Determinants of Residents Willingness to Pay for Improved Urban Environment: Choice Modeling Approach

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Abstract

This study estimates residents' willingness to pay for improved liquid waste treatment in Addis Ababa and its determinants using data collected from 384 randomly selected households in 2011 from five Woredas of five sub cities. Basic and correlated random parameter logit model with and without interaction are applied to estimate parameters by maximum simulated likelihood technique. Delta procedure is applied to calculate implicit price of attributes. Our findings indicates that though respondents preferred improvement plans with higher quantity and quality of treated domestic liquid waste, they gave more emphasis on effluents quality than increasing only the capacity and number of sewage treatment plants. We also found that the sampled households prefer a cheaper alternatives and presence of status quo bias. We found unconditional and unobserved preference heterogeneity towards attributes and alternatives in the choices. The estimated Mean willingness to pay per month was 22.14 and 4.60 Ethiopian Birr (ETB) for high quality and additional quantity of treated liquid waste, respectively. But this figure was 15.53 ETB for medium improvement scenario. The compensating surplus for the change from the status quo to the considered scenarios increased as we move towards aggressive improvement. The result indicates as large amount of public financing is expected. Finally, the paper concludes by providing a range of policy recommendation to be considered in designing city's environmental management strategies.

Keywords: *Choice experiment, random parameter logit, willingness to pay, liquid waste, urban environment.*

1. Introduction

In urban areas of Ethiopia, domestic sewages and the recent growing trends in industrialization have raised concerns about water pollution and these become increasingly critical environment and animal health risks (EPA, 2005). Insufficiency of the existing municipal waste management system and the low attitudinal and behavioural aspects of the households on waste management also aggravate the magnitude of the problem (Hutton et al. 2007). For instance, in Addis Ababa, the sewage system is serving only about 10% of the city's population. The concentration of heavy metal, nitrate, coliforms and pathogen pollution in the surface and ground water is increasing (Tamiru et al. 2005). The biochemical oxygen demand (BOD) in surface water is higher than the accepted normal concentration indicated by the Environmental Protection Authority (EPA) of Ethiopia.

Particularly as reported in Weldesilassie et al. (2008), AAEPA (2007), and Mengesha (2010) the rivers in the city such as Akaki river are highly polluted with organic and inorganic substances since they serve as a sink to almost all wastewater generated from the city. This risks the livelihood of farmers in the pre-urban area and entails the health of local and urban consumers of agricultural products from the area. De-

spite the ongoing discussions to address the challenges, little has been achieved in identifying and implementing practical and affordable strategies. In spite of considerable number of environmental studies on the topic (E.g. Getachew, 2006; Mekala et al. 2007), valuation of households' willingness to pay for its improved management has received little attention. Particularly it is important to estimate demand for and affordability of advanced Sewage Treatment Plants (STP). To fill this gap, this paper investigates resident's willingness to pay for improved waste water treatment program and its determinants.

2. Theoretical framework

Economic valuation is one of the well-established conceptual tools of welfare economics that focuses on how to estimate the impact of changes in goods and services on the welfare of individuals (Freeman 1993). It remains important tool to guide decision makers to make use of the resources in the best way possible (Haab and McConnell 2002).The classical tool for measuring welfare change is in terms of consumer's surplus (Varian 1992).The compensating surplus (CS) measures the maximum amount of money individuals are willing to pay for welfare gain and the minimum amount of compensation the individuals are willing to accept for welfare loss if change is implemented (Johanson 1991).

Research on economic valuation of non-market goods has developed into two branches: revealed preference (RP) and stated preference (SP) approaches. The RP approach infers value indirectly by observing individuals' behaviour in actual or simulated markets. The best known RP methods are Travel Cost method and the Hedonic Pricing method (Braden and Kolstad 1991). But, SP methods elicit environmental values directly from respondents by asking them about their preferences for a given environmental good or service. It includes a number of different approaches such as Contingent Valuation Method (CVM) and Choice Modeling (CM). Nowadays, SP methods are used to estimate total economic value, whereas RP methods are only restricted to estimating use values (Haab and McConnell 2002).

Choice modelling method, the concern of this study, belongs to a family of Attribute Based Methods (ABMs). By incorporating price as an attribute, ABMs can be used for the purpose of applied welfare analysis of changes and WTP. These methods assume that a respondent's WTP consistently relates to his or her underlying preferences (Louviere *et al*. 2000; Holmes and Adamowicz, 2003). CM has its origin in conjoint analysis (Adamowicz*et al*. 1998a), and was initially developed in the marketing and transport literature by Louviere and Hensher (1982), and Louviere and Woodworth (1983).But, many argue that the CM differs from typical conjoint method in that individuals are asked to choose from alternative bundles of attributes instead of ranking or rating those (Adamowicz *et al.* 1998a). The underlying basis of a choice experiment is the idea that "any good can be described in terms of its attributes, or characteristics, and the levels that these take" (Bateman *et al.* 2002).

In a CM experiment, respondents are presented with a series of alternative resource use options and are asked to choose their most preferred one. A choice set involves a choice between a constant "status quo" situation and a number of different "proposed" situations. Typically, five to nine choice sets are included in a questionnaire.

Each option is described using a common set of attributes across several set levels. CM is similar in many ways to the discrete choice variant of CVM in that both share a similar theoretical basis and survey design process (Blamey *et al.* 1999). The main difference is that CM seeks to communicate differences through the use of attributes and repeated scenarios, as compared to the single trade-off of a CVM exercise (Blamey *et al.* 1997). While both techniques can provide surplus estimates for moving from the status quo to an alternative, CM has an advantage in that.

CM has advantages of improved flexibility, increased information provision, more communication of scope issues and increased realism over the CVM (Hanley *et al.* 2001, Rolfe *et al.* 2000).Louviere *et al*. (2000) also made detailed discussion on the distinct difference between these two concepts. But, CM is now applied both in ranking and rating attributes of alternative options (Hanley *et al.* 2001). According to Colombo *et al* (2006) CM can be used to measure option values, a sub-component of passive use value. Moreover, it has advantages in its ability to model choice processes in different ways, and to report values for tradeoffs between price and a single attribute makes it a more versatile and cost-effective technique (Christie *et al.* 2006, and Jin *et al.* 2006). For these reasons, CM is the preferred technique for the economic analysis of "multiple mutually exclusive policy options" (Layton *et al.* 2006). In addition, CM techniques can be used without a status quo option, where two or more alternative management or resource use options are directly compared and estimates can be made for a broad number of alternatives (Nielsen *et al.* 2007). An application of both CVM and CM methods of valuation reveal that choice experiments outperform CVM in applied analysis (Adamowicz *et al.* 1998a).

The application of CM in environmental valuation is comparatively recent (Hanley *et al.* 1998; Blamey *et al.* 2001; Bennett and Blamey, 2001). Empirical study on CM technique has now been widely applied in many areas of environmental and resource economics, including; valuing environmental attributes of rivers (Bennett and Morrison, 2001), modelling recreation demand for rock climbing (Hanley *et al.* 2002), and estimating preservation of tropical rainforest (Rolfe *et al.* 2000). Like CVM, CM is used for measuring both use and passive use values (Adamowicz*et al.* 1998a). More recently, CE has been widely applied for the valuation of environmental and public goods such as improvements in river ecology (Hanley *et al.* 2005), wetlands' management (Birol *et al.* 2006), solid waste management (Das *et al.* 2008), capacity and technology of STP (Birol and Das 2010), and local residents' preferences for water quality management (Poirier and Fleuretz, 2010). It is with these justifications that the CM survey approach is used to evaluate impacts of different attributes of improved liquid waste management programs on respondent's welfare in Addis Ababa.

3. Methodology

3.1 Choice experiment design and data collection

Choice experiment requires respondents to select their most preferred option from an array of alternatives, choice sets. Each alternative is described using a number of attributes. This places a significant cognitive burden on the respondent. If this is not carefully managed through questionnaire design and presentation, the outcome

can be biased sampling or result. Considering the difficulty of conducting Choice Experiment (CE) studies in the context of developing countries, Fitalew and Alemu (2011) indicated the possibility for improving its contribution towards answering policy relevant questions with detailed focus group discussions. Similarly, for successful application of CE Bennett and Birol (2010) recommended using face-to-face interview with well-trained enumerators and limiting the number of alternatives and attributes.

Accordingly, this paper is based on primary data collected through household survey and secondary data obtained from various sources. Respondents of the survey were household heads of 384 sample households. To identify representative sample units the study has employed a multi-stage stratified cluster sampling procedure. The attributes were selected based on prior work. Informal survey and three group discussions were conducted with residents, and key informant interview were made with four experts of STP and manager employed by the AAWSA project office. Subsequently, we conducted an open-ended pilot contingent valuation (CV) study on purposively selected 50 households from two sub cities to identify levels of the monetary attribute and to test the language and wording that should be used in the choice experiment. Accordingly, the attributes were set as indicated in Table 1.

Table 1. Attributes and attribute levels

Definition and description of attributes	**Attributes levels**
Payment vehicle in ETB was identified through a pilot informal survey and FGD. Additional payment on water bill with improvement plan.	**0,**10, 20, 30
Quantity of Treated Domestic Liquid Waste (QT) in M^3: Refers to total volume of wastewater treated by the existing one STP or new treatment plants	**5.2,**100, 250, 327 in M^3/ Day
Quality of Treated Domestic Liquid Waste (QU): The removal efficiency of the current or new STP and microbiological parameters ability to ensure public health and safety in terms of Fecal Coliforms(FC) and helminthes egg/M^3.	**Low,** Medium, High

Orthogonal experimental design approach in which the levels of the attributes of the different alternatives are uncorrelated in the choice sets, have been used to construct the choice sets in this specific study. The creation of the alternatives to be used in the choice sets is only the first phase of the creation of an experimental design. The second phase involves the combining of alternatives together to form the complete choice set. According to (Louviere *et al.* 2000), when designing the choice sets, the aim is to ensure that all different attributes can be estimated independently of each other. On the other hand, it is unrealistic to assume that respondents will carry out a high number of choices. The three attributes included in the experiment, which

can be between two and three different levels, resulted in 18 combinations. Since (T =9) choice sets were manageable and reasonable. These 18 pair-wise alternatives were then randomly assigned to two blocks such that a single respondent would be confronted with nine choice sets.

Questionnaire for the CE is designed in such a way that respondents are asked to choose between two alternatives: one is the current situation and the other is a new program featuring combinations of attribute levels and specific cost levels. For each choice set they were asked to choose between three plans/alternatives, where the third alternative was always the baseline or opt-out alternative, i.e. no improvements and no extra costs (Table A1). Including an opt-out alternative prevents 'forced choices' by respondents, which could bias the results (Banzhaf *et al.* 2004). The two other alternatives offered various levels of improvements at various costs. Before the main survey, interviewers were trained carefully on how they approach the problem to the respondents; explain the whole scenario, and the attributes and their levels to be used in the survey. A pre-test study was conducted on 10 residents of study area in order to uncover misinterpretations of the questions and the difficulty of the choice tasks. The survey was administered using a face-to-face interview. Interviewers were closely supervised by the researcher.

The CE was introduced with elicitation of the three attributes and the additional payment levels in two hypothetical scenarios. The respondents were told about the current situation of the city sanitation coverage, liquid waste treatment facilities as compared to World Health Organization (WHO) and EPA standards for removal efficiency and challenges it faces and related environmental and health hazards. The improved program scenario was read to them along with the attribute levels planned to attain in the choice experiment. The socio economic and perception variables were also included in the model (Table A2).

3.2 Methods of data analysis

This study employed Random Parameter Logit (RPL) model using the Maximum Simulated Likelihood method (Boxall and Adamowicz 2002).It accounts for unobserved, unconditional heterogeneity in preferences across households and alternatives is employed. Based on the Lancaster's model of consumer choice (Lancaster 1966) and the random utility theory (McFadden 1974).The utility is specified in willingness to pay space with respondent i choosing between j alternative management options in each of the S_t choice sets offered in a repeated choice format. The space can be defined as:

$$U_{ijt} = \alpha_{jt} + \beta_i X_{ijt} + v_{ijt}, \text{Where } U_{ijt=}(V_{ijt} + v_{ijt}) \qquad (1)$$

Where is Alternative Specific Constant (ASC), is vectors of observable variables relating to alternatives j and vector of individual specific variables and the attributes of the alternatives. is a vector of coefficients of these variables representing the person's taste, and is a random error term that is IID extreme value. = and is the population mean and is the stochastic deviation which represents the individual's preference relative to the average preferences in the population.

The RPL model allows coefficients to vary over decision makers (instead of being fixed as in the Multinomial logit model) according to some distribution reflecting

the tastes of the decision makers. The combined error is now correlated across alternatives, whereas's alone were not. This correlation over the alternatives leads to coefficient bias in the Multinomial logit model and Conditional Logit model. Conditional on the unobservable the random parameter logit specification implies that the probability of alternative 'j' being chosen over all the other alternatives of the choice set t can be written a

$$P\ (y_i = j/t)/v_i = \frac{\exp\ (\alpha_j + \beta_x X_{ij} + X_{ij} v_i\ )}{\sum_{h\in t}^{c} \exp\ (\ \alpha_h + \beta_x X_{ih} + X_{ih} v_i)} \qquad (2)$$

The alternatives obtained from orthogonal method were Status quo (SQ) and two new improvement programs (plan A and plan B). The RPL model allows for variation in preferences across individuals and adjusts for error correlation across alternatives. We thus estimated RPL model that includes the socioeconomic and other household specific variable interacted with attributes of improved liquid domestic waste in order to estimate implicit prices specific to individuals. This enabled to examine how these variables affected the probability of an alternative being chosen. From an econometric viewpoint, data were such that, for each individual, there were as many observations as choice questions. The attributes for the status quo '*no improved waste water treatment plans*' were coded with 0 values for both quality of treated waste water and price attribute. But for quantity of treated liquid waste attribute the current value (5.2 units) was used. Since this choice experiment involves generic instead of labelled options, the alternative specific constants (ASC) were equalled to 1 when either waste water treatment plan A or B was chosen and 0 when respondents chose neither alternative (Louviere *et al.* 2000).

In the CE, the ASC was specified to account for the proportion of participation in wastewater treatment plans. A relatively more negative and significant ASC indicate a higher propensity to choose to pay for improved wastewater treatment plans. The CE data were coded according to the levels of the attributes. Binary attribute, i.e., quality of treated water, entered the utility function as binary variables that were coded (Louviere *et al.* 2000). The attribute with four levels were entered in cardinal linear form. The choice experiment was designed with the assumption that the observable utility function would follow a strictly additive form.

The model is be specified with the probability of choosing a particular wastewater treatment plan being a function of the attributes and ASC. The RPL model (both basic and correlated) is used to estimate choice-specific data through MSL method. Suppose that our sample was made of individuals, each making choices. Each choice set is made of alternatives. Let us define as being a dummy variable such that

$$\delta_{ijt} = \begin{cases} 1 \text{ ifindividual } i \text{ chose altrantive } j \text{ from choice set } A = \pi r^2 \\ 0 \text{ otherwise} \end{cases} \qquad (3)$$

The model was estimated with Stata 11 using MSL assuming normally distributed and freely correlated random parameters. In RPL model, maximum likelihood estimation would require integrating over . Hence, the log-likelihood is approximated by a simulator that is based on S draws of from the normal given current estimates of. The MSL estimator then maximizes the logarithm of the conditional probability of respondent's repeated choice which can be expressed as

$$L(y_i/\beta_i) = \prod_i^I \prod_j^J \prod_t^{S_t} [\tilde{A}(y_i = j/t)]^{\delta_{ijt}} \quad (4)$$

Where, is a simulator for Pthe unconditional probability can be expressed as:

$$P_i(y_i) = \int L(y_i / \beta_i) g(\beta_i) d\beta_i$$

With g (.) denoting the density of.Using the 10,384 choice cases elicited by 384 households, RPL model by interacting socioeconomic and other household specific variables with alternative attributes was estimated. The models were based on 1000 simulation draws. The ASC attribute were specified to be non-random, and the random additional payment on water bill, quantity of treated liquid waste and quality of treated liquid waste were specified normally distributed. In the RPL model comparison, the inclusion of correlated RPL model and interaction terms that reveal independence of choices by respondents in repeated choice cases and heterogeneity observed by the data, respectively, improves the model fit measured by and the likelihood ratio test. The associated value was small, implying the rejection of the null hypothesis that all the standard deviations are equal to zero. We found that the RPL correlated model with interaction best fit for this study, which is in line with criterion of Hensher *et al.* (2005).

3.3 Implicit prices and welfare measurement

In a linear statistical model, the β coefficients estimated under the RPL model can be used to estimate the rate at which respondents are willing to trade-off one attribute for another known as '*part-worth'* or an *'implicit price'*(Morrison *et al.* 1998). This gives us a value for an improvement in the quality of the environmental/public goods in comparison to the current situation; the status quo thus provides the basis for economic valuation of the attributes of the study good. Choice experiment enables to measure, ex ante, the effects of an improvement in resource or goods quality in terms of individual welfare:

$$\text{Part-worth} = -(\beta_{\text{non marketed attribute}} / \beta_{\text{monetary attribute}}) \quad (5)$$

$$CS = -1/\beta_P \{\ln(\Sigma \exp V_0) \ln(\Sigma \exp V_1)\} = \{-1/(|\beta_P|)\} (V_0 - V_1) \quad (6)$$

Bennett and Blamey (2001), also pointed out that the principles can also be applied to derive willingness to trade off between any pairs of attributes. In this specific study, equation (5) was used to estimate household's willingness to pay by dividing β_{QT} and β_{Qu} coefficients by β_P in order to estimate the value respondents attached for quantity of treated domestic liquid waste (QT) and quality of treated domestic liquid waste (QU). Where β_P is the coefficient of the monetary attribute and is assumed to be the marginal utility of income; and V_0 and V_1 represent the initial and subsequent utility states, respectively.

4. Results and Discussion

4.1 Descriptive results

The results show that about 80.5% of the sample respondents willing to pay for improved liquid waste treatment, while the remaining (19.5%) were non-willing to pay for improved liquid waste treatment. Among those who were not willing to pay for

the proposed plans most of them reported that their income is not sufficient to finance the STP. We found that the average annual income of the respondents is about 58,154 ETB. The mean age of sample respondents is about 41 years (Table A3).On average, sample respondents stayed in the area for 20 years and attended up to grade eight. The average family size in the study area was 5 persons. The result also indicated statistically significant mean difference between respondents choice with respect to their age, number of years stayed in the area, family size, education level, annual income, monthly expenditure, and monthly expenditure on sanitation in general and annual cost incurred for emptied pit latrine hole or septic tank. The result revealed that most of the houses were privately owned and were of ordinary type.

The result about toilet type and ownership in the study area indicated that the major part of respondents' toilets (57.3%) were pit latrine, whereas the remaining31.8% and 9.4% of the respondents' toilet were flush and septic tanks, respectively. From the total sample, 70% of them had their own private toilet, 20% were found using common pit latrine, the remaining share public pit and septic tank. Respondents were requested to express their agreement or disagreement using attitudinal and concern level questions. Based on these, almost all (96.3%) of them agreed that they are highly concerned for environmental protection. Households were also requested to express their views on whether rivers and tributaries in the city are totally polluted. In general, almost half of the sampled households strongly agreed that the rivers and tributaries are highly polluted.

4.2 Residents' willingness to pay for improved waste management

Table 2 presents results of Random Parameter Logit model and it shows that attributes of improved liquid waste treatment quantity and quality of treated domestic liquid waste (QT and QU) were found statistically significant at 5% and 1% levels, respectively. On average, households preferred higher quantity and quality of treated liquid waste and lower additional payment on monthly drinking water consumption bill. Treated liquid wastewater quantity and quality were significant factors in the choice of a liquid wastewater treatment plans, and ceteris paribus, these two attributes increase the probability that improved liquid waste treatment plans were selected. But in both RPL model, the coefficient of quality of liquid waste treated was far higher than the coefficient of quantity of liquid waste treated. This suggests that respondents prefer quality of treated domestic liquid waste water as the major component of preference heterogeneity.

Moreover the sign of the price attributes indicated that residents were choosing an alternative that has cheapest additional payment on water bill. The negative and significant coefficient implies that there were some degrees of status quo bias all else held constant, respondents would prefer to move away from the status quo situation and towards improved wastewater treatment plans even if they would have to pay higher monthly additional payment for these. In terms of significance and magnitude of coefficients, there was not large difference between the interacted RPL basic and RPL correlated models. But the RPL correlated model in both cases was best fit since it improved and log likelihood ratio test. The ratio test suggested that RPL correlated with interaction was an improvement over basic RPL and RPL correlated without interaction at 0.5% significant level. Furthermore, the explanatory power of

the model increases relative to basic RPL with and without interaction as indicated by the high of 0.59.

People with higher annual income as measured in terms of household expenditure per month (proxy variable of annual income of the household) more often choose highly improved liquid waste plans and it was found statistically significant at 1% level. In both models highly educated respondent were more interested to pay for alternative plan that can treat very high quantity of domestic liquid waste in advanced treatment facilities. Solomon (2007) also reported positive and significant effect of annual income and education level of the respondent on WTP. This is perhaps because educated respondents tend to understand environmental pollution and better value the benefits of STP. Among others, respondents who reside very close to rivers preferred both higher level alternative specific attributes, while respondent who had training on health and environment related issues were preferred only alternatives with very high quality level of treated liquid waste. But the former were significant at 1% level except the 5% level for interaction of having training with quantity of treated liquid waste attribute. Being a respondent from peri-urban were significant at 10% level in preferring alternatives with higher quantity whereas it was statistically significant at 1% level in choosing plans with very high quality of treated liquid waste.

As indicated above, we found negatively and statistically significant effect of location dummy and households' distance from the nearest rivers. So, respondents far away from these rivers and those who reside in the urban area preferred alternative plans with low quality and quantity of treated liquid waste. Being the direct victims of untreated liquid waste might be the nearer households' major reason for choosing the aggressive improvement program which demanded the presence of very high quality level treated liquid waste and four STP that can absorb the demanded requirement.

Participants who lived longer period in the area were found positively related with choosing improved liquid waste treatment program and statistically significant at 1% level. Among others, respondents who reside very close to rivers, own plot of farming land near rivers and those who have had regular contact with health extension agent preferred both higher level alternative specific attributes, while respondents who had training on health and environment related issues preferred alternatives with very high quality level of treated liquid waste. But these variables were significant at 1% level except having trained before and the effect of regular contact with health extension agent interacted with quantity of treated liquid waste attribute and found to have positive effect in choosing the specified alternatives. Regarding the effect of housing condition, ownership and type of house respondents lived in, respondent who lived in apartment and those who own a house preferred alternatives that can treat up to very high quality level with advanced STP.

Those who perceived and strongly agreed rivers and their tributaries within and around the capital city are highly polluted were found choosing aggressive improvement program. There were significance differences in explaining source of heterogeneity in both attributes. Based on the result, when individual's unconditional heterogeneity for quantity of liquid waste was insignificant, we found 1% level

of significant heterogeneity source for quality of liquid waste treated individually. Moreover, toilet ownership was found statistically significant at 1%. Therefore, those who have their own toilet and used pit whole latrine were spending more for liquid waste management and empting the hole, they preferred alternatives that handled very high quantity of liquid waste and for advanced quality level that can reduced health and environmental hazards.

Finally those respondents who claimed that they are highly concerned for environment and want to participate in any environmental protection activities have chosen alternative plan that contains very high quality level of treated domestic liquid waste. In both models, level of concern for the environment was significant at 5% level. These findings are in line with those from developed countries and it confirms the results of several environmental valuation studies, where more educated citizens, those with higher incomes, and those with highly concerned for environment and know the environmental and health hazards of river water pollution were more likely to participate in and be willing to pay higher values for interventions for environmental conservation and sustainable natural resources management (Birol*et al.* 2006).

Table 2.Maximum simulated likelihood estimates of correlated RPL model

Attributes	correlated RPL with interaction		correlated RPL without interactions	
	Coef (Std. Err.)	St. Dev(std. Err)	Coef (Std. Err.)	St. Dev(std. Err)
Random Parameters				
payment on water bill	(-0.14) (0.018)***	(0.49) (0.03)***	(-0.14) (0.02)***	(0.49) (0.03)***
Quantity of waste treated	(0.002) (0.007)**	(0.014) (0.002)***	(0.001) (0.001)**	(0.004) (0.001)***
Quality of waste treated	(1.55) (0.21)***	(3.63) (0.24)***	(1.50) (0.03)***	(4.7) (0.33)***
Non-random Parameters				
ASC	(-2.57) (3.62) ***		(-2.57) (3.6) ***	
MEXPEND* QU	(0.001) (0.0001)***			
MEXPEND* QT	(0.003) (0.0014)**			
EDUCA * QU	(0.13) (0.05)***			
EDUCA * QT	(0.48) (0.23)**			
SANIEXP* QT	(-0.32) (0.11)***			
YSTAY * QU	(0.08) (0.011)***			
TRAINING * QU	(1.30) (0.25)***			

DISTANCE * QU	(-2.79) (0.38)***			
DISTANCE * QT	(-1.64) (2.32)***			
CHEXTENS* QU	(0.75) (0.48)**			
LDUMMY* QU	(1.24) (0.45)***			
LDUMMY* QT	(0.68) (1.99) *			
HOUSET*QU	(1.56) (0.20)***			
HOUSINGC* QU	(1.06) (0.25)***			
PERCEPTION *QU	(0.69) (0.33)***			
HECON-CERN* QU	(0.81) (0.34)**			
TOWENER-SHIP* QT	(0.53) (2.22)***			
Model statistics				
N(Observations)	10,368		10,368	
	0.59		0.42	
LL_{β}	-1574.4049		-2398.9783	
χ^2,3	2801.59		2516.25	
LR test	225.74		126.85	

Note: QU refers to Quality of Treated Domestic Liquid Waste; QT refers to quantity of treated domestic liquid waste.
Source: Own survey data, 2011.

5. Conclusions and policy implications

Results show being highly paid, having higher education level, having residential area in totally urban and very close to rivers, the possibility of having training on environment or sanitation issues, being highly concerned for environmental protection and possible perception change regarding river and environmental pollution by residents took the credit for the current observable and unobservable heterogeneous movement by households to improve the current situation. Significant WTP difference was observed in terms of the two cases of RPL correlated model and for increased quality level and quantity of treated liquid waste from lower to very high level.

The mean WTP in best fit model was 26.74 ETB/month if the hypothesized aggressive sewage system improvement scenario is constructed and opened for service. Whereas, based on this model, mean WTP for medium improvement scenario were 15.53 ETB/month. When aggregate WTP/year is discounted at 10% interest rate and

for master plan life time, the increased additional payment on households' water bill (about 101millionETB) would not be sufficient to cover treatment costs (about 676 million ETB) of all the wastewater generated by the city. Therefore, an increase in additional payment by a maximum of 26.74 ETB per month may not be sufficient to cover the costs of upgrading the technology, number and capacity of the current and new STP.

The long term plans of AAWSA should not only be to strive to increase STP's and sewer line coverage, but also the existing and new coming STP should be upgraded to advanced oxidation bonds side by side so as to discharge treated domestic liquid waste in a less harm and less risky way to environment and health. The major proportion of the sampled urban households possesses high interest for the improved sewage system and additional oxidation pond STPs. The socioeconomic and other household specific features of the households were found to be the influencing factors in making decision to pay for improved STP and sanitation programs. Respondents showed heterogeneous preferences for attributes and attributes levels. A simplistic matching between supply and demand shows that households in Addis Ababa were unable to pay fully for the proposed improvements. Generally, if the proposed changes are to be implemented on the ground, none could satisfy cost recovery criterion. The main problem we found is lack of demand side policies.

Based on the findings, we can draw the following recommendations. Investment in education, awareness creating trainings and health extension programs were found to be crucial. So there is a need to promote health extension services and NGOs or other institutions that provide short term training on urban health, environmental protection and sanitation issues, besides educating people about benefits associated with improved sanitation service through promotion of formal education. In policy formulations, one should duly recognize the inherent differences and design integrated strategies for the respective class of services.

Since marginal WTP per month of this study is less than the required average investment and running cost, it cannot repay back its total cost. In fact, a large subsidy amount is expected from the government. Thus, instead of arguing that cost recovery is the only way out, the government should think of ways through which it could minimize cost, increase aggregate revenue and there by decrease subsidy amount if change has to come. Finally, it is suggested that the relevant authority could use approaches such as CM to emanate information on the level of demand especially in the design of liquid waste master plan. Furthermore, researches should be conducted to estimate industries' WTP to avert environmental and health losses due to industrial effluents.

References

AAEPA (Environmental Protection Authority of Addis Ababa), (2007). Estimation of pollution in Little and Great Akaki Rivers. Addis Ababa

Adamowicz, W.L., Boxall.,P.,Williams., M., and Louviere, J., (1998a). Stated preference approaches for measuring passive use values: Choice experiments and contingent valuation. *American Journal of Agricultural Economics,* 80(1): 64-75.

Adamowicz, W.L., Louviere, J., and Swait, J., (1998b). *Introduction to attribute-based stated choice methods*. Final report, National Oceanic and Atmospheric Administration, US Department of Commerce.

Adamowicz, W.L., Boxall, P.C., Louviere, J.J.,Swait, J., and Williams, M., (1999). Stated-preference methods for valuing environmental amenities. pp. 460-479. In: I.J. Bateman and K.G Willis (eds.). *Valuing environmental preferences: Theory and practice of the contingent valuation method in the US, EU, and developing countries*, Oxford University Press.

Banzhaf, S., Burtraw, D., Evans, D., and Krupnick, A., (2004). *Resources for the future: Valuation of natural resource improvements in the Adirondacks*. Working paper of the ecosystem-based management program, USA.

Bateman, I.J., Carson, R.T., Day, B.,Hanemann, M.,Hanley, N.,Hett, T.,Jones, L.M.,Loomes, G.,Mourato, S.,Özdemiroglu, E., Pearce, D.W.,Sugden, R. and Swanson, J., (2002). Economic valuation with stated preference techniques: A manual, Cheltenham: Edward Elgar.

Birol, E. and Das, S., (2010). Estimating the value of improved wastewater treatment: The case of River Ganga, India.*Journal of Environmental Management,*91: 2163–2171.

Birol, E., Karousakis, K. and Koundouri, P., (2006). Using a choice experiment to account for preference heterogeneity in wetland attributes: The case of Cheimaditida Wetland in Greece. *Ecological Economics,* 60 (1): 145–156

Blamey, R.K., Rolfe, J.C.,Bennett, J.W, and Morrison, M.D., (1997). *Environmental choice modeling: Issues and qualitative insights, choice modeling* research report No. 4, The University of New South Wales, Canberra.

Blamey, R., Gordon, J., and Chapman, R., (1999). Choice modeling: Assessing the environmental values of water supply options. *The Australian Journal of Agricultural and Resource Economics,* 43(3): 337-57.

Blamey, R., Rolfe, J.,Bennett, J., and Morrison, M., (2001).Valuing remnant vegetation in Central Queensland using choice modeling. *The Australian Journal of Agricultural and Resource Economics,* 44(3): 439-56.

Boxall, P.C. and Adamowicz, W.L., (2002). Understanding heterogeneous preferences in random utility models: A latent class approach. *Environmental and Resource Economics,* 23: 421–446.

Braden, J.B and Kolstad, C. D., (1991).Measuring the demand for environmental quality, Amsterdam.

Christie, M., Hanley, N.,Warren, J.,Murphy, K.,Wright, R., and Hyde, T., (2006). Valuing the diversity of biodiversity. *Ecological Economics,* 58(2): 304-317.

Colombo, S., Requena, J.C., and Hanley, N., (2006).Analyzing the social benefits of soil conservation measures using stated preference methods. *Ecological Economics,*

58: 850-861.
CSA (Central Statistical Agency), (2007).Population and housing census of Ethiopia. Bulletin of Central Statistical Agency, Addis Ababa.
Das, S., E. Birol and Bhattacharya, N.R., (2008). *Efficient and effective solid waste management to improve local environmental quality and public health: Application of the choice experiment method in West Bengal, India*. Discussion Paper Series of Environmental Economy and Policy Research, University of Cambridge.
EPA (Environmental Protection Authority), (2005).Assessment report on the Status of Little Akaki Rivers Waters Pollution. EPA, Addis Ababa.
Fitalew, A. andMekonnen, A., (2011). Low-income fishermen's willingness-to-pay for fisheries and watershed management: An application of choice experiment to Lake Tana, Ethiopia. *Journal of Ecological Economics.*71 (2011): 162–170.
Freeman, A.M., (1993). The Measurement of Environmental and Resource Values: Theory and Methods. Washington DC.
Getachew, T., (2006).*Industrial waste management practices in Addis Ababa: A case study on akaki-kality industrial zone*. An MSc Thesis Presented to School of Graduate Studies of Addis Ababa University.
Greene, W.H., (1997). *Econometric analysis*. Fourth Edition, Prentice Hall.
Haab, T.C. and McConnell, K.E., (2002).Valuing environmental and natural resources: The econometrics of non-market valuation, new horizons in environmental economics, UK.
Hanley, N., Wright, R.E., and Adamowicz, V., (1998). Using choice experiment to value the environment: Design issues, current experience and future prospects. *Environmental and Resource Economics,* 11(3-4): 413-28.
Hanley, N., Mourato, S., and Wright, R., (2001). Choice modeling approaches: A superior alternative for environmental valuation? *Journal of Economic Survey,* 15: 433-460.
Hanley, N., Wright, R.E. and Koop, G., (2002). Modeling recreation demand using choice experiments: Climbing in Scotland. *Environmental and Resource Economics,* 22 (3): 449-466.
Hensher, D., Rose, J. and Greene, W., (2005).Applied choice analysis: A primer. Cambridge University Press.
Holmes, T.P. and Adamowicz, W.L., (2003).Attribute -based methods. pp. 171-219. In: P.A. Champ, K.J. Boyle and T.C. Brown (eds.). *A primer on nonmarket valuation*. Kluwer academic publishers, Dordrecht.
Hutton, G., Haller, L., and Bartram, J., (2007).Global cost-benefit analysis of water supply and sanitation interventions . *Journal of Water and Health,* 5(4): 481–502.
Johanson, P.O., (1991). *An Introduction to modern welfare economics*, Cambridge University press, London.
Jin, J., Wang, Z. and Ran, S., (2006). Comparison of contingent valuation and choice experiment in solid waste management programs in Macao. *Ecological Economics,* 57.430–441.
Lancaster, K.J., (1966). A new approach to consumer theory. *Journal of Political Economy,* 74: 132-157.
Louviere, J. and Hensher, D., (1982) .On the design and analysis of simulated choice

or allocation experiments in travel choice modeling. *Transportation research record.* 890:11–17.
Louviere, J. and Woodworth, G., (1983). Design and analysis of simulated consumer choice or allocation experiments: An approach based on aggregate data. *Journal of Marketing Research.* 20: 350–367.
Louviere, J.J., Hensher, D.A. and Swait, J., (2000).*Stated choice methods: Analysis and applications*. Cambridge University Press.
McFadden, D., (1974). Conditional logit analysis of qualitative choice behavior. In: P. Zarembka (ed.). Frontiers in econometrics. Academic Press, New York.
Mekala, G.D., Davidson, B.A. and Boland, A., (2007). Multiple uses of wastewater: A methodology for cost-effective recycling. Pp. 335-43. In: S.J. Khan, R.M. Stuetz and J.M. Anderson (eds.). *Water reuse and recycling*, University of New South Wales (UNSW), Sydney, Australia.
Mengesha, D., (2010).Performance evaluation of Kality wastewater stabilization ponds for the treatment of municipal sewage from the city of Addis Ababa, Ethiopia. An MSc Thesis Presented to School of Graduate Studies of Addis Ababa University.
Morrison, M., Bennett, J.,Blamey, R., and Louviere, J., (1998). Choice modeling and tests of benefits transfer. Choice modeling research report 8, University of New South Wales, Canberra.
Nielsen, A.B., Olsen, S.B. and Lundhede, T., (2007). An economic valuation of the recreational benefits associated with nature-based forest management practices. *Landscape and Urban Planning,* 80: 63–71.
Poirier, J. and Fleuretz, A., (2010).Using the choice experiment method for valuing improvements in water quality: a simultaneous application to four recreation sites of a river basin. The European Water Framework Directive (WFD) achievement of good ecological status in all European waters by 2015.
Rolf, J., Bennett, J., and Louviere, J., (2000).Choice modeling and its potential application to Tropical Rainforest preservation. *Journal of Ecological Economics,* 35: 289-302.
Solomon, T., (2007). *Household's willingness to pay for solid waste management options: the case of yekka sub city*. MSc. Thesis Presented to School of Graduate Studies of Addis Ababa University.
Tamiru, A., Dagnachew, L. and Tenalem, A., (2005).Hydrology, water quality and the degree of groundwater vulnerability to pollution in Addis Ababa, Ethiopia. UNEP/UNESCO/UN-HABITAT/ECA, Addis Ababa.
Varian, H.R., (1992).*Microeconomics Analysis*.3rd edition, New York, W. W. Norton & Company.