View from Masada to the southwestern limits of the Dead Sea (© Julian Xanke)

The SALAM Initiative: Concepts and Approaches for the Resolution of the Water Deficit Problem in the Middle East at Regional Scale

Bernd Rusteberg[1], Jacob Bensabat[2], Abdel Rahman Tamimi[3], Amer Salman[4], Emad Al-Karablieh[4], Elias Salameh[4], Florian Walter[1/5], Torsten Lange[5], Martin Sauter[5]

KEY FINDINGS

The steadily increasing water demand in Jordan and Palestine during the next two decades, all sectors included, cannot be covered by the available water resources, which are limited.

Both countries already face a total annual freshwater deficit of about 783 Million m^3 (MCM). In 2035, according to SALAM forecasts, additional 1,680 MCM/a of freshwater resources will be required to ensure sustainable development (Figure 1).

SALAM believes that this amount of freshwater just can be produced by seawater desalination (SWD).

Due to the geographical characteristics of the region, transboundary cooperation and water SWAP agreements between Israel, Jordan and Palestine are required to solve the water problem.

In general, SALAM WPOs are capable of providing the additionally required water resources to the region within a reasonable time horizon and in an economically sustainable mode.

While cost of seawater desalination is comparable for all schemes, the total cost of water supply will strongly depend on the water conveyance, water storage and water swap components.

Significant water cost reduction (US$/$m^3$) could be achieved by employing hydropower generation along the water transport routes, large scale solutions for SWD and low cost renewable energy production (such as solar energy).

An integrated regional water strategy may consist of a combination of SALAM WPOs and SWAP schemes.

The decision with regard to the most appropriate strategy to be implemented will depend more on political agreements than on any other factors. Therefore, prioritization based on engineering and or economic criteria is beyond the stated scope of SALAM.

Introduction

The SALAM initiative was funded by the German Federal Ministry of Education and Research (BMBF) in the context of the SMART-MOVE IWRM project. This research project investigates the present and future water budgets in Israel, Jordan and Palestine, identified the present water deficit as well as the additional required water resources during the next two decades and delineates five so-called Water Production and Transport Options (SALAM WPOs) to solve the water deficit problem in the region. All WPO's rely on the desalination of seawater at different locations and transport of freshwater to demand centres in the region. The group of experts from the region works under the leadership of the Georg-August-University of Göttingen and Rusteberg Water Consulting, receiving support from the National stakeholders MWI (Jordanian Ministry of Water and Irrigation), PWA (Palestinian Water Authority) and MEKOROT (Israel National Water Company).

During the last two decades, Israel has engaged into massive seawater desalination (SWD) and large-scale reuse of treated effluent in irrigated agriculture. These two measures have dramatically improved the water supply situation in Israel and will ensure the matching of the Israeli water demand for the next decades, independent of climatic conditions.

Jordan made all possible efforts to develop it's water resources, including conventional and non-conventional sources of water, but the country is increasingly suffering from water shortages, due to the limited available natural water resources. These shortages will become far more acute in the near future because of population growth, influx of refugees as well as long periods of droughts and dry years, possibly resulting from climate change. The latter has a major impact on the availability of surface and groundwater in the region. Spring discharge, groundwater levels and even the natural inflow to the Lake Tiberias steadily decreases, seriously reducing the water available for abstraction. Palestine, despite all efforts, suffers from similar conditions.

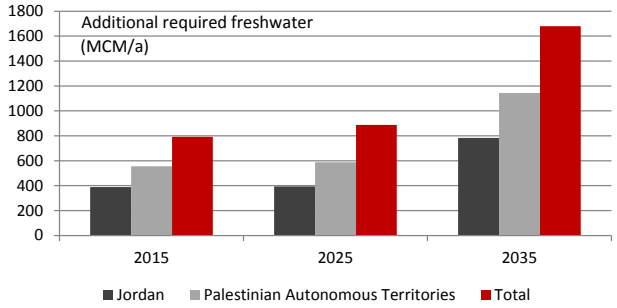

Figure 1: Additional required freshwater resources in 2015, 2025 and 2035

SALAM believes that SWD is the key solution for the water problems in Jordan and Palestine, too. SALAM WPOs are based on three key concepts: Seawater desalination, transport to demand areas and water swap among the three parties.

In addition, SALAM addresses the rehabilitation of two key environmental assets of the region: the Dead Sea, whose water level needs to be stabilized and the Lower Jordan River (LJR), which for decades lacks base flow with adverse effects on local groundwater flow and the ecosystem in the alluvial plain.

Approach

In order to resolve the problem, the SALAM initiative investigates 5 water production and transport options (listed below). According to table 1, SALAM WPO 1 and 5 further consider 3 different levels of water production by seawater desalination, given in million m^3 per year (MCM/a). The SALAM WPOs are characterized as follows:

SALAM WPO 1: Desalination plants at the Red Sea and transport by pipeline to demand areas in Jordan and southern Israel (city of Eilat), partially in exchange for additional Israeli water supply to the north of Jordan, beyond the already existing water SWAP between Israel and Jordan amounting to about 50 MCM/a (red arrows). The substantial extension of the seawater desalination plant at Aqaba, currently under tendering, and water transfer to Amman is being taken into consideration by SALAM WPOs 1-1 and 1-2. The brine could either be discharged directly into the Red Sea or mixed with seawater and transferred by pipeline to the Dead Sea to contribute to the stabilization of the Dead Sea water level (Figure 2/ dashed green line).

SALAM WPO 2: SWD at the Israeli Mediterranean coast near the city of Netanya, due to the very short distance to the Palestinian territories (less than 10 km), conveyance by pipeline to the city of Tul-Karem and from there to demand areas in the northern West-Bank.

SALAM WPO 3: Desalination plant at the Mediterranean coast of Palestine (Gaza Strip) for local water supply together with an additional pipeline from the desalination plant to the city of Hebron, crossing Israeli territory, and from there to other Palestinian cities. Due to high water cost (table 1), alternative water SWAP options between Israel and Palestine could be more appropriate and should be studied during the next phase of the project, should it be funded.

SALAM WPO 4: This option refers to the original Dead Sea-Red Sea Canal project as potential long-term solution for the region, aiming at stabilizing the Dead Sea and transporting substantial amounts of drinking water to the area, investigated by the World Bank (COYNE ET BELLIER, 2012).

SALAM WPO 5: SWD in the Western Galilee, near the city of Haifa, water transport to Lake Tiberias for storage and from there, transport to Jordan and Palestine. The water transport to the Lake may be achieved in different ways: by flow inversion of the Israeli Water Carrier (IWC) between the Haifa area and the Lake, a pipeline parallel to the IWC or the construction of a tunnel. The tunnel option has been considered to estimate the water cost (Table 1). SALAM WPO 5 is a water transfer solution

Table 1: Water Cost of SALAM WPOs as Average Incremental Cost (AIC) in US$/m³

SALAM-WPO	1-0	1-1	1-2	2	3	4	5-0	5-1	5-2
WATER PROD. (MCM/A)	80	230	500	50	50	850	250	500	1,000
WATER COST (US$/M³)	0.64 / 0.80*	1.57 / 1.61*	1.36 / 1.38*	0.73	2.16	- **	0.79	0.67	0.61

* Brine disposal in the Red Sea (/) versus brine disposal in Dead Sea, mixed with seawater

** RSDS-canal project studied by the World Bank (Coyne et Bellier, 2012)

characterized by low water cost, especially for large scale seawater desalination.

Main Results and Conclusions

Each option was studied in a preliminary way with regard to its technical feasibility, in economic terms, its contribution to the resolution of the water problems and its political acceptance. As economic indicator, the Average Incremental Cost (AIC) in US$/m³ is considered. The water cost of each WPO, calculated for a planning horizon of 20 years, is presented in Table 1.

- Five feasible engineering solutions (SALAM WPOs) have been suggested, capable of resolving the acute water problem of the region. Since the cost of seawater desalination is similar for all locations, their cost-effectiveness depends largely on the decisions to be taken with respect to transport routes, storage facilities and water swap options.
- SALAM WPOs 1, 4 and 5 permit the production of renewable energy in terms of hydropower, which would lower the overall cost of water production and transport.
- SALAM WPO 5 would significantly contribute to the rehabilitation of the Lower Jordan River (LJR), since part of the water stored in Lake Tiberias could be discharged directly to the LJR, contributing to socio-economic development in the Lower Jordan Valley.
- SALAM WPOs 1, 4 and 5 would directly contribute to the stabilization of the Dead Sea, a key concern of the neighboring countries.
- An integrated regional water strategy may consist of a combination of SALAM WPOs and SWAP schemes in an appropriate manner, taking other non-conventional water resources, such as treated effluents (reuse) and brackish groundwater into account.
- Since any major infrastructure project requires substantial time period for implementation, there is an urgent need to agree on a regional strategy with mutual benefits for the three countries and to start appropriate measures without delay.

Further Research Needs

- Study of additional schemes for a Water-Renewable Energy-Food SWAP between the three countries and their integration with SALAM WPOs.
- More detailed technical-economic analysis for each of the SALAM WPOs to achieve a refined level of design and to consolidate cost effectiveness of each WPO.
- Further studies on how to improve the cost-effectiveness of SALAM WPOs, e.g. with regards to SALAM WPO 3, where water SWAP between Israel and Palestine seems to be a promising concept instead of water transfer from Gaza to Hebron and surrounding cities by pipeline.
- More detailed water budget studies on the spatial distribution of existing and further expected water deficits in Jordan and Palestine in as a basis for the development of regional water allocation schemes.
- Multi-purpose management of the Lake Tiberias as a central regional water storage reservoir, taking ecological objectives, such as the rehabilitation of the LJR, into consideration.
- Regional waste water reuse concepts, based on centralized and decentralized solutions, contributing to the sustainable development of irrigated agriculture in the LJV.
- Development of alternative regional strategies, composed of different SALAM WPOs and existing and new SWAP schemes, taking the refined water allocation schemes as well as further non-conventional (treated effluent, brackish water) and strategic transboundary groundwater resources into account.
- Investigation of financing schemes and institutional requirements for strategy implementation.
- Development of a peace model for the region that promotes political and social willingness for sharing sources of water, renewable energy and food between Jordan, Palestine and Israel as basis for strategy implementation, supported by the international community.

AUTHORS / FURTHER CONTRIBUTING PARTNERS

RWC[1], EWRE[2], PHG[3], ATEEC[4], UGOE[5], MWI[6], MEKOROT[7], PWA[8]

CONTACT

Prof. Dr. Martin Sauter
Georg August University Göttingen, Germany,
Applied Geology
Goldschmidtstrasse 3, 37077 Göttingen
martin.sauter@geo.uni-goettingen.de

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COYNE ET BELLIER (2012): Red Sea – Dead Sea Water Conveyance Study Program, Draft Final Feasibility Study Report, Summary of Main Report, pp.88.

Further detailed information about the SALAM studies can be found on the project website: www.iwrm-smart-move.de