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Strategy of water desalination in the Gaza Strip

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Abstract

Desalination became a strategic option in the scarce-water countries, in general and in Palestine, in particular. Its cost competes with the costs of other non-conventional water resources such as wastewater reuse and groundwater recharge. The paper focuses on the Gaza Strip as the study area. Water resources in Gaza Strip suffer from deficit in the water balance of about 30%. From an environmental view, desalination has less negative impact compared to other solutions. It can participate in a significant role in the sustainability of the water resources. Various types of desalination plants in use are discussed. Technical and economical aspects of the various plants are considered. Special attention is given to the reverse osmosis (RO) plants. Although the cost of desalination is still relatively expensive for our case in the Gaza Strip, reverse osmosis desalination is strongly recommended and considered as a strategic alternative in order to overcome the water deficit and meet the future needs of desalination for the Strip. In addition and as part of the strategy, the power consumption of RO systems in Gaza Strip shall be optimized with the Global power consumption and capacity of the power plant under construction.

Keywords: Strategy; Reverse osmosis; Water shortage

1. Introduction

Since its creation in 1996, the Palestinian Water Authority (PWA) has practiced its role in an attempt to achieve its mission which is to guarantee the most efficient management of available water resources in Palestine to achieve the balance between available water quantities and the needs of the Palestinian people in the present and the future. In addition to the previous role the PWA has been implementing many water and wastewater projects to improve the water resources and infrastructure.

PWA has already prepared a Water National Plan with detailed investment program for the next 5 years and outlined for the next 20 years reflecting the investment of water and wastewater projects with about five billion dollar for both Gaza and the West Bank.

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Gaza Strip's population is 1.2 million living in a coastal area of about 365 km². This Strip has a big water problem in terms of water quantity and water quality.

Due to over abstraction of ground water from Gaza aquifer and seawater intrusion, most of water pumped from water wells have high salinity and do not meet the WHO standards.

Thus, desalination of brackish/seawater is recognized by the Palestinian Water Authority to be a vital option to face water deficit reasonably and to provide people with safe drinking water in Gaza.

2. Existing drinking water sources

There are four sources of drinking water as follows:

- Municipal water wells (50 Mm^3/y)
- Agricultural water wells (90 Mm^3/y)
- Water from an Israeli company "Mekkorot" (5 Mm^3/y)
- Brackish water reverse osmosis plants (4 Mm^3/y).

A water balance was developed to determine the impact of all the integrated aquifer management program activities as shown in the next table. New water resources account for nearly 25% of the balance. New resources include additional water purchase from mekkorot, small SWRO desalination plants and regional SWRO plants.

3. History of reverse osmosis desalination in Gaza

The first RO plant in the Gaza Strip was built in 1991 in Deir Al Balah town by EMS, a subsidiary of Mekorot Company. This plant is constructed to desalinate brackish water and has a capacity of 45 m^3/h with a recovery of 75%.

In 1997–1998 and through an Italian developing program two RO plants were constructed in Khan Younis to desalinate two brackish wells water. Each RO plant has a capacity of 50 m^3/h to supply a part of Khan Younis town with potable water.

Table 1
Existing and forecasted water supply sources in the Gaza Strip.

New water source	Year 2020 capacity (Mm^3/y)
Mekorot	10
Small SWRO plants	2
Regional seawater desalination plant	55
Total	67

Source: Desalination Master Plan, Metcalf and Eddy.

In 1998, USAID financed a BWRO plant built by an American company Metcalf and Eddy in Gaza Industrial Zone. This plant has a capacity of 45 m^3/h and was designed to supply water to the surrounded industrial complexes and adjacent part of Gaza city.

4. North and Middle Area RO plants

The government of French and Austria financed two seawater RO plants with a capacity of 5000 m^3/d and 2400 m^3/d respectively. The French-sponsored plant is located in Northern Gaza — Northern RO plant. The Austrian-sponsored plant is located in the middle area — Middle RO plant.

The North RO plant is fed by raw seawater from beach wells. It includes chlorination, addition of coagulate, sand filters, dosing of acid and antiscalent, dechlorination, and cartridge filters. Post-treatment includes addition of lime and sodium hypochlorite.

The Middle SWRO plant is supplied with feed water by two beach wells operating alternatively. This plant consists of pre-treatment unit, which includes dosing chemicals as sulpheric acid, sodium hypochlorite, flocculent and antiscalant. The water passes through multi-media filter and 5 micron cartridge filter prior to entering membranes at a high pressure (70 bar). Finally, desalinated water is post treated by adjusting pH and disinfected before it is pumped to the consumers.

The North RO plant has not been completed regarding installing electromechanical works while the Middle RO plant is now under commissioning.

5. Regional seawater RO desalination plant

PWA reviewed various desalination technologies as membrane processes and thermal evaporation and distillation processes for seawater treatment as a new water resource. Each process was evaluated on cost and ability to meet the water quality standards. As a result, PWA recommended membrane reverse osmosis treatment.

It has been decided to build a regional seawater RO plant with a capacity of about 60,000 m^3/d as a first stage in the middle of Gaza Strip, expandable to 150,000 m^3/d. This plant will be supplied with feed water by an open seawater intake located about 800 m from the shore.

The SWRO plant consists of pre-treatment unit including addition of chemicals, ultra filtration, multi-media filters and cartridge filters. It also includes high pressure pumps and membrane units. A post-treatment system includes pH adjustment and addition of limestone. The desalinated water will finally be pumped into the North-South National Water Carrier and will be mixed with other brackish water in the municipal network.

6. Desalinated water distribution

Desalinated water from the small seawater desalination plants at the North of Gaza and at the middle area will be distributed though water shops to be installed on a limited distribution network in addition to using tankers. Customers will fill their Jeri cans in these two methods. A provision for direct connections shall be allowed for high rise buildings and hotels. Desalinated water from the regional plant will be distributed in the municipal distribution networks and will be paid as part of the water bill.

7. Water costs

Currently customers are paying 25–50 cents/m^3 of the municipal water depending on the area of distribution and the source of water. The cost of 20 l desalinated sea water is calculated at 25 cents which is competitive to bottled water. The operational costs of the small seawater desalination plants has been calculated at 90 cents/m^3 while for the regional sea water desalination plant at 55 cents/m^3. The customer will pay 100 cents against 1 m^3 of the desalinated water supplied in the distribution network.

8. Power consumption

The power consumption at the small seawater desalination plants has been calculated at 5.6 kW/m^3 taking in consideration power recovery by Pelton turbines while that for the regional seawater desalination plant will be in the order of 3.5 kW/m^3. Coordination between the concept designs of the regional plant the Energy Authority resulted in considering a double feeder 16–18 MVA power supply to the plant.

9. Conclusion

Available water resources cannot meet the continuous increase in demand without employment of non-conventional water resources. Desalination of seawater by RO technology can substitute the deficit in domestic water requirements with comparatively acceptable and affordable costs.

A power purchase agreement has to be furnished with the electric power provider at reduced power costs, which can serve in lowering the operational costs. It is recommended to have large-scale SWRO plants in order to minimize the operation costs which are relatively higher than in the small ones.

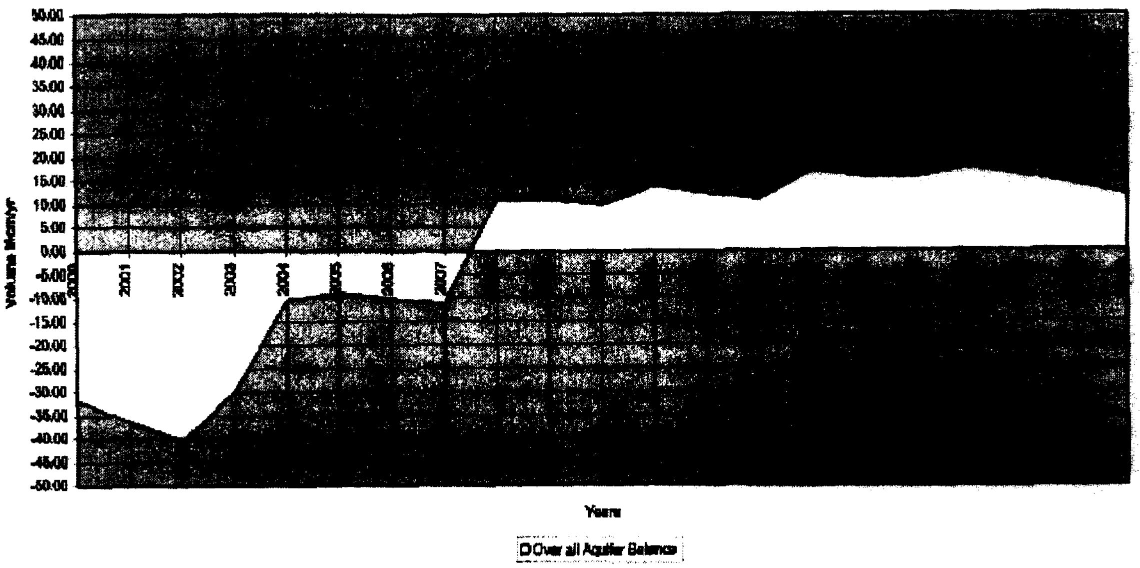

Fig. 1. Overall aquifer balance with 150,000 m³/d regional RO seawater desalination plant. Source: Integrated Aquifer Management Plan.

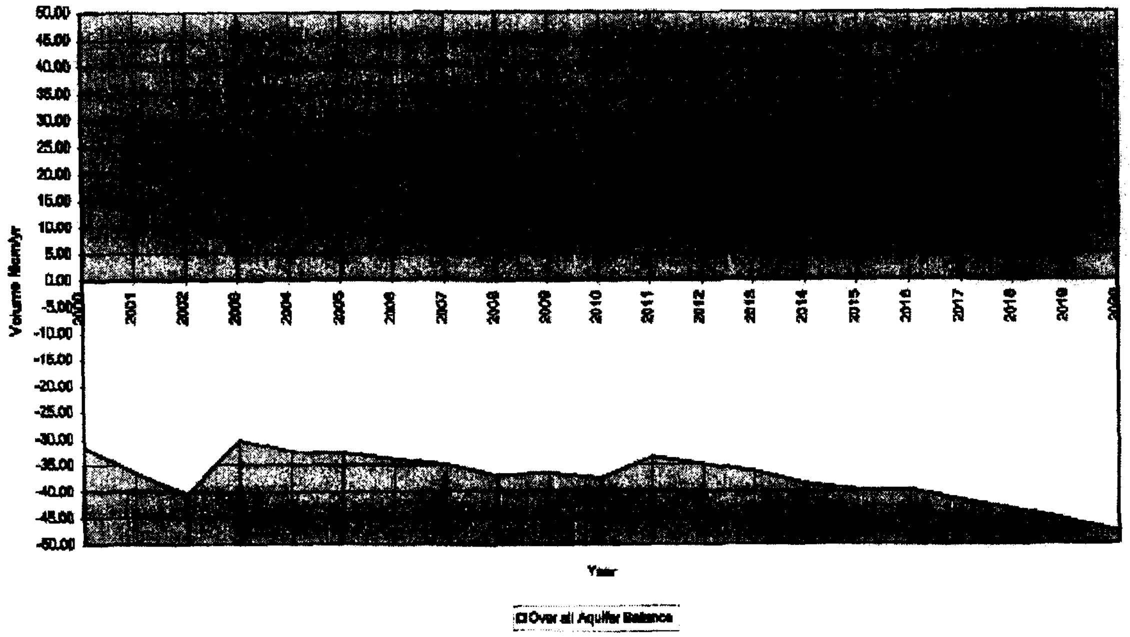

Fig. 2. Overall aquifer balance without the regional RO seawater desalination plant. Source: Integrated Aquifer Management Plan.

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