

**PROPER MANAGEMENT, MEASURES AS WELL AS LAWS AND BY-
LAWS NEEDED TOWARDS SUSTAINABLE WASTEWATER
TREATMENT AND REUSE IN PALESTINE**

Eng. Mohammed Yousef Sbeih- Irrigation Project Coordinator

APPLIED RESEARCH INSTITUTE

P.O. Box 860 BEITHLEHEM, West Bank-Palestine

Keywords: Palestine, Reuse, Irrigation, Economics, Waste Water
treatment, Sustainability

Abstract

Palestine consists of the West Bank and the Gaza Strip. The proclaimed state of Palestine has a land area of 6,657km³.

Water is always considered as an essential factor of life and development in arid and semi-arid countries. In Palestine the total per capita water consumption is 60 m³ while in the neighboring countries such as Israel is 411m³. Reusing of treated wastewater for irrigation in Palestine is considered to be one of the main solutions to the water crisis in the Middle East in general, and to the both Palestine low operation cost, technology treatment plants should be adopted for some relevant places in order to be sustainable where the residence can afford the running cost,. In addition to that

selection of the treatment plant should be designed, taking into consideration the type of crops to be irrigated.

Furthermore special attention should be made to the adoption of economical non-edible crops such as fodder crops and industrial crops as well as trees.

Since most of the land in Palestine is planted by olive, grape, and cereals, supplementary irrigation should be introduced and practiced where the production of wheat via irrigation by treated waste water was three times that under rainfed planting project implemented at furthermore public education, training and awareness should be in a pilot out as soon as possible.

Reuse of treated wastewater for irrigation stage will increase the irrigated area in Palestine and will replace the fresh water that can be used for domestic purposes.

Reuse of treated wastewater is still in the planning stage.

Feasibility wastewater treatment and so a complete set of measurement should be taken by the responsible authorities such as Palestinian water authority and Ministry of environment in cooperation with the Ministry of Agriculture.

To assure:

1. safe use of treated wastewater for irrigation
2. Reusing of treating wastewater is economically and socially feasible
3. since wastewater is considered as a source every drop of treated wastewater should be used.

The overall objective of this study is to describe briefly the required measures, laws and by-laws that we are the Palestinians should adopt benefiting from other countries experience so water should be everybody's business.

Introduction

Even the total annual ground water recharge is about 700 M.C.M./Year in the West Bank. The total water that the Palestinians have access to is only 235 M.C.M. This is due to Israeli occupation, for all the purposes (domestic, irrigation, industry). Reuse of treated wastewater for irrigation might be the only main source that will be under full control of the Palestinians. Still there isn't any functioning treatment plant efficiently in Palestine, but the Palestinians are given a great attention to this, where there are now several plans, in order to collect sewage, treat it and reuse it for irrigation.

There are several of irrigated projects in the West Bank (This study will focus on West Bank due to the fact that all my experience is from the West Bank) varies from 10 ha to 1600 ha in area. Unfortunately most of these projects are not self-sustainable, mainly due to the fact that farmers are not paying the actual cost of water for many reasons... One of these reasons is that farmers themselves manage these projects. The second main reason is the current situation especially marketing problems. This results to the failure of the project, which seems to occur, where water is flowing, thus creating environmental problems.

In the case of reusing of treated wastewater for irrigation, these projects should not be only economically safe, but also should convert the environmental nuisance to an asset not otherwise. In addition to that these projects should be sustainable. In order to fulfill this, several measures should be taken; one and the main parameter are ensuring proper operation and maintenance. For success of O+M operation, cost of treated wastewater should be as minimum as possible, in order that farmers can afford paying the full actual cost of the water, keeping in mind the safety of the project. This implies that wastewater treatment plants should be simple technology as possible as it can be and any treatment plant should serve as much people as possible.

Sample of Projects that are not successfully operated

We can say that most if not all the irrigation projects in Palestine are not self-sustainable. For more clarification, the situation of some of these projects is hereby discussed:

1. Al Fara' Irrigation Project

This project is located in the northern east of the West Bank. The water source is Al Fara' spring, has a discharge of 1000m³/hr. The water flow from the spring is by gravity through pipes. The total area that benefit from this project is 1600 ha. Farmers own the water and the project is managed and operated by a committee from the farmers. Even there are not any pumping stations in these projects, the farmers did not pay water fees of \$.01/m³ which is much cheaper than the price of irrigation water in any project. Where it happened that several failures of the project occurred, such as block of pipes, failure of embankment, etc... the committee was not able to

maintain the damage financially and the project used to be out of operation of 2 – 3 weeks until the committee was able to secure the needed funds.

2. Marj Na'ajeh Irrigation Project

The same as above, but the water source is ground water well. Some problems happened to occur without maintaining them on time.

3. Ramallah Waste Water Treatment Plant

Ramallah Municipality was the first municipality to construct in 1974 a treatment plant, in order to treat the wastewater. The flow used to be discharged in the wadi, since there isn't any use of the wastewater, the municipality didn't use to operate the treatment well, where the aerator used not to be operated in order to save electricity in the municipality point of view, where there is not use of the effluent. This results that influent quality is better than the effluent in some times. Unfortunately, the treatment plant increases the environmental problems not the otherwise as it should be.

How to Achieve Economical Environmentally Safe And Sustainable Treated Water Irrigation Project As shown in Table no. I.

The production of fodder crops in West Bank is covering only 14% of the total consumption. W.H.O. (1989) classifies the crops that can be irrigated by treated wastewater into 3 categories as follows:

Category A: Restricted Irrigation, Protection Needed Only for Field Worker.

These include:

1. Crops not for Human consumption.
2. Crops normally processed by heat or drying before human consumption.
3. Vegetables and fruits grown exclusively for canning.
4. Fodder Crops sun dried harvested and stored before consumption by animals.

Category B: Further measures may be needed

1. Pasture, green fodder crops
2. Crops for human consumption that don't come in contact with waste water.
3. Crops for human consumption normally eaten after cooking.
4. Crops for Human consumption, the peel of which is not eaten.
5. Any crops where sprinkler irrigation is used.

Table no. 1

**Total Production of Cereals as well the Cultivated Area as
the Average of the Years (1988-1994) in the West Bank**

Crop	Cultivated Area in 1000 dunum	Production Kg/D	Total production Ton/year	Total Consumption ton/year	Deficit ton/year	% of production
Wheat	170	140	23,800	300,00	267,200	7.9
Barely	140	150	21,000	108,00	87,000	19.9
Chick peas	29	80	2,320	11,885	9,565	19.5
Lentils	30	40	1,200	14,780	13,580	8
Fodder Crops	26	600	15,600	110,000	94,400	14
Total	395		63,920	544,665	480,745	11.7

Source: Palestinian ministry of agriculture statistics

Category C.

Unrestricted crops any crops including crops that are eaten raw such as tomatoes.

Shuval and others (1997) stated that the cost per cubic meter of treated wastewater is estimated to be:

1. \$0.1/m³ according to meet W.H.O. Guideline (1000 F.C./100ml)
2. \$.45/m³ according to meet USEPA/USAID Guideline (0.0.F.C./100ml)

It is clear that further reduction of Fecal coliform is the most costly parameter in wastewater treatment, where 40% of B.O.D. Reduction can be achieved by anaerobic

treatment. The W.H.O. guideline, didn't recommend any standard of fecal coliform for categories B+C where they recommend 1000 F.C./100 ml for category A.

For safety measures (conditioned that enough regulation is implemented) treatment plants can be designed in order to meet standard for category B, but regulation, and order, should be given to grow only crops from category A. This will secure safety as well as low operation cost i.e. low cost of treated wastewater where farmers can easily afford it, so proper operation of the treatment plants can be easily obtained.

Selection of Waste Water Treatment Sites

Still there is no functioning wastewater treatment plant in the Palestinian territories except ALBEIRA wastewater treatment plant ; even the first plant was constructed in 1973 in Ramallah City, provided that this treatment plant is not functioning well, as it will be discussed later on.

Due to the absence of concerned authorities, usually each city used to plan to construct a special treatment to serve the individual city without consideration of the existence of any surrounding towns. This leads to the following:

1. Construction of specialized treatment plants for each town or city, which will result in:
 - a. Difficulty of providing the suitable site for that treatment plant in order to be away from the residential area as well as to find suitable flat land for the treatment. So the selection of the type of treatment will be not

so easy, which result in selection in the most complicated type such as extended aeration. So the capital cost is very high, the O.M. cost is also high and there is a need for skilled lab also.

- b. The capital cost of the treatment plant becomes higher than it should be especially per capita.
- c. The operation cost of the treatment plant will also be higher than it should be, so the concerned municipality will not be able to cover the expenses of the treatment or the cost of treated waste water will be very high so it will be difficult for the farmers to afford this cost and they will not purchase the treated waste water for irrigation purposes. The best example of this is Ramallah wastewater treatment plants.
- d. Land for reuse will not be available economically and easily especially due to the topography of Palestine as well as that the nearest available area are planted by olive trees or others such as in Salfeet city.

S0 there should be a master plan to be carried in order to assist the communities to determine the sites of the proposed plants that will full fill the followings:

1-low operation and maintenance cost plants can be implemented such as anaerobic treatment, trickle filter, and waste stabilization ponds.

2-Ease of operation

3-The need for pumping stations is minimum, not as the case of Hebron plant that will serve Hebron region where a lot of pumping stations are needed.

4- Close to the proposed irrigated area

5- Plants that can serve one or few communities that serve the above points

Cases where bad management is practiced.

Ramallah Wastewater Treatment Plant

In 1973 Ramallah Municipality constructed the first treatment plant in Palestinian territories. The plant consists of two parallel aerated lagoon followed by two facultative ponds.

At that time the Municipality had no plans for reuse of the treated wastewater for irrigation, as well as the plant was constructed to serve only Ramallah city provided that Al Bireh city is a twin to Ramallah city, and in addition to that Al Amary camp is adjacent to Ramallah and Betunia city is ½ km away from Ramallah. Even the treatment plant was constructed adjacent to Betunia land.

The result of this bad management is the followings: due to the operation cost that the Municipality used to pay and without any economic return since there is no reuse plan, the municipality used to stop operating the aerators in order not to pay the cost of electricity, so the quality of the effluent was worse than that of the influent. The B.O.D. of effluent was 850mg/liter while it was 650 for the influent.

In addition to that the Municipality did not employ any operating staff even the guard was not on regular basis. The only maintenance that the municipality used to do is cleaning each pond one time a year or sometimes once every two years.

Still this situation is present as it is and the wastewater flows from the treatment plant to the wadi without any benefit from this wastewater, which could be consistent of huge benefit to the Palestinians, especially due to the shortage of water in the country.

Salfeet Case

This is another city where wastewater treatment plant was designed to serve only the entire city without taking into consideration the nearby towns since down word the proposed site will be a town (*Burga*) and upward the city is another town (*Kiffel Hares*). This is only because Salfeet Municipality is concerned about their city alone in the absence of the national plan by the authority.

The design of this treatment plant was completed and it is estimated that by December 20th the contractor will start construction of the treatment plant, due to the Jerusalem uprising (Intifadet Al Aqsa) which started in late September 2000. Thus the construction was postponed.

Type of Waste Treatment Plant

Here there is another story of practicing bad management. As it is known that there are several kinds of treatment plant, each one has its characteristics, especially operation cost, the need for skilled technicians and so usually the construction of treatment plant is financed by donor agency such as K.F.W., USAID, etc.

Usually in these projects, the donor came and insisted that a firm should do the design from his country even the contractor should be from his country. Here the designer came with his mentality and background about his country. The designer just sent a small team to collect information and conduct land survey and do the design in his office in his country. So the designer will select the type of treatment that is already suited to his country, which he has a lot of experience on. As example, the designer selects an extended aeration for Al Bireh city and activated sludge for Salfet. In Europe and U.S.A. the treated wastewater is not reused for irrigation widely and there is no critical need for this treated wastewater such as in Palestine, but it will be disposed in the sea or the river without affecting financial status of the project.

As example the cost of treated wastewater was estimated to be:

- 3½ U.S. Dollars when activated sludge used
- 24 U.S. Dollar when extended aerated is used
- 11 U.S. Dollars when waste stabilization is used
- 16 U.S. Dollars when aerated lagoons are used
- 17 U.S. Dollars when trickle filter is used per cubic meter according to different studies

Regarding the type of operator needed for each plant, (it is well know that wastewater rehabilitation needs the least skilled labor as well as not complicated system.

Here in Palestine still we do not have any skilled people for any kind of treatment plant except for one staff who was trained in Germany to be working in Al Beirah treatment plant, and the financial situation of the people as well as the institutions are not so good, especially farming system.

So far the sustainability of these projects, the selection of individual treatment plant should have the lowest operation and maintenance cost and the type of equipment (process used should be as simple as possible in order that Palestinian staff can operate and maintain it easily and quickly).

Al Bireh Waste Water Treatment

The Municipality of Al Beirah with funding from donor (such as K.F.W.) countries succeeded to design and construct their treatment plant.

The treatment plant is designed to serve only Al Beira city without consideration of the nearby towns and cities, even the area that is allocated for the reuse is owned by other towns.

The treatment plant is designed to be extended aeration, since the treated wastewater will flow 9 kms until it reaches the reuse area. The Municipality could select another type such as simple anaerobic pond followed by facultative pond sited at Al Beira land. Then the waste water will be transported by the pipe and further treatment can be applied on another area serving other towns as well. As in the long run there will not be enough land for expansion of Al Beirah.

This will result into the followings:

1. Sharply reduction in the capital cost
2. Sharply reduction in the operation and maintenance cost
3. No need for highly skilled labor

Reasons for bad Management

There are many reasons for bad management of wastewater and reuse even water management in general. The main reason is Israeli occupation, which is out of my paper here since it is a political issue hoping to be solved soon.

1. Lacking of power for other land. This leads in constructing the treatment plant inside the boundary of each individual city where each city tries to construct the treatments. Inside their boundaries since it has no authority outside their boundaries. This implies that:
 - a. Location of the treatment will be not the proper one, so the capital cost and the operation cost will be higher than it should be.
 - b. This will effect the selection of the reuse area since the selection of the reuse should be the nearest one inside to save pipeline and power.
2. Lack of finance

Due to the lack of finance special municipalities used to hire less qualified engineering firms to conduct the design of the treatment plants, which leads to the selection of not the proper one.

3. Shortage of water: the best example of this is Salfeet municipality where they insist to reuse the treated wastewater inside their land in order to substitute the fresh water of Al Meska spring used by the farmers for irrigation purposes and to use that fresh water for domestic use. This emphasizes to pump the water of more than 100-meter head, which increases the operation and the capital cost as well.

These all together and other lead to produce non- sustainability of the Waste water treatment and reuse projects in Palestine.

In order to achieve economical and sustainable wastewater treatment and reuse projects, better planning of these projects should be done. As an example there is no need to treat the waste water to get BOD 30 Mg/L when this treated waste water can be used for fodder crops, or drip irrigation can be used, here we can benefit from WHO. 2006 standard, as in the diagram below.

The study done by Shuval and others further indicated that the annual risk of succumbing to an infectious enteric disease from regularly eating vegetables irrigated with treated wastewater effluent meeting the World Health Organization Guidelines of 1000 FC/100ml (WHO, 1989) is negligible and of the order of 10^{-6} to 10^{-7} (One person per million or 10 million/year). The USEPA considers an annual risk of 10^{-4} (one person per 10,000/year) to be acceptable for microbial contamination of drinking water (Regli, et al. 1995). *Thus according to our initial QMRA study the 1989 recommended WHO Guidelines for Wastewater Reuse in Agriculture were some 100 to 1000 times safer than what the USEPA itself recommends as the degree of safety required for drinking water.*

In the new WHO Guidelines, a pathogen reduction of 6–7 log units is used as the performance target for unrestricted irrigation to achieve the tolerable additional disease burden of $\leq 10^{-6}$ DALY per person per year. However, the WHO report points out that "...a 6–7 log unit pathogen reduction may be achieved by the application of appropriate health protection measures, each of which has its own associated log unit

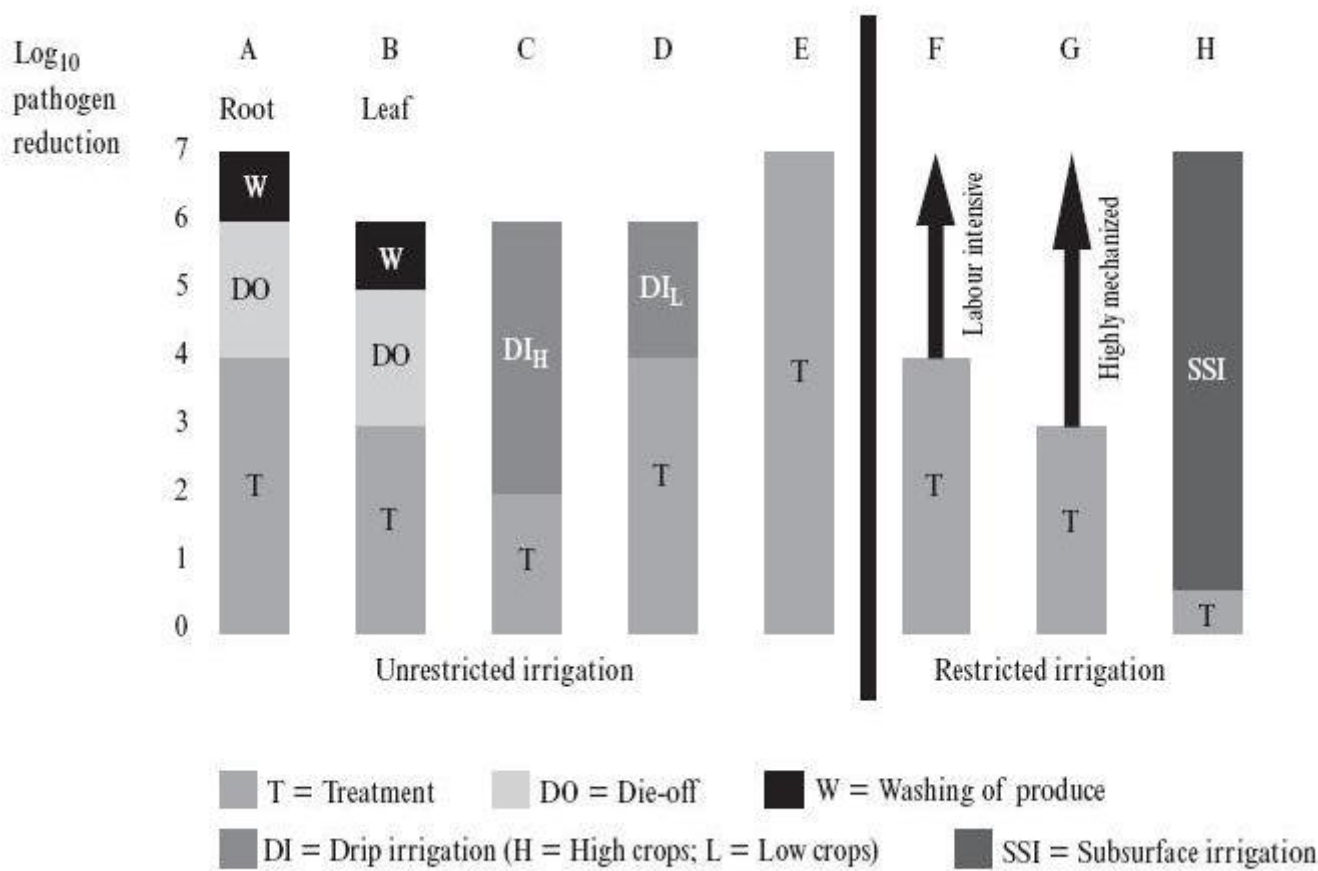
reduction or range of reductions. A combination of these measures is used, such that, for all combinations, the sum of the individual log unit reductions for each health protection measure adopted is equal to the required overall reduction of 6–7 log units".

Studies indicate that the additional costs involved in tertiary treatment of wastewater effluent to meet the recommended strict Israeli wastewater reuse guidelines (similar to the USEPA guidelines) is estimated at USA \$ 0.18/M³.

(Haruvey et. al 2004).

This extra cost of treatment may increase the economic burden of wastewater reuse in agriculture beyond the point which most agriculture crops can carry and may result in blocking the rational economic development of water recycling and reuse. Even if the farmers are not burdened directly with all of these extra costs they must be considered as part of the additional economic burden on the totalnational

economy.



The same can applied using trees with drip irrigation or subsurface irrigation

Applying this will sharply reduce the operation cost where the community will be able to cover the operation and maintenance cost, so this will help in sustaining the treatment plant and reuse project as well.

Laws and by-laws needs

The Palestinian water Authority (PWA) was established by the Presidential order no. 93 for the year 1995. By-laws no. 2 of the 1996 identified the mandates and authorities of PWA, which is mainly to achieve efficient management of water

resources, to implement water policy to establish and preserve water projects and to achieve cooperation between the parties affected by the water management. PWA has now established the organizational structure according to the international regulations and is trying to develop into a functional authority.

PWA is completely responsible for the water and wastewater, while the terms water here means water and wastewater. Even the purpose of the PWA is to establish and supervise water and water projects, unfortunately the PWA limits itself to be a regulatory body which puts itself far away from managing these projects and insure that the design and the implementation of these projects are the proper ones.

Main principles that PWA should take into consideration in managing the water and waste resources.

1. Institution and management principles. This can be fulfilled by the following:
 - a. Role of government and official bodies at all levels should be clearly defined and areas of responsibility officially established.
 - b. Structure and system of management should be designed in such a way as to facilitate involvement of the responsible authorities at different levels.
 - c. Involvement of user organizations and the private sector should be encouraged.

- d. Ongoing capacity building is needed within institutions and for participant groups at all levels.
- e. Management systems should be transparent and accountable as well as appropriate management information systems should be established.

3. Social Principles

- a. Sufficient supply of water is basic human needs to which everyone should have access.
- b. Users have important role to play and their involvement should be first fostered via a participatory approach.

4. Economical and financial principles:

- a. Wastewater is considered as a resource, so it has a value and should be recognized as an economic goal.
- b. Charging tariffs for water services is an important component of any strategy for sustainability.

5. Environmental Principles

- a. Water and wastewater related activities should aim to enhance or to cause least detrimental effect on the natural environment and its health and life – giving properties.

- b. Environmental change should be monitored so that improvements can be encouraged and detrimental impacts minimized.

6. Information, education and communications

Principles

- a. A sound information and knowledge base is needed for effective actions within all water or wastewater related activities.
- b. Education is a vital component of wastewater reuse schemes of health and life enhancement benefits are to be achieved and sustained.

This is clear in Al Beira Reuse scheme since the farmers of down stream rejects the idea of reuse for years due to their ignorance and others.

- c. Communication and awareness building are essential ingredients in all forms of water resources management.

7. Technology principles

- a. A balance approach towards (hardware) and (software) components of projects should be adopted.
- b. Choice of technology should be governed by consideration of its effluence, appropriates, cost, and sustainability for local conditions.
- c. Designated and qualify certain local engineering firms in order to be responsible for conducting detailed design of wastewater treatment

plant, where these later on will only be responsible for the design and tender should be through PWA.

- d. Conduct master plan in order to determine sets of treatment plant that can serve rural communities economically.
- e. The terms appropriate technology should be used not the term modern technology.

Conclusion and Recommendations

1. Public awareness and training is highly needed in the Palestinian Territories.
2. There is an urgent need for the PWA to conduct master plan in order to determine the proposed sites for treatment plants that serve several communities taking into consideration treatment plant that act as regional plants.
3. PWA should be responsible for selection of the type of treatment plant and the site as well, so there should be a designated committee or staff in order to follow this issue.
4. PWA has to have a special technical people from the authorities or outside to follow up on the designs of the treatment plants.
5. PWA should designate and qualify local engineering firms in order to be responsible for design of these treatment plants and these firms should be invited only to submit bids for the design of treatment plants.

6. Production of fodder crops and cereals constitutes only a maximum of 16% of the total consumption, so there is no need for the treatment to reach 100 coliform/100ml. So treated waste water can be used to irrigate fodder crops most of the time.
7. Municipalities and engineering firms should use appropriate technology in the case of selection treatment plants and to consider the modern technology.
8. The plans to reuse treated wastewater should be studied before selection the site and type of the proposed treatment plant.
9. To achieve sustainable treatment plants and reuse projects, all of the efforts should be done in order to achieve treatment plant of low operation costs and acceptable quality of water, so farmers can economically and safely use this water for irrigation purposes and can afford paying the cost of treated wastewater.

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