

Assessing the Efficiency of Ateel Wastewater Treatment Station for Rehabilitation

Improving the Water Quality and its Safe and Practical Application

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Abstract – In regions of water deficiency, wastewater treatment offers the possibility of an efficient removal of unwanted pollutants and germs so that water may be used for irrigation. Water scarcity is an old problem in Palestine due to various geographical settings and political turbulences. The problem is compounded by population growth and development. As a result of increasing demand on water, utilizing alternative options has become a must, to meet water needs. To reduce water demand by increasing the efficiency of water use and to expand the usefulness of choice sources of water previously considered unusable. One opportunity of supply is “wastewater.” The project seeks to treat and reclaim wastewater to supply irrigation water, and enhance crop production. The task results reveal that waste water from ateel wastewater station has the potential for irrigating crops and offers many social and financial benefits to improve the farmers’ source of revenue. Various parameters were monitored and measured for the Ateel wastewater water station yielding some interesting and promising data.

Keywords – Treated WasteWater; Irrigation; Agriculture; Cropping

1. Introduction

Nowadays most arid and semi-arid regions are facing water problems and conditions are very severe especially in developing countries. These areas are facing difficult challenges in meeting rising demands of water as the available supplies of freshwater are depleting due to extended droughts, population growth, more stringent health based regulations and competing demands from a variety of users [1-3]. Palestine is one of those area that fit this profile and urgent options of waste water treatment are to be considered to avert threats to sustainable development [4]. Furthermore, wastewater treatment may help reduce contamination to groundwater. In the westbank, groundwater is considered the main source of water, so, it is vital to preserve its quality from deterioration and pollution especially when it is subjected to human activities.

The aim of this project is to rehabilitate a neglected waste water treatment station in the city of Ateel located in the Tulkarm Governorate (Northern WestBank) in Palestine, and evaluate the waste water before and after treatment. Ateel city has a population of 12,900 residents. The Ateel wastewater station accumulates water from 35 households connected to the network system. The average monthly household consumption of fresh water is about 623 m³. The average daily consumption of the households is about 20.77 m³. Each house consumes about 0.6 m³ on average. The average station intake (that is coming from the households) is about 70% of the daily consumption, which equals 14.5 m³. Water quality was monitored using several parameters and indicators.

This station was built within an area that has both low rainfall and low socio-economic status, though it is considered as an agricultural region. Therefore, our intention was not only to rehabilitate the station, but also to use the water for agricultural purposes and to enhance public perception about wastewater water from negative to positive. This will help create better public awareness that will address the water problem effectively. Education and awareness-building campaigns play a critical role in building public knowledge and support for new water solutions. Poor water quality may negatively impact productivity due to illness, social and societal decay, and declines in public order. Also, increasing media attention, community pressure, and education on the impacts of water quality might lead to more

support that is worth of capital investments to protect public health and water quality through the construction of wastewater water treatment stations.

2. Materials and Methods

2.1 Site selection

Ateel city, located in the Northern WestBank was considered for this project for various factors. First An existing wastewater station within the proximity of the research center NARC is convenient for data gathering and monitoring. Second, the area is considered one of the most active agricultural regions in Palestine. Third, the willingness of farmers to reuse treated waste water for certain crops was a plus. Finally, the region has fertile soil with rain-fed agriculture and limited water resources.

2.2 Description of the Ateel waste water station

The station consist of several stages of waste water treatment. The first stage is the “inlet manhall”. Its purpose is to trap/ remove and/or isolate large pieces which might be considered contaminant to the station. The second stage is called “septic tank” sedimentation process consisting of two compartments. Its purpose is separate suspended solids (sludge) from liquid middle layer and the grease top layer. This stage is referred to as the primary treatment. The next compartment is called the “up flow trickling filter” which is filled with gravel that work as a natural sieve. This compartment has two sections. One is in use, and the second reserved as a spare in case the first one in blocked. The next stage consists on a “trickling filter” which serves as an elimination step for any small organic and dissolved matter by converting to proteins. Further, it serves as an efficient treatment of 60% of pollutants. The next stage is called the “sand filter” compartment which eliminates microorganisms and other impurities. Further, this compartment reduces bad odor which might be associated with treatment process. The last step is the “storage tank” to hold the water until needed for future use. This station is accumulates water from 35 households that connected to the network system. The average monthly household consumption of fresh water is about 623 m³. The average daily consumption of the household is a bout 20.77 m³. The average station intake (that is coming from the households) is about 70% of the daily consumption, which equals 14.5 m³. All figures were based data obtained from the Ateel City-Hall records. **Diagram 1** shows a schematic sketch of the treatment process. And **Figure 6** shows the actual photo on the station.

3. Results and Discussion

There are two main sources for Ateel city to obtain fresh water. The first one is the annual rainfall, and the second one is the underground water source. The average annual rainfall is shown in **Table 1**. Within the past ten year the average rainfall is about 607 ml. On the other hand, the underground water capacity can range from 80-100 m³/hour for each well. There istotal of six underground water wells that are privately owned. The water network system withinthe town is old, and covers 97% of the buildings. The average consumption of fresh water in the town reaches 24430.55 m³ per month. The average individual use 87.62 liter per capita per day. There is about 31.37% water loss due to leaks. It can be deduced that area has limited freshwater sources, and wastewater treatment plant might come in handy to support the existing options.

Table 1: Average rainfall in Ateel

year	average rainfall(ml)
1999-2000	517.7
2000-2001	548.2
2001-2002	697
2002-2003	970
2003-2004	573.5
2004-2005	557
2005-2006	588
2006-2007	550
2007-2008	470
2008-2009	488
2009-2010	717

Wastewater contains organic substances typically in the form of carbon, hydrogen, oxygen, and nitrogen and may contain other elements. Common concentrations of these organic materials in grey water in the forms of proteins (40 to 60 percent), carbohydrates (25 to 50 percent), and oils and fats (8 to 12 percent). The water may also contain small amounts of synthetic organic molecules (i.e., pesticides and solvents), which may range from simple to complex

in structure. Biochemical oxidation reactions convert organic material using oxygen and nutrients into carbon dioxide, water, and new cells, which can be expressed as follows: $\text{Organics} + \text{O}_2 + \text{nutrients} \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{new cells} + \text{nutrients} + \text{energy}$

In this equation, one can assume that organisms use oxygen to breakdown carbon-based materials for incorporation into new cell mass and energy. As mentioned previously, the frequent measure of this oxygen use is biochemical oxygen demand (BOD). BOD is defined as the amount of oxygen used in the metabolism of biodegradable organics. If water with a large amount of BOD is discharged into the environment, it can deplete the natural oxygen resources. Heterotrophic bacteria utilize deposited organics and O_2 at rates that exceed the oxygen-transfer rates across the water surface. This can cause anaerobic conditions, which leads to noxious odors and degradation of water quality.

Water samples were analyzed before treatment and after treatment. Some measured parameters included the following indicators:

- (a) Biochemical Oxygen Demand recorded over five days (BOD₅)
- (b) Total Suspended solids (TSS)—or Total Dissolved Solids (TDS)
- (c) Thermo-tolerant Coliforms or E. Coli (an indicator of fecal contamination) forming units (cfu) per 100 mL.
- (d) Anions such as Residual chlorine and carbonates
- (e) Cations and water hardness such as sodium, potassium, calcium and magnesium cations.

Table 2 shows the values of the various testing parameters. The data indicate a significant variations in all parameters. **Figure 1** shows the cation concentration measured before and after treatment. While **Figure 2** illustrates the anions measurements. The most interesting results are shown in **Figures 3** and **Figure 4** indicating an effective biological treatment. The efficiency of treatment in the stations shown in **Figure 5** that indicates the removal capacity of the treatment unit.

Mean BOD₅ over several periods was at 88% efficiency on average. Average BOD₅ over the entire period for all sampling was 87 mg/L (with a range from 60 mg/L-100 mg/L) after treatment. Typical BOD₅ values for grey water as reported in the literature range from 33-290 mg/L, while values for untreated domestic wastewater range from 100-400 mg/L [5]. BOD₅ in waste water sampled just prior to discharge to fields averaged 87 mg/L with a range of 60-100 mg/L. The measurements before treatments had a range of 600-800 mg/L. This gives the station an average efficiency of 88%. It might be noteworthy to pay attention to the Ecoli, COD reading which were also lowered greatly. Another interesting result was the significant lowering in the total coliforms as indicated in **Figure 4**. No significant change with respect to TDS was observed which ranged from 700-1200 mg/L.

Many of the microorganisms that exist in wastewater might be beneficial. In fact, many wastewater treatment technologies are dependent on these beneficial microorganisms for remediation of wastewater so that it won't destructively impact the environment. One of the primary purposes of water treatment system is to remove organic matter from wastewater so that excessive oxygen consumption won't become a problem when it is released to the environment. Another aim of these treatment systems is nitrification/denitrification. Nitrification is an aerobic route in which bacteria oxidize reduced forms of nitrogen (NH_4^+ , NO_2^- , NO_3^-). Denitrification is an anaerobic route by which oxidized forms of nitrogen are reduced to gaseous forms (NO_3^- , NO_2^- , N_2O or N_2), which can then escape into the atmosphere. This is important because the release of nitrogen to the aquatic environment can also cause eutrophication, which is really not so important in our case, since the water will be used in direct irrigation rather than release into streams. The efficiency of the nitrates removal is shown in **Figure 5** as well as the efficiency of removal for the rest of the parameters.

The treated wastewater was used for irrigating sorghum crops as shown in **Figures 7, 8**, and **Figure 9** shows many farmers inspecting the crops. Characterization of these crops will be the subject of another paper.

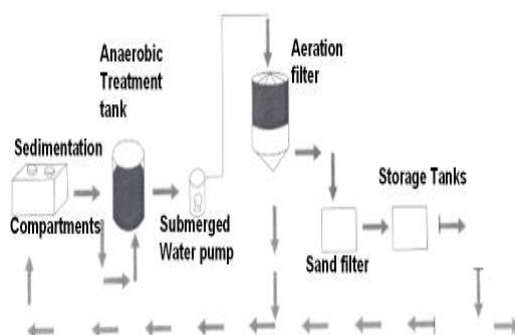
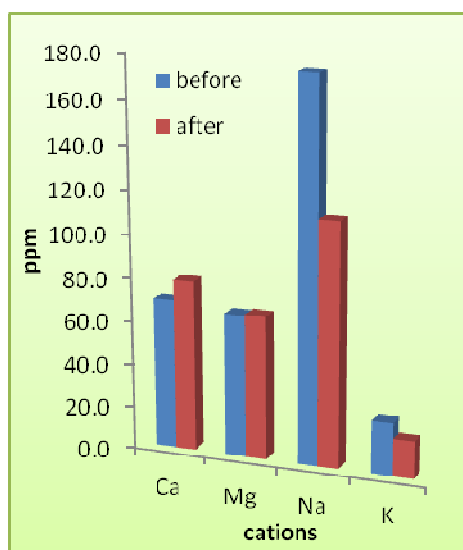


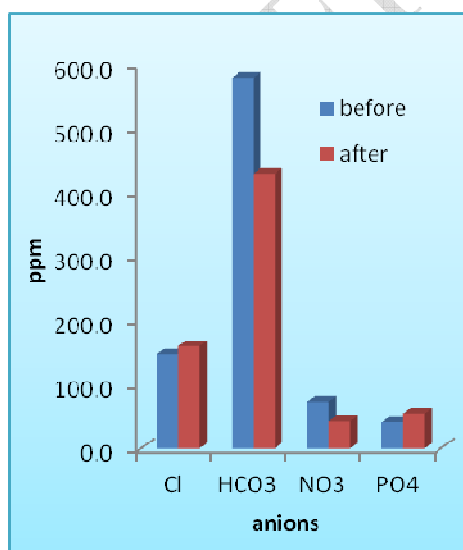
Diagram 1. Sketch of Ateel wastewater treatment station

153 **Table 2: Parameters measured**

	25/10/2011		25/3/2012		19/6/2012	
	before	after	before	after	before	after
pH	6.83	7.41	7.59	7.88	7.78	7.8
Ec(ms)	1.6	1.6	1.2	1.4	1.75	1.87
TDS	987	1024	768	896	1120	1196.8
Cl	155.98	191.43	156.0	152.4	131.165	136.48
Hardness	340	380	335.0	365.0	922.5	892.5
Ca	67.32	73.44	69.36	61.2	71.4	102
Mg	42.14	48.16	39.7	51.8	115.26	98.94
HCO ₃	1342	677.1	384.3	603.9	14.64	8.845
NO ₃	81.90	46.80	96.9	58.9	43.00	25.00
K	12.5	21.8	34.50	17.30	26	12
Na	244.00	118.60	110.8	107	170	110
PO ₄	40.52	95.90	49.20	37.10	37.00	31.25
f.Coliform	150000	3200	160000	2500	150000	2700
E.Coli	563.00	205.00	446.00	225.00	2300	600
COD	1,180.00	430.00	1,098.00	360.00	1525	139
BOD ₅	815.00	100.00	750.00	100.00	637	60



156 **Figure 1: concentration of the cations**



159 **Figure 2: concentration of anions**

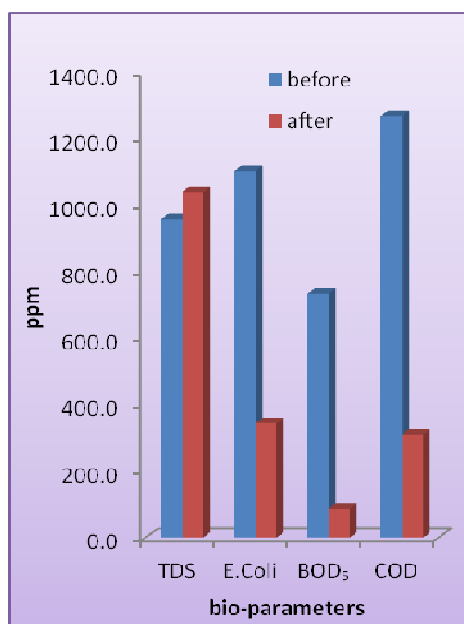


Figure 3: concentration of Biologicals

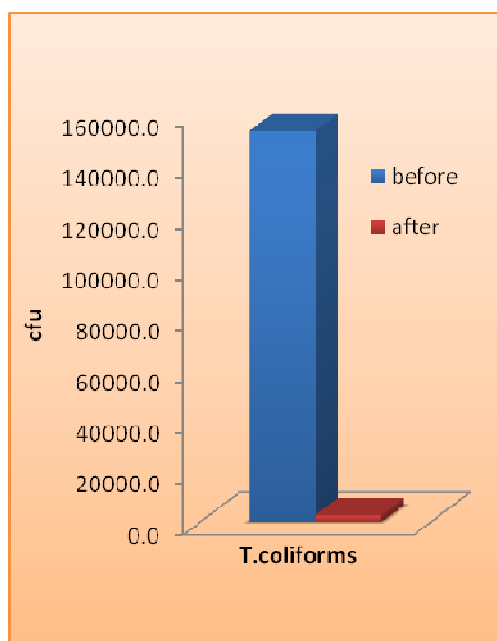


Figure 4: comparing the concentration for the total coliform before and after treatment

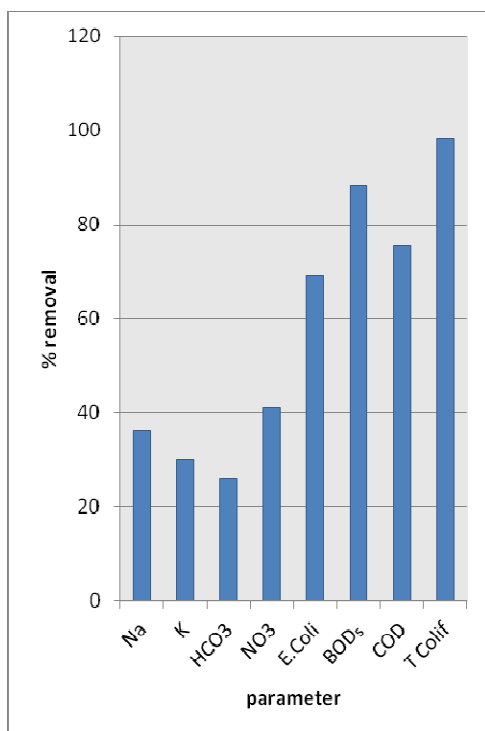


Figure 5: efficiency of the station (average)



Figure 6: Ateel wastewater station



Figure 7: One week old sorghum crop



Figure 8: sorghum crop after 45 days



Figure 9: farmers evaluating sorghum crops

4. Conclusions

The treatment station in Ateel city was evaluated and several important parameters were measured. Overall, the results were reasonably good for such an under-maintained or neglected station, and seem to be consistent and compatible with Palestinian standards. interviews with community members and farmers indicated wide community interest in reusing the treated water especially after observing the positive growth in the sorghum crops.

This might serve as a promising strategy in terms of the significant local water saving, reducing the risk of water borne diseases, especially in marginalized rural areas. Further economic benefits is underway to understand the real financial returns to farmers and the community at large.

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