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Study of Water Quality of Treatment Plant Wastewaters El-Fayoum Governorate

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Abstract

The study examines out-coming wastewater treatment plant for reuse water as non-conventional water resource in Itsa, El-Fayoum Governorate. The traditional water resources are limited so the study focuses on the quality of treated wastewater for irrigation along treatment plants. Water samples were collected during the period from 2018 to 2019. The water parameters were set using the Egyptian irrigation water standards. The results of the study clearly demonstrate restrictions to irrigate the uncooked vegetables and uncooked crops for human. The need for increasing Nile freshwater portion or pretreatment of the wastewater prior to mixing with the Nile freshwater to satisfy Egyptian irrigation water standards and USEPA 2012 as several water quality results, such as BOD, DO, and fecal coliform, are unacceptable. As a suggestion, we recommend using aerated lagoons, stabilization ponds or wetlands to treat polluted agriculture wastewater before adding to the Nile river water to satisfy Egyptian irrigation water criteria.

Key words : ITSA, El-Fayoum Governorate, Wastewater Reuse, Salinity, Irrigation.

Introduction

Water is a precious resource essential for the well being of all living organisms. However, water is under potential severe threats from all human activities. Deteriorating water quality is a particular threat in countries with scarce water resources as the case of Egypt. The water quantity management practice in Egypt is a national heritage that is passed on from one manager generation to the other. Population inflation and national development together with the new approach of sustainable development have necessitated that water quality management be incorporated into the traditional water quantity management practices.

Fayoum and its catchment have a unique character: although it is considered as oasis, it is mainly fed by Nile water that enters the Fayoum depression via a waterway called Bahr Yousef **(Fig.1)**. Fayoum is a closed basin in an arid region

with an internal drainage resulting in no water outflow except by evaporation **(Abdel Wahed et al., 2014)**. This means that all dissolved constituents will stay and concentrate in the depression either in the water or in the sediments.

The irrigation and agricultural system in the Fayoum region depend on this water. However, due to water scarcity, the secondary source of irrigation water in Fayoum is the reuse of drainage water. Reusing of drainage waters in agriculture has some general limitations because of the potentially high (semi-) metal and pathogen content **(FAO, 2003)**. The study examines treatment plant wastewaters for reuse water as non-conventional water resource in Itsa, El-Fayoum Governorate.

Material And Methods

Water quality and quantity are always degraded due to climatic changes and the increased demands for different water uses especially in agricultures practices. Moreover, cultivated land productivity is connected with soil and irrigation water quality.

Study Area

The Fayoum Governorate with a population of 2.48 million (January 2005 census) and Fayoum City as the principal town is occupying a natural closed depression in the Western Desert of Egypt between 29°020 and 29°350N and 30°230 and 31°050E. It extends over 6068 km^2 and is situated about 95 km southwest of Cairo (Fig.1).

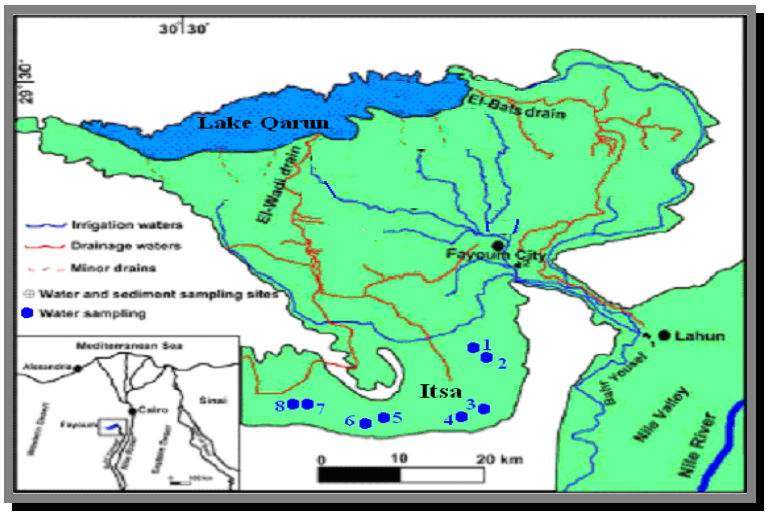

Fig. 1. Location Map of Study Area and Sampling Sites

Four monitoring locations for wastewater treatment plants namely: Itsa, Taton, El-Haker and Abu-Dahuom along Itsa, El-Fayoum Governorate are chosen for examination. Water samples that four inlets of WWTPs samples and four outlets of WWTPs) are collected during 2018-2019 as shown in **Table 1**.

Table 1. Descriptive of Locations for (WWTPs) in Itsa Area , El-Fayoum Governorate

No.	WWTPs	Drain	Treatment Technology	Sample Code	
				Inlet	Outlet
1	Itsa	Goseaf	Active sludge	A1	A5
2	Taton	ElTagen	Secondary - active sludge	A2	A6
3	El-Haker	El-prenc	Tank only (anaerobic tank)	A3	A7
4	Abu-Dahuom	Trees Forest	Oxidation ponds	A4	A8

This study focuses on the quality of treated wastewater for irrigation water as non-conventional waster resources that can be used in the area.

Methodology and Water Sampling

In order to examine treated wastewater for irrigation water quality of Itsa, Taton, El-Haker and Abu-Dahuom along Itsa, El-Fayoum Governorate, the following steps are conducted:

- Record all filed information about selected four monitoring points for the study.
- Water samples are collected during 2018 – 2019 for the measured parameters of water quality.
- The measured irrigation water quality parameters from each location are compared with the Egyptian standards Decree 92/2013, Executive Regulation of Law 48/1982 (National Environmental Egyptian Law 48/1982, Decision 92/2013) that protects fresh water courses from pollution by the discharged effluents, and **(USEPA, 2012)** standards for reclaimed water quality for irrigation.

The analysis procedures for water samples with different environmental measurements applied according international methods of Standard Methods for Examination of Water and Wastewater **(APHA, 2017)**.

Results

The results of pH showed all water samples mean value for inlet wastewater is 7.54, (the values ranged from 7.23 to 7.81) while the mean value for inlet wastewater is 7.54, (the values ranged from 7.23 to 7.81) for outlet wastewater is 7.66, (the values ranged from 7.35 to 8.07).

Figure 2 showed that the concentration mean value of TDS is 3817 mg/l for inlet WWTPs wastewater (the values ranged from 2550 to 2911 mg/l) for inlet wastewater. The concentration mean value of TDS is 1172 mg/l, (the values ranged from 1122 to 1184 mg/l) for outlet WWTPs wastewater that less than 2000 mg/l **(FAO 1985; USEPA 2012)**.

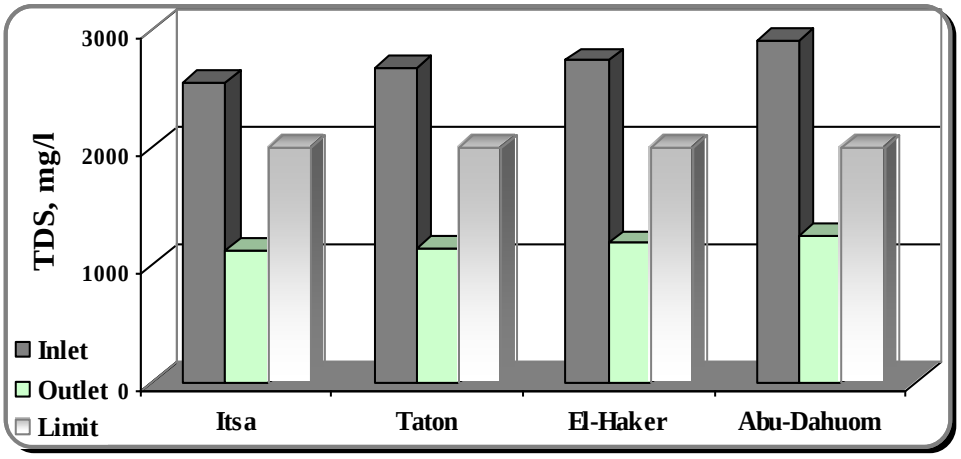

Fig. 2. TDS values for investigated WWTPs wastewater.

On other hand, the mean value of BOD is 243 mg/l for inlet WWTPs wastewater (the values ranged from 165 to 302 mg/l) while the mean value of BOD is 63 mg/l for oulet WWTPs wastewater (the values ranged from ~~44~~ to 102 mg/l) as shown in **Fig. 3**.

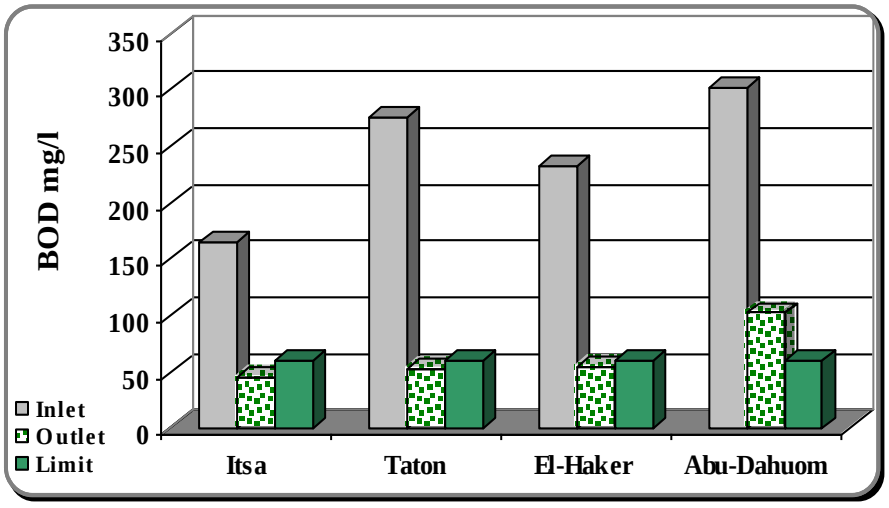

Fig. 3. BOD values for investigated WWTPs wastewater.

The data showed the mean value of the Fecal Coliform values is $255X10^4$ (CFU/100ml), (the values ranged from $31X10^4$ to $900X10^4$ (CFU/100ml) for oulet WWTPs wastewater. The valus of total nitrogen ranged from 35.8 to 45.8 mg/l for inlet WWTPs wastewater and the values for oulet WWTPs wastewater ranged from 10.1 to 20.5 mg/l as shown in **Fig. 4.**

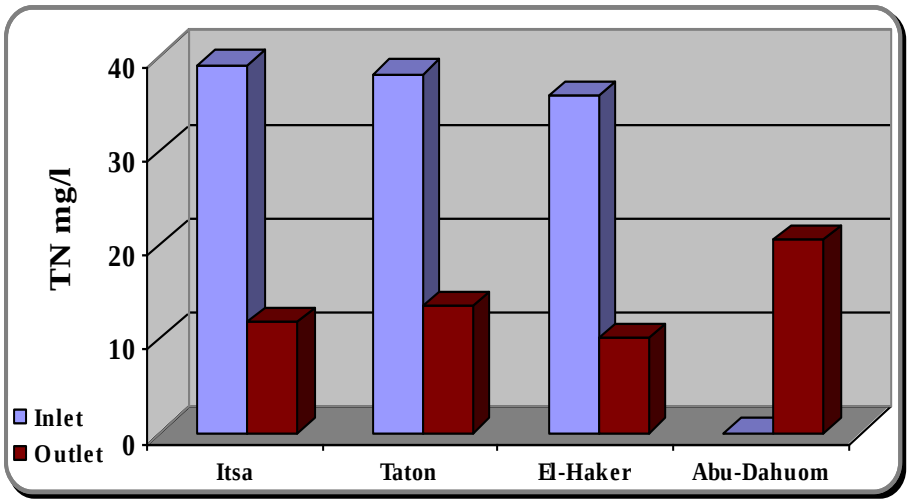

Fig. 4. TN values for investigated WWTPs wastewater

While the valus of total phosphours ranged from 3.0 to 1.6 mg/l for inlet WWTPs wastewater and the values for oulet WWTPs wastewaterranged from 5.9 to 0.9 mg/l as shown in **Fig. 5**.

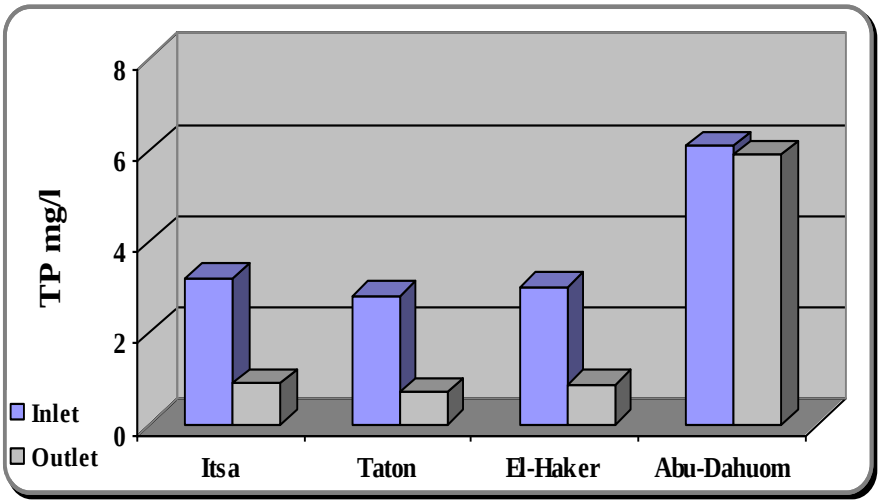

Fig. 5. TP values for investigated WWTPs wastewater

Discussion

Water quality and quantity are continuously degraded due to climatic changes and the increased demands for different water uses especially in agricultures practices. Moreover, cultivated land productivity is connected with soil and irrigation water quality **(Nishanthiny et al., 2010; Selma et al., 2017)**.

Water qulity factors

A. Salinity

The salinity comprises total dissolved solids (TDS), electro conductivity (EC), sodium adsorption ratio (SAR), sodium (Na), hydrogen concentration (pH), and Total suspended solids (TSS). It is one of the most important elements of water quality in judging its validity for irrigation. The high sodium adsorption ratio (SAR), demonstrates the potential damage in the soil, which is caused by the occurrence of high levels of sodium. The SAR value is an indicator to predict permissible sodium levels in irrigation water to maintain soil structural stability (USEPA , 2012). SAR is defined as the square root of the ratio of the sodium (Na) to calcium + magnesium (Ca + Mg) and its value is calculated by the following Equation [1].

$$SAR = Na^{+}/((1/2(Ca^{2+} + Mg^{2+}))^{1/2}) \quad (1)$$

Where:
SAR: Sodium Adsorption Ratio
Na^{+} : Sodium concentration measured in meq/l (milliequivalents per liter)
Ca^{2+} : Calcium concentrations measured in meq/l (milliequivalents per liter) and
Mg^{2+} : Magnesium concentrations measured in meq/l (milliequivalents per liter)

Salinity standards for safe reuse of wastewater have been established by Agriculture, Food Agriculture Organization **(FAO, 1985)** which put a restriction on uses divided into three degrees of severity: none, slight to moderate, and severe.

The results mean showed that the wastewater is alkaline. The measured pH values agreed with Egyptian Decree 92/2013, FAO 1985 and USEPA 2012 guidelines (pH: 6-9). The results showed that the mean value of the SAR values is 5.9 mg/l, (the values ranged from 4.51 to 6.31. Egyptian Decree 92/2013 for irrigation water standards has not specified the SAR limits. According to **FAO 1985; USEPA 2012**, WWTPs wastewater can be used for forest tree irrigation.

B. Pathogenicity

The most important indicators of the pollution of water resources are Fecal coliforms (FC) and Total coliforms (TC). It is characterized by its ability to grow in the laboratory at higher grades between 44~44.5^{o}C and producing a proliferation of gas and acid (Dichter, 2011). Their presence in the water means the possibility of the presence of pathogens and is a serious threat to public health. **WHO (2006) and USEPA (2012)** established guidelines for Fecal Coliform bacteria and Total Coliform concentrations in wastewater reuse. The values are higher than $5X10^{3}$ specified values by the local Decree 92/2013.

Characteristics of influent wastewater, type of treatment process, retention time, microorganisms, pH and the efficiency of suspended solids removal affect the removal efficiency of pathogenic and indicator microorganisms. The evaluation of technologies for pathogen removal is mostly based on fecal contamination indicators.All wastewaters of investigated wastewater treatment plants indicated their sulduges must be change and cleaned treatments units

C. Nutrients

Total Nitrogen (TN) and phosphorus (TP), are essential elements for plant growth and development and can increase the side effect on crop growth. Excessive nutrients in irrigation water are a source of groundwater contamination as well as eutrophication in coastal areas or lakes **(Ju et al., 2006)**. The increase for all invesigated wastewater plants in nitrogen and phophorous concentrations in the water leads to increase bacteria and algae aquatic plants growth **(FAO, 1985)**. Thses increases caused the rise of organic matter content in trerms of BOD and COD concentrations

D. Biological Oxygen Demand

It is the amount of oxygen consumed by microorganisms over a period of five days to oxidize the organic substances in water, and it is an indicator of the viability of the waterway for self-purification. The concentration of oxygen consumed gives an indication of the severe water pollution of bio-digestible organic matter **(Asano et al., 2007).** The values for BOD are higher than the 6 mg/l specified by the local Decree 92/2013. The sedimentation units must be cleand to remove huge suspended solids that loading by many organisams, chemical ions and organic matter. The organisms utilize the dissolved organic matter as food **(Mohamed, 2015)**

Conclusion and Recommendation

Fayoum governorate and its catchment have a unique character: although it is considered as oasis, it is mainly fed by Nile water that enters the Fayoum depression via a waterway called Bahr Yousef.The study examines treatment plant wastewaters for reuse water as non-conventional water resource in Itsa namely: Itsa, Taton, El-Haker and Abu-Dahuom, El-Fayoum Governorate are chosen for examination during 2018-2019. Water quality factors data including salinity, pathogenicity, nutrients and biological oxygen demand showed all pH and TDS results within limits of FAO 1985 and Egyptian Decree 92/2013 for irrigation water standards. While BOD concentrations and FC conunts did not agrree with FAO 1985 Egyptian Decree 92/2013 for irrigation water standards especially Abudahum WWTP that their wastewater can be used for forest tree irrigation.

The study recommended that the sedimentation units must be cleaned, analysis of sludge must be monitoring frequently for analysis and calculate the building capacity for all WWTPs.

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