

The Role of Desalinated Water in Integrated Water Resource Management in Abu Dhabi Emirate-UAE

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Abstract: Water resources components in Abu Dhabi encompass the conventional sources (rain, springs, ponds and groundwater), and unconventional sources (desalinated water and reclaimed wastewater). The latter represent the most important resources for the time being, since ground water is brackish or salty and the annual rainfall is very low in Abu Dhabi Emirate. Thus conventional water resources are considered under sever depletion and exceeded their natural recharging capacity by 24 times. Per capita water consumption is considerably high, since the average daily domestic consumption in Abu Dhabi Emirate is estimated as 350 liters per person but it is intended to be slashed by 200 liters per day in the next few years, as proposed by the Environmental Authority. This should be accompanied by intensive awareness program. This article is aiming at discussing water resources components in Abu Dhabi and their Integrated Water Resources Management (IWRM) Plan.

Key words: Desalinated water, Abu Dhabi Emirate

Introduction

United Arab Emirates (UAE) is the world's second largest consumer of water per capita after the United States and the first country in the world in the Ecological Footprints (WWF, 2008). The demand on water is increasing year-on-year due to rapid population growth, growth in hotel industry and rapid expansion of orchards and green areas in addition to the weak awareness of water scarcity and the weak water saving attitudes. All together, had led water issue in UAE to reach an alarming level, particularly because water scarcity issue could only be resolved through establishment of desalination industry which has many advantages and disadvantages (EAD 2009, Abdul-Wahab 2005) (Agashichev and Al-Nasher 2005).

According to the Environmental Agency of Abu Dhabi, water policy in the Emirate has principally emphasized on increasing water supply rather than improved demand management (EAD 2006a). This tendency has a great risk on both groundwater availability and seawater quality. Particularly, if we recall that the former is expected to be completely depleted in next 50 years (EAD 2006a) and the latter is already subjected to the threat of salinization.

It is estimated that the average daily domestic consumption in Abu Dhabi Emirate is ranging between 350-550 liters per person (EAD 2006) which is considered as considerably high rate as compared to 425 liters in the U.S. Flat residents consume on average from 170 to 200 liters of water per day, which may be considered as a reasonable range, but villa dwellers' water consumption is 270 to 1,760 liters per person per day (Teodrova 2009). On average, each Abu Dhabi resident uses 550 liters of water per day. However the Environmental Authority is planning to slash the rate of consumption by 200 liters per person per day in the next few years. On the other hand, water for agricultural uses is mostly ensured through groundwater (Dawoud 2007), whereas the rest of water demand particularly as drinking and household is fulfilled through desalination of seawater from the Arabian Gulf using multistage flash process (MSF) with a total capacity of 683 million gallon per day (MGD) (ADWEC 2011). Most of

these plants are planning to expand their production capacities, exposing in this way the fragile ecosystem of the Arabian Gulf to a greater risk due to discharge of warm brine water (Elshorbagy 2007).

This article is aiming at discussing water resources components in Abu Dhabi and their Integrated Water Resources Management (IWRM) Plan.

The Study Area

Abu Dhabi Emirate is the largest of seven United Arab Emirates (UAE). It lays on the southwestern coastline of the Arabian Gulf (Fig. 1) with a coastline extending about 350 km. Total population of UAE is estimated to be 8 million

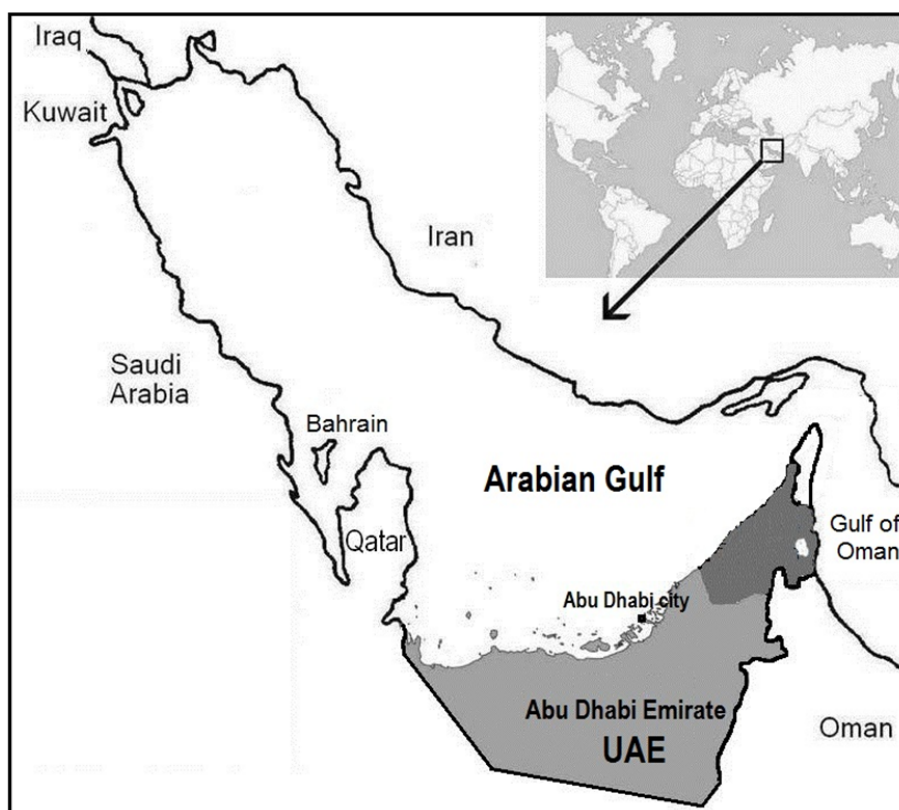


Figure 1 Location of Abu Dhabi Emirate (marked in light grey) with respect to UAE in Arabian Gulf.

in 2011 , only 12% are nationals and the rest are expatriates, while Abu Dhabi population is estimated to be 1,305,060 with approximately the same percentage of nationals to expats. Population in Abu Dhabi is steadily increasing at an annual rate of 3.7% (EAD 2006b). Being part of a desert land in the Arabian Peninsula; climate is arid with prolonged hot summer and relatively short winter. The lowest atmospheric temperature was reported as 10.6 °C whereas the maximum temperature was reported as 47.4 °C (EAD 2006a). Relative humidity is considerably high and may reach more than 90% very often.

The majority of water demand is secured through the use of groundwater (brackish 38%), which is mainly used in agriculture, followed by desalinated water (23%), then freshwater (13%). The former type is used for drinking or household and amenity (Fig. 2). Reclaimed water represent only 6% of the total and is only used in landscaping and forestry.

These water resources are generally categorized into two major groups of resources: conventional and unconventional water resources as follow:

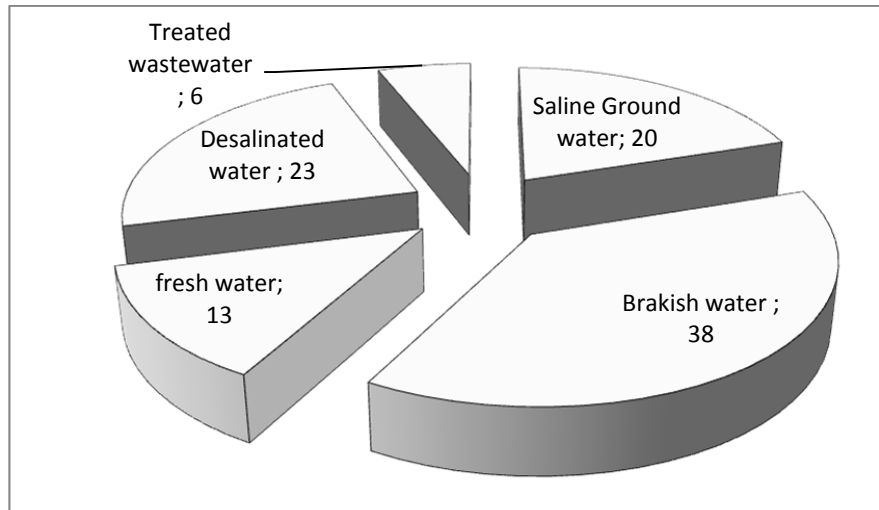


Figure 2 Sources of water in Abu Dhabi Emirate.

1. Conventional Water Resources

These are rainfall, springs and groundwater resources:

Rainfall: The reported Annual Rainfall is considerably low, reaching 20.4 mm in Abu Dhabi City and 33.8 mm in Al Ain city (EAD 2006). Most of rainy days occur during February, however in a cycle of 4-5 years, rainfall may raise the rate above these average values. On the contrary, annual evaporation rate is relatively high reaching about 2,000 mm (EAD 2009). In general rain water stock is estimated to be 24 million cubic meter (Mcm) per year according to 2007 estimates. (EAD 2009)

Ground water falls into three different categories of salinity whose available stocks according to 2007 estimates are as follow: freshwater 26,000 Mcm, moderately brackish 89,000 Mcm and brackish 132,000 Mcm (EAD 2009).

Ground water contributes to 71.2% of total water demand, yet it is being over-exploited at a rapid rate. Groundwater supply had fallen by 18 % since 2003, while the consumption of water resources in the emirate exceeded their natural recharging capacity by 24 times. (Teodorova, 2009). Therefore it is envisaged that this resource can barely last for the next 50 years. Abu Dhabi's groundwater reserves stand at 641 Mcm. However, more than 97% is brackish, its reserves of sweet or moderately brackish water that can be easily tapped can last only 20 to 40 years, the study says. It is estimated that about 630 well fields exist in Abu Dhabi however the operating wells are only 363. Springs are confined to Al-Ain area. Water in both wells and springs is brackish, moreover water of springs is hot and run at a constant temperature of 39.3° C. It is worthy to mention that groundwater is not used for drinking due to the presence of relatively high levels of boron and nitrate.

2. Unconventional Water Resources

Seawater desalination represent the only source of potable water in Abu Dhabi Emirate, it is produced by five Giant power and desalination plants whose locations and capacities are shown on the map (Fig. 3). ADWEA oversees four of the power and desalination plants are located in Abu Dhabi Emirate and uses multistage flash (MSF) and multi-

effect systems (MED), whereas the fifth is in Fujairah Emirate and uses hybrid MSF and reverse osmosis (RO). The total annual water production has escalated from 66,772.58 million gallon (MG) in 1998 to 183,560.79 MG in 2010 in addition to 28,232.49 MG imported from Fujairah power and desalination plant (ADWEC 2011). As peak daily water supply, capacity was increased from 220MGD in 1999 to reach 673 MGD in 2010 (Fig. 4) (ADWEC 2011).

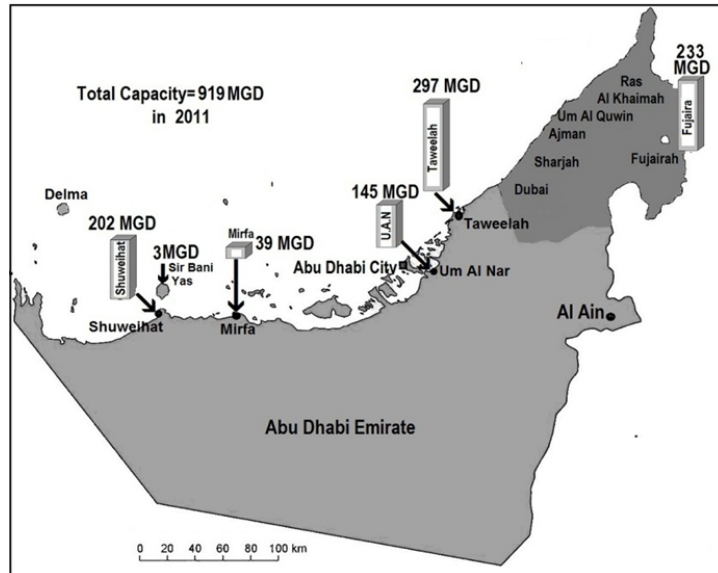


Figure 3 Map of Abu Dhabi Emirate-UAE showing locations and capacities of desalination plants.

Desalination plants are in process to expand their capacities so that the daily production rate is to be doubled in 2030 to cope with the increasing demand. Nevertheless, environmentally, this expansion shall adversely affect marine environment in the Arabian Gulf by the discharge of hot brine water, which is already under great environmental stress.

A smaller desalination plant is located in Delma island has a total capacity of 3 MGD, among which one MGD is produced by MED and the rest is produced by reverse osmosis in addition to similar or smaller RO units owned by different entities or communities among them is the one in Sir Bani Yas which has only 2 MSF units of 0.28 MGD amounting to a total capacity of 0.56 MGD.

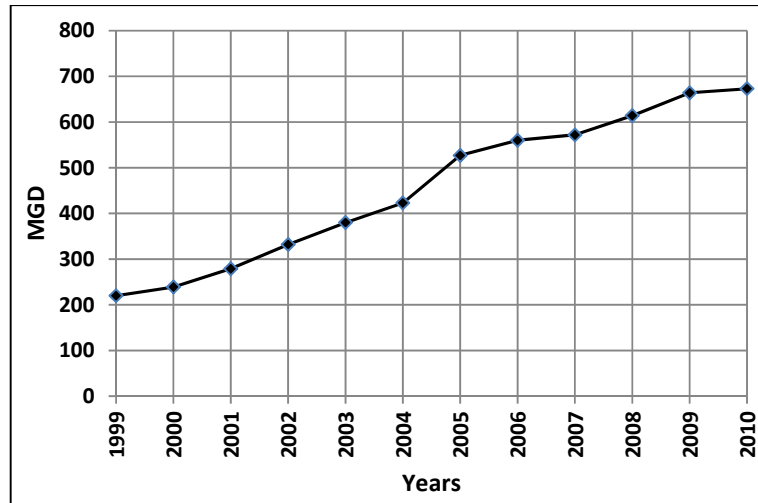


Figure 4 Increase in daily desalinated water production capacity during 1999-2010

Majority proportion of desalinated water (43%) is consumed mostly as potable and household water. The second major use is for livestock 21%. Amenity water (public facilities) is mostly used for landscaping and roadside plantations

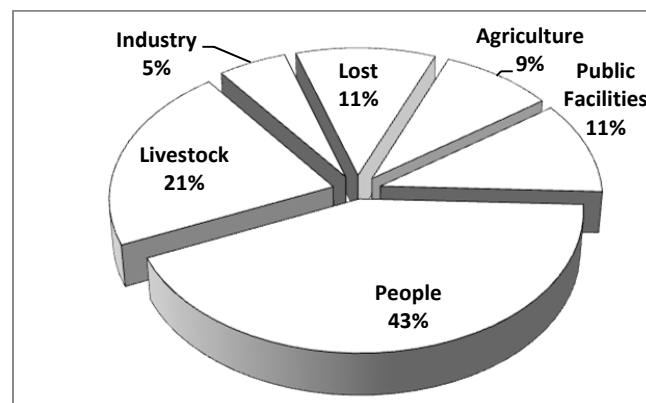


Figure 5 Major uses of desalinated water in Abu Dhabi Emirate

which account 11%, other uses are demonstrated in Fig. 5. Losses in about 11% of water is attributed to breakage of pipes, and physical leakage.

The second unconventional water resource in Abu Dhabi is the reclaimed wastewater. There are two main sewage treatment plants in Abu Dhabi City and Al Ain city, both treat almost 95% of sewage and work slightly over their design capacity (EAD 2009). In the year 2003, population of Abu Dhabi Emirate was 1.3 million; a total of 140.8 Mm³ of treated wastewater was reclaimed, representing 4% of the total water consumed that year (EAD 2006b) (ADSSC 2007). However, in 2005 a new sewage treatment plant was commissioned rising the total sewage effluents (TSE) to a level of about 139 Mm³/year, (Fig. 6) and about 182 Mm³ in 2007 (EAD 2009). Abu Dhabi collects 146 Mm³/year whereas Al Ain collects 36 Mm³/year. The rest of 5% is treated by smaller units to serve smaller communities. TSE per person per day is estimated to be 130 based on the served population of 1.4 Million. Currently 35% of TSE (i.e. 51 Mm³) is disposed of into the Gulf, the rest is used for landscaping.

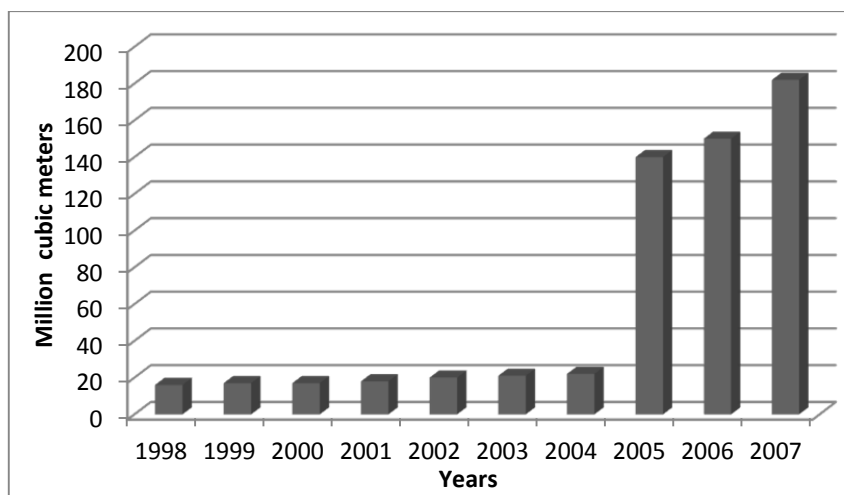


Figure 6 Quantities of reclaimed water from sewage in Abu Dhabi Emirate.

Water Scarcity Awareness

A couple of years ago, a survey of 2,363 people in the emirate showed that water conservation was the area of least concern. Only 42.8% of respondents were aware that water scarcity should be a concern in the UAE (Teodorova 2009). Taking into consideration that ground water is already under excessive extraction, surface water resources are scarce. Therefore water conservation should be considered as an essential practice disregarding its abundance or availability. Planners, engineers and policy makers are encouraged to shift toward green technologies (low-flow tabs and showers as well as low flush" toilets)...etc. Also to promote environmental awareness towards water saving behavior. On the other hand only 10 % say the task is exclusively the responsibility of consumers. (Gornall and Todorova, 2009)

Conclusions

Per capita water consumption in Abu Dhabi Emirate is considerably high, with limited resources and continuously increasing population and agricultural practices. All these factors had led desalination plants to increase their production capacities in order to meet the demand. On the other hand desalination has different adverse effect of the fragile marine environment of the Arabian Gulf. Therefore, water conservation should be considered as an essential practice and people should made aware of its importance. Per capita daily water consumption should be slashed by 200 liters per day in the next few years to come.

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