Executive Summary

Roadmap for the Rehabilitation of the Lower Jordan River

November 2011

Prepared by DHV MED on behalf of
EcoPeace/ Friends of the Earth Middle East
Amman, Bethlehem and Tel Aviv
www.foeme.org

This report was prepared with the support of the United States Agency for International Development (USAID), the Swedish International Development Cooperation Agency (SIDA) the Goldman Fund, the Global Nature Fund/ Ursula Merz Foundation, the Green Environment Fund and the Osprey Foundation.
EcoPeace/ Friends of the Earth Middle East (FoEME) is a unique organization at the forefront of the environmental peacemaking movement. As a tri-lateral organization that brings together Jordanian, Palestinian, and Israeli environmentalists, our primary objective is the promotion of cooperative efforts to protect our shared environmental heritage. In so doing, we seek to advance both sustainable regional development and the creation of necessary conditions for lasting peace in our region. FoEME has offices in Amman, Bethlehem, and Tel-Aviv. FoEME is a member of Friends of the Earth International, the largest grassroots environmental organization in the world.

For more information on FoEME or to download any of our publications please visit:  
www.foeme.org

Amman Office
Munqeth Mehyar, Jordanian Director
PO Box 840252 - Amman, Jordan, 11181
Tel: 962 6 5866602/3
Fax: 962 6 5866604
Email: info@foeme.org

Bethlehem Office
Nader Khateeb, Palestinian Director
PO Box 421 – Bethlehem, Palestine
Tel: 972 2 2747948
Fax: 972 2 2745968
Email: info@foeme.org

Tel Aviv Office
Gidon Bromberg, Israeli Director
8 Negev Street, Third Floor – Tel Aviv, 66186 Israel
Tel: 972 3 5605383
Fax: 972 3 5604693
Email: info@foeme.org

Cover Photo: © Itamar Grinberg / FoEME
Expert Author:

**Gilad Safier:** Environmental consultant, hydrologist and an expert in computerized hydrologic modeling and data systems at DHV MED. He holds a M.Sc. in Hydro-Informatics and Water Management from the Universitat Politèctica de Catalunya, Barcelona, Spain. He specializes in various models of water resources such as aquifers, rivers, flood basins, surface-runoff and more. Gilad has extensive knowledge and experience in advanced GIS tools, data processing and computerized modeling and is leading this field at DHV MED.

FoEME Project Team:

**Dr. Youval Arbel,** Israeli Deputy Director  
**Gidon Bromberg,** Israeli Director  
**Elizabeth Ya’ari,** Israeli Jordan River Rehabilitation Project Coordinator

Note of Gratitude

FoEME would like to recognize and thank the United States Agency for International Development (USAID), the Swedish International Development Cooperation Agency (SIDA) the Goldman Fund, the Global Nature Fund/ Ursula Merz Foundation, the Green Environment Fund and the Osprey Foundation for their support of this project.

Additional thanks are due to the many national and international experts for their participation in our National Advisory Committee Meetings and for providing the detailed data necessary to compile this report. Specific thanks are due to Christopher Bonzi and Assaf Chen of the GLOWA Project for allowing us access to their WEAP model which served as the basis for the Current Accounts model included in this report. Furthermore thanks are due to Dr. Alon Rimmer, Dr. Amir Givati and Dr. Doron Markel for providing valuable information on the Sea of Galilee and climate change; Ron Yitzhaki, Arik Reuveni, Gil Korati, Abraham Gilboa and Efraim Bar for their data and knowledge on the local water consumption; Nir Froiman for his guidance on the topic of fishponds; Hillel Glazman from the National Parks Authority for the samples of water quality in the basin; and to Zeev Ahipaz for his insight on long term plans of the Israeli Water Authority.

The views expressed are those of EcoPeace/ FoEME and do not necessarily represent the views of our expert team, project advisors, participants in the project's National and Regional Advisory Committee meetings or our funders.
Executive Summary

The Lower Jordan River is dying. An estimated 97% of its historical flow of some 1,258 million cubic meters (MCM) per year has been diverted by Israel, Syria and Jordan. In large patches of the LJR, there is almost no flowing water. In other parts, the remaining flow is primarily saline and wastewater. The river has already lost 50% of its biodiversity and has essentially been converted into a sewage canal.

This report was initiated by EcoPeace/Friends of the Earth Middle East (FoEME), with the aim of providing decision-makers with a specific, implementable vision for the first phase of a rehabilitation plan for the Lower Jordan River (LJR). This initial phase focuses on the Israeli side of the river between the Sea of Galilee (SoG) and Bezeq Stream (i.e. Upper LJR). All but a small portion of this stretch of the river is shared by Israel and Jordan and the resulting plan will require the approval of the Israeli-Jordanian Joint Water Committee before being implemented in practice.

The required quantities and quality of water for the LJR were identified in FoEME's Environmental Flows report published in 2010. This report concluded that the LJR requires 400 MCM/Yr (less than a third of the historical flow), to be expanded to 600 MCM over time. The river's salinity should be reduced to no more than 750 milligram per liter (mg/L). At least one flood event should be allowed per year with a discharge of approximately 20-50 m³/s lasting at least 24 hours, totaling to some 4 MCM. Summer flow should reach at least 30% of historical flows. Implementation of this strategy would remove most of the disturbances, allow natural riparian plant communities to recover and restore stable communities of flora and fauna while achieving a fair to high ecosystem integrity and health.

This goal cannot be met by one country alone and all riparian sides should be involved in the rehabilitation of this important shared natural resource. Out of the historical 1,250 MCM/Yr, some 580 MCM/Yr (46%) has been historically diverted by Israel. Adjustments for socio-economic considerations conclude that Israel should be responsible for returning 54% or 220 MCM of the minimum 400 MCM, Syria 24% or 100 MCM and Jordan 90 MCM at 22%. Palestine would not be asked to contribute water rather it needs to receive a fairer share of Jordan River waters as a riparian to the river.

On this basis, the aim of the paper is to devise viable options for Israel to reintroduce water to the LJR to meet the goal of returning 220 MCM annually, with a minimal flow of 9 MCM/month (3.5 m³/s) south of Alumot dam and maximum chloride salinity of 750 mg/L.

At present day, no active hydrometric stations exist on the LJR. Therefore, the first stage in this work was to build a computerized model of the basin, using the software WEAP (Water Evaluation And Planning), which is based on the principle of closing the water balance in a basin by drawing a scheme and inserting flow data of all the water sources, reaches, demand
sites, etc. The WEAP then calculates flow and salinity in a monthly resolution at different reaches of the LJR and its tributaries. Three scenarios are built in the model:

1. Current Accounts representing the present situation (1996-2010);

2. Zero Scenario (AKA Business As Usual) for the years 2011-2041;

3. Rehabilitation Scenario based on the Zero Scenario with added measures to rehabilitate the LJR.

Each scenario is presented in two chapters. The first deals with the methodology, scope and assumptions that were used to build the scenario. The second presents and discusses the results.

**THE LJR – AN INTRODUCTION**

Chapter Error! Reference source not found. offers a brief description of the LJR followed by a description of the model.

The LJR starts at the southern most point of the Sea of Galilee (SoG) and flows along some 100 km down to the Dead Sea. The meandering length is about 200 km and the total basin area is roughly 15,000 km². The Upper LJR stretches from the SoG to Bezeq Stream, with an aerial length of 35 km and a meandering length of 60 km. Hydrologically, the LJR can be divided as follows:

1. Deganiya to Alumot (2 km) – The northern most section lies between two closed dams, but the water level of the SoG since 2006 has been so low that no water could flow out of the lake even if the Deganiya dam was open. A few MCM/Yr are pumped into the reach as it serves as a conduit for local irrigation. This water is stopped at Alumot - a boulder dam that was built to segregate between the fresh water in the north and the saline and polluted water to its south.

2. Alumot to the confluence with the Yarmouk River (6 km) - In this section the main water sources are the Saline Water Carrier (SWC) that discharges some 15 MCM of brackish water, nearly 2 MCM of poorly treated effluents, and a seasonal contribution from Nahal Yavniel.

3. Yarmouk to Harod Stream (15 km) – The Yarmouk, which was once the main tributary of the LJR, is now almost completely dry. Other major streams in this stretch include the Tavor and Issachar Streams. Tavor has some base flow while Issachar is a wadi with only runoff.

4. Harod Stream to Bezeq Stream (14 km) – Harod Stream is today a tributary that still has significant sources of its own contributing some 10 MCM/Yr to the LJR. Along this section lies a valley with dozens of springs that total 80 MCM/Yr. Most of this water is today used and doesn't reach the LJR.
The SoG is the largest surface reservoir of fresh water in Israel, responsible for some 20% of the country's water supply. On average, 320 MCM of water are available to the lake annually. Most of the water comes from the Upper Jordan River (UJR). Since the construction of the Israeli National Water Carrier (NWC) that draws some 290 MCM/Yr on average; the SoG was regarded as an operative reservoir of the Israeli water market with an operational volume of 677 MCM that lies between -208.80 and -213 MSL respectively (between the Bottom and Top Red Lines respectively). The outlet to the LJR at Deganiya lies today at a level of -211 MSL.

The SWC is an artificial conduit, built for the purpose of lowering the salinity of the SoG. It heavily influences the LJR, as below Alumot dam 60-90% of the water comes from the SWC. Its waters originate at two saline springs to the west of the lake. Below Alumot dam, the SWC discharges to the LJR at about 14 MCM/Yr of saline water including:

- Tabgha Spring – 12-14 MCM/Yr with a chloride concentration of 2,000 mg/L;
- Tiberius Hot Springs (THS) – 1-2 MCM/Yr with a chloride concentration of 15,000-18,000 mg/L.

Another saline spring that today still flows to the SoG from the north west is the Foliya. In the future, this spring will be diverted to the SWC, and contribute 12 MCM/Yr with a Cl concentration of 2,500 mg/L. Another approved plan is to desalinate some of the water in the SWC, dilute it with the effluents of Bitaniya wastewater treatment plant (the WWTP is currently being upgraded) and use the water for irrigation. The brine will be discharged south of Harod Stream.

The Yarmouk drains about 46% of the basin of the LJR. It flows from the east and forms the border between Syria and Jordan and later between Jordan and Israel, until connecting with the LJR south of Kibbutz Ashdot-Ya'akov. Historically, some 470 MCM/Yr flowed in the Yarmouk, but today, as far as the LJR is concerned, the Yarmouk starts at Adassiyah dam, where Jordan diverts most of the remaining water to the King Abdullah Canal (KAC). Consequently, the annual flow downstream to Adassiyah has dwindled to less than 40 MCM. Israel uses most of the water before it reaches the LJR.

The LJR receives a significant amount of groundwater, although quantification of the flow is extremely difficult and inaccurate. A research by Farber concluded that downstream of Alumot, groundwater Cl concentration is 1150 mg/L and quantity is between 6 and 24 MCM. Meaning, 12 km downstream of Alumot, about 20-50% (120-450 l/s) of the flow stems from groundwater.

Most of the springs in the basin are concentrated in the south of the Upper LJR, between Harod Stream and Tavor Stream. Historically, this area called "Emeq Hamaayanot" (Valley of Springs in Hebrew) witnessed a gushing forth of some 120 MCM/Yr from about 40 springs, of which 70% came from 5 large springs (Homa, Amal, Shokek, Muda, and Migdal). Today, due to overexploitation, the springs total 60-80 MCM/Yr, most of which is diverted and does not reach the LJR directly.
The bulk of the consumed water in the area (nearly 100 MCM/Yr) is consumed by fishponds that concentrate around Harod Stream and in Emeq Hamaayanot. Fish cultivation is periodical, with most of the effluent being discharged in October-December at which time the ponds serve as a major pollution source to the LJR.

**CURRENT ACCOUNTS**

The current accounts (CA) model is based on a modification of Assaf Chen, to a model originally made by GLOWA. All the data on the Kingdom of Jordan and the Palestinian Authority was taken from the GLOWA model without alternations. From GLOWA's results, it seems only negligible amounts of water flows from the east to the upper LJR until Wadi Jumrum (opposite and 3 KM North to Bezeq Stream), and that no significant Jordanian consumption directly from the LJR was found. One can say that the Kingdom of Jordan disconnected itself from the Upper Jordan River with the construction of the KAC and dams on all of the main LJR tributaries. Data on the Israeli elements of the model was compiled from various sources including the Israeli Water Authority, Mekorot, local water associations, National Parks Authority, local farmers, literature, etc. The scenario represents the present situation and is largely based on averages of data from 1996-2010.
The methodology of the Current Accounts (CA) construction is detailed in chapter **Error! Reference source not found.**. The results, which were calibrated against salinity measurements of the National Parks Authority, are given in chapter **Error! Reference source not found.**.

The annual flow upstream of Wadi Jumrum is 71 MCM. The highest flow is in February at 11 MCM, while in June, the flow goes down to 3.3 MCM. The saltiest spot in the Upper LJR is the mouth of the SWC, with an average of more than 2,000 mg/L and typically, salinity falls as we go southwards down to a level of 1,500 mg/L at the confluence with Bezeq Stream. In October-February however, owing to discharges from fishponds, salinity increases below Harod Stream and via Emeq Hamaayanot.

The annual flow at the confluence with Bezeq is 76 MCM. The overall amount of water that enters the LJR south of Alumot is roughly 106 MCM/Yr but by the time the water reaches Bezeq, about 17 MCM are directly pumped out from the river, and 13 more are lost through evaporation. The top five contributors to this flow are:

---

1 Note: The width of the 'streams' in Figures 1, 2 and 3 represent the flow in MCM while the color represents the salinity in mg/L. The scales of flow are different in each map and so, sizes cannot be compared between maps. Rather, they indicate the relative share of the reaches within each map. The colors of salinity on the other hand are comparable, with yellow representing 750 mg/L (the target salinity). The labels on the reaches show the discharge at the top and the salinity at the bottom. The tributaries in the maps are not divided into reaches so the entire lengths of the tributaries show the values at their mouths.
a. Drainage from Emeq Hamaayanot – 27 MCM;
b. The SWC - 19 MCM;
c. Groundwater (not represented as a tributary in the maps) – 18 MCM;
d. Harod Stream – 13 MCM;
e. Tavor Stream – 8 MCM.

**Zero Scenario**

The Zero Scenario (ZS) simulates the forecasted state until 2041, if no action is taken to reinstate water into the LJR, on top of already approved plans (AKA Business As Usual). The scenario is based on several assumptions that are described in chapter Error! Reference source not found.. The two most important assumptions are the reduced consumption of the NWC and climate change. The later is taken from a work by Rimmer & Givati et.al, and assumes increased evaporation and a long term decrease in the available water to the SoG, with a defined annual variability.

Other assumptions are the addition of artesian wells upstream of the SoG, partial desalination of the SWC with usage of Bitaniya effluents, diversion of the Foliya spring into the SWC, transfer of brine to fishponds in Emeq Hamaayanot, allocation of 14 MCM/Yr from SoG to the LJR, depletion and salination of springs and wells in the basin, reinstating quotas in the Upper Jordan River basin, population growth, and future trends in agriculture including the pending fishery reform.

Results of the ZS show that the next 30 years can be split into three periods:

A. The next decade will be a transition period to the era of desalination in Israel. In that time, the SoG water level will rise on account of the pumping reduction to the NWC, but downstream flow will be minimal. The average annual flow upstream of Bezeq will be 79 MCM.

B. A short period is then expected, when the SoG will already be high, but overspills will still be minimal and sporadic. In the ZS, this period will last five years between 2020 and 2025, when the average annual flow upstream of Bezeq will be 112 MCM.

C. From the mid 2020’s on, the SoG will be close to the top red line, and overflows into the LJR will be more common. Drought years could end up with no overflows at all, but in average and above average years overflows will occur. The average annual flow in this period upstream of Bezeq will be close to 177 MCM, with a great annual variability. The maximum annual flow is 399 MCM while the minimal is only 69 MCM.

Comparison to the CA shows flow is expected to more than double in period C, and salinity will somewhat improve, especially upstream of Tavor. The two main reasons for the improvement are the rise of the SoG and the partial desalination of the SWC. Nevertheless, salinity will still be higher than the goal of 750 mg/L, throughout the entire length...
downstream Alumot, and the average flow at Bezeq will still be 35 MCM short of the goal of 220 MCM/Yr.

In years of extreme droughts in period C, the LJR will resemble the present day situation, with two important differences. First, the annual flow in the upper reaches of the LJR will be higher by 8 MCM, owing to the 14 MCM allocated from the SoG. Downstream at Emeq Hamaayanot, the picture changes and the flow will be lower by 3 MCM than in the CA as a result of the growing water shortage in the area. Second, salinity through the most part will be lower than in the CA, thanks to the partial desalination of the SWC and transfer of the brine to the fishponds of Emeq Hamaayanot. Downstream of Harod however, the picture is more complicated. There, seasonal salinity fluctuations are larger. Throughout the summer, salinity will range from 1250-1300 mg/L, about 300 mg/L lower than the CA on average. In November, when the discharges from the ponds peak, salinity will rise to 2050 mg/L, about 300 mg/L higher than today. The reason is that the bulk of the salt mass that today is spread evenly along the year will in the future be put into the ponds and discharged only during a 3 month period (baring leakage). Upstream of Harod Stream however, salinity is expected to drop dramatically, due to the decrease of salt input from the SWC. At the inflow points of Yarmouk and Tavor salinity will average 1,148 and 1,101 mg/L respectively (a drop of 700 and 400 mg/L from CA values, even in the driest year).

As far as salinity is concerned, the Upper LJR will be divided at the confluence with Harod Stream. Upstream, overall salinity will drop sharply all year round. Downstream, salinity will remain at the same magnitude from February-September, and increase noticeably in
October-January as a result of the emptying of the fishponds in the area, enhanced by the SWC brine that will now serve as a water source to the ponds. Thus, the reach with the sweetest flow in the LJR will be located below the confluence with Tavor Stream.

In rainy years of period C, more than 80% of the flow in the Upper LJR will originate in the SoG. The bulk of the flow will concentrate in February-April, which will also witness a sharp drop in salinity. In other months (May-January) however, even in the rainiest year, there will be no overflow at Deganiya dam. Consequently, the flow at Shifa could drop from 140 MCM in February to 4.9 MCM in June. Should this seasonal variability be mitigated, a change in the operation of Deganiya dam will be needed.

Water demand in the area is expected, at large, to remain the same over the next 30 years. The largest change in consumption will be a drop of 10 MCM/Yr in the demand of fishponds, as a result of the fishery reform. Local water sources however, are expected to dwindle. The available water in Emeq Hamaayanot is expected to drop by 12-18 MCM. The decrease of the natural sources will be higher, but will be somewhat mitigated by the addition of effluents, which by 2040 should amount to 5-6 MCM/Yr, and perhaps the brine from the SWC. Coupled with the decreasing flow, is an increase in the salinity of local springs. The combined effect will bring about an increasing problem to maintain present consumption levels. In dry years the shortage could top 6 MCM/Yr. Supply of fresh water for irrigation will be on the edge as well. The drainage from Emeq Hamaayanot that reaches the LJR will drop by 10 MCM/Yr, as a result of the water shortage.

**Reintroduction Scenario**

The Reintroduction Scenario (RS) is built on the basis of the ZS, with added measures to reintroduce water to the LJR. The measures are defined in chapter Error! Reference source not found.. One of the measures is changing the operation of Deganiya dam to release 125 MCM/Yr from the SoG with a minimum flow of 9 MCM in the summer and a maximum flow of 14 MCM in March. During periods when the lake drops below the bed level at Deganiya dam, the released flow should be halved. The model shows that this release is sustainable in period C, and that the lake will remain above the bottom red line even in extreme situations.

Besides the operation of Deganiya dam, 10 distinct measures were identified in the RS that aim at increasing flows and reducing salinity in the LJR. Among the most important measures are transferring the SWC brine to the Dead Sea instead of Emeq Hamaayanot, a further reduction in the pumping to the NWC, reducing agricultural consumption in the basin and the fishponds particularly by nearly 50 MCM/Yr by 2020, limiting quotas in the Upper Jordan River, and desalinating 1.5 MCM/Yr more of the SWC water.
The results of the additional measures described above are detailed in chapter Reference source not found. For period C, average annual flow at Shifa in the RS is 238 MCM, 18 MCM higher than the FoEME environmental goal. Unlike in the ZS, more than half of the flow originates in the SoG, so the river witnesses significant flows along its entire length, all year round. Average salinity in the RS is fairly even throughout the year and is constantly lower than the environmental goal (although downstream of Emeq Hamaayanot it is tangent). However, average salinity is not enough of an indicator as it has little meaning for the biota vitality in aquatic systems. Instead, one should check the Frequent Maximal Salinity (FMS), which is the average of the maximal values in each year. Until Emeq Hamaayanot, the river’s FMS is below 750mg/L. Downstream, the FMS is 753 mg/L but that is well within the error range of the model. Regardless, it is clear that meeting the 750 mg/L line will be very difficult downstream of Emeq Hamaayanot.

On average, flow and salinity meet the environmental criteria in the RS, but what about dry years? In the driest year of period C, flow at Shifa is nearly 100 MCM/Yr less than the average and is well below the desired environmental flow. Nevertheless, it is double the flow in the ZS for the parallel year, so the improvement is significant. As for salinity, throughout most of the year the improvement at Shifa compared to the ZS is in the range of 400-600 mg/L owing to the increased flow and the decreased salinity load from the SWC. In October-January the improvement is most pronounced (up to 1300 mg/L in November) thanks to the attenuation of the fishponds and the transfer of the SWC brine to the Dead Sea. Despite that improvement, the salinity goal set by FoEME is not met for the most part. Downstream of Emeq Hamaayanot, salinity is very high during most of the year (although it
stays below 1,000 mg/L). Upstream of Emeq Hamaayanot salinity levels exceed the goal from March to May because of the higher flow of the saline springs nourishing the SWC in these months.

In short, even in the driest of years the LJR shows substantial improvement in RS, but the environmental goals that can be met on average, will not be achieved in cases of subsequent droughts. The situation of the river today is grim. If nothing is done in addition to the approved plans (ZS), then the situation will improve but will still be inadequate. If the measures suggested in this paper are taken, then within a period of 10-15 years the LJR can reach a satisfying, albeit not perfect, condition.

The undiscounted direct costs were calculated for each of the measures, including capital investments in new infrastructure, maintenance; and variable costs, which comprise of energy and lost revenues to farmers according to the water usage (fresh irrigation, saline irrigation and fishponds). Real costs were calculated assuming an annual discount rate of 4%, with capital costs that are financed through loans for 20 years with an interest rate of 5%. Energy cost was assumed to be 0.45 NIS/kWh. Only direct costs were taken into account and externalities were excluded (for both benefits and costs).

The net cost and losses in revenues of all the alternatives is 3.4 billion NIS over 30 years, on top of future costs of ZS, which are split as follows: 730 million in lost revenues for the farmers in the LJR basin, 970 million in lost revenues for the farmers in the UJR basin, 370 million for dealing with the SWC and its brine, 1,300 million to decrease flow in the NWC, and 100 million to transfer effluents from the Kishon Water Works to AMWA.

Once the LJR has been restored to an acceptable degree, its water should allow all forms of saline cultivation. Present day agricultural consumption in Emeq Hamaayanot amounts to 100 MCM/Yr and in the later years of the RS, a 40 MCM/Yr reduction from farmers is needed. Allowing the local water association to pump those 40 MCM from below the confluence with Bezeq for the purpose of saline agriculture (not fishponds) could compensate local farmers with a net worth of 600 million NIS, reducing the 'total cost' of rehabilitation to 2.8 billion NIS over the next 30 years. The sensitivity of soils in the "new" fields to saline water should be examined prior to implementation. The return flows would increase salinity in the river so both the pumping and the drainage of the fields should be located as southwards as possible to minimize the effect upstream of Bezeq. Water can also be used for saline irrigation south of Bezeq Stream, in the Jordan Valley region. Best results would be achieved if the water is pumped upstream of Adam (Damya) Bridge, and even upstream of Wadi Kharuba, because of the gradual salination of the river as a result of salty groundwater in the area.

**CONCLUSIONS**

Today, the condition of the LJR is grim with flows that equal 2% of the historical flow and high levels of pollution and salinity in the river. In the next 30 years, the situation is expected to improve with the rise in the water level of the SoG and the partial desalination of the SWC. In the 2020's overspills of the SoG will even return instances of high flows to the LJR, albeit not in the same magnitude as historical flows.
Salinity wise, the river will be split at Harod Stream as a result of the SWC brine being transferred to Emeq Hamaayanot and the fishery reform. Upstream of Harod, the LJR will be sweetened to about 1,300 mg/L. Between Harod and Bezeq, the LJR's salinity will increase sharply, especially at autumn and early winter when it can top 2,000 mg/L, unless the brines will be transferred to the Dead Sea.

The object of this paper is to provide a roadmap for the initial phase of the rehabilitation of the LJR, by suggesting implementable measures to reintroduce water and reduce pollution in the river from the Israeli side. The first recommendation is to change the operation of the Deganiya dam after the rise in the SoG. The anticipated improvement is not enough to sustain a healthy biological system in the LJR and further actions will be needed. The combination of measures that is suggested in this paper could, within 10-15 years, bring the LJR to an adequate environmental condition.

Although on average the environmental goals are achievable, in drought years, especially if consecutive, that will not be possible. Meeting the salinity goal of 750 mg/L will be most difficult downstream of Emeq Hamaayanot and perhaps downstream of Harod Stream. Having said that, the proposed plan will greatly improve the condition of the LJR even in the driest of years to a level that could probably sustain the ecological system to a degree that it could quickly recover in average years.

Part of the proposed plan includes cutting back existing water rights in the area. Much of the water reintroduced into the LJR could be reused downstream of Bezeq Stream and even in Emeq Hamaayanot, as the expected quality should allow all forms of saline irrigation. Utilization of 40 MCM/Yr from the LJR should offset most of the reduction in water quotas in the LJR basin.