Determination of Maximum Willingness to pay for reclaimed water from wastewater treatment facilities by Contingent Valuation Method

Mohsin Gul Sher

ENVSC-3203

Natural Resource and Environmental Economics

Submitted to: Mr. Junaid Ahmad Noor

Table of Contents

Acknowledgment

I would like to extend thanks to Mr. Junaid Ahmad Noor, Lecturer in Economics and Instructor, ENVSC 3202, for providing us the opportunity to undertake the following research. He guided me throughout the research including survey design and data analysis. I would also like to thank Class of 2014, B.Sc (H) Environmental Sciences, G.C University, Lahore, for supporting us in all ways to complete the research project.

Furthermore, this would not have been possible without the help of my family and public who participated whole heartedly in the research work, especially in research survey.

Mohsin Gul Sher

List of Abbreviations and Acronyms

CVM	Contingent Valuation Method
WASA	Water and Sanitation Agency
WHO	World Health Organization
WTP	Willingness to Pay
R- value	Regression Value
APS	American Psychology Society
NEQS	National Environmental Quality Standards
UNIDO	United Nations Industrial Development Organization
ISO	International Standards Organization
PWSS	Pakistan Water Sector Strategy
P-EPA	Punjab Environment Protection Agency

Abstract

Pakistan faces serious water crisis and there is a need to prioritize strategy design for water conservation and efficient resource usage. To alleviate the problem of water wastage and over consumption, efforts need to be undertaken for water reclamation and reuse from different sources, including ethically unpleasant sources like waste streams, etc. Current wastewater treatment facilities are not up to the mark and require monitoring for quality control and assurance. If the current facilities are improved and international quality standards are complied by, it is possible to encourage the use of reclaimed wastewater for various domestic and non-domestic purposes. Based on the double bounded contingent valuation survey, it has been concluded that people are willing to pay lower bound cost of Rs. 350 for the treatment facility, limiting the use of reclaimed wastewater to uses other than drinking and cleaning. The research work presents the first effort to examine the degree of social acceptance of reclaimed wastewater for domestic and non-domestic uses.

Introduction

Pakistan is a water-deficit country and the water availability is set to decrease up to 700 m^3 per capita by 2025. There is no sustainable use policy for wastewater and its use after treatment. There is a dire need to address this problem as there are no incentives available for the local people and industries for recycling the wasted water and treating it for various uses. (C. Howe, 1984)Water is highly subsidized and available at extremely low price in the market so, it is majorly assumed as a free commodity but there is a need for people to realize the importance of this diminishing resources and efforts should be undertaken to conserve it.

Most pressing challenge faced by policy makers is the minimization of negative effects while maximization of the benefits of wastewater (W.Bruvold, 1982). Although pros and cons are known, costing and valuation has not been performed for reclaiming this vital resource and reusing it for various domestic and non-domestic purposes.

In Developed Countries, Public Treatment Head works are installed which treat the local wastewater of households hence, providing clean water for local use.(W.Bruvold, 1982) Contrastingly, in countries like Pakistan, sewage system is spread city-wide and all the wastewater first travels through waste streams and then about 2-5% is treated by WASA (Water and Sanitation Agency). Remaining sewage and untreated industrial effluents enter the water streams or rivers, causing environmental damage and various health implications for the ultimate users, humans.(Wedgewood, 2003) It is fundamental to appreciate the social acceptability of reclaimed wastewater and its usage in a moderately literate society. According to the American Psychology Society (APS), no matter how clean the material is, people will generally relate to its

source and make the judgment of usage accordingly. A research was carried out to check this hypothesis and it was observed people do have set perceptions about most of the things and that actually governs their thinking process. E.g. a sterilized cockroach was given to a person to eat, he did not consume besides knowing it was clean. Similarly, a person was asked to drink orange juice from a new, unused toilet seat, she still refrained to consume it. This psychological factor is called the 'Yuck Factor', and it plays a vital role in determining the end use of such products including treated or reclaimed wastewater, even if it complies with National Environmental Quality Standards (NEQS) and water quality standards set by World Health Organization (WHO).

Literature Review

Since the past few decades, concerns over water scarcity and reclamation have increased drastically and research has been undertaken to develop methods to retrieve maximum benefits from water sources including waste water from effluent discharges and sewage treatment works. US- Environmental Protection Agency has worked tremendously in this sector and developed key resources for identifying the significance of water recycling. According to a report on Environmental Benefits of Water Recycling by US-EPA in 1992, it provides an additional source of water and can help us find ways to decrease the diversion of water from sensitive ecosystems. Other benefits include decreasing wastewater discharges and reducing and preventing pollution. Recycled water can also be used to create or enhance wetlands and riparian habitats ("Water Recycling and Reuse: The Environmental Benefits," 1992).

Dupont, 2013 compares the social acceptance of water recycling with imposition of water restrictions and tariffs. She has done a contingent valuation survey and concluded that t an average annual WTP per household that ranges between $142 and $155 depends upon the scale of the treatment project and upon whether respondents are concerned that other members of their community will not comply with water use restrictions, thereby, free riding on others (P.Dupont, 2013). She has also assessed the acceptable uses of reclaimed water, concluding that most of the respondents have a feeling of distrust about the reclaimed water and avoid using it for drinking purposes, while they have no problem in using reclaimed water for other purposes including washing, cleaning, watering. Her study was restricted to household water usage only.

Murtaza and Zia 2012 focus on wastewater use potential in Pakistan and identify the key problems in implementation of a wastewater use policy. As Pakistan is an agricultural country, most of its water is used for irrigation purposes. According to both authors, that should be the priority area for Research and Development in the use of reclaimed water in irrigation sector. This can help reduce the water deficiency on agricultural lands. Other major users include industries, which need to treat their effluents and use them. This is only possible if the cost of water recovery is less than the cost of water disposal. For this purpose, strict compliance by-laws should be generated and industries should be encouraged to comply by them under all conditions. A National Sustainable Wastewater policy should be generated (Zia, 2012).

According to Irusta 2010, most water prices are either subsidised or do not include the true cost of water such as the environmental, social and economic impact of the process. There are the direct costs of headworks, storage, treatment, distribution etc., but there are also the externalities such as the impacts on public health, water resource, phosphates, nitrates, soil salinisation, environmental biodiversity, flood mitigation etc (Irusta, 2010). There is a need to perform proper

costing of water resources and people should be encouraged to use this precious resource carefully and should be made aware about the dire consequences of wasting it.

Methodology

A primary data study was carried out with a questionnaire based on Contingent Valuation Method. Double-bounded Referendum technique has been used to determine Maximum Willingness to pay for treated water from improved wastewater treatment systems. A representative sample size of 60 respondents has been used. Questionnaire filling was a guided activity as interviewer was present during the activity, ensuring complete understanding by the respondents.

Data Analysis has been performed using SPSS-16, applying Linear Regression including ANOVA and correlations. On the basis of results obtained, a list of recommendations is provided for usage of reclaimed wastewater.

Results

As mentioned before, data analysis was performed and following analytical techniques were applied:

Cross Tabs

All the 60 responses were valid and no one was missed as depicted in case process summary. Out of 60 respondents, 34 were males and remaining 26 were females. This constitutes about 56.6% males and 43.4% females. It was observed that most of the females were housewives and had

monthly incomes of less than Rs. 25,000, and paid average water bills monthly while males had greater incomes and expenses including water use bills per month.

50% females were more satisfied with the current waste disposal facility while most of them also wanted the service to be further improved. Females were less considerate about water conservation than males and had not heard about 'reclaimed water' generally.

Another cross tab was based on monthly income. A total of 9 respondents out of 60 were willing to pay Rs.500 for the facility. Out of which, 8 respondents had monthly income of Rs. 50,000 and above. Contrastingly, 35 respondents were willing to pay Rs. 350 for the service. Out of which, 28 respondents had monthly income of Rs. 50,000 and above.

Will you be willing to pay Rs. 350 per month for the same facility? * Household Monthly Income Crosstabulation

		Household Monthly Income				
		Less than Rs. 25,000	Rs. 25,000-50,000	Rs. 50,000-1,00,000	More than Rs. 1,00,000	Total
will you be willing to pay Rs. 350 per month for the same facility?	yes	1	6	14	14	35
	no	0	6	14	5	25
Total		1	12	28	19	60

Table 1.1. Cross Tabulation between Monthly Income and Lower bound WTP

Correlations among different parameters

Correlations among all variables were analyzed. This is to interpret what are important factors and which variables are correlated weakly, moderately and strongly.

	Pearson Correlation
Monthly Household Income	-0.015
Preference for improved Water Disposal System	0.199
Possible to remove 'yuck factor'	-0.33
Incentives for reclaimed water users	-0.009
WTP Rs.350 as tariff instead of Rs.500	-4.97**
The tariff rates are re-fixed at Rs. 500 per month for treatment facility, would you want a connection and pay for the bill?	1

**. Correlation is significant at the 0.01 level (2-tailed).

Table 1.2. Correlations between different parameters observed

It has been shown that preference for improved water disposal system is moderately correlated to Maximum Willingness to pay for treatment facility and reclaimed wastewater availability. Monthly Income is weakly correlated to maximum WTP as health implications and other related factors play a key role in determining the WTP for water usage. WTP of Rs.350 is strongly negatively related to WTP of Rs.500 as it is a lower bound preference.

Regression

The study elicited various aspects of a household's choice for using reclaimed water. On the bais of date present, following Maximum WTP equation can be made on the basis of 8 selected independent variables:

WTP = β_0 + β_1 Monthly Income + β_2 Concern for water conservation + β_3 Yuck Factor + β_4 Potential of reclaimed water usage +......+ error$_i$ *- equation (1)*

To do so, a regression was performed using the Ordinary Least Squares method. This method allows estimating the coefficients (β_0, …, β_8,…) that provide the best fit between the data and the assumed theoretical model represented by equation (1). The coefficients obtained from the estimation are key as they provide information on how much a change in each explanatory variable affects the maximum WTP. Table 1.3 shows the regression results.

Variable	Coefficient (β)
WTP	Dependent Variable
Constant	1.251
Monthly Income	-.073
Concern for water conservation	.662
Yuck Factor	.022
Potential of reclaimed water usage	-.138
Incentives	.008
Water Availability	.102
Satisfied with current disposal	.019
Preference for improved Service	-.270
R- Square Value	.128
Error	87.2%
N	60

Table 1.3. Regression Results

R-square value is 12.8%, which is typical of CVM studies as they are based majorly on primary data and a greater chance of error prevails in the results obtained. Error is calculated for the sample of 60 respondents, i.e. 87.2%.

Conclusion

According to the study conducted, it is concluded that besides the yuck factor and various negative factors associated with using reclaimed wastewater, respondents were willing to pay Rs. 350, lower bound WTP Amount set in the questionnaire. The respondents agreed to pay the amount for improving wastewater treatment facility but limited their use to certain distinguished uses other than drinking and cleaning. Non-direct uses like watering parks, roads, gardens, etc are more preferred by respondents as complete removal of the yuck factor is not possible.

To remove yuck factor and encouraging public to use reclaimed wastewater, following recommendations are stated:

1) Strict Monitoring of treatment process

(2) International Quality Assurance

(3) Quality Control and Standards Compliance

(4) Media and Public Awareness

According to United Nations Industrial Development Organization (UNIDO), it is estimated that up to 65% of water resource can be conserved and treated effluent reuse can be encouraged. In a nutshell, efforts need to be undertaken to develop cheap technologies and R&D for maximizing the use of reclaimed wastewater in the local context, without causing any ethical implications.

References

C. Howe, M.Griffin Smith, L.Bennet ,C.Brendecke, J.Flack, R.Hamm, R.Mann, LRozaklis, K.Wunderlich. (1984). The value of water supply reliability in urban water systems. *Journal of Environmental Economics and Management 26*, 19-30.

Irusta, D. Hidalgo and R. (2010). The cost of wastewater reclamation and reuse in agricultural production in the Mediterranean countries. *Environmental Division, CARTIF*, 6-9.

P.Dupont, Diane. (2013). Water use restrictions or wastewater recycling? A Canadian willingness to pay study for reclaimed wastewater. *Water Resources and Economics, 1*, 61-74.

W.Bruvold. (1982). Community evaluation of adopted uses of reclaimed water. *Water Resources Research 3*, 487-490.

Water Recycling and Reuse: The Environmental Benefits. (1992).　Retrieved 13 May, 2013, from http://www.epa.gov/region9/water/recycling/

Wedgewood, Alison. (2003). *Willingness to Pay Surveys- A streamlined approach* Liecestershire WEDC.

Zia, Ghulam Murtaza and Munir H. (2012). Wastewater Production, Treatment and Use in Pakistan Faisalabad: University of Agriculture.

Annexure A: QUESTIONNAIRE

<u>Determination of Maximum Willingness to pay for reclaimed water from wastewater treatment facilities by Contingent Valuation Method</u>

District/Tehsil/Town: _____

Village/Mohalla and address: _____

Day/Month/Year of interview: _____

Name of head of household: _____

Head of Household: *(select one)* Male ……..1 Female…..2

After whole questionnaire for the household have been completed, fill in the following information:

Result of HH interview:
(select one)
Completed   _____
Refused   _____
Not at home   _____
HH not found/destroyed/vacant   _____
Incomplete   _____
Other (*specify*)   _____

Name of the respondent: _____

Total number of household members: _____

INTRODUCTION AND INFORMED CONSENT

Assam-u-Alaikum. My name is _____ and I am a student of B.Sc (H) Environmental Sciences, G.C. University, Lahore. We are conducting an academic survey about the potential uses of reclaimed wastewater in our locality. I would like to ask you some questions about your household. The survey usually takes about 15 minutes to complete.

Whatever information you provide will be kept strictly confidential.

Participation in this survey is voluntary and you can choose not to answer any question or all of the questions. However, we hope that you will participate in this survey since your participation is important.

At this time, do you want to ask me anything about the survey?

ANSWER ANY QUESTIONS AND ADDRESS RESPONDENT'S CONCERNS.

May I begin the interview now?

Signature of interviewer:

_____   Date: _____

A) Socio-Demographic Information

1.	Education of the head of the household *(please tick any one)*	(1) No Schooling (2) Primary Education (1-5 years) (3) Secondary Education (6-12 years) (4) Higher Education (> 12 years)
2.	Occupation of the head of the household *(please tick any one)*	(1) Agriculture or fishing (2) Own business (3) (Semi-)Government employee/Retired (4) Private employee (5) Housewife (6) Others _____
3.	Number of persons living in the household	No. of adults (> 16 years) _____ No. of minors (< 16 years)_____
4.	Total household income per month *(please tick any one)*	(1) Less than Rs. 25,000 (2) Rs. 25,000- 50,000 (3) Rs. 50,000- 1,00,000 (4) More than Rs. 1,00,000
5.	How many persons contribute to household income? *(please tick any one)*	(1) 1 (2) 2-3 (3) 4-6 (4) More than 6
6.	Total household expense per month *(please tick any one)*	(1) Less than Rs. 25,000 (2) Rs. 25,000- 50,000 (3) Rs. 50,000- 1,00,000 (4) More than Rs. 1,00,000

B) Water Usage Patterns

7.	Size of the house *(please tick any one)*	(1) 1- 5 Marlas (2) 5-10 Marlas (3) 10-20 Marlas (4) 20- 40 Marlas (5) 40 Marlas and above
8.	Monthly average Household Bill for Water consumption (Rs.) *(please tick any one)*	(1) 250-400 (2) 400-650 (3) 700-950 (4) 1000-1200 (5) 1250 and above
9.	Source(s) of potable water *(you can choose more than one option)*	(1) Private tube well (2) Private dug well (3) Governmental supply (4) Water vendors (5) River or water stream (6) Others _____
10.	Water availability *(please tick any one)*	(1) Sufficient all year (2) Insufficient during dry season (3) Sometimes insufficient (4) Insufficient mostly

11.	Water pressure *(please tick any one)*	(1) Strong (2) Weak (3) Generally strong (4) Sometimes weak
12.	Major household uses of water *(you can choose more than one option)*	(1) Drinking (2) Domestic purposes including flushing, cleaning and washing (3) Watering (4) Others _____

| 13. | What do you think of the quality of the water delivered?

(please tick any one for each category) |

		Good	Average	Bad
A	*Taste*			
B	*Smell*			
C	*Colour*			

C) Wastewater and Health Implications		
14.	How do you dispose off your wastewater? *14.1 Human waste water (Excreta/Urina)*	 (1) Sewerage system (2) Septic tank (3) Open drainage canals (4) Into the street/road (5) Into the open field/river (6) In the garden/compound (7) Other, specify _____
	14.2 Grey waste water (washing/bathing/kitchen)	(1) Sewerage system (2) Septic tank (3) Open drainage canals (4) Into the street/road (5) Into the open field/river (6) In the garden/compound (7) Other, specify _____
15.	Are you satisfied with the current disposal of your wastewater?	(1) Yes (2) Moderately (2) Not at all
16.	Would you prefer to have an improved wastewater disposal system?	(1) Yes (2) No (3) Don't Know
17.	Is there any relation between the quality of water and illnesses in your household?	(1) Yes (2) No (3) Don't Know
18.	How many persons in your household were ill during the last year due to the consumption of unsafe water?	(1) 1 (2) 2-3 (3) 4-6 (4) More than 6
19.	How do you treat water?	(1) Boil and filter (2) Boil (3) Filter

		(4) Others _____ (5) None
D) Social Acceptance of Reclaimed Wastewater		
20.	Do you believe that water resources are finite and there is a need to conserve water for safe, future usage?	(1) Yes (2) No, it is an exaggeration (3) I don't care
21.	Do you think your wastewater is treated effectively through a properly designed local wastewater treatment facility?	(1) Yes (2) No (3) Don't Know
22.	Have you ever heard about reclaimed wastewater? *(If the respondent answers 'No', then explain 'reclaimed water' to him/her)*	(1) Yes (2) No
23.	Did you know 60% of wasted water can be reused if people start using treated or reclaimed wastewater?	(1) Yes (2) No

24. Suppose that wastewater is effectively treated and meets the quality standards, would you be willing to use it for the following purposes:

	Yes	*No*	*Maybe*
Drinking			
Toilet Flushing			
Watering vegetables in garden			
Watering grass or flowers in garden			
Laundry and Cleaning			
All household purposes			

25. Do you agree that reclaimed wastewater should be used for following non-domestic purposes?

	Yes	*No*	*Maybe*
Agriculture			
Industrial Applications			
Watering of public parks			
Watering of roads			
All non-domestic purposes			

26.	Do you think it is possible to remove the 'yuck factor' or distrust amongst the public about using reclaimed wastewater?	(1) Yes (2) No (3) Maybe in the future
27.	How can the 'yuck factor' or distrust be removed amongst the public about using reclaimed wastewater? *(you can choose more than one option)*	(1) Strict Monitoring of treatment process (2) International Quality Assurance (3) Quality Control and Standards Compliance

		(4) Media & Public Awareness (5) Others _____
28.	Water usage restrictions and tariffs be imposed on:	(1) All households (2) Only Industries (3) Households with excessive use of water (4) None
29.	If water usage restrictions and tariffs are imposed on all households and industries, should relaxations and incentives be given to users which use reclaimed wastewater?	(1) Yes (2) No (3) Maybe
30.	Suppose the local government wishes to encourage the use of reclaimed wastewater amongst the public. For this, the wastewater treatment facility is being improved according to international quality standards, and plans to provide piped water quantity, supplied 24 hours per day at adequate pressure so that you can get sufficient water with a good quality, and the tariff rates are re-fixed at Rs. 500 per month for treatment facility, would you want a connection and pay for the bill?	(1) Yes (2) No
31.	If you answered Question 30 as 'No', then will you be willing to pay Rs. 350 per month for the same facility?	(1) Yes (2) No
32.	If you answered Question 30 and 31 as 'No', then why aren't you willing to avail the service? *(you can choose more than one option)*	(1) Distrust regarding reclaimed waste water (2) Government should give the facility for free (3) Ethical reservations (4) Over-charged service (5) Others _____