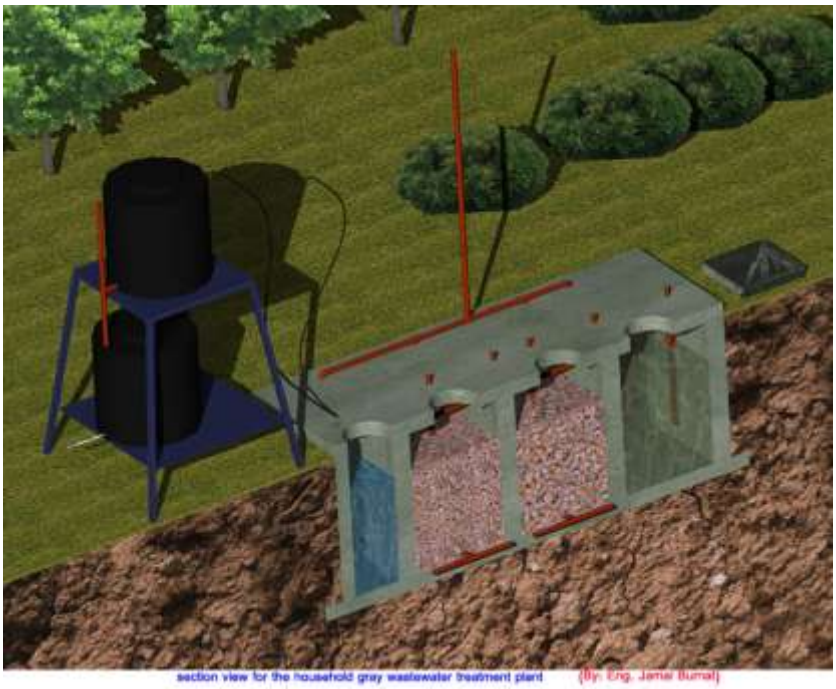
**Impact Auditing and Assessment of Gray Wastewater Management Systems Installed at Qebia Community**

**(Case Study)**




Jamal MY Burnat+ and Intissar Eshtayah++

+MSc. Wastewater & Environment Specialist, e-mail:jburnat@gmail.com

++ MSc. Agronomist & Community Development Specialist, e-mail:i.eshtayah@gmail.com

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**Abstract**

Qebia is one of poorest western Ramallah villages. It has a population of 6,500 inhabitants. It is characterized by its current high unemployment especially among men who have lost their jobs in Israel due to the closures and lack of permits. The field survey showed that 42.6% of families have more than 10 children, and 48.9 % their average income was USD300 per month.

Gray wastewater forms about 80% of the total water used at household level, at least 60% of gray wastewater can be recovered, treated and reused. At least 150,000 liters of fresh drinking water are annually saved per household. Through implementing the gray waste water treatment and reuse system at Qebia village for 48 households, large amounts of water are good managed, treated and reused in irrigating the home gardens.

The general shortage of water for the Palestinians and the high gray wastewater production from households require a careful consideration of alternative solutions that can be locally applied,

considering environmental elements, health issues and socio-economic situation. Modified septic tank up flow gravel filter followed by aerobic filter system that installed at Qebia households showed enough satisfaction to these elements.

The main Goal of this research paper is to assess and audit the impacts of gray wastewater systems efficiency on environment, health and socio-economic factors at household level. Within the framework of this study 48 pilots of on-site household gray wastewater treatment and reuse systems were investigated through field survey by using means of sampling and testing and questionnaire for beneficiaries. ACDIVOCA with Qebia Women Cooperative (QWC) implemented this project aiming at making valuable improvements to existing sanitation system in Qebia households, which were threatening, fresh water sources, public health, and subjecting a high load on socio-economic conditions, the disposal of wastewater from the old systems is known to be very costly. Also aiming at creating new sources of water to be used for irrigation at home gardens for food production.

Fresh Gray wastewater in Qebia village is found to be heavily polluted with bio-degradable matter (COD 1391 – 2405 mg/l) that should be treated before being reused in the home garden for food production. Installed treatment system reached a high efficiency even at the start up period producing water with (COD 58 – 266 mg/l) which meets WHO standards to be friendly to environment, soil and air. Fecal Coliforms are reduced from $1*10^4$-$37*10^4$ cfu/100ml in the fresh gray wastewater to Zero-$1*10^2$ in the treated gray wastewater which was reflected positively to public health.

The practiced technology is low cost one, experience and materials are locally available, no need for skilled personnel to operate and maintain, operational and maintenance and energy consumption is at very low cost (USD 20 per year), and the effluent is treated enough to be reused.

**Keywords:** gray wastewater treatment; on-site; low cost technology, gravel filter; rural households, tests, analysis and efficiency, reuse, home garden, irrigation system, food production, community development.

## 1. Introduction

The problem of water supply in the Palestinian territories is one of the most difficult problems facing Palestinian society. The lack of water resources and the competition between different uses i.e. domestic, agricultural and industrial is increasing by time.

Indeed, the limitation of water resources for the Palestinian is due to the Israeli occupation authorities laws and practices. Where Jewish colonies control over water resources, wasting a lot of fresh water, and producing a lot of wastewater which is disposed of to Palestinian land contaminating the soil and the limited water resources available for Palestinians.

Cesspits used by Palestinians to get red of their wastewater are another source of pollution for water resources. These cesspits also form a big load on the income of the Palestinian families, where some families cost them 20% of their monthly income to manage water and wastewater at house level. The pollution of the different water resource available for the Palestinian is becoming very critical.

For that Qebia Women Cooperative is running systems of gray wastewater treatment and reuse at Qebia village / Ramallah serving about 48 families, treating about 0.5 cubic meter per day per family. The treated gray wastewater is being reused for irrigating home gardens plants, fruit trees and vegetables eaten cooked.

ACDIVOCA funded the installation of these systems to encourage the use of treated gray wastewater in agriculture for improving food security.

This study measures the environmental and socio-economic impacts through the project life, it also shows audit assessment of the situation before the implementation of the project which was during the period between 1/9/2005 to 15/6/2006.

In fact, gray wastewater treatment gains importance for two main reasons:

1) It provides considerable water volumes that can be used for developing agriculture and improving the food security for Qebia community.
2) It reduces pollution resulting from using untreated wastewater for irrigation, that lead to soil pollution with organic matter, pathogens and mosquitoes.

The main Goal of this research is to assess and audit the impacts of gray wastewater systems on environment, health and socio-economic factors at household level.

## Methodology

Qebia Women Cooperative has been established in Qebia village, to serve the rural women of the village. The cooperative has been registered in the year 2004. The cooperative on the other hand provides services to non-members that cover approximately most of the village families.

The Cooperative provides the following main services:

- Improve the social and economical status of the women in the village through training;
- Train the women in food processing, other home made products, and linking them to markets;
- Train the village's women in different social and educational aspects such as family planning, and building awareness of the Qebia rural families through training and eduction;
- Facilitate a saving and credit program to help women access funding resources to fund their own small projects.

The field survey was made on 48 houses in Qebia village where most the people were using fresh gray wastewater in irrigation, the survey clarify environmental health, socio- economic assessment and the impact of construction of Gray wastewater treatment in solving this problems.

In the rural area most of houses have a home garden usually used to save little amount of vegetables and fruits for home consumption. According to the study survey 4.3% only have less than 500 square meter and 42.6 have 1000- 2000 square meter, where 55.5% of land cultivated by fruit trees and vegetables the rest is not cultivated because of lack of water, poor economic situation and the land needs reclamation.

Residents are, however, challenged by scarce water resources and burdened by the cost of piped water which is too expensive for most of them, where the cubic meter cost 1.2US$. Piped or purchased water, to be used for small garden agriculture, is not affordable for poor families, especially those who are headed by women.

That made more than 90% of the village inhabitant's sperate gray waste water pipes and using it without treatment in the home gardens, while the black wastewater is directed to the cesspit.

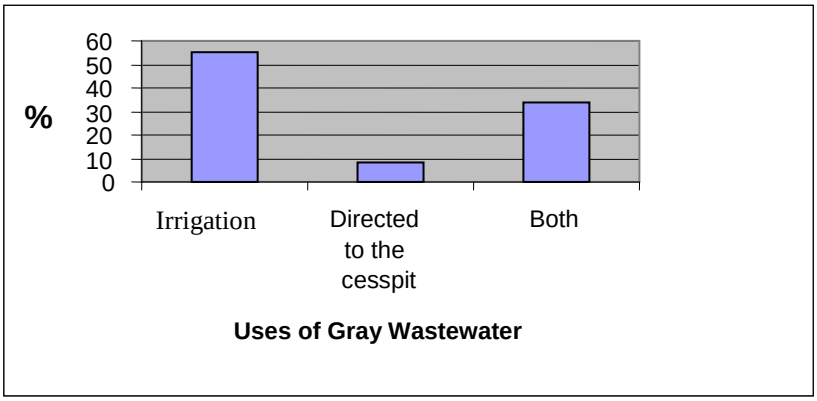
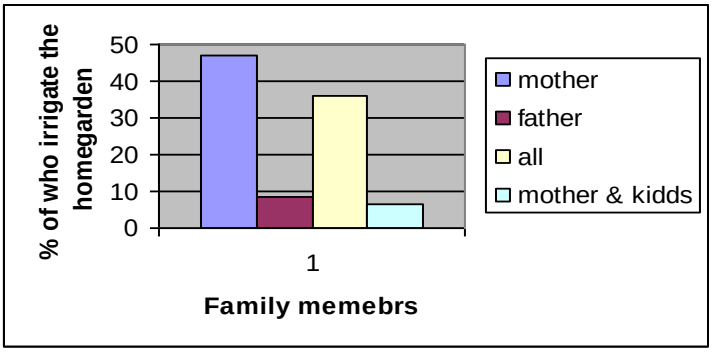



**Figure (1)** Percentages of different gray wastewater management techniques at households.

Woman playing large role in Palestinian community through saving food for her family, and this role increased due to the bad economic situation. In Qebia 46.8% of women practicing food production through irrigating the home garden by using fresh gray wastewater.




**Figure(2)** Role of family members in home garden management.

***Impact Assessment***

The tests of the 30 triplicate samples of the raw gray wastewater from Qebia households showed the following results

**Table 1** Characteristics of raw Gray Wastewater from Qebia Site.

| **Parameters** | **Qebia HH Gray Wastewater influent** |
|---|---|
| | Range |
| PH | 6.6 – 6.86 |
| BOD (mg/l) | 941 – 997 |
| COD (mg/l) | 1391 – 2405 |
| $NH_4^+$-N (mg/l) | 25 - 45 |
| Surfactant | 11-17 |

| | |
|---|---|
| NO3- (mg/l) | 0 – 1.3 |
| Total Suspended Solids(TSS) (mg/l) | 36 – 396 |
| EC | 891 - 899 |
| Total Dissolved Solids (TDS) (mg/l) | 483 - 515 |
| Fecal Coliforms CFU/100ml | $1*10^4$-$37*10^4$ |
| Total Coliforms CFU/100ml | $1*10^9$-$5*10^9$ |

These results show heavy pollution of raw gray wastewater samples taken from Qebia households.

**Environmental Assessment:**

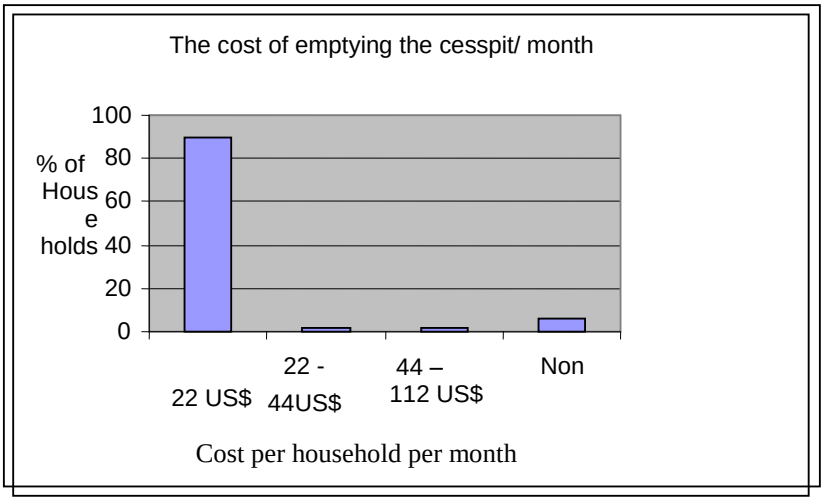
Reusing the untreated gray wastewater around the house in irrigating the plants caused many problems to the environmental elements; it affected the soil, water, and air. Creating offensive smells, insects, soil clogging and water born diseases.

**Photo 1. Fresh Gray wastewater threatining public health.**

**Water:**

The pollution of fresh water and the use of untreated gray wastewater causes many health problems for the public especially children, where cases of Anaemia, diarrhoea and abortion were counted in Qebia community through the survey.

Qebia village has water supply net work but 91.5% suffering from the water supply shortage in summer for domestic and irrigation uses. Because of that around 90% of the Village households sperate the wastewater; so that the black to go to the cesspit and the gray wastewater to be used in the home garden for plants irrigation that help them to reduce the cost of emptying the cesspit which cost about 22US$ per household per month.




**Figure( 3)**The Cost of emptying the cesspit on monthly bases.

### Soil & Plant:

The untreated gray wastewater clog the soil void space preventing the ventilation which has high negative affect on the plants, more than that the wastewater increases the salts in the soil , and algae and fungi can formulate. Also irrigating the vegetable and trees by wastewater causes many health problems, it may increases the percentage of Nitrogen and heavy metals.

**Photo 2 Fresh Gray wastewater polluting home garden soil.**

According to the survey, 89.4% of households use the untreated gray waste water in irrigating their home gardens, and most of the products go to family consumption. While 53.2% of people believed that raw gray wastewater has negative impact on the soil and plants, but the reasons for using raw gray wastewater in irrigation are: to reduce the cost of emptying the cesspit and to get water for irrigation.

**Air**

Offensive smells and bad odors in addition to the existing of the wastewater around the houses affect the neighborhoods. The survey showed that 36.2% of the neighbors are suffering from the flies, mosquitoes and insects

**Health Assessment:**

Using raw gray waste water in agriculture caused a lot of health problems, especially for the children. The survey showed that most of the families who used the fresh gray wastewater in agriculture affected by many diseases: according to the study sample 57.4 % infected by diseases, especially Amebae, Psoriasis, the doctor said it is because of using fresh gray wastewater in the home garden. That costs the family a lot of money in offering medical treatment for their children. Where these disease usually take long time to be cured.

Moreover 93.6 % used the pesticides for Mosquito control and 78.7% believed that these pesticides couldn't control and get red of the Mosquito that mostly breeding on gray wastewater seepage.

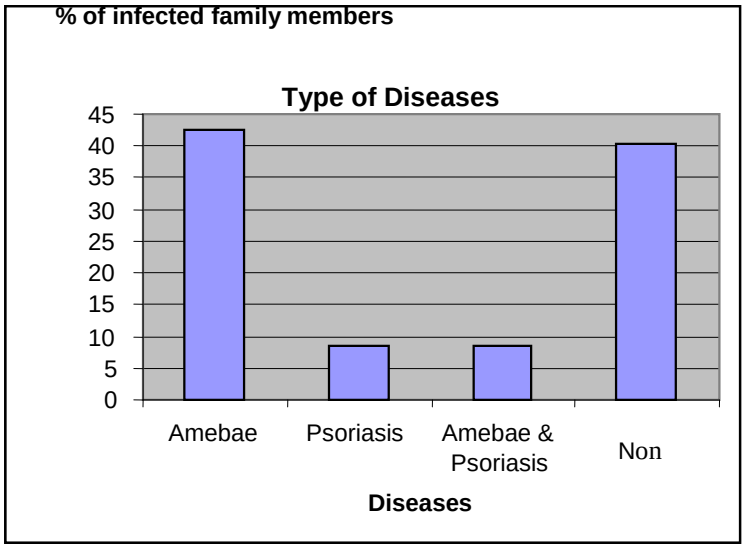



**Figure (4)** Water born diseases and percentage of infections.

**Socio-economic Assessment:**

Residents of Qebia village have phased one of the hardest economical hits. A population of 6,500 inhabitants, with high percentage of unemployment. The survey showed 50% their income average of less than $400. The average of water consumption is 50/L/capita / day for domestic uses.

In order to access enough water, Qebia families as well as many Palestinian families spend a significant proportion of their income on purchased water for domestic and agricultural purposes. Most families purchase at least 300 $m^3$ of water per year at a minimum cost of 1US$/$m^3$, spending a total of 350US$ yearly on fresh water. Some families have access to more conventional water harvesting sources such as cisterns. In these cases, the harvested rain water is 75 $m^3$ per cistern which is used for both domestic and agricultural uses. This consequently limits food production.

In addition to often lacking access to sufficient water resources, many Palestinian families also lack access to facilities to manage wastewater on the household level. As a result, many families also spend a large proportion of their income on managing wastewater. A typical Palestinian family of seven consumes an average of 350 litres of water per day with limited access to disposal facilities. Many families empty their household wastewater into a 30 $m^3$ cesspit. Monthly wastewater production is 14.7 m3 (80% Gray waste water and 20% black waste water) which fills the average cesspit in less than three months, forcing families to empty their cesspits at least four times per year. The cesspits are emptied by filling three large tanks which cost 22US$ per tank. Consequently, yearly expenditures for cesspit management are at least 270US$. This represents 5% of the household income for a family with an average annual household income of 5500US$. When combined the expenses of maintaining the cesspits and fresh water expenditures, more than 10% percent of the average family's annual household income is spent on cesspit maintenance and purchased fresh water.

The tankers then dispose of the contents in nearby open areas and valleys, creating more environmental pollution.

This dumping of wastewater into surrounding soil can seriously pollute the quality of water resources that causes many health problems to the public and affect on the neighborhood relations. In addition of that, the medical treatment of the water born diseases costs a lot of money and efforts ranging from 50US$ to 500US$ per family per year. More than that they pay a lot for controlling the mosquito especially in summer season, more than 100US$ per season, even that 80.9 % of

people believed that these pesticide have negative effect on the family, as the survey analysis showed.

## Objectives:

### Main Goal:

The main goal of the research is to assess the impact of gray wastewater systems on environment, health and socio-economic factors at household level.

### Research Objectives

1. To assess the improvement and standardizing existing individual on-site treatment plant design.
2. To assess pilot -test the effectiveness of the system on wider community
3. To assess monitoring and evaluating the performance of pilot waste treatment and reuse systems.
4. To assess preparing capital and operation and maintenance cost figures for the water management system at household level.
5. To assess development of water resources for agricultural purposes by increasing the amount of water available through effective Gray wastewater recovery, treatment and reuse.
6. To assess establishment of optimal process for household agricultural domestic gray wastewater reuse.
7. To assess promotion of community involvement concerning the issues of wastewater treatment and reuse.
8. To promote the involvement of local community, children and youth, regional institutions and policy makers in the appropriate and cost-effective community wastewater management and awareness schemes.

## *Materials and Methods*

### Questionnaire

Questionnaire formulated for identification of the hazards of using fresh gray wastewater to Environment and Agriculture; 47 questionnaire were filled from 48 families in Qebia whom benefited from GWWT units,

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### Statistical analysis

SPSS program used in analysing the data. Standard method were used in testing and analysing water samples.

### Treatment Plant

The treatment plants that gone under monitoring, sampling and testing, are seven pilots Septic Tank – upflow gravel Filter plant in Qebia Village in Ramallah District, they receive gray wastewater from household with 6 to 25 inhabitants.

### Description of Household Pilot Plant Model Used by Qebia Women Cooperative (QWC)

The house plumbing fixtures installations must be changed, to separate the gray wastewater and the black wastewater.

The black wastewater (from toilet) is discharged into the existing cesspit or to a safe disposal modified cesspit, while gray wastewater is directed to the treatment plant. The upflow gravel filter is designed as gravity loaded system, maximum flow at day hours and Zero flow at night hours. The main treatment part is anaerobic process followed by aerobic multi-layer filter (sand, coal, gravel). The layout of the pilot plant is shown in **Figure 5**.

The gravel filter media are mainly hard crushed stones of hard limestone of 0.7 to 3 cm in size. The pilot plants are made of concrete or/and bricks. It is divided into four compartments, where the first compartment is used as septic tank and grease trap, the second and the third are used as up flow graduated gravel filter, the fourth compartment is used as a balancing tank for treated wastewater where a submersible pump is installed. The pump lifts the water to a multi-layer aerobic filter through a controlled flow from a top tank, the water pass through the layers (sand, coal, gravel) to a storage tank from where it goes to the irrigation network.

The septic tank receives the gray wastewater (shower, kitchen, sinks and washing machine) from the house through a 2-inch or 4-inches diameter PVC pipe. The wastewater flows into a screen manhole to the first tank by means of a T shaped outlet, one end is directed to upward subjected to atmospheric pressure and the other at a level of about 30 cm from the bottom of the septic tank. The retention time of the wastewater in the septic tank is 1.5 to 2 days. Accumulation of grease occurred by installing a T-shape pipe at the outlet at same level of the inlet T. Also suspended solids are being settled down in the septic tank.


**Figure (5):** Sketch of the septic tank – upflow gravel filter household gray wastewater treatment plant.

Upflow Gravel Filter design is based on the following parameters:

-Void space is 40% in the first compartment of the gravel filter.

-Void space is 50% in the second compartment of the gravel filter.

-An organic loading of 0.388 kg BOD/day for 10 persons household.

- Hydraulic retention time is 2 days for the septic tank and 1.8 day for the upflow gravel filter .

***Methods of Sampling and Analysis***

Sets of water samples from different treatment units were collected and analysed by the standard method. Laboratory results from 30 samples considered as satisfactorily Sampling were checked in triplicate, storage and analysis of samples taken from source point followed the procedures mentioned in the Standard Methods for the Examination of Water and Wastewater, 19$^{th}$ edition. Table 3 summarizes the major analyses carried out. The samples were stored and tested by the Palestinian water authority laboratory.

**Table 3.** Methods of analysis.

| Item | Method |
|---|---|
| Chemical Oxygen Demand (COD) | Closed reflux, calorimetric method, spectrophotometer |
| Biochemical Oxygen Demand (BOD) | Standard method |
| Ammonia (NH3) | Direct nesslerization method |
| Kjeldahl Nitrogen (NKj) | Macro-Kjeldahl method |
| Phosphate (p) | Ascorbic acid spectrophotometric method |
| Chloride (Cl) | Argontometric titration method |
| Sulfate ($SO_4$) | Tubiditmetric method |
| Nitrate ($NO_3$) | Photometric method |

Samples were tested in triplicate after at most two hours from sampling by PWA laboratory.

## Research Findings

### Impact Assessment Results

The questionnaire covered the environmental, health and socio-economical situation before and after in the household, of more than 90% confidence. It was easy to measure the positive effect on the environmental elements, which directly appeared after implementing the Gary wastewater units, but for economic and health impact it needs long term research.

### Environment Impact (Water, Soil and Air)

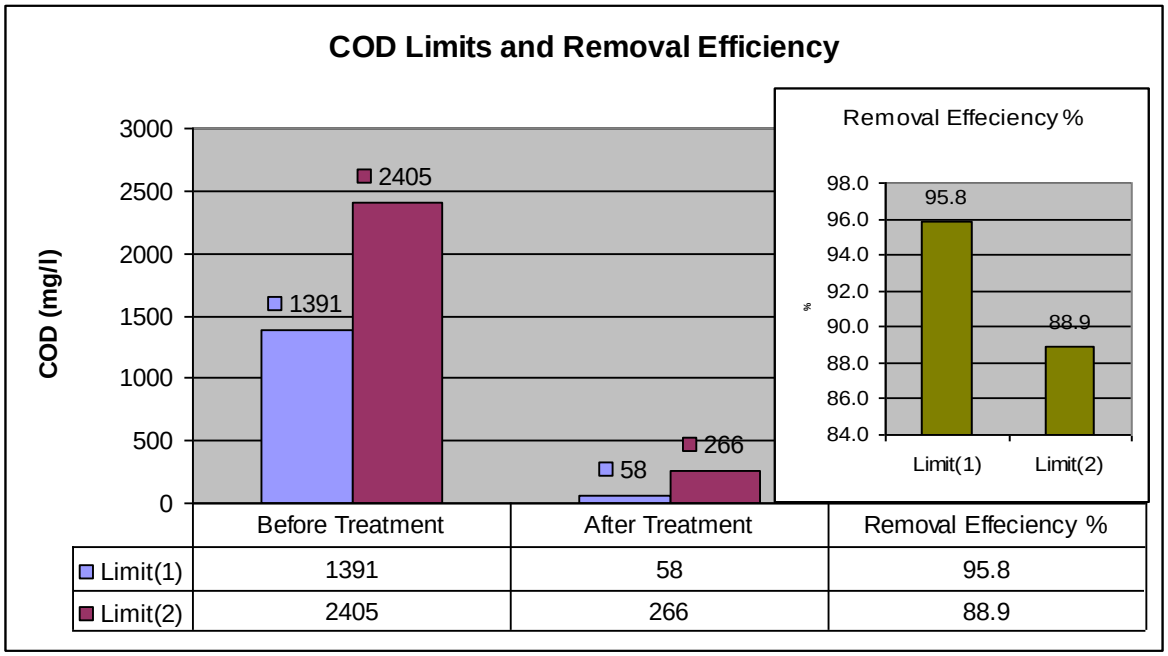
By using the gray wastewater system at the house level, to benefit from the gary wastewater in a healthy way and friendly to the environmental. The 47 cases in Qebia showed high positive impact after operating these units, the immediate effect was stoping soil pollution and beautifying the site, and reducing air contamination.

According to the survey only 36.2% believed that using untreated gray wastewater affect health. Awareness program was held to the people in the village concentrated on school students about the environment. The program covered many issues highlighting to the people the gray wastewater treatment and reuse, through demonstrating the positive effect of the treatment units and making comparison between the situation before and after constructing these units.

The tests of the samples of the treated gray wastewater from Qebia households showed the following results

**Table 4** Effluent of Gray Wastewater Treatment Plants at Qebia Site.

| **Parameters** | **Qebia HH Gray Wastewater Treatment Plant effluent** |
|---|---|
| | Range |
| PH | 6.7 – 7.79 |
| BOD (mg/l) | 21 – 121 |
| COD (mg/l) | 58 – 266 |
| $NH_4^+$-N (mg/l) | 12 - 48 |
| Surfactant | 5-13 |
| NO3- (mg/l) | 13 – 36 |
| Total Suspended Solids(TSS) (mg/l) | 4 – 24 |
| EC | 844 – 1493 |
| Total Dissolved Solids (TDS) (mg/l) | 465 – 849 |
| Feacal Coliforms cfu/100ml | Zero-$1*10^2$ |
| Total Coliforms cfu/100ml | $2*10^2$-$10*10^2$ |




**Figure(6**) Removal efficiency of COD

## Health Impact

Test for treated gray wastewater showed good results, where organic pollutants and faecal coliforms are reduced to minimum that can be reused safely in irrigating fruity trees and eaten cooked vegetables.

**Coliform bacteria:** species of gram-negative rods that may ferment lactose with gas production (or produce a distinctive colony within 24 hour to 48 hour incubation on a suitable medium) at 35 $C^o$. the total coliform group includes four genera in the Enterobacteriaceae family. These are Escherichia, Klebisella, Citrobactor, and Enterobacter. Of the group, the Escherichia genus (E.Coli species) appears to be most representative of fecal contamination.

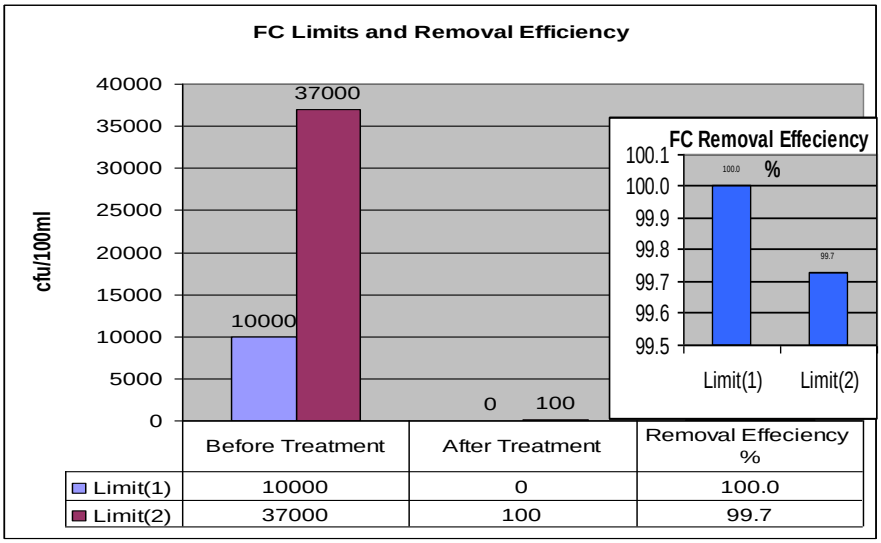
**Fecal Coliform bacteria**: A fecal coliform bacteria group was established based on the ability to produce gas (or colonies) at an elevated incubation temperature 44.5 $C^o$ for 24 hours).

**Table5** Estimated per capita contribution of indicator microorganisms from human beings and some animals.

| | **Average #/100ml/capita.24h** |
|---|---|
| **Source** | **Fecal coliform,** |
| Human | 450*$\mathbf{10^6}$ |
| Chicken | 620*$\mathbf{10^6}$ |
| Cow | 31000*$\mathbf{10^6}$ |
| Sheep | 43000*$\mathbf{10^6}$ |

Ref. Metcalf & Eddy

Treated gray wastewater samples results from 30 samples showed Fecal Coliforms concentrations between 0 to 1*$\mathbf{10^2}$ cfu/100ml, where the high results occurred in houses with small kids that are cleaned in the sinks. The Palestinian standards and measurements department allow for FC of 1000 cfu/100ml for unrestricted agriculture.




**Figure(7**) Removal efficiency of Fecal Coliforms

**Socio – Economic Impact**

According to the survey the relation ship between the people become better, where 60% said that the treatment unit have high positive impact on there social relation ships with neighbours. The cost of mosquito control is reduced. The cultivated land has increased because they now have source of water. Even 48.9 of the farmers believed that irrigating with treated gray wastewater showed better results on plants growth.

It was observed that, those gray wastewater treatment (GWWT) units showed a positive response to the mentioned problems. GWWT units allow families access to a conventional but innovative source of water. Gray wastewater that is generated on the household level was easily and efficiently treated of 130 $m^3$ per household annually, that represent nearly two full cisterns per year, for an average size family of seven persons. This amount of water is being easily treated using natural mechanisms with very low energy consumption that are easy to operate and maintain. For these good results It is expected that those beneficiaries at Qebia will encourage other community members to invest and adopt similar technology through economic savings and productive use of treated gray wastewater.

Treated Gray wastewater is being reused for agriculture resulting in water savings and reallocation of purchased water to other uses. Treated gray wastewater can only be used for agriculture but can be enough to irrigate between 100 to 200 $m^2$ of green houses or 500 $m^2$ open field home garden. Using GWWT to irrigate greenhouses can also help to assure that there is a continuous supply of water and food production, that QWC thinking to upgrade in the future. Moreover this source of water is stable, contains natural fertilizers and is free of charge. After installing and operating the wastewater management system, 80% of waste water (gray wastewater) is treated & reused for irrigating the home garden. The remaining 20% of waste water (black waste water) goes to a modified cesspit, where it is treated and safely disposed it at no cost.

Besides the clear economic impact of GWWTs, it also positively impact targeted women on two levels: most of households, the mother is responsible for water management and wastewater and cesspit management for the household as it is seen from **figure 3**. Most likely, the vacuum truck which empties the cesspit is late causing the cesspit to overflow in the neighbourhood which can deeply strain the family's relationship with neighbours and cause social problems. In a society where women often depend too much on good social relation, so strong relationships are necessary. Further more, the amount of time that women spend on water and wastewater management is

significantly reduced with the use of GWWTs which allows her to give more attention to her family and things such as home gardens that help to ensure a stable and continuous source of food for her family.

## Conclusions and Recommendations

### Conclusions

Palestinian community suffering from a lot of environmental problems. while environmental education started to get tension just since few year, most of work is as research, and to apply the results to wider communities need more investigation and investment, which can not be affordable by the local community due to the bad economic situation in Palestine with the existing of other priorities; such as health ,agricultural, education ,…….etc .

Though our research in Qebia village and after installing the gray wastewater systems, the great effect of the system was observed especially on environmental awareness in the village which was obvious on different environmental elements, health and socio-economic levels.

**Concluded Research Objectives achievements**

1. Many tests followed by improvements on the existing on-site treatment plants, these improvements aimed at eliminating the problem that rose up during operating these systems. This type of household on-site gray wastewater treatment system is its final standardization, it is a septic tank followed by up flow anaerobic gravel filter with two compartments of different grain size, then followed by storage and balancing tank where a submersible pump is located in lifting the treated water to a multilayer aerobic filter. The dimensions of the treatment plant are also standardized according to different family size distribution in the Palestinian community which are up to 10, 15 and 20 persons. Detailed drawings are prepared for the three different sizes of treatment plants. Special condition for special cases should be taken into consideration while applying the standardized design.
2. at stage one 23 gray wastewater treatment and reuse systems have been built serving a community of about 23 families. After the first stage were finished and operated, QWC received more request for applying the system from most of the community. QWC managed to apply 25 more systems to reach 48 systems which cover only 30% of the demand. The applied treatment system is mainly an up-flow anaerobic filter followed by aerobic filter. It is found that the system can provide an amount of treated water for irrigation and produce more food. The water bill is reduced after using the treated gray water for irrigating the garden instead of using fresh water. The expenditures on pumping out the cesspit is reduced dramatically at the houses where gray wastewater used to be

disposed to the cesspit. The beneficiary feels and practice the ownership of the system that he should take care of it and get benefited from it. (like owning a water heating solar system or a refrigerator)

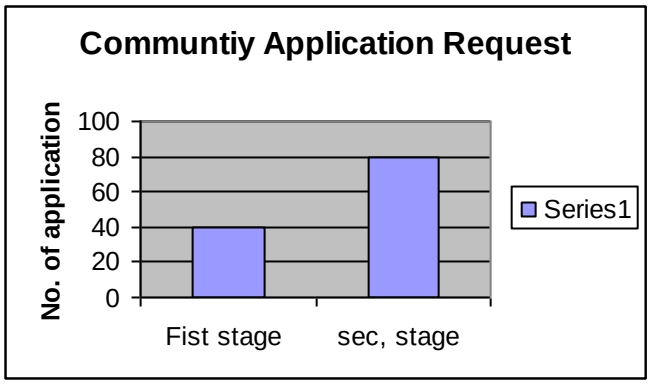



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**Figure (8)** Community involvement in the first stage and second stage.

3. More than 30 laboratory tests were *done* on the water quality and treatment plant performance and gray water characteristics.
4. Most of household recovered 100% of gray wastewater because they have already been using it for irrigation without treatment, so no difficulties were in recovering all the gray wastewater from the houses
5. Drip irrigation network is being used in all home gardens. Past experiences and literature showed that drip irrigation is an optimal way to use water. For treated gray wastewater flushed bacteria could clog the drippers, so a water filter was installed to protect the drippers from clogging, this filter has to be maintained regularly.
6. Beneficiaries in Qebia attended all workshops, training courses and extension services held on this subject, they contributed in the construction of the treatment and irrigation system and were active in solving the on work problems. They perform labour and time helping the project and research to become true. They are committed to follow the orders of QWC on operating the system and reusing the treated wastewater.
7. QWC contributed in the need assessment, the planing, the beneficiary selecting, tendering and administrative and financial follow up of the project. Women were involved in training and extension program. Children and youth were involved in an awareness program. Local women cooperatives from neighbouring communities, local and international NGO's visited the project site to be aware of the program.

## Recommendations

Palestinians are suffering from water shortage, in addition of waste water in rural area, where the people get red from it in the valleys and some time in agriculture lands which causes a lot of environmental and health problems, so that we have to work on;

- Increase the environmental awareness between the people especially young people in schools, collages and education centres and discission makers; in how to conserve the natural resources.
- Establish household gray wastewater treatment and reuse system to reduce the bad environmental and socio-economic effects resulting from using untreated gray wastewater in agriculture. Also to reduce the effect of water shortage, by creating new non-conventional source of water and reusing it in agriculture, by installing a suitable irrigation system.
- Globally, intensification of research on Gray Wastewater Recovery, Treatment and Reuse studies, including its impact on environment, socio-economic, and public health.

## Obstacles

The closure and siege that is imposed on the Palestinian territories by the Israeli occupation forces, have led to great difficulties to the Palestinian people. The obstruction of movement of personnel has its negative impact on monitoring of the systems in the field.

**Acknowledgment**

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