The Red Sea and the Mediterranean Dead Sea canals project

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Introduction

In the framework of the peace treaty between Israel and the Hashemite Kingdom of Jordan the integrated development Master Plan for the Jordan Rift Valley (JRV) was studied in the mid 1990's. The Red Sea - Dead Sea Canal (RSDSC) was considered to be one of the most important potential elements for implementing this Master Plan. The principal development objective of the RSDSC was to provide desalinated drinking water for the people of the area (the Harza JRV Group, 1996).

Contrary to the popular belief, Herzl's plan for hydroelectricity and Ludermilk's plan for irrigation were not the first of their kind. The first proposal for a Mediterranean - Dead Sea Canal (MDSC) and RSDSC was aired some 50 years before Herzl. The vision of a canal-a waterway that would connect the three water bodies that would be cheaper than the projected Suez Canal, was proposed by William Allen at 1855. This idea was conceived almost synchronously with the casual discovery that the Dead Sea Rift lies much lower than the global surface of the seas (see Vardi, 1990) .

As a result of the 1973 energy crisis and the search for alternative energy sources the idea to study the MDSC for the generation of electricity was revived and thoroughly studied. The goal of this project was to produce 800 MW during peak hours. The summary for these long studies were presented by the Mediterranean-Dead Sea Company and were the foundations for future studies (Mediterranean Sea-Dead Sea Company, 1984).

At the end of the 1980's and the beginning of the 1990'th a revaluation with a different major goal; using the process of hydrostatically supported reverse osmosis (RO) to provide a desalinated-sea water, was initiated by the Ministry of Energy and Infrastructure (Tahal, 1994).

The MDSC and RSDSC are one of these extensive plans once have been placed on the agenda remains on it for a duration carrying with it special type of fascination and vision. It might never been realized but still involves a lot of ecology, limnology and geotechnic aspects which are changing hand in hand with the environmental and political changes. The goals of the three major alignments (Fig. 1), the major components and the environmental aspects are briefly discussed in this short note.

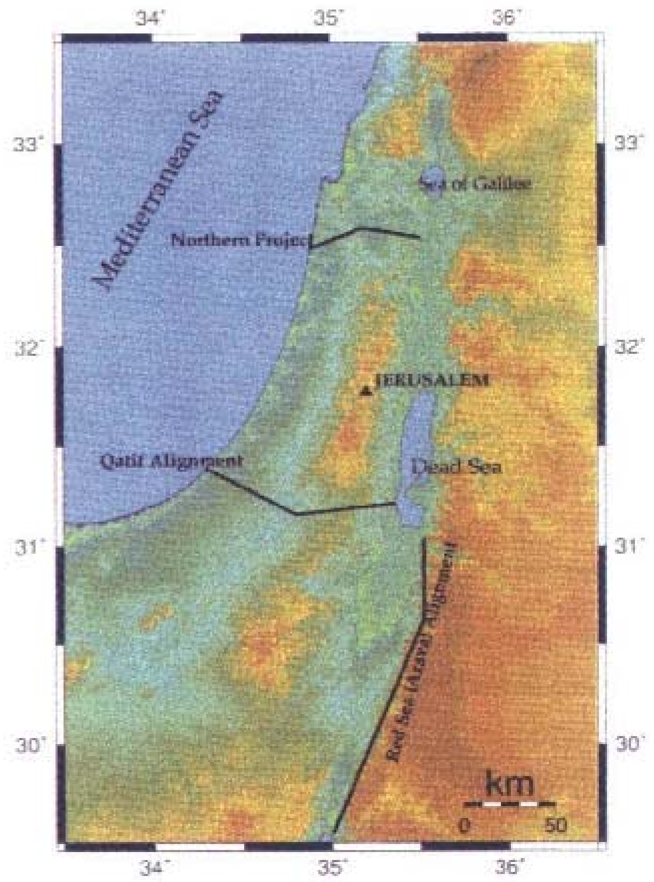


Fig. 1. The three aligments suggested for sea water desalination.

The goals

From the time desalination of sea water was suggested as the major goal replacing hydroelectric power generation, the following two major tasks were defined:

1. Desalination of 800 to 850 MCM with 20 to 300 mg/l TDS, annually.
2. The Dead Sea (DS) level restoration at around 400 mbsl.

The first task is suggested as a partial solution for the water deficit existing and predicted for the region including Israel, Jordan and the Palestinian Authority. According to the prefeasibility study carried out for the RSDSC the consumers in Amman will pay 1.34 US$/cm and in Hebron 1.11 US$/cm. The duration of the construction including the feasibility study will be around 13 years, the construction cost around $5x10^9$ US$ and annual operational cost around $5x10^6$ US$ (The Harza JRV Group, 1996). Different estimates and approaches are for the Katif and the Northern alignments which are much shorter (Tahal, 1994 and Ben Meir, 1996). In the Northern project a two stage desalination plant was suggested; the main stage will be at the Mediterranean coast where desalination up to 850 mg/l TDS will be carried out; Only at the second stage the hydrostatic energy potential of 300m elevation difference will be used for desalination which will reach 280 to 20 mg/l TDS. The cost was estimated to be between 0.67 to 0.58 US$/cm (Dvoskin and shafrir, 1997).

The second task of the Dead Sea level restoration was also strongly argument by our Jordanian colleagues. As a result of the regional irrigation projects most of the running water in the DS drainage basin is used and the water balance of the lake is negative. Also the potash industry of the Arab Potash Company and the Dead Sea Works at the DS Southern Basin are increasing the rate of evaporation. As a result the average annual DS drop is >80cm (Anati and Shasha, 1989), and the lake level reached 412.5m below sea level (Israel Hydrological Service, 1999, Fig. 2). This extreme drop causes a lot of damage to the development of the area around the DS (see environmental aspects). The only solution for such a drop in a desert environment with a growing population is importing Sea Water as a compensation for the water loss.

The alignments

Three alignments are discussed: The RSDSC, the Katif and the Northern alignment (Fig. 1). There are six major components which are common, with different specifications, to the three alignments:

1. Sea intake and pumping station.

The sea waters are pumped to +100masl at the Katif alignment and to +125 masl at the RSDSC. At the Northern alignment the cooling water from the Hedera Power Station are desalinated to 845 mgTDS.

2. Pressure pipeline.

The first part of the conveyance system transmit the sea water to the planned elevation. At the Katif alignment the length is 7.6km from Katif and at the RSDSC 5km from Aqaba and it's 3% of the whole alignment.

3. Canal and tunnel-the major conveyance system.

At the Katif and RSDSC alignments sea water are transmitted to the regulating and pretreatment reservoirs with a design flow of $60m^3$/sec. At the Katif alignment a 20km canal and 80km tunnel with 6m diameter were designed while at the RSDSC 121m tunnel with 7m diameter and 39km canal were designed. At the Northern alignment the partial desalinated sea water will be transmitted in a short tunnel below Mt. Carmel and in pipelines of a total length of 80km.

4. Regulating and pretreatment reservoirs.

At the Katif alignment a reservoir of 10MCM at +5masl at the upper basin of Nahal Parsa was designed. At the RSDSC the reservoirs were designed at +107masl at Wadi G'mal at the south eastern margin of the DS. At the Northern alignment at +43masl at Ramat Zvaiim.

5. Desalination plant.

The desalination plants are designed to be operated by using the process of hydrostatically supported reverse osmosis (RO) to provide desalinated sea water. At the RSDSC the plant will be located at Zafi at -365mbsl where with a water column of 475m. At the Katif alignment the plant will be located at Nahal Parsa at ~-390mbsl with a water column of 460m. With an annual flow of $2X10^9$CM and a recovery of 45%, $1.1X10^9$CM of rejected concentrates, will enter the DS. In the Northern alignment the plant will be located near Hamadia at an elevation of -258bsl with a water column of 300m.

6. Fresh water and reject brine carriers.

At the RSDSC two thirds of the 845MCM desalinated, fresh water are for Amman, Jordan and one third for the Palestinian Authority and Israel, Hebron and Jerusalem (The Harza JRV Group, 1996). For the transmission of the water to Amman a double pipeline of 200km with 2.75 m diameter was designed with nine pumping stations for the uplift of 1,500m. For the transmission to Hebron and Jerusalem a double pipeline of 125km with an elevation difference of 1,415m is designed. In the Northern alignment at the first stage only 200MCM with 20mgTDS/L will be transmitted along 35km to the Lake Kinneret. At the second stage 600 will be transmitted to Jordan. In the Katif alignment up to 800MCM will be transmitted annually and uplifted to 840masl to 1000masl from both sides of the Jordan Valley.

Environmental impact

One of the major ideas of the canal's project was to compensate the negative water balance (Fig. 2). The lake level for planning recommended for the Katif alignment was 390bsl (Mediterranean-Dead Sea Co., 1984) and only 12 years later for the RSDSC was 400bsl (The Harza JRV Group, 1996). Hence the second task, of the DS level restoration is getting more and more important. Two hazardous phenomena are probably resulting from this "rapid" level drop: The loss of groundwater due to the change of the groundwater gradient (The Harza JRV Group, 1996) and the formation of the so called "sinkholes" (Wakz et al., 1999). These in addition to direct planning problems in the changing level creates severe obstacles in developing this tourist attractive areas. The only way to overcome this problem is by adding sea water and create a positive balance between the running water and the loss by evaporation. But the inflow of sea water or concentrated rejects which build a upper light, stratified level may create a lower hypolimnion with reducing environment (Gavrieli, 2000), intensive precipitation of gypsum and a change of the biological environment of the upper epylimnion water mass. In addition to the limnological effects there are geotechnical considerations like building such a plant in a seismological active zone, the potential of water leakage and the contamination of the local aquifer. The Northern alignment has two advantages; 200MCM annually of desalinated water to Lake Kinneret will make the operation of Kinneret Diversion possible without effecting the water quality of the lake. The relative small amount of rejected concentrates in this alignment will not prevent an additional project if feasible.

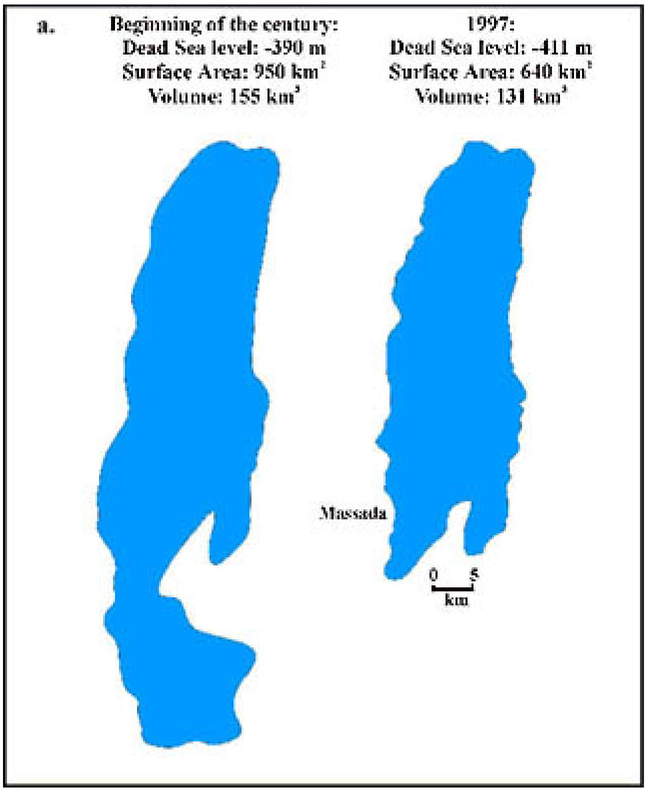


Fig. 2a. Dead Sea water level 1983-1996 (Gavrieli, 2000).

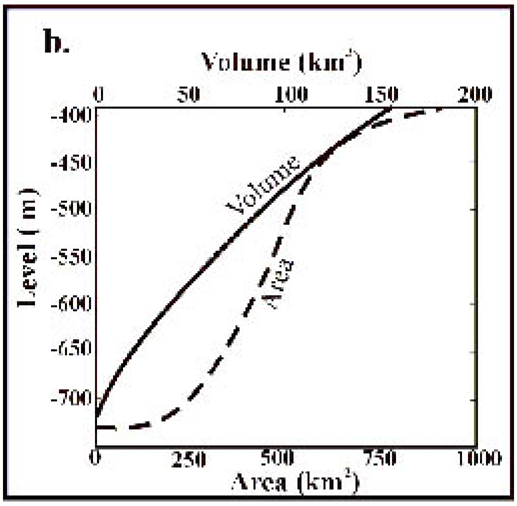
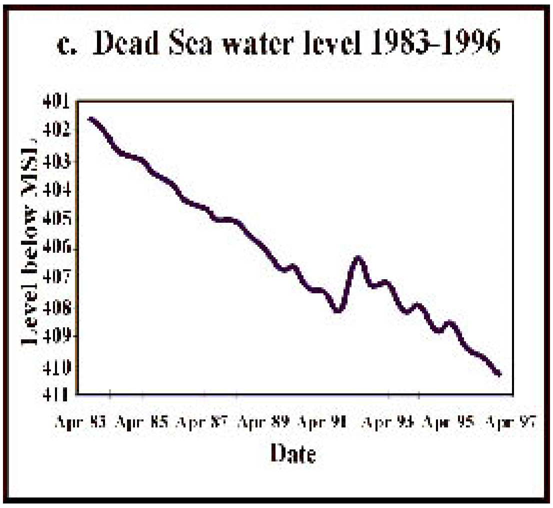


Fig 2b. Area and volume vs.lake levels (Hall and Neev, 1978).



Fif 2c. Data of the Hydrological Survey.

Summary

1. The RSDSC is the most expensive alternative between the three alignments also comparing to desalinated plants along the Mediterranean coast.
2. The save of the external sources of energy in these projects is around 22% only taking into account the pumping of the desalinated water to Amman and Jerusalem (Weiner, 1997).
3. The Northern alignment might be an integral part of the of the Central Water Carrier and the regional water system, enabling the construction of the "Kinneret Diversion" without negatively effecting the water quality of the lake. Because of the small amount of the rejected concentrates this alignment will not prevent the construction of an additional project like the Katif or the RSDSC.
4. The stratification and dilution of the DS water mass with sea water may cause losses for the Dead Sea Works and the Arab Potash Company, precipitation of gypsum and change the biological environment of the upper water mass.

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