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An analytical study of investment in the use of treated wastewater project in the Egyptian agricultural sector

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Abstract

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Egypt is suffering from water scarcity and tried to pursue a package of policies to decrease the water deficit, by using unconventional resources like treated wastewater. Wastewater is 6.9 billion m^3/year, the total of treated sewage is 5.1 billion m3 in 2019/20. The wastewater reuse potential in agriculture is 1 billion m3/year which leads us to question: What is the economic return on the use of treated sewage to reduce the water deficit and achieve targeted development? This paper aims to identify the value of investment projects in the sewage treatment sector and determine the cost and returns of treated wastewater in Agriculture by using (CBA) approach and indicators of financial analysis. The results prove that the binary stage is a commitment to the state and its responsibility to preserve the environment, the ratio of reuse of sewage to the total cost of wastewater treatment is 12%, while the ratio of the cost of compulsory treatment to the state to the total cost of wastewater treatment is 88%. It is expected that value add will increase and the benefits will be 22.5 billion L.E. The paper recommends encouraging investors to the wastewater treatment sector by setting up treatment units on their farms. NPV for the project is 388.71 Million L.E which means the project is greater than its cost, profitable, and, if the firm accepts the project, then the value of the firm would increase. PI for the project equals 1.2 Million L.E which means the investment in this project would be profitable and should be implemented and IRR is 16.4%, It is greater than the rate of cost of capital 14%, then investment in the concerned project would be profitable

Keywords: Treated Wastewater; Investment; EC 501; CBA; NPV
Abbreviations: L.E.*:* Egyptian Pound, NPV*:* Net Present Value, IRR*:* Internal rate of Return, PI*:* Profitability index, CBA*:* Cost Benefit Analysis

Introduction

The scarcity of water resources and the imbalance between supply and demand are the most important features of the reality of water resources in Egypt now. Despite the presence of the Nile River, which penetrates Egypt from the far south to the north, Egypt is considered one of the poorest countries in water resources, and even the least in terms of average per capita renewable water per year 800 m^3 per year, Its presence within the arid land belt in the Arab region, which is estimated to have an average per capita renewable water per year of about 10% of the global average, In addition to climate change, which has led to decreased annual rainfall and rising temperatures. It is now necessary to look for additional resources, unconventional resources. It can be done by reuse of drainage water, water efficiency through increasing yields per unit of water used (more crop per drop), and increasing the value of the water used (more cash per splash).

On the other hand, the water supply is still insufficient with water consumption which is higher by 6.3%. Large amounts of untreated wastewater are discharged into the Nile river, lakes, and the Mediterranean Sea (AfDB/OECD/UNDP, 2016). The amount of treated wastewater is only 50% of the total produced wastewater in Egypt, and only a fourth of that amount is used in irrigation (Abdou et al., 2019). The use of wastewater is one of the most sustainable alternatives to cope with water shortages. It would have several advantages that include closing the gap between supply and demand, stopping the pollution of freshwater resources, providing a sound solution to water scarcity and climate change, and helping to achieve sustainable development goals. In Egypt, according to official data at present, wastewater is estimated approximately 6.9 billion m^3/year, the total amount of treated sewage is 5.1 billion m^3 in 2019/20. However, the total Actual capacity of the installed treatment plants amounts to about 12.1 billion m3/year. The wastewater reuse potential in agriculture is about 1billion m^3/year. At present, there are more than 455 wastewater treatment plants (WWTP) in Egypt in 2019/2020. coverage with improved sanitation gradually increased from 56% in 2004 (Loutfy, 2010) to 65% in all of Egypt 2019/2020 (Statistics, 2020) .in addition, there exists significant unofficial wastewater reuse estimated between 2.8 and 4 Million m^3. This unofficial water reuse is not controlled by the government and poses threats. If adequate regulations are not enforced, the quality of drainage water is threatened (Welle et al., 2007).

The strategy for the reuse of treated effluents in Egypt is based on the fact that adequately treated wastewater effluents are a precious resource. Ministry of Housing (MH), Utilities, and New Communities, supported by seven technical committees, issued the Code for the Reuse of Treated Wastewater in Agriculture. Egypt in the 1950s was self-sufficient in water, Egypt's water sector is scarce and demand is increasing due to population growth and related social and economic activities. Egypt relies almost entirely on the Nile as a major water supplier with a rate of 97% (Ministry of Planning, 2021). Egypt shares 10 countries in the Nile waters, making Egypt severely affected by the developments taking place downstream, where Egypt suffers from a water deficit of up to 54 billion m3 of water per year(Irrigation, 2018). Egypt has thus become one of the countries suffering from water scarcity, which, according to Falkenmark's definition, is water insecurity, these are the countries that get (500-1000) m^3 per year per capita (UN ESCWA, 2019). That is, they are countries that are unable to achieve food security, produce cash crops and provide for the needs of households and industry. Egypt has tried to pursue a package of policies to provide the food needs of the population, including Horizontal and vertical expansion, and the legalization of the cultivation of some strategic crops with economic return and comparative advantage such as rice, and sugar cane. However, these policies have faced many challenges, the most important of which is the decrease in the water supply, which makes Egypt vulnerable to being among the countries of absolute scarcity and requires it to do a lot of effort to address water insecurity, by resorting to new water alternatives to irrigation besides the current sources to meet their future water needs, especially as the increased dependence on groundwater has led to it reaching a lower level of economic limits, and the proportion of water collected through water collection techniques is estimated at 1.5% of the total 15 billion m^3 annually of rainwater falling on Egypt.

Although government spending on the water sector ranges from 1.7-3.6% of GDP, which is less than the investment needed, estimated at 4.5%, however, the data indicate spending ranging from 20-30% of total investment spending on the water sector during the period (2000-2010) (Zubari et al., 2013) This indicates a significant funding gap within the sector. With the high cost of desalination of seawater making its exploitation in agriculture economically useless, this leads to the search for other sources of water or the development of existing sources at a lower cost. Therefore, the other alternative is to recycle the water used, i.e. wastewater treatment, and uses it in agriculture. The use of wastewater is one of the most sustainable alternatives to cope with water shortages. It would have several advantages that include closing the gap between supply and demand, stopping the pollution of freshwater resources, providing a sound solution to water scarcity and climate change, and helping to achieve sustainable development goals. Egypt, trying to cope with water shortage issues, The Ministry of Water Resources and Irrigation (MWRI) has developed a national water resources plan, with wastewater reuse as a central mechanism.

At present, in contrast, rural sanitation coverage remains incredibly low at 4%. The low coverage, in combination with a sub-optimal treatment, results in some problems of water pollution and degradation of health conditions because the majority of villages and rural areas discharge their raw domestic wastewater directly into the waterways. In Egypt, according to official data at present, wastewater is estimated approximately 6.9 billion m^3/year, the total amount of treated sewage is 5.1 billion m^3 in 2019/20. However, the total Actual capacity of the installed treatment plants amounts to about 12.1 billion m^3/year. The wastewater reuse potential in agriculture is about 1billion m^3/year. At present, there are more than 455 (WWTP) in Egypt in 2019/2020. coverage with improved sanitation gradually increased from 56% in 2004 (Loutfy, 2010) to 65% in all of Egypt 2019/2020 (Statistics, 2020). In addition, there exists significant unofficial wastewater reuse estimated between 2.8 and 4 Million m^3.

The strategy for the reuse of treated effluents in Egypt is based on the fact that adequately treated wastewater effluents are a precious resource. (MH), Utilities issued the Code for the Reuse of Treated Wastewater in Agriculture. Which is the first Appendix – Egyptian Guide for the Use of Treated Waste Water in Agriculture Egy Code (EC)? The Code stipulates exact requirements in planning and approval procedures, responsibilities, permitted use, and monitoring. In 2015 (MH) (EC 501/2015) the code classifies wastewater depending on the level of treatment and specifies the level of the maximum contaminants with each grade, and the crops that can be irrigated with each grade. This leads us to question: what are the possibilities of using non-conventional water resource potentials for better agriculture? Why is treated wastewater used in agriculture in a limited way? What is the economic return on the use of treated sewage as a means of reducing the water deficit and achieving targeted sustainable development?

The importance of this research is because there are many aspects of studies that dealt with the use of treated wastewater in agriculture, was technical or environmental. The research did not find any studies concerned with the aspect of Financial or Economic Feasibility studies of the project, especially in Egypt. The main purpose of the paper is to identify the most important indicators of security, water balance, and the water gap. Water needs of the agricultural sector, the geographical distribution of treated wastewater stations, Identify the value and number of investment projects in the sewage treatment sector and determine the cost and returns of treated wastewater in the Agriculture Sector by using Cost-Benefit Analysis (CBA) approach and indicators of financial analysis.

Material and Methods

The paper-based is on secondary data published by the Central Agency for Public Mobilization and Statistic, in addition to the primary data case study in West 6th October Station (WOS). And based on the analytical approach, all institutions, whether they be commercial entities or government agencies, are faced with decisions on how best to pursue their objectives – what to do? How to do it? When to do it? To guide investment decisions of this kind, institutions use evaluation techniques that depend on options and search for the option that maximizes the payoff. The main difference between private and public sector organizations lies not so much in the evaluation principles, but rather in the frame of reference. (CBA) is a method of measuring and evaluating the relative merits of public investment projects in support of sound economic decisions. It takes into consideration all of the effects of a project on members of society, irrespective of who is affected or whether the effect is captured in financial accounts. (CBA) is useful in planning and decision-making as it provides a common framework in which all of the important effects of investment choices can be made visible and, to the extent possible, quantified (Sunstein, 2021). It is an instrument in the quest for value for money (Wilson, 1994).

In addition to using the financial analysis indicators, the analysis of the projects will be based on their cash flows. We will compare the cash invested and the cash generated by the project.

Evaluation criteria:

Net Present Value (NPV)*:* is the difference between the present value of cash inflows and the present value of cash outflows over a while (Mota, 2015)

$$NPV = -CAPEX + \frac{CF_1}{1+r} + \frac{CF_2}{(1+r)^2} + ... + \frac{CF_n}{(1+r)^n}$$

CAPEX – Capital expenditure (or initial investment) at the year zero of the project

r – The required rate of return for the project

if NPV > 0, then the revenue from the project is greater than its cost, i.e., the project is profitable, and, if the firm accepts the project, then the value of the firm would increase. On the other hand, if NPV < 0, the cost of the project would be greater than its revenue, the project would be rejected. Lastly, if NPV = 0, the revenue and cost of the project would be equal. In this case, the firm would be neutral or indifferent between the acceptance and rejection of the project.

Profitability index (PI)*:* is a measure of a project's or investment's attractiveness(Mota, 2015)·

$$PI = \frac{NPV}{CAPEX}$$

Internal rate of return (IRR)*:* is a rate of discount (m) that makes the present value of the expected revenues to be obtained from an investment project equal to the present value of the cost of the project.

$$0 = -CAPEX + \frac{CF_1}{1+IRR} + \frac{CF_2}{(1+IRR)^2} + ... + \frac{CF_n}{(1+IRR)^n}$$

(Mota, 2015)

Modified Internal Rate of Return (MIRR)*:* is a financial measure of an investment's attractiveness. It is used in capital budgeting to rank alternative investments of equal size. As the name implies, MIRR is a modification of the internal rate of return (IRR) and as such aims to resolve some problems with the IRR.

$$MIRR = \left[\frac{\sum_{t=1}^{T} CF_t (1+i)^{T-t}}{I_0} \right]^{1/T} - 1 \qquad \text{(Albshir, 2020)}$$

Results and Discussion

Egyptian water balance

Egypt's main water resources include freshwater originating from the Nile river 94% of the average water resources estimated at 58.9 billion m^3 during the period (2014/15-2019/20) (Table 1). In addition to about 4% of non-renewable groundwater, which decreases annually at a rate of change estimated at 19%, 2.2% of rain and floods, 0.5% of desalination of seawater, and some low salinity groundwater. However, the total major water resources were estimated at 59.7 billion m^3 in 2019/20.

In addition to 23.3 billion m^3 of secondary water resources, which are water from the recycling of agricultural wastewater, and 61%, 6% of wastewater treatment output as an average for the period (2009/10-2019/20), and 33% of the renewable groundwater in the Valley and Delta. The increase in the number of water resources is mainly the result of the reuse of agricultural wastewater and sanitation, especially since the increase in the volume of groundwater is due to the re-pumping of treated water into aquifers. The water deficit increased from about 17.6 billion m^3 in 2014/15 to 22.6 billion m^3, with an annual change rate of 28.4%. This means that about 27.7% of uses depend on secondary resources, mainly in the recycling of agricultural drainage and treated wastewater. By studying the distribution of water resources to uses, the agriculture sector ranks first in terms of consumption of water resources by about 78%, followed by the drinking sector and health uses by about 13.5%, while the industrial sector consumes about 5.1% of the total water resources available during the period (2014/15-2019/20). The per capita renewable total water resources also declined from more than 1000 m^3 in the 1980s (Sewilam, 2020) to about 537 m^3 in 2019/20, indicating that Egypt falls within the limits of scarcity and water poverty.

Importance of Sewage Water Reuse

Wastewater treatment is essential to prevent pathogens from entering the environment and causing disease. While traditional wastewater treatment often thinks of sewage as waste, there are also opportunities for it to be viewed as a valuable resource, with biogas created from sludge providing cheap, clean energy, and composted making a highly effective fertilizer. Several types of secondary and tertiary treatment have been used throughout the world in preparing wastewater for groundwater recharge (Omran, 2019). So it is necessary to use treated wastewater or gray water as a reli-

Table 1. Egyptian water balance over the period (2014/15-2019/20)

Resource		2015/16	2016/17	2017/18	2018/19	2019/20	Average	%
Nile water		55.5	55.5	55.5	55.5	55.5	55.50	93.3
Deep groundwater		2.1	2.4	2.45	2.45	2.5	2.38	4.0
Rains & Floods		1.3	1.3	1.3	1.3	1.3	1.30	2.2
Desalination		0.1	0.25	0.35	0.35	0.38	0.29	0.5
Total Traditional Water Resources		59	59.45	59.6	59.6	59.68	59.5	100.0
Uses of water resources	For Agricultural	62.15	61.45	61.65	61.65	61.63	61.7	77.4
	Evaporation	2.5	2.5	2.5	2.7	3.1	2.7	3.3
	For Drinking	10.4	10.65	10.7	10.7	11.53	10.8	13.5
	For Industry	1.2	5.4	5.4	5.4	5.4	4.6	5.7
Total uses of Water Resources		76.3	80	80.3	80.5	81.7	79.7	100.0
Water Deficit		17.3	20.6	20.7	20.9	22.0	20.3	
Non-Traditional Water Resources								
Reuse of Agricultural wastewater		11.9	13.5	13.5	13.65	13.51	13.2	61.0
Reuse of wastewater		1.3	1.3	1.3	1.3	1.3	1.3	6.0
Surface Groundwater (Delta)		4.8	7.35	7.6	7.5	8.47	7.1	33.0
Total Non-Traditional Water Resources		18	22.15	22.4	22.45	23.28	21.7	100.0
Total Water Resources		77	81.6	82	82.05	82.96	81	

Source: Annual Bulletin for Environmental Statistics, Central Agency for Public Mobilization & Statistics able water supply for crop production especially in countries where freshwater is scarce. High nutrient content from the reuse of wastewaters may help to reduce costs for agriculture, and it provides an ideal medium, e.g., for aquaculture, while it can replenish groundwater reserves. Therefore, it is accepted the use of tertiary treatment such as oxidation (i.e., ozonation) or adsorption techniques (i.e., activated carbon) to amend the quality of reclaimed wastewater and reuse it in agriculture. However, such technologies are still not able to be fully applied in vulnerable communities, which do not have appropriate wastewater treatment plants or lack sufficient energy supply (Mahgoub, 2019).

The current situation for treated sewage in Egypt

The Egyptian water strategy comprises the reuse of treated wastewater either primary or binary. Despite the increasing number of treatment stations for sewage and increased amounts of treated sewage. However, an accurate estimation of the total quantity or reused effluent is difficult to perform because of the many uncontrolled sources flowing into the same drainage canals. Furthermore, irrigation drainage waters are sometimes put into direct reuse, albeit unofficially, or directed towards canals. Unofficial reuse in the delta area alone has been estimated to range from 4 to 6 billion m^3/year in 2000/01. There are gaps between the available treatment capacity and the demands for treatment. There are two huge wastewater projects in Egypt, the greater Cairo wastewater project and the Alexandria wastewater project. The former serves some 20 million people. It serves a total area of 1100 km^2 and should provide a treatment capacity of 6.28 km^2 MCM per day (Loutfy, 2010).(CAPMES) reported that the total production of refined water (fresh piped water) by Egyptian producers in 2019/20 was 11 billion m^3 from 1110 water refining stations(CAPMS, 2021) Although 80% of the delta-rural population is served with a piped water supply. Egypt has a long history of implementing large-scale centralized (WWTP). There are more than 455 such WWTPs all over the country. While the main cities are increasingly being covered with wastewater treatment, rural sanitation coverage is less than 15%. In Egypt, the concept of "rural sanitation" encompasses 4700 villages (defined as towns up to 50 000 inhabitants) and 30 000 scattered settlements (Abdel Wahaab, 2015) Only 4% is connected to a sanitation system (Elbana et al., 2019). Accurate data on wastewater generation, treatment, and use is required for improving the treatment, management, and distribution of wastewater (Sato et al., 2013). The quantity of treated sewage is 4.4 billion m^3 in 2019/20 compared to 5.05 billion m^3 in 2015/16 (Table 2).

The relative importance of the amount of treated sewage has declined from 75.7% in 2015/16 to 64.3% in 2019/20. Despite the increasing volume of treated water, the annual change rate of the total quantity of sewage is 37% from the beginning of the period, while the annual change in the amount of treated sewage was estimated at 16%.

The amount of binary treated wastewater increased from 3.1 billion m^3 in 201 5/16 to 3.6 billion m^3 in 2019/20, at a rate of change of about 15.3%, while tertiary treatment plants experienced a marked decrease during the study period, at a decrease of 39%. The total number of treated sewage stations is 455 stations in 2019/20 compared to 388 stations in 2015/16, an increase of 17%.

Geographical distribution of total quantity of sewage treatment in Egypt over the period (2015/16-2019/20)

Cairo ranks first in terms of the total quantity of Treated Sewage with 1.43 billion m^3, followed by Giza 0.77 billion m^3 in 2019/20. Cairo, Giza, Alexandria, Daqahliya, Sharkia, and Garbia 71% of the total amount of treated wastewater produced nationwide over the period (2015/16-2019-2020). By studying the geographical distribution of the amount of primary treated wastewater nationwide, it was found that the concentration of treated wastewater in Giza at an average of 506.5 million m^3, followed by Alexandria 148 million m^3 over the period (2015/16-2019/20) (Table 3).

Table 2. Total quantity of treated sewage according to type of treatment over the period (2015/16-2019/20)

Quantity: Billion M3

Title		2015/16	2016/17	2017/18	2018/19	2019/20
Total Amount of Sewage		5049	6000	6754	6882	6910
Total Amount of Treated Sewage		3822	4282	4637	5115	5135
The ratio of treated sewage to the total quantity of sanitary drainage		75.70	71.37	68.66	74.32	74.31
Quantity of Sewage According to the Type of Treatment	Primary Treatment	628	635	634	795	810.4
	Binary Treatment	3099	3216	3268.6	3583	3572
	Tertiary Therapy	95	86.5	44	40	58
Total number of treated sewage stations		388	416	432	446	455

Source: Annual Bulletin Pure Water & Sanitation Statistics, Central Agency for Public Mobilization & Statistics

Table 3. Geographical distribution of total quantity of sewage treatment over the period (2015/16-2019/20)

Quantity: Billion M3

Governorate	2015/16	2016/17	2017/18	2018/19	2019/20
Cairo	1239.4	1204	1198.5	1461.1	1425.5
Alexandria	459.4	511.7	502.4	520.9	498
Daqahliya	164.2	203.8	206.4	188.3	196.8
Sharkia	99.8	124.8	145.6	143.7	136.2
Garbia	162.9	131.6	142.3	146.9	130.4
Giza	662.6	674.9	626.3	767.6	769.8
Total	2788.3	2850.8	2821.5	3228.5	3156.7
Total General	3822	3937.2	2946.5	4418	4440
%	73	72.4	95.8	73.1	71.1

Source: Annual Bulletin Pure Water & Sanitation Statistics, Central Agency for Public Mobilization & Statistics

Table 4. Geographical distribution of quantity of sewage according to treatment type over the period (2015/16-2019/20)

Quantity: Billion M3

Quantity of Treatment Sewage to Primary Treatment						Average
Governorate	2016/2015	2017/2016	2018/2017	2019/2018	2020/2019	
Alexandria	143.4	143.6	142	165.2	148	148.44
Mounifia	15	22	0	0	0	7.4
Giza	438	438	456	588.7	612	506.54
Aswan	18.6	18.4	18.7	25.1	19.7	20.1
Red Sea	8.3	8.4	10.3	11.2	3.6	8.36
South Sinai	2.7	2.7	4.1	2.8	5.6	3.58
Total	626	633.1	631.1	793	788.9	694.42
Total General	628	635	634.1	795.1	810.4	700.52
%	99.7	99.7	99.5	99.7	97.3	99.2
Quantity of Treatment Sewage to Binary Treatment						Average
Governorate	2016/2015	2017/2016	2018/2017	2019/2018	2020/2019	
Cairo	1225	1204	1198.5	1461.1	1425.5	1302.82
Alexandria	316	365.6	360.6	355.7	350	349.58
Daqahliya	164.2	203.8	206.4	188.3	196.8	191.9
Sharkia	99.8	124.8	145.6	143.7	136.2	130.02
Garbia	162.9	131.6	142.3	147	179	152.56
Giza	169.8	182.1	170	179	157.7	171.72
Total	2137.7	2211.9	2223.4	2474.8	2445.2	2298.6
Total General	3099.1	3215.7	3268.6	3583	3572	3347.68
%	69.0	68.8	68.0	69.1	68.5	68.7
Quantity of Treatment Sewage to Tertiary Treatment						Average
Governorate	2016/2015	2017/2016	2018/2017	2019/2018	2020/2019	
Cairo	14.6	0	0	0	0	2.92
Giza	54.8	54.8	0	0	0	21.92
Assiut	25.6	29.2	31	31.4	30.2	29.48
Alexandria	0	2.5	0	0	0	0.5
Aswan	0	0	12.8	8.5	27.5	9.76
Total	95	86.5	43.8	39.9	57.7	64.58
Total General	95	86.5	43.8	40	57.8	64.62
%	100.0	100.0	100.0	99.8	99.8	99.9

Source: Annual Bulletin Pure Water & Sanitation Statistics, Central Agency for Public Mobilization & Statistics

Cairo ranks first in terms of the concentration of binary treated wastewater amounts with 1.3 billion m^3 as an average of the period followed by Alexandria with an average of 350 million m^3, where the amount of treated sewage is concentrated in Greater Cairo and Delta's governorates with high population density and higher agricultural areas. The amount of tertiary wastewater treatment is concentrated in Asyut with an average of 29.5 million m^3, followed by Giza by 22 million M^3 (Table 4).

Design, actual and deactivated capacity in sewage treatment stations

22% of the design capacity of the station during (2015/2016) is deactivated capacity. But the increase in the number of the stations from 388 in 2015/16 to 455 in 2019/20, made the ratio of deactivated capacity to design capacity 12% in 2019/20. According to design capacities and comparing them with actual capacities over the period (2015/16-2019/20) shows that actual capacity increased to 12.15 billion m^3 in 2019/2020, which means that by imposing the operation of all stations with their design capacity and fading idle capacity, this allows for an increase of 1.7 billion m^3 of treated wastewater that can be used to reduce the annual water deficit (Table 5).

Egypt's population is expected to reach about 126 million in 2033 and about 200 million in 2050, with the current growth rate stabilizing at 2.5%. Assuming the continuation of the current Nile water supply over the past 100 years and the continued use of rainfall at current levels, per capita renewable freshwater resources are expected to reach 290 m^3/year by 2050, below the absolute severe water scarcity limit of 500 m^3/year. If Egypt wants to provide a limit of scarcity, it will need 100 billion m^3/year, making it unable to achieve self-sufficiency in food or other living requirements, and if Egypt can provide a water scarcity limit (1000) m^3 per capita /year, Egypt needs about 200 billion m^3 and the volume of household consumption is expected to reach 15.8 billion m^3 in 2030 (AbuZeid, 2021).

Challenges for using wastewater in agriculture in Egypt

In 1999, FAO published the suggested guidelines for the agricultural reuse of treated waters and treatment requirements. Where it was classified the type of agricultural reuse was classified based on the type of irrigated crop (FAO, 2017) . The main objective of the update was to facilitate the development of wastewater reuse based on a compilation of global experiences. These guidelines included an updated analysis of the regional variations of water reuse, advances in wastewater treatment technologies (EPA, 2012). According to Egypt's Strategy(Planning, 2015), both the Ministry of Agriculture and Land Reclamation (MALR) and (MWRI) have agreed on a plan to reclaim an area of 1.2 million hectares by the year 2017, utilizing both treated wastewater and drainage water.

Uses of (TWW) according to (EC)(HBNRC, 2015)

Quality of treated water grade (A)

The specifications of grade (A) treatment water are improved by conducting treatment of raw sewage at the treatment plant site or by carrying out additional treatment processes at the agricultural exploitation site. The agricultural groups that can be irrigated are: green areas of educational establishments and public and private parks such as the gospel, fence plants, and flowers of all kinds, In addition to fruit crops eaten fresh without peeling such as apples, peaches, and apricots

Quality of treated water grade (B)

It is a grade (C) water quality that has been improved by diluting fresh water when available, where additional treatment is carried out at the reuse site in treatment plants. Crops that can be grown with (B) grade water: Dry grain crops and cooked and processed vegetables such as strategic dry crops of all kinds (wheat corn, rice, beans), Fruit crops: such as sustainable and leafy trees such as citrus, olives, palms, mango, pomegranates. Medicinal and aromatic plants: such as anise, hibiscus, and cumin

Table 5. Capacities of sewage treatment stations over the period (2015/16-2019/20)

Quantity: Billion M3

Year	Total number of stations	Design Capacity	Actual Capacity	Deactivated Capacity	The ratio of Deactivated Capacity to Design Capacity
2015/16	388	13433	10472	2961	22%
2016/17	416	13650	10691	2959	21.7%
2017/18	432	13172	10804	2368	18%
2018/19	446	13868	10877	2991.2	21.6%
2019/20	455	13782	12148.5	1633.5	12%
Average	427.4	13581	10998.5	2582.5	18.5%

Source: Annual Bulletin Pure Water & Sanitation Statistics, CAPMAS

Quality of treated water grade (C)

Water produced from secondary sewage treatment plants achieves physical, chemical, and biological standards, and one of the most important crops grown in them is: Crops of dry grains, fruits, and medicinal and aromatic plants contained in Group (B) in addition to sunflowers and sugar beets provided that the method of irrigation is not used by spraying. Non-food seeds: All seeds of the multiplication of major food crops such as wheat and all vegetable seeds provided that these seeds are grown in their sustainable places later, all types of seedlings that are then transported to sustainable fields such as olive seedlings, pomegranates, citrus fruits, and pears. Roses, flowers, picking, serums, and all kinds of ornamental plants such as Hosta, Coral Bells, Strelitzia Reginae, Pothos. Road trees and green belts, eucalyptus, fiber crops such as cotton and linen, berries for silk production, and all nurseries and ornamental trees such as Fix Decorah

Quality water treated grade (D)

Grade (D) rewards the quality of water from treatment plants that are limited to pre-treatment stages (refineries, sand removal basins, oil removal basins, and primary treatment). Solid biomass crops: coal-converted crops such as willow, Moranga, liquid biomass crops: all biodiesel production crops and energy oils such as soybeans, jojoba, cellulose production crops: all non-food crops for the production of glucose and its derivatives such as ethanol, acetic acid, and all trees to produce wood such as Mahogany. According to the Egyptian code for prohibited agricultural uses, irrigation with treated sewage is: Raw vegetable crops, the use of grade D treated sewage is prohibited in irrigating any food crops, whether vegetables, field crops, fruit crops, or medicinal plants. The use of treated water with treatment grades (B), (C), (D) in the irrigation of the green areas of educational facilities or public or private parks is prohibited (HBNRC, 2015).

Treated wastewater (TWW) in Agriculture

The use of treated wastewater in agriculture is economically feasible for farms, as (Elfanssi et al., 2018), where the results of agro-physiological parameters show a positive effect on alfalfa irrigated with domestic wastewater compared to well water, wastewater improves physicochemical properties and fertility of the soil compared to well water and enhances crop productivity.(Omran, 2019), conclude that the long-run application of treated wastewater to orange plants did not show any significant problems. Furthermore, no phytotoxicity problem was observed in all tested crops due to irrigation with treated wastewater This finding was in parallel with (Al-busaidi & Ahmed, 2017) study when they found no symptoms of the phytotoxicity problem was observed in date palm leaves and fruits. There was an increase in the heavy metal concentration of plants irrigated with treated wastewater compared to groundwater. However, all measured values were within the international standards, and this is agree with the increased concentration of heavy metals in soil due to sewage sludge amendment had increased content and uptake of Cd, Cr, Pb, Ni, and Zn in shoot and root as compared to those grown in untreated soil. Accumulation was more in root than shoots for most of the heavy metals. Finally, it can be concluded that treated wastewater is a good source of different nutrients that can improve soil fertility and plant growth. However, continuous monitoring is required to ensure its quality. National programs of using treated water for afforestation and greenbelts have been conducted by the Ministry of State for Environmental Affairs, (MSEA), (MALR) and (MH), 155 500 feddan (planted or under construction) of wood forests and bio-oil crops have been irrigated with TWW in the desert areas adjacent to wastewater treatment plants(Egyptian Ministry of Environment, 2017).

The Serapium Forest (located in the Ismailia governorate) is a story of successful (TWW) use in Egypt. Various species of woody trees were well-adapted to the arid environment and provided a high wood yield in Serapium (Monteverdi et al., 2014). (MSEA) has also used treatment water in cooperation with the United States Agency for International Development evaluated the safe reuse of treated water to irrigate different crops (jojoba, sorghum, flowers) in the Luxor governorate. This evaluation endorsed using drip irrigation techniques and implementing natural resource monitoring in the project area as well as conducting risk reduction measures for protecting the workers involved (MSEA, 2008)

Generally, utilizing treatment water for irrigation can be recommended because of improving wastewater treatment and continuous monitoring to prevent the accumulation of toxic elements and maintain microbiological loads within permissible levels in soil and plants (Elbana et al., 2019). When considering treatment water as an alternative agricultural irrigation source to mitigate water scarcity stress and conserve freshwater, it is important to have the consistent tertiary treatment and monitor TWW quality. Indeed, wastewater reuse has been proven to improve crop yield (Oliveira & Sperling, 2008) and result in the reduced use of fertilizers in agriculture (Adrover et al., 2012). Therefore, eutrophication conditions in water bodies would be reduced, as would the expenses for agrochemicals used by farmers (Jaramillo & Restrepo, 2017). Risk assessment, geographic variability of wastewater utilization, and regular wastewater use monitoring programs by public agencies are essential to protect public health and improve water management. Selecting crops suitable to be cultivated with treatment water is a key for achieving the successful use of treatment water. Oil crops such as canola and sunflower are suitable for treatment water irrigation (Zidan & Dawoud, 2013).

Investment in wastewater reuse for agriculture

Wastewater reuse increases agricultural production in regions experiencing water shortages, thus contributing to food safety (Corcoran et al., 2010) Approximately 805 million people, one-ninth of the global population, suffer from hunger. However, according to Food and Agriculture Organization (FAO's) latest estimations, a decreasing trend in hunger supports the possibility of halving the number of undernourished people. However, to be successful, it is first necessary to adopt a comprehensive approach that includes public and private investment aimed at increasing agricultural productivity, in addition to increasing and improving the availability of water resources and protecting vulnerable groups(FAO, 2015). Depending on the local situation, another benefit associated with agricultural wastewater reuse could be the avoided cost of extracting groundwater resources. Where, it is worth noting that the energy required to pump groundwater can represent up to 65% of the costs of irrigation activities (Jaramillo & Restrepo, 2017). Continued deterioration of water quality, water quality problems the inadequacy of government funds for sustaining new investment and operation and maintenance at current levels of engagement, and poor operational performance in water agencies. All of these factors led to the development of appropriate pricing and financing rules along with an institutional framework that encourages sustainable use practices. This led to a significant increase in investment in the water and sanitation sector and the rehabilitation of irrigation infrastructure, whether from the national budget or with the support of donors. In the mid/later 1990s, the need for a more holistic, integrated approach and the government policy has shifted to integrated water quality and quantity management.

Additionally, the nutrients naturally present in wastewater allow savings on fertilizer expenses to be realized (Drechsel et al., 2010) , thus ensuring a closed and environmentally favorable nutrient cycle that avoids the indirect return of macro- (especially nitrogen and phosphorous) and microelements to water bodies. Depending on the nutrients, wastewater may be a potential source of macro- (N, P, and K). Additionally, increased use of wastewater could contribute to the installation and optimization of treatment facilities to produce effluent of a desired quality for irrigation purposes, representing an economic benefit to sanitation projects. In those areas where climatic and geographic characteristics allow, low-cost wastewater treatment systems might also be a viable option, achieved using certain technological options that fulfill the objective of agricultural reuse (Jaramillo & Restrepo, 2017)

Geographical Distribution of General Investment Spending for Sewage Treatment Projects in Egypt over the period (2015/16-2019/20)

Total investment in sanitation projects in Egypt reached 2.61 billion L.E in 2019/20 compared to 386.6 million L.E in 2015/16, a change rate of 574%. This indicates the extent of the attention Egypt commits to pure water delivery projects and the exploitation of treated sewage as a renewable economic resource that can effectively contribute to reducing the water deficit and achieving the Sustainable Development Goals. It also turns out that Sharkia comes first in terms of

Table 6. Total investment spending for sewage treatment projects in Egypt over the period(2015/16-2019/20)

Value: Million L.E

Governorate	2016/2015	2017/2016	2018/2017	2019/2018	2020/2019	Average
Cairo	32.2	49	74	89	139	77
Alexandria	63.9	34	36	37	32	41
Daqahliya	6.4	15	244	455	609	266
Sharkia	8.5	9	176	917	919	406
Garbia	54.1	58	262	131	57	112
Behira	82.4	71	109	399	455	223
Assiout& New Valley	47	99	73	41	34	59
Sohag	11	49	32	153	77	64
Other	81.1	75.3	194	343	285	196
Total	305.5	384	1006	2222	2322	1248
Total General	386.6	459.3	1200	2565	2607	1444
%	79.0	83.6	83.8	86.6	89.1	84
New Urban Communities	–	–	–	30	45	

Source: Annual Bulletin Pure Water & Sanitation Statistics, CAPMAS the volume of investment spending on sanitation projects with an average of 406 million L.E over the period (2015/16-2019-20) followed by Daqahliya with an average of 266 million L.E. Which mean that Egypt is targeting densely populated rural areas with sanitation projects? Cairo, Alexandria, Daqahliya, Sharkia and Garbia, Behira, Assiut, and Sohag governorates represent 89% of total investment spending on sewage projects in 2019/20, compared to 79% in 2015/16. Reveals to Table 6 the volume of total investment directed to sewage projects in new urban communities was 41 million L.E in 2019/20 and is concentrated in the areas of Nubaria, 15 May, 6 October, Sadat, New Minya with a value of about 13, 10, 8, 2, 12 million L.E in 2019/20 respectively (CAPMS, 2021).

Investment projects were implemented in the sewage sector during the period (2015/16-2019/20) and its production capacity was 623 projects in 2019/20 compared to 217 in 2015/16. Production capacity doubled and was 33 m^3/day in 2019/20.

Despite the importance of investing in wastewater treatment projects for reuse, these projects are considered to be projects with large capital costs without a meaningful return to cover the costs of operation and maintenance of the project, which makes a lot of countries, especially developing countries, reluctant to carry out such projects, but in light of Egypt's suffering from water scarcity and Egypt's environmental strategy. Egypt has moved towards huge projects in the sewage sector and water reuse. And this is consistent with what (Sheikh, 2008) has mentioned in his study "Recycled water is generally priced below potable water to provide a significant incentive for customers to switch from potable to recycled water. The extent of discount ranges from 15% to as high as 100% giving the recycled water free of charge to the users, this requirement for discounting the price of reclaimed water places one more impediment on implementation of new water reuse projects: inability to repay the costs of project implementation, operation and maintenance. Because of the significant benefits of water reuse to society and the environment, the pricing schemes for potable water are generally below the actual cost of operation and maintenance not to mention the capital costs of constructing the treatment and distribution systems of the supply systems in many communities.

Thus, the even lower price of reclaimed water cannot be expected to cover the normal costs of operating a water reuse system. Subsidies, incentive payments, and transfers from other funds are commonly used to defray the gap between cost and revenue of water reuse systems."

Using the price of water as a yardstick for evaluating the benefits of saving freshwater resources through wastewater irrigation will yield suboptimal estimates. This is because water is considered a public good and hence it is rarely priced and allocated at its opportunity cost in most developing countries. In most countries, water allocation is determined by a host of legal, political, and historical factors. The fraction of the total irrigation area equipped for irrigation with treated WW varies between 1% and 2%. The constraints leading to these poor levels of WW reuse are lack of social acceptance due to inadequate information on the benefits of this practice and to the poor monitoring of treated WW, incomplete economic analysis of WW reuse options, the mismatch between water pricing and water scarcity, and lack of economic incentives for treated WW reuse (Jeuland, 2015) (Frascari et al., 2018)

In Egypt, it might not be economically feasible to upgrade wastewater quality to the requirements of non-restricted irrigation as this would increase costs (Fine et al., 2006). (Devi, 2009) and (El-Zanfaly, 2015), observed that though marginal costs of higher-level treatments are very high, sometimes these costs are justified by the crop value, degree of water scarcity, public concern, and environmental benefits. Wastewater reuse in agriculture under proper agronomic and management practices has many economic benefits which include alleviating freshwater scarcity, providing a drought-resistant source of water and nutrients that cut on fertilizer costs, increasing water productivity by cultivation multiple crops throughout the year, and confers environmental benefits (Grant et al., 2012)

Scientific studies indicate that some investors in the agricultural sector have established special units for sewage treatment inside their farms. To provide a permanent source for irrigation due to the unsuitability of groundwater for irrigation in some newly reclaimed areas, and the lack of a permanent source of water for the farm. However, it was not possible to obtain data on the number of farms or the value of the private investment in treatment units in those farms due to the lack of official statistical data on this subject. In addition to the absence of any technical or economic studies on the expansion of the use of wastewater treatment technology by the private sector. However, the research was able to find a study about SEKEM Egypt. SEKEM farm is located in Bilbeis area at the east of Sharkia Governorate. A constructed wetland was set for the treatment of wastewater resulting from a nearby school, training workshops, offices, and some houses. The system aimed to increase the available water for agriculture and solve the problem of uncontrolled wastewater disposal in the area. The treatment method was selected for its low cost, energy, and simple technology. Primary treatment of wastewater is carried out by a septic tank, and then the effluent is directed to the constructed wetland for secondary treatment. Treated wastewater is then stored to be used for irrigation of forest trees (Abdou et al., 2019). The implementation of the treatment system has improved the quality of the wastewater. In addition, the physical quality of the sandy soil has improved. The treatment system has a positive impact on the environment and the groundwater. The quality of the treated wastewater is within the permissible limits of the Egyptian standards. About 10 m^3/day of freshwater was saved for irrigating the agricultural area by using efficiently treated wastewater.

Case study in (WOS)

The station is located on the 6th of October City and is under the supervision of the New Urban Compounds Authority, (MH), the station consists of two stations:

- Station (1) was established in 1985 and was operated in 1999, with a design capacity of 150 000 m^3/day and an actual capacity is 140 000 m^3/day. The plant started as a binary treatment plant and in 2009 it was converted into a triple sewage treatment plant. The investment cost of station (1) is 853 million L.E It includes 3 major pumping stations with a total cost of 160 million L.E for the station. The station's economic life ranges from 25-30 years. And the number of lifting stations is 7 stations; the cost of the station is 120000 L.E. The annual cost of the maintenance station is about 3.5 million L.E, the project's economic life of project is 50 years, and the economic life of exchange networks is 25 years. The Total revenues for the station (1) are 13 million L.E in 2019/2020.
- Station (2), the construction of which began in 2019 and will enter the trial operation phase in 2022. It is a triple treatment plant with a design capacity of 150000 m^3/day. The total cost of the new station is 1.2 billion L.E of which 500 million L.E construction costs at the two stations

The most important characteristic of the new phase of the station is the presence of an independent stage of sludge treatment to reach the best standards, according to the law of reusing the sludge produced from drainage stations in fertilizing agricultural lands, and the sludge is dried by the latest methods. After completing the trial operation of the station and ensuring that the water conforms to the Egyptian Code, the treated water lines from the station will be connected to an irrigation network to be reused according to the Egyptian Code again in irrigating green areas, under Egypt's 2030 vision and to integrate the environmental dimension into sustainable development plans for projects with a positive impact direct on the environment.

Results of evaluation of (WOS) project

(CBA) of (WWT) and reuse

The cost-benefit social approach will be used to determine the feasibility of sewage treatment acts as a basis for expanding the activity or establishing new investments. This approach has been chosen as containing complex criteria linking national, social, and economic objectives, enabling the selection or preference of these investment programs that maximize economic and social well-being, and support the decision maker by bringing elements of transparency and objectivity. (CBA) aims to estimate the social costs and return of investment projects so that it can be decided whether or not to set up projects and this analysis differs from the analysis used by institutions in evaluating their investments (Investment Appraisal). This analysis is based on the social aspect of both costs and returns. Therefore, the benefits, benefits, and costs it can incur for the establishment of a project and the losses to the well-being of the community due to the implementation of the project may include environmental impacts. The main problem faced by this analysis is the difficulty of estimating some types of costs and returns, which are certain social benefits, as well as the difficulty of converting different measurements if they can be reached into one unit so that the comparison of costs in the benefit group as a whole can be achieved, so we should not look at this analysis as a practical tool for decision-making, but it is, in fact, a means of accessing the best possible different information that may help the government make decisions. Generally, it would seem that there has been inadequate attention to economic issues in water and sanitation interventions, but especially in the field of sanitation system alternatives (other than sewerage system) (Prihandrijanti et al., 2008).

Social cost-benefit analysis (SCBA) for the treatment and reuse of sewage in (WOS)

Total estimated costs of wastewater purification and treatment at (WOS), based on unpublished official data on the sewage treatment station, it was found that the estimated cost of wastewater treatment is up to 1000 L.E/1000 m^3 and this cost is distributed as follows:

- A basic cost to the state is whether or not treated water is reused. The total cost resulting from the construction and maintenance of the sewage facility, consisting of sewerage network lines, lifting and pumping stations, bilateral treatment, and electricity, and water costs, is up to 885 L.E./1000 m^3
- Additional costs designed to improve the properties of binary treated sewage to reach the agreed global specifications for use for agriculture purposes in-

clude triple treatment costs and the cost of constructing treated water transmission lines and accessories, estimated at 115 L.E/1000 m^3.

Direct costs:

- Operating and maintenance costs of sewage plant facilities in (WOS)

Determining the cost of operating and maintaining the sewage facilities at the station requires determining the cost of maintaining networks, pumping and lifting stations, and the cost of bi and triple treatment. The total cost of maintaining the plant is estimated at 3.5 million L.E. per year, the number of operating days is 365 days/year, the economic life of the station is 50 years, and the amount of water produced triple is estimated at 140 000 m^3. The unit producing (TWW) was therefore estimated to have a maintenance cost of 1.37 L.E./1000 m^3. Share of the binary treated unit is 1.2 L.E/1000 M^3, Triple treated unit share equals 0.16 L.E/1000 M^3

Maintenance costs are divided into:

- The cost of operating and maintaining pumping and lifting stations is estimated at 1.2 million L.E. and according to the Economic Life of the station (25 years), the cost of producing the unit of triple treated wastewater is 0.94 /1000 M^3
- The cost of maintaining networks, connections, parts of home networks, and others is estimated at 2.3 million L.E./ year and the capacity of the live drainage networks connected to the station is estimated at 500 000 m^3/day, the share of the unit produced from the cost of maintaining the networks is estimated at 0.43 L.E./ 1000 M^3

Economies of scale are the savings that a project or production unit receives as a result of the significant increase. Increased project size leads to the possibility of a reduction in production costs per unit it produces. Overall, there are limits on which any new savings depend as a result of more project size or larger production units.

- The construction cost of sewage facilities in L.E / 1000 M^3

  The construction cost of downhill or attraction lines at 1450 km and pumping lines 730 km, and the construction cost of 7 lift stations and 3 pumping stations is estimated at 500 million L.E. then the production of the station stops at the door of the plant, i.e. there is no cost to the treated wastewater transmission lines because the cost is borne by the beneficiaries of the water, this cost cannot be included in the costs of the station. Considering that the economic life of the pumping lines for sewage networks is 25 years, the unit producing treated wastewater equals 391.4 L.E/ 1000 M^3

Considering that the stages of treatment up to the binary stage are a commitment to the state and its responsibility to preserve the environment, therefore the costs of transporting, pumping, and treating sewage up to the level of binary treatment up to 344 L.E/1000 M^3. Therefore, the ratio of reuse of sewage to the estimated total cost of wastewater treatment is about 12%, while the ratio of the cost of compulsory treatment to the state to the estimated total cost of wastewater treatment is estimated at 88%.

Indirect costs:

Pollution with bad odors from the sewage system and purification of sewage The emission of bad odors are associated with the establishment of sewage treatment plants, and these smells even increase in severity according to wind direction and speed as well as temperature, where bad smells increase in the summer from treatment plants, although these smells do not lead to clear health effects if they are at safe levels. These odors appear from the anaerobic degradation of the contents of the sewage system during the purification process or are emitted during the processing phase near pumping and purification plants. (WOS) is located at the desert back of the city and has been built away from the residential communities, but the increase in urbanization in the city has led to the strong approach of the residential area to the station and thus the emission of bad smells from the station has become something felt by some residential communities near the station

Gravitational networks from expulsion lines and pumping, lifting and purification stations are exposed to destruction

Total estimated direct returns to (WWT) in (WOS) be evaluated

1 – Direct financial and economic returns for the use of treated wastewater:

A) Assessment of the financial and economic return for using treated water in productive agriculture

The selling price/M3 of triple-treated wastewater is 3.60 L.E per M3. The number of days of the year used to calculate the benefit is 330 days. The amount of water exploited by 100000 M^3/day in the areas of farms with an area of 3500 Feddan. The economic Life of the project is 50 years

Then the return equals 5.9 billion L.E

B) Benefit from switching from using freshwater to treated wastewater in productive agriculture:

Considering that the actual cost of producing and distributing M3 of freshwater is 1.7 L.E, the number of exploited days annually is 330 days. The amount of water required / day is 100 000 m^3/day. Hence, the total actual costs of producing and distributing are 2.81 billion L.E

In case of diversion from fresh water in agriculture and using triple (TWW), the direct financial return to the state as a result of the shift from using freshwater to (TWW) in agriculture and during 50 years is 8.71 billion L.E, representing an added value to the state's economy and development projects. It is expected that this added value will increase after the opening of (WOS) No. 2 in 2022 so that the production capacity of treated wastewater will become 300000 M^3/ day, and then the return will be 19.71 billion L.E . Hence, the direct return in favor of the state is 22.5 billion L.E.

Results of the financial analysis of (WOS) project

(NPV)

To obtain the present values of the flows of revenue and cost, we shall use the rate of cost of capital as the discount rate it equals 14%.

NPV= 388.71 Million L.E, Which means NPV > 0, then the revenue from the project is greater than its cost, the project is profitable, and, if the firm accepts the project, then the value of the firm would increase.

(PI)

Revels to project data PI for the project equal 1.2 Million L.E It is greater than 1 which mean the investment in this project would be profitable and should be implemented

(IRR)

According to project data IRR is 16.4%, it is greater than the rate of cost of capital 14%, then investment in the concerned project would be profitable, then the project should be implemented

(MIRR)

To obtain MIRR values of the flows of revenue and cost, we shall use the reinvest rate it is equal to 15%, According to project data MIRR is 15.6% it's less than IRR, which means the project would be profitable.

Conclusion

Egypt relies almost entirely on the Nile as a major water supplier with a rate of 97%. Egypt has thus become one of the countries suffering from water scarcity. By studying the distribution of water resources to uses, the agriculture sector ranks first in terms of consumption of water resources by about 78%, followed by the drinking sector and health uses by about 13.5%. Total investment in sanitation projects in Egypt reached 2.61 billion L.E in 2019/20 compared to 386.6 million L.E in 2015/16, a change rate of 574%. This indicates the extent of the attention Egypt commits to pure water delivery projects and the exploitation of treated sewage as a renewable economic resource that can effectively contribute to reducing the water deficit and achieving the Sustainable Development Goals. .the volume of total investment directed to sewage projects in new urban communities was 41 million L.E in 2019/20 and is concentrated in the areas of Nubaria, 15 May, 6 October, Sadat, New Minya with a value of about 13, 10, 8, 2, 12 million L.E in 2019/20 respectively. Scientific studies indicate that some investors in the agricultural sector have established special units for sewage treatment inside their farms. to provide a permanent source for irrigation due to the unsuitability of groundwater for irrigation in some newly reclaimed areas, and the lack of a permanent source of water for the farm.

The total actual costs of producing and distributing are 2.81 billion L.E In case of diversion from fresh water in agriculture and using triple (TWW), the direct financial return to the state as a result of the shift from using freshwater to (TWW) in agriculture is 8.71 billion L.E, representing an added value to the state's economy and development projects. It is expected that this added value will increase after the opening of (WOS) No. 2 in 2022 so that the production capacity of treated wastewater will become 300 000 m^3/ day, and then the return will be 19.71 billion L.E . Hence, the direct return in favor of the state is 22.5 billion L.E. NPV for the project is 388.71 Million L.E which means the project is greater than its cost, profitable, and, if the firm accepts the project, then the value of the firm would increase. PI for the project equals 1.2 Million L.E which means the investment in this project would be profitable and should be implemented and IRR is 16.4%, It is greater than the rate of cost of capital 14%, then investment in the concerned project would be profitable

Based on previous findings, research recommends

- It is necessary to increase the volume of investments carried out in sewage treatment projects
- Expanding the construction of triple treatment plants and upgrading primary plants to be binary and triple plants to reduce agricultural consumption of freshwater from traditional sources.
- Attracting private investment to the wastewater treatment sector and reusing it in agriculture by encouraging investors to set up treatment units on their farms by providing investment incentives to implementing units, in addition, allowing the private sector to participate in the establishment of triple treatment units, with the state setting conditions, rights, duration of exploitation and the price of selling water to beneficiaries, which contributes to the state's intolerance of further financial burdens.
- Start a promotional campaign to prepare and mobilize public opinion to introduce the importance of sewage treatment projects and the use of their out-

put in agriculture, and the absence of any adverse impact on public health, while clarifying to the target groups (farmers) the advantages of using treated wastewater to increase productivity and reduce The fertilizer used in agriculture and reduce production costs.

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