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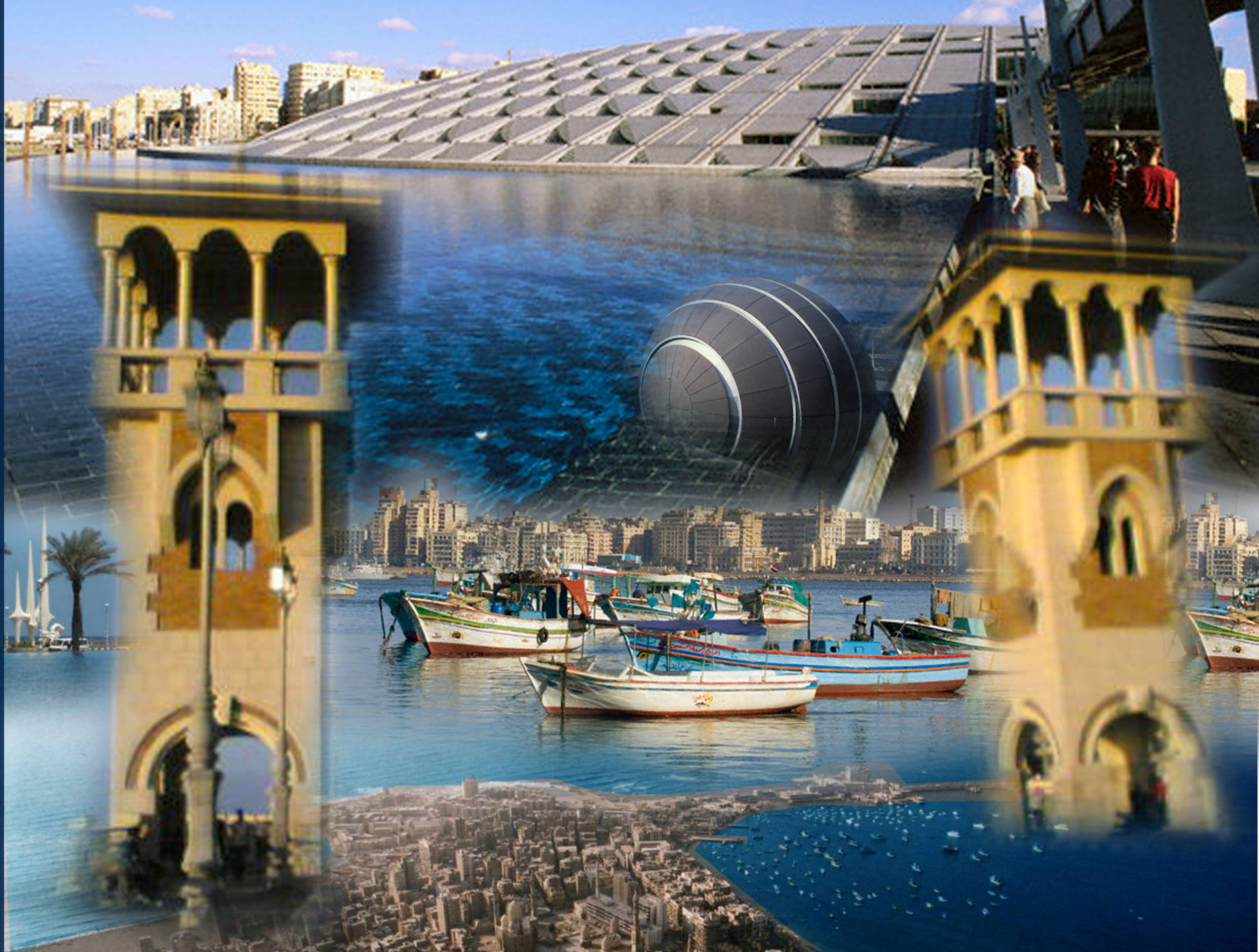

Alexandria 2030

Integrated Urban Water Management (IUWM)

Strategic Plan

Alexandria 2030 Integrated Urban Water Management (IUWM) Strategic Plan

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SWITCH

SIXTH FRAMEWORK PROGRAMME

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1. Introduction

Alexandria with 4.0 million inhabitants on the northern coast of Egypt is one of the major cities on the Mediterranean Sea and Egypt's second largest metropolitan. Alexandria accounts for about %5.5 of Egypt's Population and for almost %8 of the country's GDP. It embraces a coast line of 70 kilometers and is home to %40 of Egypt's industrial establishments.

Alexandria is the most downstream city on the longest river in the world, the Nile River, with Egypt being its most downstream country. The Nile River represents the main renewable source of water, supplying over %95 of Alexandria's water demand.

As it resides on the Mediterranean coast, Alexandria is a summer destination, increasing its population in the summer to 6 million people, putting more pressure on the city›s water demand. The city receives rainfall of less than 200 mm/year. Storm water either finds its way into sewage systems or drains into the Mediterranean Sea without use, or seeps into the coastal groundwater aquifer through the little-left infiltration areas of the city. Most of the city is covered with potable water supply networks, but many peri-urban and informal settlements lack sewage/sanitation coverage. Most of the city sewage is at least primary or secondary treated; however, potential uses of this treated wastewater are yet to be explored in line with the country›s National Water Resources Plan.

Alexandria lays north-west of the Nile delta and stretches along a narrow land strip between the Mediterranean Sea and Lake Mariut (Mareotis). The city extends southwards from the coast to a depth of 5-2Km. in the area of Abu Qir to El Dekhiela, to about 30 Km. near El Ameriya and Burg El Arab. It is linked to Cairo by two major highways and a railroad line. It is one of the most notable summer resorts in the Middle East, for, in addition to its temperate winters, its beaches, with white sands and magnificent scenery, stretch for 140 km along the Mediterranean Sea, from Abu Qir, in the east to Sidi Kerer, in the west.

In the city of Alexandria there are nine low-income, peri-urban areas that remain un- or under-served with water and sanitation services. Though there are city and governorate level plans for extending or upgrading services to these areas, the involvement of residents/users from these marginalized areas of the city has been limited.

Population in Alexandria has increased ten times in the last 100 years with pressing demand for new land development including the area around Lake Maryout which is now surrounded by urban and industrial development and drains in the hot spot of El-Mex bay.

The Governorate of Alexandria consists of three cities: Alexandria, Borg El Arab City and Centre and New Borg El Arab. The city of Alexandria is divided into six districts which are shown in Figure 1, three local village units, and five sub-village units. The six districts of the urban area are:

- Montazah District, which include five villages in the Abiss region, with a total area of 81 square kilometer.
- Eastern District, which includes two sub-district; namely; El-Raml and Sidi Gaber, with a total area of 49 square kilometer.
- Middle District, which includes three, sub-districts; namely; Bab Sharq, El-Attareen, and Moharrem Beik, with a total area of 36 square kilometer.
- Western District, which includes two sub-districts; namely; Karmoz and Mina El-Basal, with a total area of 30 square kilometer.

- Customs District which has the highest population density and is the smallest Alexandria district with a total area of about 4 square kilometer and includes four sub-districts, namely; El-Mansheya, El-Gomrok, El-Lebban and El-Meenaa El-Sharqee.

- El-Ameriah District, which includes three sub-district; namely; El-Dekheelah, El-Agamee, and El-Ameriah, with total area of 2295 square kilometer for the district.

Figure 1. The six Districts of the Urban area in Alexandria

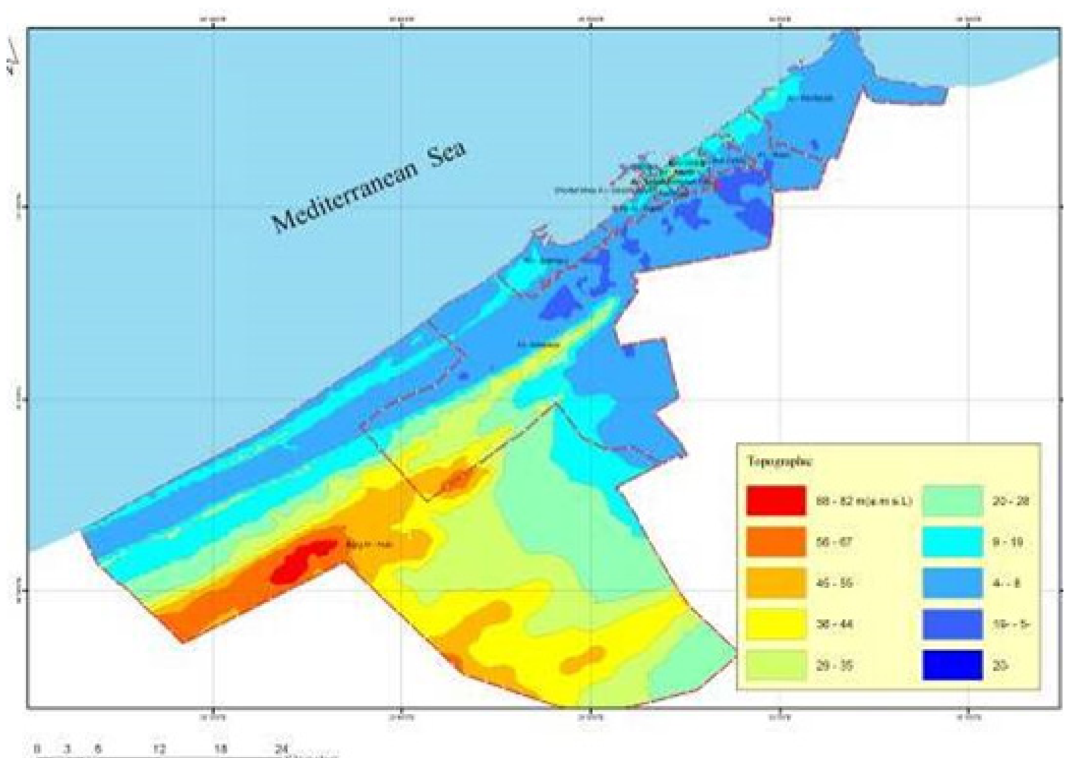

Figure 2. Location and Topographic Map of Alexandria Governorate

a. Topography

The area is characterized by irregular hills in the southern parts with an elevation from 0 to more than 40 meters above mean sea level and slopes towards the Mediterranean Sea in the north. All drainage systems of Alexandria flow into the Mediterranean Sea.

b. Climatic Conditions

The climate of the Alexandria region is one of the mildest of the Mediterranean Sea. It varies from a moderate climate in the north to arid-semi arid climate in the south. The average annual rain is 169 mm. Most of rain falls along the coastal area and it decreases suddenly moving southwards. The humidity in Alexandria is very high; however sea breeze keeps the moisture down to a comfortable level.

c. Land use

The total surface area of Alexandria Governorate is about 2680 square kilometer with different land uses which are:

- Desert land which represents about %53 of the governorate area which is about 1430 square kilometers and mainly lies in the west and western south of the city.
- Agricultural uses of total area of about 730 square kilometer represent about %27 of the total area of the governorate which mainly lies in the south and south east. . The cultivated areas are based mainly on Nile water and groundwater is used as a supplementary source in some areas.
- Surface water area which represents about %8 of the total area of the governorate and includes lakes, canals, drains and fishery farms with a total area of about 210 square kilometer.
- Municipality and Urban area which represents the remaining part of the governorate area (about %12 and 310 square kilometer) including the following uses:

1. Housing buildings of about 46 %
2. Industrial buildings of about 19 %
3. Roads, railway, and marine uses of about %29
4. Public and recreation areas of about %3
5. Military buildings of about 3 %

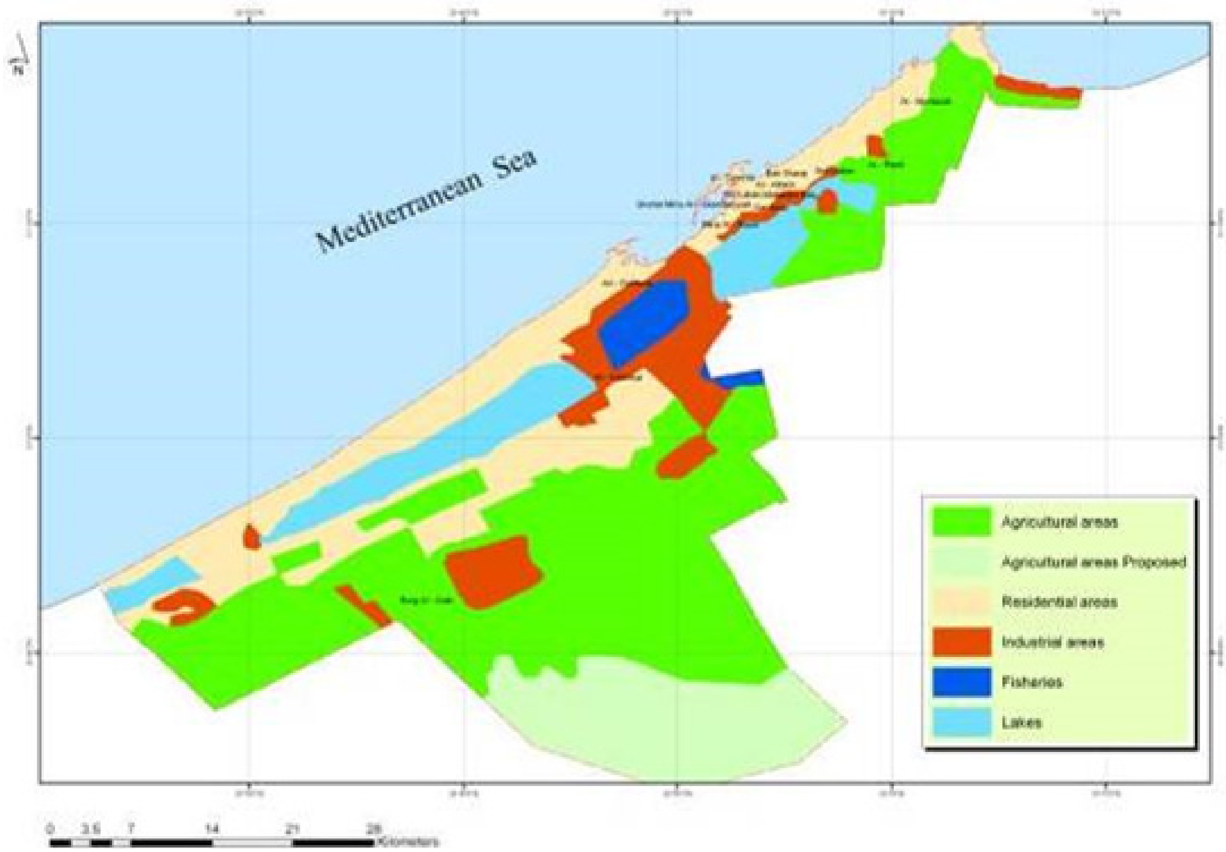

Figure 3. Land Use Map of Alexandria Governorate.

2. Background on Strategic Planning

a. SWITCH Project

SWITCH Project (Sustainable Water Management Improves Tomorrow's Cities' Health") is a research partnership funded by the European Commission (EC) undertaking innovation in the area of Integrated Urban Water Management (IUWM). SWITCH is an international consortium of 32 partners from 13 countries, led by UNESCO-IHE Institute for Water Education. The main goal of the SWITCH Project is to develop and implement scientific, technological and socioeconomic solutions that foster sustainable development and integrated urban water management. SWITCH assisted in preparing a strategic planning document in 5 of its demonstration cities around the world. Alexandria City was chosen to represent North Africa and the Arab Region. The project was set for the period between 2006 and 2011.

The Centre for Environment & Development for the Arab Region & Europe (CEDARE) is the organization which followed up the activities of the project and made the required coordination between the different related institutions and sectors in Alexandria.

Since the beginning of the SWITCH project in 2006, many activities were achieved , including forming the Learning Alliance (LA) group which consists of a group of representatives from different sectors such as Alexandria Governorate, the Holding company for water and wastewater, Alexandria water company (AWCO), Alexandria wastewater company, CEDARE, Alexandria University, the Alexandria health institution, the Ministry of environmental affairs, and the NGO for Environment , Development, and Culture in Alexandria.

Fifteen LA meetings were held, several workshops and trainings were organized in the field of water demand management, water resources assessment and modeling, visioning and scenario building. In addition the LA has determined a demonstration site in the City of Alexandria to apply and execute some of the new innovations of the SWITCH Project as a model.

To develop an IUWM strategic plan for Alexandria, ten studies were prepared representing the base for the strategic planning team to develop a strategic plan for Alexandria for the year 2030. These studies covered water demand management, wastewater management, urban water modeling, storm water management, ground water management, desalination potential, Nile water availability, financial sustainability, social inclusion and institutional mapping. Available data have been collected for the city water resources covering the history of the water system in Alexandria, description and assessment of the current and future water demand management, as well as the activities and responsibilities of different stakeholders including Ministry of Water Resources and Irrigation (MWRI), Alexandria Water Company (AWCO), Alexandria sanitary drainage company (ASDCO), and other institutions involved in water management.

b. Learning Alliance

The learning alliance has been established with representatives from all the sectors in Alexandria. The ToRs for these representatives includes highlighting the challenges faced in Alexandria with respect to water-related issues, as well as ensuring dissemination of information between the different LA stakeholders of all sectors in Alexandria. It was important to focus on IUWM and coordinate between parties to gather information from all sectors in Alexandria on resources, infrastructure, stakeholders, and demands of the people, it was then important to put guidelines for an IUWM plan to be developed and implemented in Alexandria. Rules and procedures that govern the functioning of the LA group needed time and effort to reach such clear agreements on the commitments to be made by the SWITCH project and the participants. In terms of facilitation of the learning alliance, an LA facilitator and co-facilitator were appointed for the city of Alexandria, as well as several other members of the CEDARE team who help in the LA facilitation.

Involvement in the LA included:

1. Ministry of Water Resources and Irrigation,
2. Ministry of Housing, Utilities & Urban Development,
3. Ministry of Agriculture and Land Reclamation,
4. Ministry of Health and Population,
5. Egyptian Environmental Affairs Agency,
6. Alexandria Governorate,
7. The Holding Company for Water and Sanitation Services,
8. Holding Company for Drinking Water in Alexandria,
9. Holding Company for Sanitation Services in Alexandria,
10. Professors in Universities and Research Centers,
11. NGOs.

Stakeholders are categorized in two main groups; primary and secondary. Primary stakeholders are the intended beneficiaries of the project, while secondary stakeholders are those who act as intermediaries. The two levels assisted in conducting the analysis pertaining to the management of water resources in Alexandria, and the analysis pertaining to the stakeholders' involvement in the SWITCH Project.

This may be done through carrying out specific activities such as:

This was to be all done in parallel with investigating and utilizing other water resources that are available and feasible to use such as rainwater, groundwater, desalination, as well as reuse and recycled water resources. The aim is to not become solely dependent on the River Nile water, and integrate one or more of these resources where feasible into the Alexandria water network. This is all necessary for the «Integrated Urban Water Management plan» for the city of Alexandria which will be the main output result for the SWITCH project in Alexandria to face and overcome the rapid increase in water demand of the city by the year 2030.

To develop the IUWM strategic plan for Alexandria the following steps were considered:

1. Ten studies were prepared, covering the base for the strategic planning team to develop a plan for the year 2030; eight of them are directly related to water supplying/ saving options. The studies are:
   - a. Groundwater Potential
   - b. Stormwater potential
   - c. Water Demand Management Potential
   - d. Waste Water Reuse Potential
   - e. Agricultural Drainage Reuse Potential
   - f. Sea Water Desalination Potential
   - g. Urban Water Reuse Potential
   - h. Nile Water Availability
   - i Climate Change Impact
   - j. Financial Sustainability and affordability assessment
2. Data were collected for the city water resources covering the history of the water system in Alexandria, describing the current and future water demand as well as the activities and responsibilities of different stakeholders including Ministry of Water Resources and Irrigation (MWRI), Alexandria Water Company (AWCO), Alexandria Sanitary Drainage Company (ASDCO), and other institutions involved in water management.
3. A vision for water demand management in the City of Alexandria was developed and formulated by the LA.
4. Possible scenarios for the anticipated future water system in Alexandria City were described.
5. The potential amounts of water that may be made available by eight strategic options to satisfy future water demand were studied.
6. The strategies were evaluated, costed, and ranked.

3. Current Situation

a. Water Resources and Uses

At present Alexandria receives an annual average rainfall of less than 200 mm/year, some stormwater finds its way into sewage systems, or drains into the Mediterranean Sea without use, while most of the storm water seeps into the coastal groundwater aquifer through the infiltration areas of the city. Rainfall in Alexandria is limited and its potential is not promising to promote cost effective storm water management measures.

Nile water is the main water supply to Alexandria to meet agriculture, industry, municipality, and navigation water demands. Currently, the governorate of Alexandria is allocated about 12 Million Cubic Meters (MCM)/day of Nile Water as shown in Table.1. As for groundwater, the present total groundwater extraction from the Alexandria Governorate is only 31Million m^3/year. The number of production wells is 1315. The total dissolved solids (TDS) ranges between 3808 – 794 ppm. Regarding desalination, at present there are no desalination plants in Alexandria. The future use of such resource for different purposes will largely depend on the rate of improvement in the technologies used for desalination and the cost of needed power.

Table 1 shows the water allocations from MWRI to meet all water sectors of Alexandria (Saad, 2010). It is shown that the total municipal water supply to Alexandria amounts to 3.93 MCM daily which is equivalent to 1434 MCM annually. It will be shown in the next chapters that the total amount reported by AWCO is significantly less, amounting only to 912 MCM, which indicates huge losses and/or theft along the main conveying canals.

Table 1. Water Allocations to Alexandria (MWRI, 2010)

Irrigation Directorate	Canal	Served Area in Feddans	Agriculture Demand M³/day		Industrial Demand M³/day	Navigation Demand M³/day	Drinking Demand M³/day
			Demand at present M³/day	Actual supply at presents M³/day			
Nobaria	Nobaria		2927210	1497400	130000	500000	1430000
Al Nasr	Al Nasr	107155	3088650	2316487			
Al Behera	Al Mahmoudia	25000	1000000	1000000	750000		2500000
Summation, M3/day			7015860	4813887	880000	500000	3930000
Present annual demand			12.458 MCM				

b. Water Supply

Alexandria water Company (AWCO) provides potable water for about 4 million people. This number goes up to 6 million in the summer season due to tourist influx from other parts of Egypt. Drinking water service covers more than 95 % of the service area in the city, except for small parts of the slum areas which according to the law, the citizens in these areas should submit the building license to be supplied with drinking water, which is not available in most of the cases.

AWCO›s drinking water production is maintained through the operation of the existing eight water treatment plants which have a total design capacity of 3.5 million m^3 / day.

AWCO is also responsible for the network and distributes the drinking water through its distribution system (34 Booster Pump stations & a pipe lines network of about 8,600 km length) covering the whole served area.

Unaccounted For Water (UFW) reached a high value of %36. Reducing this value is obviously of great importance to achieve water savings, minimizing the direct impact of leakage on infrastructure, excessive cost and low profits that the water company endures. AWCO has already started plans to minimize UFW.

Currently AWCO is serving an area along the Mediterranean coast extending from Abu Qir in the Eastern side of the city to El Hammam city located 63 Km west of Alexandria. Also AWCO supplies water to a southern area along the desert highway in Behira Governorate beyond the New Nubaria City, in addition to assisting in supplying Matrouh Governorate with drinking water through five transmission pipelines.

AWCO is committed to supply drinking water to the customers with suitable pressure in the network sufficient to reach the third floor of the buildings. For higher floors customers use pumps to feed reservoirs on the buildings roofs.

AWCO is following a policy aiming at installing a water meter on every household to measure, and to conserve the water consumption accurately in every housing unit and this also helps in estimating UFW.

Since 2004, AWCO started to apply the Supervisory Control And Data Acquisition (SCADA) System in the water treatment plants to monitor and control the process of water treatment.

The Annual production during the past four years is given in Figure 4, along with water selling volumes. Meanwhile, Figure 5 shows the water consumption by sectors.

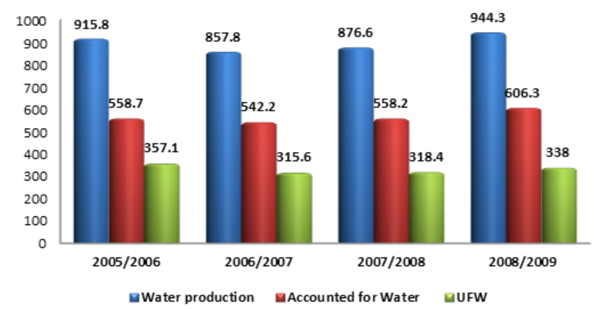

Figure 4. AMCOW's Annual Production

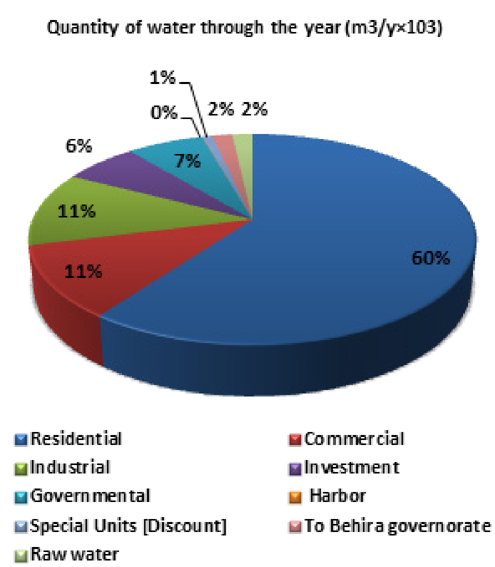

Figure 5. Alexandria's Water Consumption by Sector

Water Tariffs (per cubic meter)

A-Domestic

Tariff/m^3

Category 1: from (0-10) m^3	0.23 L.E
Category 2: from (11-20) m^3	0.23 L.E
Category 3: from (21-30) m^3	0.25 L.E
Category 4: more than >30 m^3	0.35 L.E

B-Governmental

One category:	0.80 L.E

C-Commercial

Category 1:	0.70 LE
Category 2:	0.80 LE

D-Investment – Tourism

One category:	1.15 L.E

E-Harbor

Category 1:	12 L.E
Category 2:	24 L.E
Category 3:	28 L.E

Discounted Tariff

Applied for mosques, churches, youth centers, and syndicates

Category 1:	0.21 L.E
Category 2:	0.42 L.E
Category 3:	0.48 L.E

It is obvious that the tariff is low, and this is one of the main reasons which cause the consumers to be careless about minimizing their uses and consumption of drinking water. This clarifies the importance of the following points to be considered:

* Public awareness
* Enforcement of the laws
* Increasing the tariff gradually
* Using saving devices inside all kind of buildings

Furthermore, the company adopts the increasing block pricing system, for residential users, to allow for equity between users. However, the problem with the current system is that the company set a minimum charge of L.E. 3.00 monthly, which is the value of 10 m^3, even if there is no consumption. Such arrangements do not provide incentives for water savings for low consumption.

c. Sanitation

Alexandria Sanitary Drainage Company (ASDCO) is responsible for all sanitation services of Alexandria. Most of the urban areas and about half of the rural area in Alexandria have sewerage systems ending with treatment plants. Many rural areas in Alexandria Governorate have no sewerage networks and rely on on-site sanitation. There are also sewerage projects under construction in rural areas and some of the non-served urban areas. The total length of the sewerage systems is about 750 km of various diameters ranging from 200 mm to 2750 mm.

Furthermore, there are two main wastewater treatment plants; the eastern and the western treatment plants. These existing wastewater treatment plants receive the collected wastewater through 80 pump stations of different capacities. These two wastewater treatment plants represent more than 95 % of the wastewater treatment capacity in Alexandria. The existing capacity of the Eastern Wastewater treatment plant is about 610,000 cubic meters per day while the capacity of the western wastewater treatment plant is about 470,000 cubic meters per day. There are also other two treatment plants with smaller capacities called, Hanovil Wastewater Treatment Plan with capacity of 30,000 cubic meters per day and Mubarak Wastewater Treatment Plan with capacity of 15,000 cubic meters per day. There are also smaller wastewater treatment plants for some rural areas with total capacity of less than 5,000 cubic meters per day.

Figure 6 gives the number of population served by water and wastewater facilities as of 2007/1/1.

There are sewerage systems which collect the wastewater from the served urban and rural areas. The total length of these sewerage systems is about 750 km of various diameters ranging from 200 mm to 2750 mm.

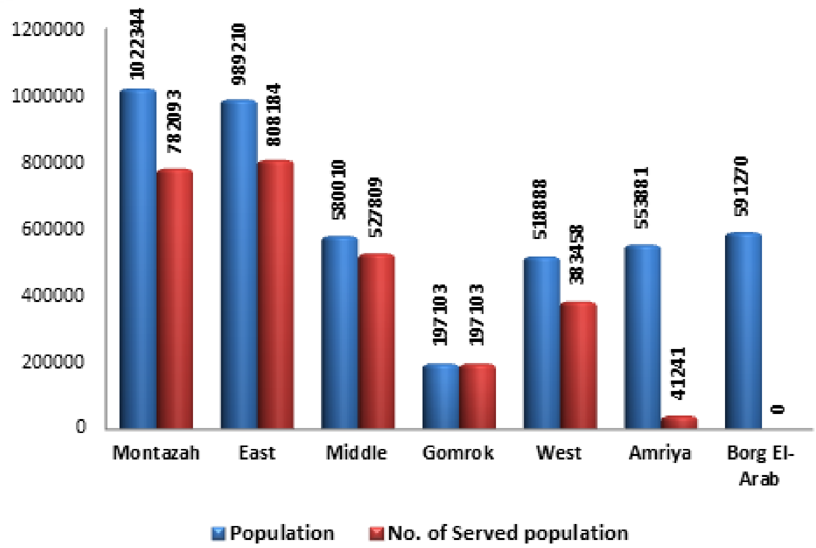

Figure 6. Served population in Alexandria

Table 2. Shows the Number of the Rural Areas in Each District of Alexandria and their Population

District	Main Village	No of Belongs	Population
Montazah	Khorsheed- El-Mohagreen- El-Tabiah - El-kobaniah- El-Emerawy El-Kobra – Mohsen El-Kobra – El-Tawfiqiah – Hood 10	62	203820
Eastern	Abis 2 – Khoseed El-Kebliah	10	21650
Middle	Abis 7 – Abis 8 – Abis 10	26	36334
El-Ameriah	Elmeseery – Deebah – Ahmed Oraby – El-Gazaer	41	151403
Borg El Arab	Bahig – Abo-Seer - Elghrobaniat	N A*	**21805**
Total			**435012**

About 50 % of the population of the villages given by table.2 has no sewerage system and depend on on-site sanitation or similar systems. However, many of these rural areas have projects for executing sewerage systems ending with treatment plant.

Generally in rural areas where there is no sewerage network, the raw sewage has on-site disposal or is evacuated and disposed at the nearest agricultural drain or surface water body. Every house has to act on their own sanitation; unsealed latrine bits and cesspools facilities are rarely adopted. They depend on disposing their sewage using leaching pit adjacent to their houses or on direct discharge of raw sewage to drains using vacuum trucks.

The new projects include treatment plants and sewerage systems. The new wastewater treatment plants include six plants in addition to the extension of the Eastern and Western treatment plans. The new treatment plants projects will add a capacity of about 500,000 cubic meters per day to the existing capacities. Table.3 show the new wastewater treatment plant projects. Some of these projects are nearly executed and under testing to be in service soon.

There are also several sewerage projects under construction in rural areas and some of the non-served urban areas. After execution of these projects about %80 of the un-served rural areas will have sewerage systems for collection of wastewater and pumping to treatments plants before disposal to the nearby drains.

Table 3. Wastewater Treatment Plant Projects Under Construction.

No.	Name	Capacity (m³/d)	Area Served	Remarks
1	Hanouvil 2 Plant	30,000	El-Dekheelah – El-Max – Om Zeghboo Rd. – Part of El-Agamy	Big part is finished
2	El-Zawaidah Plant	15,000	Villages of Khoursheed – El-zawaidah – El-Tawfiqiah – Shaker -	
3	El-Syouf West Plant	10,000	Villages of El-Syouf West – El-Bakatoush – Galal Ibrahim	
4	El-Mallahah Plant	10,000	Villages of West El-Mallahah – Masood- El-Brins – Serkis – el-Tarouti	
5	El-Agamy Plant	145,000	Bitash – El-Agamy - El-Agamy Beach	
6	Old El-Aameriah Plant	50,000	Old El-Aameriah – Merghem- Abdel-Kader Villages	
7	Extension of Eastern Plant	200,000		
8	Extension of Western Plant	100,000		

4. Future Threats and Uncertainties

a. Nile Water Availability

The available Nile water for Alexandria Governorate reaches it through three main canals which are:

- Nobaria canal
- El Nasr canal
- El Mahmoudia canal.

These canals supply Nile water to the governorate which is required to meet agriculture, industry, municipality, and navigation water demands.

A study was performed to check if there are any future plans to increase Alexandria's share from the Nile water through canal expansion. The previously expected findings of this study ensured the need for finding alternative water resources by 2030. The study showed that there are some limited canal expansion plans that would only affect their conveyance in terms of restoring back the design discharge. This will not significantly enhance the Nile Water availability in Alexandria.

b. Climate Change

According to the Intergovernmental Panel on Climate Change (IPCC) third assessment report, Alexandria is among the most vulnerable cities to sea level rise and has a very limited capacity in terms of undertaking any of the three common strategies which are: adapt, retreat, or defend. A scenario involving a sea level rise between 0.5 and 1 meter over the current century may lead to an inundation of about %30 of the governorate if no proper action is taken. (IPCC, 2001).

The IPCC fourth assessment report has pointed out that temperature increase has been observed in Alexandria from 1979 to 2005; however, the report did not record a change in precipitation during the same period due to insufficiency in data. (IPCC, 2007).

CEDARE has performed a detailed climatic analysis using temperature and precipitation data from 1957 to 2009. The results showed no particular evidence of a fixed trend as will be shown in section 6. b.

c. Population

The current and future Alexandria population are shown in tables 4 and 5, which give the estimated population given by the Master Plan 2030 for Alexandria Water Company.

Table 4. Estimated Populations in the Service Area in the Future Years

Service Area	Estimates of number of inhabitants by year, (in thousands)					
	2006	2012	2017	2022	2027	2030
Alexandria	3,885	4,262	4,605	4,973	5,371	5,629
North Coast	218	263	308	361	423	466
Beheira	132	154	175	199	226	245
Total	**4,235**	**4,679**	**5,088**	**5,533**	**6,020**	**6,340**

Table 5. Estimated Populations in the Service Area (Peak Summer Period)

Service Area	Estimates of number of inhabitants by year, (in thousands)					
	2006	2012	2017	2022	2027	2030
Alexandria	5,110	5,608	6,089	6,548	7,073	7,411
North Coast	338	408	478	560	447	640
Beheira	132	154	175	199	226	245
Total	5,580	6,170	6,742	7,307	7,746	8,296

The inhabited area of the governorate covers an area of about 307 km^2, representing about %11 of the total area of the governorate. The total population of Alexandria in 2006 was about 4.235 million people, giving an average population density of about 11,132 person/km^2. The spatial variations in population density between different districts are quite evident with the central old section of the city; Wassat district had an average of 133,460 person/km^2.

The governorate has been experiencing rapid rates of population increase over the past three decades. For instance, the total population reached in 2006 was about 4.235 million people compared with ,3.339 2.927 and 2.318 million in 1986 ,1996 and 1976, respectively as shown in figure 7.

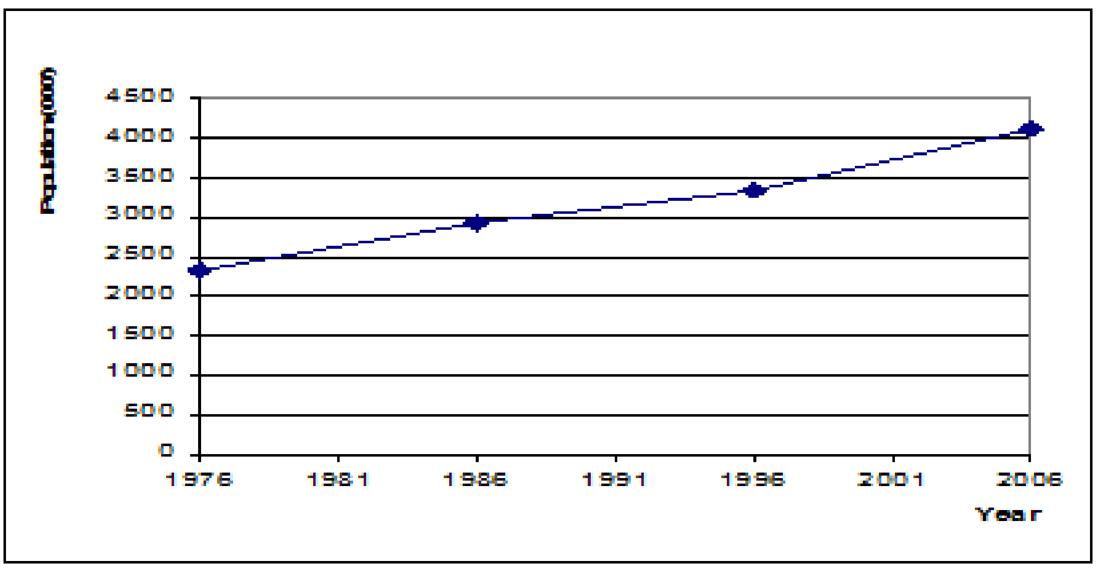

Figure 7. Population of Alexandria from 1976 to 2006

This meant an absolute increase of about 1.917 million, or %83, over the past three decades. The spatial distribution of the population was found to be rather uneven between different districts of Alexandria, with the inner district, Wassat, reaching its saturation level. This may reflect the need for a future expansion to currently uninhibited areas of Alexandria which maybe away from Nile Waters but closer to groundwater or even seawater. Figure 8 shows the future increase in production that AWCO needs to meet.

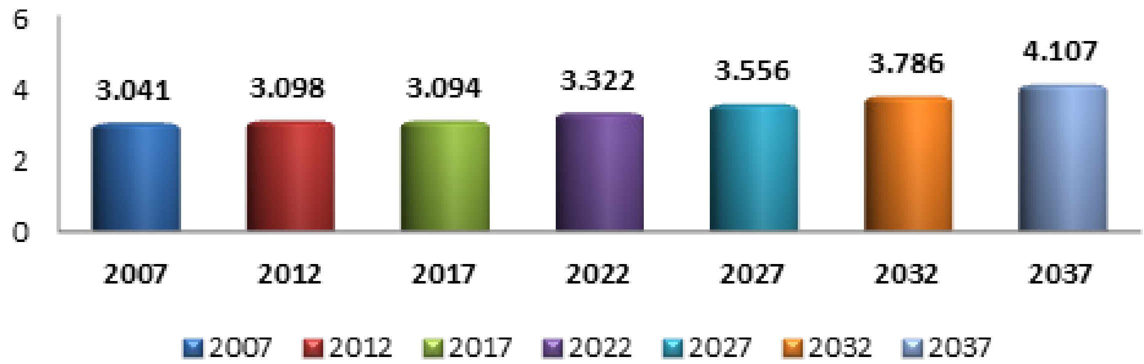

Figure 8. AWCO's Future Required Summer Production

5. The 2030 Alexandria Water Vision

A vision has been developed for water resources management in the City of Alexandria in the future taking into consideration the vision which is formulated previously by the LA. This vision expresses the hopes in achieving a sustainable urban water supply system by the year 2030. Possible scenarios for the future water system in Alexandria City have been described. The potential strategies to achieve the vision for water demand management have been determined.

The vision states:

'We envisage a city where available water resources are managed in an integrated manner, with the participation of all citizens, and are used effectively for development

Within a framework of environmental sustainability, where all citizens have access to high quality (according to national norms), reliable, sustainable, and affordable

water and sanitation services and benefit from a clean and healthy environment.'

The LA has also identified three possible future scenarios for the year 2037 which was initially intended to be the target year for strategic planning. The scenarios are as follows:

a. Worst Case Scenario

In 2037, Alexandria is a city characterized by continued explosive population growth (summer population 12 million), a weak and stagnant economy, and the city's share of Nile water is about %40 less than in 2007 (due to competition from other users and climate change), increased risk of flooding (due to sea level rise), and poor availability of financial resources.

b. Best Case Scenario

In 2030, Alexandria is a city whose population has largely stabilized (at 6.3 million), is benefiting from a dynamic and fast growing economy, has a guaranteed share of Nile water similar to that of 2007, and where climate change has tended to the most positive of scenarios (with sea level rise minimum, and increased rainfall). The new vitality of the Egyptian economy means that financial resources are readily available.

c. Business as Usual

In 2037, Alexandria continues to be city dealing with considerable uncertainty. Population is 10 million, and continues to grow. Alexandria's allocated share of Nile water is about %20 less than in 2007, while economic growth has been steady but unspectacular. Rising sea levels are starting to threaten some parts of the city.

6. IUWM Strategies to meet Future Water Demand

i. Strategic Options

a. Groundwater Potential

One of the main objectives of the Alexandria strategic planning process was to assess the groundwater potentiality in Alexandria governorate in order to increase its contribution in the water resources policy of the governorate.

A well inventory for all production wells in Alexandria governorate has been carried out during the period June – August 2009. The results of the well inventory indicate that the existing production wells are distributed all over 9 areas as shown in Figure 9. In summary:

- Total number of production wells reaches about 1315 wells.
- The total drilling depth of these wells varies between 45-6 m.
- The depth to groundwater ranges between 18- 1.5 m.
- The rate of groundwater extraction for each well varies from 60-2 m^3/hour.

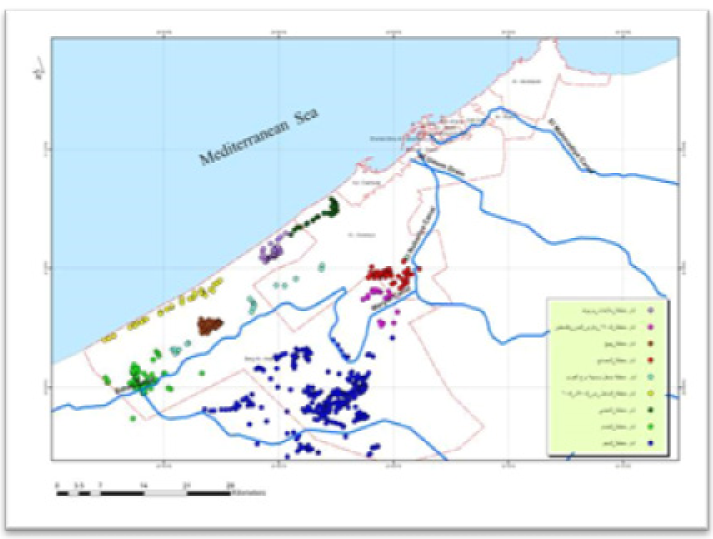

Figure 9. Location of the Production Wells in Alexandria Governorate.

The present total groundwater extraction in Alexandria Governorate is about 31 MCM/year and is mainly used for agriculture. The number of production wells and related extraction were distributed among the existing aquifers and presented in table.7.

The scenario of ground water potential can be shown in S5 Ground Water for green space irrigation in Alexandria governorate which would offer an additional 18 MCM per year (White et al, 2011). This is less than the available potential of groundwater (which is also about 31 MCM as shown in the table below), partly due to the fact that the discharge wells used for green space irrigation are only concentrated in a select number of areas, as opposed to covering the entire governorate. It is illustrated that the unit cost for this is 0.48 PV$/$m^3$.

Table 6. Groundwater Extraction (m³/year)

No.	Aquifer	Area (km²)	No.of Wells	Present Extraction (m³/year)	Total Potential (m³/year)	Available Potential (m³/year)
1	Coastal Aquifer	232	373	1,573,590	3,132,000	1,558,410
2	Nile Delta Aquifer	705	190	2,702,830	28,200,000	25,497,170
3	Ralat aquifer	553	752	26,808,830	30,968,000	4,159,470
	Total	1590	1315	31,085,250	62,300,000	31,214,750

It has been concluded that ground water could contribute an extra 31 MCM annually to the water budget of Alexandria..

b. Storm Water Potential

There are six rainfall stations in Alexandria. Rainfall data for Nozha Station for the period from 1957 to 2009 were obtained. The data covers series for daily, monthly and annual rainfall.

The analysis of annual rainfall for Nozha station reveals that the average annual value for the available data is 169 mm. Figure 10 shows a plot for the annual rainfall for the available data from 1957 till 2009. Another weather station at Alexandria Port shows that the average annual rainfall for the period from 1868 and 1973 is 197.4 mm.

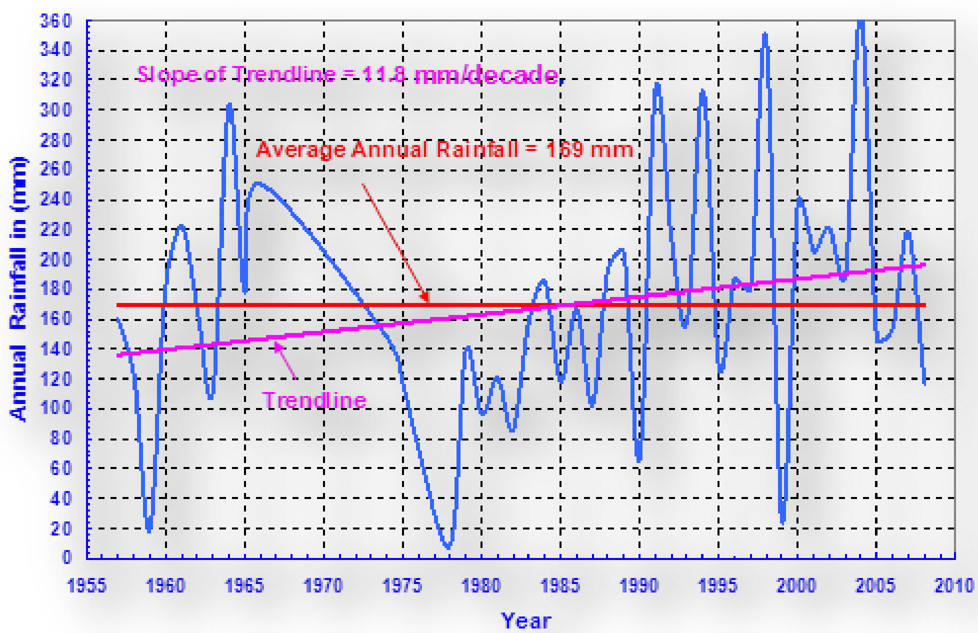

Figure 10. Annual Rainfall for Alexandria - from 1957 – 2009

To examine the potential of rainfall quantities in Alexandria, daily rainfall series were studied. The average monthly rainfall for the rainy months is considered, and months which give similar average monthly rainfalls have been identified.

Given that about %10 or less of the total governorate's area is occupied by paved, roofed, industrial or residential areas, the total volume of rainfall runoff available for harvesting does not exceed 45-50 MCM annually, assuming coastal rainfall station measurements are close to the governorate average.

It has been clearly revealed that rainfall in Alexandria is limited and its potential is not promising to promote cost effective sophisticated best management practices (BMP). However, it may be useful to apply some simple BMPs which need to be identified.

With that being said, section g (Urban Water Reuse) shows three streams that could be tapped into, two of which (rooftop and road water) are components of storm water in general.

c. Water Demand Management Potential

The main purpose of Different demand management options were considered according to different future scenarios, these options were considered in terms of amounts of water saved and cost.

Three important strategies that should make significant amounts of water available by 2030 were suggested. The first strategy involved minimizing physical and commercial losses from pipe network; it was proven that 20 MCM could be made available annually by applying this strategy. This amount is based on 2010 consumption. If no action is taken to reduce these losses in the new network expanded until 2030, the losses are expected to reach 59 MCM annually as shown in **DM6 System Leakage Reduction**. It is illustrated that the unit cost for this is 0.02 PV$/m^3 (White et al, 2011).

The second strategy was to increase the drinking water tariff gradually in a manner that could save around 57 MCM annually starting from 2030; this amount corresponds to the value of monetary savings resulting from an average tariff increase of %5.

This is shown in **DM7 Tariff Reform** with no unit cost. It is worth mentioning that the tariff reform option has been aided by an affordability study that explored the affordable water tariff in Alexandria under the assumption that between %2 and %5 of household income is spent on water and sanitation, which the same assumption is used by the World Bank. The study showed that within a period of 10 years, water and wastewater tariff could jump from 0.54 LE/m^3 to 1.92 LE/m^3 without exceeding the affordability threshold. That can include 3 options; **DM1 Water Saving Fittings Retrofit** with an amount of 26 MCM annually at a cost of 0.08 PV$/m^3, **DM2 Toilet Replacement Program** (replacing old toilets with modern, efficient models) with an amount of 6 MCM annually at a cost of 0.53 PV$/m^3, and **DM9 Appliance Efficiency Regulation** (substituting washing machines and other water-intensive appliances with newer and more efficient models) with an amount of 21 MCM annually at a cost of 0.02 PV$/m^3 (White et al, 2011).

In WDM there are 3 more options that are worth mentioning involving the control of organizations' consumption patterns: **DM3 Tourist and Commercial Audit and Retrofit** with an amount of 30 MCM annually at a cost of 0.11 PV$/m^3, **DM4 Government Buildings Audit and Retrofit** with an amount of 41 MCM annually at a cost of 0.08 PV$/m^3, and **DM5 Industrial Customers Efficiency Improvement** with an amount of 34 MCM annually at a cost of 0.06 PV$/m^3 (White et al, 2011).

d. Waste Water Reuse Potential

At present the wastewater treatment plants are of the primary type. Treated water is diverted to Lake Maryut, and then pumped to the Mediterranean Sea.

Strategies for wastewater management and reuse in Alexandria were formulated towards achieving a sustainable urban water system by the year 2030. The strategies took into account different scenarios, in terms of population growth, wastewater flows, wastewater composition, expansion of the sewer system, demand for effluent in industry, urban and agricultural uses, climate change, salt water intrusion, regulations and effluent standards. It has been shown that treated wastewater can contribute about 900 MCM yearly that can be used for agricultural purposes in different locations. The potential amount that could be used in Alexandria Governorate is shown in 3 options: **S2 ETP and WTP Wastewater Reuse in Industry** with an amount of 32 MCM annually at a cost of 0.6 PV$/m^3, S4 **ETP and WTP Wastewater Reuse for Agriculture** with an amount of 63 MCM annually at a cost of 0.48 PV$/m^3, and **S6 local Wastewater Reuse for New Developments** with an amount of 37 MCM annually at a cost of 0.4 PV$/m^3 (White et al, 2011). The reused wastewater would be a direct 'swap' for the currently utilized freshwater resources, which can be directed toward other uses.

Figure 11 shows the two most favored options in using treated wastewater in agriculture, which are the Hammam site and the ASDCO site, to which the remaining 745 MCM of treated wastewater could be diverted for irrigation purposes.

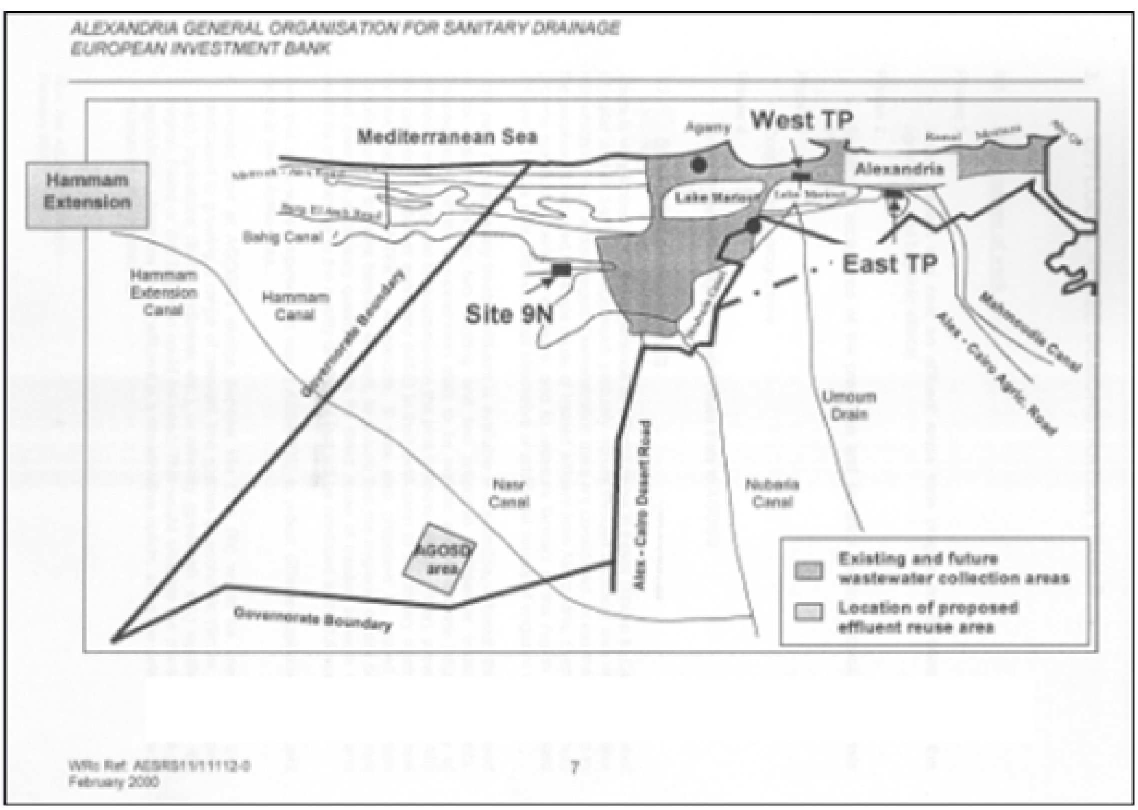

Figure 11. Options for Using Treated Wastewater in Agriculture (ASDCO)

e. Agricultural Drainage Reuse Potential

In this option (Figure 12), brackish agricultural drainage water would be extracted from the agricultural drain and treated in a desalination plant so that it is suitable for use in industrial facilities and as a non-potable supply source for coastal resorts as well as agriculture. The concept for this option is illustrated in Figure 12 the red dot marks the proposed location of the plant and the red lines represent the major trunk mains for the supply network. For this option, it has been assumed that the treated water would be delivered in a separate network and used essentially as a non-potable supply source. However, the resulting water is likely to be of a very high quality following pre-treatment and desalination, so it is possible that this water could be added to the existing water supplies in the Noubariya canal. This issue would need to be determined by the water supply and irrigation authorities. The brine resulting from this treatment process would require careful disposal. In this study it has been assumed that a separate pipeline would be used to discharge the brine into the sea, however, the impacts of this will need to be studied more carefully to ensure there will be no adverse impacts on the coastal environment (White, et al, 2011).

Irrigation losses are addressed by DM8 Agricultural efficiency offsets (reducing unnecessary leakages in channels/drains and converting some irrigation systems to drip/sprinkler methods, among other measures) with an amount of 75 MCM annually at a cost of 0.01 PV\$/m^3.

Representing the reuse of agricultural drainage (which would also be a direct 'swap' for freshwater resources) is S3 Agricultural drainage desalination and reuse, with an amount of 62 MCM annually at a cost of 0.63 PV\$/m^3 (White et al, 2011).

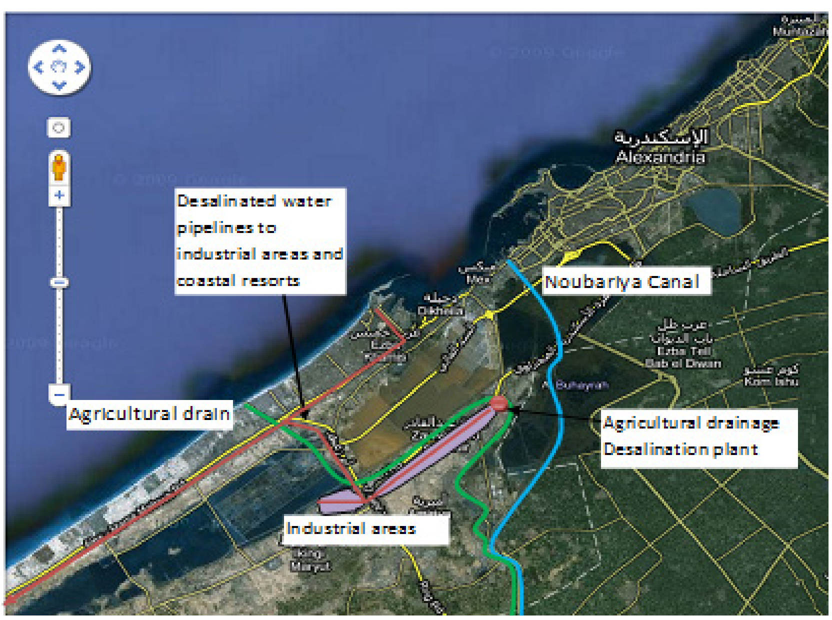

Figure 12. Agricultural Drainage Reuse Option (White, et al, 2011)

f. Sea Water Desalination Potential

Desalination plants operate in approximately 125 countries, with seawater desalination plants contributing 59 percent of the total worldwide desalination capacity. For Alexandria, it has been concluded that water desalination, as a conventional water resource should be considered as an imperative measure for water security. The future use of such resource for different purposes will largely depend on the rate of improvement in the technologies used for desalination and the cost of needed power. (White. et al, 2011). At present there are no desalination plants in Alexandria.

A critical issue in water desalination is the high energy demand and, more specifically, electricity for Reverse Osmosis (RO) desalination units. However, it has been shown that RO is the desalination process with the lowest energy requirements. Therefore, it was expected that significant efforts would be taken to implement widely available and environmentally compatible energy sources for desalination.

It has been shown that if sufficient funds are available, the maximum amount of desalinated water could reach up to 777 MCM annually starting from 2030, based on the needs of some particular coastal areas. The potential that can be actually used annually by 2030 accordingly is shown in **S1 Seawater** at a cost of 1.15 PV$/m^3 (White et al, 2011). The locations where the desalinated water can be used have also been determined. Moreover, a desalination system that could produce up to 2.13 MCM of desalinated water daily has been proposed, 366 units of the proposed system will be needed to produce the above mentioned daily amount. Fig. 13 shows a potential desalination plant.

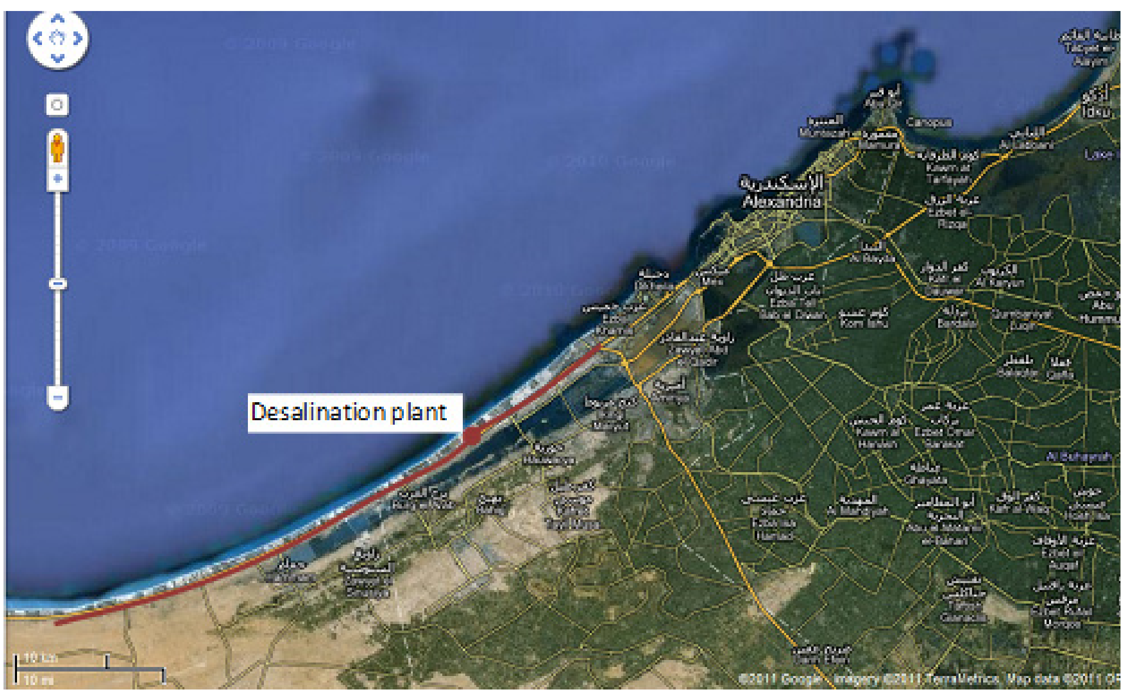

Figure 13. Location of a Potential Desalination Plant (White et.al, 2011)

g. Urban Water Reuse Potential

One of the most important objectives of strategic planning was promoting the concept of urban water modeling and setting it as a common practice between current and future water experts in Alexandria. Therefore, some strategic alternatives were assessed using the model "AQUACYCLE".

Although establishing a numerical urban water model for the different districts of Alexandria would have been a great success in itself, the applied model achieved further success as three strategic alternatives have been assessed, these are **S9 Grey Water Reuse** (with a unit cost of PV1.6$/m^3), **S7 Roof Water Reuse** (with a unit cost of PV1.0$/m^3), and **S8 Road Water Reuse** (with a unit cost of PV1.1$/m^3), the model has showed that these options could introduce 14 ,23, and 25 MCM annually to the Alexandria water budget respectively (White et al, 2011). The high unit costs of grey water reuse are attributed to major initial costs arising from the installation of grey water systems in thousands of apartment buildings in Alexandria.

ii. Analysis of Strategic Options

The next important step was to investigate all options collectively and see which of them are mutually exclusive as well as explore the practicality and feasibility of producing the theoretical amounts of water indicated for every strategic option.

It is worth mentioning that as of now, all of Alexandria's water is processed through the Alexandria water company which means that all sectors receive the same quality of water which is the highest possible as the domestic sector is the main benefactor. This is definitely something that needs to be changed in the future.

The different potential amounts that were concluded for every strategic option cannot be necessarily added altogether as some of the options could be mutually exclusive, however it is safe to assume that the amount of available water to the city of Alexandria in 2030 could exceed the needs if the strategies suggested in this study are adequately adopted.

The storm water management options were studied by the urban water modeling package AQUACYCLE will be eliminated from further assessment due to their weak potential options, these options are: greywater reuse, roof water reuse, and road water reuse.

Groundwater promises to be a semi-guaranteed option for Alexandria in the future given the fact that the water is relatively close, the quality is highly acceptable, and the treatment of brackish water is affordable.

Desalination is yet another promising future resource for Alexandria, given that the necessary funds for establishing and operating 426 Reverse Osmosis units are available.

Water Demand Management options that were proposed in a joint research effort between CEDARE and The institute of Sustainable Futures at the Technical University of Sydney (ISF-UTS) will be considered in the overall assessment due to their high feasibility; these options will be highlighted in the following section.

The most arguable strategies are those that involve the use of treated wastewater in agriculture, the locations of the two options that are highlighted in table 9 are referred to as Hammam extension and ASDCO site in Figure 11. Also the two major treatment plants are shown in the same figure (referred to as East TP and West TP). Both options are debatable as Law 48 for the year 1982 forbids the discharge of treated waste water into irrigation canals. Therefore, regardless of the technical feasibility of both options, their implementation needs a drastic change in the institutional setup of Alexandria and/or Egypt.

The agricultural drainage reuse is also a very important strategic option as the amount entering Alexandria reaches 7.5 MCM daily; studies are currently in progress to assess the possible future reliability on that resource and the efficiency of treatment.

Figure 14 shows an overall layout that outlines the water resources available to Alexandria, and covers both conventional sources (such as Nile water and precipitation) and nonconventional ones (including agricultural drainage and treated wastewater). The total amount utilized annually by the governorate at this time comes to 3492 MCM. A huge portion of this amount is not properly used, especially when it comes to precipitation and agricultural drainage, in addition to the huge amounts of irrigation water lost on both the national and farm levels (with the latter mainly due to very low irrigation system efficiencies); this has prevented Alexandria from approaching its true potential, which is about 6706 MCM.

It could be indicated from table. 6 that the estimated population for 2030 is 6.34 Million. Table. 8 shows the demand in 2010 compared to the projected demand of the year 2030 under the exact same circumstances of 2010 (business as usual), for the normal months as well as the peak period (June to August). At that case the annual demand could reach up to 1388 MCM. Implementing the demand management options proposed would ensure a reduced annual demand of 1114 MCM. Furthermore, the freshwater saved due to irrigation efficiency offsets would provide an indirect supply of 75 MCM, and the implementation of two further supply options would see the total annual supply successfully satisfy the aforementioned demand.

Table 7. Current and Future Water Demand

CURRENT SITUATION			2030 (September to May)		2030 Peak Period (June to August)		2030 Total
2010			Business as usual				
Total Water Produced		947343750	966		421		1388
Total Water Sold		606300000	618		206		825
Population		4500000	6340000		8296000		8296000*
Category	Consumption		Expected Consumption	Expected Volume	Expected Consumption	Expected Volume	Expected Volume
	%	Lit/Capita/Day	%	Mega m³/ year	%	Mega m³/year	Mega m³/ year
Domestic	61.16	218	61.16	378	61.16	126	504
Industrial	11.20	40	11.20	69	11.20	23	93
Commercial	11.71	42	11.71	73	11.71	24	97
Investment	6.51	23	6.51	40	6.51	13	53
Govermental	6.73	24	6.73	42	6.73	14	56
Harbour	0.03	0.1	0.03	0.2	0.03	0.1	0.2
Discounted Units	0.86	3	0.86	6	0.86	2	7
Exported (Behira)	1.80	6	1.80	10	1.80	3	14
Sum W/O losses	100	356	100	618	100	206	825
UFW	36	200	36	348	36	215	563
Sum ALL INCL UFW		557		966		421	1388

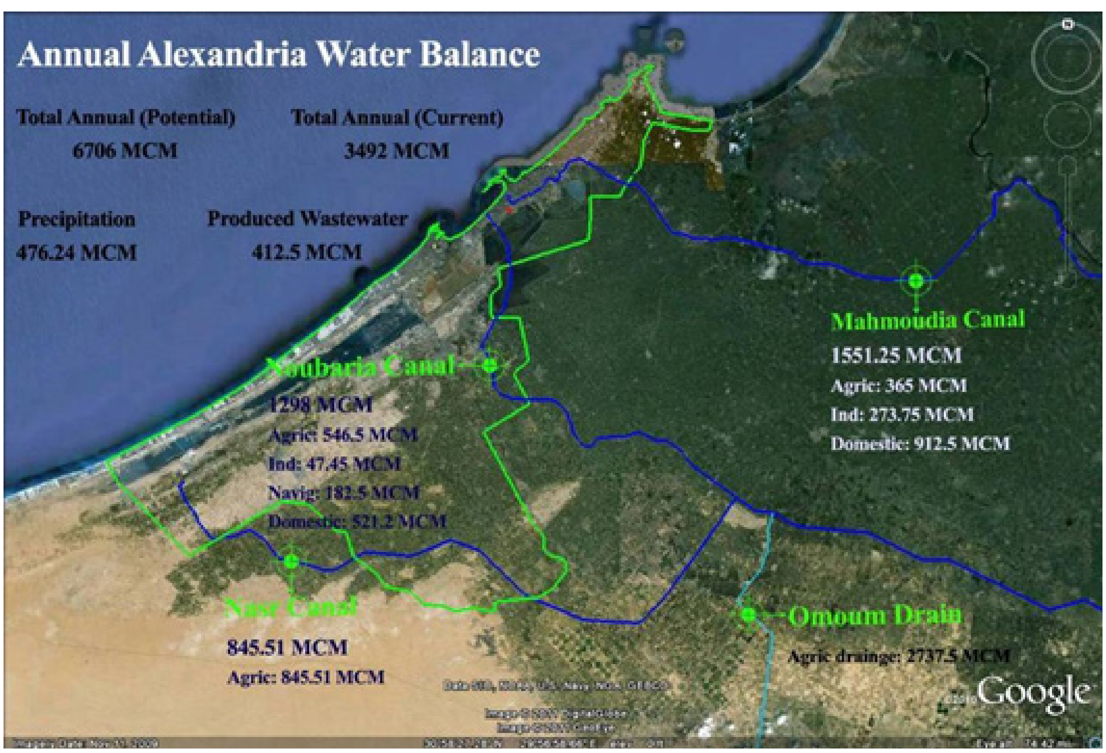

Figure 14. Alexandria Overall Water Budget

7. Meeting Multiple Objectives & Strategy Ranking

The institute of Sustainable Futures at the Technical University of Sydney (ISF-UTS) and CEDARE have modeled different supply and demand options reflecting all strategic options.

The results from modeling the water savings and costs of each option are shown in tables 8 and 9. The demand management options tended to be the most cost-effective. Options DM7 and DM8 stand out for their cost-effectiveness and high potential in terms of water savings. Greywater reuse was found to be the least cost-effective of the 18 options modeled. At $ 1.6 /m^3 it is %30 more than the second most expensive option, which was seawater desalination at $ 1.15 /m^3.

Figure 15 shows the contribution of each strategic option towards fulfilling the 2030 water demand while figure 16 shows the final ranking of all strategic options in a way that reflects the suggested order of strategies implementation. Total water savings of 449 MCM/year are projected for 2030.

Figure 17 shows the estimated annual budget which is predicted to reach a peak of around 62 Million US Dollars by 2030 after implementing all water saving/supply options.

Table 8. Strategy Ranking According to UTSISF-CEDARE Study

Code	Options	Maximum potential savings/supply (MCM)	Unit cost (PV$/m^3)
DM1	Water saving fittings retrofit	26	0.08
DM2	Toilet replacement program	6	0.53
DM3	Tourist & commercial audit & retrofit	30	0.11
DM4	Government buildings audit & retrofit	41	0.08
DM5	Industrial customers efficiency improvement	34	0.06
DM6	System leakage reduction	59	0.02
DM7	Tariff reform	57	0
DM8	Agricultural efficiency offsets	0	0.01
DM9	Appliance efficiency regulation	21	0.02
S1	Seawater Desalination	0	1.15
S2	ETP and WTP wastewater reuse for industry	32	0.6
S3	Agriculture drainage desalination & reuse	62	0.63
S4	ETP and WTP wastewater reuse for agriculture	0	0.48
S5	Groundwater for green space irrigation	18	0.48
S6	Local wastewater reuse for new developments	37	0.4
S7	Rooftop water harvesting	14	1
S8	Road water harvesting	25	1.1
S9	Greywater reuse	23	1.6
Total		1400	

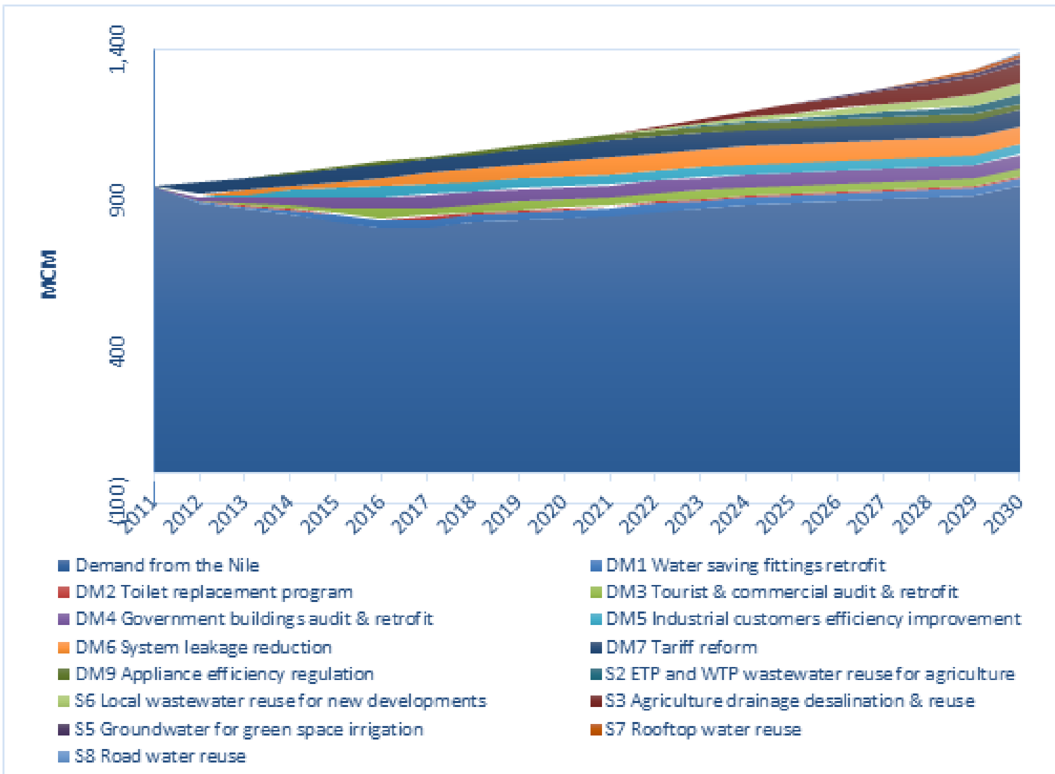

Figure 15. Projected Water Demand in Alexandria to 2030

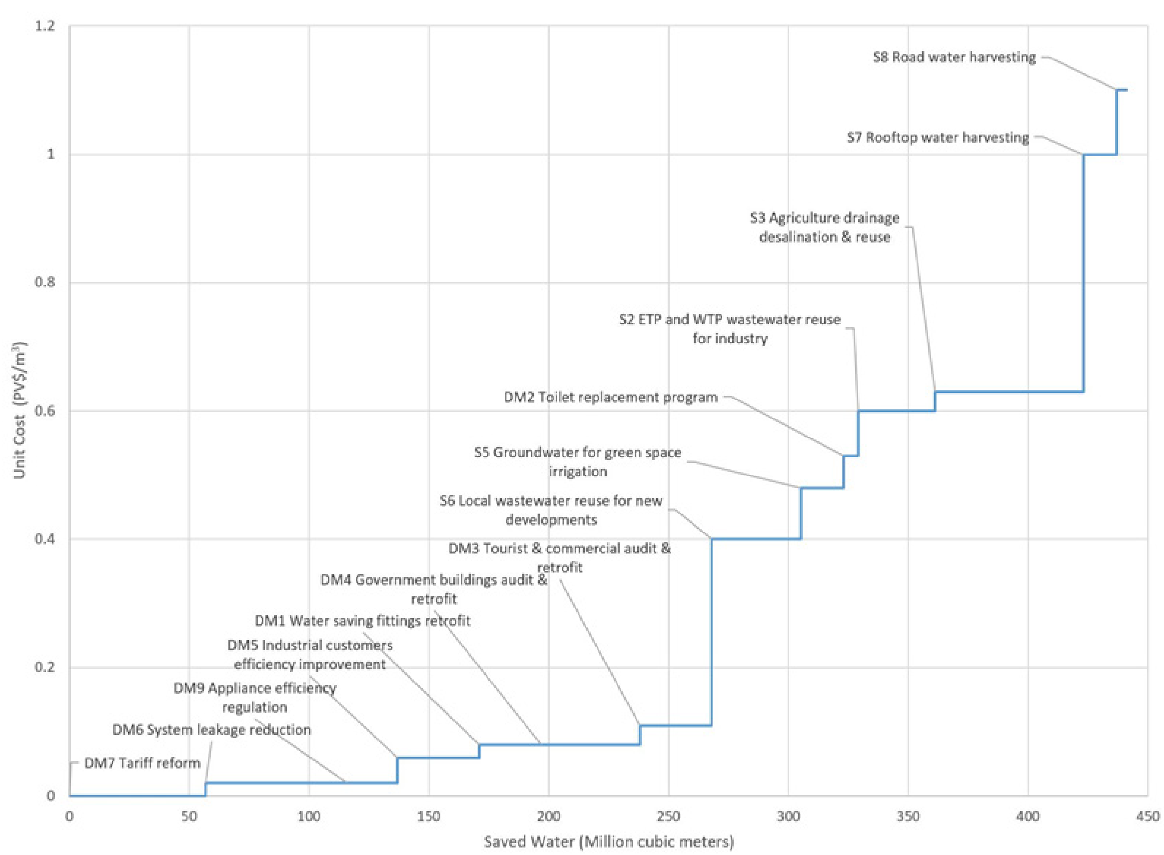

Figure 16. Supply Curve for All Strategic Options

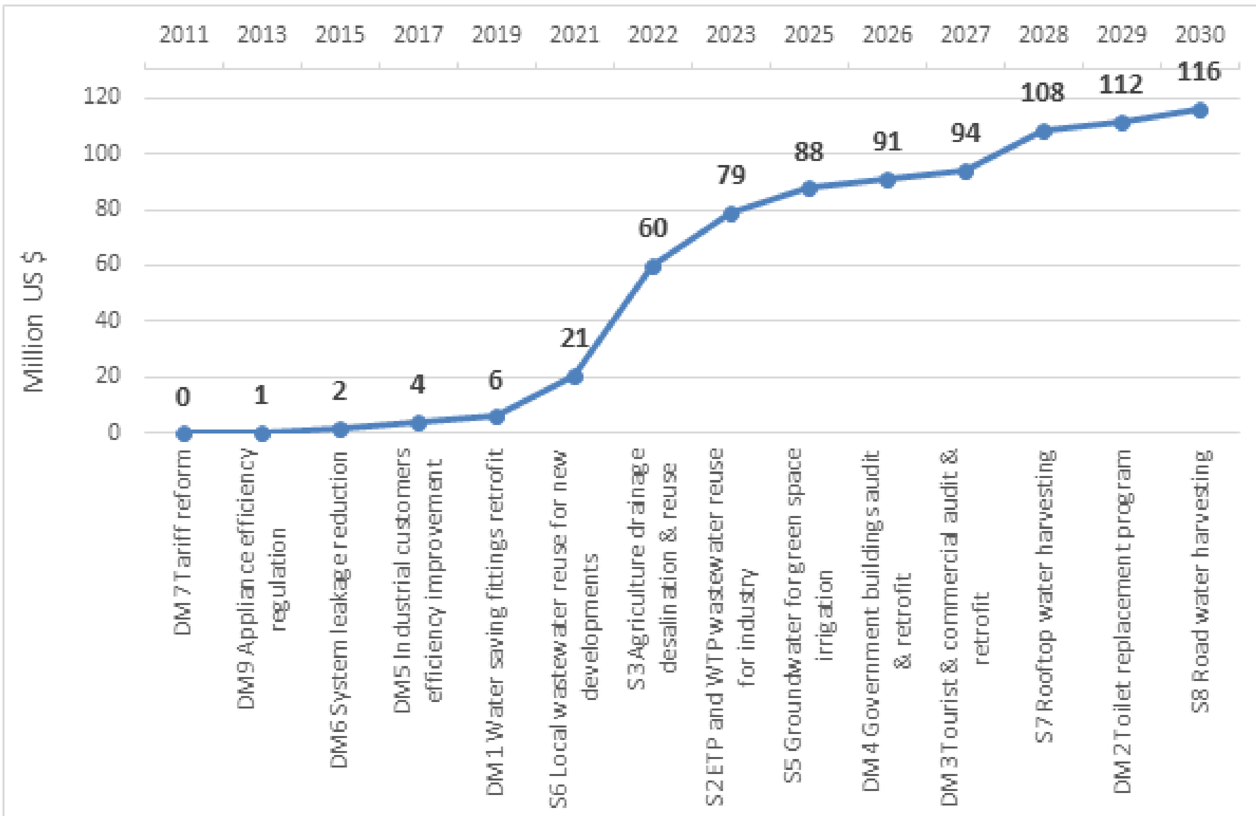

Figure 17. Estimated Annual Budget Through 2030

Under the assumption that the feasibility of both sea water desalination and agricultural drainage treatment and reuse will increase, and the problems associated with the waste water reuse options will be resolved, 449 MCM could be saved; this will significantly decrease the pressure on Nile Water which is currently just under 1400 MCM annually. With this final 2030 allocation from non-surface water options, only 940 MCM will be allocated from the Nile River to Alexandria. Table 9 shows the final allocations and the total associated costs for the options selected for Alexandria in 2030. It is clear that the total annual cost needed to implement all the options in the table amounts to around 62 Million US$, which may be unaffordable at the meantime, however, this amount is much more affordable when compared to the cost of providing the same volume which is 449 MCM by desalination only. The cost then will be around 517 Million US$.

It is also worth mentioning that this strategic plan, if adequately implemented, will be of a great national significance as it will benefit other cities/ governorates aside from Alexandria. The amount saved from the Nile Water allocation could be directed to inland governorates with no desalination potential.

Table 9. Water Volumes and Costs for 2030

Code	Options	Water saved or supplied in 2030 (Mm³/a)	Unit cost (PV$/PVm³)	Total Cost (US$)	Sort by favorable unit cost per cubic meter
DM7	Tariff reform	57	0	0	1
DM6	System leakage reduction	59	0.02	1,180,000	2
DM9	Appliance efficiency regulation	21	0.02	420,000	3
DM5	Industrial customers efficiency improvement	34	0.06	2,040,000	4
DM1	Water saving fittings retrofit	26	0.08	2,080,000	5
DM4	Government buildings audit & retrofit	41	0.08	3,280,000	6
DM3	Tourist & commercial audit & retrofit	30	0.11	3,300,000	7
S6	Local wastewater reuse for new developments	37	0.4	14,800,000	8
S5	Groundwater for green space irrigation	18	0.48	8,640,000	9
S2	ETP and WTP wastewater reuse for industry	32	0.6	19,200,000	10
S3	Agriculture drainage desalination & reuse	62	0.63	39,060,000	11
DM2	Toilet replacement program	6	0.53	3,180,000	12
S7	Rooftop water harvesting	14	1	14,000,000	13
S8	Road water harvesting	4	1.1	4,400,000	14
	Total	**441**		**115,580,000**	

Code	Options	Water saved or supplied in 2030 (Mm³/a)	Unit cost (PV$/PVm³)	Total Cost (US$)	Sort by favorable unit cost per cubic meter
S8	Road water harvesting	21	1.1	23,100,000	14
S1	Seawater desalination	777	1.15	893,550,000	15
S9	Greywater reuse	23	1.6	36,800,000	16
	Total	**821**		**953,450,000**	

Code	Options	Water saved or supplied in 2030 (Mm³/a)	Unit cost (PV$/PVm³)	Total Cost (US$)	Sort by favorable unit cost per cubic meter
DM8	Agricultural efficiency offsets	75	0.01	750,000	17
S4	ETP and WTP wastewater reuse for agriculture	63	0.48	30,240,000	18
	Total	**138**		**30,990,000**	

8. Institutional Mapping

a. Current Institutional Map

The governorate of Alexandria is the leading executive and administrative body of Alexandria.

The Ministry of Housing is responsible for all water supply and sanitation services in Alexandria. The Holding Company for waste water, which is under the Ministry of Housing, is the National Organization for Potable Water & Sanitary Drainage which covers water supply and sanitation to all the governorates in Egypt. It is the umbrella under which all local governorate drinking water and sanitation companies respond to.

b. Ability to Achieve Proposed Strategies

Although, the current institutional setup matches the anticipated IUWM plan, more flexibility in the legalization system will help in making more strategic options feasible, particularly those related to the use of treated waste water in irrigation.

c. Required Institutional Setup

While the existing institutional setup is well organized, the fact that ASDCO gets its revenues through AWCO could slightly marginalize ASDCOs decision making process compared to AWCO's more superior and independent role. ASDCO could possibly benefit from a future financial independency from AWCO which will definitely help them fund more treatment plants in a manner that will enhance the use of treated waste water in agriculture as discussed in this report.

Another process that will significantly boost the implementation of this plan is the establishment of a governorate level Inter-ministerial committee to act as a link between national and local decision makers, this committee has proved much success in four Egyptian governorates including the neighbor Behira.

One more process that could benefit the implementation of this plan as well as maintain the success achieved by the LA is establishing an advisory committee from former LA members; this will be considered an important step in the evolution of the LA.

9. Implementation Plan

a. Timeline for Implementation

Table 10 shows the proposed timeline for implementation. It shows some necessary institutional measures as well as the supply and demand options shown in figures 15 through 17.

Table 10. proposed timeline for implementation

Action	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2023	2025	2027	2028	2029	2030
Launching and promoting plan	x															
LA Evolution		x														
Establishment of a governorate level Inter-ministerial committee				x												
Resolving legal problems related to using treated waste water in irrigation						x										
Increasing tariff		x														
Increasing agricultural efficiency			x													
Appliance regulation				x												
Reducing physical losses					x											
Increasing Industrial efficiency						x										
Increasing household efficiency							x									
Increasing government building efficiency								x								
Increasing hotel/ commercial efficiency									x							
Wastewater reuse for new housing										x						
Using Groundwater for green areas Irrigation											x					
Wastewater reuse in Agriculture												x				
Household toilet replacement													x			
Wastewater reuse in Industry														x		
Expansion in Agricultural drainage reuse															x	
Expansion in sea water desalination																x

b. Constraints & Risk Assessment

One of the most significant strengths of this plan is the fact that it has been researched under the close supervision of all decision makers in the Alexandria water sector who were part of the learning Alliance, therefore a significant institutional change could affect the activities that this plan suggests, however, an early start could always be useful in making decision makers committed to these activities as it will be hard to drift away from them when funds are already allocated and works started.

c. Monitoring and Evaluation (M&E) Plan and Key Factors

The M&E plan will focus on particular criteria which are envisaged to be among the benefits acquired by strategic options selected for the plan, these criteria are as follows:

I. Economic Criteria

1. Cost Recovery.
2. Water Supply-Waste water Budget balance; as currently the waste water company gets a portion of the gross income made by the water company.

II. Social Inclusion Criteria

1. Security of service; especially to new communities and informal settlements.
2. Governance:
   a. Information availability for Local Communities
   b. Shared Data Systems between AWCO and ASDCO
   c. Measuring Governance according to "Best Management Practice Benchmarking in Egypt and/or the Mediterranean Region and also, the Water and Sanitation International Benchmarking Network (IBNET) sponsored by the World Bank (WB).
   d. Promoting Consultative and Participatory approaches.

III. Environmental Criteria

1. Environmental Impact: the quality of water in lake Mariout will be assessed as the progress in waste water treatment continues, also carbon emissions resulting from every strategic option will be calculated.

IV. Technical Criteria

1. System-wide improvements

a. Leakage reduction

b. Infiltration; which relates to the overall water quality of treated effluent.

c. Recovery rate: This is the rate of sewage produced from supply.

V. Energy Criteria

1. Specific energy consumed: one of the aims of the monitoring plan will be tracking the energy consumption associated with different strategic options in a manner that will enhance future energy reduction research. The energy per unit volume (J/m^3) produced with every strategic option will be a strong indicator of the benefits achieved from each particular option.

References

AbuZeid, K., Elrawady, M. ,Retamal, M.L , and White, S. 2011, Integrated Supply-Demand Planning for Alexandria, Egypt, Water efficiency study & business case analysis for water demand management, CEDARE and ISF-UTS, March 2011.

AbuZeid, K., Elrawady, M. ,Retamal, M.L, White, S., and Turner, A. 2011, Integrated Resource Planning for Alexandria, Egypt, Efficient 2011 conference, Amman, Jordan, March 2011.

AbuZeid, K.., Smout, I., Taha, H., Sabry, N., Elrawady, M. 2010, Alexandria Water Demand Management Study, CEDARE and Alexandria Water Company (AWCO), March 2010.

AbuZeid, K., El Arabi, N., Fekry, A., Meneum, M.A., Taha, K. and El Karamany, S., Elrawady, M. 2009. Assessment of Groundwater Potential in Alexandria Governorate, CEDARE and Research Institute for Groundwater, November 2009.

AbuZeid, K.., Assimacopoulos, D., Manoli, E., Donia, N., Sabry, N., Ramadan, A., Elrawady, M. 2010a, Alexandria Urban Water System Modeling, CEDARE and National Technical University of Athens, Alexandria Water Company, March 2010.

AbuZeid, K.., Van Der Steen, P., Hellaly, H., Kassem, A., Elrawady, M. 2010b, Alexandria wastewater treatment and reuse study, CEDARE and Alexandria Sanitary Drainage Company (ASDCO), UNESCO-IHE, March 2010.

AbuZeid, K.., Shoutes,B., Yaseen, A., Alshafie, A., Elrawady, M. 2010, Alexandria storm water management Study, CEDARE and Alexandria University (AWCO), March 2010.

AbuZeid, K., Elrawady, M. 2010, Institutional Mapping and Water Governance Analysis in the City of Alexandria, CEDARE, March 2010.

Chemonics Egypt, 2010, Affordability Assessment to Support the Integrated Urban Water Management in Alexandria – January 2011.

GTZ, 2004, New practice of participatory local development in Egypt›s urban areas, Policy paper, GTZ, Cairo.

Intergovernmental Panel on Climate Change (IPCC). (2007). Working Group I: The Physical Science Basis, Technical Summary: The Fourth Assessment Report of the Intergovernmental Panel on Climate Change pp. 87-21.

Intergovernmental Panel on Climate Change (IPCC). (2001). Working Group II: Impacts, Adaptation and Vulnerability African region: The third Assessment Report of the Intergovernmental Panel on Climate Change pp. 525-489.

Saad, M. , Future water availability in Alexandria, Ministry of Water Resources and Irrigation (MWRI), August 2010.

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