Potable water versus marine brine for saving the Dead Sea
A fundamental question that has not yet been properly examined

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The massive human interference in the water balance of the DS (Dead Sea) is reflected by a rapid drop in its level, reaching 1.2m/year on the average for the last 10 years, accompanied by considerable environmental and economic damage. The JR (Jordan River) known globally for its historic value and once the DS's major water supplier, has been reduced to a poor sewage stream.

Jordan desires to solve its water shortage by the Red Sea-Dead Sea Conduit (RSDSC), through which would flow $2Bm^3/y$ (billion cubic meters per year) of water from the RS (Red Sea) for desalination. This project would result in 0.8 Bm^3/y of desalinated water ($0.27Bm^3/y$ designated for Palestine) on the DS shore. The byproduct, ~$1.2Bm^3/y$ of marine brine, would be used of the recovery of DS.
The government of Israel neglected its own decision (No. 2863 from Jan 5th 2003) to check various alternatives for saving the DS, including by potable water, and supports the RSDSC. In light of the consensus, the World Bank is financing a feasibility study for the project that should be completed within two years, much too short a period to conduct research to bridge knowledge gaps, especially on the environmental threats. This plan would result in ~84 million tons of dissolved salts entering the DS annually, ~31.5 times more than the JR supply in the past, with a different chemical composition. Studies (see reference list) show that mixing sea (any sea) water with DS water might cause negative limnological and microbiological impacts, resulting in considerable damage to industry and tourism.
In addition to its direct impacts on the DS, the proposed RSDSC could affect the Gulf of Aqaba and the Arava Valley. Currents are a major factor of the marine ecosystem; pumping $2Bm^3/y$ from the Gulf of Aqaba might drastically change the conditions of the vulnerable and unique ecosystem of the narrow edge of Gulf on which the coastal tourism (Egypt, Israel and Jordan) is based.
The path of the RSDSC is stretched along the most active seismic belt in the region, crossing geological faults, some of which are probably active, presenting a threat of soil and aquifer contamination by sea water leakage, or damage to the alignment due to earthquakes.
In the absence of governmental initiative, a preliminary low budget alternatives comparison was carried out by the Neaman Institute (Technion), and pointed out (again) the economic and environmental inferiority of RSDSC to the MD2 (Mediterranean - Dead Sea) Canal alternative.

JR-DS (Jordan River-Dead Sea), the systemic alternative

In the light of threats and uncertainties in the marine alternatives, a systemic (JR-DS system), modular, potable water alternative, fed by either massive desalination on the coastal plane (MD1), and/or shipping water from the Turkish MS coast (T2) is demonstrated herein and offered for simultaneous study.

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MD1: looks expensive due to the desalination element cost (2.6 times per year more than in the RD and MD), but taking into consideration the benefits of the systemic attitude (following), might change the picture; dependence on crude oil (market and pollution) is its prominent disadvantage, but within the horizon of implementation significant changes are expected in the energy sources.
T2: Billions m^3/y of potable water are flowing into the Turkish MS, ~700 km north of Haifa; a contract for shipping this water has been signed but not implemented due to the high cost of conventional transportation by tankers. Experiments have yielded recently an appropriate material for producing giant tanks that have been dragged successfully this distance. A fleet of about 22 relatively small sea crafts can supply in such a way 2Bm^3/y of potable water, far beyond the expected from RD and the needs for the recovery of the JR-DS system as well; the cost is 75% of the desalination cost on the DS coast (according to the developers) but free of negative impacts and allocation of expensive coastal land for projects. The cost is expected to decrease with the increase of the tanks' capacity, which is limited to the actual capacity of the means of transportation from the factory to the sea.

Stage a: Import/desalination of ~0.35Bm^3/y for the Israeli national water conveyer consumers will replace the pumping from LK (Lake Kinneret). This will improve the lake's water quality and manageable water balance, stop the salting of soils and aquifers by LK water and enable the release of this portion downstream to recover the JR potential as a most desired pilgrimage and ecotourism site (benefits for the communities on both sides) and considerably decrease the drop in the DS level.
Stage b: Import/desalination of ~1.3Bm^3/y, 0.27 Bm^3/y of which will be transferred to Palestine from altitude 0 instead of pumping from DS (-400m), and 1.03Bm^3/y of which will flow by alignment to either JR Valley or LK (possibility: in the route of the national conveyer with an option to gain energy down stream). Of this water, 0.53Bm^3/y will flow to Jordan by the adjacent King Abdulla Canal, instead of pumping from DS (-400m), and the remaining 0.5 Bm^3/y will be released to accomplish the recovery of JR-DS system.

JR-DS alternative is the closest to the original situation and hence minimizes environmental risks and uncertainties, avoids seismic and sea water contamination threats, does not interfere in the Gulf of Aqaba ecology. It is 1/4 to 1/3 in length and 1/2 in capacity compared to the RSDSC. In addition, its modular nature is economically significant: implementation and benefits of Stage A are instant, and the revival of the JR is meaningful from both economic and heritage points of view.
Including LK in the project offers Jordan a storage capacity that the country needs; as a binational reservoir it will carry a real message of peace and cross-border cooperation that fills the purpose of the international financiers.
The RSDSC is currently preferred not because of any advantages, but due to the consensus between Jordan and Israel (but not Egypt) based on mutual suspicion, leading to opposition to any linkage between their water systems, rather than adoption of such a linkage (and others) as enhancing peace. Currently, Jordan accepts 55Mm^3/y from LK; the precedent exists and the system is ready for further development, especially in T2 version of none "made in Israel"

water.

The apparent attractiveness of JR-DS alternative does not makes it preferable over RSDSC without a comprehensive feasibility study. Bearing much fewer uncertainties, it is expected to be considerably quicker and cheaper compared to the current RSDSC study.

The responsibility to the future of DS for the generations to come obliges the regional and international bodies involved, to conduct **simultaneous** feasibility studies of the alternatives and then to choose the best of them.

The World Bank is expected to declare its support for the "best alternative, which is not known yet", as the only option, whether the partners like it or not. Jordan's need for international financing for a potable water project, together with the recognition of the administration and the public in Israel of the need to save the DS in the most beneficial and least harmful way, in addition to international guaranties, might lower the barriers of suspicion.

A comprehensive environmental and economic comparison of alternatives, free of political pressure, is the precondition needed for choosing the best way to achieve the goals of the T.O.R. document, on which Israel, Jordan and the World Bank have signed.

TABLE 2: Partial comparison of annual costs* in million USD, excluding maintenance.

Plan	**(Cost x Volume) + additional cost**	**Annual Price**
RDSC desalination	($0.45 per m^3 x 0.8 Bm^3/y) + $580M pumping and transport from Dead Sea	$940M
MD2 desalination	($0.45 per m^3 x 0.8 Bm^3/y) + $195M pumping and transport from Jordan River Valley.	$555M
MD1 desalination	($0.56 per m^3 x 1.65 Bm^3/y) + $146M pumping and transport from Jordan River Valley - 130 by gaining energy downstream	$940M
T2 import	($0.45 per m^3 x 1.65 Bm^3/y) + $146M pumping and transport from JR Valley - 130 by gaining energy downstream	$758.5M

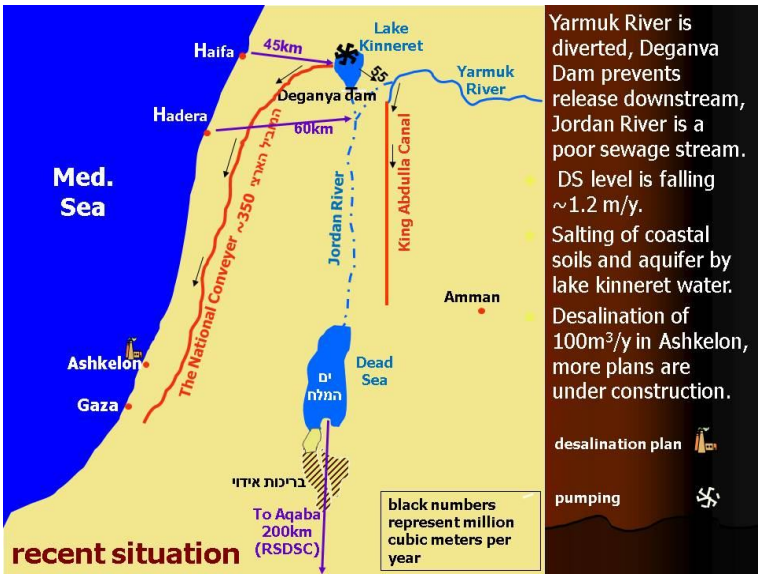
TABLE 3: Partial comparison of the main investments*** in million USD

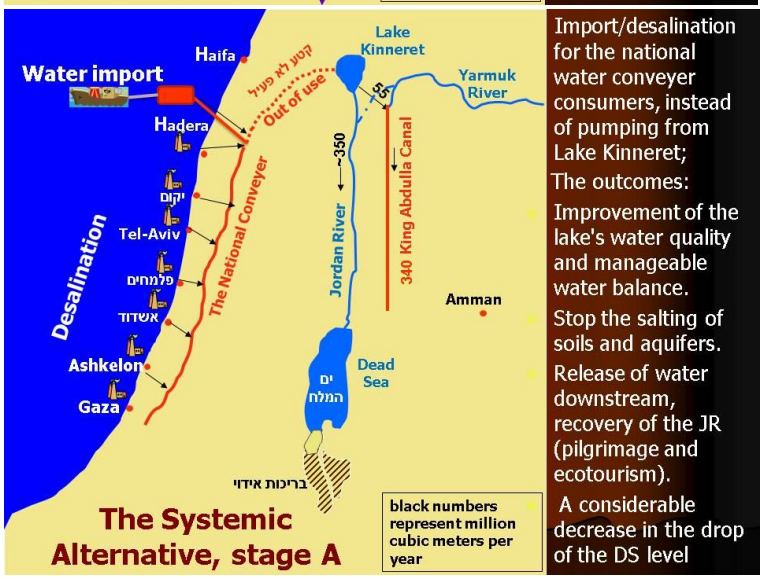
	canals	desalination plants	Pumping & transport system	total invest ment	annual desalination & transport
RSDSC* 170km for 2Bm^3/y sea water + 30km for 1.2Bm^3/y of brine	4450	3600	800	8850	940
MD2** 60km for 2Bm^3/y sea water + 110km for 1.2Bm^3/y of brine	1840	3600	270	5710	555
MD1* 60km for 1.03Bm^3/y desalinated water and no brine canal	900	5000	224	6124	940
T2 60km for 1.03Bm^3/y imported water and no brine canal	900	0000	224	1124	759

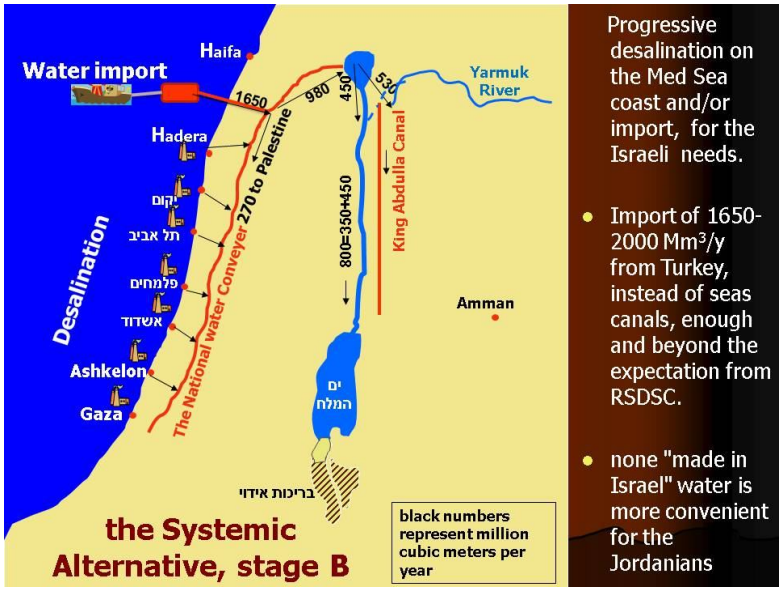
*accommodation from MD2 data; **based on Neaman Institute report + corrections

***costs are not up to date, due the changes in the global economy, but still proportional in respect one to each other

N.B. Protections against environmental threats and uncertainties are not considered.


Haifa
45km
Lake Kinneret
55
Yarmuk River
Deganya Dam
Hadera
60km
Med. Sea
~350
The National Conveyer
Jordan River
King Abdulla Canal
Amman
Ashkelon
Gaza
Dead Sea
ים המלח
בריכות אידוי
To Aqaba 200km (RSDSC)
recent situation
black numbers represent million cubic meters per year
Yarmuk River is diverted, Deganva Dam prevents release downstream, Jordan River is a poor sewage stream.
DS level is falling ~1.2 m/y.
Salting of coastal soils and aquifer by lake kinneret water.
Desalination of 100m³/y in Ashkelon, more plans are under construction.
desalination plan
pumping


Water import
Haifa
Lake Kinneret
Yarmuk River
55
Out of use
Hadera
~350
340 King Abdulla Canal
Jordan River
The National Conveyer
Desalination
יקום
Tel-Aviv
פלמחים
אשדוד
Ashkelon
Gaza
Amman
Dead Sea
ים המלח
בריכות אידוי
The Systemic Alternative, stage A
black numbers represent million cubic meters per year
Import/desalination for the national water conveyer consumers, instead of pumping from Lake Kinneret;
The outcomes:
Improvement of the lake's water quality and manageable water balance.
Stop the salting of soils and aquifers.
Release of water downstream, recovery of the JR (pilgrimage and ecotourism).
A considerable decrease in the drop of the DS level


Water import
Haifa
1650
980
450
530
Yarmuk River
Hadera
270 to Palestine
800=350+450
King Abdulla Canal
Desalination
יקום
תל אביב
פלמחים
אשדוד
Ashkelon
Gaza
The National water Conveyer
Amman
ים המלח
בריכות אידוי
the Systemic Alternative, stage B
black numbers represent million cubic meters per year
Progressive desalination on the Med Sea coast and/or import, for the Israeli needs.
Import of 1650-2000 Mm³/y from Turkey, instead of seas canals, enough and beyond the expectation from RSDSC.
none "made in Israel" water is more convenient for the Jordanians

References מקורות

Gavrieli, I., Bein., A., and Oren, A., 2005, The expected impact of the "Peace Conduit" project (the Red Sea Dead Sea pipeline) on the Dead Sea, *Mitigation and Adaptation Strategies for Global Change.* 10(1), pp. 3-22

Gavrieli, I., Lensky, N., Gazit-Yaari, N., and Oren, A., 2002, The impact of the proposed "Peace Conduit" on the Dead Sea, evaluation of current knowledge on Dead Sea – seawater mixing, *GSI/23/2002*, Geological Survey of Israel, The ministry of National Infrastructure.

Gavrieli, I., Lensky, N., Dvorkin, Y., Lyakhovsky, V., and Gertman, I., 2006, a multi-component chemistry-based model for the Dead Sea: Modeling to the 1D Princeton Oceanographic Model, *GSI/24/2006*, Geological Survey of Israel, Ministry of National Infrastructure. Including appendix V: Oren, A., Gavrieli, I., Gavrieli, J., Kohen, M., Lati, J., and Aharoni, M., Long-term field simulation of algal and archaeal bloom in the Dead Sea.

Gophen, M. 2007. Lake Management Perspectives in Arid, Semi-Arid, Sub-Tropical and Tropical Dry climate. Proceedings of the 12th International Lake Conference, Jaipur, India. Invited paper. (in press).

Gophen, M. 2007. Long term (1970 – 2001) Eco – Hydrological Processes in Lake Kinneret and its Watershed. In: "Climatic Changes and Water Resources in the Middle East and in North Africa", Invited Chapter (H. Zereini ed.), (in press).

The Harza JRV Group, 1996, Red Sea-Dead Sea Canal Project, Draft Prefeasibility Report,Main Report. Jordan Rift Valley Steering Committee of the Trilateral Economic Committee.

Shirav – Schwartz M., Calvo, R. Bein, A., Burg, A., Nof (Novitsky), R., and Baer, G., 2006, Red Sea – Dead Sea Conduit, geo-environment study along the Arava Valley, *GSI/24/2006*, Geological Survey of Israel, the Ministry of National Infrastructure.

Vardi, J., 1990,Mediterranean-Dead Sea Project: Historical Review: in Mediterranean-Dead Sea Project; Bibliography by Arad, V., Beyth, M: GSI report# 9/90 p31-50.

2007, Reclaiming the Dead Sea Alternative fore action. Technion- Israel Institute 0f Technology the Samuel Neaman Institute.