Restoration of the Besor-Hebron-Be'er Sheva Stream

A Transboundary Project Supported by the JNF Parsons Water Fund

Center for Transboundary Water Management, Arava Institute for Environmental Studies

Principle Investigators: Dr. Clive Lipchin, Eng. Shira Kronich

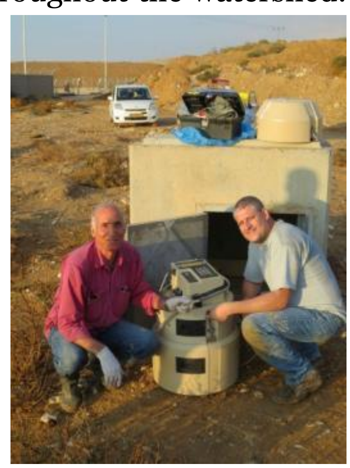
Second Year Interim Report (January 1st, 2013-August 31st, 2013)

Table of Contents

Introduction

JNF CEO, Russell Robinson, explaining Blueprint: Negev to a group of Arizona water managers on Pipes Bridge, Be'er Sheva stream.

Fulfilling its dual mission of developing Israel and improving the environment, the JNF has worked tirelessly to restore the Besor-Hebron-Be'er Sheva Stream, a section of which runs through the center of Be'er Sheva. As a part of JNF's Blueprint Negev, the Be'er Sheva river parkway, seeks to accomplish a service for a much larger region in the Negev that also relies on a safe and clean Besor-Hebron-Be'er Sheva Stream. This effort has the added feature of incorporating transboundary environmental protection, bringing together parties from both Israel and the Palestinian Authority. To fulfill these goals, the JNF Parsons Water Fund has joined with the Center for Transboundary Water Management at the Arava Institute for Environmental Studies, which has a long history in Israel of seeking practical solutions to environmental problems with diverse voices and a regional focus. While the JNF has made strides in community outreach and infrastructure projects within Be'er Sheva, the Center for Transboundary Water Management (CTWM) is researching the broader causes of pollution at a watershed level and using state-of-the-art hydrological monitors and Geographic Information Systems (GIS) and computer mapping software to evaluate water quantity and quality throughout the watershed. This baseline data gathering activity is necessary before any restoration efforts can begin. The watershed based approach fulfills the dual aims of restoring and rehabilitating the entire stream from its source in the southern West Bank to its terminus at the Mediterranean Sea and for the establishment of a viable and flourishing Be'er Sheva river park for which the stream is the lynchpin for success.



Dr. Lipchin and Yehoshua Ratzon from BGU installing our first water quality and quantity monitoring station.

This document gives an update on the progress we have made for the period January 1st- August 31st, 2013. To date, we have completed our historical data collection of previous water quantity and quality data, socio-economic information on water-use, population, and poverty in affected communities, sources of pollution and regional geographic maps. These data and associated maps have now been uploaded to a website. The website will serve as the "go-to" point for all project information and will serve as a public source of information for all stakeholders interested in the restoration and rehabilitation of the

Besor-Hebron-Be'er Sheva stream. The address for the website is: http://besormonitoring.wordpress.com/. We have also completed our first round of water quality monitoring (the results are presented below). At CTWM, the project currently involves two Israelis and one Palestinian.

Background

This research fits within JNF's wider development plan; Blueprint: Negev. The city of Be'er Sheva, the capital of the Negev, is a central focus of Blueprint: Negev. Any effort to bring more Israeli citizens to the region and to promote development of the Negev must focus on its largest city. Ten years into the project, the JNF has made significant headway in improving the infrastructure and physical outlook of the city, which has had a large impact on Be'er Sheva's image to both the region and the entire country. The centerpiece has been the beautification of the Be'er Sheva river parkway. Looking to San Antonio as an example, the JNF has sought to make the park a hub for the city's residential and commercial development. Trash and debris have been removed, landscaping is in progress, and soon recycled water will flow within the stream year around.

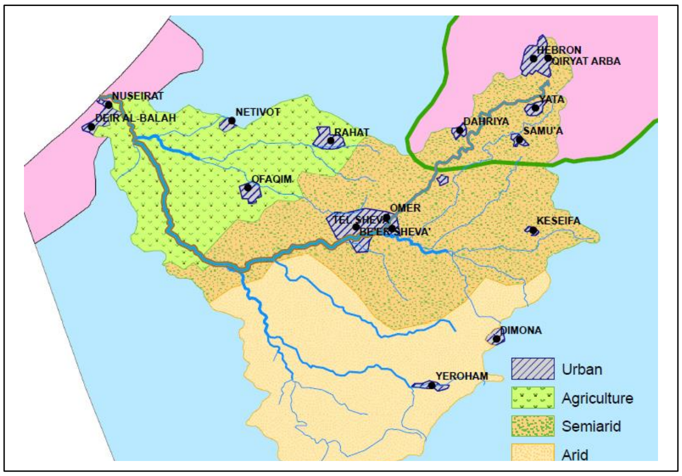
Untreated sewage flowing in the stream at Umm Batin, a Bedouin village northeast of Be'er Sheva

However, the Be'er Sheva stream does not operate in isolation. Water already does flow through the city permanently because upstream, untreated wastewater continuously pours into the section of the stream originating in the West Bank near Hebron. This sewage flows through several Palestinian communities with limited wastewater infrastructure as well as active stone cutting and olive oil industries that do not treat the wastewater from these industries. This pollution crosses into Israel at the Green Line crossing north of Meitar, where it is partially treated. This treatment however, is minimal, as Israel cannot use this treated wastewater which legally belongs to the Palestinian Authority and therefore all Israel can do is return the wastewater to the stream. By the time the water enters Be'er Sheva it has picked up additional untreated wastewater from the surrounding Bedouin villages and towns, and by the time the water reaches Be'er Sheva it is a constant sewage flow that fails to match the beauty of the park that is being created around it.

Treating this wastewater effectively and efficiently is the impetus for this project, which takes the local conditions of the stream and expands the view to tackle the issue at the regional and watershed level, in order to find a more permanent solution for the entire stream's restoration and

Hebron-Besor-Be'er Sheva Watershed in Israel and the PA

not just the section flowing through the Be'er Sheva river park. Our research looks at the entire Hebron-Besor-Be'er Sheva watershed, meaning the region where any flowing water ultimately ends up in the stream and, eventually, the Mediterranean Sea via Gaza. This region is roughly triangular, defined by Hebron in the northeast, Sde Boqer in the south, and Gaza in the west. While water freely flows across hostile political borders, the management of this transboundary watershed remains fractured. The diverse group of settlements and industry along the stream all contribute to its pollution, yet they blame each other and rarely coordinate, simply making the situation worse for all.

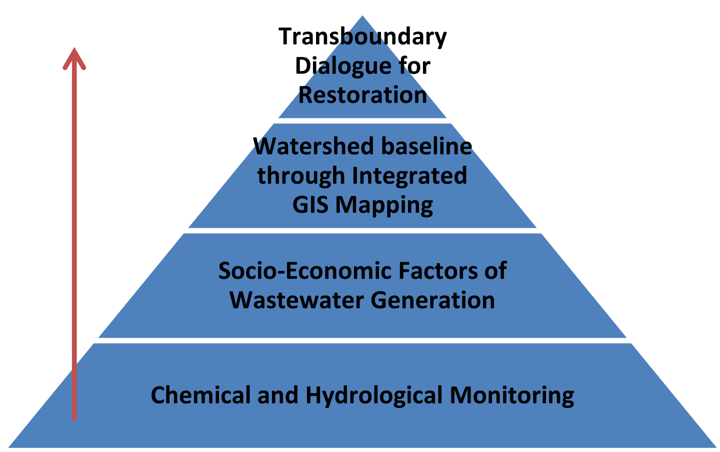


The above map shows the complexity of the watershed in terms of three political entities (West Bank, Israel and Gaza); urban communities (Israeli, Palestinian and Bedouin) and land-use. Untreated wastewater enters the watershed from all three sources.

Both the JNF Parsons Water Fund and the Arava Institute have a commitment to transboundary solutions to regional environmental problems. This is why at CTWM we are approaching this project from a watershed and systems-based view. The Jewish communities in the Negev cannot be separated from the Bedouin and Palestinians upstream. The current body of research in the area often ignores this and only looks at water quality from one side of the Green Line or the other, or may only look at physical factors while ignoring the underlying political tensions which have led to the current situation. We seek to understand the entire area that may be contributing to pollution in the watershed from both hydrological and socio-economic factors. This will give us the knowledgeable authority to begin a transboundary dialogue for sustainable restoration of the stream, for the benefit of not only Be’er Sheva and the planned Be'er Sheva River Park, but also the Negev and the entire region.

Our Work

Our research team is particularly well situated to handle this project. Dr. Clive Lipchin has worked as a water management expert in Israel for over ten years and acted as a senior editor for two books on regional transboundary water management in the Middle East. Shira Kronich is a native of the Negev region and has degrees in both environmental engineering and development policy.



Both currently live in and around Be'er Sheva. As respective director and associate director of CTWM, they have recruited a diverse group of students and interns, only possible at the Arava Institute, to work on the project and bring together all of its complex elements.

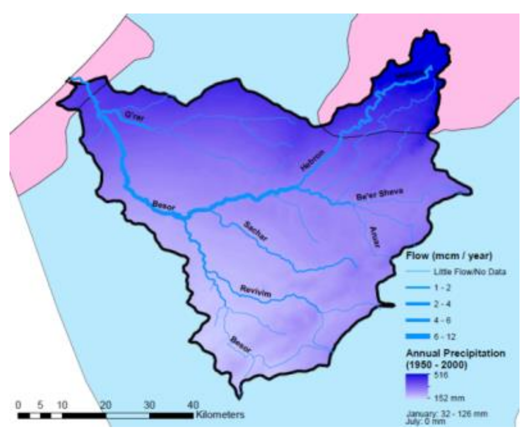
The Arava Institute is also working together on this project with the Department of Geography at Ben-Gurion University, the Zuckerburg Water Resources Institute at the Jacob Blaustein Institute for Desert Research, the Israel Water and Sewerage Authority and the Besor-Shiqma River Authority.

Installation process for a monitoring station

In collaboration with the Department of Geography at Ben-Gurion University and the Besor-Shiqma River Authority, we have begun to establish a joint effort to determine the water quality in the stream around Be'er Sheva. When completed, three advanced hydrological monitoring stations will collect data along the Hebron-Be'er Sheva stream. These stations will operate continuously, providing water quantiy and quality data in real time. The first station has already been installed, just west of Be'er Sheva and outside of the urban area. The other two stations will be placed on the Hebron and Be'er Sheva streams before they meet east of the city. The Be'er Sheva stream is considered much less polluted than the Hebron stream. Our hypothesis is that the stream will show less pollution west of the city than east, as the cleaner waters of the Be'er Sheva stream will dillute the more polluted Hebron stream.

In addition to our analysis of the physical aspects of the watershed, we are also collecting socio-economic information for communities in the entire watershed, both Israeli and Palestinian communities. The AIES has recruited a Palestinian student from East Jerusalem, Leila Hashweh as the recipient of the JNF Parsons Scholarship for graduate studies in water management. Leila has begun her studies working on this project towards an M.Sc. in Hydrology and Water Resources at Ben-Gurion University.

To establish a baseline of pollution in the watershed, we are building a geographic database of all the above factors to integrate them into a single map. We are using ArcGIS Editor 10.0, which is state-of-the-art software and the industry standard. The program allows the input of layers of maps containing different data to interact with one another such that patterns can be determined on a spatial basis. Thus far, we have generated digital maps for hydrological factors such as water flow and precipitation, human factors such as settlements and wastewater treatment facilities, and



GIS map of hydrological factors in the watershed geographic factors such as landuse and elevation. The benefit of putting all of these maps into a single digital database is that we can juxtapose maps of different types in order to generate patterns of physical and human interaction. For example, we can easily calculate and display how many of these factors change over time, or show how certain socio-economic characteristics may line up geographically with certain types of water pollution. We have used the tools of the software to build a website, as easy to use as mapquest, to distribute the information to the public. The website will be the basis for the broader and long-term effort of regional watershed restoration. The address for the website is: http://besormonitoring.wordpress.com/.

Results

This project is currently ongoing, and the research has not yet reached the stage where any conclusive results about the state of the watershed or specific recommendations about its restoration can be reported. That being said, we have made significant progress in the data gathering phase of the project.

Water Quality Monitoring Results

To rehabilitate streams it is necessary to begin by first identifying and then removing pollutant sources. Pollutant sources can be point-sources, that is the pollution flows directly into the stream or they can be non-point sources where the pollution flows indirectly into the stream. Non-point sources of pollution are more difficult to identify and regulate than point sources. Nevertheless, over the last 15 years in Israel non-point pollution loads, reaching streams, have decreased by 50-80%. Similarly, point source pollution sites have decreased from 130 sources to 80 sources. This is largely due to daily on site supervision, inspection and enforcement. The issue of pollution prevention in streams has gained great momentum over the last few years. This is due in part to the Inbar effluent (wastewater) quality regulations that have vastly improved the effluents discharged into streams.

As part of the continued commitment to improving wastewater recovery and reuse, in 2005 a draft set of new wastewater reuse standards was published containing 38 updated water quality parameters. These are known locally as the “Inbar” standards after the inter-ministerial committee chairman, Dr. Yossi Inbar, who oversaw the standard review. These standards were adopted by the Israel Ministry of Environmental Protection and the Ministrty of Health in 2007. This new policy requires that all future wastewater treatment plants would be designed to produce waste water at a quality that allows for “unlimited irrigation or discharge to streams” while existing wastewater treatment plants must be upgraded to abide by the new regulations.

The purpose of the Inbar regulations is to protect public health, prevent pollution of water resources, from sewage effluents, and to enable the utilization of wastewater recovery for safe discharge back into streams whilst protecting the environment, including ecosystems and biodiversity, soil and crops. These stringent standards place Israel as a leader among developed nations, in terms of environmental protection, focusing on the prevention of pollution entering water resources. Israel's achievments in wastewater management were recognized by the UN World Water Development Report presented in 2010.

However, despite these impressive gains by Israel all of the streams that flow westward to the Mediterranean have their source in the West Bank. The streams are therefore transboundary in nature incorporating Israel and the Palestinian Authority. Israel does not have the jurisdiction to enforce the Inbar standards in the Palestinian Authority and the wastewater infrastructure in the Palestinian Authority is woefully inadequate. The result is that large amounts of point and non-point source pollution enters the streams from the West Bank flowing across the Green Line into Israel; a case in point being the Besor-Hebron-Be'er Sheva stream. The ongoing conflict between Israel and the Palestinians does not allow for the adoption of a watershed based approach to stream management with the result that pollution continues to threaten these streams despite Israel's impressive achievements. This project is the first of its kind to adopt a watershed-based approach to stream restoration with water quality monitoring occuring throughout the watershed and we have used the Inbar standards as our baseline to determine the pollution loading in the Besor-Hebron-Be'er Sheva stream. This is because the Inbar regulations provide unprecedented number of different quality parameters which set a maximum allowable discharge limit. In addition, the regulations impose various obligations, including: monitoring and sampling plans to control wastewater effluent discharge, recording and reporting requirements for effluent quality, increased transparency to the public and publications of monitoring results. It is our hope that this project will also lead to the adoption of the Inbar standards by the Palestinian Authority.

We chose four water quality monitoring sites. Two are in the West Bank and two are in Israel. The first site is on the outskirts of the city of Hebron, the largest city in the West Bank as well as the largest populated city in the watershed; the second site is near to the Green Line in the southern West Bank; the third site is at the entrance of the Bedouin town Tel Sheva which is just east of Be'er Sheva and the final site is west of Be'er Sheva near to kibbutz Hatzerim. The selection of these sites was determined to both assess water quality in the Palestinian versus Israeli areas of the watershed as well as to assess water quality before and after the Be'er Sheva River park. The monitoring took place during June 2013.

Site name	Coordinates		Characteristics	Picture
	North	East		
Upper catchment – West Bank, outskirts of Hebron	"34 '31 26	"16 '35 01	Water cloudy, lot of sediment, stream bank chalky	
Meitar Check point – southern West Bank	"45 '31 19	"28 '34 55	Sediments mainly rocks, stream bank, chalky, water not transparent, no mosquitoes	
Tel Sheva, east of Be'er Sheva	"50 '31 14	"17 '34 50	Area strewn with garbage	
Near kibbutz Hatzerim, west of Be'er Sheva	"37 '31 13	"02 '34 45	Larvae/ mosquitoes in the water	

Parameter	Unit	Inbar Standards - discharge to streams	Upper catchment – West Bank, outskirts of Hebron	Meitar Check point – southern West Bank	Tel Sheva, east of Be'er Sheva	Near kibbutz Hatzerim, west of Be'er Sheva
pH		8.5	7.91	8.19	8.31	8.67
Electrical Conductivity (EC)	mS	2.2	2.19	2.35	2.40	2.24
Chlorine (Cl)	mg/L	250	247	252	348	411
Bromine (Br)	mg/L	0.4	0	0	0	0
Sodium (Na)	mg/L	150	196	208	287	285
Phosphate (PO4)	mg/L	5	0.877	1.092	1.139	0.969
Chemical Oxygen Demand (COD)	mg O2/L	100	1210	1230	186	170
Total Suspended Solids (TSS)	mg/L	10	1260	2721	62.0	63.0
Ammonium (NH4)	mg/L	20	2.860	2.965	0.760	0.550
Fluorine (F)	mg/L	2	35.8	18.6	0	0.73

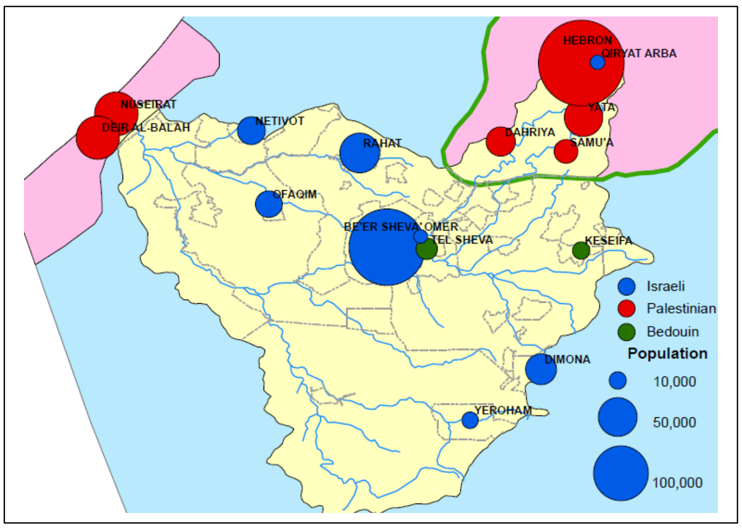
The above table indicates the results of the water quality monitoring. As can be seen from the highlighted rows there is significant pollution throughout the watershed specifically in terms of Sodium, Chemical Oxygen Demand and Total Suspended Solids. These parameters are well above the Inbar standards for wastewater discharge to streams and indicate the low quality of the water in the stream. The high numbers for Sodium (NA) is an indication of agricultural runoff from farms due to high rates of fertilizer and pesticide use. As can be seen from the table these numbers are higher in Israel than in the West Bank due to the more intensive agriculture and irrigation in Israel. Chemical Oxygen Demand (COD) is by orders of magnitude much higher in the West Bank than in Israel. The COD water quality parameter is commonly used to indirectly measure the amount of organic compounds in water. The data indicate the high rate of untreated wastwater being produced in the West Bank that is draining into the watershed. The primary cause here is most likely the stone cutting, leather tanning and olive oil industries in the Hebron region (see below for further discussion on this issue). Total Suspended Solids (TSS) is a measure of the amount of suspended particles in the water. Algae, suspended sediment, and organic matter particles can cloud the water making it more turbid. Suspended particles diffuse sunlight and absorb heat. This can increase temperature and reduce light available for algal photosynthesis. If the turbidity is caused by suspended sediment, it can be an indicator of erosion, either natural or man-made. Suspended sediments can clog the gills of fish. Once the sediment settles, it can foul gravel beds and smother fish eggs and benthic insects. The sediment can also carry pathogens, pollutants and nutrients. Like that for COD the TSS data are by orders of magnitude much higher in the West Bank further indicating the high level of untreated wastewater being generated from industrial activities in the West Bank.

In summary the table indicates a complex situation of point and non-point source pollution throughout the watershed, both in Israel and the West Bank. Very few of the parameters meet the Inbar standards reflecting a high level of pollution throughout the Besor-

Hebron-Be'er Sheva stream, including the section of the stream flowing through the Be'er Sheva River park. In some cases the data are orders of magnitute beyond what the Inbar standards require. These data are an essential step for understanding the water management situation in the watershed and for providing a base line for restoration. Further water quality monitoring will be undertaken throughout the study that will include a comparison of summer low flow season with the winter high flow season.

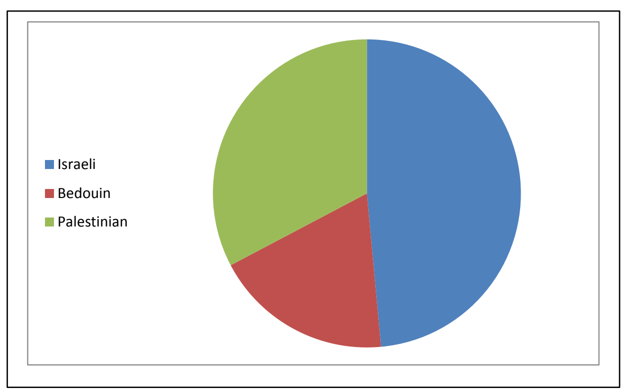
Socioeconomic Characterisation of the Watershed

There are three main population groups in the Besor-Hebron-Be'er Sheva watershed. These are Israeli, Bedouin and Palestinian. The following map shows the spatial distribution of these populations groups within the watershed. What can be clearly seen from the map is that despite most of the watershed being in Israel more Palestinians are living within the watershed than Israelis when one considers both the Palestinian population in the West Bank and Gaza.

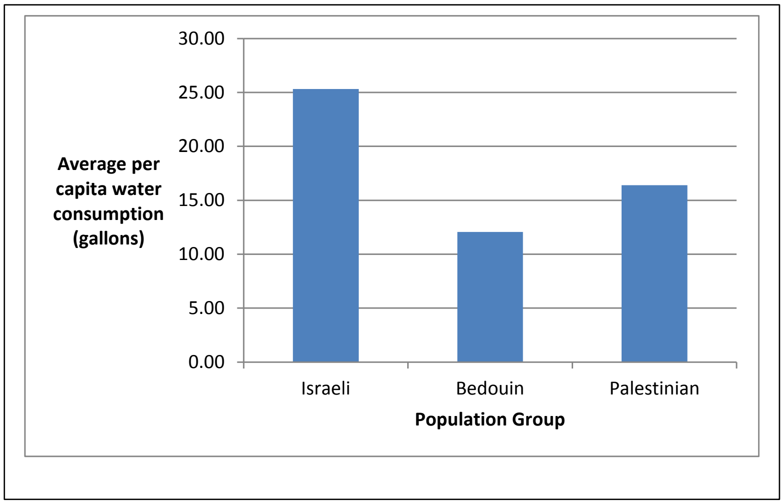


The smallest population group is the Bedouin group, indicated by green in the map.

The pie graph below shows the population distribution (2010 census data) without the Palestinian population group in Gaza and what can now be seen is that the Israeli group makes up almost half of the population in the watershed.



The bar graph below shows the differences in water consumption (2010 census data) between Israelis, Palestinians and Bedouins in the watershed. What can be seen is that the Bedouin population consumes the least amount of water (12 gallons/capita), Israelis consume the most with (25 gallons/capita) and the Palestinians are in the middle with 16 gallons per capita. The reasons for these differences in water consumption need to be studied further as they reflect differences in socioeconomic status such as employment, inome, family size etc. as well as in water infrastructure. An indepth socioeconomic analysis of the communties in the watershed is now underway.



The table below shows a breakdown of population data and water data for the main communities in the watershed. The table begins to reveal the complexity of the socioeconimc context by which water is consumed in the watershed. Neveretheless this kind of anaysis is essential for a restoration strategy that seeks to involve all stakeholders in the process of restoration and rehabilitation of the watershed. Without the involvment and "buy-in" of stakeholders in the process a successful restoration strategy will prove difficult. As this project continues further socioeconimc analysis will be carried out such that a balanced participatory process by all stakeholders in the process can be achieved. The data below present 2010 census data that were gathered from the Israeli Bureau of Statistics and the Palestinian Bureau of Statistics. The total population in the Besor-Hebron-Be'er Sheva watershed in 2010 was 647,167.

Community	Type	Total Population (Thousands)	Total Population	Total Water Consumption (Thousand cubic meters)	Per capita Water Consumption (Thousand cubic meters)	Per capita Water Consumption (liters)	Per capita Water Consumption (gallons)
Chura	Bedouin	17.5	17,500.00	554.00	0.03	31.66	8.36
Keseifa	Bedouin	17.4	17,400.00	615.00	0.04	35.34	9.34
Rahat	Bedouin	53.1	53,100.00	2,089.00	0.04	39.34	10.39
Tel Sheva	Bedouin	15.7	15,700.00	732.00	0.05	46.62	12.32
Lakiya	Bedouin	9.9	9,900.00	564.00	0.06	56.97	15.05
Segev Shalom	Bedouin	7.7	7,700.00	493.00	0.06	64.03	16.91
Netivot	Israeli	27.5	27,500.00	1,880.00	0.07	68.36	18.06
Dimona	Israeli	32.6	32,600.00	2,556.00	0.08	78.40	20.71
Kiryat Arba	Israeli	7.2	7,200.00	583.00	0.08	80.97	21.39
Be'er Sheva	Israeli	195.4	195,400.00	16,581.00	0.08	84.86	22.42
Ofakim	Israeli	24.2	24,200.00	2,149.00	0.09	88.80	23.46
Lehavim	Israeli	5.9	5,900.00	546.00	0.09	92.54	24.45
Meitar	Israeli	6.4	6,400.00	634.00	0.10	99.06	26.17
Yeruham	Israeli	8.3	8,300.00	905.00	0.11	109.04	28.80
Omer	Israeli	6.6	6,600.00	1,059.00	0.16	160.45	42.39
Al Ubeidiya	Palestinian	10.753	10,753.00	NA	0.06	56.00	14.79
Der Salah	Palestinian	3.373	3,373.00	NA	0.06	59.50	15.72
Bet Sahour	Palestinian	12.367	12,367.00	NA	0.06	60.00	15.85
Halhul	Palestinian	22.128	22,128.00	NA	0.07	65.00	17.17
Hebron	Palestinian	163.146	163,146.00	NA	0.07	70.00	18.49
Total		647.167	647,167.00				

Description of Pollution Sources in the West Bank

Some of the most problematic sources of non-point source pollution that flows into the Besor-Hebron-Be'er Sheva watershed take place in the upper catchment in the West Bank in and around the city of Hebron. This region is known for three main sources of industry that all produce problemmatic wastewater. These industries are stone cutting, leather tanning and olive oil production. Due to the serious lack of an efficient wastewater treatment infrastructure these industrial wastewater streams drain into the Besor-Hebron-Be'er Sheva watershed contributing significanlty to its degradation. This study has begun to characterize these non-point source pollution sources so that solutions may be found to treat the wastewater before it enters the watershed.

The table below describes the typical characteristics of raw wastewater in Hebron. As can be seen from the table the average value of most of the water quality parameters is greater by orders of magnitude than what is normally expected according to the typical value. (Source of data: Potential Reuse of Treated Wastewater for Irrigation in Hebron District, Imad Al-Zeer and Issam Al-Khatib. In Proceedings of the first symposium on wastewater reclamation and reuse for Water Demand Management in Palestine (pg. 87)).

Characteristics of raw wasterwater in Hebron City			
Parameter	**Unit**	**Average Value**	**Typical Value**
pH	Su	6	6.5 - 7.5
COD	mg/l	2648	200 - 780
BOD	mg/l	1221	100 - 400
TSS	mg/l	10936	120 - 360
TDS	mg/l	3549	250 - 800
Nitrate	mg/l	<10	0 - Small
NHs-N	mg/l	177	12 - 50
TKM	mg/l	229	20 - 200
SO4	mg/l	376	100 - 400
P	mg/l	48	43952
Alkalinity	mg/l	514	50 - 200
Cl	mg/l	5722	30 - 100

Currently between 22,730-25,150 m^3/day of wastewater is generated in the city of Hebron with most of this not being treated and eventaully ending up in the Besor-Hebron-Be'er Sheva watershed (Source of data: Potential Reuse of Treated Wastewater for Irrigation in Hebron District, Imad Al-Zeer and Issam Al-Khatib. In Proceedings of the first symposium on wastewater reclamation and reuse for Water Demand Management in Palestine (pg. 88)).

Olive Oil Production in the Palestinian Authority

Olive oil production is a major contribution to the national income as well as a long-standing tradition in the Palestinian Authority. The annual average production of olive fruits and olive oil reaches 120 and 24 thousand tons respectively. More than 200 olive-mills are functioning in the West Bank generating about 200 thousand m^3 per year of OIive-Mill Waste (OMW) (Subuh, 1999).

Different types of effluents are generated by olive-mills. The relatively low or non-polluted effluents from the olive washing process and the extremely high organic loaded aqueous waste generated from the oil extraction process (Shaheen, 2007). Generally, extraction of oil is carried out either by continuous or discontinuous processes, and both methods generate wastewater consisting of the water contained in olive fruit, the added water from washing the fruit, and the centrifugation process. With the continuous process, the average amount of OMW is 1.2-1.8 m^3 /ton of olives, while with the discontinuous process it is only 0.4 - 0.5 m^3 /ton of olives (Khatib, 2009a). In general, OMW produced in discontinuous mills contains a higher organic load than those generated in continuous mills.

The color of wastewater produced in both methods is usually black or reddish black due to the presence of phenolic compounds. The typical composition of OMW includes water (83%), organic compounds (15%), and inorganic chemicals (2%). The organic load in OMW is considered one of the highest of all concentrated effluents, being 100-150 times higher than the organic load of domestic wastewater. OMW is acidic, and contains a high concentration of total suspended solids (TSS), total dissolved solids (TDS), phenols, and other organic matter. The organic content is characterized by high levels of chemical oxygen demand (COD), biochemical oxygen demand (BOD), and a very high concentration of fat, oil, and grease (FOG). The BOD and COD maximum concentrations in OMW reach 100,000 and 220,000 mg/L, respectively. The OMW consists of toxic organic materials such as sugars, tannins, polyphenols, polyalcohols, pectins, proteins, and lipids (Kiritsakis, 1991). OMW is a major pollutant because of its high organic load and its high content of phytotoxic and antibacterial phenolic substances, which resist biological degradation.

Olive farms cover almost half of the cultivated area in the West Bank, and oil production contributes around 28.7% of the agriculture domestic income. The operations of these mills are split between modern and traditional models. Naturally, olive mills are generally situated close to olive orchards. (Khatib, 2009a).

Recent results published by PCBS 2008, show that there are 296 olive presses in the Palestinian Territories, of which, 264 are operating, while 32 are temporarily closed. The distribution of operating presses by automation level is as follow: 224 full automatic, 40 half automatic and traditional presses. Operating presses are concentrated in the North of the West Bank, especially in Jenin and Tubas, and Nablus Governorates. In Hebron, there are about 28 Automatic Olive Presses and no traditional or Half-Presses (El-Hamouz, 2010). The total quantity of pressed olives in 2008 was 76,387.8 tons, of which the quantity of extracted oil was 17,583.9 tons. Results show that most of the olive presses used a tight cesspit to dispose the liquid wastes (zebar) and wastewater, at 46.2%, and 45.8% respectively (El-Hamouz, 2010).

Currently, wastewater from the different olive-mills located in and around the different villages in the West Bank is being disposed of into wadis. There, it is mixed with the untreated flowing municipal wastewater or with rainwater. The resulting high organic polluted wastewater affects the soil and water receiving bodies. The disposal of the untreated OMW into the open wadis and/or the water receiving bodies (such as the Besor-Hebron-Be'er Sheva watershed) is an urgent ecological problem that deteriorates the environment in the West Bank and Israel. The biological pollution due to the improper disposal of the high organic OMW into the water courses destroys the aquatic life and prevents its further development (Shaheen, 2007). The OMW involves a seasonal disturbance and an overloading for the waters receiving bodies or for the sewage systems and treatment plants. This occurs mainly during the olive season, generally from early October to late December (Shaheen, 2007). Currently, no standard for OMW discharge disposal is currently imposed in the Palestinian Authority, but the Jordanian standards are adopted (Khatib, 2009a).

Currently, there is no appropriate method applied for treating OMW in the West Bank; it is usually disposed of in sewage systems and/or cesspools in addition to being discharged into water streams and wadis in the region. The problems created in managing OMW have been extensively investigated during the last 50 years without finding a solution that is technically feasible, economically viable and socially acceptable. Currently, the emphasis has been on detoxifying OMW prior to disposal to wastewater treatment plants. However, the present trend is towards further utilization of OMW by recovering useful by-products (Shaheen, 2007)

The table below shows the average daily pollution loads that are generated from 20 olive mills in the West Bank. Due to the seasonal nature of olive oil production the manufacute of oil oil during the season creates a large spike in highly polluted wastewater that overwhelms conventional wastewater treatment plants and causes significant harm to the streams and wadis through which this wastewater flows (Source of data: Shaheen H and AbdelKarim R., “Management of Olive-Mills Wastewater in Palestine”,An - Najah Univ. J. Res. (N. Sc.) Vol. 21, 2007, 63-83).

Average Daily Pollution Loads Generated by a Survey Carried out on 20 Olive Mills in the West Bank			
Pollution Paramter	**Pollution Load (Olive Mills Production)**	**Average**	**Maximum**
Total Waste Water	m3/day	269	320
Chemical Oxygen Demand (COD)	Kg/day	32280	38400
Biological Oxygen Demand (BOD5)	Kg/day	10760	12800
Suspended Solids	Kg/day	4035	4800
Total Phenols	Kg/day	942	1120
Total Nitrogen	Kg/day	81	96
Total Phosphurous	Kg/day	54	64
Potassium (K+)	Kg/day	1883	2240
Chloride (Cl-1)	Kg/day	323	384
*Based on pressing 355 ton of olive over the season			

Stone and Marble Production in the Palestinian Authority

Based largely in Hebron and Bethlehem, the stone & marble industry is of great economic importance to the Palestinian Authority, representing the largest manufacturing activity in the territories (USM, 2011.) The Palestinian Authority has exported raw and refined stone for centuries, building a reputation for its quality, variety and the uniqueness of the local stone. Demand for Palestinian stone and marble continues to grow, especially for the world renowned "Jerusalem Gold Stone" (USM, 2011). At a rough estimate, the industry has a value of approximately US$400 million per annum, produces between 15,000 – 20,000 direct jobs and many more in related areas, accounts for 13% of non-agricultural employment, 5% of GDP and holds 20,000 dunums of reserves. (USM, 2011).

This industry has however, serious environmental concerns as the amount of waste accumulating at quarries, stone cutting plants and open areas is a pressing problem in the West Bank. In addition to depleting mineral resources, it causes a serious environmental impact to the water, air, soil, and human communities (Joulani, 2011).

The production of building stones begins with the transportation of huge rocks from quarries into the stone cutting plants. In stone cutting plants, rock blocks are cut into different shapes and sizes. Metal saws are used in the cutting and shaping process, requiring a tremendous amount of cooling water. The cooling water is discharged out of the plant as highly viscous material commonly referred to as stone slurry waste. Almeida et al. (2007) has reported that the global stone industry is responsible for generating about 1 ton of stone slurry per 2.5 tons of final product.

The environmental impact of stone slurry waste generated from quarries and the stone cutting industry is extensive. The major impact is on surface and ground water, air quality, and on flora and fauna due to contamination of agricultural soil. Stone slurry contains an alarming amount of calcium carbonate, which accumulates in the ditches and on the soil surface, resulting in the formation of lime cemented hard pans that restrict root penetration and water infiltration into the soil layer. Stone slurry waste has been shown to reduce soil fertility due to changes of the pH-value, EC, salinity and total dissolved solids (TDS). Fine dust from dried slurry is often blown by the wind and can cover the surface of plants over a wide area for the whole summer due to the absence of rain. Furthermore, stone slurry waste dumped in sewerage systems creates blockages and damages pumping stations (Al-Joulani, 2008).

The production of building stones is one of the important professions in the Palestinian Authority, with over 300 quarries and 1,000 stone cutting factories and workshops in the territories. The Palestinian Authority produces 1.6 million tons of finished stone and marble annually (USM, 2004). Palestinian stone exports account for more than $100 million annually. An estimated 500 companies employ approximately 16,000 workers across the West Bank, with approximately 100 of those companies located in the Hebron Industrial Zone (Kahrmann, 2013). The Hebron Governate has the largest quarrying area, 40%-50% of the total, spread across Injasah, Sa'ir, Beni Naim, Sheyoukh, Tarfur and Tarqumiya (USM, 2011).

It is estimated that the stone industry uses approximately 0.5 million cubic meters of water each year and produces 3,300 metric tons/year of calcium carbonate solids (El-Hamouz, 2010). The water is mainly used to cool the saws that cut the rock blocks. The water mixes with the dust, mainly calcium carbonate, to form a viscous liquid waste, known as slurry. It is estimated that the industry generates approximately 0.7-1.0 million tons of this slurry waste. Stone slurry waste contains heavy metals and suspension solids that vary within the range of 5,000 to 12,000 mg/l, which mainly consist of Calcium Carbonate (Al-Joulani, 2011). The waste generated by the stone cutting industry has accumulated over the years, as it has been dumped in open land, valleys and sewage systems, resulting in extensive environmental and health problems (Al-Joulani, 2008).

The impact not only affects the health and safety of workers, but also the surrounding environment. Every year, drowning in open slurry waste ponds are the cause of death of humans and animals. Moreover, disposal of slurry waste in agricultural land causes a reduction of water infiltration, soil fertility and plant growth (Joulani, 2011). This practice negatively affects the fertility of the soil, contaminates the ground, increases the drainage problem and reduces ground water recharge (Joulani, 2008).

Additionally, the slurry from these companies can clog pipes and block streams. For nearly a decade, slurry from the Hebron Industrial Zone was being released into the municipal wastewater system. Further downstream, in both the West Bank and Israel, Hebron's slurry was causing blockages, creating stagnant pools that attracted disease-carrying mosquitoes and rendered nearby crops useless due to the entry of the stone slurry into the Besor-Hebron-Be'er Sheva watershed (Kahrmann, 2013). It has been reported that the slurry has flowed into the intake area at the Israeli wastewater treatment facility near Beersheva, causing severe problems for the treatment facility as the plant was not designed to handle such a complex and unique pollutant composition (Kahrmann, 2013).

Indeed, the nature of the stone cutting industry requires a significant amount of water for cooling and dust removal. While most of these enterprises recycle used water after passing it through on-site sedimentation tanks or basins, very few, if any, are connected to a sewage network. Most enterprises regularly drain the total content of the sedimentation tanks in nearby wadis, which in some cases amounts up to 12 m^3/day (El-Hamouz, 2010).

Clearly, the economic importance of the stone industry is very large. However, many problems and challenges at the national and industry levels remain to be addressed in order to realize potential gains. The glaring major environmental challenge to be addressed is the disposal of the by-product stone slurry waste generated during stone cutting and shaping (Al-Joulani, 2012)

In early 2012, USAID recognized that Israelis and Palestinians alike had an interest in ending the illegal disposal in slurry, both because of its environmental and health hazards and because of the key role the stone and marble industry plays in the West Bank economy (Kahrmann, 2013). In May 2012, the USAID water resources and infrastructure office along with representatives from the stone cutting industry in Hebron reached an agreement to help stop the slurry's release into the wastewater system. Illegal connections to the sewer system were sealed, and liquid slurry waste from factories began being transported to a central processing plant where it is treated and water is recovered for reuse by the factories and the municipality (Kahrmann, 2013).

Currently, more than 15,000 cubic meters /month of solid sludge and liquid slurry waste are being transported to the Yatta municipal landfill, where it is used to form a cover over solid waste. For the many villagers living near the Yatta landfill, the layer of slurry and sludge has benefited them by capping the smells coming from the hills of trash and reducing the number of disease-carrying flies and mosquitoes. Furthermore, it has been reported that significantly fewer feral animals are found feeding on the household garbage in the landfill (Kahrmann, 2013).

USAID is exploring additional possibilities for how stone and marble companies can pursue long-term solutions to the sludge problem. Such solutions include having stone cutting companies purchase individual filter presses, which dry and compact the slurry. Water extracted from the slurry is then reclaimed for reuse in cooling the blades used to cut the stone. The compacted slurry has the potential to be turned into useful by-products such as gypsum boards, floor tiles, concrete bricks, ornamental fixtures and even pharmaceutical products (Kahrmann, 2013).

The table below shows the estimated contaminated area caused by the stone cutting slurry from stone cutting in the Hebron district (Source of data: Al-Joulani, N. 2008. Soil Contamination in Hebron District Due to Stone Cutting Industry).

Estimated Contaminated Area From Stone Cutting in Hebron District			
Name of City/Village	**Total Municipal Area (m2)**	**Contaminated Area (m2)**	**Contamination (%)**
Hebron/Al fahs	43,000,000	1,052,394.24	2.45
Samo	27,000,000	253,731.32	0.94
Beit Ummar	34,000,000	247,123.27	0.73
Bani Naeem	25,000,000	215,866.60	0.86
Saer	17,000,000	610,657.04	3.6
Shioukh	5,140,000	1,059,824.36	20.6
Tafuh	22,000,000	386,442.56	1.76
Yatta	24,552,265	488,851.86	1.99
Total	197,692,265	4,314,891	2.18

Leather Tanning Production in the Palestinian Authority

The tanning industry is considered one of the most heavily polluting industries in the West Bank. The treatment of animal hides and skins includes the preparation and processing of this raw material, using enormous volumes of water, large amounts of chemicals, while generating significant pollution loads in the process. Air and water pollution, poisoning from toxic gas, widespread odours and unsafe disposal of waste are among the problems experienced in the tanning industry. Pollution from tanneries, as from any major industry, has a negative long-term impact on the growth potential of the West Bank, regardless of the immediate economic benefits of production (Nazer, 2006).

Typical leather manufacturing technology uses multi-step processes which include liming, pickling, tanning, etc., and involves the use of various chemicals such as lime, ammonium salts, sulfuric acid, and chromium salts (Jabari, 2009). The different pollutants found during leather processing include: ammonia, pesticides, chlorides, detergents, emulsifiers, bactericides, fungicides, inorganic residual compounds and chlorine agents hydrogen sulfide (gas), sodium sulphate and chromium (+3) salt (El-Hamouz, 2012; Mwinyihija, 2007).

Due to the mixed waste flows from various tannery processes, the composition of tannery effluent is very complex. Among the most hazardous and concerning pollutants in these effluents are chromium and sulfides, used in the process of unhairing-liming, as they are water-soluble, potentially highly toxic, and carcinogenic and cannot be removed by biological treatment (El-Hamouz, 2010; Nazer, 2006). Hafez (2002) determined the concentration of $NaCl^2$ in the effluent discharge of a tannery in Egypt to vary between 40,000 – 50,000 mg/l, producing alarming quantities of $NaCl^2$ in the wastewater. Water soluble hexavalent chromium is extremely irritating and toxic to tissues in the human body. When tanning wastewater is disposed without treatment, the infiltration of wastewater into groundwater resources may cause major pollution problems as Cr (III) would be oxidized to Cr (VI), creating high risks to the environment and health of people (Jabari, 2009).

When effluent is recycled for agriculture, these salts can affect the texture of soil and reduce crop yields. Hexavalent Chromium salt is particularly problematic, since it accumulates in residual wastewater treatment plant sludge and complicates sludge disposal solutions. Sludge from such effluents therefore provides a natural environment for enrichment for chromium resistant bacteria (El-Hamouz, 2010).

The preservation of animal skins may also include insecticides or bactericides, which may be washed out during a soaking process and drained into the wastewater system. The reuse of this wastewater could lead to absorption of these insecticides and bactericides by plants and entry into the food chain (El-Hamouz, 2010).

Tanning also produces toxic gases (mainly adsorbed by plants), such as hydrogen sulphide (H^2S), which is released into the environment when emptying the tanning drums. There are many problems related to the use of sulfur compounds such as the toxicity of hydrogen sulfide and its corrosiveness of concrete, such as in sewers. Sulfide in wastewater may result in a poorly settling sludge coupled with the unpleasant odor of hydrogen sulfide (Nazer, 2006).

In the West Bank there are about 14 tanneries, 12 of them, all relatively small, are located next to each other in Hebron city in the industrial municipal zone. These tanneries discharge wastewater into the same manhole that connects to the municipal sewer system, which then discharges into the surrounding wadis and eventually the Hebron-Besor-Be'er Sheva watershed without any type of treatment. As a result, the tanneries in Hebron are responsible for tremendous environmental impacts (Nazer, 2006). Tanneries consume large quantities of scarce freshwater, and generate and release corresponding amounts of wastewater with significant pollution loads, and sometimes with extreme pH values. The disposal of wastewater containing untreated tannery effluent in open valleys presents a high risk of groundwater pollution, as wastewater infiltrates through the limestone and into the aquifer (El-Hamouz, 2010).

Interviews with some of the largest tanneries owners in Hebron indicate that the total monthly average hides treated by the 12 tanneries are 2,500 cow hides, 1,500 sheep hides and 500 goat hides. The amount of chromium used is about 4 tons per month, which is equivalent to 7% of the weight of hides. All of the tanneries consume around 200m^3 of fresh water per day, which is equivalent to 36,000 tons of fresh water annually. All of this water ends up in municipal sewage, as hazardous effluent and is not treated. The total annual solid waste, which is heavily contaminated with sodium sulphate and chromium salt, is 1,200m^3 (El-Hamouz, 2010).

Going Further

Our most immediate next task in the project will be to combine the data we have collected in Israel with the data we have collected in the West Bank and to display these data on a single interactive GIS map that will then be uploaded to the project website. The map will contain the watershed water quality monitoringdata, socioeconomic data and data on point source and non-point source pollution, specifically that in the West Bank from the olive oil, stone cutting and tanning industries.

The Be'er Sheva River Parkway as it is today with untreated sewage flowing in the stream.

We will also begin a new water quality monitoring schedule that will take place during the winter rainy season. This is especially important in order to understand how rainfall and flooding impact the quality of the wastewater in the stream. This schedule will be coordinated and supported in part by the Israeli Water and Sewerage Authority. We will also compare these data with the data we have already gathered in June so that we can determine seasonal (summer/dry and winter/wet) difference in the water quality.

In December of 2013 we will also hold our first stakeholder workshop on restoration of the Besor-Hebron-Be'er Sheva watershed. This workshop will bring together stakeholders from all communties and from the West Bank and Israel. The purpose of the workshop will begin to identify appropriate restoration strategies for the watershed and a plan and timeline for their implementation.

References

Aktas, E. S., Sedat, I., & Ersoy, L. (2001). Characterization and Lime Treatment of Olive Mill Wastewater. Water Research, 35(9), 2336-2340.

Al-Joulani, N. (2008). Soil Contamination in Hebron District Due to Stone Cutting Industry. Journal of Applied Science, 10(1).

Al-Joulani, N. (2011). Sustainable Utilization of Stone Slurry Waste in the West Bank. Geo-Frontiers, 1345-1354.

Al-Joulani, N. (2012). Effect of Stone Powder and Lime on Strength, Compaction and CBR Properties of Fine Soils. Jordan Journal of Civil Engineering, 6(1), 1-16.

Almeida N., Branco F. De Brito J. And Santos J.R. (2007). "High-performance concrete with recycled stone slurry". Cement and Concrete Research. (37), 210-220.

El-Hamouz, A. (2010). The Development of a National Master Plan for Hazardous Waste Management for the Palestinian National Authority (PNA). An-Najah National Univeristy.

El-Hamouz, A. (2010). The Development of a National Master Plan for Hazardous Waste Management for the Palestinian National Authority (PNA). An-Najah National Univeristy.

El-Hamouz, A. (2010). The Development of a National Master Plan for Hazardous Waste Management for the Palestinian National Authority (PNA). An-Najah National Univeristy.

Futran, V. (2013) Tackling water scarcity: Israel's wastewater recycling as a model for the world's arid lands?, Global Water Forum. Available at: http://www.globalwaterforum.org/2013/03/18/tackling-water-scarcity-israels-wastewater-recycling-as-a-model-for-the-worlds-arid-lands/

Hafez, A., El-Manharawy, M. S., Khedr, M. A. (2002). RO Membrane Removal of Untreated Chromium from Spent Tanning Effluent: A Pilot Scale Study, Part 2. Desalination, 144, 237-242.

Jabari, M., Aqra, F., Shahin, S., Khatib, A. (2009). Monitoring Chromium Content in Tannery Wastewater. The Journal of the Argentine Chemical Society. 97(2), 77-87.

Kahrmann, D. (04, June, 2013). 'USAID Keeps West Bank Trade – Not Slurry – Flowing'. Article in IIP Digital. Retrieved from: http://iipdigital.usembassy.gov/st/english/article/2013/06/20130604275415.html#axzz2ZQg75Prr

Khatib, A., Aqra, F., Al-Jabari, M., Yaghi, N., Basheer, S., Sabbah, I., Al-Hayek, B., & Mosa, M. (2009a). Environmental Pollution Resulting from Olive Oil Production. Bulgarian Journal of Agricultural Science, 15(6), 544-551.

Khatib, A., Jabari, M., Yaghi, N., Subuh, Y., Hayeek, B., Musa, M., Basheer, & S., Sabbah, I. (2009b). Reducing the Environmental Impact of Olive Mill Wastewater in Palestine. American Journal of Environmental Sciences, 5(1), 1-6..

Mwinyihiya, M. (2011). Essentials of Ecotoxicology in the Tanning Industry. Journal of Environmental Chemistry and Ecotoxicology, 3(13), 323-331.

Nazer, D. W., Al-Sa'ed, R. M., Siebel, M, A. (2006). Reducing the Environmental Impact of the Unhairing-Liming Process in the Leather Tanning Industry. Journal of Cleaner Production, 14, 65-74.

Shaheen, H. & Karim, R. A. (2007). Management of Olive-Maills Wastewater in Palestine. An-Najah University. J. Res. (N. Sc.), 21, 64-83.

Subuh, Y. (1999). Anaerobic treatment of olive mills wastewater using Up-flow Anaerobic Sludge Blanket (UASB) reactor. M.Sc Thesis, Water Research. An-Najah University, Nablus, Palestine.

Union of Stone and Marble Industry (USM). (July, 2011). Stone and Marble in Palestine: Developing a Strategy for the Future. Hebron, West Bank, Palestine.

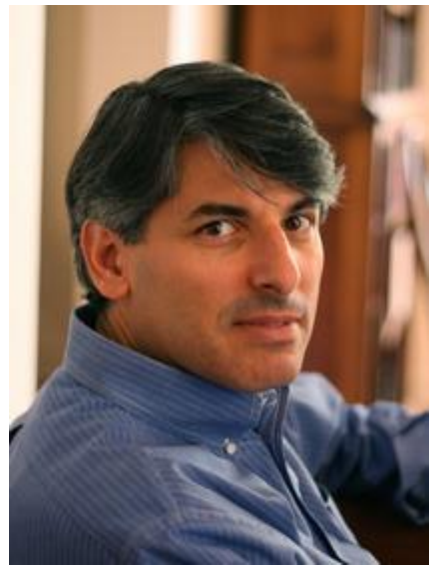
http://serc.carleton.edu/microbelife/research_methods/environ_sampling/pH_EC.html

פרוטוקול מס' 575, מישיבת ועדת הפנים והגנת הסביבה, יום שלישי, ו' בתמוז התשע"ב (26 ביוני 2012), שעה 9:30, <שיקום נחלים - בעקבות סיור הוועדה לירדן הדרומי.>

Annex One

Professor Aaron Wolf Donates International Award to Arava Institute's Transboundary Besor River Project

Oregon, USA, July 2013 - Dr. Aaron Wolf, Oregon State University Professor and winner of this year's Monito del Giardino award, has generously donated his €15,000 prize money to the Arava Institute's Transboundary Besor River Project, the first of its kind. Awarded by Bardini and Peyron Monumental Parks Foundation of Florence, this prestigious honor is given to persons who have distinguished themselves internationally as advocates of the environment. Dr. Wolf received this award for his work on international water conflict, specifically in regards to the Arab-Israeli conflict.



Prof. Aaron Wolf, Oregon State University

Dr. Clive Lipchin, Director of the Center for Transboundary Water Management at the Arava Institute for Environmental Studies, offers the deepest gratitude, "I am both delighted and humbled by his generosity. This contribution provides important support for our work with the Besor River."

The Transboundary Besor River Project, funded by the JNF Parsons Water Fund, brings together Palestinian and Israeli researchers to monitor pollution sources, and represents an important development in cross-border cooperation to preserve natural resources. Originating near Hebron in the West Bank and ending in Gaza, the Besor River receives a steady flow of poorly treated effluents and even raw sewage from local communities in both Israel and the Palestinian Authority. The river also flows through the Negev, impacting both Bedouin and Jewish populations in Israel. Despite the increasing pollution, there has been little official coordination around restoring the river's watershed. "Fortunately," says Dr. Aaron Wolf, "Professor Clive Lipchin is beginning to facilitate dialogue to take the first steps towards addressing these pressing issues, and leading the way for further collaboration."

Annex Two

Pictures from water quality sampling in the Hebron-Besor-Be'er Sheva watershed during June 2013.

Leila Hashweh, Palestinian master's student in the joint AIES-BGU MSc in Hydrology and Water Resources and the recipient of the JNF Parson scholarship taking water samples in Hebron-Besor-Be'er Sheva watershed.

Zobaida Edery, Arab-Israeli AIES student taking water samples in Hebron-Besor-Be'er Sheva watershed.

Zobaida Edery, Arab-Israeli AIES student and Leila Hashweh, Palestinian master's student taking water samples in Hebron-Besor-Be'er Sheva watershed.