JOURNAL OF WATER AND LAND DEVELOPMENT
e-ISSN 2083-4535

Polish Academy of Sciences (PAN) Institute of Technology and Life Sciences – National Research Institute (ITP – PIB)

JOURNAL OF WATER AND LAND DEVELOPMENT
DOI: 10.24425/jwld.2022.142324
2022, No. 55 (X–XII): 212–219

Public attitude towards graywater reuse: Gaza Strip as a case study

Ramadan Alkhatib ✉

Islamic University of Gaza, Faculty of Engineering, P.O. Box 108, Rimal St., Gaza City, Occupied Palestinian Territories

RECEIVED 29.06.2020 ACCEPTED 14.04.2022 AVAILABLE ONLINE 31.12.2022

Abstract: The use of graywater in households has become increasing popular. Socio-economic aspects of graywater vary from one place to another and they need to be investigated in order to predict whether graywater use can be accepted by people. The aim of this study is to investigate the social response in the Gaza Strip, Palestine, toward the reuse of graywater in households.

Results of 511 surveys among residents of the Gaza Strip revealed that about 84% of the interviewed people accepted the idea of using graywater. Knowing that installing a graywater system would cost about USD500.00 per family, people reversed their acceptance of 84% and the rejection rate reached about 90%. The situation returned back to the 84% acceptance rate when it was known that the cost paid by the resident would only be USD50.00, with the rest of the cost to be contributed by non-governmental organizations (NGOs). The study also revealed that water outage seemed to be the most compelling reason behind the feeling of having a water problem, which is encouraging for the future of graywater use because graywater can be a good alternative during times of water outage.

Keywords: Gaza, graywater, reuse, social attitude

INTRODUCTION

As of 2017, the Gaza Strip is home to a population of approximately 1.9 mln people [PCBS 2017], living on an area of about 360 km^2, which makes the Gaza Strip one of the most densely populated centers in the world [Efron *et al.* 2018].

Gaza suffers from a shortage of potable water combined with the lack of wastewater sanitation [Efron *et al.* 2018]. In 2014, less than 10% of the people in the Gaza Strip had access to safe drinking water through the public water network [UNSCO 2017]. People relied on alternatives such as water purchased from commercial trucks (in the form of water containers or filled water tanks), which now account for 90% of potable water consumption [UNSCO 2017]. Such water, usually distributed through commercial trucks, is uncontrolled, less safe, and is about 20 times more expensive than water from the municipal network. Regarding the sanitation part, more than 108,000 Mm^3 of untreated sewage flows daily from Gaza into the Mediterranean Sea [UNSCO 2017], creating serious public health issues. In some parts of the Gaza Strip, partially treated wastewater infiltrates into the groundwater, the only natural fresh water resource for Gaza residents. Water consumption in the Gaza Strip averages at about 80 dm^3·cap^{-1}·day^{-1}. Of this, only 13 dm^3·cap^{-1}·day^{-1} meets the World Health Organization (WHO) standards for drinking water [WHO 2017]. Given the current situation, wastewater sanitation and water supply are nearly impossible [Ghabayen 2004]. An alternative to the centralized reuse of water is to apply it at the household level. This type of management is provided through a decentralized system. Crites and Tchobanoglous [1998] defined decentralized wastewater systems as "systems that collect, treat and reuse or dispose of wastewater at or near its point of generation". Homeowners have the chance to apply wastewater reuse at the household level by using graywater for irrigation. It is commonly agreed that gray water can alleviate water shortage [Zhong 2013]. According to Foppen [2013], gray water is considered a valuable water resource that can be utilized for irrigating home gardens or agricultural land. Graywater comprises wastewater from washbasins, showers, bathtubs, and laundry. The majority of graywater literature nowadays prefers to exclude wastewater from kitchen sinks and dishwashers due to

several negative impacts on the graywater quality. Wastewater from kitchen sinks and dish washing machines introduces substances such as oils, grease, food wastes, and microbial contamination. Such wastes can create annoying odors and stimulate the growth of microorganisms. Casanova *et al.* [2001] showed that the inclusion of kitchen sink wastewater in the graywater stream resulted in significantly higher levels of fecal coliforms and *Escherichia coli* in both graywater and graywater-irrigated soil as compared to the graywater stream not including kitchen sink wastewater.

The goal of this study is to investigate the general acceptance by Gaza Strip residents for the use of graywater in landscape irrigation. It is extremely important to investigate the socio-economic aspects of graywater in order to predict whether graywater use will be accepted by the people.

In Palestine, the use of graywater for irrigating backyard plants is in not a new issue. The Palestinian Agricultural Development Association, a local Palestinian NGO, published several booklets and brochures containing guidelines for the use of graywater. The graywater stream included kitchen sink wastewater in addition to the other traditional sources defined earlier in this study. In the year of 2000, the Palestinian Agricultural Development Association started implementing the idea. About 17 treatment units were built for individual houses in the southern area of the Gaza Strip [Yaseen, Burnat 2002]. A larger unit serving about 30 families was also built in Al-Shouka area in the southern part of Gaza Strip [Yaseen, Burnat 2002]. At the time of writing the booklet by Yaseen and Burnat [2002], 100 individual treatment units were under construction.

The treatment unit used by the Palestinian Agricultural Development Association is shown in Figure 1 and Photo 1. It consists mainly of two parts: i) an underground part, ii) above-ground part. The underground part consists of a small manhole with a screen and four chambers (septic tank, two anaerobic upflow gravel filters, and a storage chamber). The above-ground part consists of two tanks; the first contains filtration material and the second serves as a storage reservoir for feeding the drip irrigation system. The filtration materials from top to bottom are

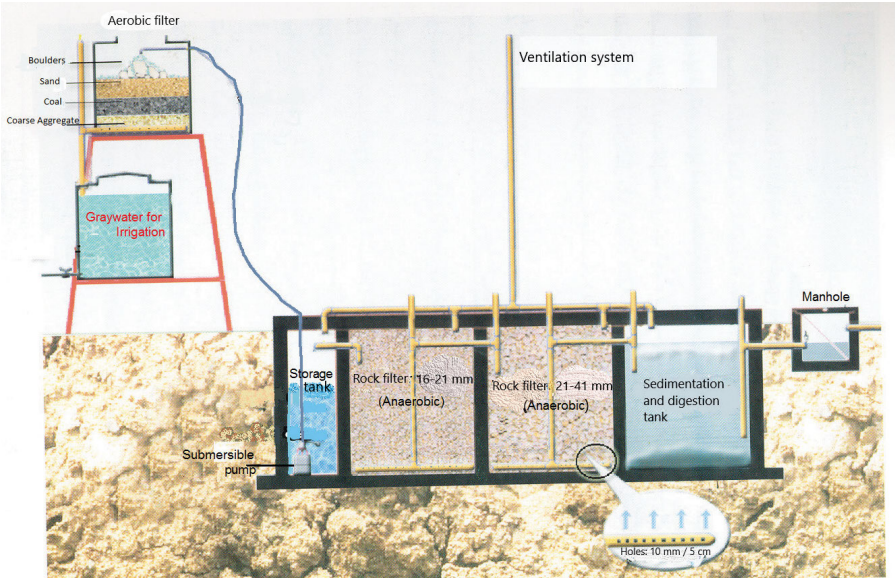

Fig. 1. Graywater system used by the Palestinian Agricultural Development Association, Palestine; source: Yaseen and Burnat [2002]

Photo 1. Graywater system used by the Palestinian Agricultural Development Association in Palestine along with the openings of each treatment chamber (phot.: *R. Alkhatib*)

sand, coal, and coarse gravel – separated by textile material; with a depth of 20 cm for each layer.

An initial personal interview was conducted with the engineers who supervised the construction of the 100 units. They mentioned that farmers were happy about the installed graywater systems. However, several odor complaints were recorded. Other problems encountered were the lack of proper maintenance by the users and malfunctioning of the submersible pump.

MATERIALS AND METHODS

QUESTIONNAIRE

To investigate the acceptance for the use of graywater in landscape irrigation to the people of Gaza Strip, a survey has been designed to collect data that can inform the researcher about the main research question: Would graywater use for landscape

irrigation be acceptable to the people in the Gaza Strip, Palestine? The surveys consisted 511 questionnaires filled in by the people in the Gaza Strip. The questionnaires were administered in the form of personal interviews in which the interviewer randomly selected houses and ran the interview with the respondent. The interviewer started with explaining the problem to the respondent followed by asking the questionnaire questions, while the background information of the respondent was taken at the end of the interview. Questionnaire results were analyzed using the SPSS statistics software. The English translation of the questionnaire is shown below. Questionnaires were originally written and administered in Arabic.

Questionnaire distributed among the people in the Gaza Strip (English translation):

Questionnaire: The acceptability by Gaza Strip residents for the use of graywater in landscape irrigation

I. Questionnaire questions

1. What types of plants are you cultivating?

2. Does the ongoing water crisis affect your ability to irrigate your backyard?

☐ Yes ☐ No

3. If the answer for question No. 2 is "Yes", your problem is really:

☐ Water outage ☐ High water prices ☐ Both ☐ Other reasons

4. If the answer for question No. 2 is "Yes", the season in which you really suffer is:

☐ Summer only

☐ I suffer in both summer and winter, but I feel it more during the summer

☐ There is no difference; i.e. I have the same level of suffering in both

5. Is your house connected to the sewer network?

☐ Yes ☐ No

6. Would you accept using the partially treated graywater in irrigating your backyard plants?

☐ Yes ☐ No

7. If your answer for question No. 6 is "No", what is/are the reasons behind this decision? (you can choose more than one reason)

☐ Water is relatively cheap for me

☐ The cost of building the treatment unit

☐ The cost and burden of maintaining the treatment unit

☐ I have a very small backyard

☐ Other reasons (Please elaborate more if possible _____)

8. If the suggested treatment system will cost you USD500 (2500 NIS), would you still accept the idea of using graywater in irrigating your backyard plants?

☐ Yes ☐ No

9. If the suggested treatment system were to cost you only USD50 (250 NIS), with the rest to be contributed by an NGO, would you accept the idea of using graywater in irrigating your backyard plants

☐ Yes ☐ No

10. If your answer to question No. 9 was "No", what is the main reason why you would still not utilise a graywater system?

_____

11. If you decided that you are going to install a graywater system, when would you use the system?

☐ Year around ☐ In summer only ☐ In both summer and winter, but more extensively in the summer

II. Background information

Occupation

☐ Farmer ☐ Merchant ☐ Governmental employee
☐ Private sector employee ☐ Labourer
☐ Other

Age:_____ **Gender:** ☐ M ☐ F

Education

☐ Illiterate ☐ Less than 9th grade ☐ High school
☐ Two-yr degree ☐ Bachelor ☐ Master or higher

Total household monthly income

☐ Less than 1500 NIS[1] ☐ From 1500 to 2000 NIS ☐ From 2000 to 3000 NIS
☐ From 3000 to 4500 NIS ☐ More than 4500 NIS

Number of families living in the house: _____

Number of people living in the house: _____

Average monthly water bill value in summer months: _____ **(NIS)**

Average monthly water bill value in winter months: _____ **(NIS)**

Area where you reside: _____

SAMPLE SIZE DETERMINATION

Sample size was determined using the population, level of confidence, and the confidence interval.

Population: The target group in this research included houses with backyards that can benefit from graywater irrigation. According to the Palestinian Central Bureau of Statistics [PCBS 2017], the total number of houses and villas in the Gaza Strip is about 84,000, which constitutes about 72% of the buildings in the Gaza Strip. The 84,000 houses were considered corresponding to the population size (N) and therefore the study sample was randomly selected based on these houses.

Level of confidence: The 95% confidence level is now widely used and accepted in the research community since it represents a reasonable balance between type I and type II errors [Rea, Parker 2005]. For the current research, the 95% confidence level was used.

Confidence interval: The confidence interval around the mean is equal to: $x \pm Z{\cdot}s/n^{0.5}$, where: s = sample standard deviation, n = sample size, Z = Z-score for various levels of confidence, $Z{\cdot}s/n^{0.5}$ = margin of error (ME).

A procedure supported by Rea and Parker [2005] was used in the determination of the sample size. The common values for ME and Z are listed below separately for large and small populations.

- **For large populations**

Margin of error in terms of proportions (ME_p) you can calculate using Equation (1):

$$ME_p = \pm Z_a(\sigma_p) \tag{1}$$

where: Z_a = Z-score for various levels of confidence, σ_p = standard error for a distribution of sample proportions.

$$\sigma_p = [p(1-p)/n]^{0.5} \tag{2}$$

Therefore,

$$ME_p = \pm Z_a[p(1-p)/n]^{0.5} \tag{3}$$

Solving for n,

$$n = \left(\frac{Z_a}{ME_p}\sqrt{p(1-p)}\right)^2 \tag{4}$$

Z_a depends on the level of confidence. For 95% confidence level, Z_a is set at 1.96. The margin of error (ME_p) is commonly set not to exceed 10%. A more typical range commonly used is from 3 to 5%. Prior to conducting the survey, the true proportion (p) is unknown. Conservatively, the true proportion can be set to p = 0.5 which would result in the highest sample size. Any p value other than 0.5 would result in a lower sample size. Therefore, p was conservatively set to 0.5.

Therefore:

$$n = \left(0.5Z_a/ME_p\right)^2 \tag{5}$$

- **For small populations**

Rea and Parker [2005] considered the population size of N = 100,000 as the distinction between large and small

populations. For small populations, i.e. less than 100,000, the sample size is calculated using Equation (6).

$$n = \frac{Z_a{}^2 0.25N}{Z_a{}^2 0.25 + (N-1)ME_p} \quad (6)$$

For ME = 5% and confidence level of 95% (Z = 1.96), the minimum sample size is:
– for large population: $n = (1.96 \cdot 0.5/ME_p)^2 = 385$ (using Eq. (5);
– for small population: Equation (6) should be used, with N = 84,000. The use of Equation (6) resulted in almost the same sample size calculated by Equation (5); i.e. a sample size of 385. Finally, sample size of 511 questionnaires was used in this study.

RESULTS AND DISCUSSION

COMPLETED SURVEYS AND GENERAL CHARACTERISTICS

The number of surveys completed in this study was 511. As mentioned in the "Materials and methods" section, in order to achieve a 5% margin of error and a 95% confidence level, the sample size should be at least 385; i.e. at least 385 questionnaires should be distributed. The whole Gaza Strip was divided into four areas: 1) northern area of the Gaza Strip, 2) Gaza City and suburbs, 3) middle refugee camps, 4) southern area of the Gaza Strip. The age of people interviewed ranged from 22 to 71, with a mean and median of 40.7 and 40.0 respectively.

RESPONSES TO THE MAIN QUESTIONS

The most important questions in the survey were questions No. 6, 7, 8, and 9. Question No. 6 asked about whether the respondent would accept the idea of using graywater for irrigation or not. Question No. 7 is directed to those who did not accept the idea of using graywater according to question No. 6 by inquiring about reasons behind the lack of acceptance for the use of graywater. Questions No. 8 and 9 bring the cost of the graywater system into the picture, asking respondents again about whether or not graywater use would be acceptable knowing that the cost for installing a graywater system are USD500 for question No. 8 and USD50 for question No. 9. Of course, the respondents did not know about question No. 9 until they answered question No. 8 since the survey was administered in an interview mode.

- **Question No. 6**

The main question in the questionnaire was question No. 6, in which the interviewee was asked whether he/she accepted the idea of using graywater in irrigating backyard plants. The results of this question are shown in Figure 2 which shows that 83.6% of the interviewed accepted the idea of using graywater in irrigating backyard plants, and 16.4% rejected the idea. This initial high acceptance rate is encouraging since at least it shows that the people in the Gaza Strip do not reject the idea entirely. At this stage of the questionnaire, nothing was mentioned about the cost of the graywater system. It was expected that the cost of installing a graywater system would have an effect on people's decision.

- **Question No. 7**

Question No. 7 aimed to identify the reasons behind not accepting the idea of using graywater. Figure 3 summarizes the responses to question No. 7. Although the rejection rate was only 16.4%, it was necessary to examine reasons behind the rejection. Knowledge of reasons behind the graywater use rejection may help researchers understand obstacles that may stand on the way.

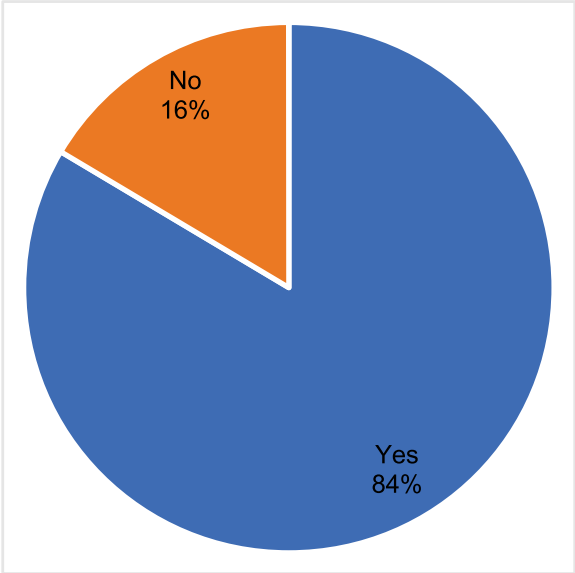

Fig. 2. Response to question No. 6: Would you accept the idea of using partially treated graywater in irrigating your backyard plants? Source: own study

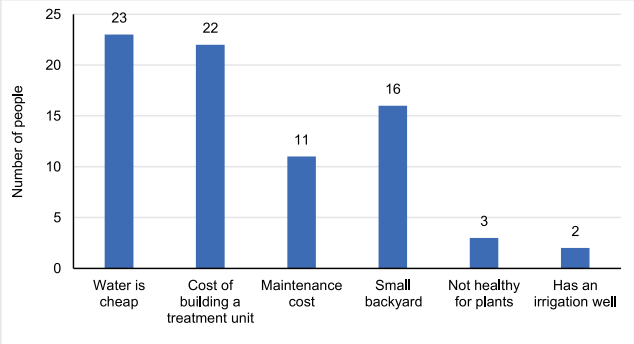

Fig. 3. Response to question No. 7 (reasons behind the lack of acceptance to the use of graywater); source: own study

- **Question No. 8**

Accepting the concept of using graywater does not necessarily mean the acceptance of installing a graywater system. Question No. 6 was merely a question that did not go into the cost of the system. Due to financial constraints in the Gaza Strip, it is expected that the cost of installing a graywater system will significantly affect people's decisions. Therefore, question No. 8 was formulated in a way to mention the cost of a graywater system and checked if the interviewee was willing to pay the cost. Figure 4 shows that the large acceptance rate (83.6%) according to question No. 6 reversed when the interviewed people knew that the system would cost USD500, with the whole cost to be paid by them. About 90% of the interviewed people rejected the use of graywater when they learned about the cost. This attitude shows people do not feel that a graywater system is a financially feasible option. It also may reveal that the financial situation does not allow people to pay USD500 for a graywater system.

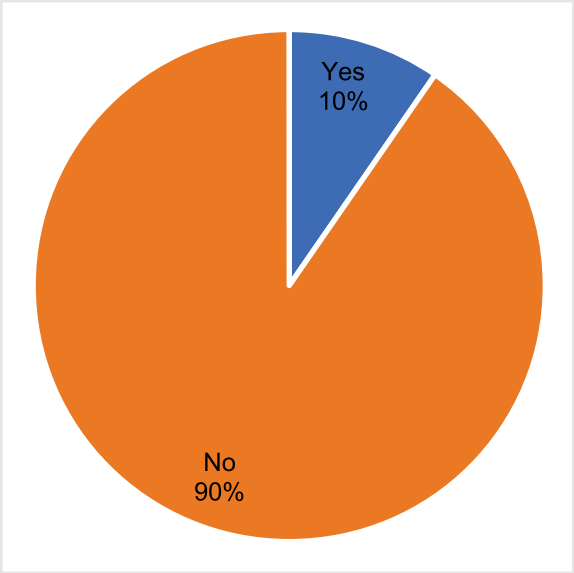

Fig. 4. Response to question No. 8: If the suggested treatment system costs you USD500, would you accept the idea of using graywater for irrigation your backyard plants? Source: own study

- **Question No. 9**

The results of question No. 8 showed that the cost of installing a graywater system played a major role in the decision of whether to use graywater is accepted or not. The results of question No. 8 also revealed that USD500 was a high cost for the residents of the Gaza Strip. Question No. 9 was formulated in an attempt to check the serious approach of people who initially accepted the concept of using graywater in question No. 6 and the sensitivity of the cost of installing a graywater system. The interviewee was asked if he/she would accept the use of graywater for the cost of USD50, with the reminder to be paid by an NGO. The drop of the cost from USD500 to USD50 reversed the situation from a high rejection rate (as in question No. 8) to a high approval rate (Fig. 5). About 84% of the interviewed people accepted the use of graywater if the cost was only USD50, with the rest to be contributed by an NGO. The role of the governmental organizations was not mentioned here since the financial support for this kind of projects comes primarily from NGOs. The USD50 value was proposed as resident's contribution since most NGOs would usually require a 10% contribution from the user. Again, the results in this question show the importance of the financial aspect in decision-making.

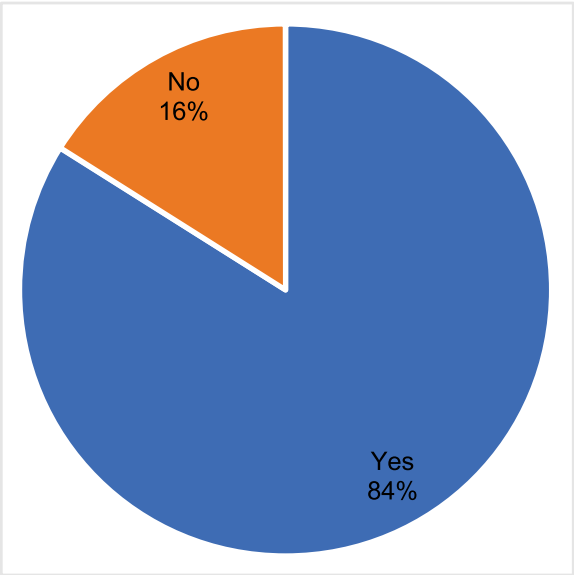

Fig. 5. Response to question No. 9: If the suggested treatment system were to cost you only USD50, with the rest to be contributed by an NGO, would you accept the idea of using graywater in irrigating your backyard plants? Source: own study

OTHER IMPORTANT RESULTS

In order to better understand the behavior of people and connect their answers to their situation, other questions were asked. In question No. 2, the interviewee was asked whether the ongoing water crisis affected the ability to irrigate the backyard. About 45% confirmed that the ongoing water crisis affected their ability to irrigate their backyards, while the rest said that the water crisis did not affect their ability to irrigate their backyards (Fig. 6).

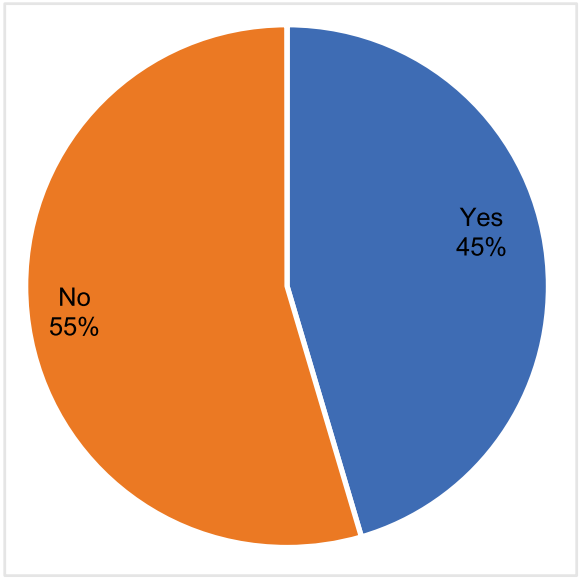

Fig. 6. Response to question No. 2: Does the ongoing water crises affect your ability to irrigate your backyard? Source: own study

Respondents who confirmed having a water problem were asked about reasons behind their attitude. Their responses are shown in Figure 7. About 75% of them mentioned that the water outage is the main reason, while about 18% mentioned that it is due to both water outage and water prices. That means that about 93% of the sample confirm that water outage is a main problem. This is encouraging for the use of graywater because the use of graywater is considered to be a drought-proof tool. During times of water outage, graywater can serve as an alternative.

IMPORTANT RELATIONSHIPS DRAWN FROM THE SURVEY

Other useful relationships can be drawn from the survey. For example, the response regarding the acceptability of using graywater (question No. 6) can be related to other variables, e.g. willingness to be connected to the sewer network, level of income, area of residence, etc. To infer such relationships, cross

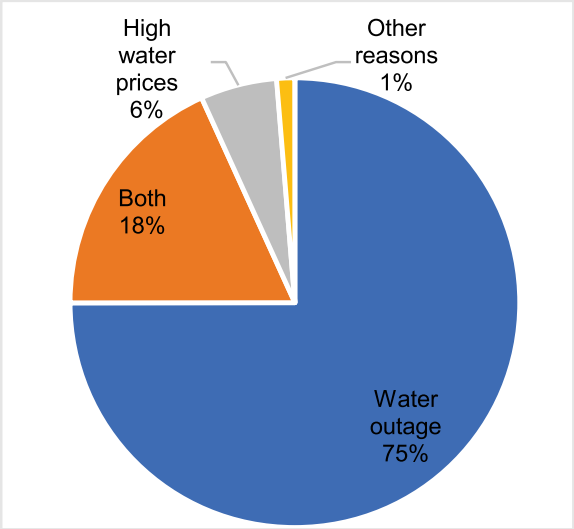

Fig. 7. Response to question No. 3: Why do you feel there is a water problem? Source: own study

tabulations and Chi-square test were performed using the SPSS software. The following hypotheses were formulated and tested.

1. Connection to the sewer network has no effect on the decision of whether or not to accept the use of graywater.
2. The people's response regarding the acceptability of using graywater does not vary depending on the occupation of the interviewee.
3. Area of residence does not affect the people's response regarding the acceptability of using graywater.
4. The level of education does not affect the people's opinion regarding the use of graywater for backyard irrigation.
5. The level of income does not affect the people's opinion regarding the use of graywater for backyard irrigation.

• Connection to the sewer network has no effect on the decision of whether or not to accept the use of graywater (hypothesis 1)

The purpose of this hypothesis is to determine whether or not a relationship exists between the acceptability of using graywater and connection to the sewer network in order to determine if the connection to the sewer network would discourage people from using graywater. The actual responses were compared with the expected responses using the Chi-square test at the 0.05 significance level. Surprisingly, the calculated Chi-square value was 0.608, which is much smaller than the critical Chi-square value of 3.841. This indicates that the null hypothesis cannot be rejected. Therefore, there is no relationship between accepting the use of graywater and connection to the sewer network. It was expected that being connected to the sewer network would discourage people from using graywater. The lack of this relationship is encouraging since the majority of areas in the Gaza Strip are currently connected to the sewer network and in the future more areas will be connected.

• The people's response regarding the acceptability of using graywater does not vary depending on the occupation of the interviewee (hypothesis 2)

The Chi-square test was run at the 0.05 significance level. The calculated Chi-square value was 9.294, which is less than the critical Chi-square value (12.592). This indicates that the null hypothesis should be accepted. Therefore, there is no relationship between accepting the use of graywater and the occupation of the respondent. By taking a closer look at the cross tabulation (not shown), and unlike what was expected, one may notice that the acceptance rate among farmers was similar to those of other occupations, such as merchants, governmental employees, private sector employees, and skilled workers. The only exception was with the laborer's category which showed the highest rejection rate among all categories (28.8%). The reasoning behind this higher rejection is not discussed since the statistical analysis shows that there is no relationship between accepting the use of graywater and the occupation of the respondent.

• Area of residence does not affect people's response regarding the acceptability of graywater use (hypothesis 3)

The results of Chi-square test revealed that the null hypothesis should be rejected since the calculated Pearson Chi-square value was 16.259, which is larger than the critical Chi-square value (7.815). This is an indication of a genuine difference among the categories, which are the areas of residence in this case. Therefore, there is a relationship between accepting or rejecting the idea of using graywater and the area of residence. The Chi-square value does not give information about the strength of this relationship. It only indicates whether the relationship is statistically significant or not. To measure the strength of this relationship, Cramer's V measure was used. Cramer's V was calculated for this case to be 0.178, which only indicates a weak association.

By taking a closer look at the rejection and acceptance rates for each category (categories being the areas of residence), one can find that the highest rejection rates (about 29%) were found in the middle refugee camp area, which is an area of houses very close to each other, with very small backyards. The highest acceptance rates (about 91%) were found in the northern area of the Gaza Strip, which is well known to be an agricultural area, with large backyards.

• The level of education does not affect people's opinions regarding the use of graywater for backyard irrigation (hypothesis 4)

The cross tabulation showed the actual and expected responses for each group of people. Groups were divided according to their education level (illiterate, less than 9th grade, high school, 2-yr degree, bachelor, and masters and higher). The calculated Chi-square value was 20.89, which is larger than the critical Chi-square value (11.07). Therefore, the null hypothesis should be rejected with the conclusion that the level of education affects people's opinions regarding the use of graywater for backyard irrigation. Cramer's V measure of association was calculated to be 0.203, which indicates a moderate association. The results showed that the highest rejection rate was found within the illiterate category (36%), while the lowest rejection rate was found within the educated category (13%). This is encouraging since the education level within the newer generation is extremely high in Gaza. It also reveals that education level promotes environmental concerns and attitude to the water scarcity problem.

• The level of income does not affect people's opinions regarding the use of graywater for backyard irrigation (hypothesis 5)

The produced cross tabulation showed the actual and expected responses for each group of people. Groups were divided according to their level of income (less than 1500 NIS,

between 1500 and 2000 NIS, between 2000 and 3000 NIS, between 3000 and 4500 NIS, and more than 4500 NIS). The calculated Chi-square value was 16.235, which was larger than the critical Chi-square value (9.488). Therefore, the null hypothesis should be rejected with the conclusion that the level of income affects the people's opinion regarding the use of graywater for backyard irrigation. Cramer's *V* measure of association was calculated to be 0.180, which indicates a weak association.

A closer look at the cross tabulation (not shown) shows that the average income categories (2000 to 3000 NIS and 3000 to 4500 NIS) are the categories of the lowest rejection rates (11 and 12% respectively). Fortunately, those categories constitute about 60% of the interviewed people, which means that they are the majority. The highest income category (4500 NIS and above) proved to be the least accepting, with a rejection rate of about 29%. This is an indication that the financial side is not the sole incentive for accepting graywater irrigation and therefore other incentives and promotional programs should be adopted besides the financial incentive in order for the graywater application to be successful within this category.

CONCLUSIONS

The vast majority of Gaza Strip residents accepted the use of graywater for backyard irrigation. The initial acceptance rate was about 84%. As expected, the cost of installing a graywater system played a major role in final decisions by respondents. When respondents knew that the cost of installing a graywater system was about USD500, the high acceptance rate of 84% turned into a high rejection rate of 90%. The situation returned back to high acceptance rate (about 84%) as soon as the respondents learned that they would only pay USD50, while the rest would be contributed by an NGO. This shift indicated that respondents were serious in accepting the idea of using graywater, knowing that they would have to pay in case they decide to install a system. Therefore, the introduction of other incentives may provide further encouragement.

The study also revealed that water outage seemed to be the strongest reason behind the feeling of having a water problem. This is encouraging for the future of graywater use because graywater can be an alternative during times of water outage.

REFERENCES

Casanova L.M., Gerba C.P., Karpiscak M. 2001. Chemical and microbial characterization of household graywater. Journal of Environmental Science and Health. Part A. Toxic/Hazardous Substances and Environmental Engineering. Vol. 36(4) p. 395–401. DOI 10.1081/ESE-100103471.

Crites R., Tchobanoglous G. 1998. Small and decentralized wastewater management systems. New York. WCB/McGraw-Hill. ISBN 9780072890877 pp. 1104.

Efron S., Fischbach J., Blum I., Karimov R., Moore M. 2018. The public health impacts of Gaza's water crisis: Analysis and policy options. Santa Monica, CA. RAND Corporation. ISBN 9781977401632 pp. 108. DOI 10.7249/RR2515.

Foppen J.W.A. 2002. Impact of high-strength wastewater infiltration on groundwater quality and drinking water supply: The case of Sana'a, Yemen. Journal of Hydrology. Vol. 263 p. 198–216. DOI 10.1016/S0022-1694(02)00051-3.

Ghabayen S. 2004. A probabilistic expert systems approach for analysis and optimization of large-scale water resources system. PhD Thesis. Logan, Utah. Utah State University pp. 136.

PCBS 2017. First results for the general population census. Housing and facilities. Ramallah, Palestine. Palestinian Central Bureau of Statistics. [Access 15.05.2020]. [In Arabic]. Available at: http://www.pcbs.gov.ps/Downloads/book2364.pdf

Rea L.M., Parker R.A. 2005. Designing and conducting survey research: A comprehensive guide. 3rd ed. Hoboken, New Jersey. John Wiley & Sons, Inc. ISBN 078797546X pp. 304.

UNSCO 2017. Gaza: Ten years later. United Nations Country Team in the Occupied Palestinian Territory. Gaza. United Nations Special Coordinator for the Middle East Peace Process pp. 30. [Access 15.05.2020]. Available at: https://reliefweb.int/report/occupied-palestinian-territory/gaza-ten-years-later

WHO 2017. Guidelines for drinking-water quality [online]. 4th ed. Vol. 3. Geneva. World Health Organization. [Access 15.05.2020]. Available at: https://www.who.int/publications/i/item/9789241549950

Yaseen B., Burnat J. 2002. Management of wastewater in the Palestinian rural communities: Treatment of graywater. Ramallah, Palestine. The Palestinian Agricultural Development Association. [In Arabic].

Zhong L. 2013. Decentralized urban wastewater reuse in China – With focus on grey water. MSc Thesis. Linköping, Sweden. Water and Environmental Studies Department of Thematic Studies. Linköping University pp. 58.