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Stream restoration as a basis for Israeli-Palestinian cooperation: a comparative analysis of two transboundary streams

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Research paper

Stream restoration as a basis for Israeli–Palestinian cooperation: a comparative analysis of two transboundary streams

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ABSTRACT

Transboundary environmental degradation often poses serious health and security threats to regional residents. The Israeli–Palestinian conflict further aggravates an environment already characterized by water scarcity, environmental distress and polluted waterways. Yet, common ground appears to emerge from a recent contingent valuation study in which both Israelis and Palestinians reveal common water use and riparian restoration preferences, as well as comparable willingness to pay for proposed restoration efforts. These surprising results – especially that despite vast economic hindrances, Palestinians have revealed similar willingness to contribute financially to stream restoration – indicate the seriousness of regional health issues and demonstrate a foundation for future cooperative restoration efforts. A simple cost–benefit analysis is conducted, which sheds light on future policy formation, especially with regard to water treatment and allocation decisions for both societies.

Keywords: Transboundary; stream restoration; contingent valuation; cost–benefit analysis

1 Introduction

Israeli–Palestinian hydrological dynamics are characterized by water's distinctive tendency to cross borders. Some 16 streams are transboundary in nature, with roughly two-thirds originating in Palestinian lands, moving across Israel and emptying into the Mediterranean to the west, while one-third originate in Israel and flow into the Palestinian West Bank to the east (Kaplan 2004, Morel and Morel 2006). The area's steep north–south rainfall gradient contributes to considerable contrasts in the flow and morphology of these watersheds. Yet, the environmental conditions of these waterways share basic similarities in the consistently high levels of pollution that preclude recreational and ecological uses of the streams (United Nations Environment Program 2003, Amir-Shapira and Mazor 2004). While the local streams are largely naturally ephemeral, flowing only intermittently during the rainy winter season, most have become 'perennial', receiving a steady flow of poorly treated effluents and even raw sewage from local communities (Tal 2002).

This study assesses the Palestinian and Israeli public perceptions and preferences for stream restoration work in two transboundary watersheds: the Zomar/Alexander and the Hebron/Besor basins (Figure 1). The primary questions asked in this study are: (1) What are each public's water

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Figure 1 Area of study

use preferences, given proposed restoration efforts? (2) What are some of the non-market benefits of such restoration projects? and (3) What are the regional water use implications from these results?

Past experiential wisdom is that effective restoration of local streams requires a coordinated effort between Israelis and Palestinians. Investment in infrastructure to control pollutants by one side will not produce meaningful progress for the regional environment (i.e. groundwater contamination) if pollution continues by the other party. To date, such coordination has been minimal and cooperation is difficult, given the asymmetrical conditions existing between the two entities. It has been widely assumed that the transboundary differences in Israeli and Palestinian society and economy would be manifested in the respective environmental and water use preferences. This assumption is challenged by this study, and a foundation is established for future shared transboundary restoration efforts.

In this study, the contingent valuation (CV) method is used in order to estimate the non-market benefit of restoring both streams. CV measures non-market and especially non-use values. Without taking into account these values, it is impossible to justify such a project on the basis of a cost–benefit analysis (CBA).

Section 2 presents the basic problems faced by the two watersheds across both Israeli and Palestinian societies. Section 3 is an overview of relevant CV studies. Sections 4 and 5 highlight the details and results, respectively, of the non-market benefit study, including a brief CBA. Results are discussed in Section 4, with a brief conclusion.

2 Description of the study area: hydrology and socioeconomics

The Zomar/Alexander watershed reaches from the western edge of the Palestinian city of Nablus to the Mediterranean Sea in the central region of Israel. The Khalil/Besor watershed is located in the more arid region of Hebron and Beersheba from the Negev Desert and westward to the Gaza Strip. Both these streams are naturally ephemeral with flow only occurring during rainy, winter months. Today, however, both stream systems are dominated year-round by base-flow from sewage, discharged by the Palestinian cities of Nablus and Tul Karem in the northern watershed and Hebron in the south, as well as a variety of Israeli point and non-point sources. The Wadi Zomar and the Wadi Khalil each receive some 5 million m^3/year of domestic effluent at the Green Line (USAID 2001, Brandeis and Halbitz 2007). While many other pollution sources exist, by far the most apparent and pressing is this perennial base flow. Recent considerations have taken place among stakeholders in both watersheds regarding the possibility of using this effluent in proposed scenarios of restoration, as treated sewage has a high economic potential to be diverted to in-stream flows in such water scarce regions as the Middle East.

The interactions between the two watersheds' many differences, coupled with the social dynamics across the Green Line (the Israel/West Bank border since 1967) creates a complex matrix of factors that affect environmental attitudes and preferences. Initial expectations were that since the Palestinian economy is relatively weaker, Palestinians do not have the 'luxury' of valuing environmental goods highly, especially in light of extreme local water scarcity. This, however, was a bit of a simplification in which environmental improvements often affect both rich and poor alike. Becker and Katz (2006) also indicate that regional willingness to pay (WTP) for improvements to the Dead Sea environment are similar in Israeli, Palestinian and Jordanian populations (Becker and Katz 2006). Nevertheless, strong transboundary economic differences are associated with differences in *ability* to pay for stream restoration. Israelis, with a developed, post-industrial economy, presumably would be much more able to pay for environmental goods. Specifically, in 2006, per capita GDP in Israel was roughly \$25,000/year (Israel Central Bureau of Statistics 2007), while in the West Bank (and Gaza Strip) it was only \$1100.[1] The recent political turbulence in the Palestinian Authority and the withholding of financial support by donor nations has exacerbated economic conditions. Accordingly, significant personal economic commitment to stream restoration for recreational use in Palestinian communities was not anticipated.

Another factor that contributes to the asymmetrical conditions is the severity of water scarcity itself. In Israel, average annual

per capita water use is on the order of 100–125 m^3/year, making it a water scarce country by international standards (Shuval and Dweik 2007). Yet, for most Israeli citizens, water scarcity is an issue of theoretical concern, and not a part of the local daily experience. By way of contrast, in the West Bank, where annual per capita water use is estimated at 35 m^3/year, and where municipal networks often provide water during only a limited number of hours in the day, water scarcity is experienced as a pressing, existential issue (Shuval and Dweik 2007). Thus, water allocation preferences would be expected to reflect the scarcity of water.

In both streams, environmental conditions are worse in the upstream Palestinian sections than in the downstream Israeli segments. For the Zomar/Alexander watershed, this asymmetry is further accentuated by an emergency treatment plant located just inside the Israeli border that purifies incoming flow to a primary level, albeit somewhat unreliably, thus improving water quality downstream. No such treatment exists in the Besor/Khalil watershed yet, although a similar Israeli plant to treat Palestinian sewage is presently under construction (Besor Drainage Authority).[2]

At the same time, significant differences exist in basin characteristics in the Palestinian versus the Israeli sides in both watersheds. There is significantly more precipitation in the Zomar/Alexander watershed than the southern area (500–700 mm/year versus 50–150 mm/year) with estuarial conditions at the bottom segment allowing for far greater recreational potential (Isakson 1996). Accordingly, the existence of a 'flagship ecological species' in Israel's Alexander Stream, the Nile soft-shelled turtle (popularly nicknamed 'Alex') surviving in its only remaining habitat in Israel, offers a popular destination for nature lovers and tourists (Becker *et al.* 2007). The photogenic giant turtles provide an additional reason for predicting that Israelis would be more committed to environmental protection and restoration in the watershed than Palestinians who lack such a tangible ecological amenity. This dynamic also exhibits a latitudinal gradient: the southern Hebron/Besor watershed has no comparable 'ecological' attractions that might serve to encourage restoration efforts in the area, other than the shared possibility of tourism associated with a restored stream ecosystem.

3 Methods

3.1 Measuring non-market benefits: the contingent valuation method background

Since the 1960s, the CV method has been employed to determine the total economic value (TEV) of environmental goods that would otherwise receive vastly underestimated market value in economic analysis (Carson 2000). The study embraced the concept of TEV of water resources as defined by Birol *et al.* (2006), which is summarized in Figure 2.

This concept is applied when conducting a CBA in which the value of an entity or goods is assessed and compared with its costs. Figure 2 demonstrates that the market price of water, traditionally associated with direct use value, does not represent the full benefit associated with a water resource. Thus, we have considered both use and non-use values, including indirect uses (specifically pollution abatement and other public health benefits) as important factors to include in a CBA.

3.2 Contingent valuation in the literature

CV studies have been conducted in both developed and developing countries to elicit the value of non-market goods as diverse as sanitation improvements (Lauria *et al.* 2001), health care (Tang *et al.* 2007), water supply (Casey *et al.* 2006), rainforest protection (Kramer and Mercer 1997), protection of endangered species (Tisdell *et al.* 2005), conservation of nature parks (Togridou *et al.* 2006) and of course environmental quality (Wang and Mullahy 2006). While much controversy remains over its precision and ethical legitimacy, the CV is an established approach in the literature (Diamond and Hausman 1994, Pourtney 1994). By now, over 2000 CV studies have been conducted in over 50 countries with the goal of providing a valuation of non-market goods (Carson 2000). Insights that CV research can offer environmental managers in the context of river or stream restoration are particularly salient (Loomis *et al.* 2000, Berrens *et al.* 2007). CV results of stream restoration projects have been shown to be consistent before and after project implementation (Tunstall *et al.* 1999). Ruijgrok and Nillesen (2004) established that certain types of riverbanks elicit higher non-use values than others. This has important implications for our study, since the two watersheds are distinct in hydrological and ecological characteristics.

Flug and Montgomery (1988) demonstrated the need to account for temporal variation of environmental benefits associated with streams. The study's methodology consisted of identifying potential in-stream benefits (specifically boating, fishing and rafting) of the New River Gorge National River in West Virginia, and evaluating the uncertainty of those predicted benefits. The study found that such benefits exhibited a seasonal pattern,

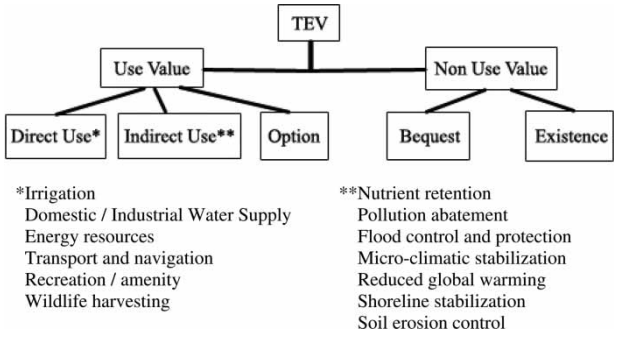

Figure 2 Components of total economic value of water resources (adapted from Birol *et al.* 2006)

inversely related to the seasonal flow of the river. In the present study, this factor is exaggerated by the precipitation contrasts and semi-arid versus the arid climate of the two watersheds as well as the naturally ephemeral dynamics of the streams. Moreover, the dramatic shift in the north–south rainfall gradient creates two very different flow regimes: the Hebron/Besor stream system naturally only contains water for a few days out of the year, while the Zomar/Alexander enjoys a far greater, but still highly seasonal flow. Accordingly, it is important to note that while boating, fishing and swimming are options for the Alexander Stream, for the foreseeable future these activities were not considered possible in the other three watershed sections studied (the Zomar, the Khalil and the Besor).

A recent travel cost (TC) method and CV study on the Turtle Bridge recreation site of the Alexander Stream yielded significant use and non-use benefits from current restoration efforts (Becker *et al.* 2007). While the TC method projected a use value ranging from 10.2 to 36.8 million shekels (about 2.5–9 million USD) per year, the CV research (which includes both use and non-use values) showed a benefit from recreational and passive use of the Alexander Stream of 5.1–92.1 million shekels (1.3–28 million USD) per year. Other studies in the region have shown significant WTP for environmental restoration efforts (Becker *et al.* 2005, Becker and Katz 2006).

3.3 Survey methods

This research utilized a survey given to a random national sample of Israelis and Palestinians (living in the West Bank – Gaza was out of reach since there was no effective research partner for this study) over the period of February to April 2007. Respondents were asked to fill out a questionnaire containing questions about river restoration. They were given a clipboard and pen with a survey and were asked to hand the survey back as soon as they finished. Respondents were chosen randomly from public places such as parks, hospital clinics, cafes, highway rest stops, universities and beaches. Differences between sample mean and overall population mean were accounted for while sampling to maximize representativeness. To this end, supplementary surveys were issued to ensure representation of the full range of local ethnic and geographical diversity. In addition, a sub-sample of visitors to the streams was taken among Israeli respondents to investigate the relationship visitation rate may have on WTP and other preferences. Cases where respondents refused to fill out the survey were counted as non-responses.

In the survey, the CV method was used to elicit the respondents' WTP for different levels of stream restoration. Although dichotomous choice mechanisms tend to introduce less bias into CV models (Arrow *et al.* 1993), the payment card (PC) method was used, in which respondents are asked to circle the amount of money on a 'menu' of choices that corresponds to their maximum WTP. This method was chosen in place of the dichotomous choice (DC) approach because while well accepted in certain sociopolitical contexts such as the USA where it is a common media for public policy questions, the DC method has to the knowledge of the authors not been used in the region and therefore presents respondents with a format with which they are unfamiliar. In addition, PC approaches have been demonstrated to provide more conservative valuation estimates (Ryan *et al.* 2004, Blaine *et al.* 2005). One weakness of the PC method, known as 'range bias', is that inappropriate payment card design may truncate the respondent's true WTP, thus skewing the results (Rowe *et al.* 1996). This was minimized during pre-testing of surveys. Each WTP bid was taken as a response for the entire household.

3.4 Survey preparation

A significant effort was spent on survey design, drafting and testing the survey instrument in a variety of pilot trials with different cohorts in a variety of settings to ensure the viability of a questionnaire for both Israelis and Palestinians. The 6-month preliminary groundwork was anticipated as it is common to spend 8 months or more on survey design (Loomis *et al.* 2000). The questionnaire was drafted after considering surveys used in previous environmental CV studies (Daubert and Young 1981, Flug and Montgomery 1988, Becker *et al.* 2005, Al-Ghuraiz and Enshassi 2005) and after consultation and several focus group tests. The questionnaire was developed in English and subsequently translated into Hebrew and Arabic. While there was a single baseline questionnaire format, specific questions were expressed differently in four different questionnaires, one for each side of the two watersheds of the study. On the Israeli side, surveys were also available in Arabic to accommodate Arab–Israeli citizens.

During the development of the final survey questions, a technique known as the 'think-aloud' probe was used (Presser *et al.* 2004). Respondents were first asked to individually fill out the survey and then asked to provide their thought process for each question in a group discussion. This technique is used to analyse and diagnose any problematic questions in the survey (Presser *et al.* 2004). After pre-testing, a rough final version was completed and back-translated into English to confirm that no meaning or connotations had been lost in translation. Once consistency was confirmed, the final version was completed and survey distribution began.

To ensure valid results, several guidelines are important when designing CV surveys. Carson (2000) outlines several conditions which most good CV studies share:

(a) an introductory section that helps set the general context for the decision to be made;
(b) a detailed description of the good (i.e. environmental improvement) to be offered to the respondent;
(c) the institutional setting in which the good will be provided;
(d) the manner in which the good will be paid for;
(e) a method by which the survey elicits the respondent's preferences with respect to the good;

(f) debriefing questions about why respondents answered certain questions the way that they did;
(g) a set of questions regarding respondent characteristics including attitudes and demographic information.

These guidelines have been applied to the survey design.

3.5 Survey instrument

The survey consisted of five sections. First, there was a description of the environmental health of the stream, as well as recent restoration efforts. The description was annotated with current photos of the stream. This section was extremely important for the survey, since the respondents' understanding of stream conditions tends to drive their response. Colour photographs were first used for this purpose in the mid-1970s (Randall *et al.* 1974, Brookshire *et al.* 1980). Two main proposals were presented: treating the effluent that is currently in the stream as baseflow, and allowing it to flow year-round at different levels of quality, or treating the effluent base flow and diverting it for other uses – in particular for agriculture. This study has adopted the incremental valuation of benefits associated with water quality as established by Daubert and Young (1981), which included a quantification of benefits from incremental increases of water quantity as measured by the different uses each level allows (boating, fishing and swimming). Within each proposal, several levels or 'stages' of restoration were presented. These are defined in Table 1.

The second section consisted of a hydrological preference question in which respondents were asked to consider the above proposals and decide whether they preferred the stream to be perennial (flowing throughout the year) or ephemeral (dry for most of the year, excepting winter rains).

The third section was designed to apply the CV, where respondents were asked to rate their willingness to pay for their preferred state of restoration. The payment method was a hypothetical stream restoration fund to which respondents would be making voluntary donations in the local currency, new Israeli shekels (NIS). Respondents were reminded that while the questions were hypothetical, their responses would be helpful in planning the restoration process. Each restoration state (perennial or ephemeral) has several stages, so respondents were reminded that they could go back and change their responses after being prompted for an additional hypothetical payment.

The fourth section included follow-up questions to the CV. The purpose of these was to further characterize respondents' attitudes. Respondents were asked to read through a list of possible reasons for their responses, and mark those that applied to them. One important role of this section was to identify protest bids, in which respondents who actually may have had positive WTP responded with a zero bid because of disagreements with some element of the survey. During the data analysis, these bids were isolated from the responses and disregarded in the WTP calculations. Another function of this section was to separate use value from non-use value.

The fifth section elicited environmental and water use preferences for in-stream flows. The sixth section consisted of various demographic questions. The purpose was to allow for deeper insights using standard econometric methods in which a correlation is tested between the WTP and the explanatory demographic variables. It was also useful to evaluate how representative of each society the respondents were, a clear indication of relevance to policy decisions.

Non-responses were counted and defined as cases when someone who would otherwise have been able to respond chose not to respond.

4 Results

4.1 Demographic analysis

Table 2 describes the demographic data in Israel and the West Bank. As a whole, survey respondents were significantly younger and more educated than national averages. Israeli respondents were more representative of the greater population than those in the West Bank, as shown by the magnitude of the differences from Palestinian national demographic characteristics. This can be accounted for by travel limitations and cultural factors (such as gender issues) specific to the West Bank, as well as by survey distribution constraints including time and other resources. For instance, travel restrictions imposed on West Bank residents impeded survey distribution significantly, making the Palestinian population available for sampling much more fragmented. While this causes substantial deviations (especially in the categories of 'age' and 'education'), it does not appear to affect statistically significant factors of the WTP bid, as discussed below.

4.2 Survey response rate

Survey responses varied across the Green Line. Table 3 compares total valid responses for WTP, non-responses and response rates for each of the four survey regions.

Table 1 Stages of restoration

Stage 1	Water quality is safe for non-contact recreation, such as boating, and allows minimal restoration of wildlife and habitat
Stage 2	Health of fish and other aquatic populations is ensured. Thus, fishing is possible. It is also safe for consumption for domestic animals (sheep and goats)
Stage 3	Swimming and other contact recreational activities are possible
Park and Trails	This involves creation of a park and walking trails along the restored stream, independent of the above stages

Table 2 Comparison of demographic data of national populations versus surveyed respondents

	Israel		West Bank	
	National data[a]	Survey	National data[a]	Survey
Gender (%)				
Male	49.4	52.6	50.9	68.3
Female	50.6	47.4	49.1	31.7
Family size	3.74	4.1	6	3.71
Urban population[b] (%)	91.2	92.4	69	84.1
Age group-relative (%)				
18–64	85	97.6	93.1	100
65+	15	2.4	6.9	0
Highest education level (%)				
Secondary	54	36.5	61.9	25.4
Professional	22	14.4	4.4	8.8
Academic	19.8	49.1	4.3	60.2
Relative income (out of five)	2.5	2.8	2.5	2.4

[a]Tunstall *et al.* (1999).
[b]For Israeli data, 'urban' refers to communities greater than 2000. For the West Bank, it is for 10,000 or more.

Table 3 Response rate in Israel and the West Bank

	Israel		West Bank	
	Alexander	Besor	Zomar	Khalil
Total responses (*N*)	169	196	181	197
	365		378	
Non-response	200		25	
Response rate (%)	64.6		93.4	

Response rates are much higher in the West Bank, perhaps due to demographic and social asymmetries. Another explanation could be that while in Israel part of the respondents were visitors, in the West Bank all respondents were living in the vicinity of the stream.

4.3 *Stream type preference*

The majority of both Israeli and Palestinian respondents prefers perennial, flowing streams, although a higher percent of Israelis prefer flowing streams than do Palestinians. Table 4 provides a breakdown of respondents' preferences. In either case, the 'unnatural' flow of the streams was deemed preferable by all cohorts in all watersheds to the naturally 'dry', ephemeral riverbeds.

Table 4 Stream type preferences (%)

	Israel		West Bank	
	Alexander	Besor	Zomar	Khalil
Perennial	93.3	91.1	78.5	77.5
Ephemeral	6.7	8.9	21.5	22.5

4.4 *Water use preferences*

Due to the dramatic contrasts in their political and institutional circumstances, the questions asked in the two societies were not identical. The following excerpt is translated from the Israeli survey of the Alexander stream:

> If the government needs to decide between using treated wastewater supply for meeting agricultural water needs, or to stream restoration, which do you prefer? Please circle your response.
>
> Agriculture Streams

On the Palestinian side, a similar water use preference question was framed in terms of delivering water to two competing sectors: water supply (for agriculture) or the environment. This was due to the concern that the lack of perceived stability in government structure may influence Palestinian responses, skewing the results away from a reflection of true water use preferences. Consider the backtranslated excerpt from the Zomar survey:

> There are two main issues regarding the Wadi Zomar restoration:
>
> Water supply and Environment.
>
> Water Supply: Since the wadi is located in a dry area, not so much water is available for people's consumption. So if the sewage in the wadi were treated, people could use the water again.
>
> Environment: If the sewage is treated, the ecosystem would improve, the wildlife would improve, and the entire area would become healthy whether there is water in the wadi or not.
>
> Which issue is more important to you?

The agricultural use value of water was unavoidably embedded within the issue of stream preference. By treating effluent and diverting it from the stream, it was understood that water would be made available for irrigation, as is common in the region. For instance, almost 50% of Israel's irrigation sector is now using treated sewage effluents (Shuval and Dweik 2007), and water scarcity has found its place in the local mindset. While market prices do indicate the local demand for reusable effluent, it was an important aim of this study to determine the non-market benefit of stream rehabilitation, *ceteris paribus*.

Caution must be used in comparing these two results, since the questions were different in significant ways. Agricultural water use, for instance, is only one component of what may be considered 'water supply' issues. Nevertheless, similar inclinations seem to emerge suggesting that Israelis and Palestinians share a commitment to ensuring the flow in streams, even if it is treated effluent in naturally ephemeral watersheds. While some differences may appear to be problematic, it is unlikely that water use priorities (environment versus water supply) differ

Table 5 Water use preferences in Israel and the West Bank (%)

Israel	Agriculture	Streams
	67.6	32.4
West Bank	Water supply	Environment
	63.1	36.9

significantly from their associated implementations (stream restoration versus agriculture). Table 5 presents the breakdown between preferences in both populations.

Both the Israeli and Palestinian publics showed *highly* similar preference trends. On the Israeli side, about two out of three respondents (67.6%) preferred treated wastewater to be used for agriculture as opposed to stream restoration. A similar fraction of Palestinian respondents (63.1%) indicated that, when considering the restoration of the streams studied, water supply issues were more important to them than environmental issues.

An interesting paradox can be observed in these results. When both societies were asked this general water use question, they revealed a preference for allocating water for the benefit of water supply/agriculture. However, the individual stream preferences revealed by the survey contradict these results: if water is allocated to water supply or agricultural use, then less is available for the environment or stream restoration. Nevertheless, most respondents in both societies responded in favour of perennial streams, which require water allocation from limited water resources.

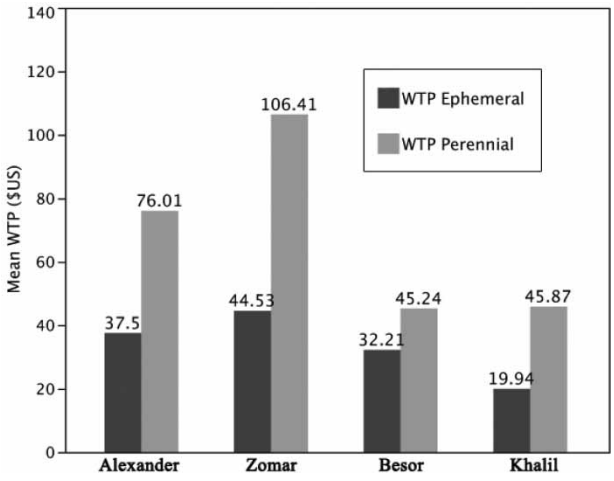

Figure 3 Mean household willingness to pay by stream and stream type preference (in US dollars: 4 NIS = 1 USD)

4.5 *Non-market value (WTP)*

Household WTP values are based upon the mean values given for each stream preference. These were estimated using several analytical techniques. First, WTP values were only considered if a stream preference was indicated or could be induced from other results. If no preference was indicated, the higher total WTP value was taken as an indication of stream preference. If this still did not yield a valid WTP response, the sample was disregarded from WTP calculations. Figure 3 describes the mean WTP at the different streams for highest proposed levels of stream restoration.

Note that for every watershed region, the public's WTP for ephemeral streams is significantly less than the equivalent WTP for perennial streams. The extremely high WTP values for both perennial and ephemeral variants of the Wadi Zomar are extraordinary, and will be further discussed. The Alexander/Zomar region elicits higher WTP than the Besor/Khalil watershed for both societies as can be seen from Table 6.

In order to calculate the total mean household WTP, we use the following formula:

$$\mathrm{WTP} = \frac{1}{2}\left(\text{Mean WTP unmet preference}\right) \times \left(\text{Percent of responses}\right) + \left(\text{Mean WTP met preference}\right) \times \left(\text{Percent of responses}\right)$$

Since only one of the two preferences can be realized, we take the full proportion of WTP values of those who prefer the outcome, and add one-half of the proportional WTP of those who do not. This is a rough estimate for valuations that were not directly elicited from the surveys.

The non-use and use value distribution is described in Table 7.

In both societies, more than half of the WTP responses are attributed to non-use values. These include both bequest and existence value as outlined above. This figure is comparable

Table 7 Israeli and Palestinian WTP bid responses

	Israel		West Bank	
Value	Count	Percent	Count	Percent
Non-use	385	57.89	336	64.62
Use	280	42.11	184	35.38

Table 6 Calculation of total mean WTP (in US dollars: 4 NIS = 1 USD)

					Total mean WTP	
Stream	Mean WTP, perennial	Percent preference	Mean WTP, ephemeral	Percent preference	Perennial	Ephemeral
Alexander	76.01	93.3	37.50	6.7	72.17	37.97
Zomar	106.41	78.5	44.53	21.5	88.32	51.34
Besor	45.24	91.1	32.21	8.9	42.65	23.47
Khalil	45.87	77.5	19.94	22.5	37.79	22.26

Table 8 Calculation of total use value

Watershed	Stream	Mean household use value ($US)	Annual visiting households	Total use value (million $US)		Annual use value[a] (million $US)	
Perennial stream variant							
Northern	Alexander	35.15	100,000[b]	3.52	3.94	0.176	0.197
	Zomar	31.27	13,342[c]	0.42		0.021	
Southern	Besor	17.96	100,000	1.80	1.98	0.090	0.099
	Khalil	13.37	13,342	0.18		0.009	
Ephemeral stream variant							
Northern	Alexander	15.96	100,000[b]	1.60	1.84	0.0798	0.0919
	Zomar	18.16	13,342[c]	0.242		0.0121	
Southern	Besor	9.88	100,000	0.988	1.09	0.0494	0.0547
	Khalil	7.88	13,342	0.105		0.053	

[a]Annual benefit = total benefit × interest rate. We assume interest rate = 5%.
[b]Becker *et al.* (2007).
[c]Proportional visitors based on demographic data (Salha 2005).

with other recent CV studies (Douglas and Taylor 1999, Ruijgrok and Nillesen 2004). By taking the proportionate amount of use and non-use value and multiplying by the appropriate population size (use value corresponds to number of annual visitors, while non-use value corresponds to total population), total benefit can be calculated. This is described in Tables 8 and 9.

The total non-market benefit is substantial. Although using population data of the entire society may be unrealistic due to substitute goods and lack of geographic sensitivity, the values calculated show surprising potential for stream restoration projects to be a valued public good among households in both societies.

4.6 *Market value*

Consider the current price of agriculturally reusable effluent to be about \$0.18 m^3 (in 2003 dollars) (Fine *et al.* 2006). Total market benefit from each watershed is given in Table 10.

Table 9 Calculation of total non-use value

Watershed	Stream	Mean household non-use value ($US)	Total households	Total non-use value (million $US)		Annual non-use value[a] (million $US)	
Perennial stream variant							
Northern	Alexander	48.33	1,968,000[b]	95.1	110.1	4.76	5.51
	Zomar	57.07	262,568[c]	15.0		0.75	
Southern	Besor	24.69	1,968,000	48.6	55.0	2.43	2.75
	Khalil	24.42	262,568	6.4		0.32	
Ephemeral stream variant							
Northern	Alexander	21.95	1,968,000[b]	43.2	51.9	2.16	2.60
	Zomar	33.18	262,568[c]	8.71		0.436	
Southern	Besor	13.59	1,968,000	26.7	30.5	1.34	1.53
	Khalil	14.38	262,568	3.78		0.189	

[a]Annual benefit = total benefit × interest rate. We assume interest rate = 5%.
[b]Becker *et al.* (2007).
[c]Proportional visitors based on demographic data (Salha 2005).

Table 10 Estimated market benefit of diverting treated effluent to agriculture

Watershed	Reusable effluent – present (MCM/year)	Reusable effluent – 2025 (MCM/year)	Annual market benefit – present ($US)	Annual market benefit – 2025 ($US)	Average annual benefit – 2025 ($US)
Northern	2.5	12.5	450,000	2.25 million	1.35 million
Southern	5	25	0.9 million	4.50 million	2.7 million

Projected effluent estimates from Volvendo Consulting (2005) and USAID (2001).

These rough estimates demonstrate that non-market benefits outweigh the price (market value) of treated wastewater. These two outcomes, however, are not mutually exclusive: stream restoration activities produce both market and non-market values. The reuse of treated effluents for agriculture can be facilitated by diverting wastewater after it is allowed to flow through a section of the streambed, an important possibility in such a water scarce region.

These figures are lower bound estimates for total benefit. Other ancillary benefits associated with the restoration project should be considered. Health risks associated with mosquito and odour nuisances surrounding communities are significant, providing an associated public health benefit. Also, reduction of groundwater contamination from effluents that presently percolate into groundwater is associated with a significant future cost reduction. Increased property values along the restored streams may prove substantial. Beer Sheva, a city of 200,000 that is planning its future urban growth along a riparian urban park, may experience such benefits as were recently revealed in an effluent reuse strategy in San Antonio, Texas.[3]

4.7 *Cost–benefit analysis*

Cost estimates were conducted with the assumption that wastewater treatment and reuse, while not the only investment associated with stream restoration, represent the primary cost and all others (construction of parks and trails, garbage removal, etc.) may be neglected for the purposes here. A recent study of Israeli wastewater reuse found that, due to the necessary removal of excess nitrogen for stream discharge, it is actually less costly to treat wastewater for agricultural reuse (Fine *et al.* 2006). The CBA results are shown in Table 11.

Perennial stream variants elicit greater net benefit than the ephemeral state with agricultural reuse. It is noteworthy that the possibility of both agricultural and in-stream uses are real and viable in the region. Restoration of the northern watershed elicits greater benefit than costs. The success of a recent restoration project along the Israeli stretch of the Alexander Stream confirms the feasibility of such efforts (Brandeis and Halbitz 2007). On the basis of existing data, the southern watershed comes close, but appears to fail a CBA. A more detailed analysis of the anticipated increase in property values in the city of Beer Sheva as a result of natural resource restoration in the future might change this equation.

4.8 *Marginal WTP*

According to economic theory, marginal willingness to pay for an additional level of restoration should be decreasing, as demand for a good decreases with increasing price. This was confirmed by the survey results and is presented for perennial streams in Figure 4.

Except for the Besor Stream (in which only Stage 1 applied), the overall trend for restoration stages is such that the marginal value of restoration is decreasing.

4.9 *Regression analysis*

The WTP responses of the survey were regressed on the demographic factors using ordinary least squares. Factors include water use preference (agriculture versus streams), visitation rate, satisfaction with household water (quality, quantity and reliability), sex, age, birthplace (in or out of Israel/West Bank), marital status, number of children, distance from residence to watershed, population size of residence, green organization membership, highest education level and relative income.

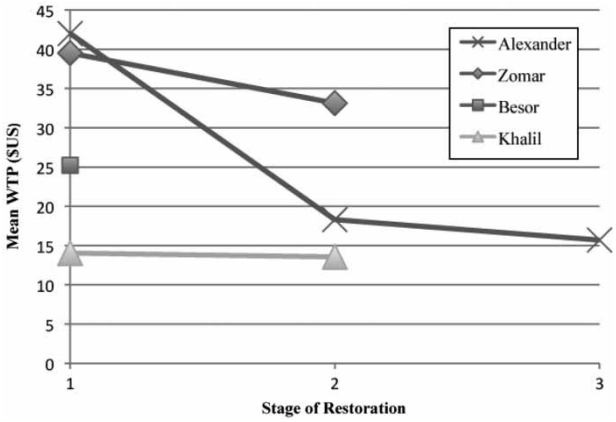

Figure 4 Mean WTP for incremental stages of restoration of a perennial stream (in US dollars: 4 NIS = 1 USD)

Table 11 Calculation of net benefit

Watershed	River recharge treatment cost ($US/m^3)	Mean annual discharge (MCM/year)	Mean annual cost ($US million/year)	Mean annual benefit ($US million/year)	Net benefit ($US million/year)
Perennial stream variant					
Northern	0.41	7.5	3.08	7.06	3.98
Southern	0.41	15	6.15	5.55	−0.60
Ephemeral stream variant					
Northern	0.36	7.5	2.7	4.04	1.34
Southern	0.36	15	5.4	4.28	−1.12

Table 12 Reduced form regression analysis of factors affecting total WTP

	Israel		West Bank	
R^2	0.0925		0.299	
N	159		240	
	Coefficient	*t*-Stat	Coefficient	*t*-Stat
Intercept	25.42	0.288	82.37	0.751
Visitation rate (per year)	14.06	3.611***	NA	NA
Stream	67.79	1.700*	210.84	4.621***
Satisfaction with water reliability	NA	NA	61.72	2.714***
Satisfaction with water quantity	NA	NA	−64.83	−3.029***
Marital status	NA	NA	−93.01	−2.101**
Income	NA	NA	140.17	6.801***
Perennial/ephemeral	NA	NA	−138.94	−2.687***

*$P < 0.10$, **$P < 0.05$, ***$P < 0.01$.

Reduced form equations were used to rerun the regressions using only factors found to be statistically significant at the 90% level. This is presented in Table 12.

4.10 Significant factors of WTP

4.10.1 Visitation rate (per year)

Respondents were asked to indicate the number of times per year they intended to visit the stream if it were restored to their desired level and state of preference. Israeli responses were highly related to this factor, while no relationship was found among West Bank respondents. In fact, for every additional intended visit per year, Israelis were willing to contribute roughly $4 more to restore the stream.

It is important to note here two aspects related to the transboundary nature of the project. First, mean residence-to-watershed distance is significantly asymmetrical: in Israel, it is 37.5 km, with 25.2% of respondents living in the watershed, whereas in the West Bank, the mean distance is only 1.4 km and 75.8% of the respondents live in the watershed. This may explain the higher than expected Palestinian WTP bids, as visitors tend to show greater valuation of water resources (Viscusi *et al.* 2008).

Consequently, mean visitation rate is vastly different for the two societies. In Israel, mean visitation rate is 3.57 times per year, while it is 18.5 times per year in the West Bank. This is due to the correlation between distance from watershed and visitation rate that exists in both societies (for a simple visitation rate by distance fit, prob $< F$ is less than 0.0001 for both Israel and the West Bank). In addition, the greater range of recreational options available in Israel, in light of higher mobility of the residents, may also explain the relationship of visitation rate to Israeli WTP. Other than stream and flow preference, this is the only factor found to be significant among Israeli results.

4.10.2 Satisfaction with household water

Respondents were asked to indicate their level of satisfaction with the quantity and reliability of their primary water source from 1 = very unsatisfied to 5 = very satisfied. It was hypothesized that dissatisfaction with domestic water would be associated with an inclination to support stream restoration. Results are presented in Figure 5.

It is noteworthy that the relative similarity in satisfaction scores between Israel and the West Bank was not intuitively anticipated. Water conditions are not symmetrical across the border; per-capita water use in the West Bank, on average 96.8 l/day, is less than that of Israel by a factor of three or four.[4] Israel enjoys both more abundant and more reliable water than its West Bank neighbours (Shuval and Dweik 2007). Yet, satisfaction seems to be roughly the same for both societies – apparently an indicator that satisfaction with water quality and reliability is an attitude that is 'relative' and linked to overall socioeconomic and natural resource conditions in a given society.

Water reliability is a significant factor in the West Bank. Contrary to intuition, respondents are willing to pay less for stream restoration as their satisfaction decreases, suggesting that the public does not perceive proposed restoration efforts as improving their water reliability concerns.

However, satisfaction with water quantity does vary inversely with WTP bids. This suggests that respondents may believe that a relationship exists between environmental improvements and household water supply such that investing in watershed restoration may increase domestic water quantity.

4.10.3 Marital status

In the West Bank, married respondents were less willing to pay for restoration by a factor of 93 NIS (about $23). Presumably, economic pressures on families are greater than for the single population sampled, many of whom were students, who may

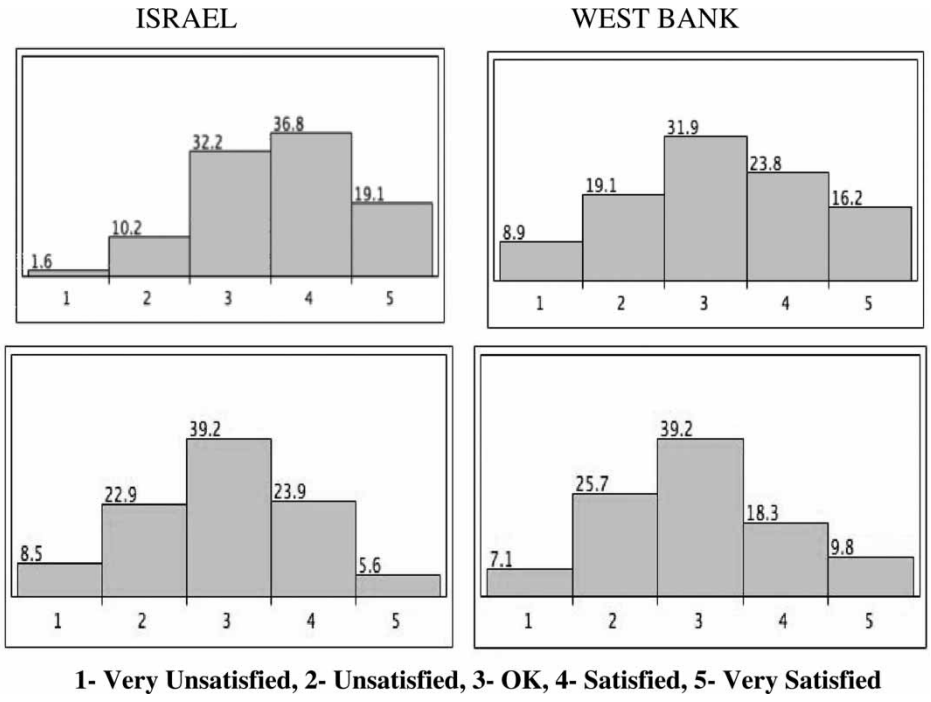

Figure 5 Satisfaction with household water quantity (top) and water reliability (bottom), percentage of responses

harbour greater 'idealism' about investing in environmental initiatives. In Israel, marital status is not a significant factor.

4.10.4 Income

Income level was a strong factor in the West Bank. For each of the five income level categories, an increase in household income of 1000 NIS/month (about $250) is associated with a mean increase in WTP of 140 NIS (about $35). This suggests that the *ability* to pay is an important factor in willingness to pay. This is commensurate with similar international studies in which statistically significant relationships were found between income levels and WTP for environmental improvements (Arimah 1996, Lauria *et al.* 2001). The existence of a significant relationship between income and WTP on the poorer side of the boundary suggests that donations to environmental causes respond to income level more strongly when budget limitations prohibit voluntary donations where they would otherwise exist. As these findings are consistent with economic theory and similar studies, they serve to confirm the legitimacy of the survey instrument and data generation methods.

It is interesting that the profound contrast between the economies of Israel and the West Bank was *not* reflected in the two societies' WTP for restoration. As discussed above, an 'average income' response for an Israeli is higher by approximately 10 or 20. When compared with other developing countries, where expendable income is comparable with that of the West Bank, these results are quite extraordinary. For instance, Choe *et al.* (1996) found that willingness to pay for surface water improvements in the Philippines was less than 1% of stated income, whereas Palestinians have revealed that they are willing to contribute close to 10% of their income for stream restoration.

4.10.5 Stream identity

As confirmed by mean WTP results, both the Israeli and Palestinian publics were partial to contributing to certain watersheds. Israelis were willing to contribute $19.50 more for restoring the Alexander Stream than the Besor, and Palestinians indicated a mean WTP $52 higher for Wadi Zomar than for restoring the Wadi Khalil. This may be due to higher visitation rates and greater public awareness of the northern watershed and its greater natural flow which for many offers a more compelling recreational resource.

4.10.6 Perennial/ephemeral

Similarly, respondents bid higher for perennial streams than for ephemeral variants. While this trend existed in both societies, it is more developed in the West Bank than in Israel.

4.11 WTP bid explanations

Given the centrality of WTP as a finding of this study, it was important to elicit direct explanations for positions expressed rather than to rely on conjecture. Accordingly, respondents were prompted to mark applicable reasons for their WTP bids from a list of possible responses. Results are shown in Table 13.

These results are quite similar between societies. Perhaps the most significant difference lies in the lower portion of West Bank respondents (43%) who expressed an identification with stream restoration (Reason 1) as compared with Israelis (57.6%). This

Table 13 Explanations chosen to justify WTP bid, and percent of affirmative responses (out of total valid WTP bids, excluding protest bids)

Reason	Israel (%)	West Bank (%)
1. I identify with restoration causes and it's important to me to return life to streams in the land	57.6	43.0
2. I am planning to visit/recreate the stream	57.6	50.0
3. I want to ensure that future generations will have a healthy environment	46.3	48.6
4. I am not able to spend money on stream restoration	12.4	9.0
5. There are more important issues on which to spend money	3.1	7.3
6. It is not my responsibility to pay for restoration	8.8	2.2

may appear trivial, but given the comparable transboundary WTP values, there is quite possibly an important story behind this difference. This is addressed below. Nevertheless, the difference can be partly explained by the historically lower base-flow and the reduced recreational appeal of the streams in their upper, Palestinian reaches.

Responses were considered to be protest bids if Reason 6 ('It's not my responsibility to pay for restoration.') was marked with a zero WTP bid. Of Israelis, 20 responses fell in this category, while 15 Palestinian protest bids were recorded.

The first and third questions correspond to an individual's non-use value of the proposed restoration efforts. Question 2 elicits use value. Results were used to dichotomize the WTP bids into non-use and use value.

5 Discussion

Results suggest that, for the most part, Palestinian respondents are largely in step with their Israeli counterparts on a number of key environmental issues (water use preference, stream restoration preference and valuation, etc.). The differences in trends are rational and follow the conventional expectations of CV studies.

An important element of this transboundary consistency is that the northern watershed elicits a higher WTP for both societies than the southern. This may possibly be due to the corresponding hydrological differences – while both societies prefer perennial streams, the northern watershed receives about four times more rainfall, and its restored state exhibits a higher flow rate. Further study of demographics and socioeconomic trends may reveal important insights into this phenomenon.

Despite these similarities, the simple question remains 'How is it that Palestinians, with much less expendable income, seem to be so willing to spend money on environmental improvement?'. Or, to frame it more bluntly, 'How is it that, relative to per capita GDP, Palestinians outbid Israelis by a factor of 10 to 20, yet have shown, if anything, less environmentalism?'.[5]

While, of course, it is possible that Palestinian respondents are in fact expressing a stronger preference for environmental values per se, the magnitude of their indicated willingness to pay demands a strong justification. We argue that the aggregate WTP is stronger than the data here suggest. For instance, although mean visitation rate, traditionally associated with use value, was nearly six times higher in the West Bank, it does not correlate significantly with higher WTP. That is, the Palestinian WTP bids do not change to any significant degree with a change in visitation rate. Nor can the high bids be explained by the fact that most respondents live near the streams. On the other hand, income levels and dissatisfaction with the quantity of household water *do* correlate with WTP, suggesting that issues of poverty and human need are important elements for future investigation. This is confirmed by a supplemental question elicited by the survey. This is described in Table 14.

The two categories, drinking water and sewage, both basic human needs, were regarded as the most important investments for Palestinian society before 'nature preservation'. Interestingly, both investments are related to rehabilitating waterways; sewage treatment is a prerequisite for stream restoration, and drinking water supply is an auxiliary beneficiary of reducing pollution sources to aquifers and increasing total usable water supply. Thus, it is quite likely that along with the environmental benefits, Palestinians are bidding for perceived improvements to health and welfare that add considerable value to the stream restoration project. For example, mitigating the negative health effects caused by untreated sewage or eradicating the bothersome smells are probably higher priorities for residents of the upstream sections of the watersheds.

There are two basic explanations for this pattern. The first is that ecological devastation is disproportionately allocated upstream. Palestinians are willing to pay so much, despite relative economic hardship, because of the severe environmental conditions that they face. A recent publication by the

Table 14 Palestinian public's ranking of social investment preferences

Issue	Mean rank (out of 6)	Standard deviation	*N*	Rank
Drinking water	1.99	1.22	378	1
Sewage	2.81	1.38	378	2
Nature preservation	2.98	1.47	377	3
Solid waste	4.21	1.38	378	4
Transportation	4.21	1.61	378	5
Phone/electricity	4.73	1.44	377	6

environmental NGO Friends of the Earth Middle East identified three issues of concern in the Tul Karem municipality that threaten the local population with 'increasingly dangerous health hazards and long-term environmental degradation'. Of three environmental woes, wastewater treatment, which is currently non-existent in 90% of the West Bank, was deemed the issue of highest concern because of dire consequences, especially for local water resources (Bromberg *et al.* 2007). A study of temporal Tul Karem groundwater quality changes from 1984 to 1998 revealed some startling findings: chloride concentrations were observed to increase in some wells at rates as high as 19 mg/l/year, while nitrate concentrations, known to cause methemoglobinemia (a potentially fatal 'blue baby' syndrome), increased by 3.5 mg/l/year on average with present levels reaching concentrations as high as 70 mg/l. These are well above international recommended levels of 45 mg/l for drinking water.[6]

The ecological crisis renders individuals with otherwise moderate environmental values to support more meaningful measures. Daily exposure to poor environmental conditions continues to aggravate local residents even as the older generations nostalgically recall the days when the stream was yet healthy. A minister from the Tul Karem municipality remembers the Wadi Zomar's brighter days: 'I myself was swimming in this valley when I was a child. Today, I couldn't be very near to this valley because of the bad smell'.[7]

The second factor is purely economic. From this point of view, environmental values exhibited by the residents of the West Bank are quite reasonable. The marginal benefit from restoration increases inversely with current stream health. Thus, as expected, the Palestinian responses act in conjunction with economic optimization criteria such that maximal return for restoration investment is reached in areas of lowest ecological health.

The CBA results offer insights for water allocation decisions. The greatest net benefit for both watersheds exist in the perennial 'flowing' state, even if the in-stream flows preclude the reuse of effluent for agriculture.

Significant factors related to WTP responses should inform future policy initiatives. Visitation to stream sites should be encouraged by local municipalities as part of an overall environmental strategy, since a positive relationship exists between support and valuation with intention to visit proposed improvements. As was demonstrated recently by Israeli efforts to restore the Alexander Stream, both education and encouraging visitation can be incorporated to bring widespread awareness that in turn can bring positive changes to local environments (Brandeis and Halbitz 2007).

6 Conclusion

Contrary to the initial hypothesis of this study, the divide between Israeli and Palestinian environmental values was less substantial and expansive than social, economic and environmental factors may have predicted. Not only were riparian and water use preferences similar, but each society expressed comparable willingness to pay for restoration efforts. This unity of purpose can provide substantial support for transboundary cooperative restoration projects and lays important groundwork for future developments. In order to be effective instruments of change, environmental improvement projects must be developed within the context of a larger framework that incorporates basic human needs and welfare along with ecological health. The transboundary element of this project constitutes an important case study, demonstrating the interdependence of two societies and the level of the commitment shared to restoring a degraded environment, notwithstanding profound cultural and socioeconomic difference. As results from this study indicate, both populations support the improvement of their riparian environments and are willing to contribute to that goal. The CBA reveals that in-stream flows, as opposed to diversion of effluents for agricultural reuse, provide the most benefit to the public. Further investigation should be done to determine the specific quantities of treated effluent that optimize net benefit for both watersheds.

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Notes

1. https://www.cia.gov/library/publications/the-world-factbook/print/we.html
2. Itai Freeman, personal communication, 15 February 2008.
3. http://www.edwardsaquifer.net/treatme.html
4. Census, 1997, Palestinian Central Bureau of Statistics, www.pcbs.gov.ps
5. While per capita income is a misleading indication due to tansboundary differences in family size, Israeli per capita GDP of $25,000 is more than 20 times larger, and therefore the relative magnitude of willingness to pay is comparable with this figure.
6. Temporal trends for water resources data in areas of Israeli, Jordanian and Palestinian interest, http://exact-me.org/trends/othercl.htm
7. Ministry of Economics, personal communication, 21 December 2006.

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