Case study final report[1]

The Alexander River – Wadi Zeimar Basin

Palestinian Israeli Case Study


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Executive Summery

This report deals with a hydro-economic modeling of the Alexander – Zeimar river basin. The river originates near Nablus, which is located in the Palestinian Authority, and crosses the green line into the Israeli territory where it flows until it reaches to the Mediterranean Sea. While there are about 600,000 residents along the river, the management questions are related to the entire nation of Israel as well as the Palestinian authority.

The major issue which river planners have to deal with, in this case, is water quality. Since the 1950's the river became a sewage outlet, used by Israelis and Palestinians alike. There are lost opportunities for recreation and also nature conservation principals have been severely violated.

In the mid-nineties a master plan was approved for the 14 major rivers in Israel, which the Alexander was one. The plan determined very specific water quality targets and local authorities had to develop plans to meet them. Since the river is a cross-boundary river, the effort required was envisaged as being mutual. Pollution was to be taken care of in the Palestinian Authority and in Israel.

The major purpose of this research was to estimate the costs and benefits deriving from the Master Plan. We also analyzed the benefits secured by a future clean-up of the river so that it can be used for recreation (fishing, boating etc.). Our studies concentrated on two focal points: The "turtle bridge," which is a major tourist attraction in the Israeli part of the river and is also in an area along the border that is being considered for the creation of a "Peace Park. "

In order to achieve the stated goals we gathered information and modeled three aspects of the system: the river's hydrology, pollution abatement costs and pollution abatement benefits. River modeling from a hydrological point of view was done through the models developed within the OPTIMA group: namely, RRM, WRM and STREAM. Through these models we traced how pollution moves along the river as well as the effect of a possible reduction in some or all of the pollution sources. This gave us the opportunity, later on, to test how this reduction in pollution is related to the costs and benefits.

Abatement costs were derived from the best technology available. We entered costs unto the WRM and the STREAM models and ran the model with the reduced pollution but at a higher cost.

Benefits were derived by different methods: Water which has been diverted to agricultural uses was assigned the shadow value of water in the region. However, the remaining clean water in the river provided a non –market benefit which had to be estimated by non-market valuation methods. We have used two such methods: a Travel Cost Method (TCM) to estimate the current situation (as of 2005) and the Contingent Valuation Method (CVM) in order to estimate future water clean up efforts.

We concentrated on three main pollution sources for the scenarios: the Netanya wastewater treatment plant, the Kubani river diversion and the treatment plant that was built on the green line to accommodate polluted water coming from upstream. We have analyzed eight scenarios, which include all treatment possibilities. Regarding the criteria for future water quality, we have analyzed at least one of the focal points (The "turtle bridge" or the Peace Park, or a combined version in which both locations are treated).

The Cost Benefit Analysis (CBA), with respect to the 2005 vs. 1995 situation, reveals that by treating *all* pollution sources we could reach a positive net benefit of $500,000 per year. However, out of that about $270,000 are non-market net benefits. Financially, the river is a net loser by $230,000 annually but socially there is a net gain.

With respect to future water quality upgrade, it was found that the best alternative is to treat both focal points; the "turtle bridge" as well as the Peace Park. The net benefit in such case reaches about one million dollars annually. Treating either one of the two separately creates a positive net benefit but lower than that secured by treating both locations.

The major lesson is that in the case of the Alexander – Zeimar river basin, only by treating the entire system can we reach a positive net benefit in the first CBA case. In the second case, all possible options yield a positive net benefit; but the overall treatment option yields the highest net benefit.

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1. Basin description

1.1 Basic physiographic and hydrological aspects

The Alexander River is the name given to the lower 32 kilometer section of a river running from the mountains of the West Bank in the Palestinian authority to the coastal plain within Israel. The upper, Palestinian, 22 kilometer section is known as Wadi Zeimar and makes its way from the town of Nablus down to the coastal plain. With its total of 44 kilometers it is one of the longest rivers west to the Jordan River. The hydrographic catchments area is approximately 22 kilometers long and 5 kilometers wide with an over surface of about 11,800 ha. The bottom slope is about 1.2% in the first 10 kilometers and 0.9% in the remaining length. The river system is partly coupled to the large, regional Mountain Aquifer. Polluted river water leaches into the mountain aquifer and, at the same time, there are springs originating from the aquifer that replenish the river downstream. A general map indicating the location of the basin is given in map 1.1 below.

Annually, from an average annual rainfall in the basin of 538 MCM[2], only 8 MCM reach the outlet to the Mediterranean (mainly as a consequence of human activities). The temperature of the region averages between 14.8 to 24.4°C (*ibid.)*. The average meteorological data for the basin are summarized in table 1.1 below.

Flow characteristics of the Alexander River have been measured since 1939 at Elyashiv, near the river's outlet, where the drainage area is 492 square kilometers. At this location, the stream typically flows only during December through March. Flows (other than wastewater) have never been observed from July through September, as shown in figure 1. There have been 4 years since 1939 when zero flow was observed for the entire year. The largest flood observed on the Alexander River occurred on January 30, 1958, and had a peak discharge of 260 m3/s. Several large storms during 1992 led to an annual-flow volume that year more than double that of any other year since 1939.

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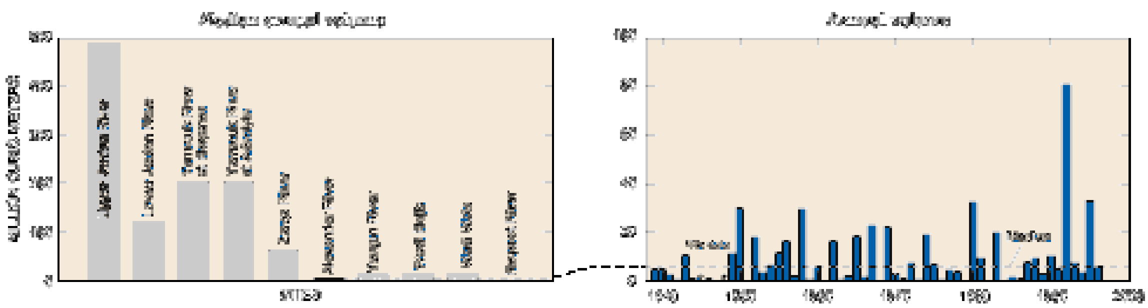
[2] Israeli Meteorological Service, multi-annual average for the Haifa region.

Map 1.1: Location of the basin

Table 1.1: Different meteorological data for the basin

Month	Temperature C°		Relative Humidity %	Rain mm	Penman Evapo-transp. mm	Wind speed km/hr
	Ave max	Ave min				
Jan	12.2	7.2	72	230.0	61	4.3
Feb	12.8	6.7	77	136.2	65	4.0
Mar	17.4	7.2	76	24.2	99	3.8
Apr	21.9	12.0	64	11.1	130	3.4
May	24.0	14.2	57	1.2	150	3.4
Jun	26.2	16.8	67	0	169	2.9
Jul	28.0	20.5	63	0	180	2.9
Aug	28.8	21.6	72	0	165	2.7
Sept	27.2	19.1	67	0	131	2.6
Oct	25.2	16.8	68	0.4	116	2.9
Nov	21.8	11.6	65	152.8	82	3.8
Dec	16.9	9.5	71	83.6	63	4.0
Ann Ave	21.9	13.6	68	639.5	118	3.4

Figure 1.1: Median annual volumes at different rivers in the region and annual volumes



Groundwater is the most important source of fresh water supply in the area and consists of the main aquifer system, the Mountain Aquifer, which is located and recharged from rainfall in the West Bank in the Palestinian authority. The West Bank aquifers vary spatially in the quantities and quality of groundwater that they yield. The hydro-geology determines the spatial distribution, quantity, quality and extraction cost of groundwater. In these aquifers groundwater flow is dynamic, always moving down the anticline that constitutes the mountain range. Groundwater that is not extracted from an aquifer flows through the aquifer itself, either leaving the system through springs or by entering an adjacent aquifer system.

Land use in the Alexander River area has several river bank parks which have been established as a result of the River Restoration Project. The total bank length of the parks is 3 kilometers. There are also some fish ponds along the river. Several villages and kibbutzim (collective villages) are located along the river as well as some light industries, which contribute to the pollution in the river.

In the Wadi Zeimar area there is only marginal use of water for agricultural purposes. This is due to the poor water quality in the river.

The major use of the system is for sewage discharge. This includes light industry in both sides of the boarder as well as olive mill waste in the Palestinian side and fish pond waste in the Israeli side.

1.2 Socio-economic aspects

The two main municipalities in the river region are Tulkarem and Emek Hefer.

Tulkarem is a major Palestinian city, with a population of over 113,000[*]. Nablus is another major city and Sebastia and Anabta are medium-sized towns. There are also villages which each have a population of a few thousand people.

Emek Hefer is a region which is comprised of 30,000 residents, from 29 Kibbutzim and Moshavim (cooperative farms).[*] There are 4,866 households in the local authority of Emek Hefer[3]. The southern border of this area is Natanya, Sharon Junction, Yonah Village and Lev HaSharon local aunicipality. In the north the border reaches Hadera, Beit Eliezer and Menashe authorities. The east borders Menashe,

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[*] http://www.foeme.org/projects.php?ind=72 as of June 23, 2006

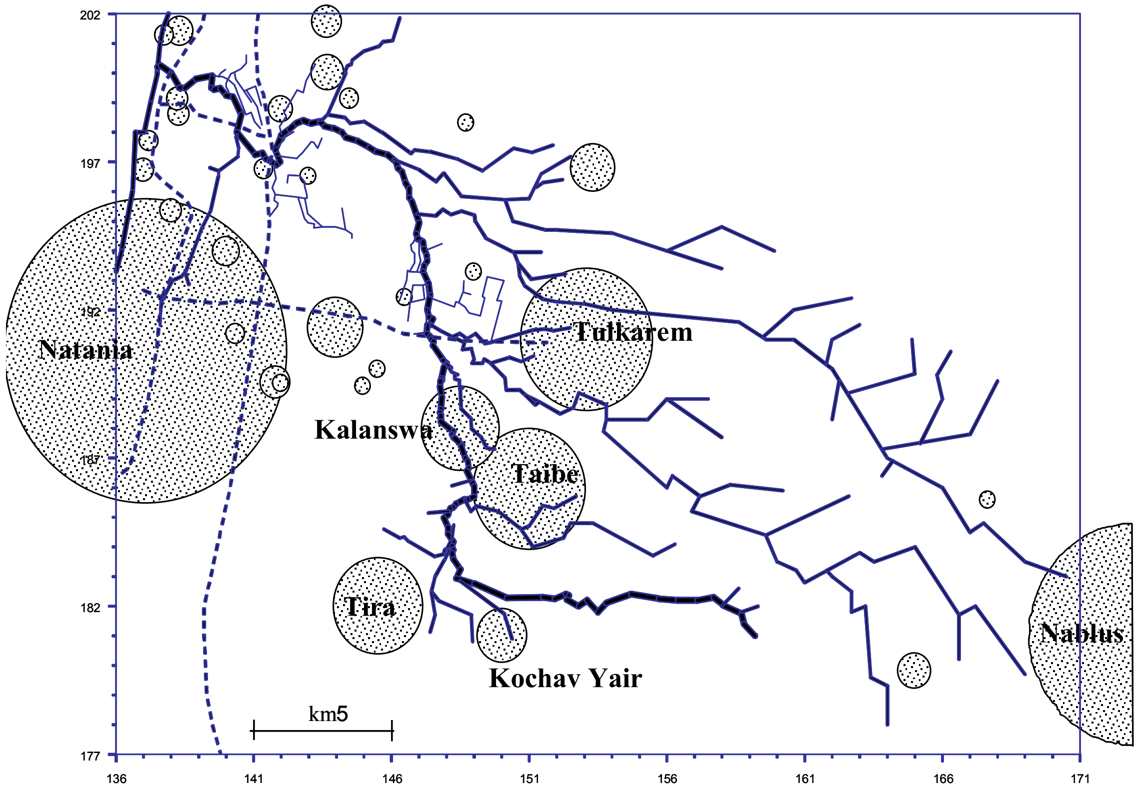
[3] http://www.hefer.org.il as of June 28, 2006

Zemer Municipality and Tulkarem. The western border of Emek Hefer is the Mediterranean Sea.

A generic layout of the population in the basin is given in figure 1.2 below.

Figure.1.2: Generic layout of the population spread in the basin

(Circles' sizes are proportional to the population in each town/city)



1.3 Demography, land use change

Within the Wadi Zeimar Catchment, nearly 40% of the available area is dedicated to agriculture (primarily olives, but also including citrus, almonds, vegetables, wheat and barley). The built-up area covers slightly more than 5% of the catchments; forests cover about 1% of the available land, while more than half the basin area is "un-used." Although less than 10% of the total cultivated lands in the region which is included in the Palestinian authority are under irrigation (i.e. more than 90% is rain-fed), the agricultural production of this sector represents more than 50% of the total agricultural production. Vegetables and fruit trees are the most important crops in irrigated agriculture in the Palestinian part of the basin. Water scarcity, however, represents a critical constraint to further expanding, or even maintaining present irrigated areas. There are increasing demands for agricultural water use to be restricted in favor of other water consumers, such as local communities and industry.

The Alexander River section of the basin is well developed. The percentage of open and undeveloped land is small, less than 10%. This includes a substantial area designated as a nature reserve/national park. There is no substantial town in the area but there are numerous small communities, collective settlements (kibbutzim), rural villages (both Arab and Jewish), and a few semi-urban communities which act as suburbs of cities outside the basin. Most communities have some agricultural land, the majority of it irrigated. Many of the small communities have factories associated with them and there are several larger industrial plants in the basin. Residents in the Emek Hefer Municipality pay a minimum of 3.57 NIS and a maximum of 6.79 NIS for a cubic meter of water (as of June 28, 2006).[4]

Currently water available from natural run off, flow from the Alexander River, waste water treatment plants both in the basin and in nearby towns, and a number of wells, is such as to ensure that competition between the various sectors, domestic consumers, agriculturalists and industrial users, has not reached significant proportions. However, there are serious problems with water quality in the Alexander River and consumer demand may have to be further controlled if the amount of relatively pure water to reach the river is to be sufficient to enable its use for recreational purposes and to ensure the biodiversity of the area is maintained.

The case study basin is small but heavily populated (a total of about 600,000 inhabitants). There is a growing need for water to meet the demand of a drastically increasing population and standards of living. Future demographic projects for the area will need to be taken into account when planning for the future distribution of water. It is likely that the population will increase by at least 20 per cent in the next decade in the Alexander river section and a doubling in population by 2020 in the Wadi Zeimar section.

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[4] Phone conversation with Machleket Gaviyah of Emek Hefer June 28, 2006.

Other important issues are biodiversity conservation. A 1973 survey of river vegetation and of the impact of pollution on the distribution and composition of species revealed that out of 81 different species of vegetation which once flourished along the river, 27 have disappeared. The need to improve the environmental value of the water course in terms of is recreational use is also of importance. The major flag specie is the Nile soft shell turtle, which has its largest community in Israel (more then 100 individuals) in this river.

1.4 Regulatory framework and enforcement

In Israel, the Water Commission is responsible for the general framework and regulatory structure of the river, but day-to-day control is handled by the Drainage Board in cooperation with local authorities.

In the PA, although the water department within municipalities is responsible for water supply and wastewater collection and disposal, the main regulatory body for water and wastewater management by law is the Palestinian Water Authority (PWA). The Palestinian ministries of agriculture, tourism, and localities have less influence or responsibilities.

2. WRM baseline Scenario

2.1.Networks description

Alexander River was used as a waste canal for many years, and the WRM models that were built describe the river in two representative years: 1995 and 2005 (before and after the restoration program). The major purpose of the two models is to provide the basic data for STREAM scenarios, in which the pollutants levels are computed. Using these pollution levels, it is possible to estimate the cost-benefit of the restoration program, and to evaluate future scenarios that will be discussed. The networks are composed of 62 nodes, and a total length of up to 93Km. All of the nodes are contributing water into the river, but because of the current poor quality of the water - only 3 are using the river's water (the 3 fish farms).

2.2. Nodes by class:

There are 5 Nodes of major interest in the two models:

1. **Netanya's Wastewater treatment plant** (*TREATMENT NODE*) has a major influence on the water budget. The plant is treating almost 15MCM per year. This source used to flow into Alexander River in 1995, but today the water is being sold to farmers in the vicinity of the river. In the future scenarios the role of this key player will be discussed.
2. **Kubani Creek** (*START NODE*). This creek was much polluted at 1995 and today is contributing only runoff (about 0.3MCM/year).
3. **HaÓgen Reservoir** (*RESERVOIR NODE*). This reservoir is part of the "emergency solution" for the two months olive production period every year. While its 0.4MCM/year contribution is relatively small – the high level of pollutants is very problematic. The node is used to capture 100% of the olive wastes and release it back to the river with the second flood onwards.
4. **Nablus Wastewater Treatment Plant** (*TREATMENT NODE*). As part of the "emergency solution", this node catches the waste-water that comes from wadi Zeimar and treats it, than – it is released back to the river in a better quality.
5. **Ma'gar Hao'gen** (*RESERVOIR*) - During the olive harvest period (October - November), at the time of severe pollution from the olive mills, the sewage from

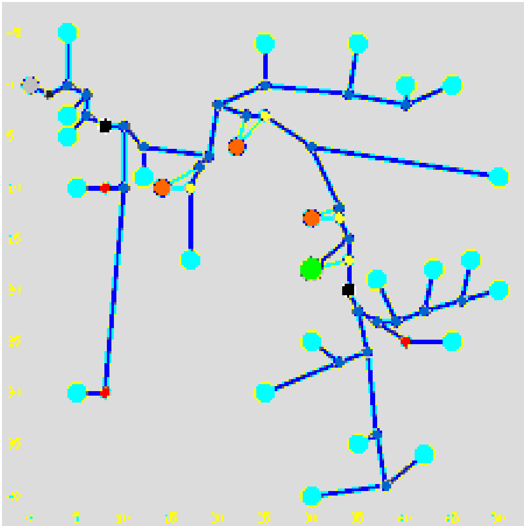
the riverbed is pumped to a different reservoir (Hao'gen) , to prevent potential damage to the "Emergency Project", which could be caused by the very high concentration of organic material.

Other nodes have a smaller contribution and the vast majority of them are *START* nodes.

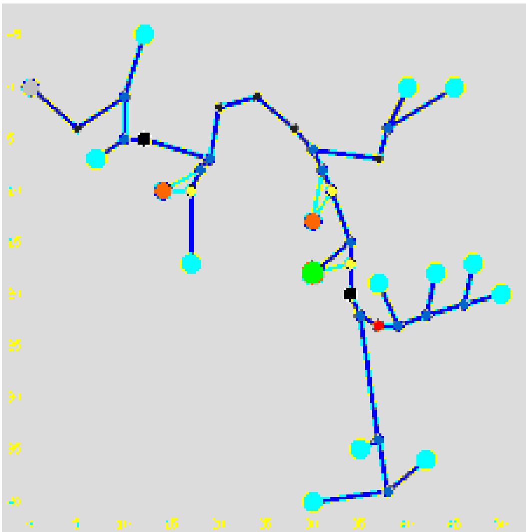
A general schematic look of the WRM is given in figure 2.1 below, figure 2.1a depicts the topological structure of the river in 1995 and figure 2.1bb shows the topological structure in 2005 ten years into the rehabilitation program.

Figure 2.1: Schematic view of the WRM for the Alexander–Zeimar basin

2.1a Topological structure in 1995



2.1b Topological structure in 2005 (ten years into the rehabilitation program)



2.3.Basic water budget

The following tables, 2.1 and 2.2 summarizes the water budget according to the WRM for 1995 and 2005 respectively.

Table 2.1: Water budget - 1995

Annual mass budget summary (Mio. m3)		
Inflow	17.5	100.00%
Direct rain	1.99	3.34%
Consumptive use	0.01	0.02%
Evaporation	7.95	13.38%
Seepage	0.00	0.00%
Delta storage	0.40	0.67%
Outflow	52.82	88.90%
Mass Budget Error	0.22	0.37%

Table 2.2: Water budget - 2005

Annual mass budget summary (Mio. m3)		
Inflow	18.51	100.00%
Direct rain	0.46	2.46%
Consumptive use	0.00	0.00%
Evaporation	2.99	16.16%
Seepage	0.00	0.00%
Delta storage	0.29	1.58%
Outflow	16.16	87.29%
Mass Budget Error	0.11	0.59%

Because of the poor quality of the water, the only "consumptive use" is by the fish farms. The consumptive use in total is so low, that the computed value is zero.

2.4. Issues / problems

The most restricted factor in the system is the water quality issue. It related to both domestic as well as cross boundary problem. Cleaning up the river has its own benefits and costs.

The report will proceed in the following manner: The next section will deal with the cost benefit analysis of the rehabilitation project which started in 1995. The reference year will be 2005. That is, are the costs associated with the project beneficial? The non-market technique which was used is the Travel Cost Method (TCM) which can be implemented in relation to existing resources.

The following section will deal with the question of cleaning up the water as required by the new governmental committee (Inbar Committee) which set up stricter water quality standards. This will be the basis for the second cost benefit analysis. In this section we will also introduce a site that can be involved after the stricter water quality standards are in place. This site is on the "Green Line" and is called the "Peace Park". It will be a trigger for further cooperative efforts in the water issues between Palestinians and Israelis. The non-market technique which was used in this section is the Contingent Valuation Technique (CVM) which is mainly used for hypothetical scenarios.

3. Basic economic of water use, estimated cost and benefit: 1995 vs. 2005

3.1 Costs

The cost, in order to get the pollution values to the 2005 level are based on 3 main features:

1. Treatment plants.
2. Reservoirs.
3. Pipes and Pumps. (connecting the pollution sources to the treatment plants)

Table 3.1 describes a partial list of technologies used and their estimated costs

Table 3.1: Partial cost estimates for technologies used for the Cost Benefit Analysis

	Fixed annual costs	regular O&M monthly costs	variable costs	Duration of Project (serviceable life)	Initial investment	Operation cost per unit (CM)
Intermediate water seepage	$0	$0	0.0000	0.0000	0.0000	0.0000
Hofit springs	$0	$0	0.0000	0.0000	0.0000	0.0000
Emeq-Hefer industrial zone.	$0	$0	0.0000	0.0000	0.0000	0.0000
Tnuva-Export Packing House	$0	$0	0.0000	0.0000	0.0000	0.0000
Kfar-Vitkin Animal feed center	$0	$0	0.0000	0.0000	0.0000	0.0000
Natania WWTP (Bet-Herut)	$132,445	$99,630	0.0990	25	$8,400,000	$0.18
Natania WWTP (Bet Yitzhak)	$0	$0	0.0000			
Maábrot Wastewater Effluent	$7,304	$38	0.0000	40	$125,333	
Mishmar Hasharon fish-farm	$0	$0	0.0000			
Kubani Creek	$561,698	$3,900	0.0000	20	$7,000,000	$0.13
Ein-Hahoresh fish-farm water discharge	$0.00	$0.00	0.0000			
Ein-Hahoresh fish-farm water leaks	$0.00	$0.00	0.0000			
Bahan Wastewater	$35,307	$113	0.0500	20	$440,000	$0.05
Hogla springs	$0.00	$0.00	0.0000			
Maábarot - fish farm water discharge	$0.00	$0.00	0.0000	0	$0	$0.00
Ha'Ogen reservoir	32,377	0	0.0000	40	$555,000	
Water seepage - Emeq-Hefer reservoir	$0.00	$0.00	0.0000			
Burgta wastewater	$36,780	$192	0.0000	40	$631,111	
Kfar-Yona wastewater	$89,515	$466	0.0000	40	$1,536,000	
Tnuvot reservoir effluent	$638,572	$99,630	0.0990	25	$9,000,000	$0.18
Kalaswa wastewater	$25,798	$134	0.0000	40	$442,667	$0.00
Taybe wastewater	$67,344	$351	0.0000	40	$1,155,556	$0.00
Tira wastewater	$0.00	$0.00	0.0000	0	$0	$0.00
Kibbuz Ein-Hahoresh wastewater	$35,307	$184	0.0500	20	$440,000	$0.05
Meretz reservoir effluent	$39,733	$11,232	0.5720	25	$560,000	$1.04
Hamaàpil fish-farm water discharge	$0.00	$0.00	0.0000		$0	$0.00
Kibbutz Hamaàpil wastewater	$0.00	$0.00	0.0000		$0	$0.00
Kibbutz Yad-Hana wastewater	$25,746	$134	0.0000	40	$441,778	$0.00
Zeimer Water Treatment	$358,761	3942$		25	$5,056,362	$55,555
Tul-Karem						
Anabta						
Sabastya						
Nablus						

3.2 Benefits

The measurement of the "Use Value" of the site in its current situation was done according to the Travel Cost Method (TCM). The expected benefit from improving the water quality as a result of operating the emergency project for the treated Wadi Zeimar water is divided to "Benefits from Future Use" and "Existence Value."

This method was developed in the 1950s the late economist Harold Hotlling. The method was mainly meant to estimate recreation and resort value in nature reserves and national parks, as well as within open spaces located at the border of the urban areas.

The basic assumption using this method is that there is no market value for the site, but there is cost involved in reaching it. This cost is a complex of several factors, including:

<u>Driving Cost</u> – contains the gas cost and the amortization caused to the vehicle while traveling to the site.

<u>Time Cost</u> – the alternative cost to the traveling time and resort time, time in which some other use could have been made of the time (such as working).

<u>Direct Cost</u> – direct costs of the services in the site.

Estimating the benefit from the site is done in an *indirect manner* because there are no sellers or buyers for nature reserves, but reserves still have economical value based on examining the costs incurred by visitors. Even if people do not pay entrance fee, they still pay a certain price by deciding to come to the site.

3.2.1 Research method:

When the visitors arrive to the site they received a questionnaire from which some information can be extracted, such as residential location, the frequency of visits in the site, and statistical details, including education, number of children, etc.

The second stage is a technical stage in which the site is circled by circles representing distances from the site. Then all data is organized into a table so that a demand graph can be made. The demand graph reflects the inter-dependence between the price of visiting the site (the arrival and time cost would be used as estimation to the price) and the number of visitors. Then the site's value (benefit), which is the area under the demand graph line, can be found.

The advantages of this method:

- The method is basically based on actions, meaning what people actually do and not on statements of willingness to pay.
- The costs of the method and the implementation are not high.
- The results received are relatively easy to process and explain.

The disadvantages of this method:

- The main disadvantage of the method is the assumption that the traveling cost reflects the site's value. The basis of this assumption is a contradiction, since it might be presumed that the site is more expensive for the local residents, but their "arrival cost" is lower than other visitors.

The "Use Value" of the benefit from the improvement in the water of the river was calculated on the basis of the population visiting in the river. The "Existence Value" of the improvement is calculated according to a survey made within the population that does not visit the river. There is secondary value attached to the population that is not visiting at the river now, but who after improvement and development of the site, would visit. The size of this population was estimated, and the benefit derived by future development was calculated and classified as "Future Use Value".
In this research there are two kinds of questionnaires- questionnaire one was handed out of the site itself, and included:

A. Questions meant to define travel cost components.
B. Questions meant to test the "Future Use Value" from the improvement in water quality.
C. Questions meant to characterize the socio-economic characteristics of the respondents.

185 questionnaires were handed over on 2 Saturdays (one on June and one on July). After disqualification 10 of them, there were 175 left for the analysis, about 95% of the visitors.

Questionnaire two was meant to test the "Existence Value" of the river. The questionnaire represents the benefit that the population which does not visit the river receives from the knowledge of the existence of its existence. This questionnaire was distributed in different spots, close to the river, as well as at more distance places. In this questionnaire the questions which relates to the travel cost were left out. There was a short explanation included about the river, its restoration process and the option of improving water quality.

All together there were 160 questionnaires distributed; after disqualification there were 150 left for analysis.

We used the zonal travel cost method in order to estimate the use value of the site. Table 3.2 below describes the data taken from the survey in order to create the demand function.

Table 3.2: TCM data

Visit per capita	% of visitors from the region	Population in the region	Number of visitors from the region	Travel cost (NIS)
0.0747831	0.5	668,600	50,000	87
0.0163443	0.38043	2,327,600	38,043	174
0.0062916	0.08695	1,382,000	8,695	261
0.0019071	0.02173	1,139,400	2,173	348
0.0060704	0.01086	178,900	1,086	435
0	0	235,900	0	522
		5,932,400	**99,997**	**Total**

We used several functional forms and will present here the exponential form which turned out to simulate the best the visiting behavior of the individuals who were surveyed. Figure 3.1 below is the depicted exponential demand function for the site. The exponential function is given by:

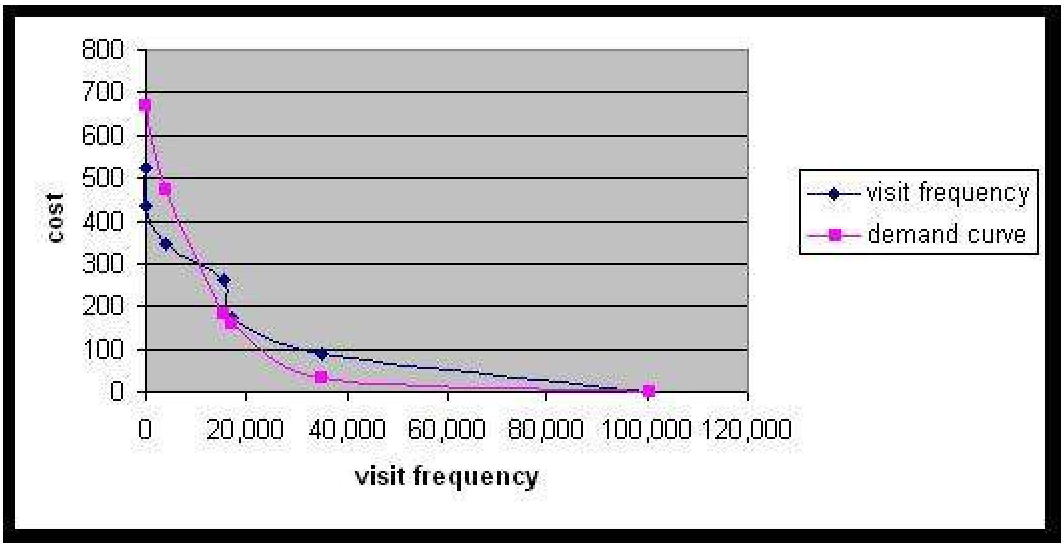
Visits =[6.504756-ln(Travel Cost)]/0.00008426

The inverse demand function is given by:

Travel Cost =668.3*exp{-0.00008426*(Visits)}

Integration of the area beneath the curve yields the total recreational value of the site. This was found to be **13,530,000** NIS (3.3 millions dollars) per year.

Figure 3.1: Exponential demand function for the site



3.3 STREAM water quality scenario

Before estimating the cost benefit issue we present the results as were presented in the *STREAM* model. Figures 3.2 and 3.3 contain results of the two models: 1995 and 2005. Fig. 3.2 presents the 1995 situation while the 2005 situation is presented in fig. 3.3. Fig. 3.4 presents some pictures of the river before and after the rehabilitation project.

Figure 3.2: STREAM output - 1995

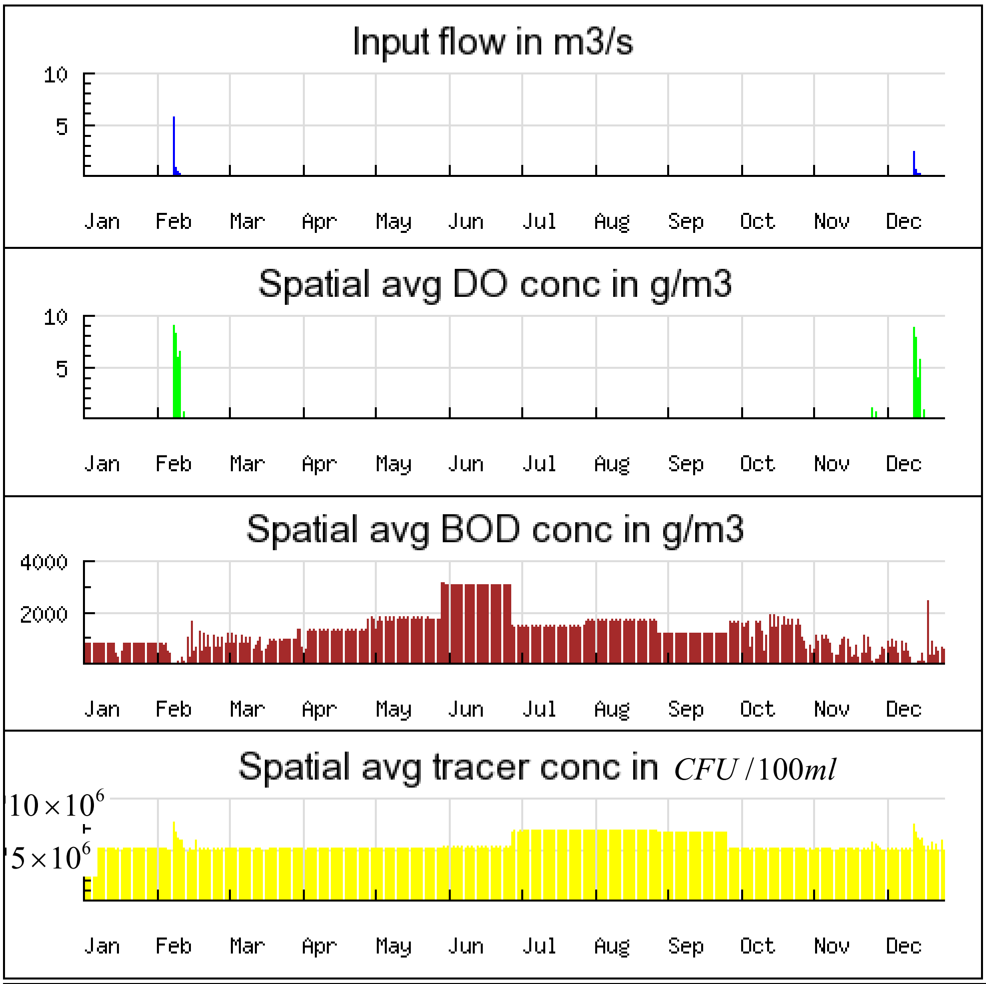
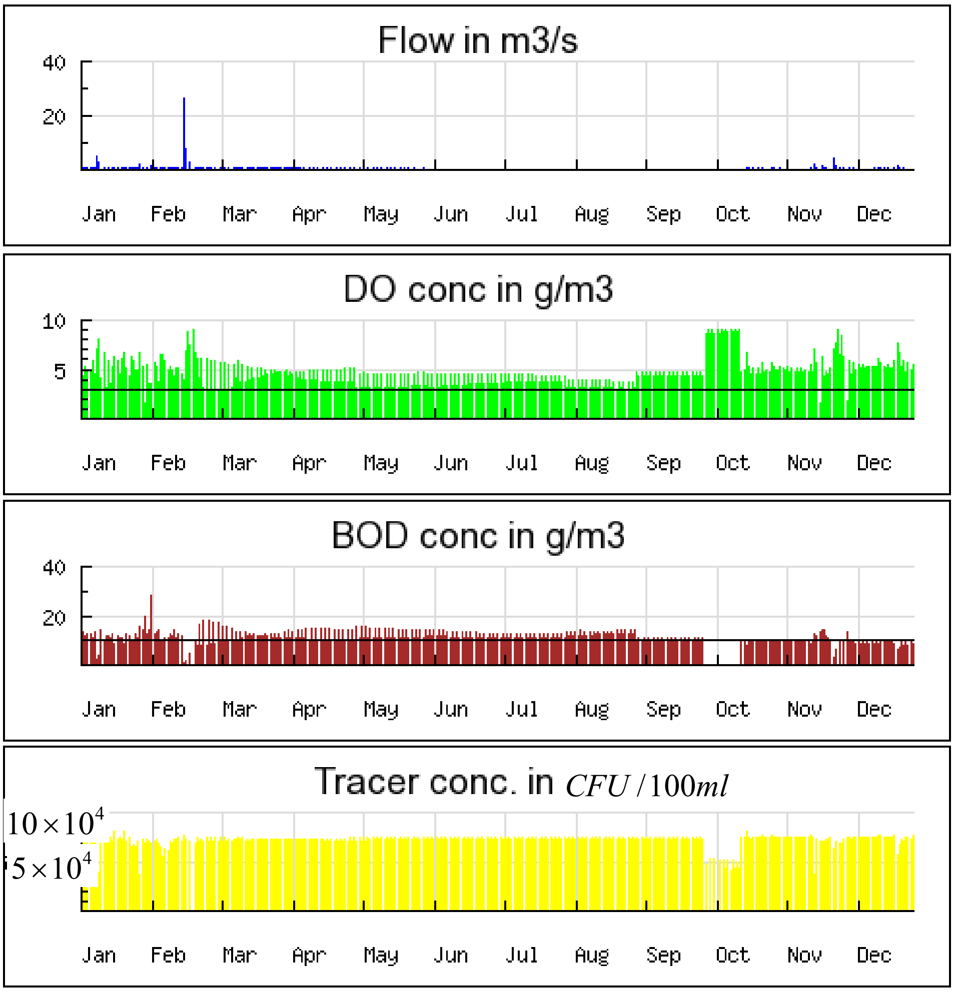


Figure 3.3: STREAM output - 2005



Note: 2005 includes completing the "emergency solution", disconnecting "Natanya water treatment plant" from the river and removing most of the pollution causing elements from the river.

Figure 3.4: Photographs of the river in 1995 (before rehabilitation commenced) and in 2005 (ten years into the rehabilitation program)

In what follows we concentrate on the major pollution sources and the changes occurred during the 10 years of the rehabilitation project.

In what follows we present the change in the major pollution sources which are treated actually as the *instruments* in the economic analysis.

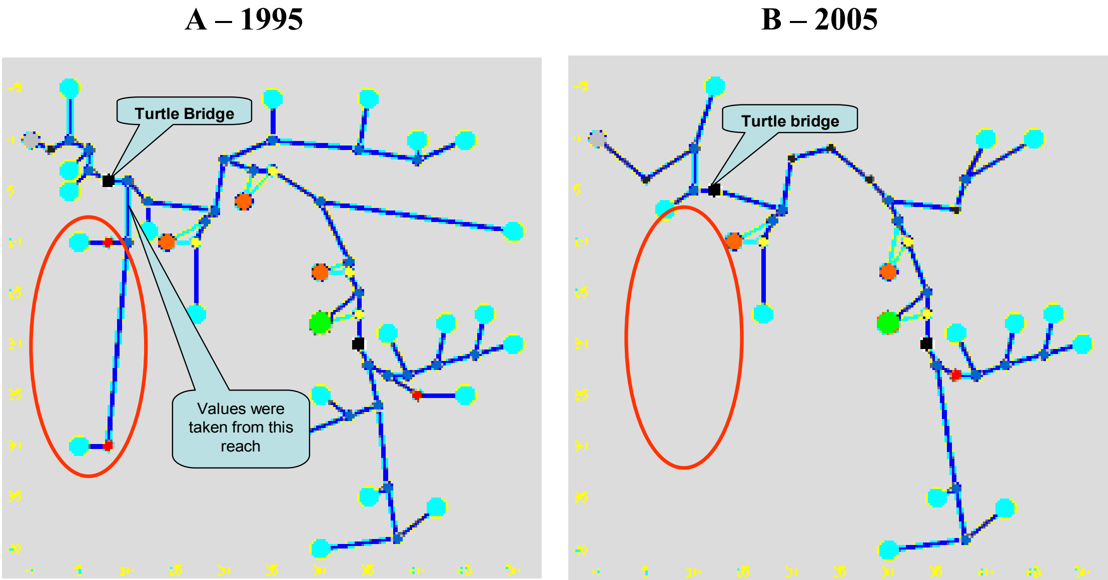
Netanya's Wastewater Treatment Plant:

The Situation in 1995

The plant treats the wastewater of Netanya (p.e. 146,000). The plant discharges $12 \cdot 10^6$ m^3/y effluent to the river with 0 mg/L DO, BOD of 50-60 mg/L and 10^4 cfu/100 ml of Faecal coliforms.

The WWTP had a direct effect on the focal point (The Turtle Bridge). The high discharge diluted most pollutants in the river (Figure 3.5).

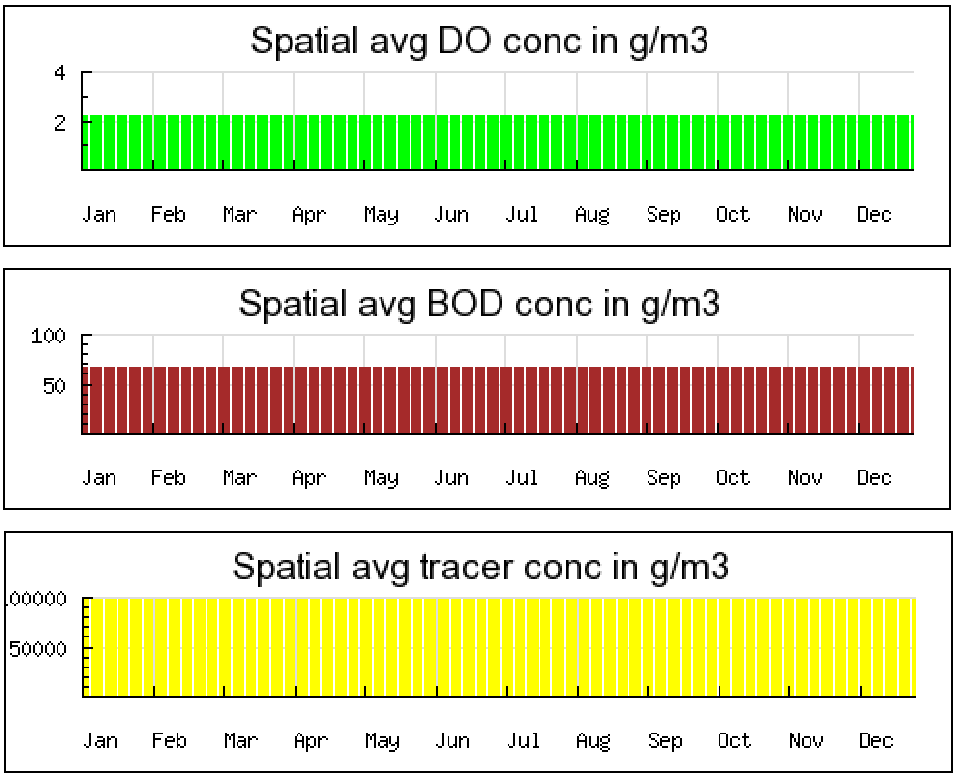
Figure 3.5: Schematic layout of Natanya's WWTP contribution to the focal point



The situation in 2005

As of 1999, Natanya WWTP stopped discharging treated wastewater into the river. Today these effluents are instead used for agriculture. Therefore, there is no contribution of the WWTP to the river (fig 3.6).

Figure 3.6: The effect of Natanya WWTP on the water quality on the Turtle Bridge 1995



Kubani Creek:

The situation in 1995

The Kubani creek used to collect wastewater from four towns and two factories into a sedimentation pond. The wastewater was then discharge into a wastewater reservoir and from there to the main river.

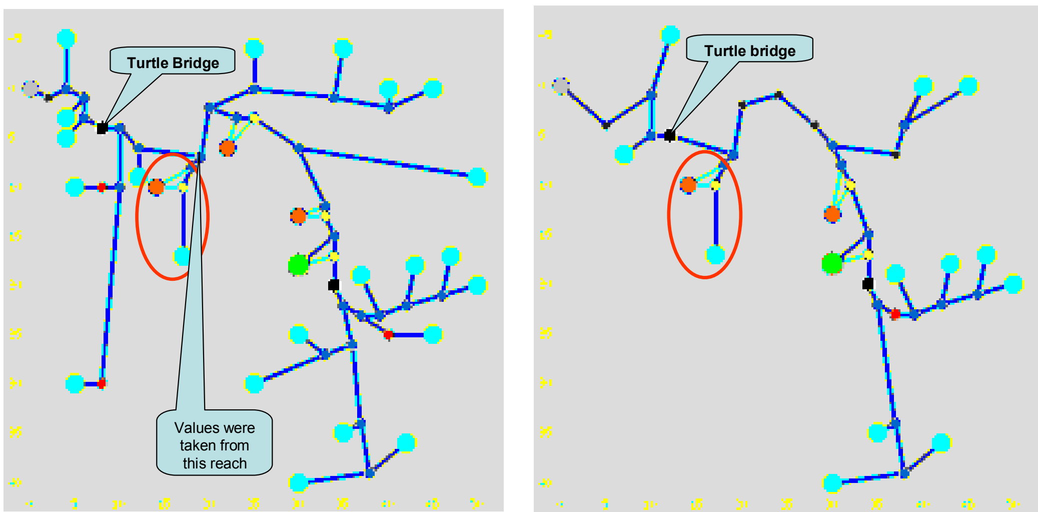
In reality, the ponds and the reservoir were not maintained and their capacity was only 5-10% of their design capacity. This meant that most of the flow went straight into the river year round.

-The fish farm contributes water to the creek once a year, which in 1995 was not considered to be a major problem

The effect of the Kubani Creek in the river is depicted in figures 3.7.

<u>Figure 3.7: Discharge of the Kubani stream</u>

A - 1995 **B - 2005**



The Situation in 2005

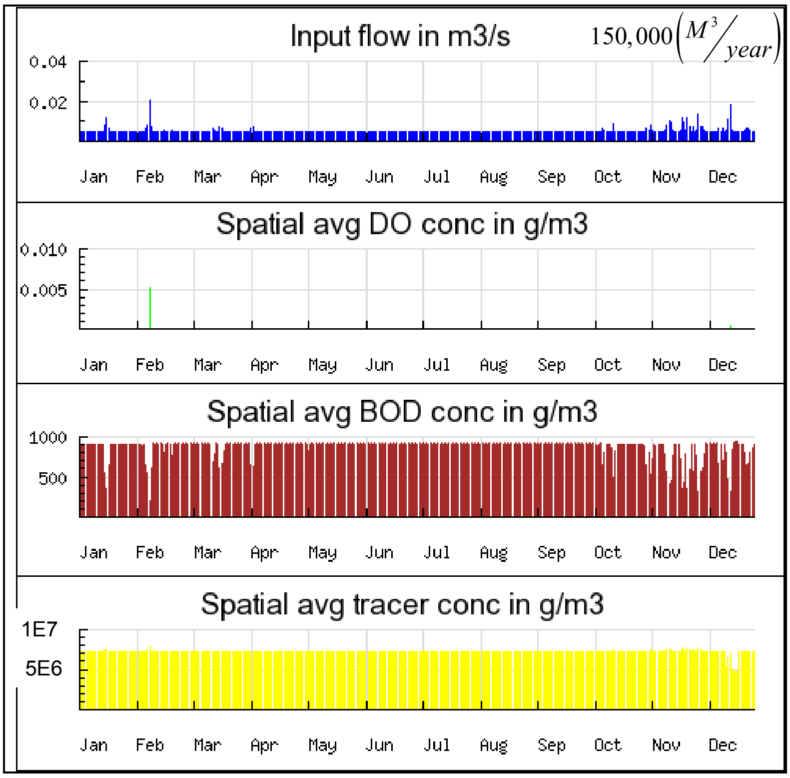
The four towns and two factories do not discharge any sewage to the creek. The creek collects only runoff, and its flow is calculated using the RRM model.

The fish ponds are now considered to be the only pollution point in the creek. This pollution occurs once a year – for a week long period – at the end of December, when the ponds recycle their water back into the creek.

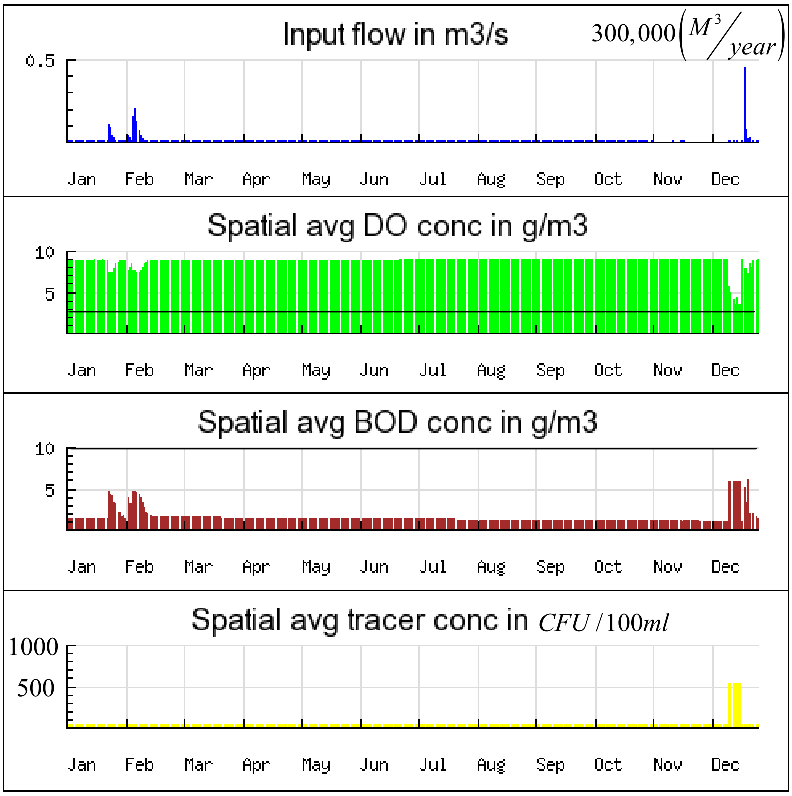
The improvement of the water quality in the river can be seen in figures 3.8.

<u>Figure 3.8: Water quality in the Alexander-Zeimar River at the entrance node of the Kubani stream</u>

A - 1995



B – 2005



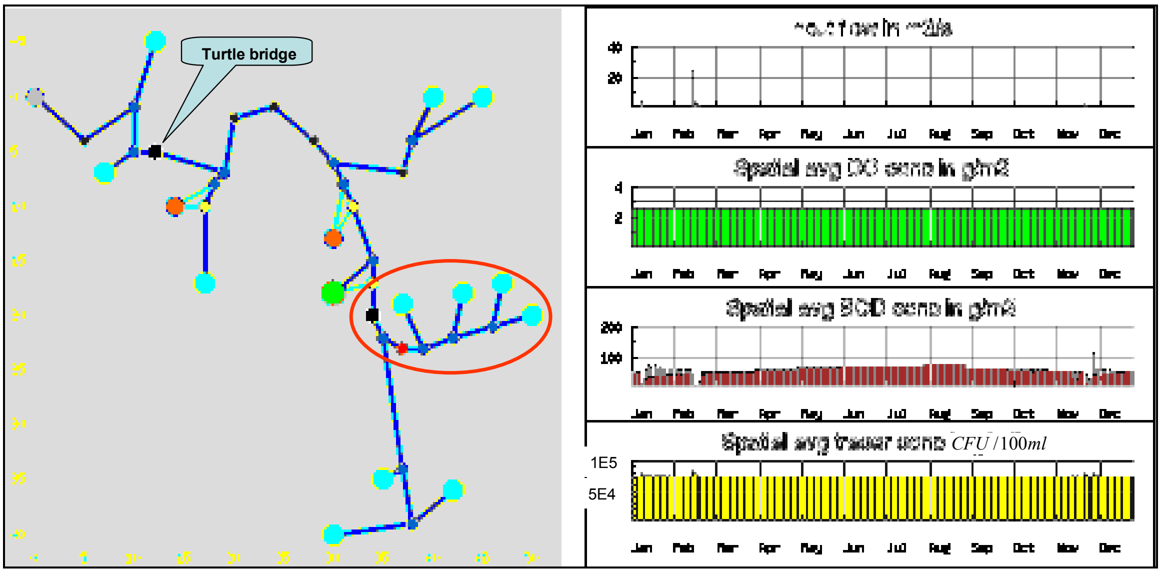
Wadi Zeimar:

The situation in 1995

Waste waters from Nablus, Sabastya, Anabta and Tul-Karem is discharged into Wadi Zeimar. These contain wastewater from industries, stone sawmills, solid wastes, leather factories, garages and more.

In addition, for two months every year (October-December) olive waste is released into the stream from approximately 26 olive mills that are spread along the stream. Ten months out of every year, the color of the water is white, due to the stone powder in it. For two months every year, the water is black, due to the organic matter in the olive waste. In 1995, the total amount of flow from Zeimar Stream was 1.5-2 MCM.

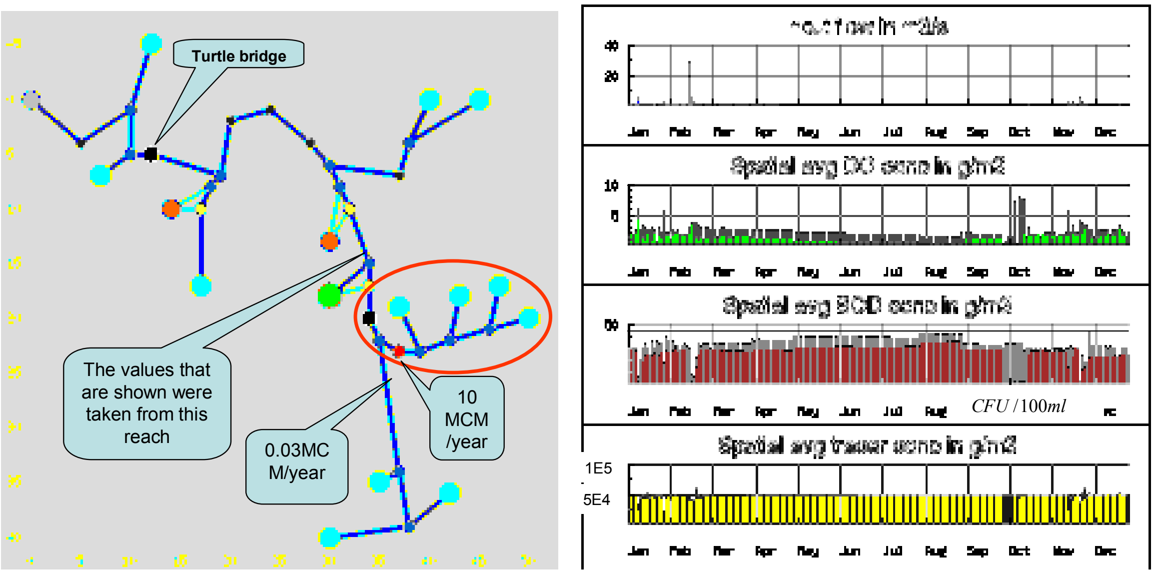
Figure 3.9: Wadi Zeimar - 1995



The situation in 2005

An "Emergency Solution" is applied during the olive harvest in a form of a dam that diverts 100% of the flow into a reservoir, until the reservoir reaches its full capacity (400,000 m^3). The waste water then is stored in the reservoir and released back into the river during times of floods (defined as flow above 5 m^3/s in the river).

Figure 3.10: Wadi Zeimar - 2005



An example of comparison-use of the model to estimate cost-effectiveness of changes that were made in the river. This is depicted in figures 3.11 and 3.12.

In this case, an attempt was made to see what the water quality in the “turtle bridge” node would be if:

1. Netanya’s water treatment facility was still contributing it’s water to the river, as was the case in 1995.
2. Wadi-Zeimar was flowing into the river as it is today, but without treatment.
3. The rest of the points are as they were in 1995, and have a minor affect, since their flow is very low in comparison.

Figure 3.11: Topological layout of the hypothetical scenario

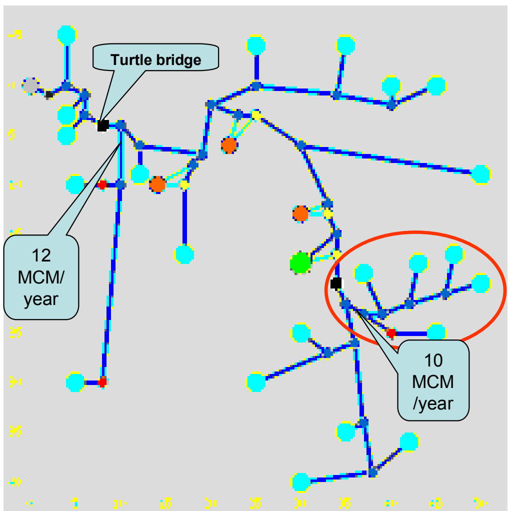
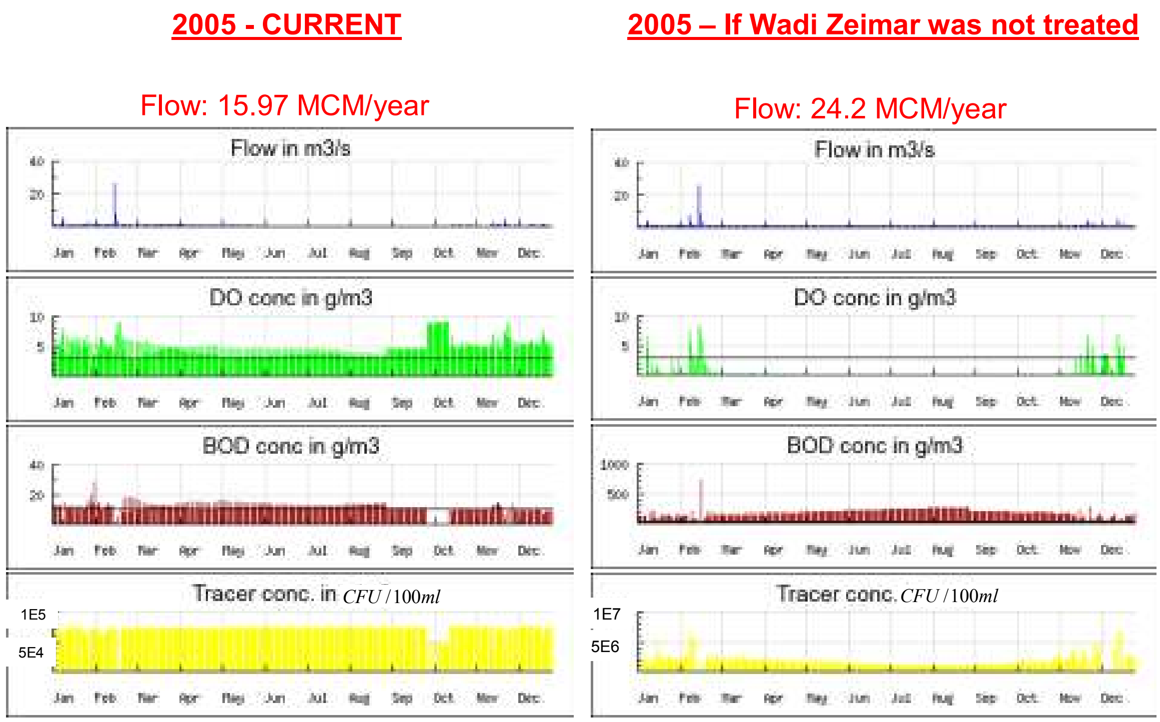


Figure 3.12: Water quality in the hypothetical scenario



3.3.1 Cost benefit analysis of the change between 1995 and 2005:

We performed a base case scenario as well as several other scenarios. The base case scenario dealt with the situation in practice. All three major pollution sources were taken care off. Other scenarios tested intermediate scenarios in which only part of the pollution sources were treated.

The costs and benefits of the steps taken in reality are given in table

The scenarios are given by table 3.3:

Table 3.3: Costs and benefits derived from the 1995 – 2005 change

	$	Direct benefit	Compliance	Captial	Operation	Penalties
WRM	Genaric demand	-	0	-	-	-
	Municipal Demand	-		-	-	-
	Touristic Demand	-			-	-
	Agricultural Demand	3,844,780		250,000	817,491	-
	Irrigation Demand	195,813		112,000	394,593	-
	Industrial Demand	-		-	-	-
	Light industry Demand	5,156		-	-	-
	Services Demand	-		-	-	-
	Commercial Demand	-		-	-	-
	Compliance (control nodes)		-			-
	Supply - Diversions			-	-	
	Supply - Start nodes			697,350	1,257,970	
	Reservoirs	-		40,000	8,880	
	Sub Total	4,045,749	-	1,099,350	2,478,934	-
STREAM (WTP)	Treatment nodes		-	710,000	1,932,030	-
	Sub Total	0	-	710,000	1,932,030	-
	Total	4,045,749	-	1,809,350	4,410,964	

Table 3.4 presents the net benefit from the change:

Table 3.4: Net benefit of the 1995 - 2005 change – Only market benefits included

Economic Summary:	direct monetary	
Total Costs:	6,220,314	$
Total Benefits:	4,045,749	$
Net Benefits:	-2,174,565	$

As can be seen, if we take only the market benefits into account, the river "loses" about $2.17 million annually. However, as was explained earlier, the major benefit of cleaning up the river is the non-market benefit which we denote as the recreational value of the river. The added non-market benefit changes the net benefit table which is presented below in table 3.5

Table 3.5: Net benefit of the 1995 – 2005 change – Market and non-matket benefits and costs included

Touristic cost	629,201	$
touristic benefit	3,300,000	$

Economic Summary:	direct monetary	
Total Costs:	6,849,515	$
Total Benefits:	7,345,749	$
Net Benefits:	496,234	$

As can be seen clearly from the above table, the addition of the non-market segment is the trigger for passing the cost benefit test. The net benefit now is about half a million dollars annually.

3.4 Alternative scenarios:

As explained before we analyzed intermediate scenarios in which only part of the pollution sources are being treated. The list of scenarios is given in table 3.6.

Table 3.6: List of Scenarios

	Natanya WWTP	Kubani	Zeimar
1	untreated	untreated	untreated
2	untreated	untreated	treated
3	untreated	treated	untreated
4	untreated	treated	treated
5	treated	untreated	untreated
6	treated	untreated	treated
7	treated	treated	untreated
8	treated	treated	treated

As can be seen from the table, scenarios 1 and 8 illustrate the 1995 and 2005 situations, respectively. All the others deal with any part of the pollution sources.

In what follows we will analyze the different scenarios by the net benefit as well as water quality criteria.

The solutions to the different scenarios are presented below (table 3.7):

Table 3.7: - summary of the net benefits the different scenarios

Scenario		BOD	DO	F.coli	Water quality in the river (elaborated value)	Net benefit without investing in the landscape value	Landscape benefit compared to the water quality in the river	Net benefit from further investment in landscape value	Improvement percentage in net benefit	Landscape benefit compared to the water quality in the river	Net benefit from further investment in landscape value	Improvement percentage in clean benefit
Essence	No.	10	3	2.3		million $/year	million $/year	million $/year	%	million $/year	million $/year	%
No element is being treated	1	0.07	0.10	0.36	0.18	-2.59	0.53	-2.69	-3.94%	0.88	-2.34	9.66%
Shchem only	2	0.18	0.25	0.36	0.26	-3.92	0.79	-3.76	4.15%	1.32	-3.23	17.62%
Kubani only	3	0.08	0.12	0.45	0.21	-3.10	0.65	-3.08	0.51%	1.08	-2.65	14.41%
Shchem and Kubani	4	0.34	0.66	0.46	0.49	-4.43	1.46	-3.59	18.83%	2.44	-2.62	40.87%
Natanya only	5	0.02	0.10	0.33	0.15	-1.05	0.46	-1.22	-15.91%	0.77	-0.91	13.52%
Natanya and Shchem	6	0.09	0.21	0.33	0.21	-2.38	0.63	-2.38	0.08%	1.05	-1.96	17.78%
Natanya and Kubani	7	0.03	0.13	0.45	0.20	-1.56	0.61	-1.57	-1.10%	1.02	-1.16	25.16%
Existing situation, 2005	8	1.10	1.66	0.53	1.10	-2.81	3.3	0.49		5.5	2.69	

It should be noted that if the water is being partially treated, the benefit is partially increases. The way to calculate the relative benefit increase is to create the following index:

$$BOD_{index} = \frac{BOD_s}{BOD}$$

$$DO_{index} = \frac{DO}{DO_s}$$

$$F.coli_{index} = \frac{\log(F.coli_s)}{\log(F.coli)}$$

As can be seen, the index considers the share of the water quality indicator in each scenario relative to the water quality indicator reached in scenario 8 (the cleanest alternative).

3.4.1 Scenario 1 - No Treatment

In this scenario we shall examine the river situation today if the three main pollution sources are not treated. Water quality according to this scenario has worsened since 1995. Netanya sewage purification facility can not fully handle the large amount of treated waste water arriving there. However, the treated waste water flowing from the sewage purification facility to the river, although its quality is far from good, is diluting heavyily polluted water arriving from Wadi Zeimar and Kubani River, that are not treated at all. A small benefit is received, but there is no investment in, or benefit from, landscape value. In this scenario, parameter values indicate water quality that does not allow any agricultural, industrial or tourist benefit from the river's water.

The benefit received from investing in the landscape value, in a situation where the three main pollution sources are not being treated, can bring about the following results:
A net benefit worsening ($630,000 of landscape value investment versus $530,000 of landscape benefit a year), if the figure of $3.3 million is used, or to a net benefit improvement ($630,000of landscape value investment versus $880,000 of landscape benefit a year, is the $5.5 million is used).

3.4.2 Scenario 2 – Ttreating Only the Wadi Zeimar Sewage.

In this scenario we shall examine the river's situation if only Wadi Zeimar pollution is treated. It is possible to see that the water quality is better compared to scenario 1, in which none of the big 3 polluters are treated. It is also easy to see that the net benefit is very negative.

Establishing the Shechem sewage purification facility with large investment and without having a direct profit from selling the treated waste water for agricultural use, improves only a little the water quality in the "turtle bridge" area downstream. The benefit received indicates that the money is not affectively invested. If simultaneously efforts were made to improve the river's appearance, the net benefit was less negative (table 3.7).

Scenario 2 indicates that treating only Wadi Zeimar wastewater will not solve, even partially, the general pollution problem in the Alexander River, although it was considered in 1995 as the main polluter.

3.4.3 Scenario 3:

In this scenario only Kubani River waste water is being treated. Because Kubani River is carrying crude sewage to the river near the "turtle bridge" point, the sewage quantity is small compared to the Netanya and Nablus sewage. A small improvement in the water quality in the "turtle bridge" area is shown, compared to scenario 1. However, the net benefit is even more negative than scenario 1, regardless of whether or not investment is made in the landscape value. That means that the small improvement in the water quality, gained from the Kubani River area being treated, involves high costs because the area has many small pollution sources demanding specific treatment (army camp, security factories, etc.). Despite the treated waste water usage, the net benefit indicates that treating the Kubani River area alone is not effective, and does not justify an investment in the landscape value in this case.

The net benefit is negligible if the non-market value is $3.3 million but substantial if it is $5.5 million (14.41% improvement in the net benefit).

3.4.4 Scenario 4:

In this scenario Wadi Zeimar and Kubani River wastewater are treated, Netanya sewage purification facility flows to the Alexander River via the Avihail tributary, and the treated waste water is diluting the water arriving from the Alexander River ascent. Despite the treated waste water's medium quality, the big quantities flowing to a point close to the "Turtle Bridge" improves the water quality. Together with scenario no. 8, this scenario shows the highest improvement in water quality.

It is also interesting to note that in this case investing in the landscape value achieved 19%-41% improvement in the net benefit. The explanation is found in the water quality: because the calculated water index affects directly the landscape benefit, every combination of water quality that results in landscape benefit over 630,000$, improves the net benefit results from the general scenario. The interesting conclusion from analyzing scenario 4 is that in order to improve the net benefit, the index calculated in table 1 has to pass the value 0.21. Therefore the sufficient water quality for improving the net benefit needs to bring the polluters values to a “distance” of one-fifth of their standard value. However, it must be noted that the index is only a comparative measure, and in reality the landscape benefit is not related only to the water quality.

The net benefit in scenario no. 4 is the most negative one of all scenarios analyzed. The combination of the high investment in order to treat Wadi Zeimar and Kubani River, with the non-usage of the large quantities of treated waste water leaving Netanya sewage purification facility for agriculture, cause the poor results of scenario 4. The landscape benefit of both cases, 3.3 and 5.5 million USD, is not sufficient to compensate for the loss in the direct benefit resulted from not using the treated waste water.

3.4.5 Scenario 5:

This scenario refers to the Natanya sewage purification facility upgraded to a tertiary treatment level and letting the large treated waste water quantities be used for agriculture. Using treated waste water causes significant economic benefit. It seems that this scenario’s net benefit is the one of the highest, equivalent to that in scenario no. 8. However, releasing 15 MCM a year in medium-reasonable water quality, from a point so close to the “turtle bridge” area, is the cause of heavy pollution arriving from Wadi Zeimar and Kubani River (not treated in this scenario), and is not diluted. Therefore the water quality in the “turtle bridge” area is the worst among all scenarios.

The bad water quality of the “turtle bridge” area obviously affects the landscape benefit that would have been received. Investing in the landscape benefit in this scenario would have caused a 16% more negative net benefit with respect to the 3.3 million USD or 13.5% improvement in the net benefit with respect to the 5.5 million USD. Therefore this scenario has a great importance in relation to landscape benefit.

The conclusion from this scenario analysis is that upgrading Netanya sewage purification facility and let the treated waste water flow for agricultural use was actually a turning point in Alexander River treatment, as far as the “turtle bridge” area is concerned. On one hand, upgrading Netanya sewage purification facility and letting the treated waste water flow for agricultural use without giving any treatment to the Wadi Zeimar and/or Kubani River creates worse water quality than if the river would have none of the three polluters treated. On the other hand, there is a significant economic benefit caused by using the treated waste water for agricultural purposes.

In other words, scenario 5 can be called: “Economical worthy but environmental harmful”.

3.4.6 Scenario 6:

This scenario is actually continuation of scenario no. 5. In this scenario we shall examine the possibility of adding Wadi Zeimar treatment to the Netanya sewage purification facility upgrade. Compared to scenario 1, in which no polluter is being treated, the water quality has not improved much. The Wadi Zeimar treatment contributes to the water quality small improvement at the “turtle bridge” area, but requires high costs. Upgrading Netanya sewage purification facility and let the treated waste water flow for agricultural use cause direct high benefits but prevents water dilution.

An interesting conclusion from analyzing the results of scenario 6, is that the difference between the scenario in which Netanya sewage purification facility and Wadi Zeimar are treated and the scenario in which none of the polluters are treated – is negligible, regarding to the water quality and the cost/benefit relation resulting from this scenario.

Investing in the landscape value – because of the poor water quality would have caused to net benefit to be identical to the one resulting from not treating at all with respect to the 3.3 million USD and 18% better (less negative) net benefit with respect to the 5.5 million USD.

3.4.7 Scenario 7:

This scenario is the second option of treating the Netanya sewage purification facility and another polluter,,the Kubani River, simultaneously. It seems that the net benefit is higher than in scenario 6, but the water quality in the “turtle bridge” would remain poor, despite the Kubani River treatment.

An interesting detail in scenario 7 is the great variance between the pollution values in the “Turtle Bridge” compared to the existing situation in the river without any treatment at all.

While the DO concentration stays more or less the same, the BOD concentration is much higher in scenario7 than in scenario1. The reason is probably because the high BOD concentration arriving from Wadi Zeimar is not being diluted in the treated waste water arriving from Natanya sewage purification facility. However, the situation is opposite regarding the F.coli values: in scenario 7 the F.coli concentration is lower by almost two orders of magnitude than in the non-treatment situation. The short half-life time of the F.coli, despite its high concentration in the Wadi Zeimar water, causes the “Turtle Bridge” point not to end up with a high concentration of F.coli.

Investing in the landscape value in this scenario causes a little more negative net benefit with respect to the $3.3 million figure. This result can be understood because of the poor water quality in the “turtle bridge” area. However, with respect to the $5.5 million, the benefit received is improved by 25% compared with the original benefit.

3.4.8 Scenario 8:

Analyzing scenario no. 8 is actually concluding the Economical Model chapter, and a significant part of the whole papers' conclusion. Scenario 8 describes the current situation in the river. The water quality and its causes were widely discussed earlier.

Comparing the results of all other scenarios with this scenario shows that every one of the three main polluters is critical regarding to the water quality in the “turtle bridge” area:

Kubani River area – in the past the area had very poor water quality, mainly because of the flow of crude sewage to the river in which the F.coli concentration is high. The short half-life time of the F.coli allows high concentration of it at the “turtle bridge.” The treatment of Kubani River area involved high costs, but the purified treated waste water usage and investing in landscape value caused the net benefit from treating Kubani River to be positive.

Wadi Zeimar – Wadi Zeimar was actually the main cause to the high BOD concentration (and therefore to the low DO concentration) at the “turtle bridge.” In all scenarios in which the Wadi Zeimar appears, there are very high BOD concentrations.

It is important to note that the high F.coli concentration in the Wadi Zeimar water, despite their short half-life time, is the main problem at the “turtle bridge.”

Treating Wadi Zeimar water involves high investment and dos not carry with it direct benefits since the treated waste water are flows back to the river.. Therefore the cost of treating Wadi Zeimar wastewater is the reason for the negative benefit in all scenarios.

Netanya sewage purification facility - in the past the Netanya sewage purification facility diluted water at the "turtle bridge” area. This dilution, although decreasing the polluters concentrations near the "turtle bridge” area, did not bring the water quality in 1995 to a quality that allowed any usage at all. Upgrading the Netanya sewage purification facility and let the treated waste water flow for agricultural usage were an important step in preserving the local economy as well as preserving the river water quality as concluded from analyzing scenario 4. The better treated waste water quality today and its agricultural usage causes a great direct benefit – while expelling the polluted water from the river improves the landscape benefit.

Generally, scenario no. 8 is the only one bringing the DO and BOD values to the Health Ministry values range standard that allows some water usage, without human contact. It is also possible to see that this scenario is the lowest considering F.coli concentration, but still has a high value (10^4). Compared to the other scenarios it is possible to see that with respect to the net benefit, this scenario is the highest (closest to 0).

The main conclusion from analyzing the economic model is that one parameter from those examined in this analysis can not be related to the net benefit in isolation. Moreover, it will not be correct to try to do so because each of the parameters has different characteristics that change its value entirely at the "turtle bridge" area –or any other point in the river—in every scenario.

However, developing an index, relating the rivers water quality in a way that could result in combining different parameters, can actually serve the need to quantify the relation between the Alexander River water quality and the net benefit received from the activities taking place throughout the river.

The index described here is an attempt to show how this kind of index should be developed. There is no doubt that this attempt is not sufficient and a more reliable index should be created, in which every polluter has a defined and clear weight relating to the cur rent situation reflected in the value of various parameters.

4. Future Scenarios

We use the CVM method in order to evaluate future water quality improvement. CVM is based on hypothetical survey which is particularly suitable for future scenarios and the public's willingness to pay for those improvements.

Our scenarios are based on the recommendations of recent governmental committee, the Inbar committee. The implications of the committee's standards were analyzed both from a benefit as well as the cost component. Inbar's water quality standards are presented in table 4.1 in comparison to the 1995 and 2005 water quality means.

Table 4.1: Inbar's water quality standards vs. past and current situation

Parameter	Units	1995	2005	Inbar's water quality standards
BOD5	mg/l	30-70	10-20	10
D.O.	mg/l	3-4	4-9	> 3
F. Coli.	CFU / 100 ml	10^6-10^7	10^4-10^5	200

The second future development is creation of a "Peace Park" just on the "Green Line" on the border between Israel and the Palestinian Authority. The location of the Peace Park can be seen in figure 4.1

Figure 4.1: The Peace Park

An incremental cost benefit analysis would be carried out for both future scenarios in a mixed setting. That is, increase water quality standards and its implication on both sites: the turtle bridge and the peace park.

4.1 Incremental costs associated with the Inbar Committee's water standards

In order to understand the impact of stricter water quality requirements we need to compare to proposed policy to the existing one. Table 4.2 describes the existing removal efficiencies of BOD and F. Coli in the two major wastewater treatment plants in the watershed, namely the Netania and Tulkarem treatment plants.

Table 4.2: Current removal efficiencies of the major WWTP in the watershed

Parameter	Removal Efficiency	
	Natania	Tulkarem
BOD	93 %	91 %
F. Coli.	97% (1.5 logs)	99.5% (2.3 logs)
Max. Design flow [m^3/s]	1	0.5

Using the *STREAM* model we can get an insight into the behavior of water quality indicators in the Alexander-Zeimar steam in the current situation. This is described in table 4.3

Table 4.3: Water quality indicators at the two focal points

	Peace park			**Turtle bridge**		
	avg	min	max	avg	min	max
BOD [mg/l]	43	9.9	83	9.	0	282
D.O. [mg/l]	0.41	0	7.3	5.0	0	7.9
F.coli [cfu/100ml]	26,800	5,900	393,000	23,400	0	136,100

In order to meet the Inbar's water quality criteria several actions should be taken to reduce the pollutants contribution to the river. In the following we shortly describe each sight (focal point) and the associated acts and costs.

4.1.1 The Peace Park:

BOD and D.O.:

In order to meet the Inbar Committee's criteria there is a need to upgrade the WWTPs in order to increase BOD removal efficiency to 97.6%. This could be achieved by adding tertiary treatment in the form of contact filtration (flocculation directly followed by sand filtration). The associated annual cost of this additional treatment is estimated at $459,672.

F-Coli:

It is possible to increase the removal efficiency of F. Coli. to 99.99% (4 logs) by adding a chlorination unit to treat the diverted flow from the WWTPs in cases when the flow in the Zeimar exceeds the design flow of the WWTP (0.5 m^3/s). The design flow of this chlorination unit should be 12.5 m^3/s. The associated annual cost of constructing and running a chlorination unit of this size is estimated at $611,715.

After the addition of these complementary treatment units, the predicted concentrations of the water quality indicators in the Peace Park are given in table 4.4. It is important to note that the water quality criteria are met only on an average basis. As can be seen from the table, the maximum (and for D.O. the minimum) values still do not meet the requirements.

Table 4.4: Water quality at the Peace Park after the upgrade of Tul-Karem WWTP to meet Inbar's water quality criteria

Parameter		Avg	Min	Max
BOD	[mg/l]	10	3.3	41
D.O.	[mg/l]	3.6	0.38	7.3
F. Coli	[cfu/100ml]	195	2	59,000

4.1.2 The Turtle Bridge:

BOD and DO:

The 2005 scenario already meets the average Inbar Committee's water quality criteria regarding BOD and D.O. Therefore, regarding these two parameters there is no extra investment (or cost) needed.

F-Coli:

In order to meet the Inbar's water quality criteria regarding F. Coli, there is a need to achieve 99.99% (4 logs) removal in the Tul-Karem WWTP and to construct an additional chlorination unit to handle 14.9 m^3/s of diversion flow in cases when the flow in the Zeimar exceeds the design flow of the treatment plant (0.5 m^3/s). The associated annual cost is estimated at $653,001.

In addition there are two other acts that should be done.

- Divert the raw wastewater town of Taibe from the drainage basin of the river. The construction of the diversion was completed prior to 2005 and thus was incorporated into the cost-benefit analysis of 2005 scenario. However, although constructed the raw sewage was not yet diverted. Therefore, the only need is to make this diversion operative (there is no extra cost associated with it).

- Additional chlorination unit is needed to disinfect the effluent of Kalaswa-Tnuvot reservoir which is discharged into the river. This unit should achieve 95% removal (1.3 logs) of F. Coli. The associated annual cost is estimated at $50,101.

These acts yield the water quality indicators which are described in table 4.5.

Table 4.5: Water quality indicators in the Turtle Bridge after diversion of Taibe sewage and chlorination of the effluent of Kalansawa-Tnuvot reservoir

Parameter		Avg	Min	Max
BOD	[mg/l]	9	< 1	280
DO	[mg/l]	5.0	0.0	7.9
F. Coli	[cfu/100ml]	195	< 1	55,200

Table 4.6 summarizes the additional annual costs of the different alternatives.

Table 4.6: Cost summery (in $ per year)

	Peace park	Turtle bridge	Peace park + Turtle bridge
Tertiary treatment at Tulkarem WWTP	459,694	-	459,672
Chlorination unit for excess discharge at the Tul-Karem WWTP	611,715	653,001	653,001
Chlorination of effluent of Kalanswa-Tnuvot reservoir	-	50,101	50,101
Total	1,071,388	655,164	1,162,775

4.2 Benefits associated with the Inbar's water quality standards

The benefit from a stricter water quality standard was estimated via the CVM which is best suitable for such hypothetical situations.

This method estimates the benefits of natural resources that cannot be monetary valuated in a direct manner. The valuation in this method depends on the estimations that the community gives to the natural resource. The U.S Water Resources Council developed the method in 1979 as an instrument for analyzing projects.

The method is based upon questionnaires[5] that evaluate the willingness of individuals to pay for environmental changes, purchasing the environmental product and the service provided by the natural resource. Individuals are asked directly about their willingness to pay for the environmental improvement, and the financial value that individual willing to contribute reflects the benefit that he or she receives from the product or service. Then the average willingness to pay is found, and it is extrapolated on the relevant population in order to evaluate the value of the site.

There are several important points in creating the questionnaire, including:

- Background on the natural resource, its current state and the possible changes.
- Question about the willingness to pay for preserving the resource.

[5] There are four different kinds of questions. Each has its advantages and disadvantages.

- A description of the hypothetical manner of payment.
- Socio-demographic data (age, income, etc.) in order to show validity of the willingness to pay question (why that price was quoted) and the manner of using the product (visiting the site, etc.).
- Questions that are directed to the statistical sample of population affected by the change.

The method intends to produce the closest estimation to real market situation, if exists. Therefore the questionnaire must simulate the market situation in a way which is closest to reality. It is important to note that this method allows comprehensive values of the resource, including use and non-use values. Therefore a greater benefit is expected using this method than using the TCM method.

Use values are values derived from direct use of the resource, mainly visiting the site. Non-use values are values derived not necessarily from using the resource and they include values such as the *option value* **-** to visit the site in the future, *bequest value* – knowing that the resource would be preserved for future generations, and *existence value* – the existence of the resource even if the respondent does not visit it.

<u>The advantages of the method:</u>

- The method is flexible and can be used to estimate the economical value of almost anything, real or virtual. It is more accurate when examining real merchandise and services.
- A revision experiment can be made on the respondent population and the kind of question, which requires presenting the questions to different populations and comparing the answers. This indicates how flexible the questionnaire is.
- Use and non-use values can be separated in the questionnaire.

<u>The disadvantages of the method:</u>

- The fact that the questionnaire presents a hypothetical possibility and not existing situation.

- The method assumes that the respondents that purchase real products will consider similar considerations to those they make while deciding on the willingness to pay for purchasing services in the resorts.
- The respondents are donating money to good causes such as rivers preservation. However, is this what they would be willing to pay in reality.
- Bias influencing the results:
    1. Some respondents have high willingness to pay not because the importance of the site, but the desire to be involved in good deeds.
    2. Some of the respondents would not be willing to pay although they are interested in rehabilitating and preserving the site, since they are afraid of a tax increase.

5. The questionnaire design and implementation

Between April-June 2006 a CVM survey took place, in order to estimate the benefit from stricter water standards. The survey was made by handing out the questionnaires in two public places: the first was Alexander River ("Turtle Bridge" area) while the second was distributed within train users in the Nahariya – Ben Gurion Airport line.

5.1 The questionnaire included:

Background on rivers pollution, the Alexander River rehabilitation project and the suggested environmental change for further treatment and improvement of the river water quality.

- The respondents were asked to quote how much they were willing to donate for rehabilitating the river water out of their budget**,** *on a yearly basis*. The price possibilities were presented to the respondents in an ascending order (Payment card) Close to the request to quote a price, there was a reminder about budget-planning compulsions and other environmental objectives that might be taken into consideration.
- A part which requested the respondents to choose the arguments explaining best why they quoted this price. The arguments included use and non-use values.
- A set of questions regarding the respondent's socio-demographic variants.

The survey sampled 300 respondents from diverse populations; most of them are Alexander River visitors. The questionnaire was short and practical, so the time needed for filling is was relatively short. The survey was presented to the respondents face to face.

At the same time as the questionnaires were completed, pictures showing the pollution situation in the river along the years and the soft-shell turtle's population stabilization were presented to the respondents. The presentation was accompanied by explanations. The set of pictures are presented in appendix A.

Following the Noaa's panel there were several conditions which should be met in order for the survey to be acceptable. It should:

- Be neutral.
- Make sure that the respondents are not under the impression that the survey intends to promote interests of one of the sides (green organizations, entrepreneurs, etc.)
- Be conservative in estimating the willingness to pay.
- Be confidential and not to be passed on to any external entity.
- Be anonymous

5.2 CVM – Descriptive Statistics:

Two hundered and ninety individuals completed the survey. Most of them—*85.2%*- were willing to pay a certain price for further river water rehabilitation. *11%* of them made a protest answer; hence they were left out of the analysis. We have arranged and processed the questionnaires for analysis. We excluded responses in which the respondents decided not to donate anything, using the arguments that is not their duty to finance this work and/or they can not afford to spend money on river rehabilitation. The exclusion of such responses yielded a narrower sample – 254 responses. In this sample the willingness to pay was positive in *96.6%* of the individuals sampled.
A summary table is provided in table 5.1. A more detailed description is presented in appendix B.

Table 5.1: Descriptive statistics of the WTP

	General willingness to pay (in NIS)		
	Total	Alexander River visitors	General population
Average	49.11417	51.2043796	46.6666667
Median	30	40	30
Mode	50	50	50
st. dev.	52.96078	59.1095865	44.8320621
skewness	3.478053	4.1490387	1.32199641
kurtosis	22.18628	26.0349143	1.29425797

As can be seen from the table, the average willingness to pay for household in Alexander River is higher compared to the general population (the train sample).

The division between use and non use values is presented in table 5.2 below:

Table 5.2: Mean WTP divided by use vs. non-use values

Existence	Relative part existence	Bequest	Relative part Bequest	Non-usage value total	Relative part total	Usage value	Relative part usage
23.83839	0.536575	17.24469	0.324646	41.08307	0.86122	7.902559	0.137283

As can be seen, most of the respondents, 86%, explained their willingness to pay with arguments related to non-use values. Table 5.3 presents descriptive statistics about the use value.

Table 5.3: Descriptive statistics – Use value

	Relative part (0.137)	Use value	
	Total	Alexander River visitors	General population
average	7.902559	6.73357664	9.27136752
median	0	0	0
mode	0	0	0
st. dev.	18.30867	18.7322162	17.782021
skewness	3.868498	2.08248529	2.14222943
kurtosis	22.84827	37.8112608	3.8948738

It can be seen from the table that the average use value is *dramatically* low compared to the average total of the willingness to pay. Indeed, it explains why the median and mode in both places equals zero. The average use value is higher in the general population compared to the Alexander River visitors. Table 5.4 presents a descriptive statistics of the non-use value.

Table 5.4: Descriptive statistics of the non-use value

	Relative part (0.861)	Non-use value	
	Total	Alexander River	Israel Railways
average	41.08307	44.3656934	37.2393162
median	30	30	20
mode	50	50	50
st. dev.	43.98136	49.6097498	36.1361099
skewness	2.694256	3.07091242	1.06671339
kurtosis	12.18117	13.2670617	0.04132562

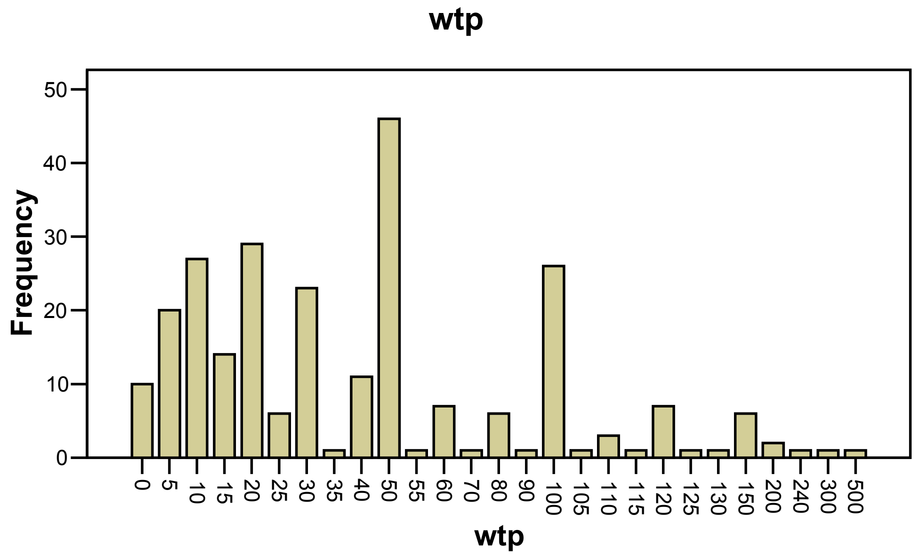
As can be seen from the table, the non-use values averages are higher than the use values averages presented in the previous table. The average non-use value among the river's visitors is higher than the train passengers. The median in the Alexander River sample (30 NIS) is higher than the median in Israel Railways sample (20 NIS).
Table 5.5 summarized both use and non-use together:

Table 5.5: Use vs Non-Use

	Use value	Non-use value	Total WTP
Total Average	7.902559	41.08307	49.114173
Alexander River	6.733577	44.36569	51.20438
General population	9.271368	37.23932	46.666667

Figure 5.1 presents the frequency distribution of the WTP.

Figure 5.1 WTP didtribution



It can be clearly seen from the graph that when the price increases, the number of people willing to donate that amount of money decreases. We also tested this relation in the Alexander River sample and Israel Railways passengers separately, but there were no significant differences between the two places.

Responses from local esidents (55) were separated from the wider sample (199). The reason for this decision was to test the WTP among the local residents only and compare the results to the total sample.

Tables 5.6. and 5.7 present descriptive statistics for both groups:

Table 5.6: Descriptive statistics – WTP within local residents

	Visits	Green Organization	education	income	usage	Non-usage	WTP
Valid	55	55	55	55	55	55	55
Missing	236	236	236	236	236	236	236
Mean	3.237091	1.163636	3.327273	3.454545	8.35	42.06364	50.54545
Median	2	1	4	3	0	30	35
Mode	2	1	4	3	0	50	100
Std. Deviation	3.760099	0.373355	0.903789	0.958745	16.05812	46.79263	51.45722
Minimum	0.1	1	1	1	0	0	0
Maximum	12	2	4	5	75	300	300

Table 5.7: Descriptive statistics – WTP within the general sample

	visits	Green org	education	income	usage	Non-usage	WTP
Valid	254	254	254	254	254	254	254
Missing	2	2	2	2	2	2	2
Mean	1.768858	1.110236	3.307087	3.283465	7.902559	41.08307	49.11417
Median	1	1	4	3	0	30	30
Mode	1	1	4	3	0	50	50
Minimum	0.1	1	1	1	0	0	0
Maximum	12	2	4	5	165	330	500

As was predicted, the mean WTP and all of it's components is higher among local residents than among all residents, but not dramatically. The average visits frequency of local residents is *double* than that of all responses.

Based on the above data, it is possible to calculate the benefit from further rehabilitation based on the responses of local residents only; the local residents are estimated at about 668,600 individuals, about 200,000 households. We gathered the required information in table 5.8:

Table 5.8: Willingness to pay and it's components – Local residents vs. the entire sample

Values	Non-use	Use	Total	
Alexander River	41.49796	6.259184	47.85714	Local residents
Israel Railways	46.68333	25.425	72.5	
Alexander River	44.36569	6.733577	51.20438	Entire sample
Israel Railways	37.23932	9.271368	46.66667	

The difference between the two samples (the local and general) is clear.. The train passengers living in the river basin are willing to pay more than those who live far from the site.

Averaging over the use value only for both visitors and the general population we get 9.02 million NIS which is equal to 2.2 million USD. Thus the value of future development with respect to stricter water quality standards is $2.2 millions. Since there is no way to divide the extra benefit between the Peace Park and the "turtle bridge" we assume that the benefit is equally shared.

5.3 Cost *Benefit* Analysis of stricter water quality standards

Based on the cost table provided in section 4.1 and the benefit derived for both sites of interest we can calculate the net benefit for the different alternatives. They are presented in table 5.9.

Table 5.9: Benefit of stricter water quality criterions (in M. $)

Peace park + Turtle bridge	**Turtle bridge**	**Peace park**	
1.16	**0.66**	**1.07**	**Costs**
2.2	**1.10**	**1.10**	**Benefits**
1.04	**0.44**	**0.03**	**Net Benefit (in M. $)**

It is interesting to note that investing in the two sites together is the preferred option. However, investing in either one of them alone passes the cost benefit test. The Peace Park has only a negligible net benefit while the better one is the Turtle Bridge. Since the Peace Park can contribute to a more peaceful life conditions to Israelis and Arabs along the river we can conclude that the shadow price of peace in this situation is $0.60 M. compared to the Turtle Bridge alone.

6. **Summary**:

This case study dealt with managing a cross border river in which there is a strong interdependence between different users. The major concern in the river is water pollution. We have conducted two economic analyses. The first economic analysis tested the 10 years long master plan of the river between 1995 and 2005. The second economic analysis tested the stricter water quality standards which will enable more use along the river.

In order to perform the first analysis we have modeled the entire river system from hydrological point of view. We than estimated the costs associated with the master plan action which were taken in the 1995 – 2005 period. We contrasted those costs with the benefits derived from this acts where these benefits were divided into market and non-market ones. The market benefits were derived by the shadow price of the removed wastewater into agriculture while the non-market benefits were derived by the Travel Cost method.

The major conclusion is that only by a mixed strategy which dealt with *all* major pollution sources, was there a positive net benefit. This net benefit was estimated to be about $0.49 million annually.

In order to perform the second economic analysis we measured the incremental cost associated with stricter water quality standards. Those were measures at two points, namely the Turtle Bridge and the potential Peace Park. The costs associated with these stricter standards were contrasted with the benefit. This time there were only non-market benefits involved and since it is a hypothetical scenario we have used the CVM in order to estimate them.

The major conclusion here is in line with that of the first economic analysis. Undertaking both projects seems to be the best alternative. If we restrict ourselves to only one project, the Turtle Bridge is the better option. However, in order to foster cross border cooperation, the alternative cost of creating a Peace Park is about $0.6 M.

7. Appendix A: Pictures shown in the CVM survey to demonstrate the past, present and "future" situation

(All pictures were taken by A. Gazit)

Before

Current

Future

8. Appendix B: Socio-demographic profile in the CVM questionnaire:

Factor	Average / Characteristic	Description
Age	Age average 22-29 years	The age range 18-35 is 52% of the sample
Gender		46%- male; 54% -female
Country of origin	Most of the respondent were born in Israel	85%- Israel; 15% -other
Number of children	33% of the respondent do not have children	33%- none; 12%- one child; 26.5%- two children; 21%- three children; 6.25%- four children
Income	The average income observed is a little over the average income	3.1%- significantly below the average; 10.5%- below average; 45%- average; 35%- over the average; significantly below average
Education	Most of the respondents are academic, 58% observed	1%- elementary; 26%- high school, 14%- professional; 58%- academic
Green organizations	The majority of the sample are not green organizations activists	89%- non activists; 11%- activists
Marital status	The majority of the sample respondents are married	26%- single; 70%- married; 4%- other
Visits frequency	25% of the sample respondents visit the reservation every year	10%- have not visited; 14%- 10 yrs; 1%- 9 yrs; 1%- 8 yrs; 1%- 7 yrs;1.5%- 6 yrs; 6%- 5 yrs; 2.7%- 4 yrs; 5.5%- 3yrs; 6.2%- 2 yrs; 24%- 1 year; 0.4%- 11 mns; 0.4%- 10 mns; 0.4%- 8 mns; 10.5%- 6 mns; 0.8%- 5 mns; 1.5%- 4 mns; 4.3%- 3 mns; 2.4%- 2mns; 6%- 1 month