



Egypt 2030 Shared Water Reuse Strategy

"a strategy that ensures safe and appropriate reuse of all waters"



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Acronyms

AWC	Arab Water Council
BCM	Billion Cubic Meters
CAPMAS	Central Agency for Public Mobilization and Statistics
CEDARE	Centre for Environment and Development for the Arab Region and Europe
EEAA	Egyptian Environmental Affairs Agency
EWRA	Egyptian Water and Wastewater Regulatory Agency
HCWW	Holding Company for Water and Wastewater
ICARDA	International Center for Agricultural Research in the Dry Areas
IWMI	International Water Management Institute
LAS	League of Arab States
MCM	Million Cubic Meters
MENA	Middle East and North Africa
MALR	Ministry of Agriculture and Land Reclamation
MoD	Ministry of Defense
MHUUC	Ministry of Housing, Utilities & Urban Communities
MPED	Ministry of Planning and Economic Development
MWRI	Ministry of Water Resources and Irrigation
NUCA	New Urban Communities Authority
NWRP	National Water Resources Plan
SDG	Sustainable Development Goals
SIDA	Swedish International Development Cooperation Agency
UN	United Nations

Glossary

Agricultural Wastewater / Drainage: Agricultural drainage refers to the drainage water after irrigating the agricultural lands. It may also include treated or untreated municipal or industrial wastewater. However, the government is working on eliminating all sources of untreated municipal and industrial wastewater disposal in agricultural drains.

Collected Wastewater: not all wastewater is collected. Collected wastewater here refers to wastewater collected in the sewage network

Direct Reuse or Direct Water Reuse: refers to direct use of treated wastewater from the wastewater treatment plant

Indirect Reuse: refers to indirect use of treated wastewater, collected in the agricultural drainage system

Produced Water: Municipal / Domestic Water produced for domestic use

Produced Wastewater or Wastewater Production: Wastewater produced based on the amount of domestic / municipal water used.

Reclaimed Water: refers to the reuse of treated wastewater

Treated Agriculture Drainage: refers only to water treated from the agriculture drains (which may include treated or untreated municipal or industrial wastewater).

Treated Wastewater: refers to wastewater collected and treated in a wastewater treatment plant

Wastewater / Municipal Wastewater / Domestic Wastewater / Sewage: any water that has been used for domestic and urban purposes: this wastewater may also be mixed with industrial wastewater. However, the law prohibits disposal of untreated industrial wastewater into sewage domestic wastewater networks

Landscape: Green cover in cities and urban areas which could be in the form of grass, trees, and or ornamentals.

Champion: for the purpose of this strategy, the champion is a selected lead institution with the mandate of supervising the implementation of this strategy and coordinating water reuse activities, actions, and projects under the umbrella of this strategy.

Learning Alliance: the group of institutional representatives, experts, and stakeholders who participated in the consultation and validation dialogues on water reuse in Egypt for the purpose of developing this strategy.

ReWater: The Water Reuse project which was funded by SIDA, coordinated by IWMI, and implemented in Egypt by CEDARE to develop with the relevant stakeholders the hereby presented Water Reuse Strategy.

I. Executive Summary

“The Egypt 2030 Shared Water Reuse Strategy” was prepared in cooperation with representation from the key relevant governmental institutions and several national experts and stakeholders together forming what is considered as a Learning Alliance for Water Reuse in Egypt. The strategy aims at addressing the important need to increase water reuse as the “renewable increasing water resource of the future”. It ensures safe and appropriate reuse of all waters. Water reuse adds contributes to sustainable development, which is three dimensions; Economic, Social and Environmental. It improves economics to utilize water that would be otherwise wasted, and by making water more productive. It improves the social dimension by addressing water scarcity and satisfying the increasing water demand for sustainable livelihoods. It also improves the environment by increasing wastewater treatment levels and reducing pollution.

The strategy provides a 2020 baseline overview and a 2030 projection. Based on the population growth, by 2030, with a population of 126 million people, the produced wastewater will become 12.63 BCM/y and a total of 11 BCM/y would be collected and treated providing an additional availability of 9 BCM/Y of water reuse.

The existing agricultural expansion projects were analyzed as potential water reuse areas, including areas that were developed based on groundwater use which is now depleted.

A review was made of the existing goals, strategies, plans and their targets to develop the 2030 National and Local Water Reuse Targets presented below

National 2030 Reuse Targets	
Sanitation Coverage for Planned Reuse	
1	By 2030, increase access to adequate, equitable & safely managed sanitation from 51% of population in 2015 to 100%, where all excreta is safely disposed of in situ or treated off-site. (UN SDG 6.2.1.a)
Mixed Industrial and Domestic Wastewater Reuse	
2	By 2030, halve the proportion of untreated (and unsafely treated) Domestic and Industrial wastewater produced from 60% in 2015 to 30%, and ensure that at least 70% of the produced wastewater is safely treated. (UN SDG 6.3.1.a)
3	By 2030, eliminate disposed non-compliant industrial wastewater to the wastewater network. (Ministry of Housing Decree)
Clean Water Bodies for Indirect Reuse	
4	By 2030, eliminate disposed non-compliant wastewater to all water bodies. (Environment Law)

Target Outcomes	4a	By 2030, the proportion of compliant industrial wastewater disposed into the Nile will increase from 79% of total disposed industrial wastewater into the Nile in 2017 to 100%. (Egypt SDS 2030 Vision)
	4b	By 2030, the proportion of compliant domestic wastewater disposed into the Nile will increase from 50% of total disposed domestic wastewater into the Nile in 2017 to 100%. (Egypt SDS 2030 Vision)
	4c	By 2030, all wastewater that used to be directly disposed into Mediterranean Sea and Northern Lakes and indirectly through agriculture drains and Nile Branches will be treated. (MWRI Law 48)
Level of Wastewater Treatment for Appropriate Reuse		
5	By 2030, all <u>collectable</u> domestic wastewater will be collected by sewage networks and treated by at least secondary treatment. (2030 Reuse Vision)	
6	By 2030, all uncollectable domestic wastewater will be disposed of in an environmentally sound gravel filter septic tanks or solid based septic tanks to be pumped out and disposed of in at least secondary treatment plants. (2030 Reuse Vision)	
7	By 2030, increase the proportion of tertiary treated wastewater to reach at least 10% of produced domestic wastewater.	
Increase of Reuse		
8	By 2030, reuse 100% of the collectable produced wastewater with 50% through direct reuse, and 50% through indirect reuse. (Reuse Vision 2030)	
Target Outcomes	8a	By 2030, the ratio of reused wastewater to total allocated domestic water will increase from 39% in 2015 to 70% in 2030.
	8b	By 2030, the ratio of non conventional water resources used to the conventional water resources used will increase from 36% in 2015 to 45%.
	8c	By 2030, <u>direct</u> reuse of treated wastewater will increase from 0.27 BCM in 2011 to 5.5 BCM. (2030 Reuse Vision)
	8d	By 2030, <u>indirect</u> reuse of treated wastewater will increase from 3.10 BCM in 2011 to 5.5 BCM in 2030. (2030 Reuse Vision)
	8e	By 2030, reuse of mixed agriculture drainage & treated wastewater will increase from 13.5 BCM in 2011 to 16 BCM. (MWRI for SDS 2030 Vision)
	8f	By 2030, all wastewater that used to be directly disposed into Mediterranean Sea and Northern Lakes and indirectly through agriculture drains and Nile Branches will be reused.
9	By 2030, increase proportion of produced agricultural drainage safely reused for agricultural purposes from 44% in 2015 to 50%. (MWRI 2037 Plan)	
Reuse for Fresh Water Savings		
10	By 2030, 10% of Nile water allocated to Irrigation in 2018 will be swapped with treated wastewater.	
11	By 2030, 10% of groundwater allocated to Irrigation will be swapped with treated reused wastewater.	
12	By 2030, 50% (0.35 BCM) of fresh water used for landscaping in 2020 (0.7 BCM in 2020) will be swapped with treated wastewater.	
Reuse for Agriculture Development & Urban Landscaping		
13	By 2030, at least 5% (0.55 BCM) of treated wastewater would be directly reused for about 130,000 feddans of urban landscaping, 0.15 BCM of which will be directed to new landscape areas.	
14	By 2030, 45% (4.95 BCM) of 11 BCM treated wastewater would be directly reused for 1,000,000 feddans of agriculture lands and another 45% (4.95 BCM) of treated wastewater will be indirectly reused for another 1,000,000 feddans.	

Local 2030 Water Reuse Targets	
Treatment and Reuse of Mixed Agriculture Drainage & Wastewater	
1	By 2030, treat and (indirectly/directly) reuse 1.83 BCM/y of mixed agriculture drainage and wastewater from Bahr El Baqr drain for 365,000 feddans of agriculture in North Sinai
2	By 2030, treat and (indirectly/directly) reuse 0.365 BCM/y of mixed agriculture drainage and wastewater from Mahsama drain for 73,000 feddans of agriculture in North Sinai
3	By 2030, treat and reuse 2.19 BCM/y of mixed agricultural drainage and wastewater from Alhamam plant to supplement groundwater in irrigating 1,500,000 feddans of agriculture land in the New Delta project including Mustaqbal Masr project. (new*)
Swap Non-Renewable Groundwater with Direct Treated Wastewater Reuse	
4	By 2030, swap 0.9 BCM/y of allocated non-renewable groundwater with direct treated wastewater for 180,000 feddans of agriculture lands within the 1.5 million feddan project and save fresh groundwater for drinking purposes
5	By 2030, swap 0.7 BCM/y of allocated non-renewable fresh groundwater with direct treated wastewater for 140,000 feddans of agriculture lands in West Menya & West West Menia within the 1.5 million feddan project
6	By 2030, swap 0.10 BCM/y of allocated non-renewable fresh groundwater with direct treated wastewater for 20,000 feddans of agriculture lands in El-Marashda, Qena within the 1.5 million feddan project
7	By 2030, swap 0.060 BCM/y of allocated non-renewable fresh groundwater with direct treated wastewater for 12,000 feddans of agriculture lands in West Kom Ombo, Aswan within the 1.5 million feddan project
8	By 2030, swap 0.04 BCM/y of allocated non-renewable fresh groundwater with direct treated wastewater for 8,000 feddans of agriculture lands in El-Tor, South Sinai within the 1.5 million feddan project
Supplement Depleted Groundwater with Treated Reused Water	
9	By 2030, supplement depleted groundwater with 0.7 BCM/y of treated wastewater for direct reuse for the priority areas of 144,000 feddans in the West Delta agriculture project
WW Reuse for New Cities Landscaping & Neighboring Agriculture	
10	By 2030, direct 0.25 BCM/y of treated wastewater generated from the New Administrative City to 5000 feddans of Landscaping within the City and about 30,000 feddans of neighboring agriculture areas.

The expected challenges facing the achievement of these targets were discussed and the required enabling environment was put forward to include the following:

Institutional Setup:

- a national Champion or lead governmental institution (such as the office of the Prime Minister) that has clear authority and supervisory role is to lead the supervision of the implementation process of this water reuse strategy.

Policy, Financial & Incentive Measures:

- clear incentives and policies supporting farmers to encourage water reuse and market water reuse agricultural products
- strong monitoring and evaluation system and reporting mechanism
- enhanced financial sustainability
- improved public awareness and sustainability

Code, Regulatory and Legislative Measures:

- revised and new codes related to treated drainage water reuse, wastewater treatment & reuse, and industrial water treatment & reuse.

Implementation Cost

- The wastewater/drainage infrastructure component of the National Targets were estimated to cost a total of about 116 Billion USD in capital costs, with 0.98 Billion USD annually in O&M costs. The total accumulative capital and O&M costs of water reuse, agriculture, and/or livestock components combined for the National Targets between 2020 and 2030 is expected to be about 313 Billion USD with total returns of about 367 Billion USD resulting in total net benefits of about 54 Billion USD. The implementation cost to achieve the wastewater/drainage infrastructure component of the key Local Targets, which are part of the National Targets, are estimated to cost about 2 Billion USD in capital costs, with 0.22 Billion USD annually in O&M costs. The total accumulative capital and O&M costs of water reuse, agriculture, and/or livestock components combined for the key Local Targets between 2020 and 2030 is expected to be about 52 Billion USD with total returns of about 76 Billion USD resulting in total net benefits of about 25 Billion USD with a payback period ranging between 2-7 years among all local targets.

Putting the “2030 Egypt Water Reuse Strategy” on top of the political agenda is a continued effort towards sustainable development through ensuring safe and appropriate reuse of all waters.

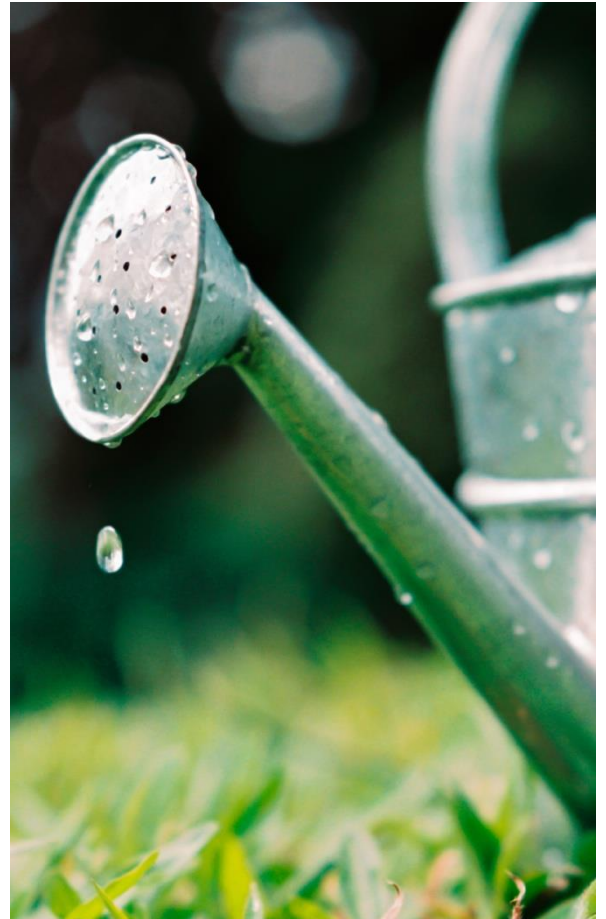
II. Introduction

Water availability is a critical issue as the region has five percent of the world's population having access to merely one percent of the world's total water resources.

Water scarcity is growing quickly, especially in the arid and semi-arid regions along with the growing population. In the Arab region alone, the number of countries that are below the water scarcity limit of renewable blue water resources of 1000 m³ per person per year is increasing. In 2015, 17 out of the 22 Arab countries were water under the water scarcity limit, (3rd State of the Water report, 2019), including Egypt.

In addition to water scarcity, there is a growing water pollution in the region. The untreated wastewater is disposed to freshwater bodies, to open seas, to the marine environment, to the groundwater aquifers or to agriculture drains, resulting in an increased amount of environmental degradation and reduced economic development.

While there is worldwide experience of reuse of treated wastewater, it is still far from its potential. In Egypt, there has been major steps taken to improve services and increase reuse. With effective and comprehensive efforts to reuse water, more sustainable and economic development can be achieved by providing water, food and energy security as well as the protection of the health of the population and ecosystems. All this can be provided by adopting a comprehensive strategy on water reuse which will contribute to the global and national objectives of circular economy. Previous national strategies and plans have been aiming at managing water resources at large including water reuse. A 2030 Wastewater Reuse Vision for Egypt was developed about 10 years ago involving six ministries and other stakeholders in an effort that was coordinated by CEDARE. That was one of the efforts that was focusing on visioning and planning of wastewater reuse. This strategy here is an update of that vision with more focus on strategic matters of water reuse and more detailed alignment with the country's new plans, objectives and commitments to national and global sustainable development goals which is considered complimentary to other related national and ministerial plans in Egypt.



III. Development of the Strategy

Egypt aims at promoting more and safe water reuse through the development of the “*Egypt 2030 Shared Strategy for Water Reuse*” via the participatory process of experts and stakeholders under a Learning Alliance model. Experts that participated in the process included water management and reuse experts from various ministries, water reuse codes experts, water supply & sanitation experts, agricultural experts, environmental experts, policy experts and strategy development experts as well as representatives of end users and stakeholders.

In order to develop the strategy, the current baseline situation had to be considered and then the strategy targets had to be developed and finally the enabling environment and implementation cost required for achieving those targets had to be envisioned. A National Steering Committee (NSC) was formed for the project of developing the Strategy including development and technical support organizations as well representatives from the concerned ministries. The concept of the Learning Alliance was embraced to form a National Learning Alliance (NLA) for Water Reuse comprised of key Ministries’ representatives, Water Users Associations, Farmers Associations, Academia, Agriculture Production Investors, NGOs, experts and other interested entities. As a result, the concerned governmental entities and stakeholders represented in the NLA developed the “*Egypt 2030 Shared Strategy for Water Reuse*” through 3 stages: *Baseline*, *Targets*, and *Strategy*. A series of 6 meetings for the National Steering Committee (NSC) and 6 meetings for the National Learning Alliance (NLA) were held to ultimately develop this strategy. The NSC provided overall guidance for the strategy development, while the NLA provided technical guidance. For each stage, there were consultation and validation meetings in which the NSC and NLA members provided advice and constructive feedback, as shown in Figure 1.

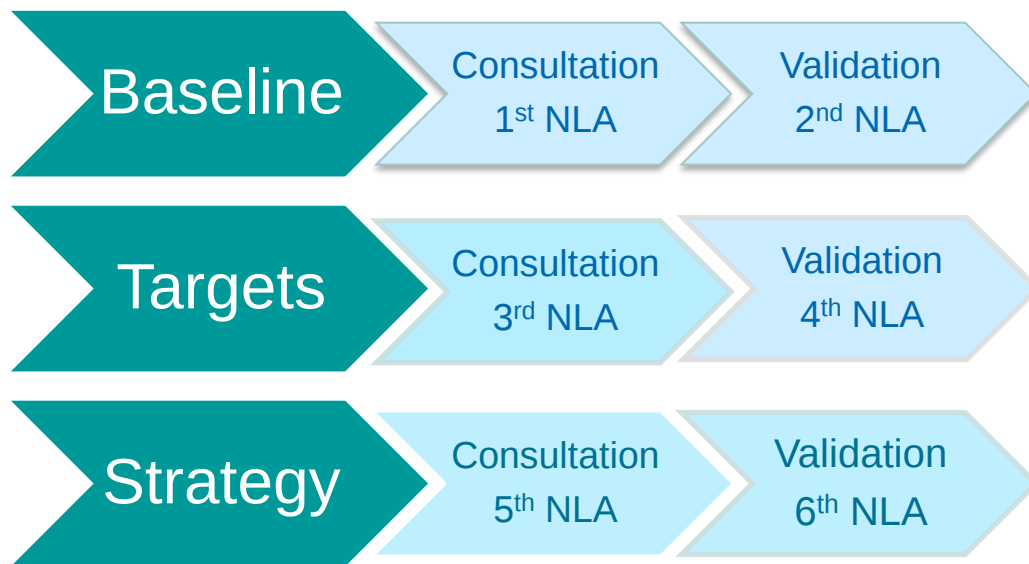


Figure 1: Development Process of “Egypt 2030 Shared Strategy for Water Reuse”

In the first stage, the *baseline* data was collected and shared in the 1st NLA Dialogue for stakeholders to review and comment. Then, with the feedback from the stakeholders, the results were updated and validated by the 2nd NLA Dialogue. The baseline overview is summarized in “Section IV Baseline Overview”. The data was obtained from official CAPMAS sources which receives its data from the Ministry of Housing and the Holding Company for Water & Wastewater. Based on the baseline, the expected projections for 2030 were estimated in “Section V - 2030 Population, Water and Wastewater Probable Projection Scenario”.

In the 2nd stage, the following analysis was presented in the 3rd NLA Dialogue:

- the 2030 Projections for Population, Water and Wastewater Production
- Current Agricultural Expansion Plans and Potential Reuse, as shown in section VI of this report,
- Existing Plans and Strategies including Water Reuse, as shown in section VIII of this report,
- Targets in Existing Plans and Strategies related to Wastewater Treatment and Water Reuse, as shown in section IX of this report

Based on consultation on the above during the 3rd NLA Dialogue, and after proposals for the Targets were prepared resulting in 25 National Targets and 9 Local targets, as shown in Figure

2., Validation during the 4th NLA Dialogue resulted in Targets consolidation to form 14 National Targets and 10 Local Targets, as shown in Figure 3.

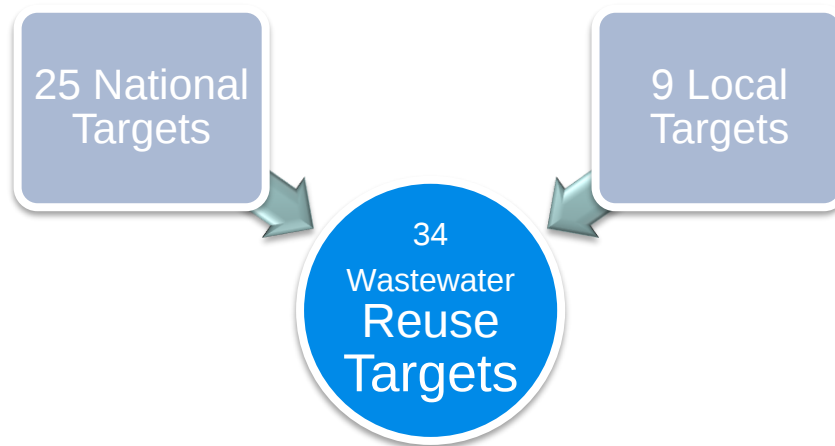


Figure 2: Consultation on the “Egypt 2030 Shared Targets for Water Reuse”

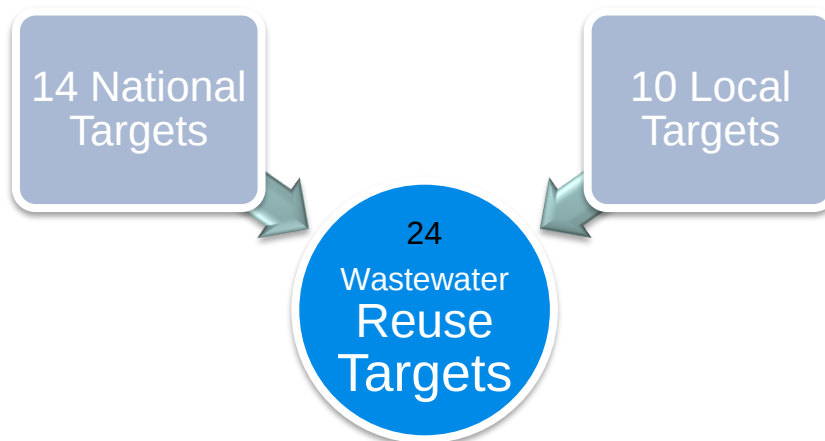


Figure 3: Validation on the “Egypt 2030 Shared Targets for Water Reuse”

In the 3rd stage, The overall proposed strategy was prepared and presented for consultation during the 5th NLA Dialogue for feedback and discussion on how to move forward by providing an enabling environment to implement the “***Egypt 2030 Shared Strategy for Water Reuse***”. The NLA discussed the following 4 main pillars needed to provide the enabling environment for the implementation of the strategy

- Institutional Setup: Roles and Responsibilities
- Policy, Financial & Incentive Measures

- Code, Regulatory and Legislative Measures
- Implementation Cost

The 6th NLA Dialogue was then held to validate the overall strategy and provide final comments and feedback which were then included in the current version of the strategy to complete a process that lasted over 3 years.

IV. 2020 Baseline Overview

In order to prepare a realistic strategy, it is important to have a clear starting point. This baseline reviews the population, domestic water supply, produced wastewater, and treated wastewater and its reuse. The baseline year was selected to be 2018 at the beginning of the process and was then modified to be 2020 towards the end of strategy development when official statistical data became available as that is the year in which the latest official CAPMAS data was published.

A. 2020 Population

The 2020 Census reported the population of Egypt at 99.8 million inhabitants (CAPMAS, 2020).

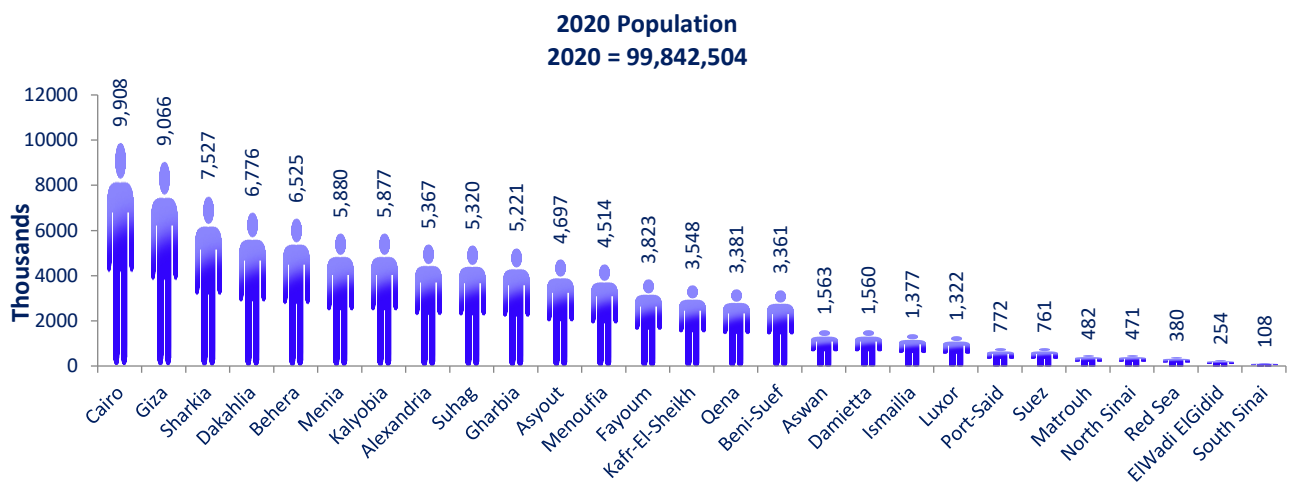


Figure 4 shows the distribution of the population by governorate.

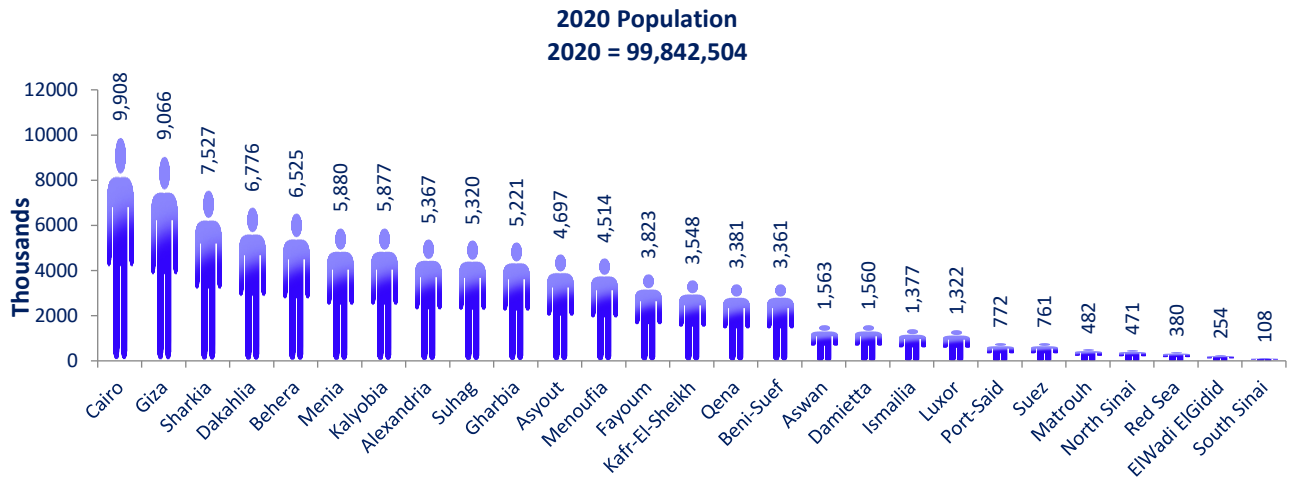


Figure 4: Egypt 2020 Population (CAPMAS, 2020) (graph prepared by CEDARE)

It is to be noted that the population is reported only on the Egyptian national population. There has been a great influx of foreigners from the region that require additional municipal services not taken into account in the population census. Actual population is higher and this impacts all current and future planning.

Based on population of 99.8 million, the per capita share of the renewable blue water from the Nile water is 556 m³/year, below the “Water Scarcity” limit of 1000 m³/year, and just above the “Severe Water Scarcity” limit of 500 m³/year.

B. 2020 Domestic Water Supply

In 2020, 11.0 BCM of domestic water was produced (the equivalent of 30.1 MCM/d) where 89.1% was from the Nile River, as the main source, 10.0% from groundwater wells, and 0.9% from desalination plants. 40% of the water stations are supplying the water from the Nile River, while 58% of the water stations are supplying groundwater, and 2% of the water stations supply desalination water. The average per capita share of water supplied was 110.1 m³ in 2020 (CAPMAS, 2020), and even less with the influx of foreigners.

From 2014 to 2020, an additional 216 water treatment were added to supply an additional production capacity of 5,506 MCM/year (CAPMAS, 2020). There are ongoing efforts to expand the water supply infrastructure to keep up with the population growth rates through the “Hayat Karima” program that included more infrastructure systems.

There is a total of 2,742 Water Treatment plants, as shown in Figure 5, which includes: 1,110 surface water stations, 1,580 groundwater well plants and 52 desalination plants. These facilities are managed under 3 organizations: the HCWW, Suez Canal Authority (SCA) and The New Urban Communities Authority (NUCA). HCWW manages 81% of the production, while NUCA manages 18% of the production, with the SCA managing 1% of the production. (CAPMAS, 2020).

2020 Number of Water Treatment Plants (Total = 2,742)

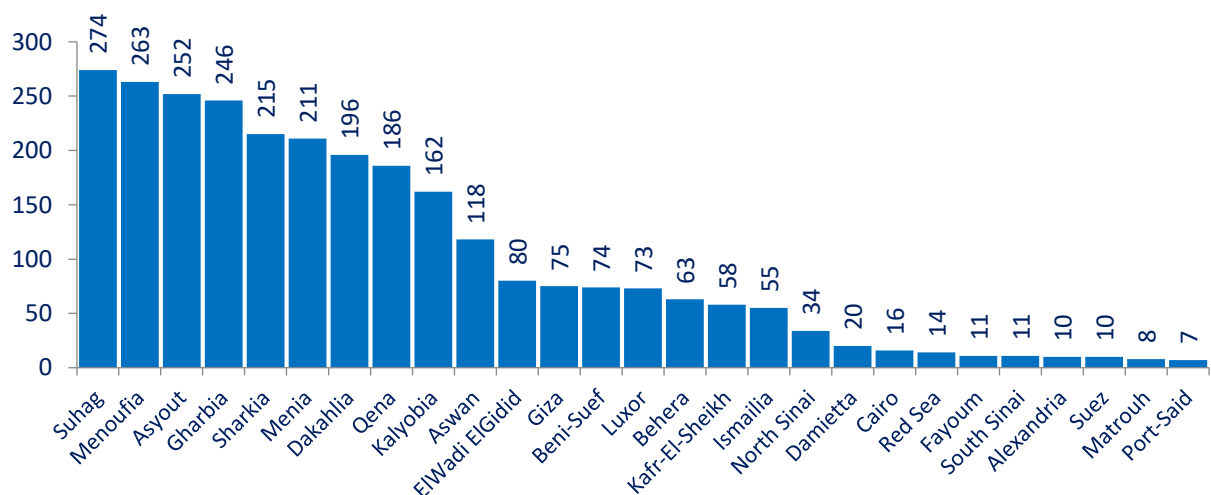


Figure 5: Number of Water Treatment Plants (CAPMAS, 2020) (prepared by CEDARE)

The Cairo governorate has the largest water production (see Figure 6) yet it has less treatment plants than other governorates due to the fact that it contains large capacity plants. The water from the water treatment plants is then distributed to customers in the supply network, including residential, industrial and commercial establishments.

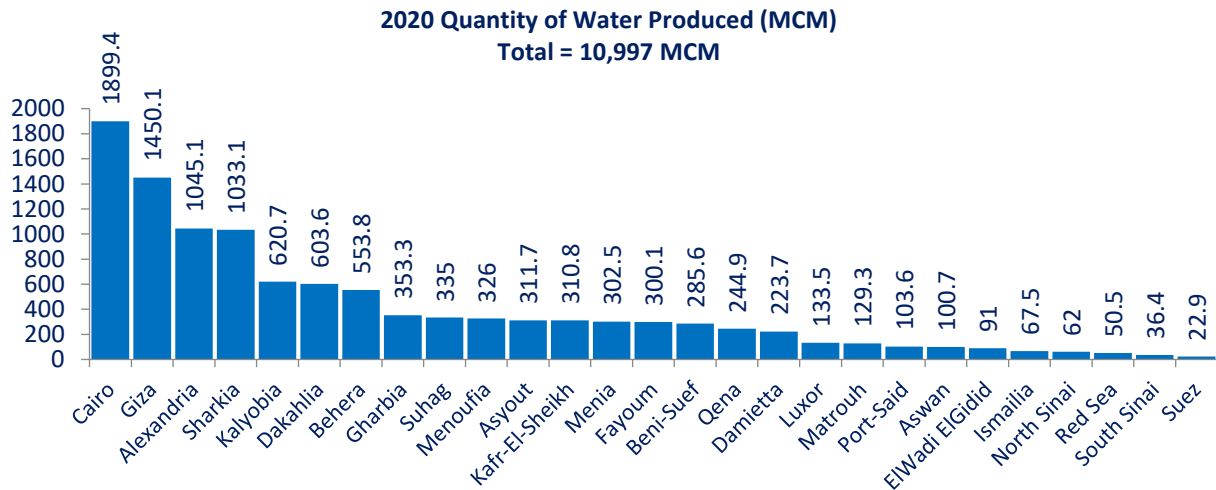


Figure 6: Actual Water Production (CAPMAS, 2020) (prepared by CEDARE)

C. 2020 Estimated Produced Wastewater

In order to plan for water reuse, it is important to understand the availability. It not just based on the wastewater coming out of the treatment plants, but it is much more. The various types of wastewaters can be depicted in the figure below.



Figure 7: Types of Wastewater

Produced Wastewater or Wastewater Production is the wastewater produced based on the amount of domestic / municipal water used. In this report, it was estimated to be 80% (AbuZeid, K. 2017) of the produced water supply due to the fact that there are losses due to leakages in the system as well as domestic use evaporation. According to the 2020 CAPMAS report, HCWW experienced 28.4% losses on the water supply side including both commercial losses and physical losses due to leakages in the system. Separating commercial from physical losses, and noting that there is a national program to reduce physical losses, assuming that there is an 80% recovery of wastewater is considered a realistic number. When planning reuse projects, it is important to ensure that losses are minimized and that reuse projects are designed based on realistic values and to maximize reuse.

Wastewater that is collected in sewage networks for treatment (**Collected Wastewater**) may be less than produced wastewater. Not all the produced wastewater is collected in sewage networks after domestic use, thus part of the produced wastewater is considered **Uncollected Wastewater**. Uncollected wastewater is the difference between produced domestic wastewater and collected domestic wastewater.

In this report, **Treated Wastewater** refers to wastewater collected and treated in wastewater treatment plants. Not all wastewater that is collected is treated. **Untreated Wastewater**, exists in cases where collection systems are in place, while the treatment facility is not operating or complete, or where collected wastewater exceeds the capacity of the treatment facility.

The 2020 produced wastewater is estimated at 8,797 MCM based on the municipal water produced as depicted in Figure 8.

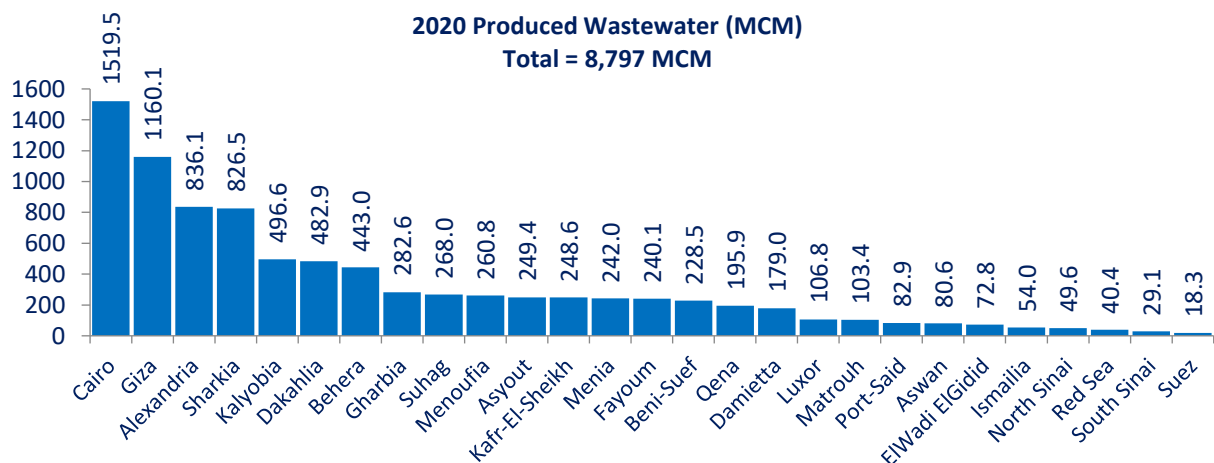


Figure 8: Produced Wastewater (calculated based on CAPMAS 2020 data, prepared by CEDARE)

Not all *produced wastewater* is collected and not all *collected wastewater* is treated. In 2020, the amount of *collected wastewater* was 5.821 BCM and the amount that was treated was 5.135 BCM (CAPMAS, 2020).

D. 2020 Wastewater Treatment

Wastewater is collected in sewage collection networks that have a total length of 48,000 km (CAPMAS, 2020) and it sent to the treatment plants.

Between the years 2014 and 2020, 110 new sanitation treatment plants were added to the system to provide an additional production capacity of 3,511 MCM/year (CAPMAS, 2020) to keep up with the continuous demands. In 2020, the percent of treated sewage to the total quantity of wastewater was about 74.32% (CAPMAS, 2020), more specifically; it was 95% in urban areas and 34% in rural areas. Wastewater Treatment is an essential process for benefiting from the produced wastewater.

Figure 9 illustrates the locations of the wastewater treatment plants as of 2011, in which the intensity of spatial distribution follows the same trend of Egypt's population distribution.

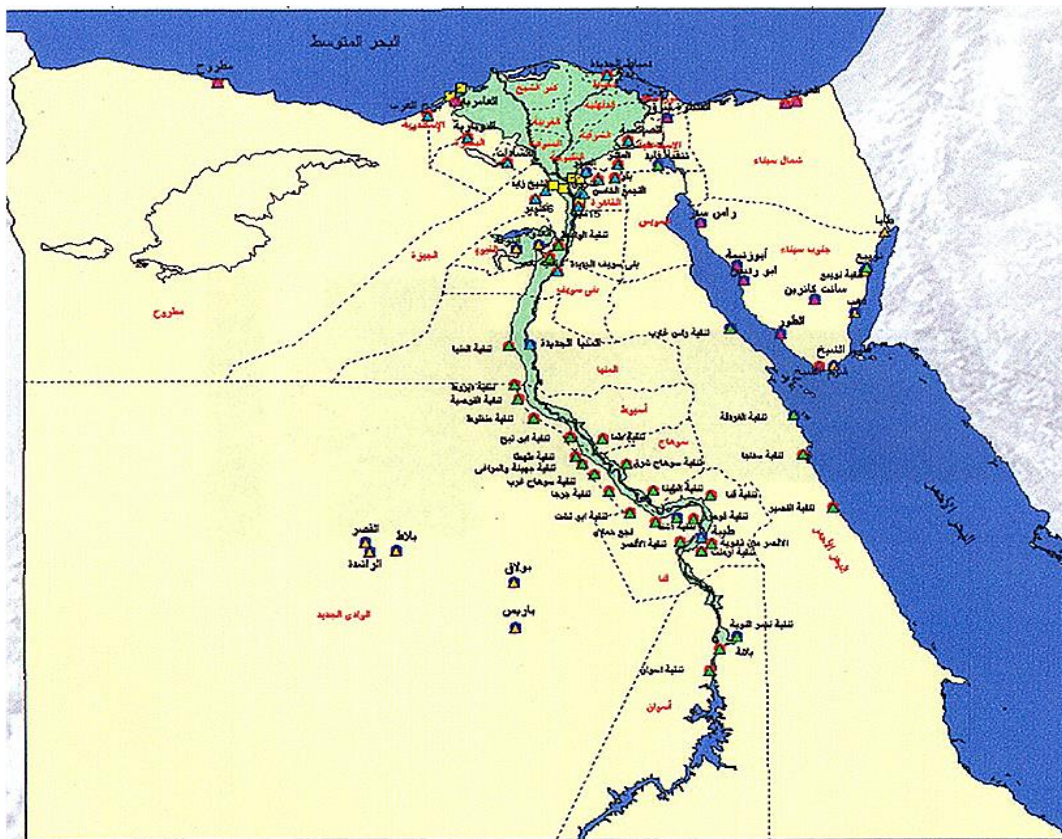


Figure 9: Wastewater Treatment Plants in Egypt (HCWW, 2011)

As of 2020, a total of 455 wastewater treatment plants (Figure 10) treated about 5.14 BCM of wastewater annually Figure 11 (CAPMAS, 2020).

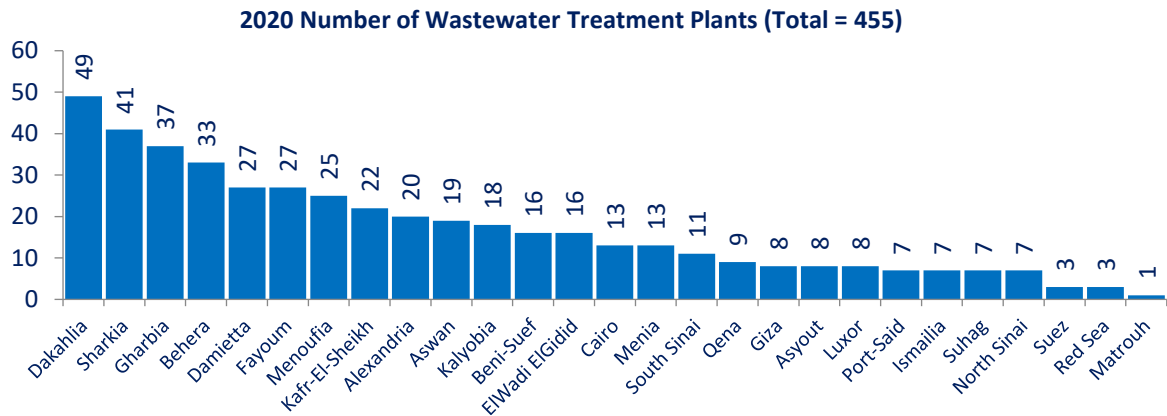


Figure 10: Number of wastewater treatment stations in Egypt by governorate (CAPMAS 2020) (prepared by CEDARE)

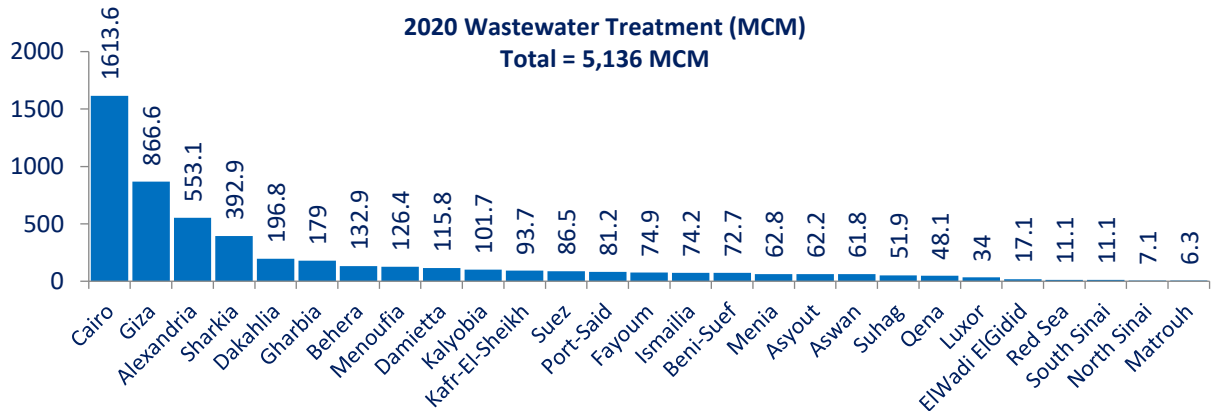


Figure 11: Quantity of Treated Wastewater by governorate (CAPMAS 2020) (prepared by CEDARE)

Conventional wastewater treatment is made up of three phases—primary, secondary, and tertiary treatment.

Primary Treatment—The aim of the primary stage—which is mechanical—is to reduce the velocity and release the pressure of the flow where flow transits from a closed section (sewer) to an open flow section (chambers). In this primary treatment stage, wastewater flows through screens where floating and large-size suspended solids are retained. The flow then passes from the screening chamber to the gritting chamber, where sand and other non-organic materials of diameters exceeding 2 mm are allowed to settle. The next step is the transmission of the flow

to the primary sedimentation tanks, where 30–40 percent of the organic suspended materials and 50-70 percent of suspended non-organic materials settle in the bottom of the tank.

Secondary Treatment—Secondary treatment provides biological treatment, whereby suspended and dissolved organic matters that have not settled in the primary sedimentation tanks are transformed to suspended matters. The treatment process activates the aerobic bacteria through aeration. Three types of biological treatment processes are commonly used: activated sludge, contact stabilization, and oxidation ponds. The wastewater treated by activated sludge, the most common treatment technique in Egypt, allows to further settle in a final sedimentation tank, where flocks of suspended solids formed during the secondary treatment precipitate in the bottom of the tank forming a layer of sludge.

Tertiary treatment—Tertiary Treatment provides additional steps after secondary treatment to further reduce organics, turbidity, nitrogen, phosphorus, metals, and pathogens. Most processes involve some type of physicochemical treatment such as coagulation, filtration, activated carbon adsorption of organics, reverse osmosis, and additional disinfection. Tertiary treatment of wastewater is practiced for additional protection of wildlife after discharge into rivers or lakes. Even more commonly, it is performed when the wastewater is to be reused for irrigation (e.g., food crops, golf courses), for recreational purposes (e.g., lakes, estuaries), or for drinking water.

In 2020, About 0.81 BCM was subjected to primary treatment, 3.75 BCM was subjected to Secondary treatment and the remaining 0.57 BCM result from tertiary treatment. (CAPMAS, 2020)

Furthermore, Figure 12 shows the quantities of Primary treated wastewater by governorate, while Figure 13 shows the secondary treated quantities. As for the tertiary treatment, it is only applied in thirteen governorates as shown in Figure 14 In summary, 16% is primary treated, 73% is secondary treated, and 11% is tertiary treated.

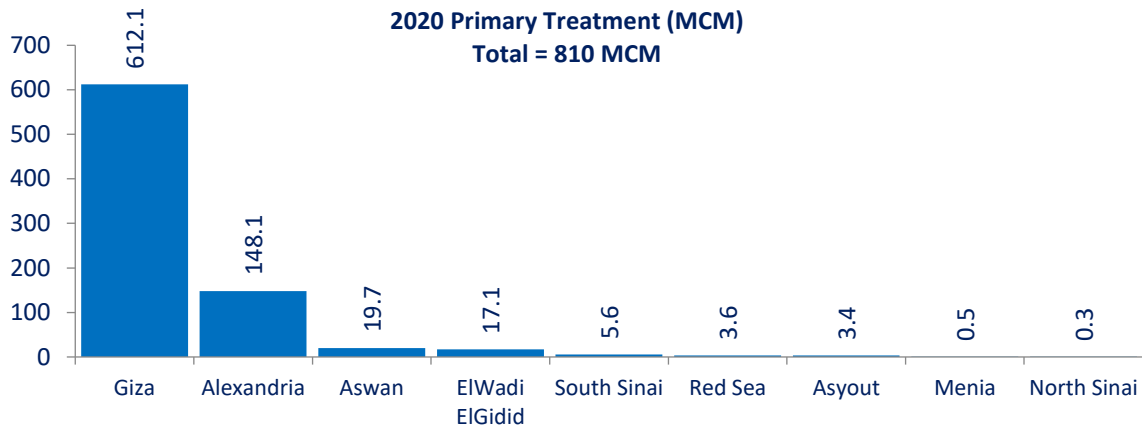


Figure 12: Primary treated wastewater by governorates (CAPMAS, 2020) (prepared by CEDARE)

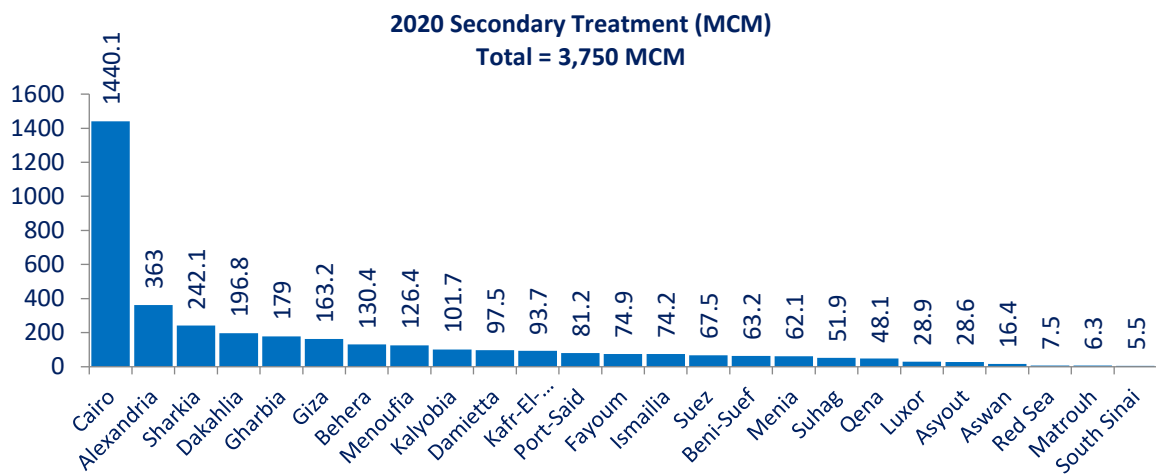


Figure 13: Secondary treated wastewater by governorates (CAPMAS, 2020) (prepared by CEDARE)

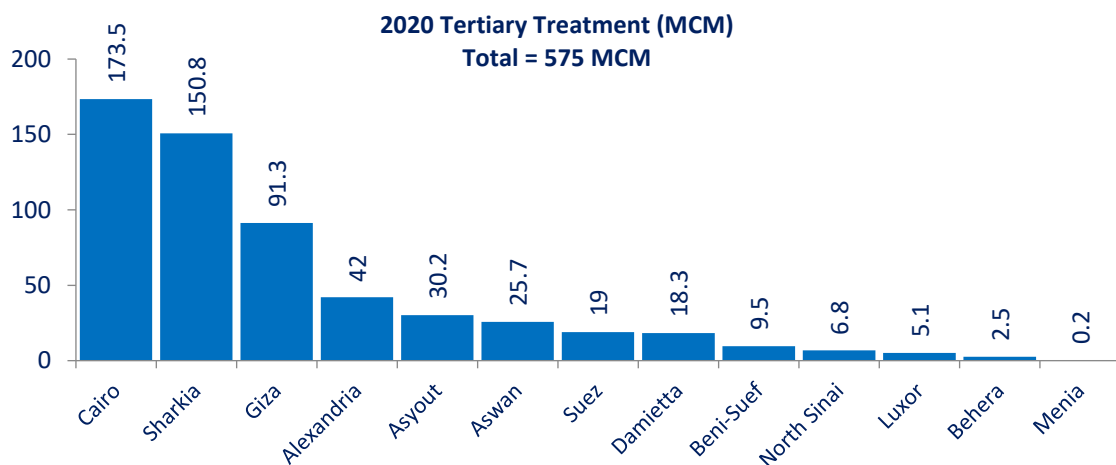


Figure 14: Tertiary treated wastewater by governorates (CAPMAS, 2020) (prepared by CEDARE)

E. 2020 Wastewater Summary

The 2020 Wastewater situation is summarized in Figure 15, where it can be visually seen that the opportunities for increasing the collection of wastewater along with more treatment and more reuse still exists.

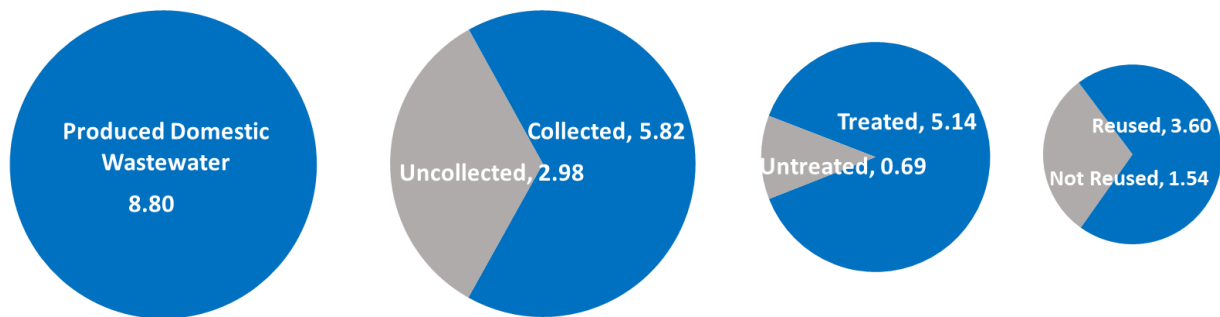


Figure 15 Wastewater Situation in Egypt in 2020 in BCM (prepared by CEDARE)

The wastewater situation is also summarized from a different perspective as shown in Figure 16.

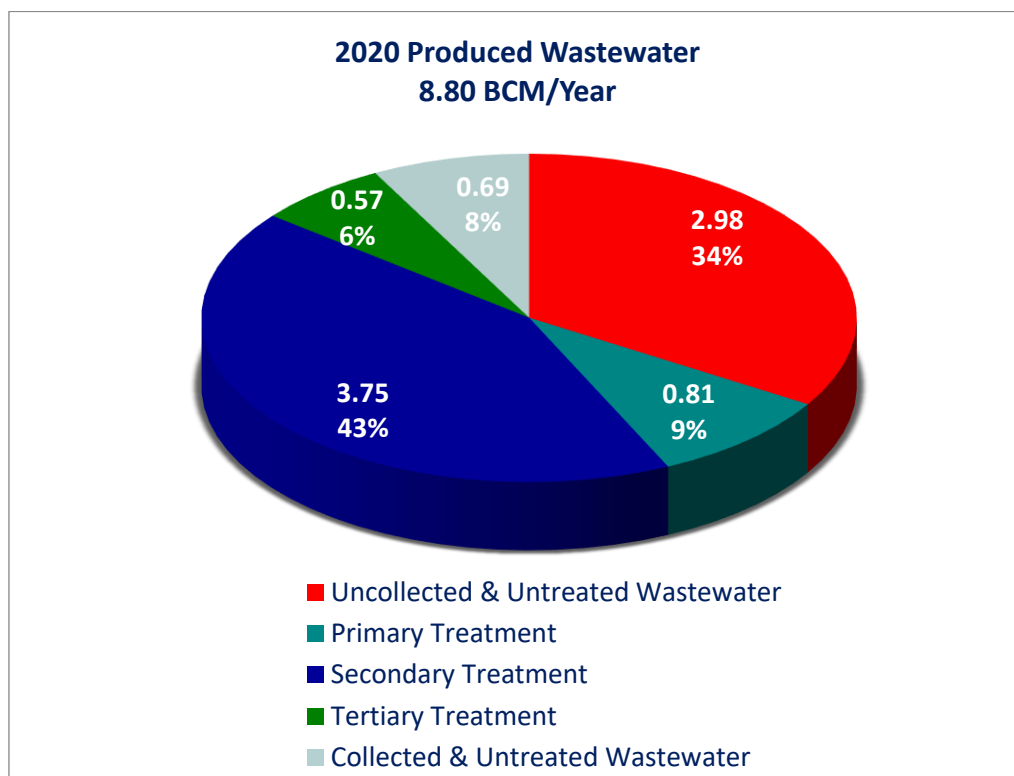


Figure 16: 2020 Produced Wastewater (prepared by CEDARE)

The 2020 national baseline wastewater balance was estimated below to show the different types of wastewater including domestic and industrial wastewater as well as agriculture drainage which are often times difficult to separate. It includes an estimated amount of uncollectable wastewater which mainly goes to septic tanks. It also shows the estimated amounts of direct and indirect water reuse including the estimated amounts of indirect reuse of mixed domestic and industrial wastewater that goes through every type of conveyance channels; Nile River and irrigation canals as well as agriculture drains. It also shows the final destination of the produced wastewater and agriculture drainage (treated and/or untreated); whether it is reused in agriculture, landscaping or disposed into seas (Mediterranean and Red Sea), coastal lakes (Northern Mediterranean Lakes) or internal lakes (Lake Qarun and Wadi ElRayan). The salinity of the disposed agriculture drainage ranges from 1000 ppm to 3000 ppm. (See Figure 17).

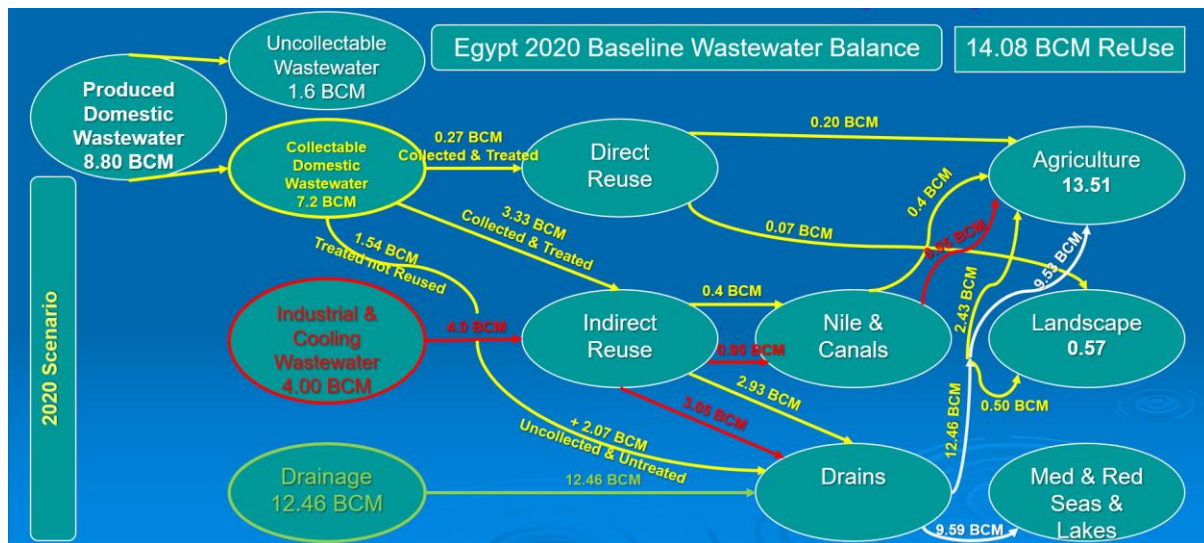


Figure 17: Egypt Baseline Wastewater Balance for 2020 (prepared by CEDARE)

V. 2030 Population, Water and Wastewater Probable Projection Scenario

A. 2030 Population Probable Projection

In order to address the water reuse issue properly, a projection of the population increase to the year 2030 is necessary. In the last 20 years, the average of 4 years (2012-2015) with the highest population growth rate was 2.3%. (World Bank). Assuming the 2.3% growth rate, which is reasonable considering that the recent migration fluxes into Egypt are not considered in the census, the 2030 population in Egypt is projected to reach 126 million. As a result, the renewable freshwater water (mostly Nile Water) per person water share will reach about 450 m³/year, which is below the “absolute severe water scarcity” limit of 500 m³/year.

Two different scenarios were initially projected to forecast the 2030 distribution of the 126 million by governorate. The first scenario (Uniform Growth Scenario) assumed the same growth rate for all the governorates. The second scenario (Out-of-Valley Growth Scenario) took into consideration that there will be no room for expansion in the Delta and the Nile Valley governorates (Port Said, Damietta, Dakahlia, Kafr-El-Sheikh and Gharbia) and that there will be potential expansion in the desert front governorates. The desert front governorates have potential to absorb more population due to the available land to expand on agricultural, industrial and urban expansion projects. Whereas any expansion in urbanization or industrial activities in the Nile Valley and Delta governorates will be on the expense of building encroachment on existing fertile agriculture lands. See

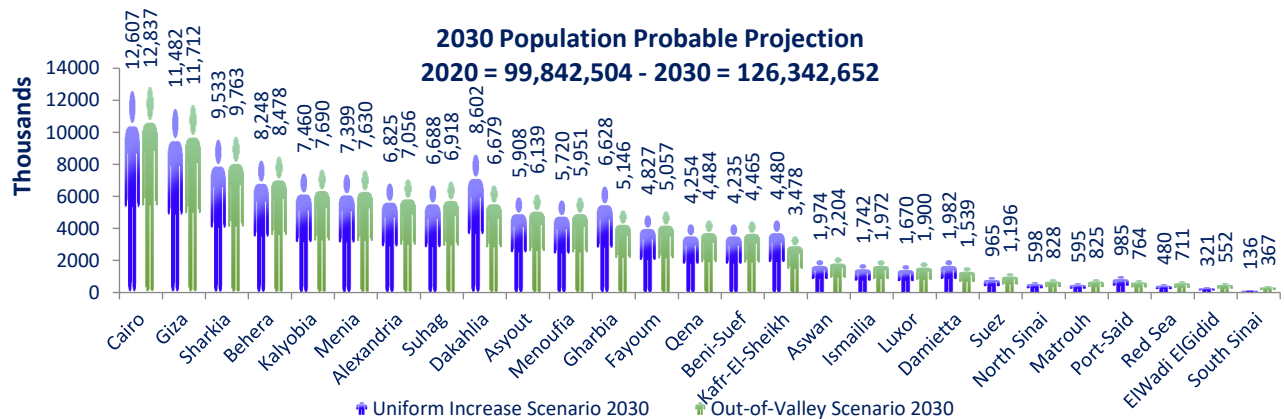


Figure 18 to see the expected distribution of growth by governorate for both scenarios.

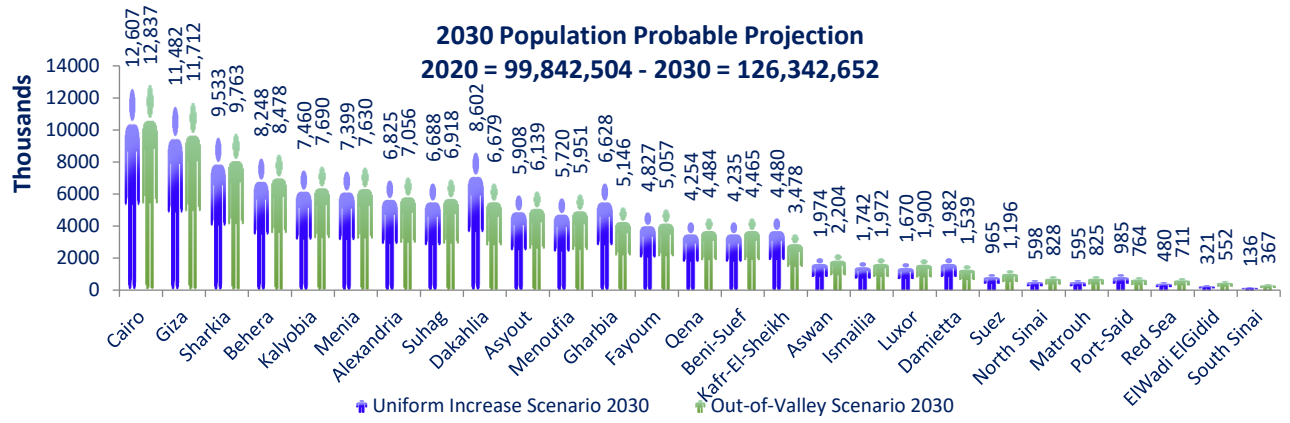


Figure 18: Egypt 2030 Population Projection (prepared by CEDARE)

B. 2030 Domestic Water Supply Probable Projection

Based on an estimated annual per capita demand of domestic water of 125 cubic meters of water (for planning purposes and to allow the capacity to meet peak demands) and a population of 126 million, the forecasted need for the water production for 2030 is expected to be 15.793 BCM/year. Based on the Uniform Growth Scenario and the Out-of-Valley Growth Scenario, the 2030 Water Supply was projected by governorate, Since the focus of the government is to move out of the valley, the “Out-of-Valley” scenario was considered, as shown in Figure 19.

Table 1 below shows a range of consumption design rates of different urban and rural areas in the 2010 Egyptian Code for the operation and design of drinking water and sanitation networks.

Table 1 Range of Consumption of different Urban & Rural Areas

Range of Consumption of different Urban & Rural Areas					
Zone type	Population (capita)	Daily Consumption Range (liter/capita/day)		Annual Consumption Range (m3/capita/year)	
Villages	to 50,000	100	150	36.50	54.75
Centers	50,000 - 500,000	150	200	54.75	73.00
Small Cities	500,000 - 1000,000	200	250	73.00	91.25
Big Cities	> 1000,000	250	280	91.25	102.20
New Cities		280	320	102.20	116.80
Tourism Cities		350	400	127.75	146.00

Table 2 below shows the 2020 Baseline for Domestic Water Supply & Industrial Water Supply in BCM/year.

Table 2: 2020 Baseline of Domestic Water Supply & Industrial Water Supply

2020 Baseline	Water Supply	Industry	Total (BCM/Y)
2020 Baseline	11.00	4.00	15.00

Table 3 below shows 2030 Domestic Water Supply & Industrial Water Supply from the MWRI NWRP Plan 2037.

Table 3: 2030 Domestic Water Supply & Industrial Water Supply from NWRP Plan 2037

NWRP Plan 2037	Water Supply	Industry	Total (BCM/Y)
Optimistic BaU 2030	12.63	5.71	18.34
Probable BaU 2030	12.96	5.81	18.77
Pessimistic BaU 2030	14.43	5.98	20.41
Probable NWRP 2030	12.97	5.64	18.61

The Table 4 below shows 2030 Domestic Water Supply according to MHUUC/HCWW

Table 4 2030 Domestic Water Supply (MHUUC/HCWW)

2030 MHUC/HCWW	Water Supply
2030 MHUC/HCWW	15.90

The Table 5 below shows 2030 Domestic Water Supply & Industrial Water Supply scenarios considered in this 2030 Water Reuse Strategy

Table 5 2030 Domestic Water Supply & Industrial Water Supply in 2030 Water Reuse Strategy

2030 Water Reuse Strategy	Water Supply	Industry	Total
Probable Scenario 2030	15.79	4.25	20.04
Conservative Scenario 2030	12.63	5.71	18.34

The following analyzed scenario considers the Probable 2030 Scenario as an upper limit of what could be provided in wastewater potential which is in its total of domestic and industrial water supply reaches about 20 BCM/year in 2030 but considers MHUUC projections for domestic water supply of 15.79 BCM/year by 2030.

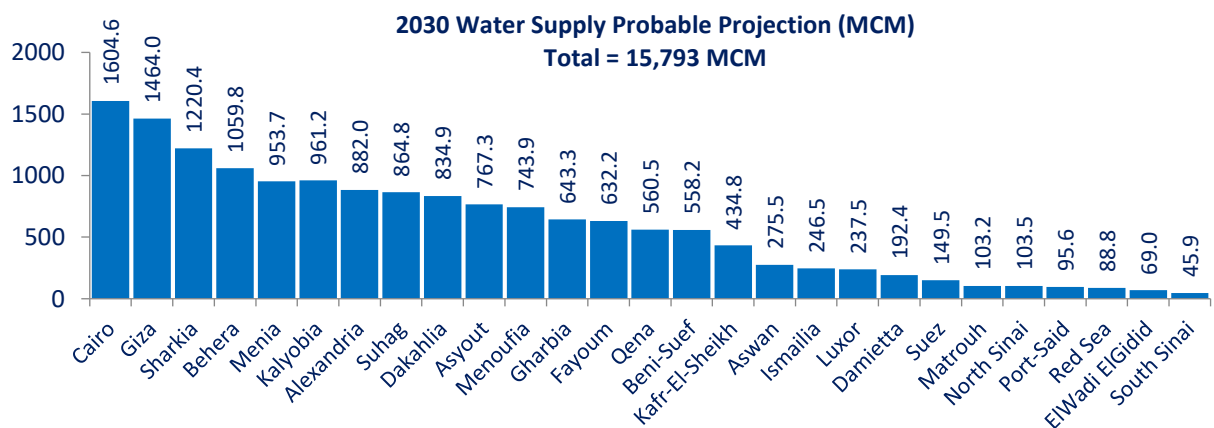


Figure 19: 2030 Projected Domestic Water Production, "Out-of-Valley" scenario (prepared by CEDARE)

B. 2030 Produced Wastewater and Treated Wastewater Probable Projection

As previously mentioned, since there are national programs to reduce system losses, for the sake of this strategy, it is estimated that 80% of the produced water will be transformed to the produced wastewater in 2030, with losses as low as 20%. That is, the 2030 Produced wastewater was forecasted for 2030 to be 12.634 BCM/year. Figure 20 displays the expected produced wastewater by governorate for the 2 scenarios.

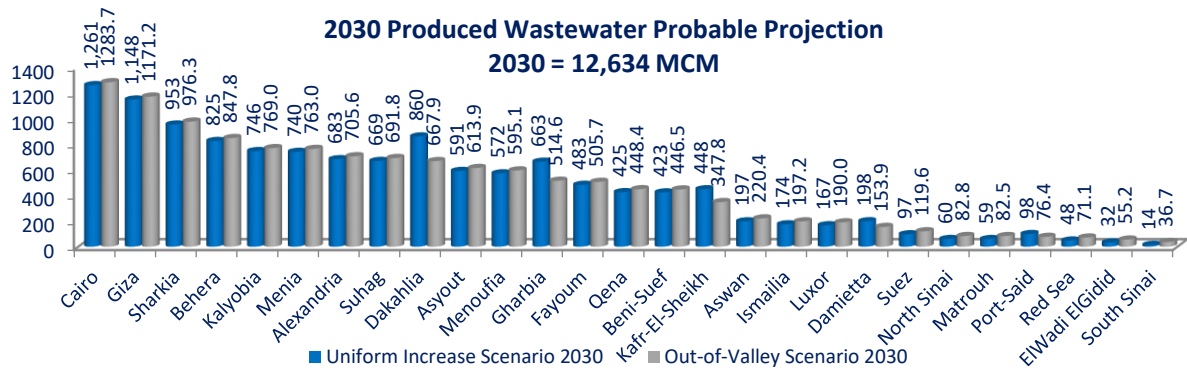


Figure 20: 2030 Produced Wastewater Projections (prepared by CEDARE)

Since the focus of the government is to move out of the valley, the “Out-of-Valley” scenario was considered, as shown in Figure 21.

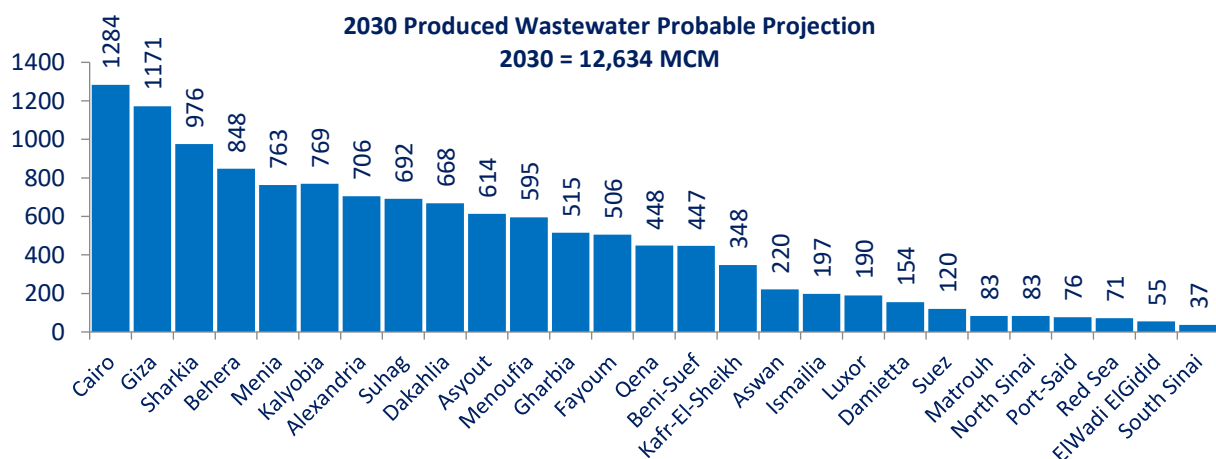


Figure 21: 2030 Produced Wastewater Projections, “Out-of-Valley” Scenario (prepared by CEDARE)

B. 2030 Projected Wastewater Summary Probable Projection

The forecasted 2030 Wastewater situation is summarized in Figure 22, where it can be visually seen when compared to the baseline that there is increased collection of wastewater along with more treatment and more reuse.

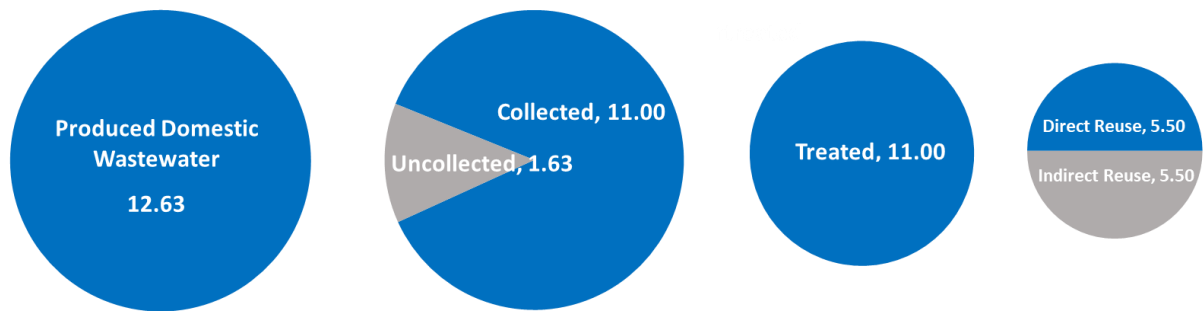


Figure 22: Wastewater & Reuse Projections for 2030 (prepared by CEDARE)

The projected 2030 Wastewater situation is summarized in Figure 23. The 2030 Strategy targets that all collected wastewater will be at least secondary treated. Figure 24 also shows uncollected wastewater and tertiary treated wastewater. It shows that there will almost be no increase in uncollected wastewater.

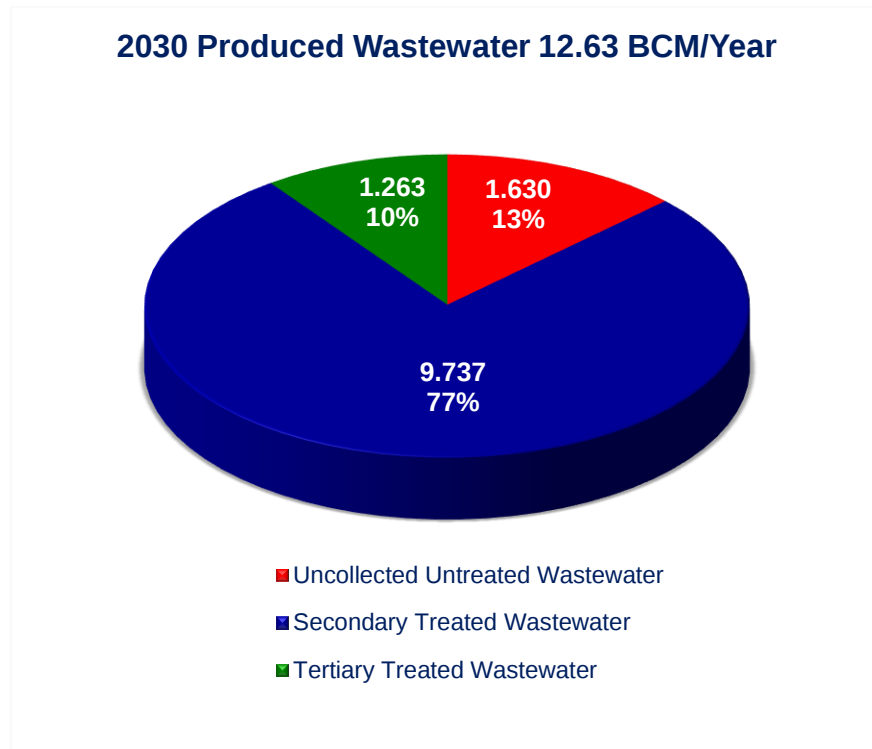


Figure 23: 2030 Produced Wastewater (prepared by CEDARE)

Figure 24 shows the 2030 Wastewater Balance based on the achievement of this 2030 Strategy Targets. It shows when compared to the Baseline Wastewater Balance that the amount of mixed wastewater drainage water disposed into the seas and lakes will be significantly reduced due to the increase in the amount of water reuse. There are also parallel national programs that are taking place for modernizing irrigation which will have their impact on the reduction of agriculture drainage as reflected in the amount of produced agriculture drainage in 2030 compared to the Baseline amount of produced agriculture drainage. The 2030 Wastewater Balance shows the increase in direct and indirect reuse amounts in 2030 with a total water reuse around 23 BCM/year with about 9 BCM/year more than the Baseline. The details of these reuse amounts and wastewater and agriculture drainage disposal is related to the 2030 targets which are projected in the following sections of this strategy document.

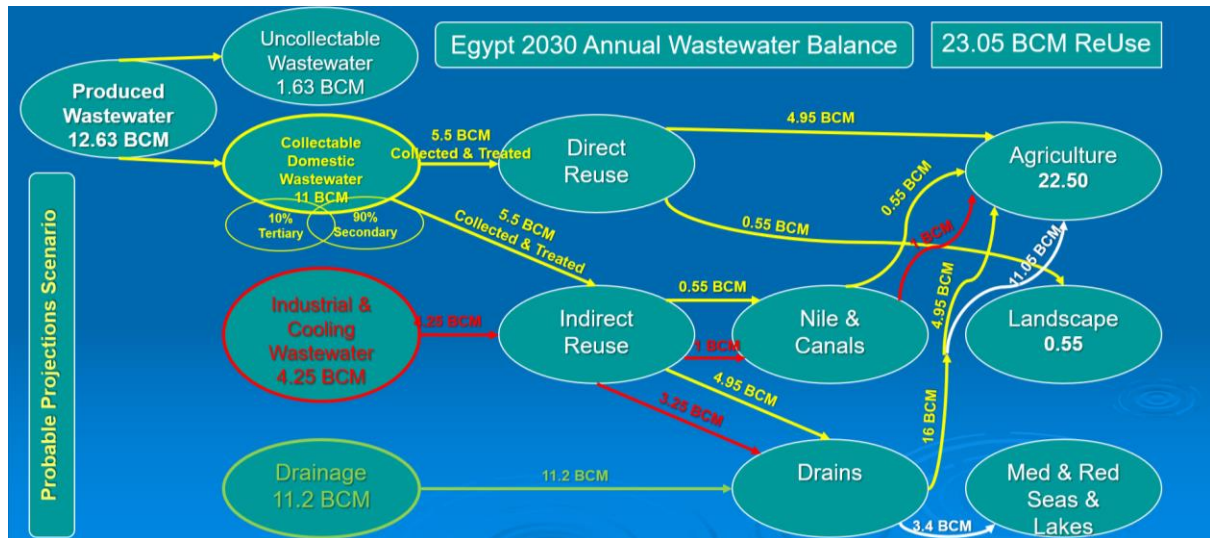


Figure 24: Egypt 2030 Wastewater Balance (prepared by CEDARE)

It can be seen that the mixed wastewater and agricultural drainage disposed into the Seas and Lakes in 2030 will be reduced from about 9.59 BCM/year (essential to get rid of the accumulated salts) in 2020 to about 3.4 BCM/year in 2030.

C. 2030 Projected Growth Needed

Figure 25 summarizes the needed growth in domestic water supply (water treatment and/or desalination) and the expected produced domestic wastewater, along with the expected wastewater treatment assuming all collectable wastewater will be treated and uncollectable wastewater going to septic tanks is considered naturally treated wastewater.

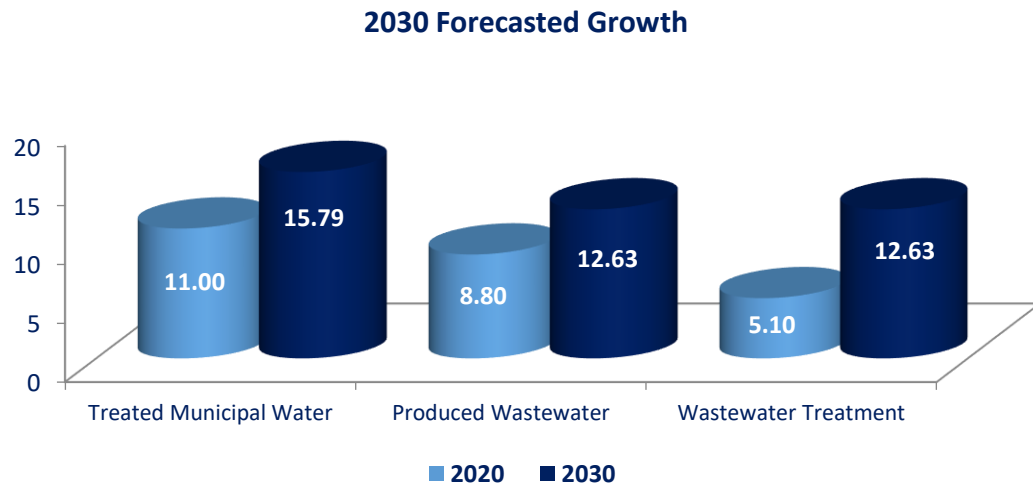


Figure 25: 2030 Forecasted Growth (prepared by CEDARE)

In conclusion, growth in domestic water supply treatment and desalination as well as wastewater treatment are no longer an option. It is an obligation. The following are needs to meet and keep up with the expected growth for domestic water and wastewater between 2020 and 2030:

- Additional 4.79 BCM of domestic water supply (i.e., surface water or groundwater treatment plants or desalination plants)
- Additional wastewater collection systems (i.e., wastewater networks or properly managed septic tanks) to handle an additional 3.83 BCM produced wastewater
- Additional 7.53 BCM in wastewater treatment

Based on the needed growth in municipal water, it is estimated that a water treatment capacity of 0.5 BCM needs to be built every year between 2020 and 2030.

Figure 26 below summarizes the needed growth in domestic water supply capacity until 2030.

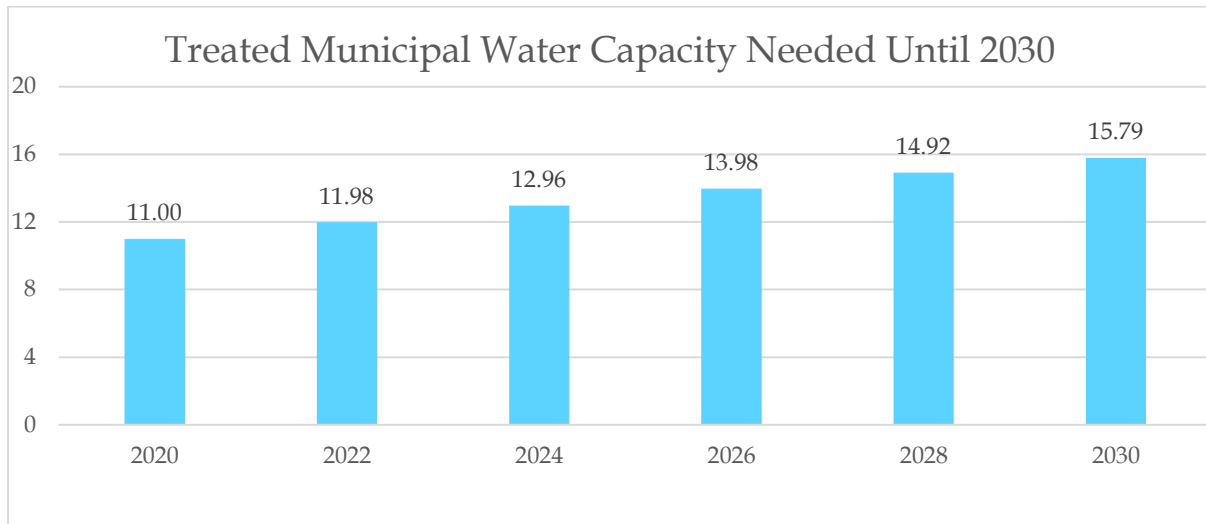


Figure 26: Treated Municipal Water Capacity Needed Until 2030 (modified from HCWW, 2011) (prepared by CEDARE)

Based on the needed growth in wastewater treatment, it is estimated that a wastewater treatment capacity of 0.75 BCM needs to be built every year between 2020 and 2030. The rate of wastewater treatment capacity increase is greater than water capacity as this sector was lagging behind.

Figure 27 below summarizes the needed growth in wastewater treatment capacity until 2030.

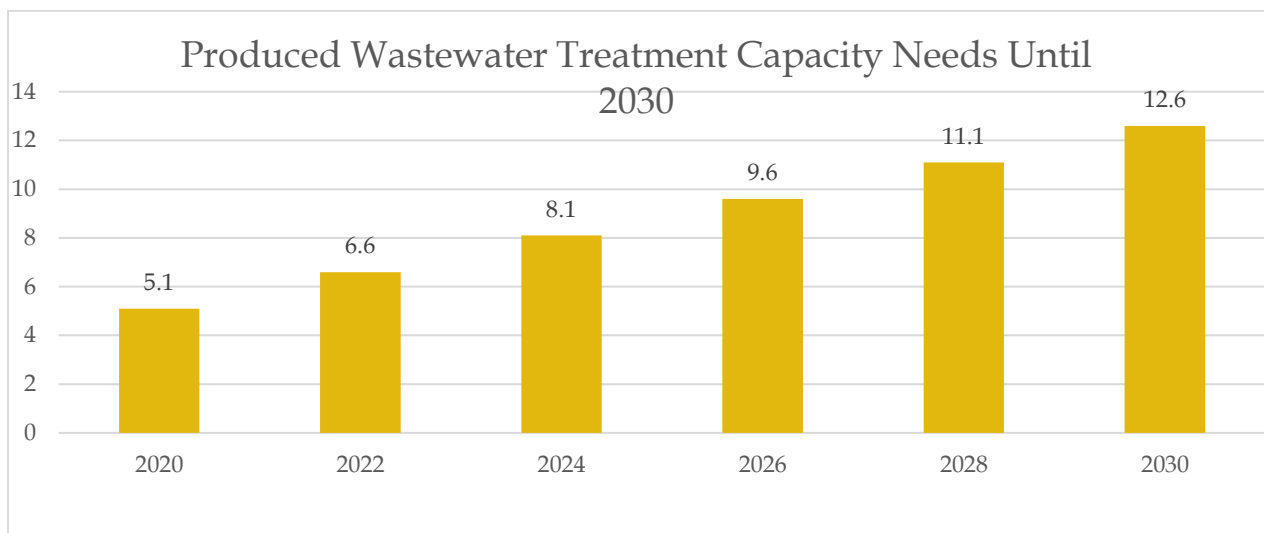


Figure 27: Produced Wastewater Treatment Capacity Needs until year 2030 (modified from HCWW, 2011) (prepared by CEDARE)

D. Water Reuse Potential

Of course, water resources management and development should be done ideally in an integrated manner where wastewater treatment plants are located near local populations and agricultural development areas. With integrated planning, and the implementation of this 2030 Water Reuse Strategy, an additional 8.97 BCM/year of reclaimed water can be supplied to agricultural lands and landscape irrigation over the 14.08 BCM/year of wastewater and agriculture drainage reuse in 2020 to reach a total of about 23.05 BCM/year. It has to be noted that there is another form of reuse that is also taking place in Egypt's water system represented in the shallow groundwater reuse of water that is captured from percolation and infiltration from irrigation networks before going to agriculture drains.

VI. 2030 Water and Wastewater Conservative Projection Scenario

A. 2030 Domestic Water Supply Conservative Projection

Based on an estimated annual per capita demand of domestic water of 100 cubic meters of water (for planning purposes and to allow the capacity to meet peak demands) and a population of 126 million, the forecasted need for the water production for 2030 is expected to be 12.63 BCM/year. Since the focus of the government is to move out of the valley for urban development, based on the Out-of-Valley Growth Scenario, the 2030 Water Supply was projected by governorate as shown in Figure 28.

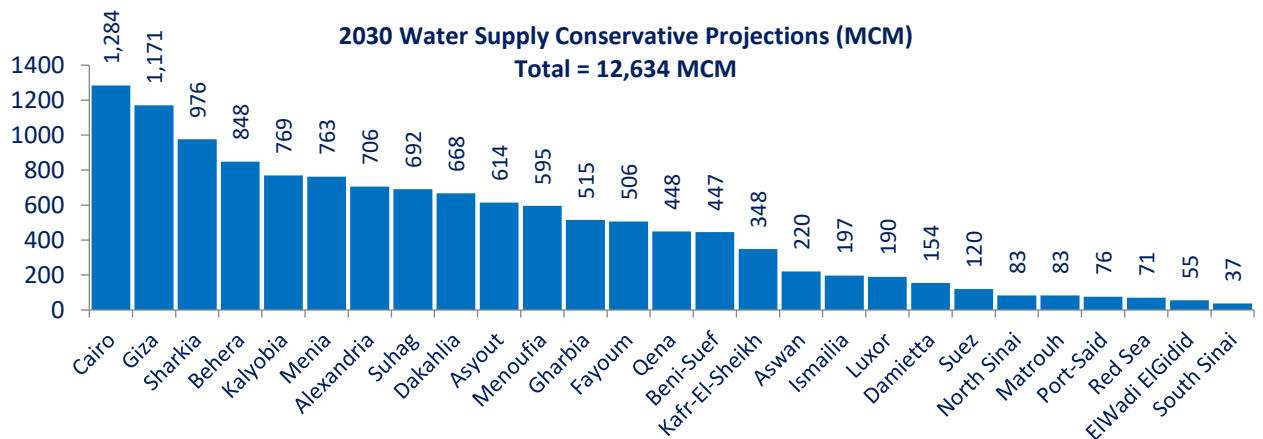


Figure 28: 2030 Water Supply Projections, “Out-of-Valley” Scenario (prepared by CEDARE)

B. 2030 Produced Wastewater and Treated Wastewater Conservative Projection

As previously mentioned, since there are national programs to reduce system losses, for the sake of this strategy, it is estimated that 80% of the produced water will be transformed to the produced wastewater in 2030, with losses as low as 20%. That is, the 2030 Produced wastewater was forecasted for 2030 to be 10.11 BCM/year.

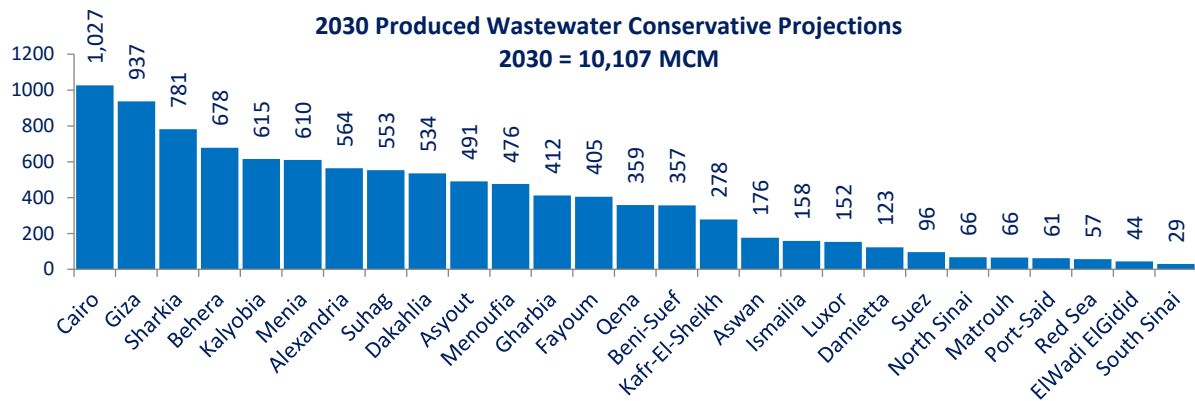


Figure 29 displays the expected produced wastewater by governorate.

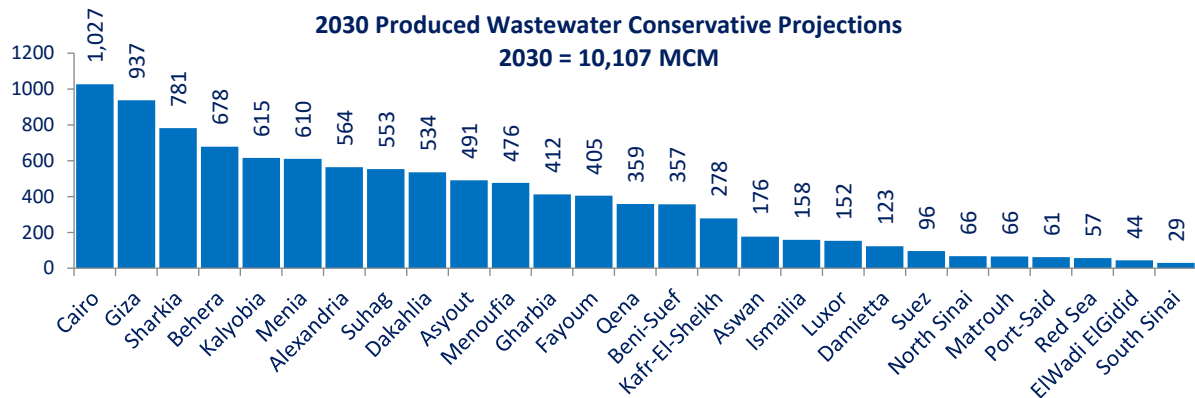


Figure 29: 2030 Produced Wastewater Projections (prepared by CEDARE)

C. 2030 Wastewater Summary Conservative Projection

The forecasted 2030 Wastewater situation is summarized in Figure 30, where it can be visually seen when compared to the baseline that there is increased collection of wastewater along with more treatment and more reuse.

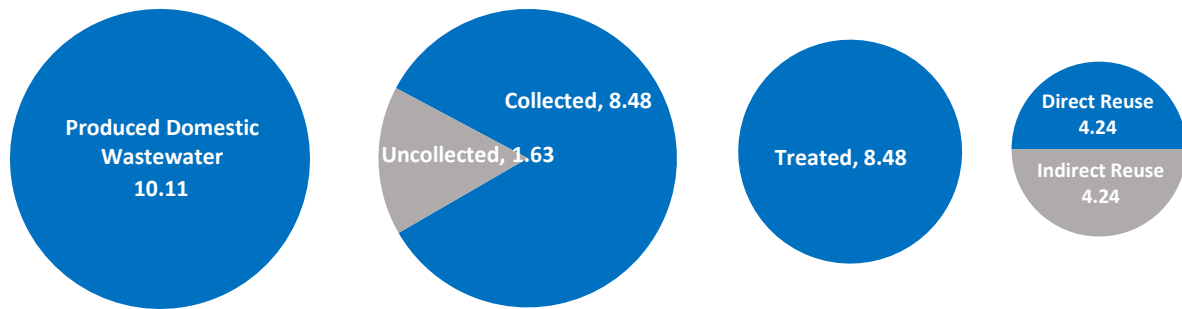


Figure 30: Wastewater & Reuse Projections for 2030 (prepared by CEDARE)

The projected 2030 Wastewater situation is summarized in Figure 31. The 2030 Strategy targets that all collected wastewater will be at least secondary treated. Figure 24 also shows uncollected wastewater and tertiary treated wastewater. It shows that there will almost be no increase in uncollected wastewater.

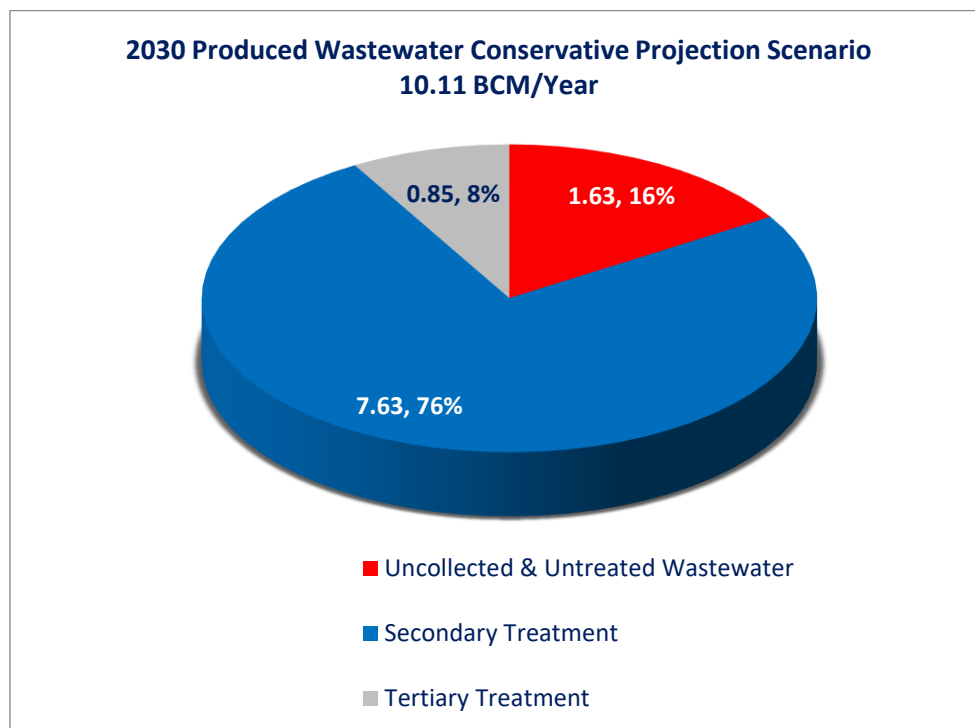


Figure 31: 2030 Produced Wastewater (prepared by CEDARE)

Figure 32 shows the 2030 Wastewater Balance based on the achievement of this 2030 Strategy Targets. It shows when compared to the Baseline Wastewater Balance that the amount of mixed wastewater drainage water disposed into the seas and lakes will be significantly reduced due to the increase in the amount of water reuse. There are also parallel national programs that are taking place for modernizing irrigation which will have their impact on the reduction of

agriculture drainage as reflected in the amount of produced agriculture drainage (estimated at 10.46 BCM/year) in the “Conservative” 2030 scenario as compared to that in the “Probable” 2030 Scenario (11.2 BCM/year) and the Baseline amount (12.46 BCM/year) of produced agriculture drainage. The 2030 Wastewater Balance shows the increase in direct and indirect reuse amounts in 2030 with a total water reuse around 21.7 BCM/year with about 7.7 BCM/year more than the Baseline. The details of these reuse amounts and wastewater and agriculture drainage disposal is related to the 2030 targets which are projected in the following sections of this strategy document.

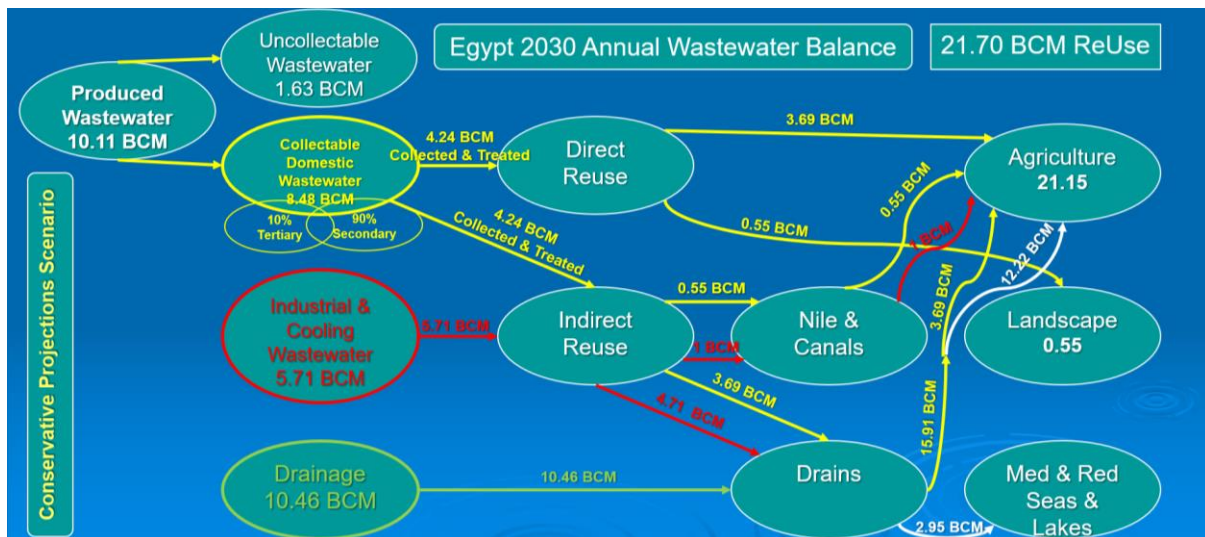


Figure 32: Egypt 2030 Wastewater Balance (prepared by CEDARE)

It can be seen that the mixed wastewater and agricultural drainage disposed into the Seas and Lakes in 2030 will be reduced from about 9.59 BCM/year (essential to get rid of the accumulated salts) in 2020 to about 2.95 BCM/year in 2030.

VII. Expansion Projects and Potential for Water Reuse

During the preparation of this strategy, there has been an acceleration of developmental projects including three major agricultural drainage treatment and reuse projects were announced. They are included here and in the following sections of this strategy where the 2030 local targets are being presented. They were inaugurated after the development of this strategy had started. It is important to note that these water reuse projects are considered indirect wastewater reuse projects as they include agricultural drainage mixed with municipal treated wastewater, while other agriculture expansion or rehabilitation projects that are potential for reuse projects discussed in this section are considered potential for direct domestic wastewater reuse. Some of these projects are agricultural expansion projects that were being planned to depend on groundwater use, which is mostly groundwater and could be a potential for wastewater reuse where wastewater can provide a more sustainable and “renewable” water resource.

On the other hand, there are ongoing efforts to expand the municipal water supply and wastewater treatment infrastructure, in urban areas and rural areas especially through the “Hayat Karima” program.

In this section, the main projects that are potential for direct and indirect water reuse will be discussed.

A. West Delta Irrigation Improvement

Figure 33 shows the extent of the West Delta agriculture development area that requires water for supplemental irrigation. The area was developed on the basis of using groundwater for irrigation, but over the years, groundwater was depleted, with water table decreasing and salinity increasing. A different and additional source of water is required. Previously, there were other proposals to support the depleted groundwater with water from the Nile, and the World Bank together with the Ministry of Water Resources & Irrigation studied the feasibility of the project. The area is important for agriculture development and export of agriculture products. Big private investment has been spent in that area which is about 180,000 feddans. In a survey that was conducted by the Egyptian Water Partnership in the first stage area of about 144,000 feddans, the majority of agriculture investors in the area expressed their

willingness to pay for the conveyance of supplemental water to compensate for the depleted groundwater. This encouraged financial institutions such as the World Bank to explore financing the project. The project was going to be built and operated by the private sector, a model that was going to be implemented for the first time in Egypt. However, due to the government's fear at that time to commit to the risk of guaranteeing cost recovery payments by the agriculture investors (farmers), in addition to the risk in securing enough freshwater from the Nile river to that project due to the increasing and competing demand, the government halted the project which didn't move forward since the conclusion of its feasibility study in 2009. In addition, there were not many private sector companies that were interested in bidding for operating the project.

The same project could be revisited with water reuse in mind where it could be proposed to reuse water from close-by domestic wastewater treatment stations. For example, the Abu-Rawash wastewater treatment plant with design capacity of 1.2 MCM/day (0.4 BCM/Year), and which is currently being upgraded to a design capacity of 1.6 MCM/day (0.58 BCM/Year) (ORASCOM, 2019) could provide an adequate water resource for the supplemental irrigation needed. This water can be reused to supply the agriculture lands that are deserted due to depleted groundwater via direct reuse, subject to technical and economic feasibility.

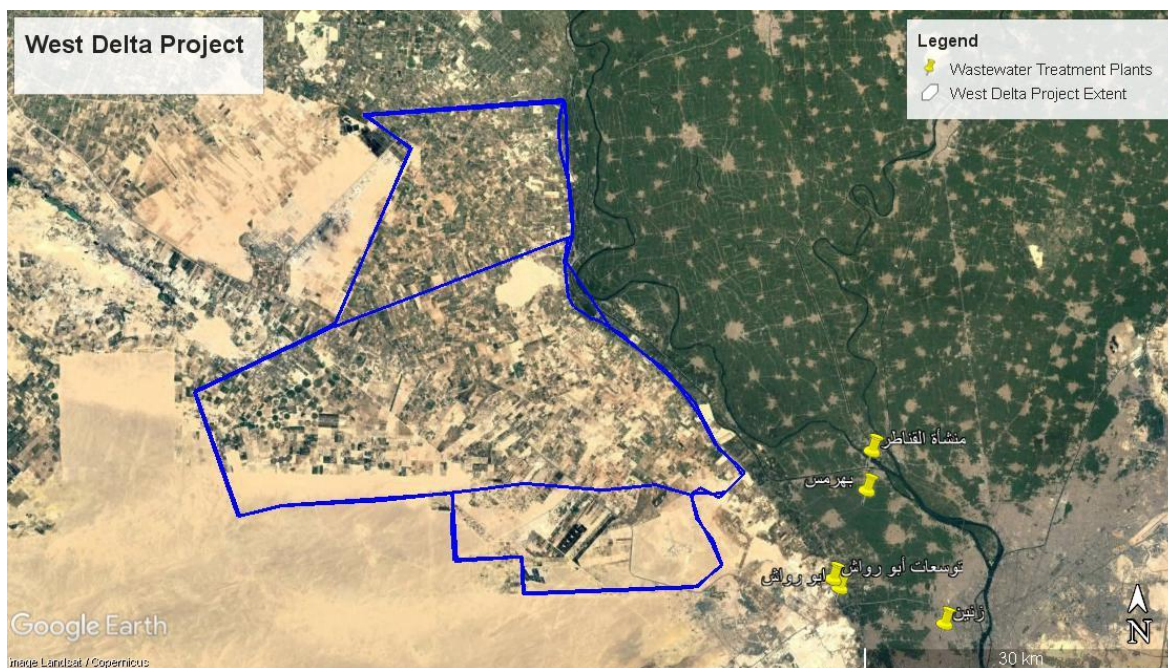


Figure 33: West Delta Project (prepared by CEDARE)

B. 1.5 Million Feddans Project

In 2015, Egypt inaugurated the 1.5 million feddans project to expand agricultural lands in the desert front governorates where there is space agriculture expansion and possible associated urban development. The areas and locations planned for cultivation are summarized in Table 6 below. Figure 34 shows the geographical locations of the project.

Table 6: 1.5 Million Feddans Project Locations (Scientific Research Ministry, 2016)

Location	Area (1000 Feddans)
Old Farafra	190
New Farafra	40
Dakhla Extension	50
El-Moghara	170
Amal Village	3.5
Toshka	138
El-Marashda	43.5
West West-Minya	370
South West Qattara Depression	140
East Siwa	30
West Kom Ombo	25
West Minya	250
El-Tor	20
Total	1500

Originally, the plan was to develop those lands using groundwater, which is mostly non-renewable. The cultivation of the 1.5 million feddans are estimated to need 4000 cubic meter/year of water for each feddan for a net total of 6 BCM/y. (Ministry of Scientific

Research, 2016). With the potential of population increase due to this development, there will be extra domestic and industrial water demand added.

Given the fact that groundwater in these areas is mostly non-renewable, an alternative proposal would be to reuse water from nearby municipal wastewater treatment plants for supplemental irrigation. The reuse of water in the agriculture sector could relieve the stress on the non-renewable groundwater, making it available for the domestic purposes (drinking water). 4 of the above-mentioned locations may be considered as a potential for water reuse as these are locations that may be relatively closer to treatment plants. The section on local targets in this strategy explores this potential in more details.

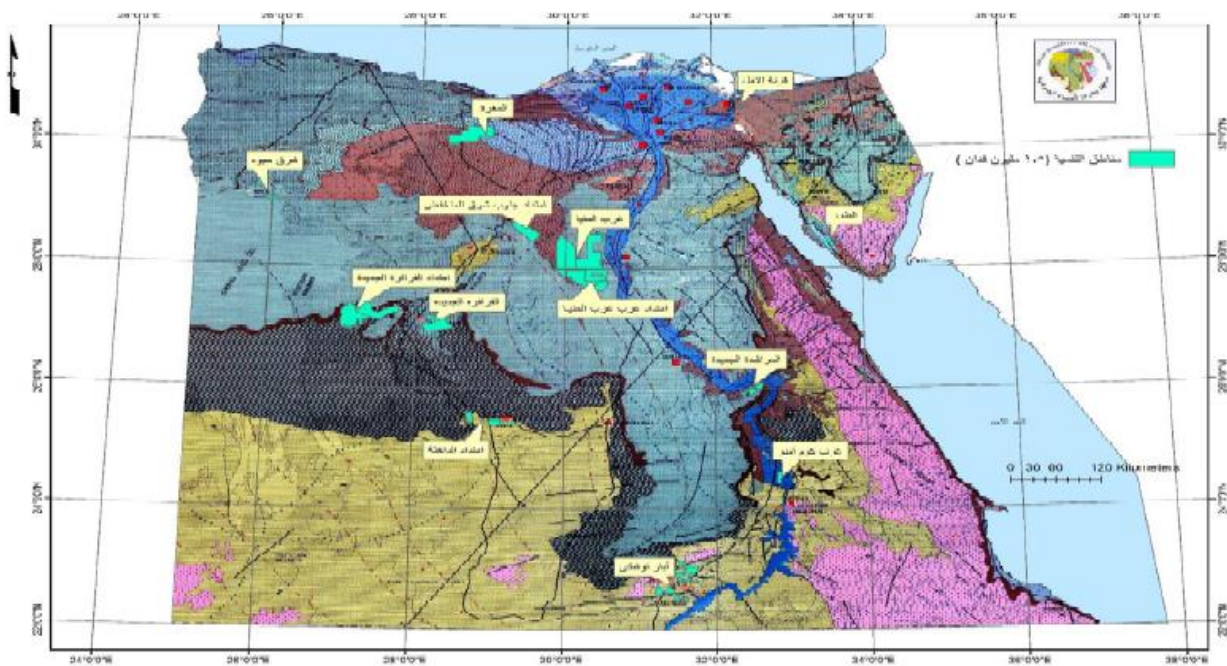


Figure 34 : 1.5 Million Feddans project locations

C. Agriculture Development with Treated Agriculture Drainage (Mixed with Indirect Wastewater)

Another alternative is the indirect reuse of reclaimed wastewater mixed with agriculture drainage. This approach utilizes mixed treated/untreated wastewater with agricultural drainage water from agriculture drains to be treated for agricultural expansion projects.

Three major examples for this approach are the Mahsama, Bahr El-Baqar, and New Delta (ELHamam) projects. Mahsama has the capacity to treat 1 MCM/day to be also conveyed to the east side of the Suez Canal for irrigation. Bahr El-Baqar has the capacity to treat 5.6 MCM/day from Bahr El-Baqar drain, where the treated water is then conveyed to Sheikh Gaber Canal to be used east of the Suez Canal to cultivate 380 thousand feddans in North Sinai. The New Delta treatment plant will have the capacity of treating about 7.5 MCM/day, where treated will be conveyed to provide irrigation water to the New Delta/Mostakbal Masr agriculture development area of about 2.0 million feddans.

D. New Cities' and the New Administrative Capital

With the continuing progress in developing new cities, including the New Administrative Capital, New Alamein, ElGalala, a closer look should be taken on the fate of water reuse from wastewater treatment plants in the vicinity. While normally this reclaimed water would be reused in landscaping, the potential would be to shift to desert landscaping, which consumes less water, and to utilize reclaimed water in agriculture of beneficial crops and food production in neighboring lands. This concept could be also applied in all new cities and communities being developed and planned by the New Urban Communities Authority (NUCA).

The New Administrative Capital is a long term phased project which is planned to be operational in its first phase which will be completed in 2022. It is expected when fully operational to be generating substantial amounts of wastewater which could be a potential for supporting the city's landscaping but may also have the potential of supporting agriculture.

VIII. Existing Goals, Strategies, Plans and Wastewater Treatment & Reuse related Targets

The topic of water reuse was addressed below in the description of different Goals, Strategies and Plans and the related Targets to water reuse. An overview on the targets are also summarized in Table 7.

A. 2030 UN Sustainable Development Goal 6



The UN Sustainable Development Goals are global goals to achieve a more sustainable future for all and the goals were endorsed by the UN General Assembly in 2015. The goals are to be achieved by 2030. Among the 17 goals was the 6th goal, SDG 6, to “ensure availability and sustainable management of water and sanitation for all”. There are 6 targets related to SDG 6, of which 2 targets that are relevant to wastewater and

reuse and thus to this strategy, Target 6.2 and 6.3.

- Target 6.2 addresses the access to sanitation and hygiene and on open defecation that states: "By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations." This target has one indicator: Indicator 6.2.1 is the "Proportion of population using (a) safely managed sanitation services and (b) a hand-washing facility with soap and water".

According to the Egypt's Holding Company for Water and Wastewater (HCWW), this indicator was translated to mean that they will target the following: “By 2030, achieve 100% of safely managed sanitation coverage from 51% in 2015.

- Target 6.3 aims to improve water quality, wastewater treatment and safe reuse: “By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally”.

(UN Sustainable Development Goals, 2015) There are 2 indicators that are relevant. Indicator 6.3.1.a and Indicator 6.3.1.b

- SDG Indicator 6.3.1.a: By 2030, halving the proportion of untreated (and unsafely treated) domestic and industrial wastewater. Accordingly, this can be restated for the local case to state: By 2030, halve the percentage of produced untreated wastewater from 40% in 2015, according the “3rd Arab State of the Water Report for the Arab Region”. (UN Sustainable Development Goals, SDG 6.3)
- SDG Indicator 6.3.1.b: By 2030, substantially increasing recycling and safe reuse globally.

B. Sustainable Development Strategy (SDS): 2030 Egypt Vision



The 2030 Egypt Vision is an ambitious national agenda launched in February 2016 by the Egyptian Government. The vision consists of eight main national goals to be met by 2030 that are in line with the United Nations Sustainable Development Goals (SDGs) and the Sustainable Development Strategy for Africa 2063.

The vision is under revision, but the preliminary and relevant targets related to wastewater and wastewater reuse include:

- Increasing treatment of wastewater. By 2030, increase the percentage of treated wastewater from the total wastewater to 80% from 50% in 2015. (Egypt 2030 Vision for Sustainable Development)
- Increasing the non-conventional water resources. By 2030, increase the percentage of non-conventional water resources used to total water resources to 40% from 20% in 2015. (Egypt 2030 Vision for Sustainable Development)
- By 2030, Decrease the share of disposed non-compliant industrial wastewater along the Nile to total disposed industrial wastewater from 21% in 2017 to 0%.
- By 2030, Increase the share of domestic wastewater meeting standards to the Nile River from 50% in 2017 to 100%.

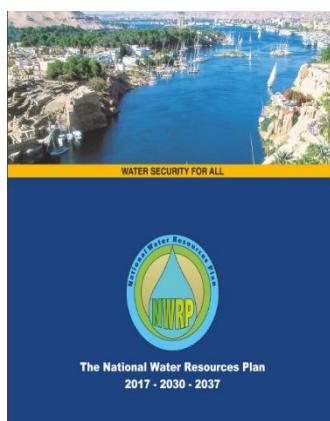
One of the comprehensive megaprojects under the Egypt Vision 2030 is the Hayah Karima project. It targets Egypt's most impoverished and vulnerable segments of the society in the countryside and remote villages mainly. Hayah Karima aims to provide decent housing, quality medical and educational services, and the necessary and basic infrastructure for the most impoverished and deprived rural villages and remote areas in Egypt that are needed for a decent life. The megaproject aims to significantly improve the quality of life and livelihood of 60 million Egyptians living in the countryside.

C. MWRI's Sustainable Development Strategy (SDS) 2030 Vision for Water Resources Management in Egypt

In the “Sustainable Development Strategy (SDS) 2030 Vision for Water Resources Management in Egypt” prepared by the MWRI, the amounts of treated wastewater was projected. Based on those projections, the amounts of the mixed agricultural and domestic wastewater for irrigation purposes are included and the quantities are specified quantities. (MWRI, 2017). The 2 relevant targets in this strategy include:

- By 2030, increase the amount of treated wastewater from 4 BCM in 2017 to 10.2 BCM. (2030 Sustainable Development Strategy for Water Resources Management in Egypt)
- By 2030, increase the amount of mixed agricultural and domestic wastewater used for agricultural purposes to 16 BCM from 13.5 BCM in 2017. (2030 Sustainable Development Strategy for Water Resources Management in Egypt).

D. The National Water Resources Plan 2017-2030-2037 (MWRI 7/2017)



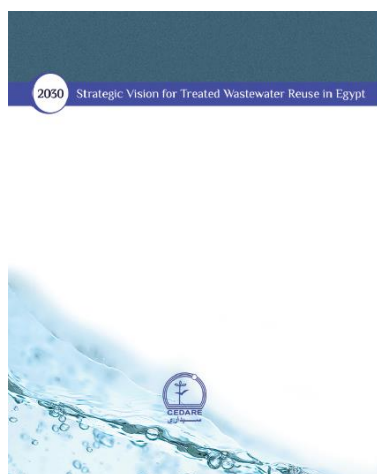
“The National Water Resources Plan 2017-2030-2037” was prepared by MWRI included plans to increase the amounts of available water resources by 2030, thus increasing produced treated wastewater. The related target for water reuse states:

- By 2037, 50% of the agricultural drainage flow will be safely reused for agricultural purposes.

E. Reuse of Domestic & Agricultural Wastewater Roadmap (2017)

A Roadmap was developed in 2017 by the water science committee under Academy for Scientific Research for “Reuse of Domestic & Agriculture Wastewater”.

F. “2030 Strategic Vision for Treated Wastewater Reuse in Egypt”



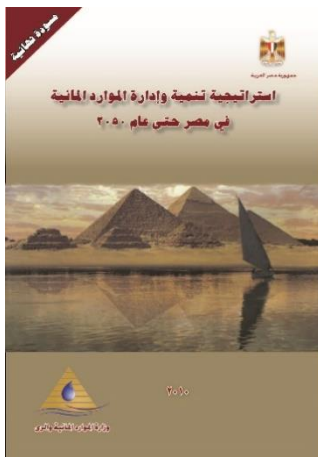
A “2030 Strategic Vision for Treated Wastewater Reuse in Egypt” was published by CEDARE in cooperation with six Ministries and included a study for the current situation back then in 2011 and offered strategic directions for waste reuse, including projections for wastewater and potential reuse in 2030 and the levels of treatment required. It also highlighted the targeted quantities to be reused with a plan to direct the treated wastewater to the areas with agricultural expansion potential.

The vision also included cost estimates for implementation and the roles of the different stakeholders. The strategic vision also played a role in the revision of the wastewater reuse code as will be highlighted in the next section. (CEDARE, 2014)

- By 2030, upgrade all the wastewater treatment plants operating using primary treatment to secondary treatment while maintaining all the plants using secondary treatment. The plants using tertiary treatment will be maintained without further upgrade of other plants to tertiary treatment. (2030 Strategic Vision for Treated Wastewater Reuse in Egypt)
- By 2030, a projected amount of 11.67 BCM of produced wastewater, from 7.05 BCM in the year 2011, will be treated mainly using secondary treatment (11.61 BCM) and the rest is the existing tertiary treated wastewater. (2030 Strategic vision for Treated Wastewater Reuse in Egypt)
- By 2030, 5.82 BCM of treated wastewater will be directly used in agricultural expansion areas. An increase in the amount of treated wastewater disposal into drains from 3.1 BCM in 2011 to 5.53 BCM as a potential for indirect reuse. (2030 Strategic vision for Treated Wastewater Reuse in Egypt)
- By 2030, 5.42 BCM of treated wastewater could be directed to cultivate the 1.4 million feddans planned in the “2030 Sustainable Agriculture Strategy”. An additional 97,560

feddans can be reclaimed using 0.4 BCM of treated wastewater (2030 Strategic vision for Treated Wastewater Reuse in Egypt)

G. 2050 National Strategy for Development and Management of Water Resources



The “2050 National Strategy for Development and Management of Water Resources” recognizes wastewater treatment as a possible solution in relation to one of the assumed future scenarios. According to the national strategy, expansion in water reuse is conditioned on the involvement of the private sector. (MWRI, 2010)

- By 2050, reach an amount of 18 BCM/year of treated wastewater (domestic, agricultural, and industrial) assuming a critical scenario in Egypt regarding population and economic growth. (MWRI, 2010)
- By 2050, reach an amount of 14.7 BCM/year of treated wastewater (domestic, agricultural, and industrial) assuming a balanced scenario in Egypt regarding population and economic growth. (MWRI, 2010)
- By 2050, reach an amount of 12.2 BCM/year of treated wastewater (domestic, agricultural, and industrial) assuming an optimistic scenario in Egypt regarding population and economic growth. (MWRI, 2010)
- By 2050, reach an amount of 12.2 BCM/year of treated wastewater (domestic, agricultural, and industrial) assuming an optimistic scenario in Egypt regarding population and economic growth. (MWRI, 2010)

H. Water Resources Development and Management Strategy Until 2050



The 2050 strategy for water resources development and management has been revised by MWRI to include 4 main pillars. This includes development of water resources, improvement of water quality, rationalization of water uses, and providing the enabling environment.

The following table presents a Summary of the above Existing Goals, Strategies, Plans and Targets related to Wastewater Treatment and Water Reuse.

Table 7: Summary of Existing Goals, Strategies, Plans and Targets related to Wastewater Treatment and Water Reuse
(prepared by CEDARE)

National Targets in current Visions, Strategies, and Plans	
A. 2030 UN Sustainable Development Goal 6 (SDG 6)	
1	SDG Target 6.2.1.a: By 2030, Achieve access to adequate and equitable & safely managed sanitation for all. (A safely managed sanitation facility is one where excreta is safely disposed of in situ or treated off-site.)
2	SDG Target 6.3.1.a: By 2030, Halving the proportion of untreated (and unsafely treated) domestic and industrial wastewater
3	SDG Target 6.3.1.b: By 2030, Substantially increasing recycling and safe reuse globally.
B. Egypt Sustainable Development Strategy (SDS) 2030 Vision	

4	By 2030, Increase the share of non-conventional water resources to the total water resources used from 20% in 2017 to 40%.
5	By 2030, Increase the share of treated wastewater to total generated wastewater from 50% in 2017 to 80%.
6	By 2030, Decrease the share of disposed non-compliant industrial wastewater along the Nile to total disposed industrial wastewater from 21% in 2017 to 0%.
7	By 2030, Increase the share of domestic wastewater meeting standards to the Nile River from 50% in 2017 to 100%.
C. MWRI for Sustainable Development Strategy (SDS) 2030 Vision	
8	By 2030, Increase non-conventional water resources used as a percentage of total used water resources from 26% in 2017 to 28%.
9	By 2030, Increase treated domestic wastewater from 4 BCM in 2017 to 10.2 BCM.
10	By 2030, Increase agricultural drainage & domestic wastewater mixed with fresh water for irrigation (Indirect Use) from 13.5 BCM in 2017 to 16 BCM.
D. The National Water Resources Plan 2017-2030-2037 (MWRI 7/2017)	
11	By 2037, 50% of the agricultural drainage flow will be safely reused for agricultural purposes.
Reuse of Domestic & Agricultural Wastewater Roadmap (2017)	
12	Modify National Strategies, Plans and Laws (up to 2 years).
F. 2030 Strategic Vision for Treated Wastewater Reuse (CEDARE, MWRI, MOA, MHUUC/HCWW, MOH, MOE, MOI)	
13	By 2030, Upgrade 0.9 BCM of primary treated wastewater in 2011 to secondary treatment.
14	By 2030, Eliminate all untreated wastewater (treat by secondary treatment)

15	By 2030, Increase the amount of secondary treated wastewater (domestic and industrial) from 2.42 BCM in 2011 to 11.61 BCM.
16	By 2030, Continue to operate the tertiary treatment (domestic and industrial) facilities without building new tertiary treatment plants.
17	By 2030, Increase direct reuse of treated wastewater from 0.27 BCM in 2011 to 5.82 BCM.
18	By 2030, Increase Indirect reuse of treated wastewater from 3.10 BCM in 2011 to 5.53 BCM.

IX. 2030 Shared National Water Reuse Targets

In order to assess the maximum potential water reuse by 2030, the Probable Projection Scenario mentioned in Section V was considered. The 2030 Shared National Water Reuse Targets agreed by the stakeholders of the NLA were divided into the 7 following categories, as shown in Figure 35, which are key to achieving maximum potential. It should be noted that these targets should preferably be done in an integrated manner when implementing any activities.

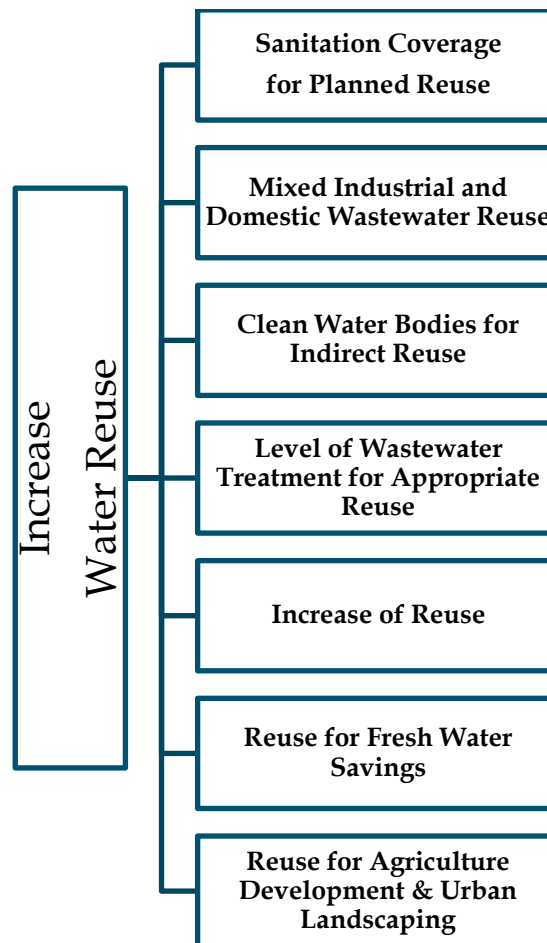


Figure 35: Categories to Achieve Increased Reuse

Sanitation Coverage for Planned Reuse: In this category, the aim is to provide 100 % sanitation coverage where all municipal waste are safely disposed of in situ or treated off-site. That is, either the municipal wastewater is collected in a municipal wastewater system, or the wastewater is safely disposed of in situ (i.e., in a septic tank) and the sludge is properly disposed via trucks. Proper monitoring for the in situ systems is needed safe disposal of sludge to the nearest municipal treatment plant.

Mixed Industrial and Domestic Wastewater Reuse: In this category, the main aim is:

- To halve the proportion of Domestic and Industrial wastewater to 30% and ensure that at least 70% of the 70% of the produced wastewater is safely treated.
- To eliminate the industrial wastewater from the municipal wastewater system, and

Clean Water Bodies for Indirect Reuse: In this category, the main aim is to eliminate the disposal of non-complaint wastewater to all water bodies to ensure that the water bodies are clean for indirect reuse. This can be attained by:

- Ensuring that all the disposed industrial wastewater into the Nile is 100% compliant
- Ensuring that all disposed domestic wastewater into the Nile is 100% compliant
- Ensuring that all wastewater is treated before disposing into Mediterranean Sea and Northern Lake as well as agricultural drains and Nile branches.

Level of Wastewater Treatment for Appropriate Reuse: In this category, the objective is to ensure the level of wastewater treatment for reuse. This include the following:

- To ensure that all collectable domestic wastewater is collected by the sewage network and at treated with secondary treatment,
- To ensure that all uncollectable domestic wastewater is disposed of properly in septic tanks and solids are pumped out and disposed of in secondary treatment plants.
- To increase the proportion of tertiary treated wastewater to reach at least 10% of produced domestic wastewater.

Increase of Reuse: In this category, the aim is to reuse all collectable produced wastewater, where 50% is through direct reuse and 50% is through indirect reuse. This can be achieved by:

- Increasing the ratio of reused wastewater to allocated domestic water
- Increasing the ratio of non-conventional water resources
- Increasing direct reuse
- Increasing indirect reuse
- Reusing mixed agricultural drainage and treated wastewater
- Reuse all wastewater that was disposed of in drains
- Increasing agricultural drainage water safely.

Reuse for Fresh Water Savings: In this category, the aim is to swap Nile water, groundwater and freshwater with treated wastewater for reuse. This includes swapping:

- Nile water allocated to Irrigation with treated wastewater.
- Groundwater allocated to Irrigation with treated reused wastewater.
- Fresh water used for landscaping with treated wastewater.

Reuse for Agriculture Development & Urban Landscaping: In this category, the aim is to target reuse in agricultural development and urban landscaping. This includes:

- Directly use reclaimed water for urban landscaping
- Directly use reclaimed water for agriculture lands and indirectly reclaim water for agricultural development.

An assessment of landscape area in 2020 shows that there is 716 million m² and by 2030 the landscape area will be 882 million m², as shown in Table 8 below. Based on this, the water use is estimated.

Table 8: 2020/2030 Summary of Landscape and Water Assessment

	2020	2030
Population (Person)	1.02E+08	1.26E+08
Rate (m ² /person)	7	7
Area (m ²)	7.16E+08	8.82E+08
Water Use 1 (m ³) (1.2 m ³ /m ²)	8.60E+08	1.06E+08
Water Use 2 (m ³) (1.2 m ³ /m ²)	7.16E+08	8.82E+08

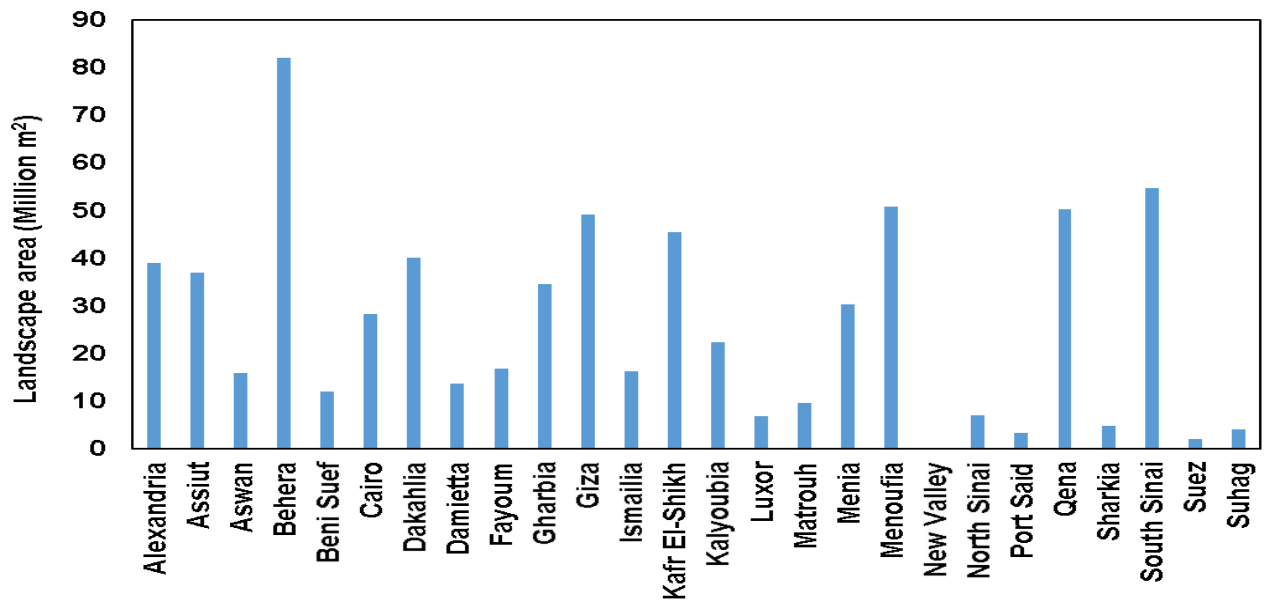


Figure 36: Landscape Area per Governorate

The following figures show the change detection maps of green landscape in several urban areas in Egypt. An analysis has been conducted to show the reduction in landscape water demand that resulted due to that change. The new green landscape areas have been detected by remote sensing and GIS maps to provide the new 2020 baseline status. And a projection till 2030 was made to match the ratio of landscape areas to the population in 2020, assuming the ratio will remain the same.

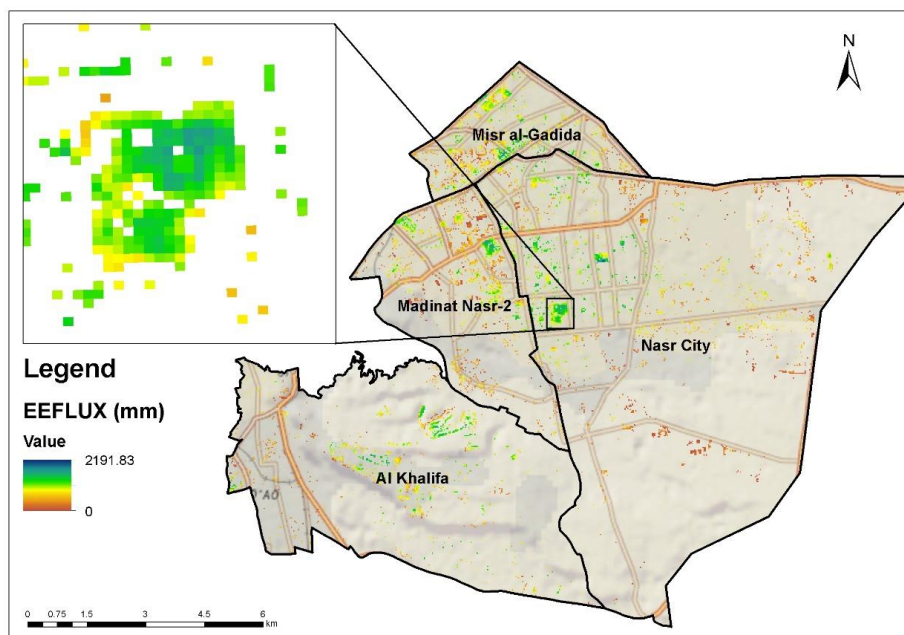


Figure 37: Landscape Assessment 1 (prepared by CEDARE)



Figure 38: Landscape Assessment 2 (prepared by CEDARE)



Figure 39: Urban landscape areas in Egypt (prepared by CEDARE)

The following table shows the 2030 Shared National Water Reuse Targets were validated by the NLA and comprise the proposed national targets by the Strategy.

Table 9: 2030 Shared National Water Reuse Targets

	2030 Shared National Water Reuse Targets		
	Sanitation Coverage for Planned Reuse		
1	By 2030, increase access to adequate, equitable & safely managed sanitation from 51% of population in 2015 to 100%, where all excreta are safely disposed of in situ or treated off-site. (UN SDG 6.2.1.a)		
	Mixed Industrial and Domestic Wastewater Reuse		
2	By 2030, halve the proportion of untreated (and unsafely treated) Domestic and Industrial wastewater produced from 60% in 2015 to 30%, and ensure that at least 70% of the produced wastewater is safely treated. (UN SDG 6.3.1.a)		
3	By 2030, eliminate disposed non-compliant industrial wastewater to the wastewater network. (Ministry of Housing Decree)		
	Clean Water Bodies for Indirect Reuse		
4	By 2030, eliminate disposed non-compliant wastewater to all water bodies. (Environment Law)		
	Target Outcomes	4a	By 2030, the proportion of compliant industrial wastewater disposed into the Nile will increase from 79% of total disposed industrial wastewater into the Nile in 2017 to 100%. (Egypt SDS 2030 Vision)
		4b	By 2030, the proportion of compliant domestic wastewater disposed into the Nile will increase from 50% of total disposed domestic wastewater into the Nile in 2017 to 100%. (Egypt SDS 2030 Vision)
		4c	By 2030, all wastewater that used to be directly disposed into Mediterranean Sea and Northern Lakes and indirectly through agriculture drains and Nile Branches will be treated. (MWRI Law 48)

	Level of Wastewater Treatment for Appropriate Reuse		
5	By 2030, all <u>collectable</u> domestic wastewater will be collected by sewage networks and treated by at least secondary treatment. (2030 Reuse Vision)		
6	By 2030, all <u>uncollectable</u> domestic wastewater will be disposed of in an environmentally sound gravel filter septic tanks or solid based septic tanks to be pumped out and disposed of in at least secondary treatment plants. (2030 Reuse Vision)		
7	By 2030, increase the proportion of tertiary treated wastewater to reach at least 10% of produced domestic wastewater.		
	Increase of Reuse		
8	By 2030, reuse 100% of the collectable produced wastewater with 50% through direct reuse, and 50% through indirect reuse. (Reuse Vision 2030)		
	Target Outcomes	8a	By 2030, the ratio of reused wastewater to total allocated domestic water will increase from 39% in 2015 to 70% in 2030.
		8b	By 2030, the ratio of non-conventional water resources used to the conventional water resources used will increase from 36% in 2015 to 45%.
		8c	By 2030, <u>direct</u> reuse of treated wastewater will increase from 0.27 BCM in 2011 to 5.5 BCM. (2030 Reuse Vision)
		8d	By 2030, <u>indirect</u> reuse of treated wastewater will increase from 3.10 BCM in 2011 to 5.5 BCM in 2030. (2030 Reuse Vision)
		8e	By 2030, reuse of mixed agriculture drainage & treated wastewater will increase from 13.5 BCM in 2011 to 16 BCM. (MWRI for SDS 2030 Vision)
		8f	By 2030, all wastewater that used to be directly disposed into Mediterranean Sea and Northern Lakes and indirectly through agriculture drains and Nile Branches will be reused.

9	By 2030, increase proportion of produced agricultural drainage safely reused for agricultural purposes from 44% in 2015 to 50%. (MWRI 2037 Plan)
	Reuse for Fresh Water Savings
10	By 2030, 10% of Nile water allocated to Irrigation in 2018 will be swapped with treated wastewater.
11	By 2030, 10% of groundwater allocated to Irrigation will be swapped with treated reused wastewater.
12	By 2030, 50% (0.35 BCM) of fresh water used for landscaping in 2020 (0.7 BCM in 2020) will be swapped with treated wastewater.
	Reuse for Agriculture Development & Urban Landscaping
13	By 2030, at least 5% (0.55 BCM) of treated wastewater would be directly reused for about 130,000 feddans of urban landscaping, 0.15 BCM of which will be directed to new landscape areas.
14	By 2030, 45% (4.95 BCM) of 11 BCM treated wastewater would be directly reused for 1,000,000 feddans of agriculture lands and another 45% (4.95 BCM) of treated wastewater will be indirectly reused for another 1,000,000 feddans.

X. 2030 Shared Local Water Reuse Targets

The 2030 Shared Local Water Reuse Targets agreed by the NLA were divided into the 4 following categories, as shown in Figure 40

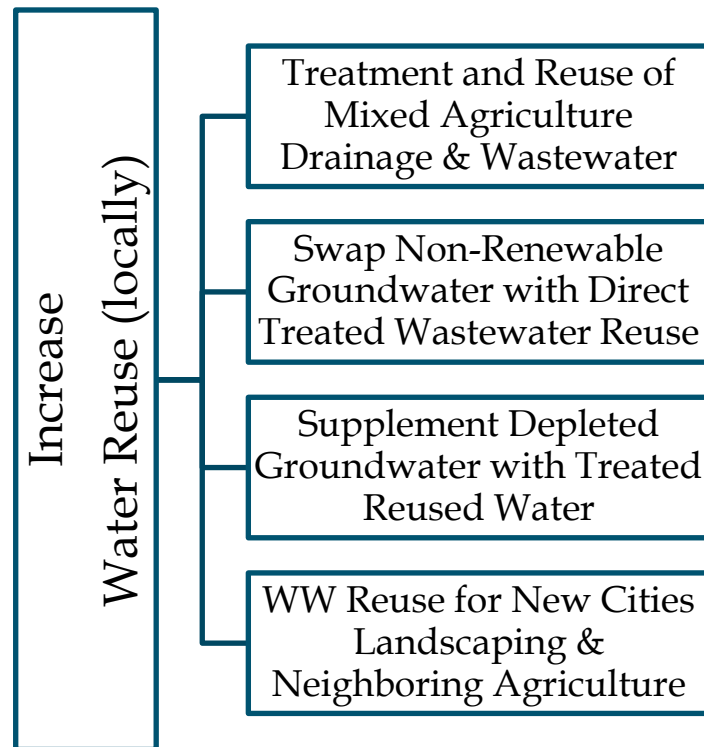


Figure 40: Categories to Achieve Increased Reuse

The following table shows the 2030 Shared Local Water Reuse Targets were validated by the NLA and comprise the proposed local targets by the Strategy. They present sample of specific projects that represent the type of key projects to be implemented by the strategy to achieve the 2030 Shared National Targets.

Table 10: 2030 Shared Local Water Reuse Targets

2030 Shared Local Water Reuse Targets	
Treatment and Reuse of Mixed Agriculture Drainage & Wastewater	
1	By 2030, treat and (indirectly/directly) reuse 1.83 BCM/y of mixed agriculture drainage and wastewater from Bahr El Baqar drain for 365,000 feddans of agriculture in North Sinai

2	By 2030, treat and (indirectly/directly) reuse 0.365 BCM/y of mixed agriculture drainage and wastewater from Mahsama drain for 73,000 feddans of agriculture in North Sinai
3	By 2030, treat and reuse 2.19 BCM/y of mixed agricultural drainage and wastewater from Alhamam plant to supplement groundwater in irrigating 1,500,000 feddans of agriculture land in the New Delta project including Mustaqbal Masr project. (new*)
Swap Non-Renewable Groundwater with Direct Water Reuse	
4	By 2030, swap 0.9 BCM/y of allocated nonrenewable groundwater with Direct treated wastewater for 180,000 feddans of agriculture lands within the 1.5 million feddans project and save fresh groundwater for drinking purposes
5	By 2030, swap 0.7 BCM/y of allocated nonrenewable fresh groundwater with direct treated wastewater for 140,000 feddans of agriculture lands in West Minya & West West-Minya within the 1.5 million feddans project
6	By 2030, swap 0.10 BCM/y of allocated nonrenewable fresh groundwater with direct treated wastewater for 20,000 feddans of agriculture lands in El-Marashda, Qena within the 1.5 million feddans project
7	By 2030, swap 0.060 BCM/y of allocated nonrenewable fresh groundwater with direct treated wastewater for 12,000 feddans of agriculture lands in West Kom Ombo, Aswan within the 1.5 million feddans project
8	By 2030, swap 0.04 BCM/y of allocated nonrenewable fresh groundwater with direct treated wastewater for 8,000 feddans of agriculture lands in El-Tor, South Sinai within the 1.5 million feddans project
Supplement Depleted Groundwater with Treated Reused Water	
9	By 2030, supplement depleted groundwater with 0.7 BCM/y of treated wastewater for direct reuse for the priority areas of 144,000 feddans in the West Delta agriculture project
Treated Wastewater for Reuse in New Cities Landscaping & Neighboring Agriculture	

- 10 By 2030, direct 0.25 BCM/y of treated wastewater generated from the New Administrative City to 5000 feddans of Landscaping within the City and about 30,000 feddans of neighboring agriculture areas.

There are 3 mega wastewater treatment plants to support agricultural expansion that include: El-Mahsama, Bahr El Baqar and Hammam. In 2020, the first mega wastewater treatment plant (El-Mahsama WWTP) was inaugurated in the east of Suez Canal in Sinai Peninsula to treat 0.365 BCM per year (or 1.0 million m³ per day) of the El-Mahsama Agricultural Drain and other small drains (agricultural drainage mixed with treated wastewater) conveyed to the east side of the Suez Canal for treatment and irrigation through the Sheikh Zayed Canal for the agricultural development of approximately 73000 feddans in North Sinai.

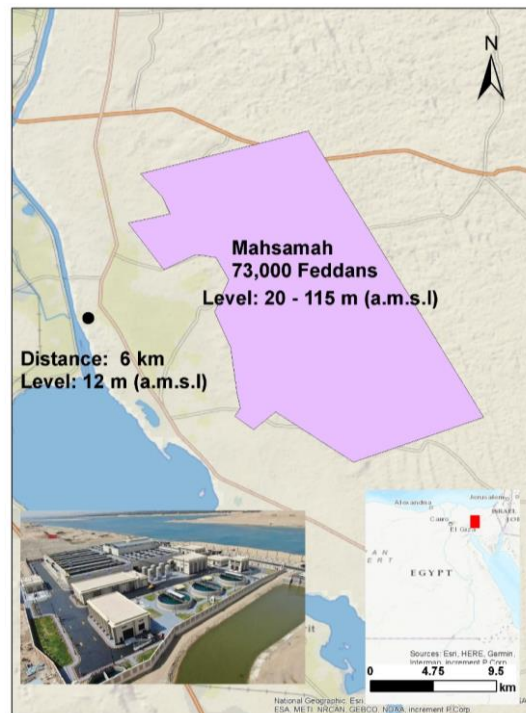


Figure 41: Mahsama Location (prepared by CEDARE)

In 2021, Bahr El Baqar wastewater treatment plant was inaugurated. It is the largest facility of its kind in the world, treating around 1.83 BCM/y (5.6 million m³ per day) of treated mixed agriculture drainage and wastewater from the Bahr El Baqar basin, where the water is then conveyed to Sheikh Gaber Canal to be used east of the Suez Canal to cultivate -365,000 feddans in another region in North Sinai.

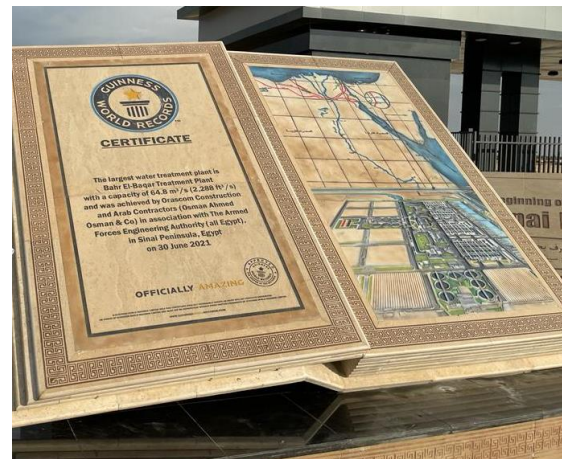
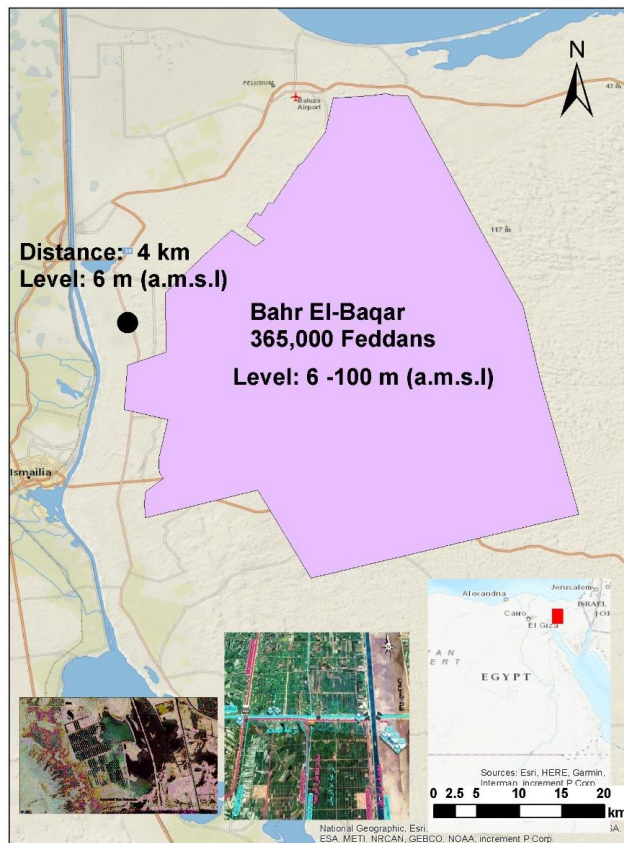


Figure 42: Bahr El-Baqar Location (agricultural are is conceptual, prepared by CEDARE)

An even bigger mega project is under development and it is expected to operate in 2022 to treat and reuse 2.19 BCM/y (6 million m³ per day) of mixed agricultural drainage and wastewater at the Hammam (New Delta) treatment plant in irrigating 1,500,000 feddans of agriculture land in the New Delta project including Mustaqbal Masr project. This treated water will supplement groundwater to cover an even larger agriculture area.

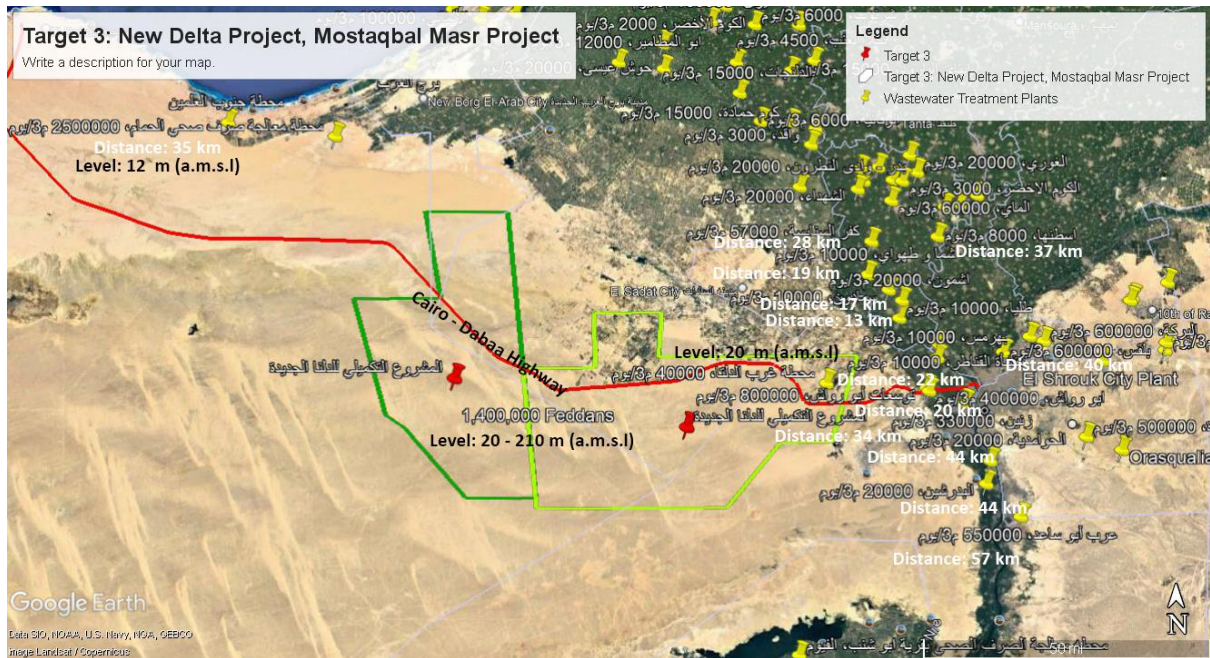


Figure 43: New Delta/ Mustaqbal Masr Project Location (prepared by CEDARE)

In West Minya & West West-Minya it is suggested to swap 0.7 BCM/y of allocated nonrenewable fresh groundwater with direct treated wastewater for 140,000 feddans of agriculture lands.

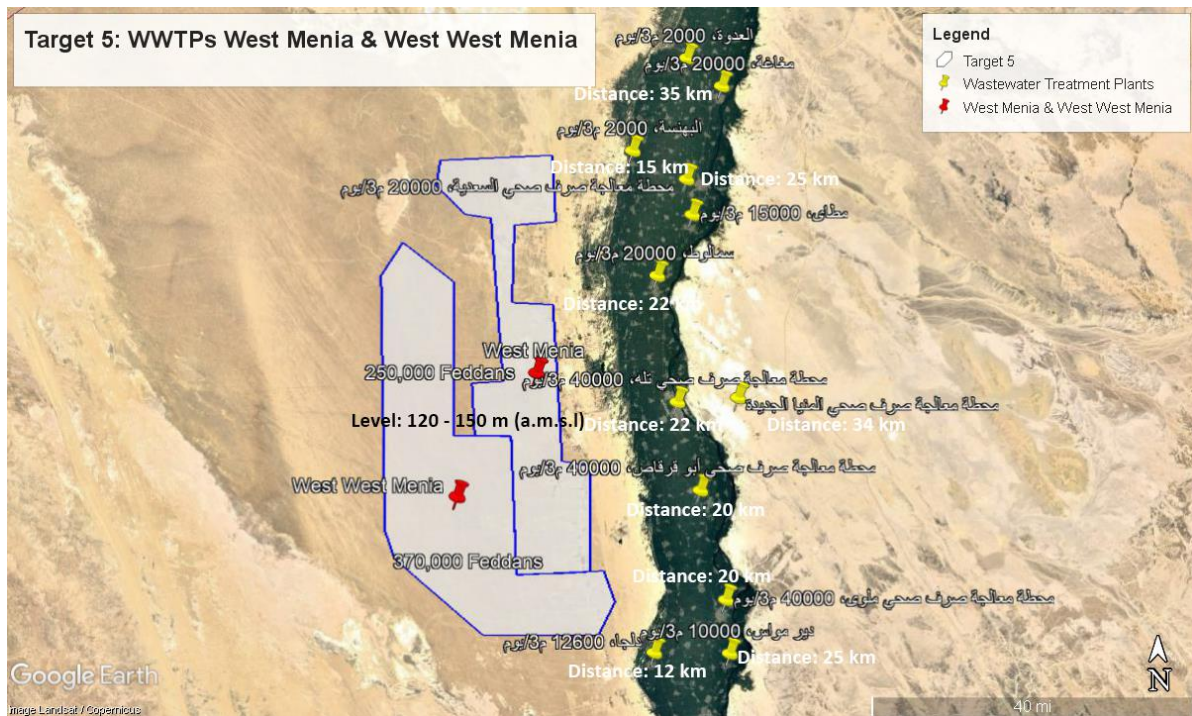


Figure 44: West Minya Agriculture Expansion Location (prepared by CEDARE)

In El-Marashda, Qena, it is suggested to swap 0.10 BCM/y of allocated nonrenewable fresh groundwater with direct treated wastewater for 20,000 feddans of agriculture lands

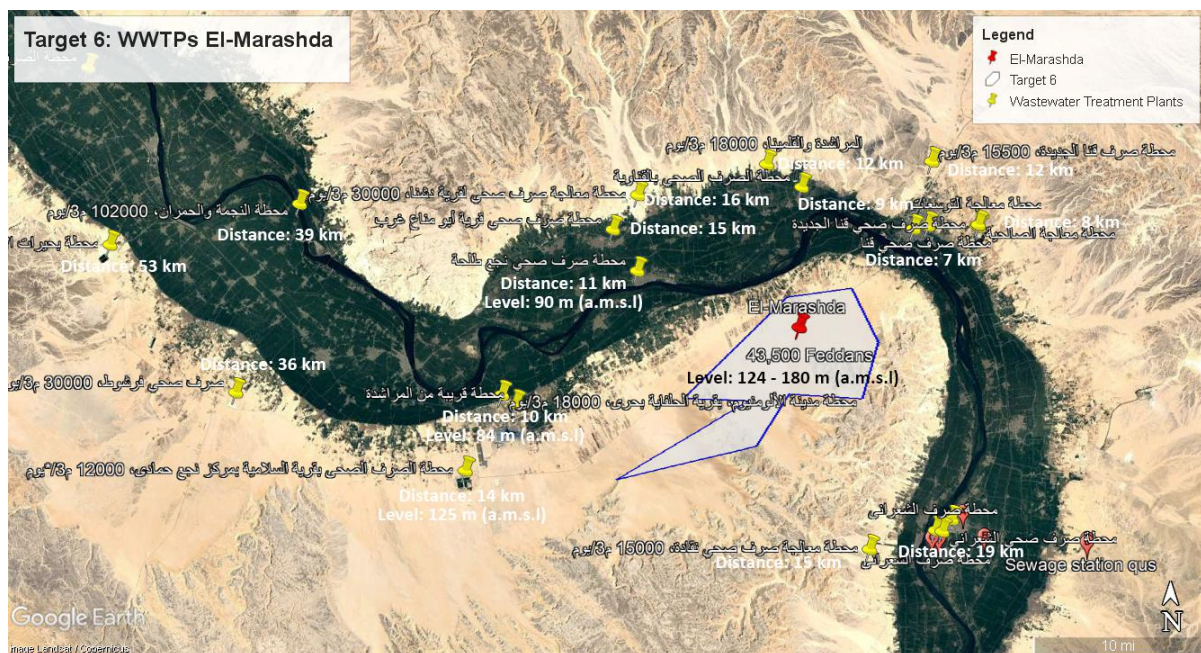


Figure 45: El-Marashda Location (prepared by CEDARE)

In West Kom Ombo, Aswan Swap 0.060 BCM/y of allocated nonrenewable fresh groundwater with direct treated wastewater for 12,000 feddans of agriculture lands

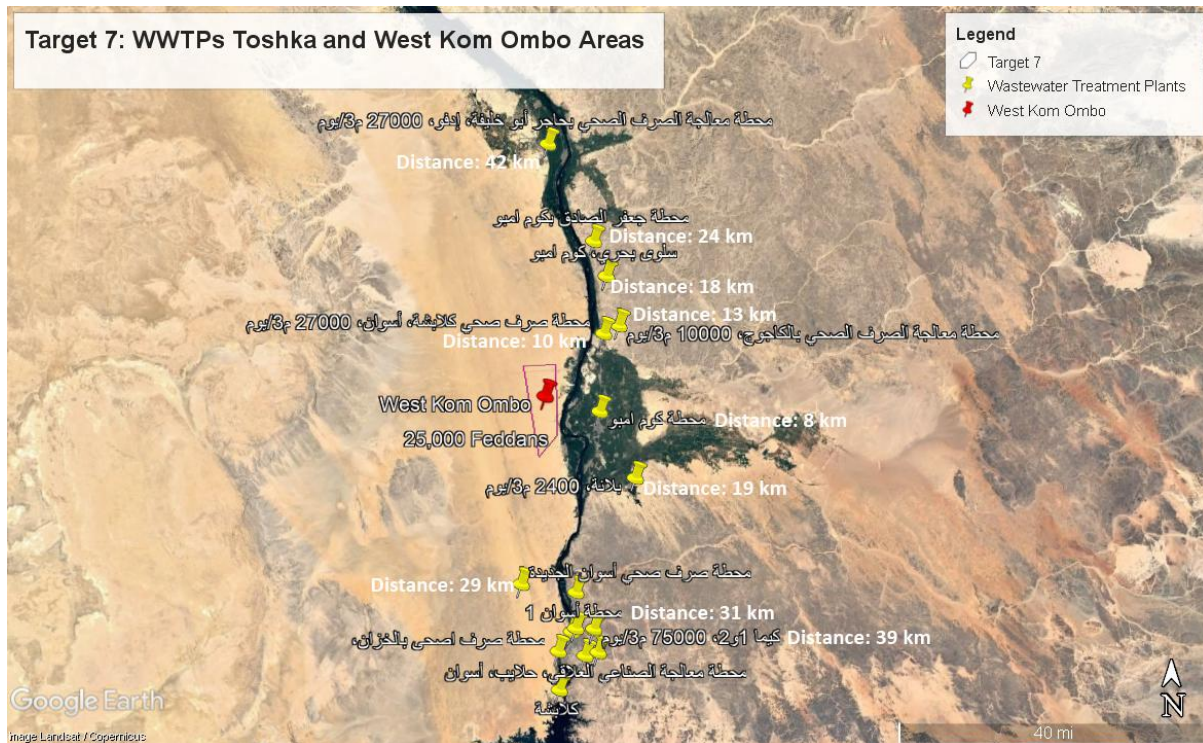


Figure 46: West Kom Ombo Location (prepared by CEDARE)

In El-Tor, South Sinai, swap 0.04 BCM/y of allocated nonrenewable fresh groundwater with direct treated wastewater for 8,000 feddans of agriculture lands.



Figure 47: El-Tor Location (prepared by CEDARE)



Figure 49: New Administrative Capital Location (prepared by CEDARE)

XI. Expected Challenges Facing Targets' Achievement

After discussions with the NLA members, it was agreed that the following challenges exist:

1. Competition with other national priority.
2. Financial / Time limitations
3. Enabling environment limitations (Institutional and regulatory).
4. Lack of social acceptance.
5. Competition between New Agriculture Development Projects over available wastewater.
6. Competition between New Agriculture Projects & Old Groundwater Depleted Agriculture Establishments.
7. Competition between Agriculture & Urban Landscaping over available wastewater.
8. Physical & Financial Losses due to Prioritizing Indirect Reuse over Direct Reuse of Wastewater.
9. Consistent Water Quality for reuse
10. Compliance with Egypt 501/2015 Reuse Code so that Agriculture products meet quality requirements.

XII. The Required Enabling Environment for Water Reuse

Water Reuse is one of the most sustainable ways to cope with water shortage, but it obviously requires additional management and supervision as compared to management of traditional Nile water resources. In order to move forward with the expansion of water reuse in a holistic way, 3 Key areas were identified to ensure that an “enabling environment” will provide successful implementation for water reuse, such as:

- Institutional Setup: Roles and Responsibilities
- Policy, financial, & Incentive Measures
- Code, Regulatory and Legislative Measures

To implement the enabling environment proposed, priorities have to be established with identified phasing schedules for the short, medium and long term.

Based on the discussions held with the NLA and NSC, the main recommendations for the enabling environment are summarized below.

A. Institutional Setup: Roles and Responsibilities

Currently, treated drainage wastewater is under the umbrella of the MWRI and the treated domestic wastewater is under the umbrella of the MHUUC, and agriculture and cultivation is under the umbrella of MALR. Close coordination vis a vis water reuse is needed where roles and responsibilities are clarified.

Therefore, since water reuse has grown and will continue to grow in the future, it is very important to **identify a champion**, that would have supervisory power and authority to oversee implementation of the Water Reuse Strategy and Agricultural Expansion and to be able to solve any related issues or challenges. This champion can be the prime minister’s office, a central ministry or a new authority that encompasses the 3 main ministries, MWRI, MHUUC and MALR.

The Champion would work closely with the existing institutions and other stakeholders through a high-level steering committee. The roles and responsibilities of various institutions in the high-level steering committee in relation to water reuse needs to be defined and any institutional gaps and overlaps are avoided.

There needs to be an active participation of civil society & private sector in the high-level steering committee to smooth the implementation process of the strategy as they are the main driver for innovation. This can include the water users' associations and farmers cooperates and others that are deemed necessary.

The roles and responsibilities of the key stakeholders to support water reuse should include:

- The Office of the Prime Minister
- Ministry of Water Resources & Irrigation
- Ministry of Housing
- Ministry of Agriculture and Land Reclamation
- Ministry of Environment
- Ministry of Health
- Private Sector
- Civil Society
- Others stakeholders can also include, as needed, including:
 - Ministry of Finance and
 - Ministry of Planning

B. Policy, Financial & Incentive Measures

With the above-mentioned Institutional setup in place, the policies, financial and incentive measures should be adopted to ensure the enabling environment is in place for implementing the Water Reuse Strategy.

Policy measures should ensure:

- Adopting the National and Local Water Reuse Targets

- Formalizing wastewater reuse arrangements by licensing for various water uses in agricultural production to ensure better control of the water reuse (including groundwater, surface water uses and water reuse)
- Reviewing import and export policies for agricultural products to ensure that there are incentives for local agriculture production with water reuse
- Supporting farmers reusing water to:
 - monitor quality of agricultural products
 - market their agricultural products locally or for export
 - label agricultural products irrigated with water reuse for compliance of product quality with local and international standards.
 - provide favorable marketing opportunities for their agricultural products.
- Supporting continuous monitoring and evaluation of the quality of the Reuse Water to ensure its compliance with the local and international regulations and codes.
- Considering global policy instruments that govern import and export of agricultural products (e.g. carbon and water footprints).
- Supporting a national Monitoring and Evaluation System for Water Reuse to monitor and regularly report on:
 - locations that are utilizing water reuse (including agriculture and landscape)
 - locations that utilize direct water reuse and indirect water reuse
 - status of the implementation of the National and Local Water Reuse Targets
 - water reuse quality and quantities
 - quality of treatment should be appropriate for use
 - quantity should be made available when needed for the farmers
 - agricultural product quality
 - health and safety issues
 - challenges & needs related to Water Reuse.
- Re-introducing a nation-wide crop pattern to maximize water use efficiency and provide better marketing opportunities of products
- Considering conjunctive use of groundwater and reuse water

On the other hand, Incentives & Financial measures should include:

- Allocating the necessary budget to achieve the adopted Targets
- Accessing flexible funding instruments to encourage growth of this water reuse industry (e.g., soft loans, revolving funds, ..etc)
- Putting the necessary regulations that sets the right Tariffs for government operated, private sector operated reuse systems that are attractive for different consumers
- Encouraging private sector involvement and commercialization of decentralized wastewater treatment and reuse industry by applying separate water and wastewater tariffs for different uses and different treatment qualities.
- Providing risk reduction policies (e.g., insurance schemes) to encourage private sector to invest in water reuse projects.
- Considering cost recovery of Water Reuse (based on the actual costs and that is comparable to similar regional and global contexts).
- Reviewing Lessons learned from successful contractual PPP agreements, such as the Gabal Asfar water treatment plant and private energy production schemes
- Reducing operating costs by selling of treated sludge from treatment processes
- Putting attractive incentives policies, where end-users may be incentivized by subsidies on agricultural products (such as fertilizers and water tariff) for agricultural products produced by reused Water
- Recommending integrated tariff rates for end-users using combined reuse water, fresh Nile water and groundwater to encourage water reuse
- Enforcing penalties or tariff on farmers that are informally reusing water
- Considering subsidies for reuse water in comparison to fresh water sources to encourage water reuse
- Providing incentives for swapping from freshwater for agriculture and landscaping to reused water for agriculture and landscaping
- Licensing policies with favorable tariffs for reused drainage and/or treated wastewater reuse versus groundwater and surface water uses

C. Code, Regulatory and Legislative Measures

A revision of the laws, regulations and codes need to be performed in light of water reuse and its expected growth and management. They should consider the above mentioned institutional arrangements, policies, incentives and financial measures.

The laws and regulations shall consider treated drainage water reuse, treated wastewater reuse, along with industrial wastewater reuse.

Law 48 should be revised to allow for water reuse of different water qualities from different types of water ways (Nile River, canals, or drains) based on the level of areas' sensitivity and type of withdrawal from canals and or drains especially considering waterways used for domestic water use withdrawals.

The wastewater reuse code is constantly evolving in Egypt. The 501 Wastewater Reuse code has been revised and modified in 2015 after a recommendation from the 2030 Vision developed by CEDARE (AbuZeid, K. & Elrawady, M, 2014). The revised code in 2017 introduces a wider variety of crops that could be cultivated using treated wastewater, and according to the level of treatment as shown in Table 11 and Table 12. Awareness about the new code is needed and agriculture, irrigation, and water management plans need to incorporate the new code, (AbuZeid, K. 2017). However, the code still prohibits the use of treated wastewater for the cultivation of vegetables. It is recommended that the code be revised especially that codes in Egypt according to the regulations have to be revised every 5 years.

Table 11. Grades of treated wastewater (Wastewater Re-use 501/2015 Code), (AbuZeid, K. 2017)

Requirements and Standards		Treatment Degree			
		Grade A	Grade B	Grade C	Grade D
Maximum limit for physical and chemical standards	TSS mg/liter	15	30	50	300
	Turbidity NTU	5	N/A	N/A	N/A
	BOD ₅ mg/liter	15	30	80	350
Maximum limit for pathogens standards	Potential count of Fecal Coli-forms (E. coli bacteria) per 100 ml	20	100	1000	N/A
	No. of eggs of Intestinal nematodes/liter	1	N/A	N/A	N/A

Table 12. Agricultural groups by grade (Wastewater Re-use 501/2015 Code), (AbuZeid, K. 2017)

Grade	Agricultural Group	Description
A	G1-1: Green spaces for educational facilities and public and private parks	Palm trees of all kinds, Fence plants and flowers of all kinds
	G1-2: Fruit crops	Fruits eaten fresh without peeling such as: apples, apricots, plums, grapes, etc.
B	G2-1: Dry cereals, cooked and processed vegetables crops	Vegetables of all kinds (processed) and dry strategic crops of all kinds such as: wheat - corn - barley - rice - beans - lentils - sesame
	G2-2: Fruit crops	All types of fruit trees that are permanent and leafy, such as citrus, olive, palm, mango, pomegranate, and fig for drying.
	G2-3: Medicinal plants crops	Such as: Anise - Hibiscus - Cumin - Marjoram - Khallet - Fenugreek seeds - Moghat - Barley - Chamomile - Almamriya
C	G3-1: Dry cereals crops, fruit crops and medicinal plant crops in Group B	The same varieties as in Group B in addition to sunflower plants and sugar beet plants provided that sprinkler irrigation method is not used
	G3-2: Non-edible seeds for edible crops	All reproduction seeds of major edible crops such as: wheat, maize and vegetable seeds of all kinds provided that these seeds are planted in their permanent places later
	G3-3: All types of seedlings that are then transferred to the permanent fields	Such as: Olive seedlings - pomegranate - citrus fruits - bananas- palm trees - fig seedlings - mango - apples - pear
	G3-4: Roses and flowers	Such as: Roses - Eagle Rose - a set of bulbs such as Gladiolas and bird paradise and all kinds of ornamental plants
	G3-5: Trees suitable for landscaping highways and green belts	Such as: Casuarina - camphor - dapella - atoll - types of ornamental palms
	G3-6: All fiber crops	Such as: Cotton - linen - jute - Tal plant
	G3-7: Fodder crops and legumes	Such as: Types of sorghum and types of Nafl
	G3-8: Mulberry to produce silk	Such as: All varieties of berries
	G3-9: All Nurseries of Ornamental Plants & Trees	Such as: Ficus Decora - Phyllis nite - Spender - Acacia

Grade	Agricultural Group	Description
D	G4-1: Solid biomass crops	All crops that are converted into charcoal (compact discs) such as: willow, poplar and mornage
	G4-2: Liquid biomass crops	All crops that produce biodiesel and energy oils such as: soybean - rapeseed - jojoba - jatropha - castor
	G4-3: Cellulose production crops	All non-food crops that produce glucose and its derivatives such as: ethanol and acetic acid - ethanol gel
	G4-4: Wood trees	All trees for timber production are: kaya - camphor - mahogany

XIII. Implementation Cost

Below are estimated costs related the National Targets infrastructure and the costs and benefits related to the water reuse and development projects based on those National Targets.

A. Module Design Guideline and Criteria

1. Module Design Guideline

Change rate \$	17.75	EGP
Wheat acre yield	2.7	Ton/Acres
The cost of planting an acre of wheat	7000	EGP/Acres
Selling price for ton wheat	11800	EGP/Ton
Number of Olive trees per Acres	120	Tress /Acres
Olive tree price	12	EGP/Tree
Olive tree productivity in third year	3	kg/ tree
Olive tree productivity in Fourth year	10	kg/ tree
Olive tree productivity in Fifth to 15 year	20	kg/ tree
Raw sugar beet crop productivity	1.1	ton/Acres
Canola seed crop productivity	1.3	ton/Acres
Bean soy seed crop productivity	1.3	ton/Acres
Sunflower seed crop productivity	1.5	ton/Acres
Raw sugar beet crop productivity cost	4500	EGP/Acres
Canola seed crop productivity cost	4800	EGP/Acres
Bean soy seed crop productivity cost	4500	EGP/Acres
Sunflower seed crop productivity cost	4500	EGP/Acres
Raw sugar beet crop selling price	7000	EGY/Ton
Canola seed crop selling price	8000	EGY/Ton
Bean soy seed crop selling price	800	EGY/Ton
Sunflower seed crop selling price	8500	EGY/Ton

2. Criteria

Reference

Annual Bulletin Pure Water & Sanitation
Statistic 2019/202

Modeling Criteria

Population @2013	person	83,700,000
Population @2015	person	88,000,000
Population estimated 2019-2020	person	99,842,504
Population estimated 2018-2019	person	98,101,011
Pure water production 2019 - 2020	m ³ /y	10,996,900,000
	m ³ /d	30,128,493
Average pure water per Capita	m ³ / year	110.14
	L/d	302
Total Waste water	m ³ / year	6,909,900,000
	m ³ /d	18,931,233
Waste water / product water		0.628
Treated waste water	m ³ / year	5,135,300,000
	m ³ /d	14,069,315
Existing design capacity for WWTP	m ³ /d	13,782,000
	m ³ / year	5,030,430,000
Estimated construction cost per m ³ of Waste water	1000- 1200	USD/m ³
Power cost	1	EGY/KW

B. Implementation Cost of 2030 National Targets

Table 13. Implementation Cost of 2030 National Targets, (prepared by CEDARE)

National Targets									
Target Number	National Target Description	Cost				Benefit			
		Capital Cost (\$)	O&M Cost (\$)	Capital Cost per m ³ (\$)	O&M per m ³	Payback Period	2030 Total Cost \$1 million	2030 Total Benefit \$1 million	2030 Net Benefit \$1 million
1	By 2030, increase access to adequate, equitable & safely managed sanitation from 51% of population in 2015 to 100%, where all excreta is safely disposed of in situ or treated off-site. (UN SDG 6.2.1.a)	14,031,343,461	42,971,851	1,201.32	0.010	3	14,314	41,113	26,799
3	By 2030, eliminate disposed non-compliant industrial wastewater to the wastewater network. (Ministry of Housing Decree)	17,753,424,658	54,000,000	1,200.00	0.010	2	20,456	22,033	1,577
6	By 2030, all uncollectable domestic wastewater will be disposed of in an environmentally sound gravel filter septic tanks or solid based septic tanks to be pumped out and disposed of in at least secondary treatment plants. (2030 Reuse Vision)	1,701,346	-	90.44	0.000	3	2,172	7,603	5,431
8	By 2030 reuse 100% of the collectable produced wastewater with 50% through direct reuse, and 50% through indirect reuse. (Reuse Vision 2030)	14,306,953,960	130,550,955	1,210.95	0.03	6	12,787	15,207	2,420

9	By 2030, increase proportion of produced agricultural drainage safely reused for agricultural purposes from 44% in 2015 to 50%. (MWRI 2037 Plan)	1,402,463,578	145,547,212	98.77	0.028	4	26,543	31,016	4,473
10	By 2030, 10% of Nile water allocated to Irrigation in 2018 will be swapped with treated wastewater	15,509,589,041	51,892,500	1200.000	0.011	7	58,308	61,933	3,625
11	By 2030, 10% of groundwater allocated to Irrigation will be swapped with treated reused wastewater	15,509,589,041	51,892,500	1,200.00	0.001	8	58,308	61,933	3,625
12	By 2030, 50% (0.35 BCM) of fresh water used for landscaping in 2020 (0.7 BCM in 2020) will be swapped with treated wastewater	1,342,465,753	140,304,176	700.000	0.200	7	6,237	6,426	189
13	By 2030, at least 5% (0.55 BCM) of treated wastewater would be directly reused for about 130,000 feddans of urban landscaping, 0.15 BCM of which will be directed to new landscape areas	287,560,000	30,053,555	700.000	0.200	8	7,366	6,896	(470)
14	By 2030, 45% (4.95 BCM) of 11 BCM treated wastewater would be directly reused for 1,000,000 feddans of agriculture lands and another 45% (4.95 BCM) of treated wastewater will be indirectly reused for another 1,000,000 feddans	36,169,380,000	329,426,370	2665.000	0.067	8	106,627	112,878	6,251
Total		116,314,470,838	976,639,119				\$ 313,118	\$ 367,038	\$ 53,920

The graph below shows the capital cost of the wastewater plants and networks infrastructure.

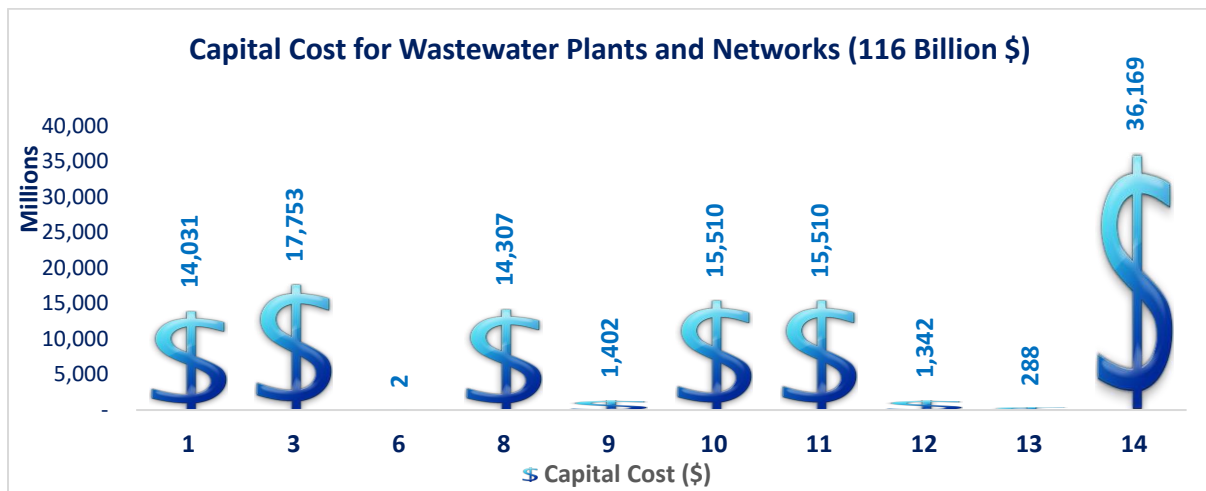


Figure 50: Capital Costs of Wastewater Plants and Networks infrastructure (prepared by CEDARE)

The graph below shows the Operation and Maintenance (O & M) Cost of the wastewater plants and networks infrastructure.

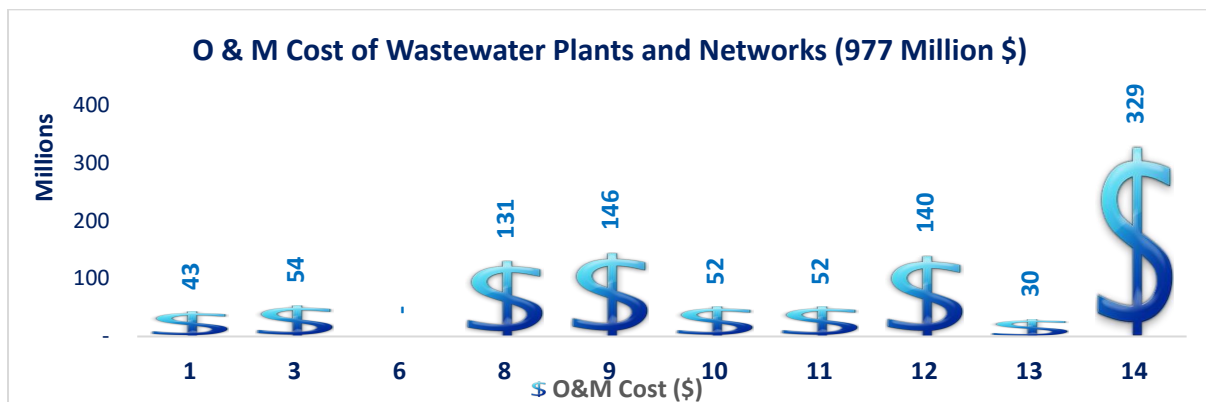


Figure 51: Annual O & M Costs of Wastewater Plants and Networks infrastructure (prepared by CEDARE)

The graph below shows the payback period of national targets water reuse projects.

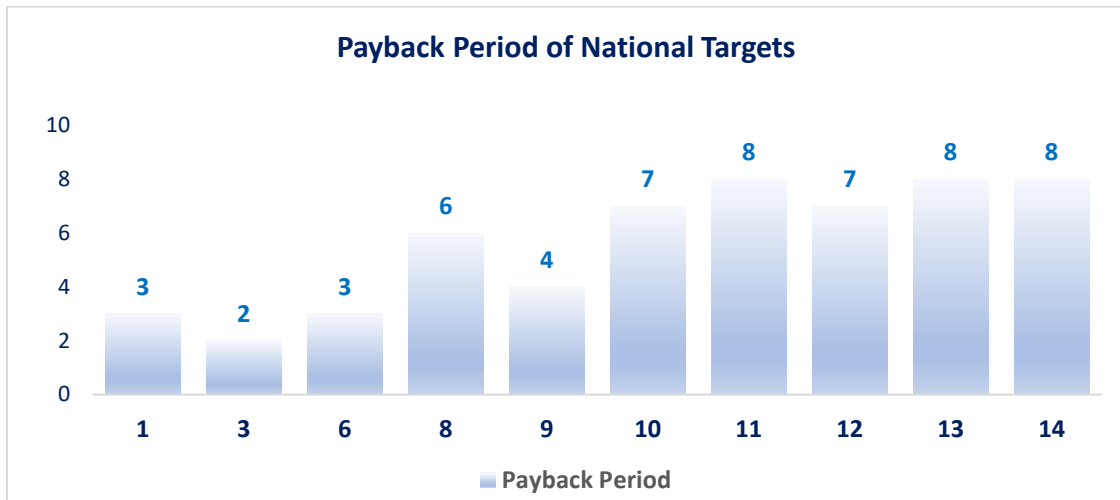


Figure 52: Payback of National Targets (prepared by CEDARE)

The graph below shows the 2030 total costs and total benefits of water reuse projects of the National Targets including the agriculture and livestock projects costs and benefits.

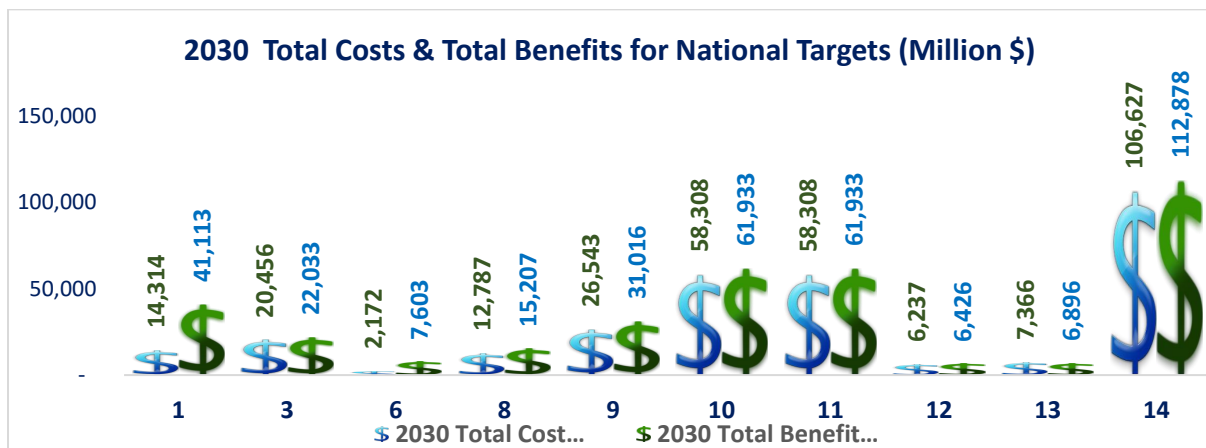


Figure 53: Total Costs & Total Benefits of National Targets (prepared by CEDARE)

The figure below shows 2030 net benefits for the National Targets.

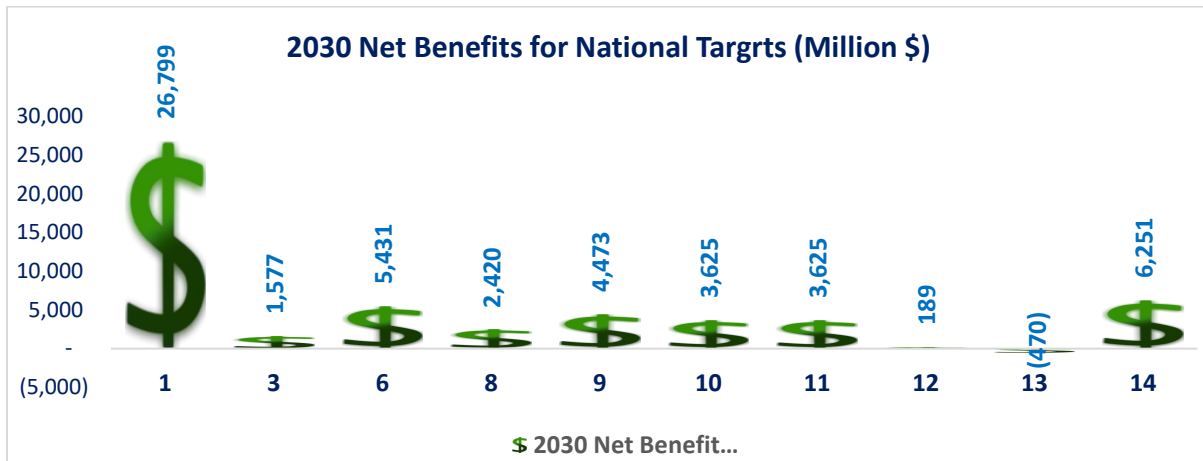


Figure 54: 2030 Net Benefits of National Targets (prepared by CEDARE)

The graph below shows the first target of the national targets which was used as an example to show the accumulative costs and benefits for the project lifetime and the breakeven year.

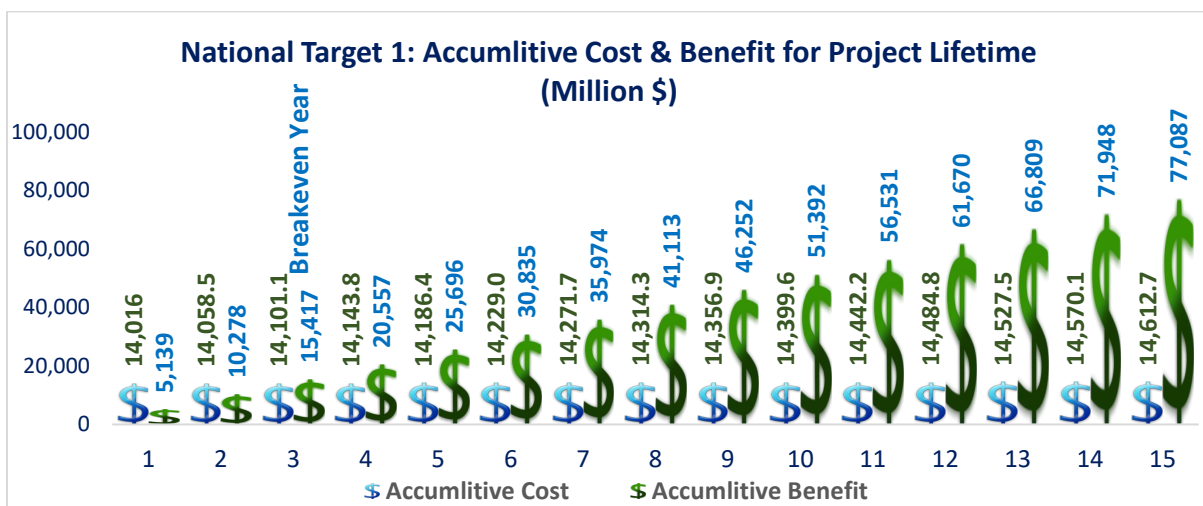


Figure 55: Accumulative Cost & Benefit for Project Lifetime (Million \$) for Target 1 (prepared by CEDARE)

The graph below shows the first target of the national targets which was used as an example to show the net benefits for the project lifetime.

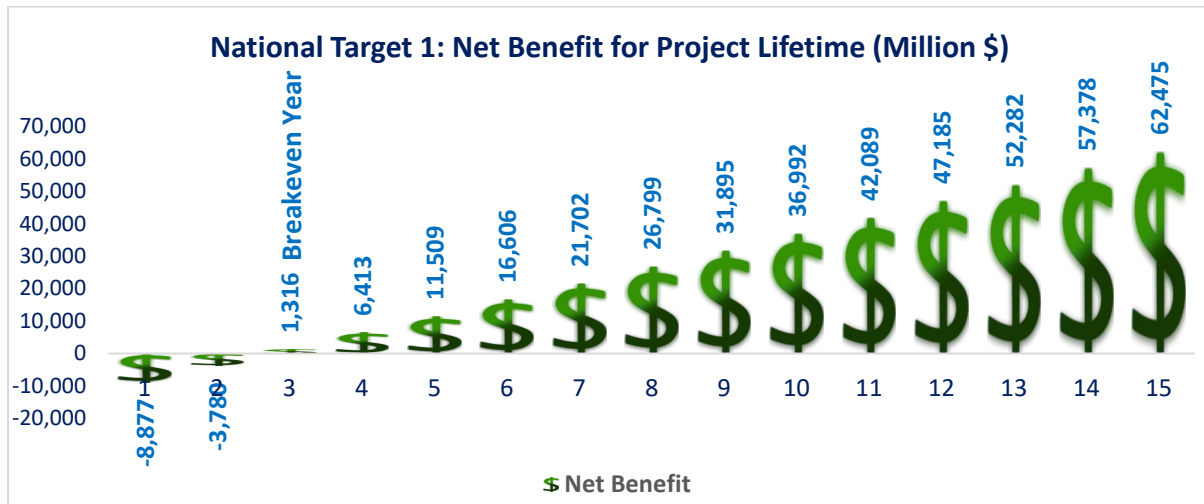


Figure 56: Net Benefit for Project Lifetime (Million \$) for Target 1 (prepared by CEDARE)

C. Implementation Cost of 2030 Local Targets

Table 14. Implementation Cost of 2030 Local Targets, (prepared by CEDARE)

Local Targets									
Target Number	Local Target Description	Cost				Benefit			
		Capital Cost (\$)	O&M Cost (\$)	Capital Cost per m ³ (\$)	O&M per m ³	Payback Period	2030 Total Cost \$1 million	2030 Total Benefit \$1 million	2030 Net Benefit \$1 million
1	By 2030, treat and (indirectly/directly) reuse 1.83 BCM/y of mixed agriculture drainage and wastewater from Bahr El Baqar drain for 365,000 feddans of agriculture in North Sinai	1,070,698,807	57,398,900	0.52	0.028	5	8,630	13,620	4,990
2	By 2030, treat and (indirectly/directly) reuse 0.365 BCM/y of mixed agriculture drainage and wastewater from Mahsama drain for 73,000 feddans of agriculture in North Sinai	226,003,020	7,905,651	0.62	0.022	6	6,616	8,512	1,896
3	By 2030, treat and reuse 2.19 BCM/y of mixed agricultural drainage and wastewater from Alhamam plant to supplement groundwater in irrigating 1,500,000 feddans of agriculture land in the New Delta project including Mustaqbal Masr project.	673,367,032	64,361,108	0.24	0.023	4	12,458	17,317	4,859
4	By 2030, swap 0.9 BCM/y of allocated nonrenewable groundwater with Direct treated wastewater for 180,000 feddans of agriculture lands within the 1.5 million feddans project and save fresh groundwater for drinking purposes								
5	By 2030, swap 0.7 BCM/y of allocated nonrenewable fresh groundwater with direct treated wastewater for 140,000 feddans of agriculture lands in West Minya & West West-Minya within the 1.5 million feddans project	28,450,055	42,826,667	0.04	0.063	7	7,971	9,982	2,011

6	By 2030, swap 0.10 BCM/y of allocated nonrenewable fresh groundwater with direct treated wastewater for 20,000 feddans of agriculture lands in El-Marashda, Qena within the 1.5 million feddans project	6,010,619	693,038	200.35	0.063	3	1,998	2,620	622
7	By 2030, swap 0.060 BCM/y of allocated nonrenewable fresh groundwater with direct treated wastewater for 12,000 feddans of agriculture lands in West Kom Ombo, Aswan within the 1.5 million feddans project	5,465,729	545,559	195.20	0.053	6	2,605	3,549	944
8	By 2030, swap 0.04 BCM/y of allocated nonrenewable fresh groundwater with direct treated wastewater for 8,000 feddans of agriculture lands in El-Tor, South Sinai within the 1.5 million feddans project	9,761,898	369,620	610.12	0.063	3	2,353	3,235	882
9	By 2030, supplement depleted groundwater with 0.7 BCM/y of treated wastewater for direct reuse for the priority areas of 144,000 feddans in the West Delta agriculture project	27,573,101	44,908,861	23.10	0.063	6	3,877	4,960	1,083
10	By 2030, direct 0.25 BCM/y of treated wastewater generated from the New Administrative City to 5000 feddans of Landscaping within the City and about 30,000 feddans of neighboring agriculture areas.	36,304,140	2,346,429	484.06	0.086	2	686	959	273
Total		2,083,634,402	221,355,832				51,593	76,149	24,556

Looking at the presented key Local Targets (projects), we find the following:

- The economic feasibility of these projects show a payback period of 2 - 7 seven years, but the majority of the projects will be recover costs of capital investment within 6 years.
- By comparing the financial treatment between the reuse of treated water directly or indirectly, it is confirmed that the use of direct treatment of water is better than indirect in terms of cost.
- Regardless of the economic return of these projects, there is an environmental return on the use of treated water that cannot be overlooked.
- Through these projects, the agricultural area can be increased by about 1,850,000 feddans.
- Through these projects, 5 billion cubic meters per year of groundwater and the Nile River can be saved.

The graph below shows the capital costs of the wastewater plants and networks infrastructure for key local targets.

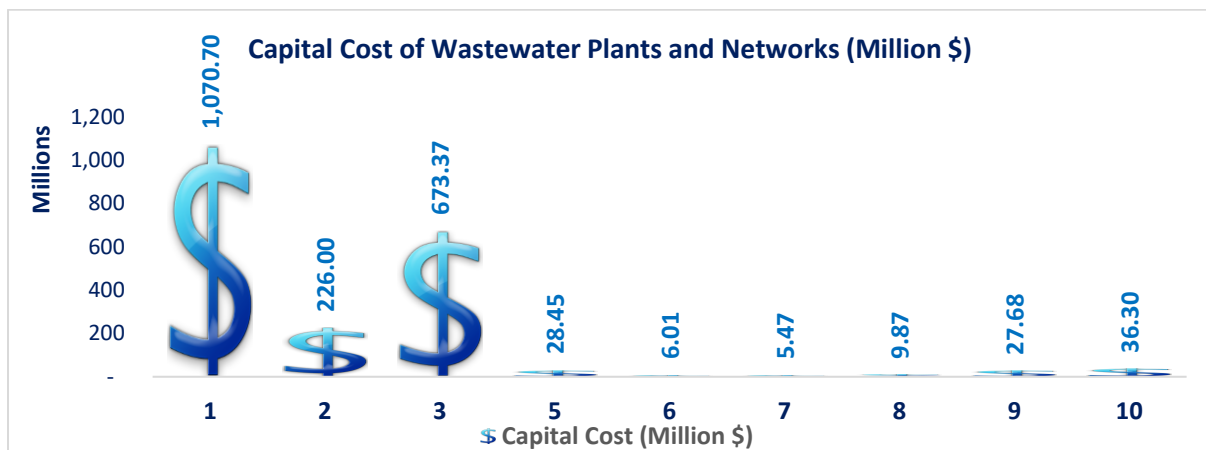


Figure 57: Capital Cost of Wastewater Plants and Networks (prepared by CEDARE)

The graph below shows the Operation and Maintenance (O & M) Costs of the wastewater plants and networks for selected key Local Targets.

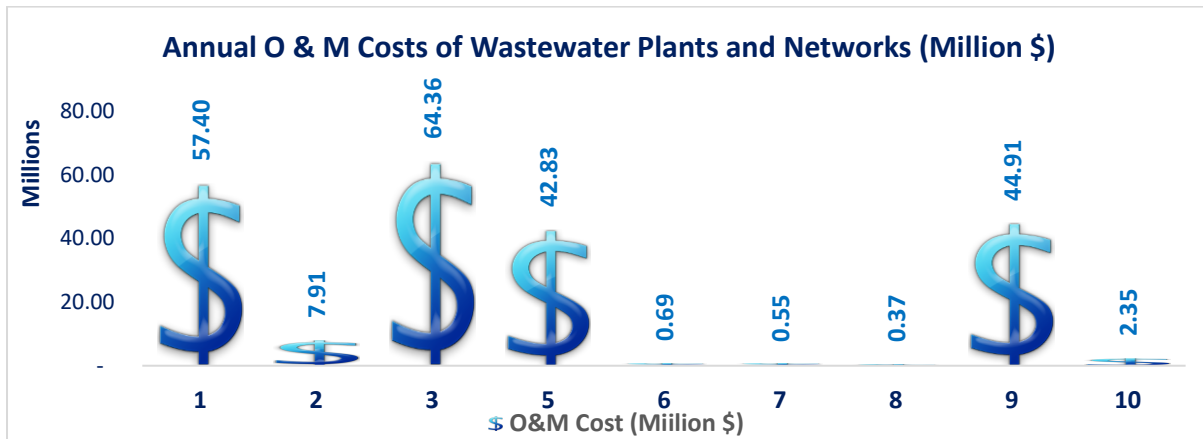


Figure 58: Annual O & M Costs Wastewater Plants and Networks infrastructure of Local Targets (prepared by CEDARE)

The graph below shows the payback period of local targets.

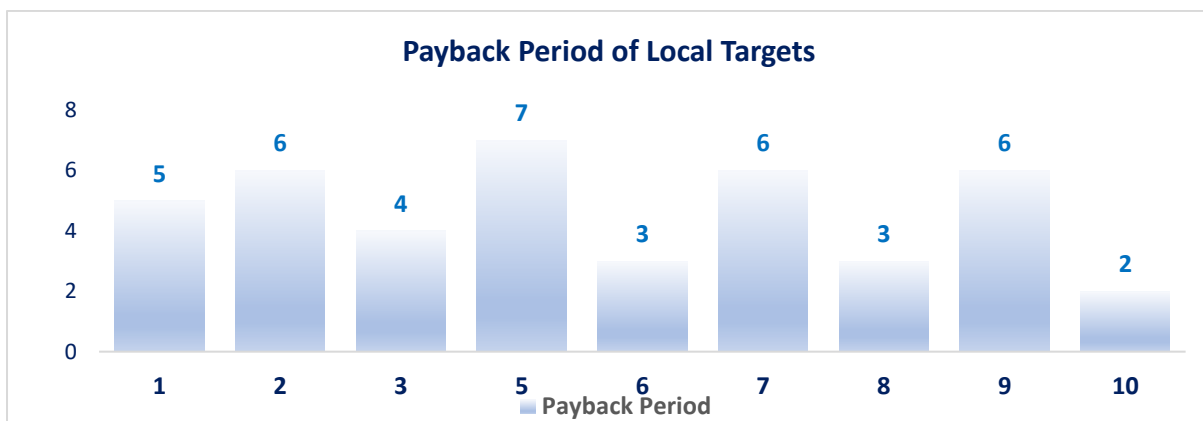


Figure 59: Payback of Local Targets (prepared by CEDARE)

The graph below shows the 2030 total costs and total benefits for Local Targets including the agriculture and livestock water reuse projects.

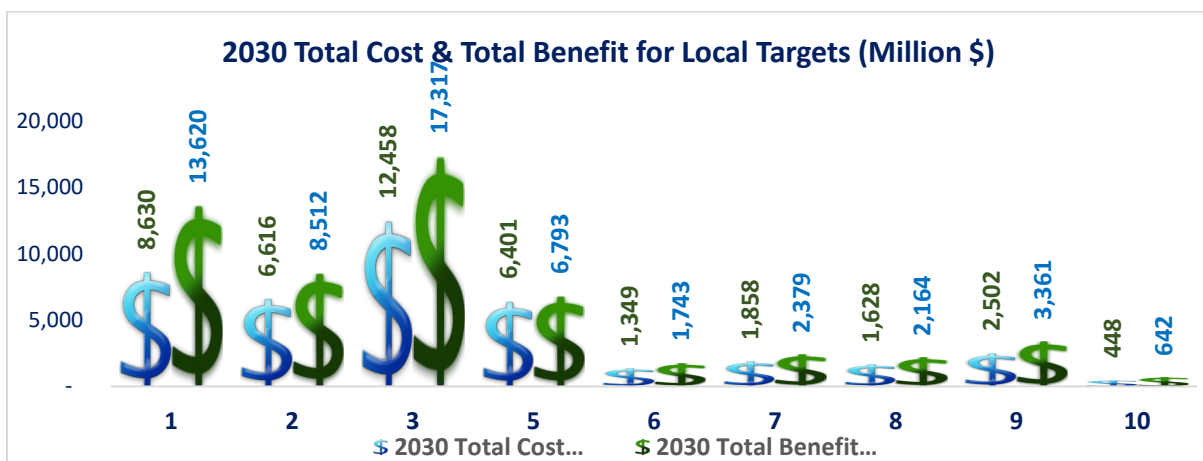


Figure 60: Total Costs & Total Benefits of Local Targets (prepared by CEDARE)

The graph below shows 2030 net benefits for local targets.

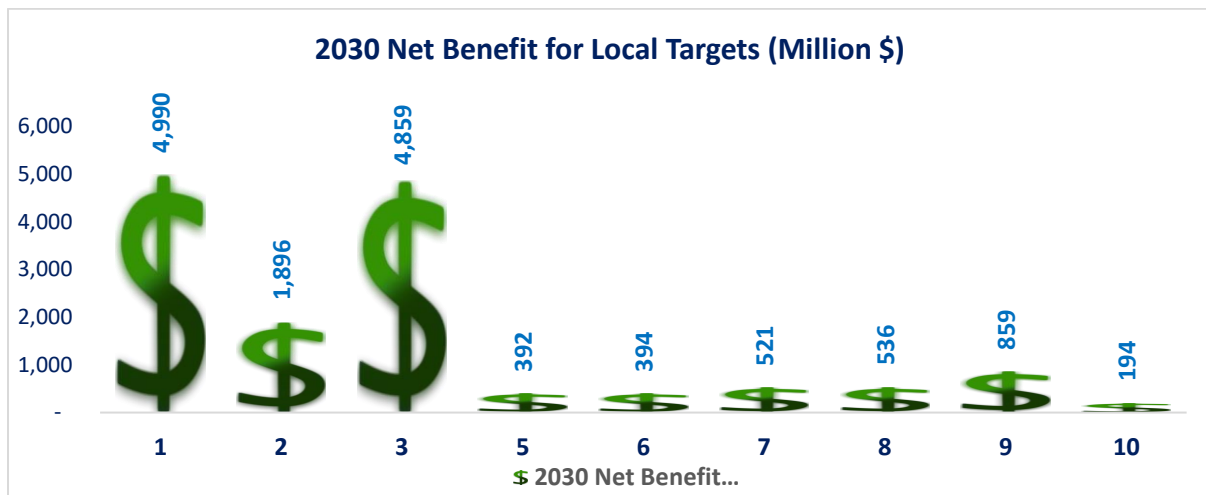


Figure 61: 2030 Net Benefits for Local Targets (prepared by CEDARE)

The graph below shows the first target of the local targets which was used as an example to show the accumulative costs and benefits for the project lifetime.

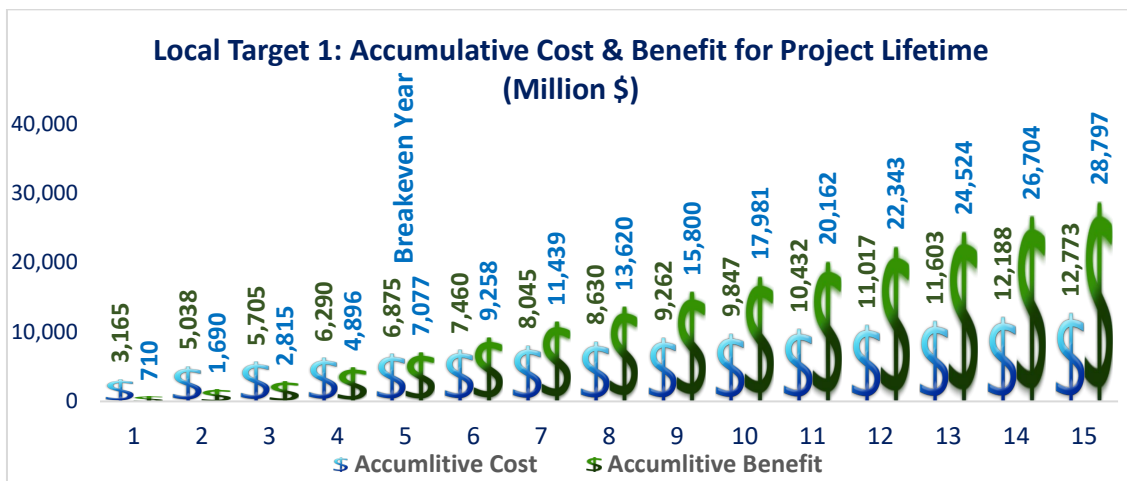


Figure 62: Accumulative Cost & Benefit for Project Lifetime (Million \$) for Target 1 (prepared by CEDARE)

The graph below shows the first target of the local targets which was used as an example to show the net benefits for the project lifetime.

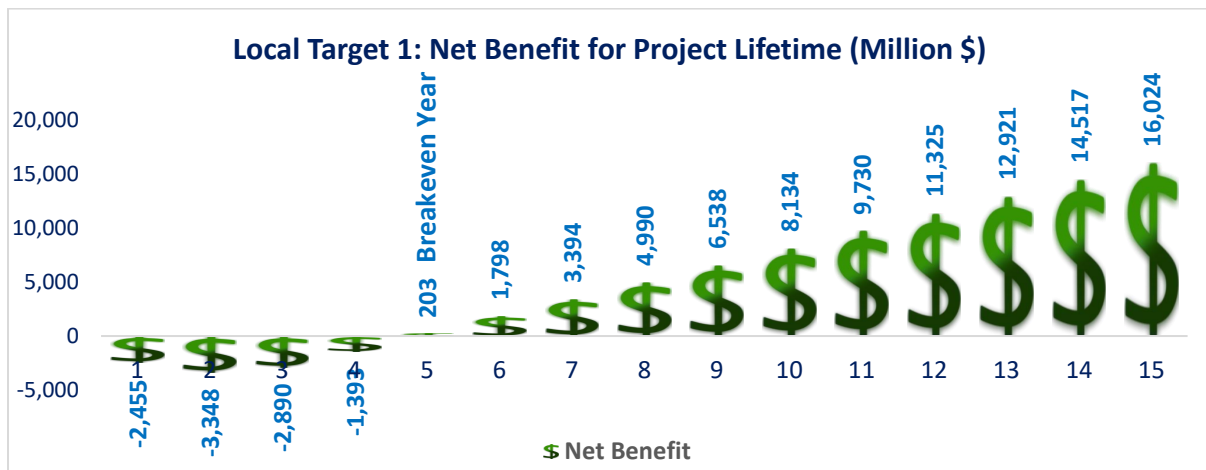


Figure 63: Net Benefit for Project Lifetime (Million \$) for Target 1 (prepared by CEDARE)

XIV. Water Reuse Strategy Outcomes and Benefits

Reuse of treated wastewater contributes to sustainable development by providing economic, social, health and environmental benefits, as opposed to no treatment, no reuse or reuse of untreated wastewater. (Wastewater Reuse Policy Paper, AWC & UNESCO, 2015)

A. Economic Benefits of Water Reuse

- It converts wastewater that potentially damages the environment into a resource that can improve the water quality and environment, as well as contributing to agriculture production, thus improving GDP
- For every \$1 invested in water and sanitation, there is an expected \$4 economic return (WHO, 2012)
- It conserves, when used for agriculture, freshwater as a more valuable resource for drinking and domestic use
- It is the least expensive non-conventional water resource (AWC & IFAD, Water, Food Security and Climate Change Nexus: Arab Water Council Assessment Study, 2013)
- It can improve economic output for the farmers as compared to untreated wastewater, thus improving their livelihood
- It can save on fertilizer costs since the treated wastewater may have a higher nutrient content, as well as increase crop productivity and quality
- It can save on high transportation cost of fresh wastewater sources that may be far away from demand areas

B. Cost-Benefit Comparison between Direct & Indirect Reuse of Treated Wastewater

In the graph below, the eighth target of the national targets was used as an example for the Comparison between direct and indirect wastewater reuse.

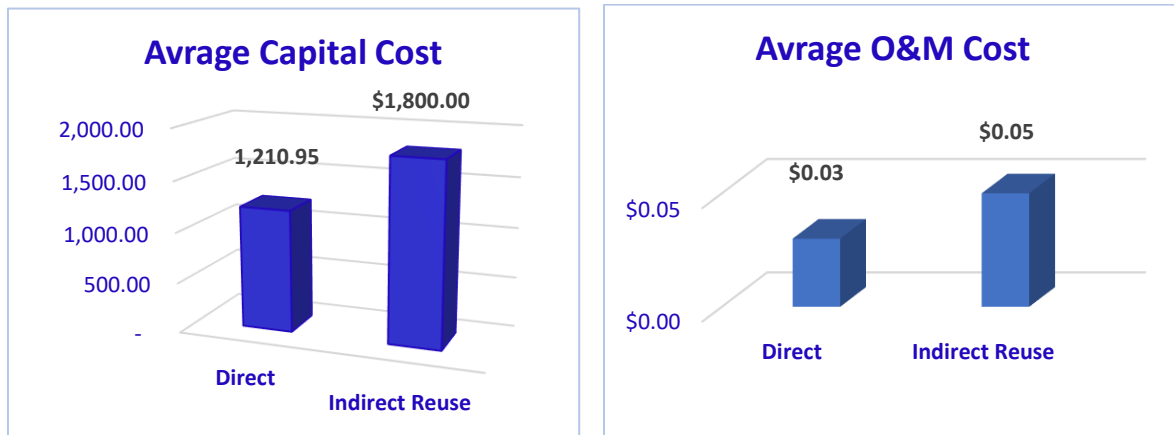


Figure 64: Comparison between Direct & Indirect Reuse (CEDARE, 2022)

Cost-Benefit (Direct Reuse 2030)			
Years of Breakeven	Cost	Total Benefit	Net Benefit
6	12,786	15,207	2,421

Cost-Benefit (Indirect Reuse 2030)			
Years of Breakeven	Cost	Total Benefit	Net Benefit
6	14,036	15,207	1,170

- Direct reuse is lower in cost than Indirect reuse.
- Direct reuse of treated wastewater for that Target is about 9% of the cost less than indirect use, whereas the net benefit more than doubled.
- When cultivating desert places that are far from treatment plants, we will have to use the indirect reuse option

C. Social, Health & Environmental Benefits of Water Reuse

- Treatment of wastewater protects water bodies and the environment
- Improvement of livelihood of communities
- Reduction of diseases and other health issues
- Treatment and reuse create more jobs

Specifically, in relation to this water reuse strategy, it is estimated to cost:

- 15 billion USD to increase the sanitation coverage
- 20 billion USD to increase treatment and reuse
- 2 billion USD to implement key important local targets
- It has also been determined that the cost of water reuse was more cost effective compared to nonrenewable groundwater use for large agricultural development projects
- The cost effectiveness of water reuse is based on the expense of connecting the treatment plants to agricultural lands only as the treatment costs is a given and must be done. Therefore, the cost benefits analysis shows the economic visibility of reuse.

Therefore, this water reuse strategy is crucial for the development and sustainability given the current water scarcity conditions of Egypt and the need for circular economy measures such as water reuse.

XV. References

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Egypt 2030 Shared Water Reuse Strategy

“ a strategy that ensures safe and appropriate reuse of all waters ”