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Study of the Readiness for Receiving Desalinated Seawater – Gaza City Case Study

Mazen Abualtayef[1], Mohanad Salha[2], Khalid Qahman[3]
1 Civil and Environmental Engineering Department, Islamic University of Gaza, Palestine
2 Municipality of Gaza, Palestine
3 Environment Quality Affairs, Palestine
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Abstract— The readiness for receiving desalinated water in Gaza city was evaluated, by ensuring the technical, economical and social readiness, and identifying the current obsticles and problems to achieve the greatest possible benefit from Gaza seawater desalination plant.

The conditions of existing water networks in Gaza city were assessed through the age of network, the age of flowmeters, determining the locations of asbestos lines, determining the places of breakage and failure, and generating spatially thermal maps. Furthermore, studying the percentage of collection system based on social and economical aspects was carried out to determine the acceptance of defined new tariff as a consequence of improving the water service.

The results revealed that 68% of the water networks are aging more than 10 years, as well as 66% of water flowmeters are aging more than 10 years. There is a close relationship between the use of 2” diameter pipes with the occurrence of breaks and failure in the networks. The collection is not exceeding 4% of total bills value, which represents 29% of the number of cutomers. The socio-economic results found that 65% of the customers are not paying the bills due to bad economic and 35% due to poor water service. However, 64% of the customers agreed to raise the tarrif for reciving-desalinated water, and 97% agreed if the tarrif does not exceed 2 shekels per cubic meter. Existing water networks problems should be maintained to ensure optimal use of desalinated water, and public awareness for citizens should be carried out to incrase the level of social responsibility and paying the bills in order to obtain a better service and sustainability.

Index Terms— Readiness; desalination; water services; Gaza

I INTRODUCTION

Water demand in the Gaza Strip is increasing continuously due to economic development and population increase resulting from natural growth, while the water resources are constant or even decreasing due to urban development [2,10]. Gaza Strip is classified as a semi-arid region and suffers from water scarcity. The renewable amount of water that replenishes the groundwater system is less than the demanded amount, and this resulted in deterioration of the groundwater system in both quantitative and qualitative aspects.

Desalination of seawater has become a component of the strategic plan of the Palestinian water authority (PWA), since the domestic water demand by year 2020 was about 182 MCM/year [1]. Gaza Strip is not only afflicted with a chronical shortage of drinking water, but also is suffering from the deterioration of its water quality. In order to solve these problems, there is no choice but to construct a large-scale seawater desalination plant as well as to restrict groundwater abstraction. Under such conditions, PWA has been planning to construct Gaza central desalination plant with initial capacity of 55 MCM/year and maximum capacity of 110 MCM/year based on the coastal aquifer management plan [2], this 55 MCM/year of production volume and about 14 MCM/year form short-term low-volume desalination plants that established in different areas in Gaza Strip will cover about 40% of water demand in 2025. The associated works include the north-south carrier lines, local non-revenue water reduction, and construction of reservoirs.

Despite of clear strategy of PWA and water utilities in Gaza Strip to provide customers with healthy and safe drinking water from the seawater desalination plants and imported drinkable water from Mekorot. It is not clear that how water utilities will manage such amount knowing that the overall amount of drinkable water will cover 40% of domestic use and the cost of desalinated water will increase the tariff rate.

Pumping desalinated water in the existing water networks without considering their conditions such as pipes age, materials, and the losses; therefore, it will increase the cost, which will affect the sustainability of such strategic projects.

In addition to the economical and social aspects, water utilities must change people's attitudes about the water that comes out of their taps, persuade them that it is drinkable water that can be used in everyday situations and does not cause any health problems, as people have developed a negative perception of this source [3, 4, 5, 6]. In view of people's deteriorating economic status, the economic side is important, in which the tarrif rate may reach 1 $/m^3$ [7].

The aim of this study is to assess the readiness of receiving desalinated water by considering technical, economical and social aspects to achieve sustainability in water service.

II Materials And Methods

2.1 Overview of the study area

The study area of Gaza city was considered, which serves a population of about 700 thousand inhabitants [8]. Gaza city suffers from a scarcity of drinkable water resources, which resulted from more than 97% of the extracted water is not suitable for human use. There are three main sources of drinking water in the city, which are Mekorot, private desalination plants and Gaza seawater desalination. Gaza city has a non-revenue of about 38% and the water is being pumped from wells into the networks directly. The existing water networks consist of UPVC, steel, asbestos and polyethylene pipes. The distribution schedule varies from one neighbourhood to another where the average number of hours of water access for the households is about 3 hours a day [9].

2.2 Methodology

The methodology inlcudes technical part that assesses the status of the water networks, and economical and social part that examines the extent of readiness to receive desalinated water.

a. Technical part

The data were collected from different departments at Gaza municipality and maped spatially on the city map [9]. Extensive efforts were done to verify the collected data with the operator. The collected data includes:

- Water quality data was collected through the water department. The actual water quality for each area in Gaza City was obtained and signed spatially on a complete plan for Gaza City.
- The age of existing water networks was obtained from the GIS department from all projects implemented in the city since 2010 and linked to coordinates. Then the data was classified according to the age into a network of less than 10 years, and older than 10 years.
- The material types of water networks were collected from the maintenance and GIS departments and the type of material (asbestos, iron, UPVC) was spatially maped on Gaza City.
- The pipe's diameters of existing water networks were collected from the water and GIS departments and identified by means of undersizes and witness problems during operation.
- The breaks of water network are collected from operation and maintenance department, which obtained through the complaints receiving system at the Gaza municipality. The archived complaints of network failure in the existing water network, their location and rehabilitation method for the period of 2018-2020 were collected. Thermal maps of breaks were generated for all neighbourhoods of the city to demonstare the intensity of failure in the network, identify areas that need intervention, and make the necessary development to raise the network's efficiency.
- The ages of existing flowmeters data were obtained from the licensing department with the date of installion and classified into two groups less than 10 years or grater than 10 years. The data was calssified based on the neighbourhoods of the city to know how many meters have exceeded the age of 10 years.
- The revenue percentage were obtained from the collection/financial department for each neighbourhood.

The collected data were analyzed spatially using the geographic information systems and thermal maps were generated to illustrate the numerical values for easy reading and better decision making.

b. Socio-economic part

The economical and social aspects taken into consideration to study the readiness of receiving desalinated water through a questionnaire targeting the residents of Gaza city. The questionnaire was developed using previous studies [10, 11, 12, 13] for the study area. The questionnaire was conducted between August 2020 and January 2021 in the city with a representative sample of 380 out of 47,264 subscribers were distributed. The questionnaire was divided into:

- General household's socio-economic and water resources data.
- Household's satisfaction with water quality and quantity.
- Citizen's ability to pay the cost of drinking water and willingness to pay in the event of improving the quality of the supplied municipal water.

The questionnaire was distributed electronically to the target groups due to Covid-19 pandemic using Google tool. The data was analyzed using SPSS and Excel.

III Results And Discussion

The results of technical and socioeconomic aspects are addressed here.

3.1 Results of technical part

The followings are the main findings for evaluating the technical aspects of existing water networks in Gaza city:

Age of existing flowmeters

66% of flowmeters are aging more than 10 years, where the old city neighborhood has the highest percentage of 80%. Therefore, this neighborhood should be given priority in future rehabilitation projects.

Beaks in existing water networks

Several neiborhoods such as Judaida, Turkman, Daraj, Remal, Sabraa and Nasser have the highest records of breaks during 2018-2020. A heat map was prepared that shows the density of the break points as shown in Figure 1.

Age of existing networks

68% of the age of existing water networks are greater than 10 years and covering the whole city as shown in Figure 2.

Pipe diameters of existing networks

Most of the maintenance activities took place in pipe diamters of 2 inches. It also increased the chance of pipe breaks (see Figure 3).

Material types of existing networks

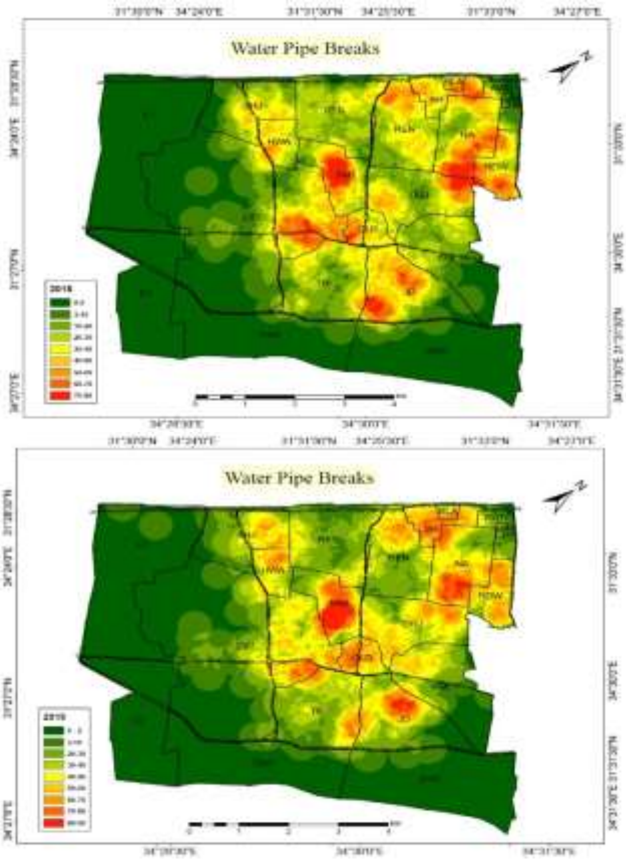
63.19% of pipe materials are from UPVC, 18.78% steel, 17.64% PE and 0.39% Asbesstos. Figure 0 shows the location of Asbestos pipes in Gaza city.

Water quality of the provided municipal water:

The city was classificated based on the total dissolved solids (TDS) quality into 3 categories: less than 500, 500-1500, higher than 1500. Figure 5 shows the TDS of provided municipal water to customers.

The collection percentage of bills

29% of subscribers are paying the bills in 2020, which represents of about 4% of the total bill values. The highest percentage paid in Remal and Sheikh Ejleen areas (8-10%) and the lowest in Turkman and Judaida areas (2%).



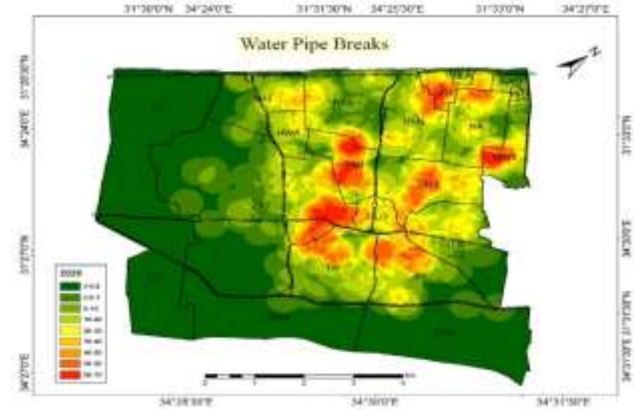


Figure 1: Water pipe breaks in 2018 (above), 2019 (middle) and 2020 (bottom) in Gaza city

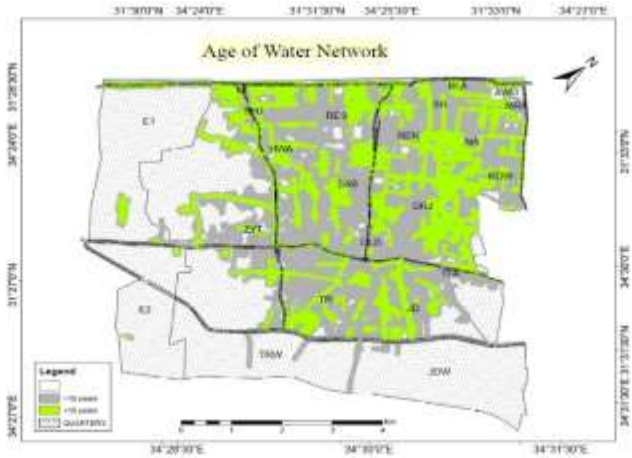


Figure 2: Age of existing water networks in Gaza city

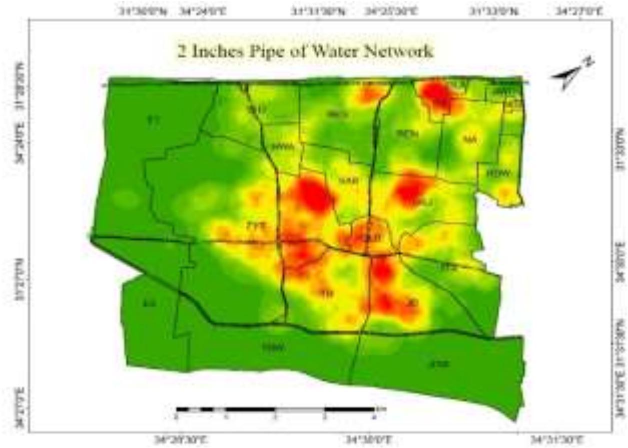


Figure 3: Location of 2" pipe diameters heat map in Gaza city

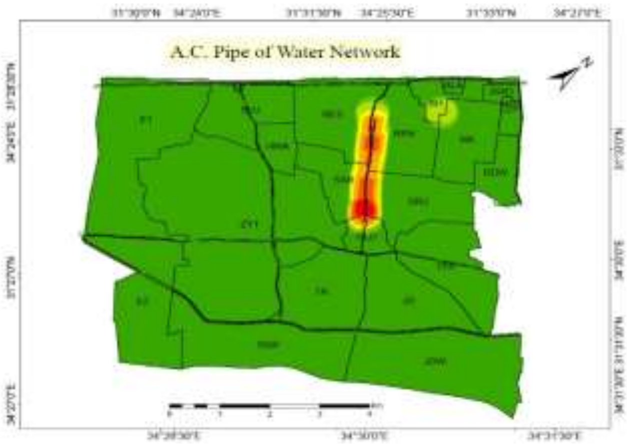


Figure 0: Location of asbestos pipes in Gaza city

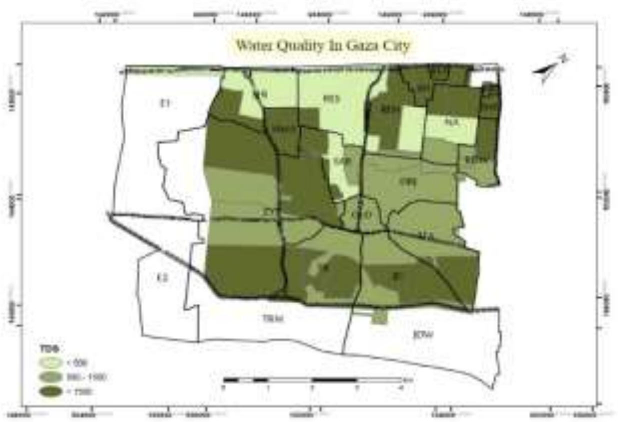


Figure 5: TDS values of municipal water

3.2 Results of socio-economic part

The socioeconomic readiness for receiving desalinated water in Gaza city was carried out and the followings are the main findings.

The monthly household expenditures

16.5% of the households their monthly expenditures are less than 1000 NIS, 37.6% between 1001-2000 NIS, 28.2% between 2001-3000 NIS, and 17.6% more than 3000 NIS.

The main water supply

The majority of households are using the municipal water as the main source (i.e. 95.3%), while 4.7% are using private wells source.

The monthly bill values of municipal water

24.5% of the households are paying less than 50 NIS per month, 56.9% are paying between 51-100 NIS, 15.3% are paying between 101-150 NIS, and 3.3% are paying more than 150 NIS. The results revealed that the minority of households are paying bills with a value more than 150 NIS for municipal water.

The schedule of water distribution

The majority of the households (68.7%) are following 2-day water distribution schedule, 16% are following 3-day schedule, 13.6% are following municipal water in daily basis, and finally a very small percentage (1.6%) are following once a week schedule.

The monthly cost of drinking water

29.2% of the households pay less than 20 NIS for drinking water per month, (59.8%) pay between 20-40 NIS, and 11.1% pay more than 40 NIS.

Source of drinking water

Most households are using drinking water that purchased from vendors (97.3%), 1.1% are using small household RO units, 0.2% from municipal water, and 1.4% use other sources.

Satisfaction of municipal water quality and water distribution schedule

49.6% of households are satisfied with a moderate degree of municipal water quality in terms of salinity, while 36.7% are not. As for the water distribution schedule, the results showed that 55.1% are satisfied with a moderate degree, while 27.1% have a low degree of satisfaction.

Reasons for non-compliance with paying bills

12.9% of households do not pay the bills due to the high cost, 43.5% do not pay due to the low income, 19.1% do not pay due to the lack of water and its low quality, while 24.5% do not pay it due to their dissatisfaction with the level of municipality services.

Willingness to pay for service improvement

64% of the households are willing to pay and accept to increae the tarrif rate if the received desalinated.

Affordibility to pay

54.3% of households afford to pay less than 1 NIS/m^3, 58.3% between 1-2 NIS/m^3, and minority can pay between 2-3 NIS/m^3 in case of the municipal water quality is improved and receiving desalinated water.

The relationship between main water supply and the source of drinking water is drawn. It is found that 87.7% of households rely on municipal water source are buying drinking water from vendors and 11.1% rely on home RO unit. In addition, 80% of households rely on private wells source are buying drinking water from vendors and 10% rely on a household RO unit.

57.3% of households rely on municipal water source do not want to pay the water bill for socio-economic reasons and 42,7% for low level of service quality. Likewise, 40% of households rely on private wells source do not want to pay for economic reasons and 60% for low level of service quality.

The relationship between unwillingness to pay the bill and agreeing to increase the tariff rate for improving the service is reflected, where 37.9% are against raising the tariff rate. While, 68.1% of households with poor municipal services agreeing to raise tariffs for improving service. Majority of customers who agree to raise the tarrif rate for improving the water quality and servies do not prefer to increase the cost more than 2 NIS, in which 54.5% accept tarrif of 1 NIS, 42.2% accept tarrif of 1-2 NIS and 3.3% accept tariff of 2-3 NIS.

IV Conclusions

This study showed Gaza city's readiness to receive desalinated water by measuring the technical, economical and social aspects. The infrastructure development of the water networks is required, as 66% of the residential water flow meters are aging more than 10 years, and 68% of the networks age is more than 10 years. Furterhmore, there is a close relationship between the location of 2" pipes with the break points, which requires replacement of undersize pipes.

The collection system of the bill values does not exceed 4%, which represent 29% of the subscribers. This indicates a significant decline in the collection rate.

The socio-economic study revealed that 64% of households are willing to increase the cost for improving the water quality and water services with a tarrif rate up to 2 NIS/m^3.

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Mazen Abualtayef is a Professor of coastal engineering in environmental engineering department at the Islamic University of Gaza. He is a water engineering expert and got a versatile experience during his 25 years of experience of working in managing, designing, and supervising of infrastructure projects especially water and coastal projects. He participates in teaching many courses such as port and coastal engineering, brine management, renewable energy for desalination, O&M of water-sewerage-stormwater networks, engineering economics, surveying and GIS, environmental modeling, fluid mechanics, hydraulics, numerical analysis.

Mohanad Salha is the Head of project preparation department in municipality of Gaza, holds a master's degree in civil engineering, he had 13 years of practical experience in the design and supervision of infrastructure and development projects in Gaza, holds several international trainings in planning tools, and participated in several specialized committees for the preparation of strategic plans and identification of development projects in the city.

Khalid Qahman is an expert in water resources engineering in which he began his professional career as a water engineer planner and contributed to several interdisciplinary projects. Currently, he is working as Assistant Chairman of the Palestinian Minister of Environment and a guest lecturer in postgraduate studies indifferent universities. His experience includes hydrological and environmental investigations and monitoring, water and wastewater systems, stormwater drainage assessments, design and management, irrigation networks design, and climate change adaptation. He conducted hydrologic, hydraulic and water quality modeling for various areas of Palestine and Morocco utilizing also GIS capabilities.