gaza city used 2378.5 M^3/D of brackish water, to produce 1626M^3/D desalinated water, with efficiency of 68.9%.
6. The desalination plants in Gaza city occupy 1.7% of the total area of the city.
7. Half of the desalination plants locate in a separate building, 63% locate in streets less than 15m in width, 70% 0f them locate near facilities such as schools, factories, mosques and hospitals.
8. About 80% of the delivery trucks work in the desalination plants, were manufactured during the period 1992-2002, the pipe of discharge was fixed well in 72% of the trucks and the location of the generator was suitable in 76% of the trucks.
9. About 63% of the desalination plants dispose the brine water in the sewage system.
10. Most of the desalination plants were not disinfect the tanks, 74% of the plants add chlorine to the desalinated water.
11. There are no any problems in the physiochemical parameters of the desalinated water. All the samples were according to the WHO standards, the problems were present in the brackish water where all the samples have physiochemical parameters higher than the standards.
12. There was bacteriological contamination in 29.6% of the plants with FC, and 25.9% were contaminated of E coli bacteria because of the absence of disinfection.

13. The air quality were not affected with the operation of the desalination plants, but the air quality was affected during the operation of the delivery trucks, there were difference between the concentrations of CO and CO_2 before and during the operation of the trucks, but the exposure time was little.
14. The desalination plants cause noise pollution, by the operation of the pumps and the operation of the delivery trucks. All of the measured values of noise levels during the operation of the plant and the trucks were higher than the WHO standards.
15. There were a weakness of monitoring and follow up which must be conducted from MOH and the municipality, but this weakness is in the technical issues and in the terms of conditions, hygiene, free of diseases certificates and safety factors.
16. There are 85.2% of the plants suffer of water leakage from the pipes. While 53.8% suffer from leakage during filling the truck's tanks, this lead to water accumulation.
17. It is noticed that there is a clear absence of the periodic maintenance.
18. The level follow up was 85.2% for the water quality results from the desalination plants through conducting periodic tests.
19. There are 55.6% of the workers have low academic qualifications (primary school).
20. The vast majority (92%) of the plants workers were not targeted in any awareness activities.
21. There are 37% of the workers don't know that contaminated water can cause diseases.
22. There are only 22.2% of the workers read or heard about water contaminants.
23. About 50% of the desalination plants workers obtained their information from TV.
24. Desalination plants cause a lot of problems like noise, dust, crowd, accidents, and water accumulation. The effect of the problems decreases as the distance increases from the plant.
25. There are 60.6% satisfied for the presence of the desalination plant near their homes.
26. There are 90.4% satisfied for the water quality which produced by the plants.

5.2 Recommendations

1. The desalination plants must not be located near the facilities such as schools, they must be in appropriate site to avoid the problems.
2. All of the desalination plants must have a system for disinfection for the tanks and for the desalinated water.
3. The competent authorities must implement monitoring programs for the plants, delivery trucks.
4. Standards and protocols for safety and periodic maintenance in the desalination plants should be set.
5. All contaminated desalination plants should be followed-up until they become clean, and the follow-up must not delay.
6. All water sources and wells in desalination plants should be well closed.
7. Standards and measures for air quality and noise should be set.
8. Mitigation measures should be set for noise and dust.
9. Activation of Palestinian environmental law, and the Palestinian environmental assessment policy.
10. Further studies on the effects of brine water on the pipelines and asphalt.
11. Guide manual must be produced by the competent authorities, contain all the issues related to desalination plants.
12. Awareness activities must be implemented to the workers.
13. Activate the role of media in the awareness process.
14. The desalination plants must not be located near homes.

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APPENDIX A:

Current desalination plants in Gaza city (PWA,2012)

No	Name of the plant	Address
1	Abed plant	Gaza-alshejaea
2	Almnar plant	Gaza-alshejaea
3	Almujamma 1 plant	Gaza-alshejaea
4	Aleain(Dader) plant	Gaza- alshejaea-alsekka
5	Aleain(Faisal) plant	Gaza- alshejaea
6	Alkarama school plant	Gaza-Alshaaf
7	Alramla school plant	Gaza -Aldaraj
8	Alshahd plant	Gaza-Altofah
9	Zamzam plant	Gaza-near alsakhra
10	Salsabeel plant	Gaza-salaheldeen street – near aldora hospital
11	Alsahaba plant	Gaza-Alsahaba street
12	Farah plant	Gaza-Alsahaba street
13	Arajanarwa	Gaza-Alzaytoon-Asqoola
14	Alsabra plant	Gaza-Alsabra
15	Alkhair plant	Gaza-Alsabra
16	Alferdous plant	Gaza- Tal elhawa
17	Alkawther plant	Gaza- Tal elhawa
18	Alrahma plant	Gaza- Tal elhawa
19	Erheem plant	Gaza- Tal elhawa
20	Almujamaa2 plant	Gaza- near street 8
21	Asmaa school plant	Gaza-Alsheikhredwan
22	Alqemma plant	Gaza-Alsheikhredwan
23	Alrasheed plant	Gaza-Alsheikhredwan
24	Alhanjouri plant	Gaza-alnafaq
25	Yaseen plant	Gaza-alsaftawee
26	Mecca plant	Gaza-Lababidi street
27	Alfarabi school plant	Gaza-Alyarmouk
28	Alshatea plant	Gaza-Alshatea camp
29	Seha plant	Gaza-Alshatea camp
30	Alamal Alkhairya plant	Gaza-Lababidi street

APPENDIX B:

Raw data for water samples parameters

Plant	EC (Brackish)	EC (Desalinated)	pH (Brackish)	pH (Desalinated)	TDS (Brackish)	TDS (Desalinated	Chloride (Brackish)	Clhloride (Desalinated)	No3 (Brackish)	No3 (Desalinated)	F (Brackish)	F (Desalinated)
1	4205	130	7.3	6.7	2330	110	1000	31	230	29	3.2	0.5
2	4120	72	7.3	6.9	2330	72	529	34	185	24.5	5	0.4
3	1880	35	6.8	6.3	1560	45	689	25.5	176	11.5	4	0.5
4	2760	120	7.9	7	1750	140	260	40	251	40	5	0.49
5	2510	105	7.8	6.5	1540	100	260	33	206	22.5	6	0.4
6	4630	120	7.6	6.3	2290	115	1099	45	194	20	4.7	0.3
7	3760	240	6.9	6.6	2910	110	1205	48	75	19	3	0.55
8	4850	475	7.6	6.5	2450	125	560	52.5	268	28	5.4	0.4
9	6370	120	7	7	3420	415	811	97	200	40	3	0.4
10	2140	240	7.9	7.4	1370	115	230	60	176	25	2.1	0.45
11	3430	475	7.5	7.2	1880	165	393	45	88	34	3	0.55
12	4440	120	7.5	6.8	2460	210	620	80	202	33.5	4	0.55
13	2160	175	7.3	7	1200	70	500	33	75	27.5	5	0.57
14	4430	225	8	6.4	2360	140	1012	25	180	27	3.4	0.5
15	1370	75	7.8	6.8	1250	68	350	29.7	92	28.3	2.5	0.35
16	4430	90	7.7	6.9	2250	140	750	39.5	225	34.5	2.5	0.7
17	4170	80	7.5	6.5	2160	95	748	33.5	255	29	4	0.45
18	1300	150	7.9	7.8	900	53	128	43.5	154	27.5	3	0.65
19	2270	80	7.8	6.4	1020	85	155	80	88	14.5	4	2
20	1490	135	7.9	6.9	1410	130	500	43	167	29.5	5	0.45
21	2000	155	8	7.2	1300	150	276	40.5	128	24	5.7	0.6
22	1360	90	7.5	7.4	1200	85	420	48	154	19	6.7	0.55
23	230	145	7.6	6.9	1240	135	223	40	220	29.5	5	0.5
24	1850	125	8	6.5	1540	125	680	68.5	110	30.5	7	0.4
25	2390	85	7.8	6.5	1960	90	990	38	168	12	5.4	0.48
26	860	35	7.3	6.7	760	45	763	31.5	110	44	6	0.55
27	6720	380	8	7	3700	360	900	100	310	90	6.4	0.6

APPENDIX C:

Percentage efficiency of the desalination plants for each parameter

Plant	% efficiency (EC)	% efficiency (pH)	% efficiency (TDS)	% efficiency (Cl)	% efficiency (NO_3)	%efficiency (F)
1	88.1	92.6	94.1	66.0	74.7	81.0
2	95.9	95.7	94.1	48.4	63.3	84.0
3	88.5	100.0	91.7	82.1	61.4	80.0
4	93.4	91.8	92.9	73.9	83.5	85.0
5	94.5	94.5	94.2	84.6	69.2	83.3
6	90.9	95.9	89.1	87.3	72.3	83.3
7	93.2	91.8	94.6	85.3	60.0	83.3
8	98.1	96.0	88.5	91.5	81.3	85.9
9	92.3	90.7	91.6	88.5	82.1	91.2
10	91.9	98.7	90.8	88.6	87.7	90.0
11	96.5	86.7	91.9	91.4	82.3	86.3
12	96.4	85.5	93.5	93.4	92.9	87.8
13	89.7	82.9	97.1	93.6	85.8	86.3
14	95.8	90.8	92.0	90.7	93.5	89.8
15	95.7	89.6	91.2	87.1	85.0	88.0
16	86.2	83.3	95.4	89.9	86.8	90.0
17	93.6	87.2	95.6	96.3	89.7	92.0
18	98.3	83.3	93.8	95.5	80.0	89.0
19	98.1	82.1	95.0	94.7	83.4	93.0
20	96.9	88.6	96.9	95.9	89.1	91.7
21	94.9	98.7	95.3	88.0	86.6	88.9
22	98.0	93.7	94.1	88.9	84.7	90.0
23	97.3	87.3	94.9	96.2	87.4	89.2
24	97.4	80.0	91.5	96.9	84.1	93.3
25	90.2	81.3	96.2	97.5	88.6	93.8
26	98.1	87.5	96.5	95.9	89.6	92.5
27	94.3	90.0	96.2	96.0	71.0	71.4

Appendix D:

Copy of the used observation card

بطاقة ملاحظة و مقابلة خاصة بمحطات التحلية

م	السؤال.	الإجابة
1-	معلومات عن المحطة	
1-	اسم المحطة.	
2-	العنوان.	
3-	تاريخ التأسيس.	
4-	المحطة مرخصة / غير مرخصة.	
5-	مصدر المياه في المحطة بئر خاص / بلدية.	
6-	هل مصدر المياه مرخص.	
7-	المسافة بالمتر بين المصدر والمحطة.	
8-	هل المصدر محمي من أي مصدر للتلوث.	
9-	مساحة المحطة بالمتر.	
10-	هل المحطة تقع في بناية منفصلة.	
11-	عرض الشارع الذي تقع فيه المحطة بالمتر.	
12-	الشارع الذي تقع فيه المحطة رملي / إسفلتي / مبلط.	
13-	هل يوجد أي مرافق بجوار (بالقرب) من المحطة.	
14-	إذا كانت الإجابة نعم ما هي المرافق.	
15-	مصدر الطاقة الكهربية / الشبكة / مولد كهربائي/ كلاهما.	
16-	ما هي قدرة المولد الكهربي.	
17-	نوع الوقود المستخدم / ديزل / بنزين.	
18-	عدد ساعات عمل المحطة.	
19-	استهلاك المحطة من الكهرباء يوميا.	
20-	عدد الشاحنات التي تعبئ من المحطة.	
21-	السنة التي صنعت فيها الشاحنة. 2002-1992 2013-2003	
22-	الوقود المستخدم للشاحنات بنزين/ سولار.	
23-	الخرطوم الخاص بالتعبئة موقعه مناسب ومثبت جيدا.	
24-	موقع المولد الكهربي على الشاحنة مناسب / غير مناسب.	
25-	إنتاج المحطة متر مكعب / يوم.	
26-	مياه مالحة ناتجة متر مكعب/يوم	
27-	نسبة الاستخلاص.	
28-	أين يتم التخلص من المياه المالحة ؟	
29-	نوع الخزانات المستخدمة في المحطة.	
30-	حجم الخزان بالمتر المكعب.	
31-	موقع الخزانات مناسب ومحمي من التلوث.	
32-	ارتفاع الخزانات عن سطح الأرض بالسنتمتر.	
33-	هل يتم تعقيم الخزان؟	▪ نعم (انتقل إلى سؤال33) ▪ لا
34-	متى يتم التعقيم أسبوعيا / شهريا / سنويا ؟	
35-	ما المادة المستخدمة في التعقيم ؟	

36	هل يتم إضافة الكلور للمياه الناتجة من المحطة؟	▪ نعم (انتقل إلى سؤال36) • لا					
37	كيف تتم إضافة الكلور؟						
-2	**المعايير الكيمائية والبكتيريولوجية**	المياه المالحة			المياه المحلاة		
		1	2	3	1	2	3
-1	التوصيل الكهربي (ميكرو سيمينز)						
-2	درجة الحموضة						
-3	الأجسام الذائبة الصلبة (ملجم / لتر)						
-4	الكلور (ملجم / لتر)						
-5	النترات (ملجم / لتر)						
-6	الفلور (ملجم / لتر)						
-7	Fecal coliform(colony/100ml)						
-8	E – coli(colony/100ml)						
-3	**العوامل الصحية والبيئية وعوامل السلامة.**						
		Co			Co2		
-1	أول أكسيد الكربون ملغم / لتر ثاني أكسيد الكربون ملغم / لتر قبل عمل المحطة.						
-2	أول أكسيد الكربون ملغم / لتر ثاني أكسيد الكربون ملغم / لتر أثناء عمل المحطة.						
-3	أول أكسيد الكربون ملغم / لتر ثاني أكسيد الكربون ملغم / لتر قبل عمل الشاحنات .						
-4	أول أكسيد الكربون ملغم / لتر ثاني أكسيد الكربون ملغم / لتر أثناء عمل الشاحنات .						
-5	مستوى الضوضاء (ديسيبل) قبل عمل المحطة.						
-6	مستوى الضوضاء (ديسيبل) أثناء عمل المحطة.						
-7	مستوى الضوضاء (ديسيبل) أثناء عمل الشاحنات.						
-8	أرضية المحطة مبلطة وخالية من الشقوق.						
-9	جدران المحطة مبلطة وخالية من الشقوق.						
-10	واجهة المحطة من الزجاج.						
-11	الصرف الصحي لدورة المياه غير متصل بالصرف الصحي لتحلية المياه.						
-12	دورات المياه نظيفة وبها صابون.						
-13	كم مرة يتم تنظيف المحطة ؟						
-14	هل يوجد تسريب في الأنابيب في المحطة ؟						
-15	هل المواد الكيميائية مخزنة في مكان آمن ؟						
-16	كم مرة يتم تغيير الفلاتر ؟						
-17	هل صاحب المحطة يقوم بعمل الفحوصات الكيميائية والفيزيائية؟	▪ نعم (انتقل إلى سؤال18) ▪ لا					
-18	متى يتم ذلك أسبوعيا / شهريا / سنوياً.						
-19	هل قامت أي جهة بعمل تلك الفحوصات.	▪ نعم (انتقل إلى سؤال20) ▪ لا					
-20	متى يتم ذلك أسبوعياً / شهرياً / سنوياً.						
-21	هل يقوم صاحب المحطة بإجراء فحوصات بكتيريولوجية في مختبر مرخص ؟	▪ نعم (انتقل إلى سؤال22) ▪ لا					
-22	متى يتم ذلك أسبوعيا / شهرياً / سنوياً .						
-23	هل يتم حفظ النتائج في سجلات أو مستندات في المحطة؟						

-24	هل يتم التخلص من النفايات الصلبة والسائلة بطريقة مناسبة؟	
-25	العاملون بالمحطة لديهم شهادة خلو أمراض سارية المفعول؟	
-26	العاملون بالمحطة يرتدون زياً خاصاً.	
-27	العاملون بالمحطة محافظين على النظافة الشخصية.	
-28	هل يوجد تسريب للمياه عند تعبئة المياه من المحطة المحطة؟	
-4	**معرفة العاملين في المحطة بقضايا المياه.**	
-1	العمر	▪ 20> ▪ 30-20 ▪ 40-30 ▪ 50-40 ▪ 50<
-2	التعليم	▪ أساسي ▪ ثانوي ▪ دبلوم ▪ جامعة
-3	العاملون بالمحطة يعلمون أن المياه الملوثة قد تسبب الأمراض	▪ نعم (انتقل إلى سؤال4 ▪ لا
-4	ما هي أهم الأمراض	
-5	هل سمعت / قرأت عن أهم ملوثات المياه	▪ نعم (انتقل إلى سؤال6 ▪ لا
-6	ما هو المصدر الذي أخذت منه معلوماتك.	
-7	هل قامت أي جهة بتنفيذ أنشطة لتوعيتكم بقضايا المياه؟	▪ نعم (انتقل إلى سؤال8 لا
-8	ماذا كانت تلك الأنشطة ؟	
-9	ما أهم المواضيع التي أنت بحاجة لها لتعرفها عن المياه؟	

Appendix E:

Copy of the used questionnaire for neighbors of the plants

استبانه خاصة بجيران محطة التحلية

م	السؤال	الإجابة
1-	العمر	▪ 18> ▪ 18- 24 ▪ 25-35 ▪ 36-45 ▪ 46-55 ▪ 55<
2-	التعليم	▪ غير متعلم ▪ أساسي ▪ ثانوي/ دبلوم ▪ جامعي / فأكثر
3-	الجنس	▪ ذكر ▪ أنثى
4-	كم تبعد عن محطة تحلية المياه بالمتر.	▪ 10> ▪ 11-30 ▪ 31-50 ▪ 51-70 ▪ 71-90 ▪ 90<
5-	ما نوع المياه التي تستخدمها للشرب.	▪ مياه الحنفية. ▪ فلتر ▪ مياه محلاه(من المحطة)
6-	هل أنت راضي عن وجود المحطة بجوارك ؟	
7-	هل أنت راضي عن جودة المياه المقدمة من المحطة ؟	
8-	ما أهم المشاكل التي يسببها لك وجود المحطة بجوارك ؟	▪ ضوضاء. ▪ غبار. ▪ حوادث مرورية. ▪ ازدحام. ▪ تسرب مياه. ▪ عوادم السيارات. ▪ كل ما سبق ▪ لا يوجد مشاكل من السابق.

Appendix F:

بسم الله الرحمن الرحيم

الجامعة الإسلامية – غزة

The Islamic University - Gaza

قسم البيئة و علوم الأرض – كلية العلوم – الجامعة الإسلامية – غزة

الرقم........................ Ref

التاريخ...2012 / 10 / 10... Da

السيادة /أصحاب محطات التحلية... حفظهم الله

السلام عليكم و رحمة الله و بركاته ،،،

الموضوع : تسهيل مهمة باحث ماجستير

نهديكم في قسم البيئة و علوم الأرض أطيب التحيات و نرجو التكرم بالعلم بأن الطالـــب / **مازن صبحي البطنيجي** يحتاج إلى أخذ عينات و عمل بعض الفحوصات المتعلقة بجودة الهواء و الضوضاء في محطات تحلية المياه ضمن رسالة الماجستير الخاصة به و المعنونة بـــ

"تأثير محطات التحلية على البيئة المحيطة و صحة الانسان في مدينة غزة"

علما بأن الطالب المذكور أعلاه هو طالب في برنامج ماجستير العلوم البيئية شعبة الادارة و المراقبة البيئية ، لذا نرجو من سيادتكم مساعدة الطالب المذكور أعلاه من أجل البحث العلمي لا غير.

و تقبلوا فائق الاحترام و التقدير،،،

أ.سمير محمد حرارة

رئيس قسم البيئة و علوم الأرض

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