Water Resources Management in Sharjah, UAE

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Abstract

Water is essential for socio-economic development and for maintaining healthy ecosystems. Properly managed water resources are a critical component of growth. Water resources management aims to optimize the available natural water flows, including surface and ground water, to satisfy these competing needs. Exacerbating the uncertainty, climate change will increase the complexity of managing water resources. In some parts of the world, there will be more water available, but in other parts there will be less.

The ability of countries to make more water available for domestic, agricultural, industrial and environmental uses will depend on better management of water resources and more cross-sectoral planning and integration.

Economic development and population growth in the UAE are exerting great pressure on water resources. Since the UAE lacks dependable surface resources, it relies on groundwater and seawater desalination to meet these needs. Continuous population growth, rising living standards and expanding agricultural and industrial activities have led to a greater demand for fresh water.

The harsh arid climate of the UAE, with low annual rainfall, presents several difficulties for the sustainable supply of water. The UAE has one of the lowest national renewable water resource capacities, which on a per capita basis, equals 64 m³ per year, or the equivalent of 1% of the world average. To supplement the limited renewable natural water resources, overall water resources in the UAE include groundwater, desalination, surface water and treated wastewater. These sources are required to progressively meet increasing demands from agriculture, utility supply, commerce and industry.

Keywords: Climate, Flajes, Ground Water, Water Resources.

1. Introduction

The UAE was extremely dependent on groundwater production from major aquifers for water supply. The production of groundwater is reliant on the amount of rain-fall which is scarce. The consumption rates of water resources have been exceeding the natural recharge. This scarcity has resulted in an imbalance between the input and output of water to the system and causes the deterioration of groundwater quality.

1. www.carboun.com
and seawater intrusion in coastal areas. Desalination plants have been established to cover the shortfall of conventional water resources and to meet the high water demand for domestic, agricultural and industrial purposes. In addition, wastewater treatment plants are launched in different parts of the country to reduce groundwater production and even lighten the burden of the costly production of desalinated water.

The depletion of groundwater resources, accompanied with increasing water demand in the UAE as a result of population growth, have put the country in stress with the limited availability of natural water resources. Shortages in water resources threaten the sustainability of development and have classified the country as one of the world’s poorest in terms of water resources availability.

This paper will discuss water resources in the Sharjah Emirate and water management issues addressed by the Sharjah Electricity & Water Authority (SEWA), including existing and future projects to meet the increase in water demand.

2. Water Management Principles

A 1992 meeting in Dublin established four principles that became the basis of water resources management:

**Principle 1:** Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.

The notion that freshwater is a finite resource arises as the hydrological cycle on average yields a fixed quantity of water per time period. This overall quantity cannot yet be altered significantly by human actions, though it can be, and frequently is, depleted by man-made pollution. The freshwater resource is a natural asset that needs to be maintained to ensure that the desired services it provides are sustained. This principle recognizes that water is required for many different purposes, functions and services; management therefore, has to be holistic (integrated) and involve consideration of the demands placed on the resource and the threats to it.

**Principle 2:** Water development and management should be based on a participatory approach, involving users, planners and policymakers at all levels.

Water is a subject in which everyone is a stakeholder. Real participation only takes place when stakeholders are part of the decision-making process. The type of participation will depend upon the spatial scale relevant to particular water management and investment decisions. It will be affected too by the nature of the political environment in which such decisions take place. A participatory approach is the best means for achieving long-lasting consensus and common agreement.

Governments have to help create the opportunity and capacity to participate, particularly among women and other marginalized social groups.

**Principle 3:** Women play a central part in the provision, management and safeguarding of water.

The pivotal role of women as providers and users of water and guardians of the living environment has seldom been reflected in institutional arrangements for the development and management of water resources. It is widely acknowledged that women play a key role in the collection and safeguarding of water for domestic and – in many cases – agricultural use, but that they have a much less influential role than men in management, problem analysis and the decision-making processes related to water resources.

There is an important synergy between gender equity and sustainable water management. Involving men and women in influential roles at all levels of water management can speed up the achievement of sustainability; and managing water in an integrated and sustainable way contributes significantly to gender equity by improving the access of women and men to water and water-related services to meet their essential needs.

**Principle 4:** Water has an economic value in all its competing uses and should be recognized as an economic good as well as a social good.

Within this principle, it is vital to recognize first the basic right of all human beings to have access to clean water and sanitation at an affordable price. Managing water as an economic good is an important way of achieving social objectives such as efficient and equitable use, and of encouraging conservation and protection of water resources. Water has a value as an economic
good as well as a social good. Many past failures in water resources management are attributable to the fact that the full value of water was not recognized.

**Value and charges** are two different measures and should be clearly distinguished. The value of water in alternative uses is important for the rational allocation of water as a scarce resource, whether by regulatory or economic means. Charging (or not charging) for water is applying an economic instrument to support disadvantaged groups, modify behavior towards conservation and efficient water usage, provide incentives for demand management, ensure cost recovery and signal the consumers’ willingness to pay for additional investments in water services.

Treating water as an economic commodity is an important means for decision making on the allocation of water.
The lack of water resources management is very...
to each function. These water management objectives should delineate functions into more manageable and understandable parts. Water management objectives thus set the goal for water resources management and lay out the strategy of implementing the functions.

5. UAE Climate

The UAE is located within the arid zone to the southeastern part of the Arabian Peninsula. This arid zone is characterized by low rainfall and high evaporation rates.

According to rainfall statistics of different emirates between 2000 and 2006, the lowest and highest volume of received rainfall in the Sharjah Emirate was 9 mm in 2001 and 168.21 mm in 2006, respectively.

6. Management of Water Resources in the Sharjah Emirate

Water resources can be classified into conventional and non-conventional water resources. Conventional water resources depend on rain volumes and comprise groundwater, falajes, springs and flash floods. Non-conventional water resources are desalinated water and treated wastewater.

Previously, Sharjah was largely dependent on conventional water resources, in particular groundwater, but at present the Emirate relies on non-conventional resources, particularly desalinated water.
SEWA is responsible for supplying all parts of the Emirate with drinking water from both underground and desalination sources. Modern desalination and production plants produce and treat seawater and underground water for distribution to residential, commercial and industrial consumers through transmission and distribution networks.

The process of offering water services is subject to several transactions such as applications, inspection, specification preparation, cost evaluation and issuing A/c Nos. in accordance with the location, and finally connection to the required service.

### 6.1 Management of Conventional Water Resources:

#### 6.1.1 Surface Run-off

Surface water is one of the conventional resources and its availability in Sharjah is limited and temporary because of the low rainfall and high evaporation rates. Estimated surface water in the UAE was about 39.6 billion gallon/year (0.15 billion m$^3$/year).

At present, 114 dams of different sizes protect flooded water and increase the groundwater recharge in the area with an approximate capacity of 31152 million gallons.

The Ministry of Environment and Water (MEW) will build 68 new dams with a capacity of 26400 million gallons. Out of these new planned dams, 37 dams will be built in the eastern region of the country. Up to December 2007, the total surface water stored behind

### Figure 8. Total accumulated surface water (in million gallons) in main dams from their construction date to December 2007 (MEW 2008)

### Figure 9. Total stored surface water (in million gallons) in main dams of Fujairah, Ras Al-Khaimah, Ajman and Sharjah Emirates from dam construction date to December 2007 (MEW, off.comm., 2008).

### Table 2. Main dams built in the United Arab Emirates

<table>
<thead>
<tr>
<th>Dam name</th>
<th>Capacity (Mm$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bih</td>
<td>7.5</td>
</tr>
<tr>
<td>Ham</td>
<td>7.0</td>
</tr>
<tr>
<td>Hadf</td>
<td>0.3</td>
</tr>
<tr>
<td>Zikt</td>
<td>3.5</td>
</tr>
<tr>
<td>Tawyyaen</td>
<td>19.5</td>
</tr>
<tr>
<td>Hatta</td>
<td>4.5</td>
</tr>
<tr>
<td>Shuaib</td>
<td>20.0</td>
</tr>
<tr>
<td>Shi</td>
<td>3.0</td>
</tr>
<tr>
<td>Warnaiaa</td>
<td>5.5</td>
</tr>
<tr>
<td>Gulfia</td>
<td>0.125</td>
</tr>
<tr>
<td>Eden</td>
<td>0.05</td>
</tr>
<tr>
<td>Gheli</td>
<td>0.12</td>
</tr>
<tr>
<td>Siji</td>
<td>0.750</td>
</tr>
<tr>
<td>Sufini</td>
<td>0.460</td>
</tr>
<tr>
<td>Shawkah</td>
<td>0.272</td>
</tr>
<tr>
<td>Dalm</td>
<td>0.272</td>
</tr>
<tr>
<td>Safad, Thyib</td>
<td>0.260</td>
</tr>
<tr>
<td>Ghailalah</td>
<td>0.250</td>
</tr>
<tr>
<td>Merbih, Kadfaa</td>
<td>0.242</td>
</tr>
<tr>
<td>Kidaa</td>
<td>0.220</td>
</tr>
<tr>
<td>Shaam</td>
<td>0.152</td>
</tr>
<tr>
<td>Ramth</td>
<td>0.134</td>
</tr>
<tr>
<td>Mai</td>
<td>0.113</td>
</tr>
</tbody>
</table>
the 65 MEW-owned dams was 56083.95 million gallons. Beyond this, 49435.58 million gallons are stored in 10 dams called Al-Beeh, Tawiyeen, Ham, Alowais, Adhen, Wuraya, Showkah, Hadhaf, Gulfa and Baseerah.

The total surface water stored in dams in Sharjah Emirate from their date of construction to December 2007 was 303.864 million gallons.

Surface water is not a significant source as its availability in UAE is associated with intense periods of rainfall which rarely occur in the area.

6.1.2 Springs

In the United Arab Emirates, several springs, such as Khatt (Ras Al-Khaimah), Maddab (Al-Fujairah) and Bu Sukhanah or Ain Al-Faydah (Al-Ain) are utilized as recreational and touristic sites. The Khatt springs are located about 13 km east of Diba and 15 km south of Ras Al-Khaimah. Siji spring lies about 50 km west of Al-Fujairah and 75 km east of Sharjah. Bu Sukhanah spring is located about 4 km west of Jabal Hafit, and south of Al-Ain town. Thus, no springs are available in the Sharjah Emirate itself.

6.1.3 Falajes

Until recently, falajes represented the main arteries of life in the eastern parts of United Arab Emirates. At present, many United Arab Emirates falajes are dry because of excessive groundwater pumping.

6.1.4 Groundwater

Groundwater is the main conventional water resource in the Sharjah Emirate and is produced by SEWA and by the public through private wells.

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The main aquifers in the United Arab Emirates include the limestone aquifers in the north and east, fractured ophiolite rocks in the east, the gravel aquifers flanking the eastern mountain ranges on the east and west and the sand dune aquifers in the south and west.

The largest reserve of fresh groundwater in the United Arab Emirates is found in the alluvial deposits of the piedmont plains bounding the eastern mountains from the east and west. Two aquifers can be distinguished. These are the eastern gravel aquifer and the western gravel aquifer.

The groundwater supply in the Sharjah emirate comes from the western gravel aquifer.

A general increase in groundwater salinity in the western gravel aquifer occurs as water moves from the eastern recharge area towards the discharge area in the west. Groundwater with > 10,000 mg/l of total dissolved solids is found at Al-Dhaid, west and south of Al-Ain and Kalba. However, because of excessive pumping, groundwater in several areas is now affected by salt-water intrusion not only from the sea but from deeper horizons of the same aquifer, and possibly from nearby sabkha deposits. The groundwater is very hard in the northeast at Al-Dhaid, Kalba, Al-Khaznah and along the western coast.

Groundwater salinities are low to high brackish and development is mostly for agriculture. Groundwater hydrochemistry is very variable, being of the magnesium bicarbonate, calcium bicarbonate, calcium sulphate, magnesium sulphate and sodium chloride types.
Figure 13. Sharjah freshwater produced capacity and quantity for 2010

Table No. 1-2-1: Produced Water Quantities at Enroites of Sharjah in million gallons (Type of production Wise)

<table>
<thead>
<tr>
<th>Type of Production</th>
<th>December</th>
<th>November</th>
<th>October</th>
<th>September</th>
<th>August</th>
<th>July</th>
<th>June</th>
<th>May</th>
<th>April</th>
<th>March</th>
<th>February</th>
<th>January</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underground Water</td>
<td>69.70</td>
<td>68.48</td>
<td>69.57</td>
<td>70.00</td>
<td>72.88</td>
<td>75.08</td>
<td>72.11</td>
<td>69.10</td>
<td>73.33</td>
<td>69.10</td>
<td>73.08</td>
<td>73.60</td>
<td>67.09</td>
</tr>
<tr>
<td>Desalinated Water</td>
<td>17.81</td>
<td>19.19</td>
<td>15.74</td>
<td>16.77</td>
<td>17.27</td>
<td>18.85</td>
<td>19.26</td>
<td>17.68</td>
<td>20.35</td>
<td>18.34</td>
<td>19.95</td>
<td>21.98</td>
<td>18.55</td>
</tr>
<tr>
<td>SWWA Total</td>
<td>87.51</td>
<td>87.66</td>
<td>85.33</td>
<td>86.77</td>
<td>91.15</td>
<td>94.41</td>
<td>92.37</td>
<td>88.25</td>
<td>91.58</td>
<td>88.25</td>
<td>93.64</td>
<td>95.58</td>
<td>85.64</td>
</tr>
</tbody>
</table>

Figure 14. Produced water quantities in Sharjah in million gallons
Figure 15. Sewa’s drinking water storage tanks capacity in million gallons - 2010

Figure 16. Water quantities produced, pumped and sold in Sharjah in million gallons (production site wise)
Figure 17. Sold water quantities in million gallons consumer capacity wise.

Total estimated groundwater production is gradually decreasing and amounted to 35557.25 and 20033.93 million gallons in 2000 and 2006, respectively. In 2000, groundwater production by SEWA was 9907 million gallons. However, the production of groundwater in 2006 was 9407.3 million gallons. The production of groundwater by SEWA decreased in 2004, and then increased until 2006.

By managing groundwater dependency (percentage of groundwater production relative to total production of groundwater and desalinated water), SEWA reduced this dependency from 47.22% in 2000 to 33.22% in 2006.

Dependency on groundwater is gradually decreasing and this indicates that the Emirate relies at present on non-conventional water resources such as desalinated water and treated wastewater. The total amount of groundwater used is high when compared with the annual recharge and total amount of groundwater production. This would create a deficit in groundwater reserves, which deficit is covered by increasing the production of costly desalinated water. The huge difference between groundwater abstractions and recharge points tend to increase water demand in the Emirate due to population growth which accompanied economic development and political stability. The large difference between recharge and groundwater consumption is also created by agricultural practices which account for about 70% of total groundwater consumption. Groundwater reduction and deterioration hinder the sustainability of this source to be considered as the main source of water in the Emirate.

7. Dr. Al-Mulla, M. Ministry of Environment and Water. Wastewater Resources Management in the UAE, Experts Consultation on Wastewater Management in the Arab World, 22-24 May 2011, Dubai, UAE.
6.2 Management of Non-Conventional Resources:

6.2.1 Desalinated Water

The Sharjah Emirate is supporting the deficit in conventional water resources with non-conventional water resources, in particular the desalination of seawater and brackish water.

A total of 36 desalination plants were built in the UAE by end 2006. There were 12 main desalination stations in Sharjah.

**TABLE 3.**

<table>
<thead>
<tr>
<th>Desalination Plant Name</th>
<th>Type</th>
<th>Production (Mm$^3$/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharjah Layyah</td>
<td>Multi Effect Distillation (MED)</td>
<td>51.60</td>
</tr>
<tr>
<td>Kalba</td>
<td>Reverse Osmosis (RO)</td>
<td>0.01</td>
</tr>
<tr>
<td>Abu Massa</td>
<td>Reverse Osmosis (RO)</td>
<td>0.01</td>
</tr>
<tr>
<td>Al-Hamriyah</td>
<td>Reverse Osmosis (RO)</td>
<td>0.02</td>
</tr>
</tbody>
</table>

**Figure 18.** Location of the main desalination plants in the UAE

**Figure 19.** Sharjah daily average water production
The total production of desalinated water in the UAE was 134,412.8 million gallons in 2000 and increased to 277,942.14 million gallons in 2006. Desalinated water produced by SEWA was 11,075 million gallons in 2000 and increased to 18,438.54 million gallons in 2006.

<table>
<thead>
<tr>
<th>Project</th>
<th>Details</th>
</tr>
</thead>
</table>
| Hamriyah Generation & Desalination   | • AED 349.8 million for Phase 1 of installation and commissioning of 5 combined cycle gas turbines including the civil works.  
• AED 160 million for Phase 1 of R.O units.  
• AED 138.5 million for installation and commissioning 4 desalination units of 10 mgpd each.  
• AED 17.4 million for construction of fuel tanks, off-loading terminal and 220 &132 KV switchgear.  
• AED 30 million for Hamdah and Badei 800 mm water main.  
• AED 35 million for Phase one of Hamriyah and Saja’a 1200 mm water main, Saja’a Halwan 1200 mm water main and Layyah and Mamzar 800 pipeline  
• AED 40 million for phase 1 of new storage tanks in Saja’a and Falaj.  
• AED 51 million for phase 1 of new pumping stations n Saja’a, Hamda and Badie.  
• AED 60 million for water distribution network at King Abdul Aziz Road, Layyah and Nahda pipe line and phase 1 of the water distribution system reinforcement.  
• AED million for network developments in areas of Rahmania and Suyouh.  
• AED 1 million for a water distribution system in the Eastern Zone.  
• AED 26 million.                                                                                                                                                                                                                     |
| Expansion Project                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Water Distribution Projects          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Layyah Generation & Desalination     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

Dependency on SEWA’s desalinated water in 2000 was 52.78% and increased to 66.22% in 2006. The production of groundwater by the Sharjah Emirate is relatively high due to the proximity of the recharge area, but dependency on groundwater in those areas will decrease with the time while dependency on desalinated water will increase to cover the deficit in groundwater as the Emirate’s population continues to rapidly grow.

In response to these challenges, SEWA has already built several desalination plants and intends to invest in developing some other plants. Among existing plants we find:

SEWA is investing in new desalination projects as an integral part of its non-conventional water resources management strategy deployed to meet increasing water demand. These investments are summarized in the following table:

### 6.2.2 Treated Wastewater

Treated wastewater is one of the non-conventional water resources and is considered a supportive source for the fresh water used for irrigation activities which account for 70% of groundwater production in UAE. The percentage of treated water accounted for 5.1% of total water production in UAE in 1995. Due to shortages in conventional resources, the production of treated water is increasing by 10% annually and this type of water can be utilized for domestic purposes after assurances of its suitability for use.

There are 7 wastewater treatment plants in the Sharjah Emirate with a total capacity of 42.438 million gallon/day. However, the total production of treated water from all seven stations in Sharjah was 40.9741 million gallons in 2006.

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Increasing the production of treated wastewater is a result of shortages in water availability which could harm agricultural activities. Most treated water in the emirate is used for landscaping and irrigation as agriculture activities represent one of the main land uses in the area.

6.2.3 Wastewater Treatment Process in Sharjah

- **Pumping Stations:** Wastewater “influent” from Sharjah City arrives at the plant through three main pumping stations.

- **Preliminary or Primary Treatment:** It consists of separating floating materials and grit, sand etc. The process uses a screening device to remove floating papers, rags, cloths and plastic materials, and detroiters (grit track) for removing grit and sand.

- **Secondary Treatment:** Secondary treatment involves further treatment of the screened and properly mixed flow for biological oxidation by activated sludge process in aeration tanks, followed by solids/ mixed liquor settlement in the final setting tanks.

- **Tertiary Treatment:** The supernatant flow from the settlement tanks which is cleared of 85% of solids is finally passed through the sand filters to remove remaining suspended solids, followed by pre-chlorination and ultra violet disinfection. The disinfected effluent is finally pumped to the elevated tanks for town irrigation.

- **Sludge Treatment:** The removed solids from the treatment system are treated by polyelectrolytes in

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*Figure 21. Wastewater treatment diagram*
two stages: primary thickening is carried out at belt thickeners to achieve thickening (1.5% to 4%). This thickened sludge is digested aerobically and further thickened to 5%. The thickened sludge is pumped to the belt press to increase thickening up to 16-18% solids. Sludge is transported to the area of bridge No: 8 (SAJAA) to be composted. The excess sludge is dried in open yards to be utilized when required.

- Odor Control: Two stage air scrubbers are used at inlet works and tanker discharge facility to neutralize malodorous gases. Odor control performance is constantly monitored in PLC controlled monitoring system.

- Effluent water for irrigation: Effluent is discharged to the city through a network. Part of the effluent water is discharged to the sea.

**Conclusion**

Great efforts were made by the UAE government to face water scarcity. The UAE government implemented the national environmental strategy for water resources in order to improve the difficult situation of water resources. This strategy is aimed at planning and managing water resources through implementing the water management policy.

The production of desalinated water is increasing annually while groundwater production is decreasing. The deficit in groundwater production is covered by increasing the production of desalinated water which will require further financial resources in view of the cost of operating and maintaining desalination plants.

The most important water-related problems in Sharjah Emirate are the depletion of Al-Dhaid aquifers, saline-water intrusion and quality deterioration for waters associated with agricultural activities.

Groundwater abstraction is now around 3 billion cubic meters per year in the UAE. In the northern emirates where fresh groundwater still contributes to municipal supplies, declining water tables, exacerbated by agricultural development, led to salt water intrusion in coastal zones. Salt water intrusion is now active along the UAE’s eastern coastal plain which extends between Dibba in the north and Kalba in the south for about 70 km. Salt water from the Gulf of Oman intrudes into the fresh water of coastal aquifers, raising its salinity and deteriorating its quality.

Studies and research are urgently required to improve water resources management issues. Among the issues to be considered for a better optimization of the management plan are:

**Planning and management of water resources:**

- Development of a coordinated national water management policy.
- Development of legislative instruments to encourage water conservation.
- Improvements in water resources management statistics.
- Capacity-building in water resources management, particularly the participation of UAE nationals.
- Mapping the fresh water - saline water interface in space and time along the eastern coast of the UAE.
- Determining the fresh water reserve, annual rate of recharge and annual rate of discharge.

**Groundwater management:**

- Implementation of a national program to conserve groundwater and promote rational use.
- Improvements in groundwater statistics including the documentation and licensing of groundwater abstractions.
- Programs to improve collection of rainwater and its use for groundwater recharge.

**Efficient use of water in agriculture:**

- Rationalization of water use in agriculture.
- Programs to improve water use through:
1. Better identification of crop water requirements.
2. Changes in cropping patterns.
3. Improved irrigation practices and efficiency.
4. Evaluation of use of alternative water resources (such as treated wastewater in agriculture).

**Domestic and industrial demand management:**

- Improved programs monitoring and control of distribution system leakage.
- Economic instruments to promote water conservation and enhance cost recovery.
- Studies of the pattern of domestic water use to identify conservation opportunities, including the use of more water-efficient equipment.
- Promotion of water-efficient industry and discouragement of industries with high water usage.

**Sustainability of desalination:**

- Research programs to assess the impact of increasing levels of desalination on the marine environment and optimize intake and discharge locations.
- Develop national emergency plans for desalination plants.
- Build national capacities in desalination operations.

**Wastewater treatment and reuse:**

- Programs for the construction of wastewater treatment plants in areas not currently serviced.
- Evaluation of further uses of treated wastewater.
- Setting of harmonized standards for treated wastewater reuse.