9 Do People Appreciate Economic Value of Water in Baku City of Azerbaijan?

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Abstract

The increase in demand in potable water, in response to the growing population, assumes great significance in the context of Azerbaijan due to its implications for economic growth, productivity, and poverty reduction. Efficient and equitable management of water, wastewater, and stormwater for the big cities is becoming an increasingly complex task. Increasing shortages of water and pollution issues in and around urban centers are superimposed on issues such as continuing urbanization, inadequate management capacities, poor governance, and inadequate legal and regulatory regimes, posing a daunting task for the future.

This study aimed to develop the quantitative basis for a comprehensive analysis and evaluation of water use and non-use values in the Great Baku Area of Azerbaijan, with a vision of integrated water management, including potable water and wastewater treatment. Water distribution system, with its leakages, patches, and breaks, gradually worsens the quality of the water causing it to fall well below the standards. Low service quality and reliability have also driven consumers to resort to various coping strategies such as use of overhead storage tanks, household filters, pumps, boiling of water, and consumption of bottled water, at considerable financial cost.

The Contingent Valuation (CV) methodology is used to estimate willingness to pay (WTP) of Baku residents for improved water services in the context of integrated demand. Results suggest that Baku residents behave as rational

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consumers in evaluating water opportunity costs and are ready to pay for better water services.

Keywords

Willingness to pay · Water services · Water shortages · Water values · Bidding game · Drinking water

9.1 Introduction

The challenge of ensuring efficient and proper water, wastewater, and stormwater management in large cities is becoming increasingly difficult. Water scarcity and pollution problems are becoming more prevalent in and around urban areas, compounded by issues such as continued urbanization, insufficient management capacities, weak governance, and ineffective legal and regulatory frameworks, posing a daunting challenge for the future (Phu Le 2004).

The increase in demand for drinking water is of great importance in the context of population growth, economic growth, and poverty reduction. The country's limited water resources, scarce water resources, weak natural water supply, and uneven distribution across the country require a quicker solution to these problems (Abbasov and Smakhtin 2012). The water resources of Azerbaijan are not abundant, and they are unevenly distributed both seasonally and geographically (Abbasov and Smakhtin 2010).

Located on the Absheron Peninsula and on the shores of the Caspian Sea, Baku is both the capital and the largest city in the country. Most of the country's industry is connected with Baku. For this reason, a significant part of the Azerbaijani population lives in Baku and the nearby city of Sumgait. Together with Sumgait and the other towns of the Absheron Peninsula, Baku is the central city of the main urban area in Azerbaijan, named the Greater Baku Area (GBA).

GBA population at the early 2019 was estimated at over three million and 65,000 people. Following the disintegration of the Soviet Union, the rural areas of Azerbaijan have been suffering from considerably high unemployment rates, and many people have migrated to the Baku and Sumgait areas in search of jobs and opportunities. In 1993 Baku accommodated 153,400 internally displaced persons and 93,400 refugees. Current (unofficial) estimates indicate that the Greater Baku area has more than three million people, or about 30% of all inhabitants of Azerbaijan (Mammadzadeh 2020).

Several estimates agree on a normal water use in GBA of 400 L per capita per day. While the latest surveys show that real consumption was never more than 170 L/day, the apparently high individual water use rate is the result of several influences, mostly related to the bad condition of the water distribution networks, of home water devices, as well as to the absence of metering (Mammadzadeh 2020).

Despite the high rates of consumption, in most parts of GBA, water supply is not available for 24 h 7 days a week (Fig. 9.1). In most cases, duration of water services

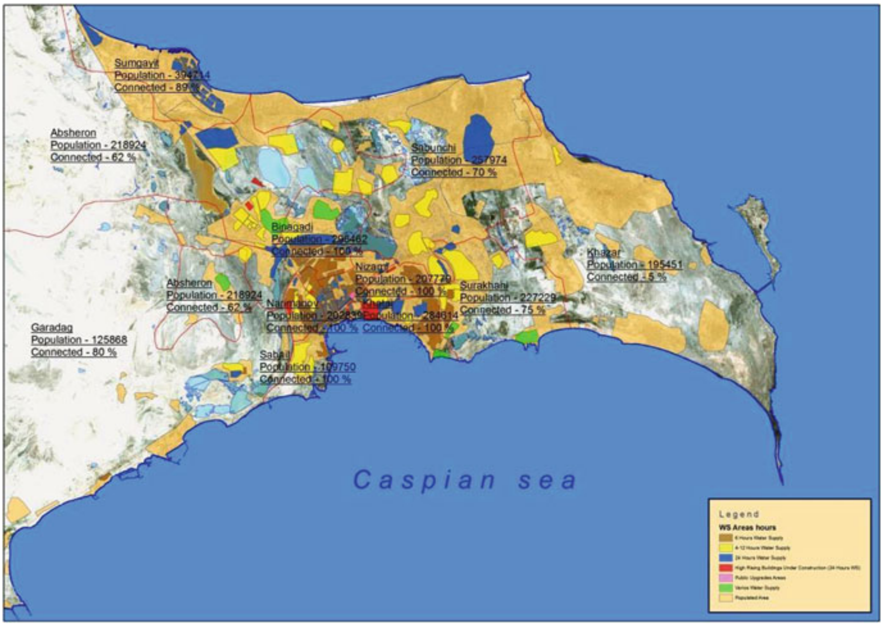

Fig. 9.1 Length of the water services in Greater Baku Area (2017)

has been less than 4 h a day, with most households suffering from low-quality, unreliable water services.

Lacking reliability and safety of water services in GBA are the main causes of the still not satisfactory quality of the water. The old water distribution system, with its leakages, patches, and breaks, gradually worsens the quality of the water causing it to fall well below standards. Reliability is affected by service interruptions and low pressure. The low level of the water quality is also associated to bad color, taste, odor, and chemical/bacteriological contamination.

An additional problem of water supply is the considerable urbanization of the Absheron Peninsula. The problem is not only the rise in number of the Baku population but also the constant inflow of population from the villages and the refugee migration to the GBA area. Various types of small and big houses built by refugees and other migrating population have turned the Baku suburban area into a huge illegal region of shanty towns. None of these shanty towns has been equipped with planning water supply networks, but only after construction, in order to meet daily needs, illegal pipe networks have been laid out and connected to the main pipelines. These illegal pipes are usually shared by three or four and sometimes five or more neighboring houses, which are typically made from low-quality materials and may be easily broken or damaged. These circumstances cause huge amounts of water losses during service hours. In these illegal residential areas, city water is supplied for only few hours each day on a rotating schedule that is incompatible with sanitary requirements. Crossing lines of wastewater and water supply networks make the situation especially risky for public health. Serious health concerns have been raised by the increasing stress on the water supply and the growing pollution problems.

Uneven distribution of the network has been an additional problem of the water supply. Most of the highly urbanized areas are relatively better supplied by the distribution network, while some of the agricultural sub-regions and remote towns are not connected to the network and are supplied only by local groundwater resources.

The other most important problem of the water management in the region relates to the urban wastewater management and the degradation of ground and surface water quality from illegal urbanization, chemicals associated with the oil industry, and fertilizers and pesticides from agriculture. Oil and gas production has polluted large areas of the Absheron Peninsula, including the heavily populated sub-regions. Leaking sewage pipelines have further degraded the water quality in the superficial aquifer, while agricultural production has contributed to nitrate and pesticide pollution. Water supply contamination is aggravated by spills from chemical plants and aerial deposition of pollutants from the highly industrialized areas of Baku and Sumgait as in the rather common cases were oil fragrant water comes directly to households. As a consequence of all these factors, evidence of water contamination is frequently observed throughout the water distribution network, and most of the population is supplied with drinking water that does not meet generally accepted standards.

In GBA, the wastewater network serves roughly 80% of the total households, but only about half of the wastewater is cleaned. The state of wastewater treatment plants is generally deplorable. The key causes are a lack of maintenance for more than a decade, excessive flows due to leaks and infiltration, and a poor quality of construction and materials. Discharges of inadequately treated polluted industrial wastewater into municipal drain systems weaken the effectiveness of the wastewater treatment plants. In some places, the wastewater systems have been constructed by residents but are not adequate to standards and are sources of permanent leakages. These leakages in most cases occur in places, where the water distribution network is located. These circumstances cause mixing of potable waters with sewage waters.

These issues are tackled by the Integrated Urban Water Management (IUWM) strategy, which views water supply as a portion of a larger and more comprehensive problem of strategic urban planning, in which the city serves as a catchment area for water from a variety of sources and uses, including drinking, washing, wastewater disposal, recreational uses of water sources and waterways, recycling, and a variety of other activities (Green and Srinivasan 1978; Srinivasan 1988; Ehrlich and Becker 1972).

Low service quality and reliability have driven consumers to resort to various coping strategies such as use of overhead storage tanks, household filters, pumps, boiling of water, and consumption of bottled water, at considerable financial cost. Inadequate demand side management of available water supply remains an issue in most urban areas.

This research aims to provide a quantitative foundation for a systematic overview of water usage and non-use values in the GBA, with the goal of achieving sustainable water management at the basin level, which includes potable water, wastewater storage, and stormwater.

The study also aims to the more ambitious goal of taking into account that rational choices from water users are performed in the context of dynamic uncertainty, thereby using option values as one the main frameworks of formulation and interpretation of the questions asked. In accordance with the bulk of the literature, the option value is interpreted as something akin to a risk premium arising from a combination of the individual's uncertainty about his future demand for a natural resource or its services and uncertainty about their future availability (Carson and Mitchell 1993). This kind of uncertainty concerns the potential future value of the quantity and quality of the water if it were preserved in the present form or were improved through various means and policies. More generally, it is suggested that option value is the hypothetical risk premium arising from the difference between the expected value of water at a future date and its certainty equivalent, i.e., the object of the usual WTP elicitation at the time of estimation (Trigeorgis 1996; Wilson et al. 2020; Otsetsewe 2001). This suggests that, by asking the respondents to elaborate on their preferences under uncertainty, the survey may be able to obtain a richer set of estimates, where controls for consistency will be more demanding and, if successful, more convincing (Wang et al. 2010; Pearce 1993; Mark 2000).

9.2 Materials and Methods

In order to address these issues within an appropriate economic framework, an approach to water evaluation has been developed that comprises of three complementary methodologies: cost avoidance measurements, hedonic analysis, and contingent evaluation. These three techniques are utilized to measure both use and non-use values (Hausman et al. 1993; Sen 1984; Bueno et al. 2016) from the stakeholders' point of view.

The study is based on a field survey with the main purpose to investigate the most important aspects of water consumption, perception of water quality, health and hygiene, productivity, and value. The survey itself was conducted by asking a sample of GBA residents a series of questions built on the hypothesis that water consumption in its various forms is the consequence of a rational choice (Shaikh et al. 2007). In this sense, the objectives of the survey were as follows:

- To reveal how citizens of GBA cope with the issue of insufficient water supply by implementing a number of strategies to improve the quantity and efficiency of water consumed, from direct purchase and storage of water to various strategies for improving its quality, such as boiling, filtering, purifying it, etc.
- To investigate the importance of water availability, wastewater treatment, and quality of services in determining decisions for choosing one's residence and, as a consequence, as determinants of housing values.

The target groups of the study were the GBA population, and for this purpose the GBA population was divided into several categories, according to the rights and interests held by each group:

1. People who live or work in the Baku city: given the geographic location of the city and its relation with the other areas of GBA, any change affecting water services, or the waterfront, could impact the everyday life of these users.
2. Other GBA citizens: they are the holders of significant interests linked mostly with the public good function of water and water services, and they may be more likely to face a change in their everyday life as a consequence of major improvements in water supply.
3. Visitors/tourists: they represent potential users of both water services and the waterfront.

The questionnaire was composed of closed questions, in order to facilitate the task of the interviewers and because of time constraints. Closed questions tend, in fact, to be quicker to administer and easier to analyze, even though they tend to have also drawbacks (McFadden 1978; Freeman 1979; McFadden 1999; Train and McFadden 1978). The most important drawback is that the respondents cannot raise new issues during the interview, so that relevant and interesting information could be lost (Train 1986, 1998, 2001). To avoid this risk, a question on whether the respondent wanted to add something was included at the end of each questionnaire.

The bulk of the interviews were concentrated on the households connected to the water network, which, according to the official records, comprise 90% of the total population. These households can be classified into four categories, according to the length to the service: 18–24 h, 12–18 h, 4–12 h, and up to 4 h. The last two categories represent the greatest majority of the respondents. The sixth group, represented by the households not still connected to the water network, appears to be a very small proportion of the total. They are mostly dependent either on the provision of a public hydrant or a private tube well. While the average willingness to pay varies somewhat across the different groups, these variations turned out to be not statistically significant.

The following sections were included in the questionnaire:

Socioeconomic data: The sections concerning personal data, education, and income were aimed at framing the answers that the respondent would give in all the other sections of the questionnaire (socioeconomic data are demonstrated to be important drivers of individual preferences and decisions about the consumption and use of public goods). These sections enclose questions concerning age, gender, household status, education level and domain, job, and earnings.

Hedonic prices: This section concerned the location and the quality of the dwelling of the respondent and had the objective to identify characteristics for the hedonic analysis, which may give also the possibility of estimating hedonic prices for water services (Train 1986).

Feelings and knowledge: This section had a special importance for GBA citizens, given their condition of distress and discontent regarding water services. Outlining and understanding the feelings of local community members with respect to the quantity and the quality of water services delivered were also central for framing more specific questions in other sections of the questionnaire and to obtain insights on the value of water from the point of view of the individuals and the community. Answers to the questions of this section can also be used to analyze to what extent and in what forms a communication program would be needed to appropriately implement any rehabilitation plan (Wang et al. 2010).

Possible uses: this section explored the preferences of the respondents with respect to alternative uses of water as a public good (e.g., potable water, irrigation, energy, etc.). A list of facilities and services was presented to the respondent, and she/he was asked to declare whether or not she/he would like to see each of them realized. The objective of these questions was to give the respondents the possibility to combine the uses and services proposed in a way that they would consider suitable for water resources.

WTP: In this section a set of alternatives of quantity/quality of water supply are presented to the respondent, who is asked both to order them on the basis of her preferences and to declare how much she would be willing to pay to see each of them realized, according with a bidding game that progresses gradually across alternative monetary ranges (McFadden 1999). The alternatives represent possible combinations of activities and services that could be implemented inside the area and were chosen to represent different approaches to the rehabilitation of water supply in GBA. In building up the themes, we also chose to stress the social and economic functions of water under the different approaches. Therefore each theme represents a different way to provide and use water. The choices offered to the respondents range from a traditional water supply network to a multifunctional model (water management and waterfront use) fully integrated in the everyday life of GBA citizens. The questions in this segment, when paired with the questions in the previous parts, were designed to see how respondents shape their perceptions about water usage and whether these expectations meet general economic rationality hypotheses (coordination between ends and means, continuity, promotion of individual and communal gains, knowledge of alternative alternatives, sea level rise, etc.).

Feelings and knowledge on climate change: This section had the objective to investigate the level of awareness and the impact of climate changes attitudes on water demand, willingness to pay, and possible changes of behavior of GBA citizens.

9.3 Results and Discussion

9.3.1 Survey Results

The survey lasted approximately 6 weeks. A total of 24 enumerators and 3 tabulators were involved in the process with average number of 90 questionnaires filled by each enumerator. The questionnaires completed were 2155.

Table 9.1 presents some general results of the survey of willingness to pay (WTP) for potable water service. Average WTP (additional to the tariff already paid) for the full service is about 15 AZN. A comparison of survey results with official government data reveals many differences. Official data were provided by the State Statistics Committee.

Respondents showed a high interest in better services, including wastewater, and most of them (70–80%) exhibited enthusiasm and cooperation in participating to the survey process. Women tended to participate more actively than men and more often asked enumerators about the purpose of the survey. Respondents also posed a variety of questions on social problems and future plans of the government. In several cases, nevertheless, for various reasons, respondents declined to be interviewed, because they were either tired or busy.

The duration of the interview was one of the main challenges for enumerators. According to them, the interest on the questions of the respondents tended to wane after the first 30–40 min, with cases when respondents interrupted the interview, because they were "tired." After the pretest of the questionnaire, short breaks

Table 9.1 Comparison of the survey results with official data of government of Azerbaijan

Monthly expenses on (AZN)	Survey averages	Survey modes	Official data
Food	237.6	200	390.656
Clothing	67.4	50	57.988
Housing (rent, repair etc.)	42.7	10	
Transport	112.9	50	68.016
Utilities	54.1	50	61.912
Education	161.2	100	20.928
Health	42.5	20	32.264
Other	129	100	
Number of persons that contribute to household income	1.736419	2	
Yearly savings if any	1299.4	0	1891
Total household income per month	857.77	1000	833
Number of persons living in the household	2.96	4	4.36
No. of adults (>16 years)	2.92	2	2.08
No. of minors (<16 years)	1.43	2	2.38
Education (years)			>12
Value of the house, for 1 sq.m; AZN	1650.4		1350

Table 9.2 Water service characteristics

Water availability	Maximum	Minimum	Average	Variance	Mode	S.D.
Length of the daily water services in hours	24	2	9.2744	47.55	6	6.9
Number of days per week with water service	7	2	6.77	0.52	7	0.72
Number of days with water service during July–September	90	0	85.1845	66.42863	90	8.15
Number of days with water service during December–March	93	0	85.4129	59.72332	90	7.73
Number of days in a year with no water service	250	0	14.2097	702.8351	1	26.51

(5–10 min) were used to keep respondents' interest high. During these breaks, respondents asked additional questions regarding the goals of the survey, and some of them expressed opinions on the social policy of the government.

The responders, who contained water users, were asked if they would agree to a rise in their monthly water bill to help another investment project outcome such as improving water provision, sewage treatment, and the protection of the environment. These projects included investment to secure immediately and with certainty (i) uninterrupted water supply to the users, and/or (ii) full wastewater treatment, and longer term investment with the same aims but on a longer time horizon and with some uncertainty.

Table 9.1 shows a comparison between the survey results and the official statistics, which points to very similar mean values for almost all variables, including the most difficult to measure such as income and savings. However, major discrepancies appear in the statistics on transport and education, where the sample means are much larger than those reported in the government statistics. Table 9.1 shows descriptive statistics for the sample data.

According to the interviews (Table 9.2), water interruption happens in the summer for 512 of the households connected, for 243 households in the winter, and for 1042 households "all the time." The irregularities in water provision, however, appear, paradoxically, very regular, as Table 9.1 shows very little variation (relatively low variances) of all answers to the questions inquiring on the number of days of water service, water availability during the different seasons, and complete lack of service. While most of the households declared that the water service was available seven times a week, however, the average length of water service per day was 9.2 h and the mode only of 6 h. The number of days without any service during the year, on the other hand, was said on average to be 14 days but with a standard deviation of about 27 and a mode of only 1 day. Thus, the picture of potable water service emerging from the survey is not a dismal one, and most households do

Table 9.3 For households with primary source from a public street hydrant

Water availability from public water hydrants	Maximum	Minimum	Average	Variance	Mode	S.D.
Distance from the public street hydrant, m	150	3	21.7742	1076.637	6	32.80
Consumption (L/day)	400	5	116.947	11220.39	100	105.92
Collecting time (min/day)	120	1	35.7059	1533.564	10	39.15
Monthly charges, if any	50	2	14.3636	168.4545	15	12.96
How many hours per day do you receive water from the public street hydrant?	24	1	10.3333	46.47179	7	6.78
How many days per week do you receive water from the public street hydrant?	7	1	6.72308	0.703365	7	0.84
In summer/dry season, how many days per week do you receive water from the public street hydrant?	7	3	6.46	0.824898	7	0.91
In winter/rainy season, how many days per week do you receive water from the public street hydrant?	7	5	6.02273	0.67389	6	0.82

appear to have access to fresh water throughout the year, even though the reliability of such an access is low and appears to be rather variable across the population.

The households using water from a street hydrant (Table 9.3), on their part, with much lower water consumption than the average (116 vs. 400 L per day), show a somewhat less variable picture of availability and continuity of supply, with the same average provision of water in number of days (6.72) of the households connected, but with more continuous service throughout the year. The households receiving water from other sources, such as street vendors and bottled water, manage an average level of consumption near 200 L per day, with similar regularity

Table 9.4 Water quality and waterborne diseases

			1	2	3
Water quality	Taste	1. Good 2. Average 3. Bad	109	1524	347
	Smell	1. Good 2. Average 3. Bad	121	1628	225
	Color	1. Good 2. Average 3. Bad	54	1377	543
Information of responders about the quality of consumed water		1. Yes 2. No	392	1551	
Waterborne diseases occurred in the household during the last year		1. Cholera 2. Typhoid 3. Malaria	4	3	16

Table 9.5 Characteristics of waterborne diseases

Characteristics	Maximum	Minimum	Average	Variance	Mode
Number of persons that were ill in one household due to the consumption of unsafe water	10	1	1.57143	2.920635	1
Duration of sickness, days	90	1	20.3103	591.7217	30
Medical costs (Manat)	1200	2	211.759	61675.98	250

parameters to the public hydrant sources, with a majority stating that the present arrangement is satisfactory.

Tables 9.4 and 9.5 offer a picture of the perception of the quality of the water and its effects. While most respondents consider the quality "average" and the great majority professes of not being informed, a considerable number of not identified illnesses are attributed to the bad quality of the water. Finally, Tables 9.6 and 9.7 show some statistics on water use that reveal a consistent picture of low pressure, poor availability, and widespread practices both to purify the water, mostly through boiling and filtering, and to use privately installed storage capacity to secure more continuous water supply. This last practice, in particular, appears to be costly, both for capital costs (about300 AZN on average) and for maintenance (about 50 AZN per year).

Table 9.8 presents some general results of the survey of WTP for potable water service. Average WTP (additional to the tariff already paid) for the full service is about 15 AZN (Manat), with a standard deviation (S.D.) of about 7 and a mode of only 10 AZN. For a long-term investment with the same results, but only in 10 years' time and with a 20% probability of failure, average WTP is about 9 AZN per month, with a mode of 8 AZN and S.D. of 2.8. This WTP can be interpreted as an option value, i.e., as a risk premium that users would be willing to pay to avoid further

Table 9.6 Characteristics of household water use

		1	2	3	4	5	6
Water pressure	1. Strong 2. Generally strong 3. Weak 4. Sometimes weak 5. Very weak 6. I use own pumping engine to create pressure	631	274	338	204	205	211
House water treatment	1. Boil 2. Filter 3. Precipitate 4. Others	1343	339	106	16		
Type of water collector	1. Overhead tank 2. Underground tank 3. Drum 4. Bucket/vessel	1107	70	213	82		
Preferred payment	1. Fixed charge 2. Metered bill	198	1692				
Water from secondary source, if any	1. Neighbor 2. Public street hydrant	11	331	0	0		

Table 9.7 Characteristics of overhead tank use

	Maximum	Minimum	Average	Variance	Mode	S.D.
Total volume of a water tank	6000	50	1004.48	458.313	500	676.99
Installation cost (Manat)	1200	0	124.543	18136.8	50	134.67
Capital costs (initial purchase costs in AZN)	1380	0	241.281	54409.93	150	233.26
Purchase cost of pump (AZN)	500	0	64.5545	10146.52	20	100.73
Cost of other materials (AZN)	100	5	26.5385	530.9201	5	27.04
Annual maintenance cost (cleanup, energy, etc.)	50	0	23.7895	306.731	10	17.51
How many additional hours per day of water supply will be required to meet all your needs?	24	0	6.54054	13.65525	5	3.70

deterioration of the service. As shown in Table 9.9, the willingness to pay for service improvement extends to wastewater disposal, both in the scenario of immediate action and in the option like scenario of uncertain, time delayed action. WTP for

Table 9.8 Willingness to pay: potable water

Willingness to pay characteristics	1	2	3	4	Maximum	Average	Variance	Mode	S. D.
WTP for 24/7 quantity of water with adequate pressure and high quality (AZN)					60	15.1	52.8	10	7.26
Agreement for general tax increase for 24/7 quantity of water with adequate pressure and high quality instead of paying for bill 1. Yes 2. No	938	1031							
Percentage increases in income taxes instead of paying for bill 1. 5% 2. 10% 3. 20% 4. 40%	703	145	42	20					
WTP for 24/7 quantity of water with adequate pressure and high quality, but only after 10 years with 50% of success and 50% failure (AZN)					16	10			
Agreement for general tax increase for 24/7 quantity of water with adequate pressure and high quality instead of paying for bill but only after 10 years with 50% of success and 50% failure 1. Yes 2. No	428	1359							
Percentage increases in income taxes instead of paying for bill 1. 5% 2. 10% 3. 20% 4. 40%	294	78	17	12					
WTP for 24/7 quantity of water with adequate pressure and high quality, but only after 10 years with 80% of success and 20% failure (AZN)					20	9.12	7.84	8	2.79

(continued)

Table 9.8 (continued)

Willingness to pay characteristics	1	2	3	4	Maximum	Average	Variance	Mode	S. D.
Agreement for general tax increase for 24/7 quantity of water with adequate pressure and high quality instead of paying for bill but only after 10 years with 80% of success and 20% failure 1. Yes 2. No		431	1443						
Percentage increases in income taxes instead of paying for bill 1. 5% 2. 10% 3. 20% 4. 40%	219	64	52	11					

Table 9.9 Willingness to pay for better wastewater services and recreational water use

	1	2	3	4	Maximum	Average	Variance	Mode	S.D.
Disposal of wastewater 1. Sewerage system 2. Septic tank 3. Open drainage canals 4. Into the street/road	1891	42	29	2					
Satisfaction with the current disposal of your wastewater 1. Satisfied 2. Partially satisfied 3. Not satisfied	884	685	427						
Preference to have an improved wastewater system 1. Yes 2. No	494	318							
Type of the desired wastewater disposal system 1. Septic tank 2. Open drains 3. Improved sewage	6	11	1740						
WTP for better wastewater disposal services (AZN)					45	6.39	27.7	0	5.26
Willingness to pay for better wastewater disposal services, but only after 10 years with 50% of success and 50% failure (AZN)					45	3.78	28.5	0	5.34
Willingness to pay for better wastewater disposal services, but only after 10 years with 80% of success and 20% failure (AZN)					150	5.20	166.4	0	12.90
Willingness to pay via credit scheme monthly (AZN)					3	1.63	0.23	2	1.28
Willingness to pay for recreational water use (boating, swimming, surfing, fishing, etc.) through general tax increasing 1. Yes 2. No	631	1088							

(continued)

Table 9.9 (continued)

	1	2	3	4	Maximum	Average	Variance	Mode	S.D.
Percentage increases in income taxes for recreational water use 1. 5% 2. 10% 3. 20% 4. 40%	514	45	33	34					
Willingness to pay for better wastewater disposal to protect valuable fish in the Caspian Sea 1. Yes 2. No	1053	755							
Willingness to pay to protect Caspian Sea fish species through general tax increases; percentage increases in income taxes 1. 5% 2. 10% 3. 20% 4. 40%	528	289	75	40					

waste disposal is roughly one third or less of WTP for potable water and tends to decline sharply with uncertainty and time delayed investment.

9.4 Econometric Analysis: A Structural Model of Demand for Integrated Water Services

9.4.1 Random Utility Model

WTP can be rigorously defined in the indirect utility framework as follows (Train 1986; McFadden 2001): for a fixed level of public good provision, a respondent's WTP is defined as the dollar amount Y, which equalizes two indirect utilities:

$$V_1(I - Y|Z, \varepsilon) = V_0(I|Z, \varepsilon) \tag{9.1}$$

In Eq. (9.1), I is disposable income, Z is a vector of observed social demographic characteristics, ε is a scalar variable representing unobserved personal characteristics, and V_1 and V_0 are, respectively, the respondents indirect utility with and without the provision of the public good. When two levels of the public good provision are compared, V_1 and V_2 may have the same functional form but include the level as an independent function argument. Assume that for any fixed (Z, ε), V_1 (u|Z, ε) is monotonically increasing in u. Then there exists an inverse function U (v: Z, ε) such that $U(V_1(u|Z, \varepsilon) : Z, \sum) = u$ for all $u \geq 0$. Therefore, WTP can be expressed as

$$Y = I - U(V_0(I|Z, \varepsilon) : Z, \varepsilon) \equiv \Phi * (X, \varepsilon), \text{where } X = (I, Z) \tag{9.2}$$

Marschak (1960) developed the random utility model in Eq. (9.1), which has since been researched, modified, and applied by a number of scholars, including McFadden (1978, 1999, 2001), Train (1998, 2001), Train and McFadden (1978), and Hausman et al. (1993). The model assumes that economic agents' decisions are heterogeneous due to two factors: a systematic component based on the agent's measurable socioeconomic characteristics (e.g., sex, age, wages, family size, etc.) and an unobservable random component. Using this hypothesis, we can thus investigate the preferences of a sample of agents by using a survey designed on the assumption that the WTP of each given agent could be considered as a latent process explained by a number of socioeconomic and behavioral variables and by a random shock.

Each interviewee was asked a question on her WTP for a particular investment outcome, using the so called "bidding game" procedure (Nam and Son 2004). According to whether the interviewee responded "yes" or "no" to the question, the interviewer asked the same question for the next highest price or the next lowest price. As a consequence, for each series of questions, the WTP of the ith interviewed lies in an interval whose lower bound, $WTLP_i$, is given by the highest value to which the respondent answered "yes" and the upper bound, $WTHP_i$, by the lowest value to which he answered "no." Because the intervals were designed to be rather small, in our survey, upper and lower bounds for each interval are sufficiently close that the last "yes" answer can be considered to approximate reasonably well the maximum willingness to pay of the respondent.

In the literature on willingness to pay for water services, WTP is generally interpreted as a "demand price," i.e., as the maximum amount of money that the respondent is willing to pay for one or more specific features of the water service (e.g., 24 h continuous availability of potable water). Problems of separability arise, however, for several reasons. First, water services are likely to be interdependent both in demand and in supply, and respondents may be presumed to perceive this interdependence in their own responses. Second, because service improvements are proposed as outcomes of a specific investment program, respondents are likely to consider their delivery to be jointly conditional to the program's success. Third, the hypothetical nature of the improvements and the fact that they are contingent on projects yet to be decided upon and depending on a host of external factors (politics, financing, etc.) cast a common shadow of uncertainty on all elicited WTPs, creating one more sources of interdependence.

Because of these reasons, the WTPs elicited with the survey can be considered altogether indexes of integrated water demand. Even though their analysis cannot be simplified by strong separability assumptions, it can provide important information on the extent to which consumers' utility is affected by joint performance of key water services.

Even though it has been criticized because its results may be affected by the initial value provided to the interviewees, the bidding game has the advantage to yield a direct measure of the maximum willingness to pay, comprising the whole consumer's surplus of the respondent. In our survey, in particular, any possible initial value bias is partly neutralized by the fact that we explicitly anchor our questions to the last monthly bill paid by the respondent. The effect of this variable can thus be explicitly factored out and taken into account in the statistical analysis. That said, the WTP can be either retrieved from the ordered choice questions or, more directly, from a regression of the maximum WTP bid on a series of explanatory variables collected by the survey. These variables include income, a few measures of wealth, various types of consumption, several socioeconomic characteristics of the household, and a number of features related to the quantity and the quality of the water provided today. As the results of some studies (e.g., Otsetsewe 2001) suggest, these variables are likely to be the main determinants of households' WTPs. However, several critiques have been made to CV studies and their conclusions. These critiques range from responses to please the interviewer to the lack of a real budget constraint and from various responses to starting point biases (Mitchel and Richard 1989). Because cross-sectional CV studies have often shown low R-squared, several studies (e.g., Carson and Mitchell 1993) have indicated that a minimum level of fitness to the data (such as an R2 of at least 15%) is necessary to reject the hypothesis that the CV results are just the effect of random responses on the part of the interviewees.

In our study, we follow the stochastic utility model in assuming that the expected WTP is linearly dependent on a vector of social and economic characteristics X_i and on a stochastic term with zero mean:

$$\mathrm{WTP}_{ij} = E\left(\mathrm{WTP}_{ij}/X\right) + \varepsilon_{ij} = \alpha_j + \beta_j X_{li} + \beta_{2j} X_{2i} + \ldots + \beta_{nj} X_{ni} + \varepsilon_{ij}, i = 1, 2 \ldots N \quad (9.3)$$

where WTP_{ij} is the *i*th stakeholder's willingness to pay for the *j*-th investment, given by the highest bid he has accepted, X_k $k = 1,2,\ldots n$ a set of conditioning variables, and ε_{ij} a random disturbance. We confine our estimates to households connected to the water pipe (98% of the population), and, because of the interdependencies across the range of water services and the consequent problems of identification, we specify and estimate the following structural demand model for integrated water services:

$$C_i = a_c + b_c S_i\_c_c M_i + \beta_{1c} X_{1c} + \beta_{2c} X_{2i} + \ldots + \beta_{2c} X_{ni} + \varepsilon_{ic} \quad (9.4)$$

$$S_i = a_s + b_s C_i + c_s M_i + \beta_{2s} X_{2i} + \ldots + \beta_{ns} X_{ni} + \varepsilon_{is} \quad (9.5)$$

$$M_i = a_m + b_m C_i + c_m S_i + \beta_{2m} X_{2i} + \ldots + \beta_{nm} X_{ni} + \varepsilon_{im} \quad (9.6)$$

$$WTP_i = a_w + b_w C_i + \gamma_w S_i + \lambda_w M_i + \mu_w WWTP_i + \beta_{1w} X_{li} + \beta_{2w} X_{2i} + \ldots + \beta_{nw} X_{ni} + \varepsilon_{iw} \quad (9.7)$$

$$WTPU_i = a_u + b_u C_i + \gamma_u S_i + \lambda_u M_i + \beta_{1w} X_{li} + \beta_{2w} X_{2i} + \ldots + \beta_{nw} X_{ni} + \varepsilon_{iw} \quad (9.8)$$

In Eqs. (9.4), (9.5), (9.6), and (9.7), the X_{ji} are the exogenous variables, while the endogenous variables are specified as follows[1]:

C_i = water consumption of the *i*th household; S_i = storage volume installed of the *i*th household; M_i = market value of the dwelling of the *i*th household; WTP_i = willingness to pay for an investment aimed at improving water supply and/or wastewater treatment; WWTP_i = willingness to pay for an investment aimed at improving water supply and/or wastewater treatment different from the above; and WTPU_i = willingness to pay to reduce uncertainty (option price—willingness to pay either in water supply or in water supply and wastewater treatment).

The model in Eqs. (9.4), (9.5), (9.6), (9.7), and (9.8) is based on the hypothesis that demand levels for water, storage, and housing are simultaneously determined, while, at the same time, willingness to pay measures are interdependent with water demand and are themselves simultaneously determined. Equation (9.7), in particular, hypothesizes that WTP to contribute to a project to improve water

[1] Because of the literature suggestion that WTP and the perceived quality of water may be simultaneously determined (e.g., Whittington 2003), we tested and rejected the hypothesis of endogeneity of water quality in our sample.

supply depends on the present level of water consumption, the demand for storage, the value of the dwelling, and, possibly, on WTP measures for other improvements. Equation (9.8), on the other hand, shows a similar hypothesis for the WTP to reduce uncertainty, obtained by subtracting from the WTP for improvement the WTP stated under uncertainty, which in the question asked was quantified as a 50% probability in 10 years for the improvement to be delivered.

9.4.2 The Econometric Estimates

The model in Eqs. (9.1), (9.2), (9.3), (9.4), (9.5), (9.6), (9.7), and (9.8) has been estimated with two stage least squares and white heteroskedasticity consistent covariance. Tables 9.10, 9.11, 9.12, 9.13, 9.14, and 9.15 present the estimation results and show that the following hypotheses cannot be rejected at a high level of statistical confidence:

1. WTP depends on present conditions of water supply, the current level of consumption, available storage, and how users perceive the quality of the existing water.
2. Women are more active in the survey and interested in paying more for better water and sanitation services.
3. Income and wealth of a household positively affect the WTP for improved water service.
4. Educational level of the respondent positively affects WTP.
5. Households would be willing to pay for their water use at the rate equivalent to the average incremental cost of provision better water service.
6. WTPs and demand for different water services are interdependent and depend positively on incomes, current water prices paid, and per capita water consumption.

While these are general conclusions, the equations estimated present also several interesting features.

First, R-squared are generally well over the threshold of 0.15 indicated by Mitchel and Richard (1989), but they increase considerably when zero (possibly protest) responses are singled out as fixed effect variables. This can be seen in the equation estimated by using the first principal component of all WTP measures and by a set of parallel results shown in the appendix. The latter can also be considered a robustness test of the main results presented in the text.

Second, for per capita consumption of water, in spite of some elements of rationing in water supply and the flat rate component dominating the water bill, the equation estimated displays the typical features of market demand, with positive income and negative price elasticities of the same orders of magnitude of most studies reported in the literature. For example, our estimated price elasticity is around −0.65 which is just at the top of the range of −0.3 to −0.6 reported by

Table 9.10 Estimates of the integrated water service demand model

	P.c. water consumption (log)		Storage volume installed (log)		Market value of the dwelling (log)		WTP for water delivery improvement (log)	
Method	TSLS		TSLS		TSLS		TSLS	
Variable	Coefficient	*p*-value	Coefficient	*p*-value	Coefficient	*p*-value	Coefficient	*p*-value
Constant	0.28	0.179	2.04	0.402	10.51**	0.000	−0.60	0.46
Log (income)	0.16***	0.000			0.15**	0.001	0.044	0.11
Log (bill/cons)	−0.65***	0.000						
Log (bill)			0.43**	0.006			0.498***	0.000
Log (p.c. water cons.)							−0.004***	0.026
Log (volume storage)	0.02***	0.000			−0.026**	0.002	−0.009***	0.0027
Log (tot persons in household)	−0.81***	0.000	−0.01*	0.046				
Education (years)	0.05**	0.009	0.04**	0.001				
Log (education)					0.019***	0.0038		
Log (water bad quality rating)	0.21**	0.004	1.30**	0.0061				
Log (house market value)			−0.44**	0.00324			0.063*	0.0003
Hours per day of service	0.01***	0.000	0.00	0.112			0.184*	0.0382
No delivery during dry season			−0.19*	0.057				
Lack of water pressure			0.29**	0.0000	−0.022*	0.0747		
Index of water shortage (lack of availability)					−0.040*	0.0654		
Log (distance from subway)					−0.042**	0.0033		
R2	0.34		0.06		0.237		0.464	
Observations	1444		904		375		1562	

Note: 1. Stars stand for degrees of significance: *** = 0.001 or better, ** = 0.01 or better, * = 0.05 or better; 2. Dummy variables are defined as being equal to 1 when the response to the corresponding variable is non-zero and zero otherwise

Table 9.11 Estimates of the integrated water service demand model

	Log total WTP (water and waste treatment)		All WTPs' first principal component	
Method	TSLS		TSLS	
Variable	Coefficient	*p*-value	Coefficient	*p*-value
Constant	0.617*	0.056	−4.969***	0.0003
Log (income)	0.105***	0.000	0.048***	0.0000
Log (water cons.)	−0.051**	0.0066	−0.020	0.323
Log (bill)	0.440***	0.000	0.121***	0.0000
Log (vol. storage)	−0.0075*	0.0302	−0.058*	0.0299
Gender (1 = female, 0 = male)	0.067***	0.0002	0.043*	0.0612
Lack of water pressure	0.026***	0.0004		
No delivery season	0.036***	0.0003		
Education (years)	0.082***	0.0000	0.024*	0.0293
Log (water bad quality rating)			−0.048	0.223
Log (house market value)	0.065**	0.0023	0.051**	0.0026
Dummy WTP			1.958***	0.000
Dummy WTP waste			1.744***	0.000
Dummy WTP waste 50			1.393***	0.000
R2	0.337		0.943	
Observations	1575		1620	

Note: 1. Stars stand for degrees of significance: *** = 0.001 or better, ** = 0.01 or better, * = 0.05 or better; 2. All dummy variables are defined as being equal to 1 when the response to the corresponding variable is non-zero and zero otherwise

Nauges and Whittington (2010) for LDCs and is not significantly different from the average price elasticity (−0.51) reported by Espey et al. (1997) for industrialized countries. Similarly, our estimate of income elasticity equals 0.159, well within the typically estimated range (0.1–0.4) reported in the study of Arbués-Gracia et al. (2003). The effect of household size is found to be significant, implying a reduction of per capita consumption of about 87% when the number of permanent residents doubles, a result larger, but of comparable magnitude of the effect (50%) estimated by Cheesman et al. (2008) for Vietnam. Also similarly to results reported in the literature, an extra hour of piped water availability would increase per capita consumption of households of 2.2%. Nauges and Van Den Berg (2009) estimate for Sri Lanka an average effect of by 2%.

Third, estimates of demand for storage volume and the value of the dwelling are based on a smaller number of useful responses and, even though plausible enough in the coefficient estimates, exhibit much lower fits. Demand for storage appears to be not significantly affected by p.c. income but positively related to the size of the bill, education, the index of bad quality rating for water, the lack of water pressure, and the reliability of water delivery. The value of the dwelling, as shown in several classical studies (e.g., Freeman 1979), turns out to be significantly related to income (the income elasticity is approximately the same as for water consumption) and

Table 9.12 Estimates of the integrated water service demand model

	Log risk premium = WTP to reduce uncertainty in the improvement of water supply		Log risk premium = WTP to reduce uncertainty in the improvement of water supply and wastewater treatment		Log WTP Waste treatment (recreational use of water)		WTP credit for sanitation (log)	
Method	TSLS		TSLS		Probit		TSLS	
Variable	Coefficient	*p*-value	Coefficient	*p*-value	Coefficient	*p*-value	Coefficient	*p*-value
Constant	0.909	0.0088	1.053	0.000	−1.95	0.037	−4.442	0.000
Log (income)	0.113	0.0129	0.120	0.0005	0.048	0.477	0.000	0.926
Log (p.c. water cons.)	0.815	0.000	0.711	0.000	−0.380	0.0008	0.143	0.0013
Log(bill)					0.456	0.0003	0.161	0.000
Log (bill/water cons.)	0.995	0.000	0.791	0.000	−0.408	0.0133		
Log (vol. storage)					0.045	0.0005		
Log (water bad quality rating)					−0.888	0.000		
Waterfront					0.586	0.000		
Log (house market value)					0.183	0.0253		
Dummy WTP waste treatment							−0.512	0.0042
Dummy credit							170.577	0.000
R2	0.323		0.313		0.10			0.968
Observations	319		353		1327			1344

education of the head of the household and negatively related to the volume of storage installed, unreliable water supply, and distance from the subway.

9.5 Conclusions

This paper has presented the results of a study on water services and WTP in the GBA, in the context of integrated demand. The main results confirm the integrated nature of water services and suggest the following conclusions:

1. Water consumption preferences are exercised in the context of constrained choices and depend on the present conditions of water supply, as well as on past investment in housing and water storage.
2. As a consequence, water consumption, available storage, housing values, and WTPs for water supply improvements are all interdependent.
3. Water demand, storage, housing values, and WTPs are all significantly dependent, but inelastic, on per capita incomes.
4. While water demand is negatively related (in an inelastic way) to water price, WTPs appear to be positively related (though still inelastic) to it.
5. The introduction of uncertainty tends to reduce WTPs of an amount that is itself a function of the present conditions of water supply, incomes, and water prices.
6. Gender significantly affects willingness to pay for improved water services (women are willing to pay more, especially for sanitation).
7. The educational level of the respondent positively affects WTP.
8. Households would be willing to pay for their water consumption at the rate equal to the average incremental cost of supplying improved water service.

From a theoretical point of view, the results obtained provide support to the hypothesis that demand for water services is consistent with the economic paradigm of rational choice. From the policy perspective, this implies that WTP for existing and expanded water services is sizable and appears to justify further investment in increasing integrated water supply services, in terms of size, reliability, and quality of the water for all its uses, including drinking, sanitation, and recreation.

Conflict of Interest Statement The authors report no conflict of interest for this publication.

Appendix

Estimates with dummy variables for zero (protest) responses (Tables 9.13, 9.14, and 9.15)

Table 9.13 Estimates of the integrated water service demand model

	P.c. water consumption (log)		Storage volume installed (log)		WTP for water delivery improvement (log)		Long-term WTP under uncertainty (log)	
Method	TSLS		OLS		TSLS		TSLS	
Variable	Coefficient	*p*-value	Coefficient	*p*-value	Coefficient	*p*-value	Coefficient	*p*-value
Constant	−5.036***	0.000	−5.21***	0.000	−6.83***	0.000	−4.40***	0.000
Log (income)	0.161***	0.000	0.049**	0.0004	0.076***	0.000	0.069***	0.0011
Log (bill/cons)	−0.567***	0.000						
Log (bill)					0.501***	0.000		
Log (p.c. water cons.)					−0.003**	0.033	0.009	0.675
Log (volume storage)	0.022***	0.000			−0.009***	0.0006	−0.0096*	0.0218
Log (tot persons in household)	−0.869***	0.000	−0.0044*	0.0458				
Number adults	0.037*	0.0224						
Education (years)	0.051**	0.0112	0.041***	0.0002			0.061***	0.0004
Log (water bad quality rating)	0.225**	0.0016	−0.127**	0.0074				
Log (house market value)	0.136*	0.0152	0.044**	0.0093	0.063*	0.0003		
Hours per day of service	0.013***	0.000	0.002	0.112				
No delivery during dry season			−0.062***	0.000				
Lack of water pressure			0.010*	0.0842				
Log (WTP)							0.140**	0.0085
Dummy water cons.	5.459***	0.000						
Dummy storage			6.805***	0.000				
Dummy WTP					7.429***	0.000	−1.061**	0.0161
Dummy long WTP							6.967***	0.000
R2	0.443		0.988		0.847		0.942	
Observations	1517		1774		1671		1646	

Note: 1. Stars stand for degrees of significance: *** = 0.001 or better, ** = 0.01 or better, *= 0.05 or better; 2. All dummy variables are defined as being equal to 1 when the response to the corresponding variable is non-zero and zero otherwise

Table 9.14 Estimates of the integrated water service demand model

	WTP waste		WTP waste 50		All WTPs' first principal component	
Method	TSLS		TSLS		TSLS	
Variable	Coefficient	*p*-value	Coefficient	*p*-value	Coefficient	*p*-value
Constant	−6.474***	0.000	−4.969***	0.000	−4.969***	0.0003
Log (income)	0.087***	0.000	0.051***	0.000	0.048***	0.0000
Log (water cons.)	−0.111***	0.0004	−0.021**	0.0014	−0.020	0.323
Log (bill)	0.116***	0.0012	0.117***	0.0007	0.121***	0.0000
Log (vol. storage)					−0.058*	0.0299
Gender (1 = female, 0 = male)	0.131***	0.0002	0.043*	0.0493	0.043*	0.0612
Education (years)	0.082***	0.0000	0.025*	0.031	0.024*	0.0293
Log (water bad quality rating)	−0.147**	0.0180	−0.071**	0.0014	−0.048	0.223
Log (house market value)	0.115***	0.0000	0.053***		0.051**	0.0026
Log (WTP water)	0.051**	0.0034	1.958*	0.0872		
Log (WTP waste)			1.744*	0.0856		
Dummy WTP	1.399***	0.000			1.958***	0.000
Dummy WTP waste	6.574***	0.000	0.938***	0.000	1.744***	0.000
Dummy WTP waste50			6.607***	0.000	1.393***	0.000
R2	0.971		0.989		0.943	
Observations	1517		1774		1620	

Note: 1. Stars stand for degrees of significance: *** = 0.001 or better, ** = 0.01 or better, * = 0.05 or better; 2. All dummy variables are defined as being equal to 1 when the response to the corresponding variable is non-zero and zero otherwise

Table 9.15 Estimates of the integrated water service demand model

	Log WTP waste treatment (recreational use of water)		WTP credit for sanitation (log)	
Method	Probit		TSLS	
Variable	Coefficient	*p*-value	Coefficient	*p*-value
Constant	−1.95	0.037	−4.442	0.000
Log (income)	0.048	0.477	−0.000	0.926
Log (p.c. water cons.)	−0.380	0.0008	0.143	0.0013
Log (bill)	0.456	0.0003	0.161	0.000
Log (bill/water cons.)	−0.408	0.0133		
Log (vol. storage)	0.045	0.0005		
Log (water bad quality rating)	−0.888	0.000		
Waterfront	0.586	0.000		
Log (house market value)	0.183	0.0253		
Dummy WTP waste treatment			−0.512	0.0042
Dummy credit			170.577	0.000
R2	0.10			0.968
Observations	1327			1344

References

Abbasov RK, Smakhtin VU (2010) Introducing environmental thresholds into water withdrawal management of mountain streams in the Kura River basin, Azerbaijan. Hydrol Sci J 54(6): 1068–1078

Abbasov RK, Smakhtin VU (2012) Indexing the environmental vulnerability of mountain streams in Azerbaijan. Mt Res Dev 32(1):73–82. https://doi.org/10.1659/MRD-JOURNAL-D-11-00012.1

Arbués-Gracia F, García-Valiñas MA, Martínez-Espiñeira R (2003) Estimation of residential water demand: a state of the art review. J Socio-Econ 32(1):81–102

Bueno EA, Ancog R, Obalan E et al (2016) Measuring households' willingness to pay for water quality restoration of a Natural Urban Lake in the Philippines. Environ Process 3:875–894. https://doi.org/10.1007/s40710-016-0169-8

Carson TR, Mitchell RC (1993) The value of clean water: the public's willingness to pay for Boatable, fishable, and swimmable quality water. Water Resour Res 29(7):2445–2454

Cheesman J, Bennett J, Son T (2008) Estimating household water demand using revealed and contingent behaviors: evidence from Viet Nam. Water Resour Res 44:W11428. https://doi.org/10.1029/2007WR006265

Ehrlich I, Becker GS (1972) Market insurance, self-insurance, and self-protection. J Polit Econ 80(4):623–648

Espey M, Espey J, Shaw WD (1997) Price elasticity of residential demand for water: a meta-analysis. Water Resour Res 33(6):1369–1374

Freeman MA (1979) Hedonic prices, property values and measuring environmental benefits: a survey of the issues. Scand J Econ 81(2):154–173

Green P, Srinivasan V (1978) Conjoint analysis in consumer research: issues and outlook. J Consum Res 5:103–123

Hausman JA, Leonard GK, McFadden D (1993) Assessing use value losses caused by natural resource injury. Elsevier Science Publishers BV, pp 341–363

Mammadzadeh I (2020) Water resources Management in the Republic of Azerbaijan: overview and outlook. Baku, 32–39

Mark YA (2000) A semiparametric distribution for willingness to pay and statistical inference with dichotomous choice contingent valuation data. Am J Agric Econ Agric Appl Econ Assoc 82(3): 487–500

Marschak J (1960) Binary choice constraints on random utility indicators. In: Arrow K (ed) Mathematical methods in the social sciences, 1959. Stanford University Press, Stanford, CA, pp 312–329

McFadden D (1978) Modeling the choice of residential location. In: Karlqvist A, Lundqvist L, Snickars F, Weibull J (eds) Spatial interaction theory and planning models. North-Holland, Amsterdam, pp 75–96

McFadden D (1999) Computing willingness-to-pay in random utility models. In: Moore J, Riezman R (eds) Trade, theory and econometrics: essays in honour of John S. Chipman London. Routledge, New York, pp 253–274

McFadden D (2001) Economic choices. Am Econ Rev 91:351–378

Mitchel RC, Richard CT (1989) Using surveys to value public goods: the contingent valuation method. Resources for the Future, Washington, DC

Nam PK, Son TVH (2004) Recreational value of the coral surrounding the Hon Mun Islands in Vietnam: a travel cost and contingent valuation study1. In: Economic valuation and policy priorities for sustainable management of coral reefs, p 84

Nauges C, Van Den Berg C (2009) Perception of health risk and averting behavior: an analysis of household water consumption in Southwest Sri Lanka. TSE working papers 09–139, Toulouse School of Economics (TSE)

Nauges C, Whittington D (2010) Estimation of water demand in developing countries - an overview. World Bank Res Obs 25(2):263–294

Otsetsewe M (2001) Willingness to pay for private water connection in Kanye: a contingent valuation approach. Unpublished BA Project, Department of Economics, University of Botswana

Pearce D (1993) Economic values and the natural world. Earthscan Publications Ltd, London

Phu Le V (2004) Urbanization and water Management in ho chi Minh City Vietnam – issues, challenges perspective. Geo J 70(1):75–89

Sen AK (1984) Resources, values and development. Basil Blackwell, Oxford

Shaikh SL, Sun L, Kooten CG (2007) Treating respondent uncertainty in contingent valuation: a comparison of empirical treatments. Ecol Econ 62(1):115–125

Srinivasan V (1988) A conjunctive-compensatory approach to the self-explication of multi attributed preferences. Decis Sci 19:295–305

Train K (1986) Qualitative choice analysis. MIT Press, Cambridge

Train K (1998) Recreation demand models with taste variation. Land Econ 74(2):230–239

Train K (2001) Discrete choice methods with simulation. Cambridge University Press, Cambridge

Train K, McFadden D (1978) The goods-leisure tradeoff and disaggregate work trip mode choice models. Transp Res 12(5):349–353

Trigeorgis L (1996) Real options: managerial flexibility and strategy in resource allocation. MIT Press, Cambridge/London, pp 13–427

Wang H, Xie J, Li H (2010) Water pricing with household surveys: a study of acceptability and willingness to pay in Chongqing, China. China Econ Rev 21:136–149

Wilson C, Athukorala W, Torgler B et al (2020) Willingness to pay to ensure a continuous water supply with minimum restrictions. Empir Econ. https://doi.org/10.1007/s00181-020-01955-8

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