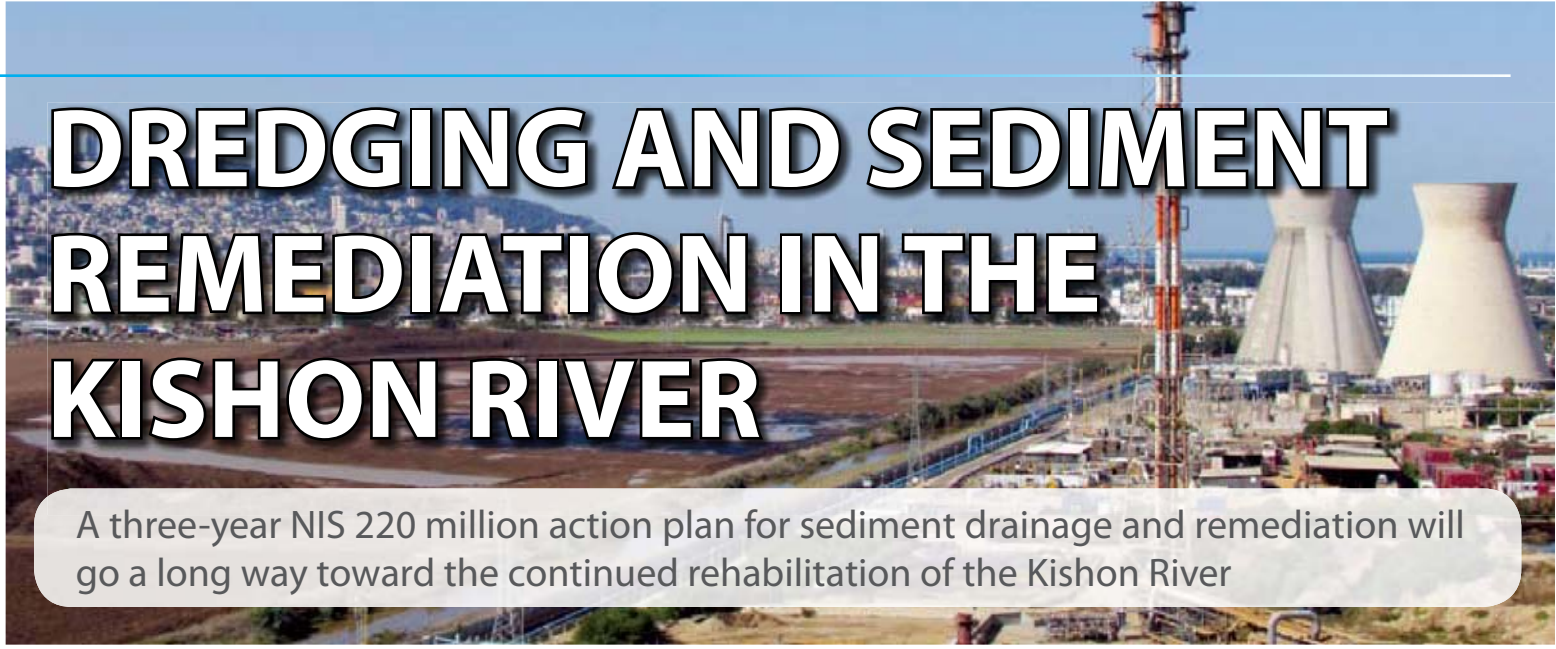


Kishon River meander/Photo: Alon ben Meir, Kishon River Authority

DREDGING AND SEDIMENT REMEDIATION IN THE KISHON RIVER

A three-year NIS 220 million action plan for sediment drainage and remediation will go a long way toward the continued rehabilitation of the Kishon River

Something good is happening in the Kishon River. The challenge of restoring "that ancient stream, the stream of Kishon," (Judges 5:21) to its former glory is being met. The revitalization of the river will not only restore life to the river but will provide flood protection and a green lung to residents of Israel's northern region.

The Kishon River, the second largest among Israel's coastal rivers, flows from Jenin in Samaria along some 70 kilometers, through the Jezreel Valley, until it empties into the sea at Haifa. The perennial river, which drains an area of 1,100 square kilometers, traverses the heart of the Haifa metropolitan area. However, the final seven kilometers downstream have been plagued by pollution which originated in both industrial effluents and municipal wastewater. Contamination transformed the once vital river into an open sewage canal which flows to Haifa Bay.

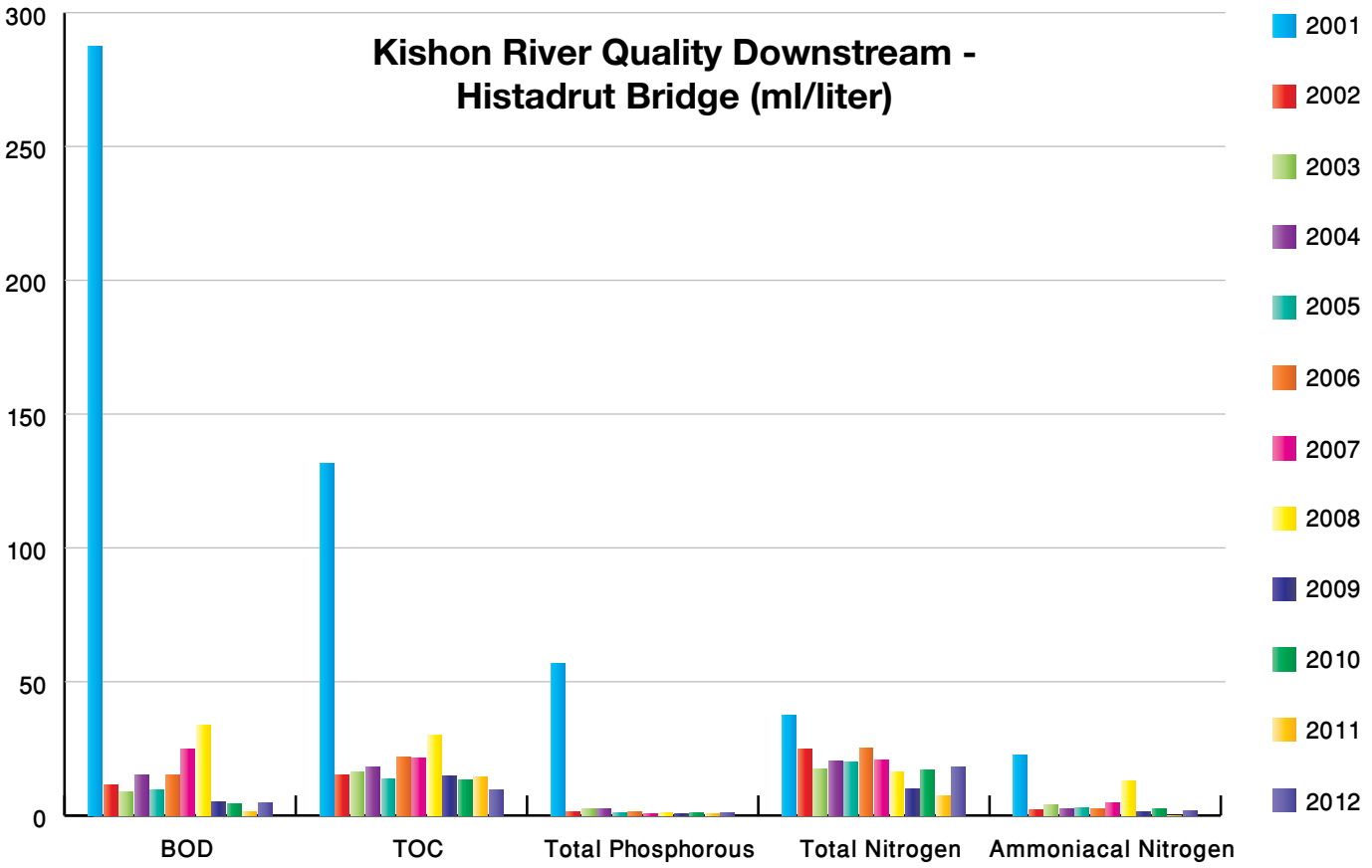
Contamination of the river began long ago. In the 1930s, the river which had previously boasted a rich biodiversity and served as a source of recreation, sailing and fishing, was first transformed into a receptacle for the pollutants discharged by the oil refineries and petrochemical plants that were established in Haifa Bay. Additional pollution reached the ailing river in the 1960s and 1970s with the discharge of effluents and wastewater from the chemical fertilizer industry and from the Haifa wastewater treatment plant. In parallel, pollutants, including heavy metals and hydrocarbons, sank to the river bottom, together with runoff from the Jezreel Valley. Sediment analyses found high concentrations of toxic pollutants, due to the indiscriminate discharge of industrial effluents into the river for decades. And, to make matters worse, dozens of veterans of an elite navy commando unit filed a legal suit against both industrial and government bodies in 2000, claiming health damages, including cancer, as a result of diver training in the polluted river.

Something clearly had to be done.

Revitalizing an Ailing River

Recognition of the dire quality of the Kishon River waters led to a number of initiatives over the past two decades: a Kishon River Authority was established by the Minister of Environmental Protection in 1994 to restore life to the river's water, ecological and planning surveys were carried out, and a master plan for the restoration of the river as the green lung for residents of the Haifa metropolitan area and of the country's north was approved by Israel's government in November 2001. Most importantly, in the late 1990s, the Ministry of Environmental Protection required the polluting industries and the Haifa wastewater treatment plant to apply for waste discharge permits under the Prevention of Sea Pollution by Land-Based Sources Law and to comply with the stringent conditions stipulated in the permits. The requirement was accompanied by an enforcement campaign against seven major industrial plants in the environs of the river. The plants could no longer discharge their effluents to the Kishon River with impunity.

The results were soon in coming. **By January of 2002, the pollution load from the industrial plants was drastically reduced by as much as 90%, with continuing improvements in subsequent years,** and the destructive acidity (with a pH below 2) which had characterized the river for dozens of years disappeared. The water column improved and ecological rehabilitation began. Fish, birds and soft-shelled turtles along with a rich variety of vegetation began to return to the river, including some twenty fish species and dozens of bird species. In fact, in the most recent cormorant count, some 4,385 cormorants were counted in the downstream section of the Kishon,



constituting the largest roosting site for these birds in Israel.

Sediment Pollution: A Growing Problem

However, the rehabilitation process was not complete. The toxic sediment at the river bottom – the result of its historic contamination – remained, impeding the rehabilitation of the ecosystem and preventing leisure and recreation activities in and around the river. At the same time, flooding during major winter rainstorms has continued to plague residents downstream due to the inability of the river channel to transport the required peak flow to the sea as a result of the sediment buildup. In fact, in an effort to increase the flow rates in the wake of devastating flooding events in the winter of 1991-92, the Kishon Drainage Authority dredged tens of thousands of cubic meters of contaminated sludge from the river bottom throughout the 1990s. The sludge was transferred to sealed temporary pools along the river bank and later disposed. However two of the pools have remained in the area until today. Clearly, despite the progress in dramatically reducing the pollution load to the river, two of the provisions of the 2001 master plan for river rehabilitation were yet to be fulfilled: the need to "dredge, pump, remove and treat the

Cormorants in the Kishon/Photo: Gil Gutman, Kishon River Authority

Kishon riverside park/Photo: Gil Gutman, Kishon River Authority

contaminated sludge in the riverbed" and to "remove the existing sludge ponds along the riverbanks."

To fulfill these provisions and find solutions, an expert committee was established in 2004, including representatives of academia, the Chief Scientist of the Ministry of Environmental Protection, and professionals from the Kishon River Authority and the Kishon Drainage and Rivers Authority. In accordance with the guidelines of the committee, the Kishon River Authority initiated a survey of the riverbed in 2006, which confirmed the polluted state of seven kilometers downstream by Total Petroleum Hydrocarbons (TPH) and heavy metals, especially cadmium and chromium. The contaminated layer, some 2.5 meters deep, generally correlated with the hydraulic profile needed for river regulation and flood protection. According to the calculations, some **400,000 cubic meters of material** had to be removed from the river bottom.

The Preferred Solution

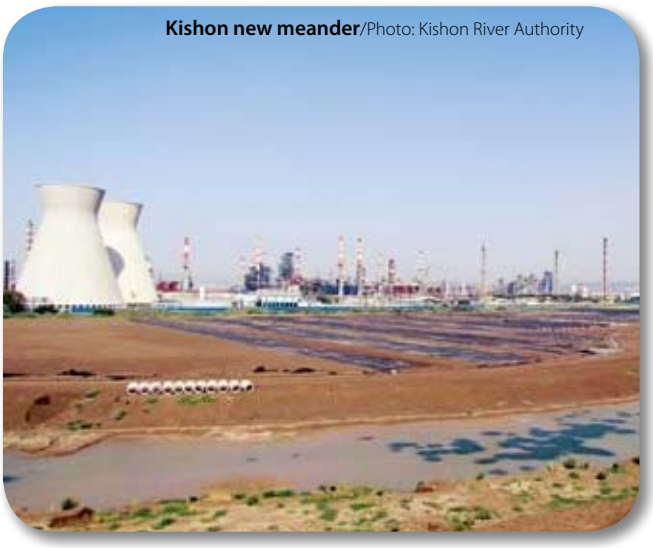
With the findings in hand, it was time to decide on the optimal method of treating the dredged material along with the 150,000 cubic meters of contaminated sludge which were still stored in the old sludge ponds on the riverbank. The expert committee set out to assess different alternatives: disposal, incineration, chemical stabilization, thermal treatment and biological treatment. **The preferred solution was bioremediation.** In order to verify the feasibility of the solution, a professional study tour to a number of European countries was organized in October 2010 with the participation of all stakeholders. The tour confirmed the feasibility of the proposed bioremediation solution and the project got a go-ahead. It was agreed that an international company with extensive experience would carry out the project and that a joint administration would manage and oversee the project at every stage.

At the end of the day, says Alon Zask, head of the Water and Streams Division at the Ministry of Environmental Protection, it was decided to "kill two birds with one stone" by integrating the solutions to two problems. On the one hand, a solution had to be found to the problem of the contaminated sediment which had accumulated on the riverbed, along with the clean sediment from the Jezreel Valley, in order to protect the river's ecosystem and to promote leisure and recreation by residents and visitors. On the other hand, a solution had to be found to the problem of the accumulated sediment, which blocked the channel, in order to prevent floods and their attendant damages to both human life and property.

The solution, which is expected to bring an end both to the drainage problem and to the environmental-ecological problem, is based on a master plan for the lower portion of the Kishon River which was proposed by the Kishon Drainage and Rivers Authority. In 2009, the Authority published a tender aimed at better understanding the problem and developing an effective plan for flood mitigation. The solution, developed by Yodfat Engineers, called for a number of steps:

- Diverting the Kishon channel into a new meander in its course just south of the petrochemical plants and creating dry open land to serve as the remediation site for the contaminated sediment;
- Dredging and removing the sediment from some seven kilometers in the downstream section of the Kishon riverbed;
- Mechanically dewatering the dredged sediment slurry;
- Treating the supernatant produced by the dewatering process prior to discharge back to the river;
- Mixing the dewatered sediment cake with the dried material from the old ponds and with clean, inert bulking agents to achieve sufficient porosity to allow the required aeration;
- Biologically treating the sediment in the aerated bio-piles to the required threshold levels;
- Piling the treated sediment into landscaped hills in preparation for their incorporation into a public park, based on the guidelines of a landscape architect.

Every aspect of the complex process – from laboratory analyses to tenders, from budgetary allocations to education and information - was carefully discussed



Kishon new meander/Photo: Kishon River Authority

by planning teams set up under the project administration. And what's more, decisions on the treatment method were based on a risk assessment conducted by an international expert and the entire biological treatment process was simulated and tested in overseas laboratories to ensure its feasibility prior to the decision to go ahead with the project.

Government Decision

On July 10, 2011, the Israel cabinet took a momentous decision. It approved a three-year NIS 220 million (about $60 million) action plan for the cleanup and rehabilitation of the Kishon River which was proposed by the Ministry of Environmental Protection, with budgetary allocations to be divided among the polluting industries, local authorities and government ministries.

Moving Forward

The Kishon dredging and sediment remediation project is divided into two implementation stages – diverting the Kishon, digging a meander and preparing the ground for the treatment site, and dredging and remediating the material on site in preparation for the development of a metropolitan park in the region.

Tenders were prepared for both stages of the work in June of 2012 – an earthworks tender targeted at an Israeli company and a dredging and treatment tender targeted at an international company. Work on the first phase of the project was inaugurated

Main Components of the Government Decision

1. *The **Ministry of Environmental Protection** will coordinate the activities necessary for implementation of the action plan by the different stakeholders including government ministries (Agriculture, Interior, Water and Energy and Finance), the Water Authority, the Kishon Drainage Authority, the Kishon River Authority, local authorities and industries.*
2. *The **Ministry of Agriculture** will assist the Ministry of Environmental Protection to implement the activities necessary within its authorities under the 1957 Drainage and Flood Control Law.*
3. *The **Minister of Environmental Protection** will appoint an interministerial administration for implementing the action plan including representatives of the following: Ministry of Environmental Protection (chair), Ministry of Agriculture, Ministry of Water and Energy, Water Authority, Kishon River Authority, Kishon Drainage Authority, Haifa Municipality, Zevulun Regional Council, Nesher Municipality, Manufacturers Association, and the umbrella organization of environmental organizations. The administration will manage the different aspects of the project including policy on information management, priorities, oversight of progress, and input in major decision points along the way.*
4. *The **Kishon Drainage Authority** will implement the plan on behalf of the administration, in cooperation with the Ministry of Agriculture and the Water Authority. A separate budget will be allocated for this purpose within the framework of the Drainage Authority.*
5. *The **Kishon River Authority** will implement the spokesmanship, communication and information aspects of the project on behalf of the administration, by means of a separate budget which will be allocated for this purpose.*
6. *Up to **NIS 220 million** will be allocated for the project according to the following division:*
   - *NIS 60 million (NIS 15 million over a four year period) will be transferred to the Ministry of Environmental Protection for the treatment of the contaminated sediment from the Kishon River bottom;*
   - *Up to NIS 30 million will be allocated from the Maintenance of Cleanliness Fund, subject to the approval of its administration, for the development of alternatives to in-situ landfilling of the waste and for promoting its reuse by the partner industries and local authorities.*
   - *Matching funds will be allocated by non-governmental bodies, with their agreement:*
   - *NIS 120 million from industrial plants which discharged effluents to the sea through the Kishon River;*
   - *NIS 20 million from local authorities which discharged effluents to the sea through the Kishon River and whose wastewater is treated in the Haifa Wastewater Treatment Plant.*

in September 2012 with completion scheduled for mid-2013. During this phase, a 1.5 kilometer portion of the Kishon River route was diverted and a new river meander was created. The resulting dry area between the old and new channel near the oil refineries, about 25 hectares in size, is already being prepared to serve as a sediment treatment area, including its covering by HDPE linings. And at every step along the way, efforts will focus on ensuring that the entire process is implemented in the most environmentally responsible manner.

The dredging and remediation project will be carried out by Canada's **EnGlobe**, a major environmental services company with extensive experience in the treatment of contaminated soils, which won the tender. The tender itself laid out the extensive and unique expertise required for the project: an understanding of drainage and flood control, dredging of a river bed, contaminated sediment bioremediation, return of treated water to the river and landscaping of the treated soil. In August of 2013, special EnGlobe barges are expected to begin dredging the sediment with the expectation that by 2015, the treatment of more than half a million cubic meters of sediment will be completed, paving the way for the site's transformation into a public park.

This is a flagship project, says Dr. Yeshayahu Bar-Or, Deputy Director General for Natural Resources at the Ministry of Environmental Protection, who heads the joint administration committee for the

Pumping in the Kishon River/Photo: Gil Gutman, Kishon River Authority

Toward Restoration of the Kishon River: A Revolution

Sharon Nissim, Director of the Kishon River Authority

The Kishon River was long branded Israel's most polluted river – a symbol of pollution. However, over the past decade the lifeless river has gradually been revitalized. **The full recovery of the river is a complex process which includes three main components:** stopping the pollution from industrial, sanitary and agricultural sources; cleaning up the river bed and treating the contaminated sediment; and supplying water to the river in the quantity and quality needed for restoration.

Major progress has been made in stopping the discharge of industrial effluents to the river, but more is necessary in order to truly restore river quality. Therefore, industrial plants are now required to comply with upgraded effluents quality standards which set higher treatment levels for effluents discharged to rivers. At the same time, there is no doubt that the sediment remediation project will play a vital role in rehabilitating the river and its environs. Similarly, a water plan for the restoration of the river, prepared by the Kishon River Authority and the Water Authority, has been completed, which will see the release of an additional four million cubic meters of water per year to the river from decommissioned wells at the edge of the Jezreel Valley together with the release of spring water which is currently used for agriculture. The implementation of all three elements will rehabilitate the river and its habitats, restore its flow, conserve its unique natural assets and allow it to function as an open public area for the benefit of the public.

The Kishon River Authority will continue to monitor the Kishon's water quality and will invest major efforts in ecological rehabilitation alongside park development. One initiative will see the establishment of a 90 hectare park downstream, where the last remnant of the Kishon salt marshes will be preserved in the southern part, while the northern area will be developed for leisure, recreation and sport for the benefit of the public.

The wide gamut of projects now taking place in the Kishon River represents a true revolution in the restoration of the river.

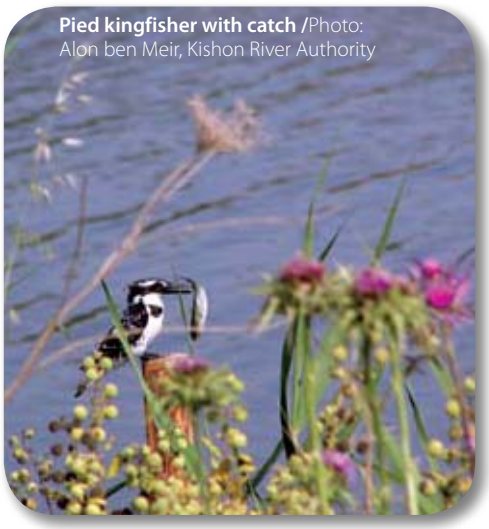
The Kishon Sediment Dredging and Remediation Project: A Pioneering Project

Haim Hemi, Director General, Kishon Drainage and Rivers Authority

Today's drainage authorities view rivers not only as drainage channels but also as ecological corridors in which pollution must be prevented, water quality maintained and the river environment developed for public benefit. They have therefore been redefined as drainage and river authorities, with a river basin management approach.

The Kishon dredging and sediment remediation project, which was initiated by the Kishon Drainage and Rivers Authority, is a pioneering project in Israel. It will solve the drainage problem in the river which was responsible for devastating floods over the years while providing for a cleaner Kishon in the future. Our solution will not only deepen the river to facilitate drainage but will provide an environmental solution to the contaminated sediment. The polluted sediment will not be transported elsewhere. The air will not be polluted by incineration of the sediment. Rather, we have opted for on-site bioremediation of the contaminated sediment as practiced in advanced countries worldwide. We did not invent the wheel, but we used the experience and expertise which exists in advanced countries worldwide. The project will be a test case. I believe that its success will facilitate the treatment of contaminated soils elsewhere in the country using similar methods. It will demonstrate that soils polluted by industry can be cleaned up and restored to the public.

It is especially important that this groundbreaking project is being implemented in the Kishon River, with its history of pollution, for the benefit of the populace of the Haifa metropolitan area, Israel's northern region and Israel as a whole. It is not easy to move from planning to implementation, but we are already in the midst of the project. The participation of government, local authorities and industry in funding the project makes an important social statement: the polluter must pay. And due to this cooperation, we will hopefully witness the transformation of the treatment site into a metropolitan park which will be inaugurated by 2015.



Pied kingfisher with catch /Photo: Alon ben Meir, Kishon River Authority

project. While the process was long and exhaustive, including surveys, risk assessment, laboratory analyses, professional tours abroad to review alternatives, and much more, Dr. Bar-Or is certain that at the end of the line, "the treated material will be transformed into landscaped hills and mounds which will make up part of the planned Haifa metropolitan park, and will provide the public with two banks in which to enjoy the river instead of only one bank today". Most importantly, he continues, "we will be returning the eroded soil from the Jezreel Valley to the public. This eroded soil was contaminated by the industrial effluents and wastewater which were discharged to the river for years. We will now dredge it, treat it, and return it to the public in a safe and aesthetic manner."

Significantly, under the responsibility of the Kishon River Authority, public participation and information constitute an important element in the project. A dedicated website, www.cleankishon.co.il was created to acquaint the public with the project and a special event was held in March 2012, with the participation of the Minister of Environmental Protection and other stakeholders, to present information about the project and invite questions and comments. Major efforts will be invested throughout the lifetime of the project in changing the public's perception of the river and raising public awareness of the river's reawakening, with its huge potential for tourism and recreation. The challenge will be to change the image of the river from a river of death and pollution to a river of life and vitality.

With the completion of the landmark project, drainage and flood prevention in the Haifa region will be assured, water quality in the river will continue to improve, life will return to what was not long ago a dead river, and new opportunities for leisure, sport and recreation will be afforded to the residents of the Haifa metropolitan area. **A symbol of pollution will be transformed into a symbol of life and well-being.**