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ARTICLE

Environmental and Socio- Economic Impact of Wastewater in Wadi- Qana Drainage Basin- Salfeet- Palestine

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ABSTRACT

This study discussed the social- economic and environmental impacts of wastewater on Qana drainage basin. This study has been accomplished through carrying out biological and physio-chemical characterization for water samples from various springs in Qana valley in order to specify the quality of the springs' water. Moreover, the socio-economic effects of wastewater on the population in the study area were discussed. The study was relied mainly on using the analytical field methodology to analyse the samples of the springs water. It also used the applied quantitative methodology to check the results of the questionnaire that was distributed between the farmers in Qana valley.

The study has found that the flowing wastewater from the Israeli settlements that lie in the study area is regarded as the main source in polluting the underground water in the basin. The results also revealed that 84% of the population of the Palestinian villages that lie in Qana basin use open septic tanks in getting rid of their wastewater then draining it in the nearby valleys which in turn increased the percentage of pollution. Moreover, results also pointed that 82% of Qana valley population has left their homes in Qana valley to the nearby villages because of the spread of bad smells in the valley. The results also revealed that 45.5% of Qana valley farmers have stopped planting their agricultural lands because of wastewater which in turn lowers the percentage of agricultural production. The analyses showed that all the springs in the study area are biologically polluted by the bacteria which is regarded as an indicator wastewater pollution. The chemical analyses also revealed that all elements lie within the allowed limits according to the World Health Organization except iron which exceeded the allowed limits in Al-Fawwar and Al-Maasser springs which indicates the pollution of these springs.

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1. Introduction

Wastewater is a major contaminant to the environment, especially in rural areas [1], where the world produces a high proportion of wastewater and disposed it without treatment. West Bank suffers from these problems due to the steady increase of population which led to an increase in the quantities of wastewater that reached about 92 million cubic meters. The proportion of untreated wastewater reached 90% of its quantity that is disposed randomly [2]. The percentage of Palestinian households disposing of their wastewater through the sewage network is 55% and 36% of the households use cesspits as means of wastewater disposing, 8% use the endowment, 1% use open networks.[3] The West Bank and the Gaza Strip have six wastewater treatment plants with low production capacity. The rest of the wastewater is disposed of either by discharging it directly into the valleys or by withdrawing wastewater from the cesspits and dumping it into the valleys [4] affecting the social impact on the nearby population.The effect of water stress on the germination rate of the seeds of nine pieces of species used for landscaping works in Kastamonu is investigated and the seeds of these species have been subject to germination trials with water stress level between 0 and -8 bar and the germination percentages of the seeds have been identified.[5] The use of drought-resistant plant species reduces maintenance and irrigation costs, and plants increase the retention and success to continue its life in arid landscape.[6] Some plant species used have been studied to determine their tolerance to drought stress in gardens and parks in Kastamonu. The study showed increased water stress and reduce the percentage of germination in all species.

Climate type-related changes in the leaf micro-morphological characters of certain landscape plants was studied by Cetin et. al. [7] It aimed to determine changes to some micro-morphological characteristics of certain landscape plants grown in areas with different dominant climate types. The results show that the lowest values were for plants grown in the terrestrial climate, while the highest values were for plants grown in the Mediterranean climate for all characteristics. Spatial data analysis with R programming for environment. Human and Ecological Risk Assessment was indicated that The use of open source software, which has been constantly evolving since the mid-2000s, has affected every research discipline.[8] The analysis and visualization of spatial data with the help of open source software has caused the emergence of new different features, which are cost effective and editable by other users. Recently researchers found that water stress is important and the effect of level of stress. It is important for irrigation and soils. Also, conducting similar studies on different species and the different origins of the species determined to be resistant to drought in wider fields carries great importance in terms of identifying the species most resistant to drought and in this way preparing healthy landscaping planning in arid fields. [7]

The study area is located in the Qana Valley located within the mountains of Central Palestine and characterized by a terrain diversity of plains, valleys and mountains. The study area lies within the coordinates of: 17 350- 59 340 E and 11 320 – 06 320 N [9]. The study area extends over an area of about 229 km^2 [10] (Figure 1). The total number of communities in the study area is 54, with a population of 176580 and 15 Israeli settlements [11] with a population of 58195 [12]. The Qana Valley basin is characterized by many springs located along sides of the valley. Farmers use their water to irrigate agricultural crops, irrigate sheep [13].

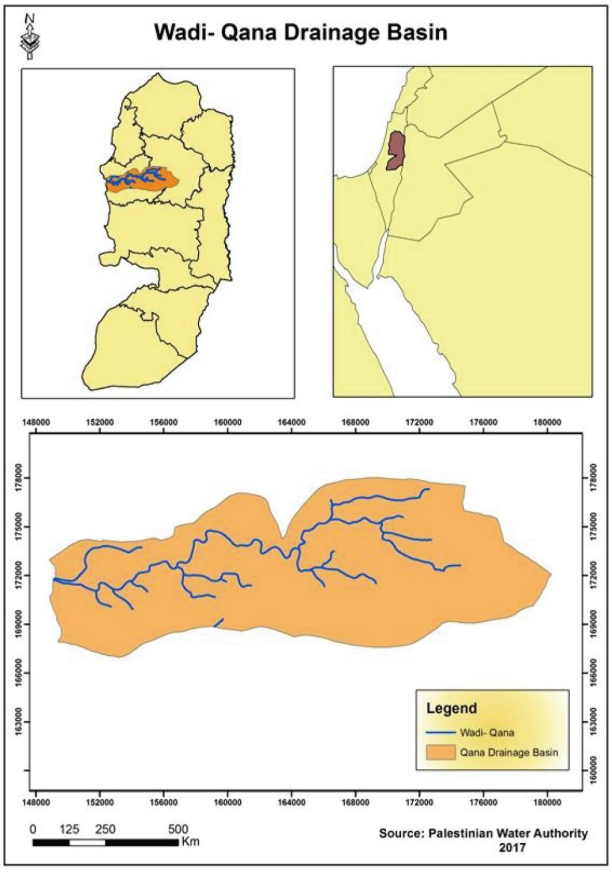

Figure 1. Map of the location of the Qana Basin

2. Methodology of the Study

In order to obtain results on the environmental, social and economic impacts of wastewater on the Qana basin, the descriptive approach was used to study the current situation of the study area and describe it in terms of

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population growth, the disposal of wastewater from the population and the role of the Israeli colonies in increasing wastewater in Qana basin. The analytical method was used by sampling spring water in Wadi Qana, which was analyzed chemically, physiologically and biologically in the laboratories of Birzeit University in order to determine the concentration of calcium carbonate, potassium, magnesium, sodium, nitrate, acidity, pH and fecal Coliform bacteria. Analyses of heavy metals was conducted in Al-Quds University laboratories in Abu Dis. Questionnaire was used to understand the impact of spring water on the health, economic and socio-economic of the farmers in the study area as well as environmental aspects. It was distributed to farmers who own land in the Wadi Qana of about 200 farmers [14].

3. Discussions and Results

3.1 Spring Water Quality and Analysis

Six spring water samples were collected from Wadi Qana basin in order to determine their physical, hydrochemical and biological characteristics, five of which were taken from the spring sources, and the sixth was taken from the spring water pool used for irrigation (Figure 2). The spring water samples were analyzed at the water laboratory at Bir Zeit University and the laboratories of Al-Quds University - Abu Dis on 1/10/2017. Each one of which is 500 ml, has their suitability for domestic and agriculture use were determined.

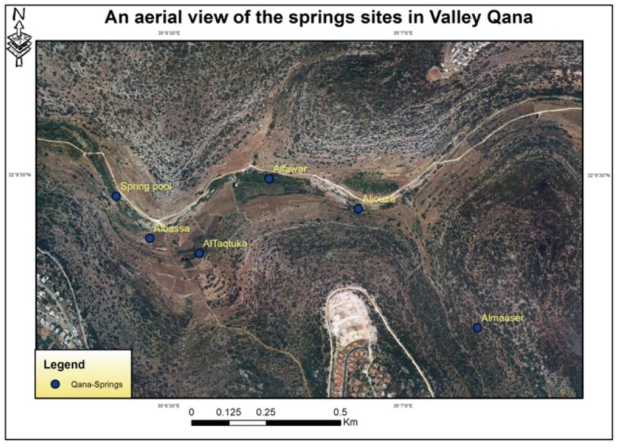

Figure 2. Location of springs of the study area

3.1.1 Physical Properties of Spring Water

The electrical conductivity average of the spring waters of the Wadi Qana basin is 200 µm /cm^3, which lies within the standard limits of World Health Organization (WHO) of human use suitability (1000 µ-simens /cm^3). The average rate of the dissolved oxygen is 11.2 mg / L, which considered as oxygenated water according to WHO. Water is considered to be pure if the TDS is less than 1000 mg / L and saline if it exceeds 1000 mg/L [15]. The average of the TDS in the spring water samples is 550 mg / L, which indicates of low salinity type (Fig. 3). The highest TDS in the study area showed in Al Juza spring of 746 mg / L and the lowest was shown in Al Maaser spring 378 mg / L. The pH of the spring water in the study area ranges between 6.8 and 7.2 and the average temperature for all springs is 20.2 ºC .

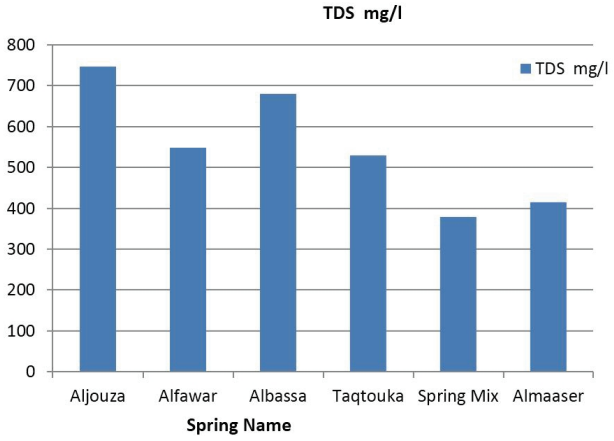

Figure 3. The TDS concentration in the springs of the study area

3.1.2 Hydrochemistry

The anions and cations concentrations are illustrated in Figures 4 and 5. The results showed that all springs have NO3 concentrations less than 10 mg/L, which is lower than the allowed concentration of 45 mg/L (WHO). The samples showed that all the springs in the study area contained chloride within the permissible limit, with an average of 39.8 mg / L ranging between 49.5 and 33.4 mg / L. The concentration of bicarbonate was found in these springs within the world limit of 400 mg / L. The average rate of bicarbonates in the study area is 179 mg / L due to the limestone forming reservoirs [16]. The percentage of sulphates in the study area is within the permitted percentage according to the World Health Organization (WHO) of 200 mg / L ranging between 30.8 and 19.2 mg / L. The low percentage of the springs in the area is due to the possibility of gypsum in the rocky layers of limestone and marl. Using of agricultural pesticides increase sulfer concentration in groundwater and contribute to the increase of sulphates in spring water [17]. The highest concentration of Sodium and potassium was found in the Aljouza spring of 20 and 2mg/L, respectively. The average of calcium and Magnesium concentrations was found to be 15.5 and 25.5 mg/L. Cation concentrations was found to be less than the WHO standard for domestic use of the springs.

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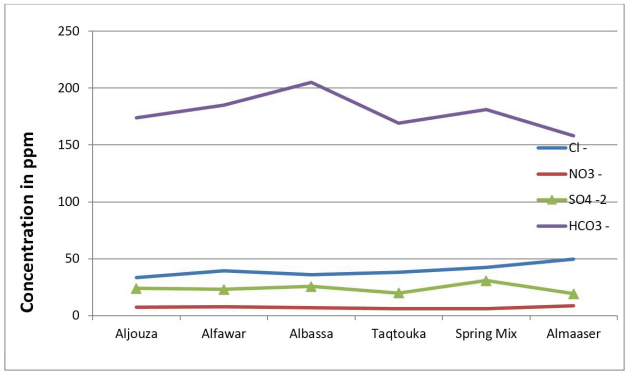

Figure 4. The anion concentration of the springs of the study area in ppm

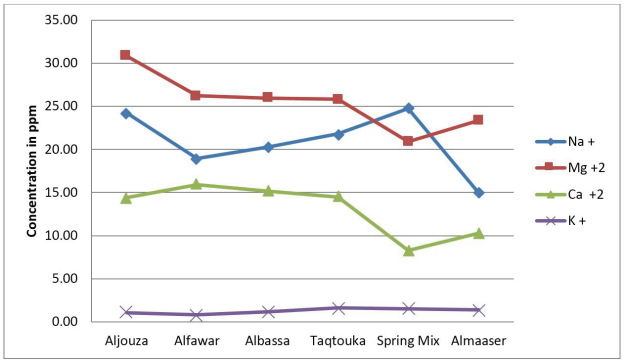

Figure 5. The cation concentration of the springs of the study area in ppm

3.1.3 Heavy Metals

The spring water samples was analyzed for heavy metals of B, Fe, Ba, Ti, Pb, Al, Cr, Ni, Cu, Zn, Ag and Cd at the laboratory of the University of Jerusalem - AbuDais. It was found that the spring water contains heavy metals concentration of less than the WHO (300 µg / L) (Fig. 6 and 7). However, the iron shows high concentrations ranging between 305 and 332 µg / L.

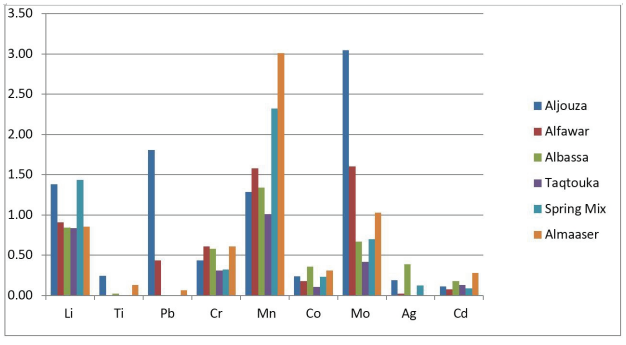

Figure 6. Heavy metals in the springs of the study area of less than 3.5 µg / L

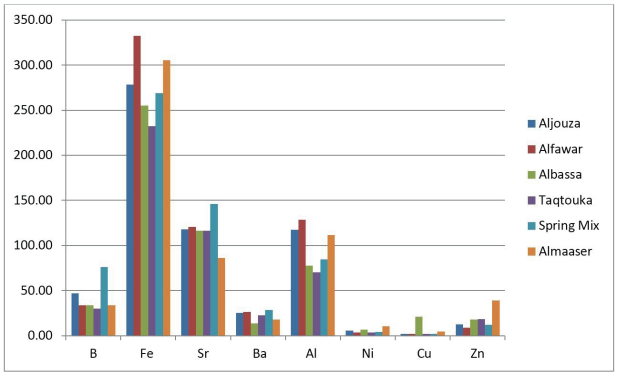

Figure 7. Heavy metals in the springs of the study area of less than 350 µg / L

3.1.4 Biological Analyses

Biological characteristics of spring water samples from the study area showed that all springs were contaminated with total coliform bacteria and that three springs were contaminated with fecal coliform bacteria (Fig. 8). Pollution rates vary from one spring to another and it is due to the mixing of wastewater flowing in the valley with these springs. It was also found that the spring of the Bossa has the coliform bacteria colonies of 184 / 100 ml, which exceeds the permissible levels for drinking purposes due to its contamination with wastewater. The results showed that three samples were found to be contaminated with fecal bacteria: the springs complex, the Bossa and the Al Maaser, the highest in the springs complex, which has 66, 52 and 20 colonies / 100 ml, respectively.

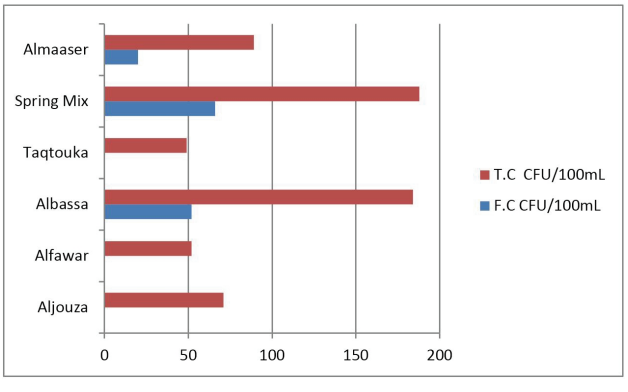

Figure 8. The fecal and total coliforms of the springs in the study area in colonies / 100ml

3.2 Social, Economic and Environmental Aspects

The questionnaire included many questions related to the environmental aspects like the methods for the disposal of wastewater at their homes. The results show that most of them disposed it using the cesspits, which reached 84.1% of the sample. 9.8% of them using open network, while

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the method for running wastewater in open channels had the lowest percentage of 6.1%. It is also possible to observe the presence of an indicator of groundwater pollution in Wadi Qana, especially that the cesspits are disposed by random discharge in the open areas and valleys near the Qana Valley springs, which affects the springs, due to the possibility of leakage into the ground and thus contamination to the spring water. 4.8% of the sample indicated that there is The pollution is due to the wastewater discharged by the villagers adjacent to the springs in an open areas and close to the springs, and the Israeli colonies surrounding Qana Valley are disposing their wastewater into the Qana Valley, which may seep into the groundwater.

The results showed that 90.1% of the respondents confirmed that the wastewater has an effect on the wild plants in the study area, while 2.3% indicated that the damage of the wastewater has little effect on the valley plants. The result of this damage is the lack of quantity, number and density of wild vegetation surrounding the area. The results showed that 75.8% of the respondents indicated that the wastewater has an effect on the aesthetic dimension of the nature, and these are water smells foul especially in summer times from the spreading of wastewater pools next to farmland, trees and natural plants. On the other hand, 55.3% of the respondents indicated that the wastewater has changed the color of the soil in Wadi Qana. It is clear from the results that 92.4% of the sample feel bad from the smells emitted from the wastewater. On the other hand, 97.7% of the sample found that the smell emanating from the valley is in summer times higher than winter. The reason for this is that the rain water mixed with the winter water, which reduces the smell, but in summer, the proportion of wastewater is high because of the lack of rain water dilution, which increases the spread of bad smell.

3.2.1 Social Impact on the Study Community

It is clear from the results that most of the sample have changed their place of residence as a result of the negative effects of wastewater in the valley, which amounted to 82.6%. The impact of wastewater on the place of residence can be confirmed, as there are currently no farmers living near the Wadi Qana, and the proportion of agricultural land is less than in the past as a result of wastewater disposal. On the other hand, 27.3% of those who had left their lands in the valley are without cultivation, due to wastewater spreading in the valley. Accordingly, there are social and economic impacts on farmers of the study area. 87% of the respondents believe that the wastewater has directly or indirectly affected the public health of the population in the study area. Moreover, 46.2% reported that they suffered from diseases due to the current wastewater in Wadi Qana, and 53.8% reported that they did not suffer from diseases due to wastewater in the valley.

3.2.2 Economic Side of the Study Community

96.2% of the respondents believe that the wastewater in the valley damages the sheep wealth. This is evidenced by the decline in the number of sheep in Wadi Qana, where the number of sheep living in the Qana Valley in the early 1980s exceeded 50 thousand, but in 2017 did not exceed three thousand, which left economic effects on poor breeders of animals in Wadi Qana [14].

It was found that 87.9% of the farmers who owned agricultural lands adjacent to the Wadi Qana had not cultivated their lands in 2017. In addition, 58.3% of the respondents mentioned that the discharge of wastewater and access to agricultural land reduced the agricultural production in these lands (Table 1). For those farmers who still in the area, 68.9% of them use spring water to irrigate their fruit trees, citrus and almonds (Table 2).

Table 1. Effect of wastewater on economic aspects

Domain	Yes	No	Total
Do you own agricultural land adjacent to the Wadi Qana	87.9%	12.1%	100%
Has these lands been cultivated in the past	84.8%	15.2%	100%
Are you cultivating these lands now?	82.6%	17.4%	100%
Has the discharge of wastewater and access to agricultural land to reduce the production of land from agriculture	58.3%	41.7%	100%
Is agricultural land considered a primary source of family income?	50%	50%	100%
Do Palestinian Authority institutions support farmers in the Qana Wadi	44.7%	55.3%	100%

Table 2. Type of use of spring water in Wadi Qana

What is the type of water use for these springs	relative distribution
For irrigating fruit trees	68.9%
Irrigation of fruit trees and watering of animals	14.4%
To irrigate fruit trees and irrigate crops	12.1%
For irrigation of animals and for irrigation of trees and crops	4.4%
Total	100%

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The Israeli occupation has a negative affects the spring water in study area in polluting them by discharging their wastewater into the Qana valley. The survey found that 73.5% of the respondents found that the presence of the Israeli settlements hindered the farmers' to access to their lands around the valley, which affecting in decreasing the ability of farmers to use their land. 68.9% of them said that the Israeli settlements have a significant impact on increasing the quantity of wastewater in the Wadi Qana.

4. Conclusion

This study aims to identify the environmental, social and economic impacts of wastewater on the springs of Qana basin, as well as to identify the physical, biological and hydrochemical characteristics of its springs. The Israeli settlements adjacent to the Wadi Qana forming the main pollution sources to the groundwater in the study area through seeping their untreated wastewater into the valley. The results of the survey showed that 82.6% of the residents of Wadi Qana abandoned their place of residence to the neighboring villages because of the effects of the untreated wastewater to their lands and social lives. The results of the survey showed that 45.5% of the farmers in Wadi Qana abandoned their agricultural lands in the Wadi Qana due to wastewater in the valley, indicating a decline in agricultural production in the study area. The general view of the landscaping was affected negatively by the wastewater flow in the wadi. Hydrochemical concentrations of the cations and anions of spring water samples shown concentrations within the WHO concentration standards. The calcium carbonate type of the spring water passes with the geological outcroppings of springs emerging rocks. Iron element shows higher concentration in the spring water of the study area, which is due to industrial pollution through wastewater. Biological tests indicated that all the springs are not suitable for drinking purposes because of their contamination with E. coli and fecal bacteria. This indicates of wastewater pollution causing health problems for the residents of Qana area.

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