ENVIRONMENTAL CHEMISTRY, POLLUTION & WASTE MANAGEMENT | RESEARCH ARTICLE

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Urban dwellers and solid waste management plans: A case study of selected towns in Afar regional state, Ethiopia

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Abstract: The increase in quantity and composition of solid waste has come up with a necessity of effective measures to cope up with its negative impacts in our society. One possible measure, in this case, is the participation of the public as part of the solution. This study is aimed at the estimation of the non-market welfare gain as a result of proposed improved solid waste management plans for households in some selected towns of Afar region, Ethiopia using Contingent Valuation Method. The proposed improvements are presented by a scenario where the frequency, payment vehicle, and appropriate disposal mechanism were considered. Ordinary Least Square model with twelve variables for residential households and with nine variables for commercial households was estimated. We have notable differences between residential households and commercial households' average willingness to pay for improvement in solid waste management. Generally, it was seen that solid waste management could also be source of income apart from the environmental benefits. The people can play a decisive role in solid waste management by sharing its costs.

Subjects: Environmental Management; Environment & Resources; Environment & Society; Environment & Economics; Environment & the City; Environmental Change & Pollution

Keywords: households; contingent valuation method; solid waste management; ordinary least square; Ethiopia

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Metkel Aregay Gebreeyosus is a lecturer in the department of Agricultural and Resource Economics at Mekelle University, Ethiopia. He has researched on range of environmental issues including sustainable land management, community developed exclosures and investment on land. Generally, his research interests include waste management, forestry and livelihood, issues related to rural land and poverty among others. This current work relates the general solid waste management scenario to the perceptions of urban dwellers. It helps solid waste management policies to look into the demand side of the story rather than focusing on the supply side only.

PUBLIC INTEREST STATEMENT

Solid waste management is a widely researched area of study. There are ample studies on waste generation, waste recycling, waste disposal and waste content. However, the public preference and potential participation is less sought. Public policies based on researches that neglect this important part are obviously one sided. The large amount of solid waste generation is a real threat to the environment. In Afar region, solid waste management is at its lowest stage compared to even the Ethiopian standard. The inclusion of the perceptions of urban dwellers can help better informed policies and decisions.

1. Introduction

Rapid urbanization, population explosion, and increases in income and consumption have led to a rapid increase in the amount of waste around the world. The change in the consumption patterns of most people, for example the purchase of more luxury goods, has resulted in shortening the life spans of products and hence bringing about the early disposal of recyclable products, such as furniture, home electronics and home appliances. The increase in overall consumption and the use of disposable products and excessive packaging are creating increasing challenges for waste management authorities. Moreover, the limitation on landfill capacity and the rising real costs of garbage disposal have made it more difficult to dispose of solid waste in some areas. Therefore, waste has become a serious social problem and a threat to the environment. Also, finding ways to reduce waste has become very crucial and the issues associated with waste generation and management cannot be resolved without efforts to reduce the growing amount of waste generation (Beeds and Bloom 1995; Ogwueleka, 2009; Se-Ju Ku et al. 2009).

Solid waste generation is an inevitable consequence of production and consumption activities in any economy. Generally, it is positively related to the level of income and quantity of solid wastes per capita. Metropolitan cities in developing countries are usually beset with solid waste management-related problems such as flooding, uncollected garbage and inadequate or inappropriate disposal sites. (Eugenia, Georgina, & Ramil, 2002)

Increasing volume and complexity of solid waste pose the greatest challenges to large cities in developing countries, where the organization and planning of solid waste collection and disposal services tend to be rudimentary. Due to budget and infrastructure constraints, public authorities in these cities are often unable to manage large amounts of solid waste generated. This fact is reflected in the unknown volume and types of solid wastes collected; the amount recovered and recycled; the inadequacy of disposal sites, as well as inefficient reutilization and recycling programs (Buenrostro et al. 2003). Developing countries have similar patterns of solid waste management services, which are characterised by lack of planning, poor or no segregation of waste at source and unscientific and informal disposal systems. Lack of sufficient public and private funds and corrupt public sector are considered among the major bottlenecks to the improvement of the services (Das, Birol, & Bhattacharya, 2008).

In addition, most municipalities in developing countries spend a large proportion of their budgets on the collection, transport, and disposal of solid wastes. For example, Cointreau (1987), found that in most cities in developing countries, municipal solid waste management costs account for 20–50% of municipal revenues yet collection service levels remain low with only 50 and 70% of residents receiving service and most disposals being unsafe.

Furthermore, poor solid waste management is a threat to public health and reduces the quality of life for urban residents. Moreover, the situation is likely to worsen due to continuing population growth and urbanization in developing countries. This problem is further exacerbated by increasing globalization and changing lifestyles which have resulted in increased consumption of packaged and processed goods in recent years, including food and other items. This in turn increases the volume and composition of solid wastes and there by the cost of managing it.

Longe, Longe, and Ukpebor (2009) pointed out that in most countries of the world, especially developing and transition countries and European social democracies, the management of waste has been considered to be the responsibility of the government, financed by general revenues. However, in recent years, partly as a result of austerity and structural adjustment policies and pressures from multilateral financial institutions, and partly as a result of pressures to limit taxes, various governments have increasingly focused on identifying specific revenue sources for waste management. Even though the fundamental objectives of any solid waste management programme are to minimize environmental pollution, these goals become unachievable in the absence of sustained funding, affordable local technological option and lack of participatory approach to integrated solid waste

management. This indicates the management of solid waste in many different developing countries absorbs large share of their respective budgets but still is in unsatisfactory stage.

Afar region is no different as a region with emerging towns in a developing country. The management of solid waste is almost a forgotten aspect in the region. Many factors made up adequate and sound solid waste management, the leader being huge financial resource. The municipalities of the respective towns covered in the study incur all the costs related to solid waste management. Searching for extensive literature in the area and looking at the realities of the towns a question comes to the researchers' mind: what if the cost of managing solid wastes is shared by households (residential and commercial entities)? Households are the main sources of solid waste as well as the main victims of the negative effects of unmanaged solid waste; therefore, it is appropriate to include these stakeholders in designing related policies. If households participate in solid waste management activities starting from policy design unto cost sharing, municipalities can render reliable service. Cost of SWM is not shared by households and studies of this issue in Ethiopia has neglected Afar region so far. This study attempts to fill this gap.

The objective of the study is estimation of the non-market welfare gain as a result of the proposed improved solid waste management plan for households in some selected towns of Afar region by employing contingent valuation method. The article is outlined as follows: section two deals with the roots and nature of the methodology, section three gives the detailed results and findings, and the last section is reserved for the conclusions.

2. Roots and nature of the methodology

2.1. Introduction to environmental valuation methods

Proper solid waste management improves environmental quality and public health. As a result of this people have different preferences on various solid waste management schemes. Valuing these different options of the people is very difficult since there is no direct price on the market. Microeconomic consumer theory has a way of dealing with this type of individual preferences (Ramos, 2010). Various actions of the consumers are expressed in terms of demand functions under this theory. The consumer demand is measured by the amount of environmental quality consumed and it is built as a function of the faced prices, real income of the consumer and the tastes and preferences of the consumer as approximated by various characteristics. The consumer therefore, is in a place to trade off his limited budget with the different consumption possibilities his sole aim being to maximize his utility subject to the budget constraint. In this respect, a certain individual is highly challenged in determining his optimal allocation. The problem enlarges when talking about environmental goods because those goods contain large elements of public goods by their nature and there exists high possibility of free riding. When we attempt to value certain changes in these environmental commodities it is assumed that going for the non-market value of the change, one is valuing human preference and not the environment (Aadland & Caplan, 2003; Suh & Harrison, 2005).

The consumer's goal is therefore to maximize utility given his budget constraint. For a constant income level, Y, and vector of prices p_1 and $p_{2;}$

$$\sum p_{ii}(X, \Omega) = Y_{i=1,\,2} \tag{1}$$

Where X = environmental quality

Ω = Other goods and services

P is vector of prices ($P = {}_{p1},\ {}_{p2}$)

P_1 = Price of waste collection.

P_2 = Price of other goods.

Y = income of the household.

It is assumed that the household has the ability to compare all the possible alternatives.

Thus there exists an ordinal utility function.

$$U = U\ (X, \Omega) \tag{2}$$

This is the household's preference expressed mathematically. The household's selection of the most preferred bundle that satisfies the budget constraint.

Mathematically, utility of a household is maximized subject to the budget constraint.

Maximize $U = U\ (X, \Omega)$ *Subjectto* $\sum^{p_i}(X, \Omega) = Y$

P, Y > 0;

In this respect, a certain individual is highly challenged in determining his optimal allocation (Sansa & Kaseka, 2004). This tells us that huge care is required when trying to value changes in environmental goods. Since the value of most of these goods cannot be reflected in the market, cautious analysis of human behaviour is needed. We need environmental valuation techniques to obtain the values of environmental resources and thereby to approximate a socially optimal decision and to demonstrate the importance of environmental policy, it is in this regard that contingent valuation method becomes useful.

2.2. What is contingent valuation method?

Contingent Valuation method (CVM) is a survey method to elicit consumers' valuation of goods and services not sold in the market place, by calculating their Willingness to Pay. The method has extensively been used in the valuation of non-market resources such as recreation, wildlife and environmental quality. In this method, the researcher creates a hypothetical market in a non-market or new good, invites a group of subjects (survey respondents or experimental subjects) to operate in that market, and records the results. The values generated through use of the hypothetical market are treated as estimates of the hypothetical market (Riera, 2001).

These surveys tend to ask people questions, to choose between things, or to give personal valuation they place on certain non marketed costs or benefits. It is a survey-based method that uses responses to some questions posed to the consumer to their preferences and WTP for a hypothetical product or service. Thus, individuals could be asked how much money they are willing to pay for successive additional quantities of a collective non-marketed good. By aggregating these WTP values one could obtain a market demand schedule. This is the essence of the CVM as applied to environmental resources. Thus, the CVM seeks to estimate the economic value of various non-market goods by asking WTP or WTA (willingness to accept) questions depending on whether the good to be sold is an economic good or economic bad. The method is called contingent because it depends on the hypothetical situation presented to the interviewee in the course of trying to create a market for the good that otherwise has no usual market.

Hanley, Wright, and Adamowicz (1998) identifies six distinct phases involved in the practical application of Contingent Valuation Method. The practice starts with preparations, which include activities like setting up a hypothetical market, defining the elicitation methods, providing information regarding the quality and/or quality change in the provision of the good and defining the payment vehicle. The second step is surveying where the necessary responses for the questionnaire are

obtained from the respondents. Surveying is followed by calculation and estimation respectively where WTP/WTA (willingness to accept) from the responses is calculated and a bid curve can be estimated to investigate the determinants of WTP. Finally, we have aggregation and where we move up from mean WTP to total value and we could check the successfulness of the CVM exercise. In this article, the mean WTP calculation and the aggregation took place in the third section.

CVM is the most widely used stated preference method is endowed with many advantages which, among others include the attainability of data on the service in question and the ability of the estimated models to cover a whole bundle of the environmental services provided by a public good (including some very elusive and intangible values such as existence and bequest values). Many studies have used CVM for studying solid waste management (Alebel and Dawit, n.d.; in Ethiopia and Othman, 2002; in Korea are some examples).

2.3. Data source and sampling techniques

The study heavily depends on primary data, which was directly collected from three selected towns of Afar region namely Assayta, Dubti and Logiya. The main source of information, therefore, was face-to-face interview with the selected households (which includes both residential and commercial households).

The elements of sampling here are not individuals but households. The total number of households in the three towns made up the sampling frame for each town and both categories of households. A total of 450 households which are made up of 75 residential households from each of the three towns and 75 commercial households from each of the three towns were randomly selected and interviewed.

2.4. The model, the variables and expected outcomes

Linear relationship is assumed between the dependent and independent variables. The dependent variable in this case is willingness to pay of households for improved solid waste management and we have a group of independent variables. Let's first see the model for residential households;

WTP = f(SWAMT, AGE, SEX, MARSTAT, EDU, FAMSIZ, <10, HOMOWN, LENGLIV, EMPL, INCOME, CHAT)

WTP: is the maximum amount of money that the residential household is willing to pay for the improved solid waste management. Respondents were asked to freely state how much they are willing to pay for an improved hypothetical scenario of solid waste management. WTP is the dependent variable of the model.

SWAMT: indicates the amount of solid waste that a certain residential household can generate per week. Households were asked to state the amount of solid waste that they generate in 50 kg sack. The amount of solid waste generated by a household in concern is expected to be positively related to the amount of money that these households are willing to pay for improved solid waste management. The fact that households are generating more solid waste logically means they are willing to pay more money to get rid of them.

AGE: is age of the respondent. This variable is expected to have negative relationship with willingness to pay. The reason is people tend care less for environment as they get older and older.

SEX: is a dummy variable that indicates the gender of the respondent. It takes the value 1 for female and 0 for male. Positive relationship with willingness to pay is expected given the fact that women tend to care more for the cleanness of their houses than men.

MARSTAT: stands for the marital status of the respondent. There are married and single respondents not to mention the widow/widower and the divorced ones. Married people are

expected to have more family to care and more solid waste to generate which there by gave rise to a positive relationship with the amount of money to be paid the improvement of solid waste management.

EDU: is a variable for the level of formal education that a respondent has in years. People which are more educated are expected to pay more for improvement in solid waste management because they can understand its importance easily.

FAMSIZ: stands for the family size in a certain household that is represented by the number of the family members in that household. A household with larger family size generates more solid waste than a family with smaller members, which might be an incentive to pay more.

<10: is a dummy variable that takes 1 if the household in concern has children less than 10 years old and 0 otherwise. Households with children under 10 years old are expected to pay more to keep their environment clean for healthy environment to their children.

HOMOWN: is dummy variable that takes 1 if the respondent owns a house and 0 otherwise. People are expected to care for their own house than a rented house.

LENGLIV: stands for the years that the respondent lives in the vicinity where he/she is now. People are expected to care for an environment where they have been for long.

EMPL: is dummy variable for employment. It takes a value 1 for employed respondents and 0 for unemployed ones. Employed people earn more money so they are expected to pay more for improvement.

INCOME: indicates the monthly average income level of the household in concern. Households with more income levels are expected to pay more money for improvement in solid waste management.

CHAT: is a dummy variable that takes 1 if the respondent chews *khat*[1] and 0 otherwise. Chewing chat might contribute to a volume of solid waste and thereby motivate households to pay more for improvement in solid waste management.

The model for commercial households has comparable characteristics and it has the following variables.

WTP = F (SWAMT, AGE, SEX, MARSTAT, EDU, NOWRKRS, HOMOWN, WRKYRS, INCOME)

NOWRKRS: stands for the number of workers that a commercial household has. Households with more workers are expected to generate more solid waste and thereby pay more for improvement.

HOMOWN: is dummy variable that takes 1 if the respondent owns the house that he/she works and 0 otherwise. People are expected to care for their own house than a rented house.

WRKYRS: stands for the years that the respondent works in the vicinity where he/she is now. People are expected to care for an environment where they have been for longer times.

The other variables included in the above model, including the dependent variable, have the same characteristics with the residential households' model except that the reference here is the manager/owner of the commercial household than the household head.

3. Results and discussions

The response rate was about 98 per cent. Out of the 450 questionnaires employed, only 10 were found unusable. Separate sections for residential and commercial households are devoted.

3.1. Residential households

3.1.1. Description of some selected variables for residential households

Many variables have been included in the study. Data on these variables have been thoroughly collected from the respondents in focus and Table A1 shows the likelihood of some of the included variables. Dwellers in the three towns are found to be willing and cooperative for improvement in the current solid waste management system. The mean willingness to pay, of course, is slightly different in the towns. Assayta registers the highest WTP of Birr 12.2 per household followed by Logiya with Birr 12.1 and we have the lowest WTP of Birr 9.5 in Dubti as compared to the two. The overall average WTP for residential households in the three towns is Birr 11.3. Still Assayta takes the lead in terms of average age rate of the respondents, Logiya with the lowest. The educational background of the respondents in the three towns seems to be stretched between 0 and 16 years of formal education. Respondents from Dubti live for longer times (18.9 years) than the dwellers of the two. The average monthly income of households in the towns entertains some discrepancies. Households in Logiya are found to earn higher average monthly income (Birr 1712.6) than their counterparts in Dubti and Assayta.

Apart these socioeconomic and demographic factors that might determine the willingness of households for improvement in solid waste management, some other additional questions were included. For the question regarding the concern of the respondents to their environment and solid waste activities in their vicinity almost all the respondents are concerned. Concerning the disposal mechanisms adopted, it is quite practiced in irregular and unsafe ways. Many households dispose solid waste in open spaces, which is unhealthy disposal practice. The researchers' observations here proves that in some cases households carelessly dispose waste in rivers and streets. Another salient question posed was the way households treat plastic bags and other packaging materials. The nature and location of the study areas is exposed to larger consumptions of packaged beverages and foods. The bad news here is that these plastic nature materials are not easily decay able and they stay in the environment for longer times than other solid wastes. Consequently, households were asked on how they treat these types of solid wastes. Lion share of the households be residential or commercial do not consider the damage that these type of wastes make on the environment and tend to treat them together with other wastes which are relatively harmless. Only very few households understand the danger and try to burry and burn these type of wastes which of course is not safe again.

3.1.2. Regression results of residential households

The willingness to pay of households for improved solid waste management is linearly related to the factors that are included in the study. Table A2 contains the detailed regression analysis of residential households. The explanatory variables included are the amount of solid waste households generate per week in 50 kg sack (SWAMT), age of the respondent (AGE), gender of the respondent (SEX), marital status of the respondent (MARSTAT), respondent's level of formal education in years (EDU), family size of the residential household (FAMSIZ), availability of children under 10 years old in the household (<10), house ownership status of the household (HOMOWN), length of time that the respondent lives in the vicinity (LENGLIV), employment status of the respondent (EMPL), average monthly income level of the household (INCOME) and a variable for identifying whether the respondent chews chat or not (CHAT). Except for one incomplete questionnaire in Logiya, the response rate is full which means the regression was undertaken for all responses.

One can see from Table A2 in the appendices that the amount of solid waste generated by residential households is significant and with the priori expected sign for the three towns. As the generations of solid waste keep increasing, households are willing to pay more money for the

improvement of solid waste management. This finding is in conformity with Tesfahun (2007). Another socioeconomic and demographic variable included in the analysis is age of the respondent. It is significant and with negative sign for Logiya but insignificant for Assayta and Dubti. The negative relationship between the willingness of people to pay for improved solid waste management and their age indicates that people became less careful for the cleanness of their environment as they get older. Othman (2002) and others have found the same effect in Malaysia. Regarding gender of the respondent, it is significant and has met the expectations in Assayta and Dubti except for the insignificance in Logiya. Female respondents in Assayta are willing to pay Birr 2.063 more than their male counterparts. In Dubti, the differential of WTP between the two sexes comes down to Birr 0.825. Tiruneh (2006) found comparable result. In our society females tend to spend more time at home than males; this of course, keeps them close to the cleanings giving them a motive to pay more than males for improvement.

Married people pay Birr 2.838 more for improvement in solid waste management than singles in Logiya town. In Dubti the difference in WTP between married people and singles is about birr 0.511 which is far smaller than that of Logiya. Despite the insignificant effects of marital status in Assayta, married people were hypothesized to pay more than unmarried ones. The reason is married people tend to have larger income and ability to pay in addition to the amount of waste they could generate. This was proved true for Logiya and Dubti but not for Assayta. The higher the numbers of years spent on formal education the higher will be the income an individual earn and the better will be the knowledge he/she gains. The variable education is pretty significant and with the expected sign for the three towns. An individual with an additional year of formal education is willing to pay birr 0.477 for an improvement in solid waste management with the given scenario in Logiya town. Another significant and as hypothesized variable is family size of residential households. This variable was approximated by the number of family members. A household with an additional family member in Assayta is willing to pay Birr 2.439 for an improvement in solid waste management. The WTP for an additional member of Logiya is Birr 2.083 but for Dubti it is much less, that is Birr 0.631. Hagos (2003) and Tesfahun (2007) found positive relationship between family size and the WTP for improved solid waste management.

Residential households with children less than 10 years were hypothesized as more caring compared to households who have not little children. The reason is the vulnerability of little children to various health problems that solid waste may cause. The regression results show nothing of these. This variable is found insignificant for the three towns. People are expected to care more for their homes than a rented house. The variable for house ownership which takes 1 if the respondent owns the house where his family leaves and 0 otherwise was included in the regression as one explanatory variable. There is significant relationship between HOMOWN and WTP in Logiya and Dubti. A respondent who owns a house is willing to pay Birr 1.207 more than a respondent who does not own a house in Logiya. In Dubti, the differential is Birr 1.157. Length of living is another explanatory variable included. Respondents who live longer in certain vicinity are expected to pay more than relatively new comers. This variable is significant and with the priori expected signs in the three towns. A respondent who lives one year longer is willing to pay Birr 0.104 in Assayta. The highest effect here is for Dubti, that is Birr 0.92.

Employment status of respondents also affects household's willingness to pay for improved solid waste management. This variable was included as a dummy where employed respondent is 1 and 0 otherwise. This variable is found significant and with the expected sign for all the three towns. An employed respondent in Assayta is willing to pay Birr 7.324 more than unemployed respondent. We have much lower differentials in Logiya and Dubti. Employed people earn more money than the unemployed ones and are willing to pay more. This finding is in conformity with Alebel and Dawit, n.d. Another important variable is the monthly income level of households. This variable answers whether higher income implies higher willingness to pay. It was found to significantly affect WTP in all towns. For an additional Birr 1 in the monthly level of income, a household is willing to pay Birr 0.091 to improve solid waste services in Logiya. Most studies in this area agree on the positive impacts of

income on the willingness to pay for improved solid waste management (Alebel and Dawit, n.d.; Othman, 2002; Seleshi, 2007 are some examples). Finally, a variable which was intended to capture the effect of chewing "chat" on the WTP of households towards solid waste improvement was included. The result is striking. It was expected as if chewing "chat" contributes to the amount of solid waste and chewers will be willing to pay more. There is insignificant effect in Logiya; however, we have significant effects with different signs in Assayta and Dubti. In Assayta, a chewer is willing to pay Birr 5.432 more than non users of chat. Chewers in Assayta may opt to pay for clean chewing places. In Dubti, however, a chewer pays Birr 0.755 lower than non-user which is the proposed type of effect. The overall significance of the models for the three towns is indicated by the F value. We have the highest degrees of freedom for Dubti as compared to Logiya and Assayta where about 77 per cent of the variations in the dependent variable are explained by the variations in the explanatory variables.

3.2. Commercial households

3.2.1. Description of some selected variables for commercial households

In addition to the residential households, commercial households from the three towns are also included in the study. Here are some of the included variables. As can be seen from Table A3, we have the highest willingness to pay for Logiya followed by Assayta. Comparing the willingness to pay of commercial households with the willingness to pay of residential households in Table A1, we have higher values for commercial households in all the three towns as expected. The overall average WTP for the three towns in this case, which is Birr 16.1, is far higher than the average for residential households. Commercial households generate more waste and earn more income, which motivates them to pay more than the residential households. The mean age of the respondent is highest for Dubti (35.1). On average respondents from commercial households are somehow younger. The level of formal education ranges between zero and 16 years. Average number of workers tend to around two for all, Logiya being slightly the highest. All in all the length of time that the covered commercial households work in the area where they are now ranges from 6 months to 40 years. The name commercial households simply indicate that we expect more monthly income than the residential ones. Among themselves, commercial households in Logiya earn higher monthly income than commercial households in the other towns.

3.2.2. Regression results of commercial households

Like the case of the residential households discussed above, willingness to pay of commercial households is linearly regressed against nine explanatory variables. The explanatory variables included are the amount of solid waste that a commercial household generates in a week in 50 kg sack (SWAMT), age of respondent (AGE), gender of the respondent (SEX), marital status of the respondent (MARSTAT), respondent's level of formal education in years (EDU), number of workers in the commercial household (NOWRKRS), a variable that shows the commercial household owns the house where it operates its business (HOMOWN), length of time where the commercial household operates in the given vicinity (WRKYRS) and average monthly income that the commercial household earns (INCOME). Table A4 shows the regression analysis for commercial households in Logiya, Assayta and Dubti.

For commercial households in Logiya all variables are significant and with the priori expected signs except for gender of the respondent and number of workers per commercial household. Years where the commercial household worked in the given vicinity is the only insignificant variable in Assayta. In Dubti, gender of the respondent and home ownership status are insignificant. The amount of solid waste generated per commercial household is key determinant of the willingness to pay for improved solid waste management services. This was proved true for the three towns included in the study as can be seen from Table A4. Age significantly and negatively affect WTP of commercial households in the three towns owing to the reluctance of elder people to participate in environmental improvement activities. The significance of AGE is contrary to the case of residential households where it was significant only for Logiya. The two important variables that prove to be significant determinants of WTP for both residential and commercial households are level of formal education in years (EDU) and average monthly income (INCOME). A respondent with an additional one-year formal education is

willing to pay additional Birr 0.318, Birr 0.189 and Birr 3.605 in Logiya, Assayta and Dubti respectively. The marginal effect of level of formal education on WTP is almost equal in the three towns (0.003, 0.003 and 0.002 for Logiya, Assayta and Dubti respectively). Regarding the degrees of freedom we have the highest value for Dubti where about 81 per cent of the variations in willingness to pay of commercial households for improvements in solid waste management services are explained by the variations in the included explanatory variables.

3.3. Aggregation of welfare for households

The primary premise of the study is that environmental quality, solid waste management in this case, is linked to households' welfare. Good quality environment improves households' welfare and bad environment deteriorates welfare. The improvement in the contemporary solid waste management in the three considered towns improves welfare of their dwellers. Households reveal this improvement in welfare by the amount of money they are willing to pay for the improvement. It is worth to see the aggregate value of welfare improvement in the towns. The problem here is we do not have a disaggregated number of households for commercial and residential establishments. Rather than leaving this section, the researcher prefers to compute overall mean for commercial and residential households together. The overall mean for both households is Birr 13.7.

According to the 2007 projections, there were a total of 46,702 households in urban kebeles in Afar region. Out of these households Logiya constitutes 4,298 households. Taking the average overall average WTP, that year, a total of Birr 706,591.2 could have been generated annually by giving the proposed improvements in the solid waste management. In Assayta, there were 4,365 households in 2007 which could have given the city administration the opportunity to extract annual income of Birr 717,606 from solid waste management activities. Another town covered in the study is Dubti, which registered 4,181 households in 2007. This number could have been a source of Birr 687,356.4 per year had it for improvements in solid waste management services as per the given scenario.

Unmanaged solid waste is a source of health problems. Solid waste is a useful material in a wrong place. In addition to the vast reusing and recycling possibilities, proper solid waste management is a big plus to community health and it is a huge source of income too. The aggregation for the year 2007 shows how much one can reap from this activity. For sure there is a great addition in the number of people and households, which magnifies the benefit, not to mention the increase in solid waste of course.

3.4. Conclusion

The study attempted to show the link between environmental quality as represented by an improvement in solid waste management and households' welfare. Households reveal this improvement in welfare by the amount of money they are willing to pay for the improvement. The study employed the so-called contingent valuation method. Both commercial and residential households were included in the analysis. The improvement was represented by a scenario where solid waste is collected door-to-door weekly and standardized waste disposal mechanisms are employed. The mean WTP for commercial households is found to be greater than the residential ones.

The amount of solid waste generated, the level of education, and the level of income of the respondent are significant and with the expected signs for both residential and commercial households in all the three towns. With the amount of solid waste generated, households are willing to pay more for solid waste management improvement. Increase in the level of education also increases the willingness of households to participate in SWM improvements. This might be due to the fact that education increases environmental awareness. Households with higher income were found to favour SWM improvement scenarios.

Households are the main sources of solid waste as well as primarily vulnerable to the negative effects of unmanaged waste therefore their perception should be included in policy making regarding solid waste management in addition to the supply side information. Not only in policy making but also households should actively participate in its implementation. Policy makers can

use different combinations of the willingness to pay of households. The aggregated values per year in the study show the possibility of immense cost sharing by the people.

Very few households were found to separate and burn plastic bags. Most households treat plastic bags together with other solid wastes. Therefore, concerned bodies should work in creating awareness regarding this. If not treated properly, plastic bags stay long in the environment by their nature. Another serious problem observed and found is poor waste disposal mechanism. It, obviously, takes time and money to build sanitary landfills but mid night street dumping could still be avoided. Concentrated bodies should levy high punishments on those who carelessly dump wastes on streets, rivers and even their back yard.

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Note
1. Khat is a plant with chewable leaves that is widely chewed in the study area and in many parts of Ethiopia as a stimulant. It is highly addictive.

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Appendices
Appendix 1

Table A1. Description of some selected variables for residential HHs in the three towns

Variable	Logiya			Assayta			Dubti		
	Mean	Min.	Max.	Mean	Min.	Max	Mean	Min.	Max.
WTP	16.9	5	60	16.7	5	40	14.7	2	50
AGE	31.7	14	64	34.9	24	75	35.1	20	60
EDUC	7.5	0	16	8	0	13	7.6	0	16
NOWRKR	2.5	1	10	2	1	7	2.4	1	12
WRKYR	5.4	0.5	40	8.7	1	30	10.2	0.5	37
INCOME	2576.1	500	12,000	2525.5	1000	5000	2750	600	10,000

Table A2. Regression results of residential households

Variable	Logiya		Assayta		Dubti	
	Number of obs = 74 F(11, 62) = 39.46 Prob > F = 0.0000 R-squared = 0.6731		Number of obs = 75 F(12, 62) = 55.37 Prob > F = 0.0000 R-squared = 0.5862		Number of obs = 75 F(12, 62) = 30.30 Prob > F = 0.0000 R-squared = 0.7676	
	Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|
SWAMT	.352***	0.000	.168***	0.000	.027***	0.000
AGE	−.085***	0.000	−.046	0.289	.008	0.422
SEX	.963	0.062	2.063**	0.028	.825**	0.031
MARSTAT	2.838***	0.000	.443	0.369	.511***	0.001
EDU	.477***	0.000	.395***	0.008	.072**	0.044
FAMSIZ	2.083***	0.000	2.439***	0.000	.631***	0.000
<10	.284	0.549	−1.447	0.071	−.150	0.556
HOMOWN	1.207**	0.031	1.259	0.058	1.157***	0.000
LENGLIV	.169***	0.001	.104***	0.008	.092***	0.000
EMPL	1.277***	0.005	7.324***	0.000	1.125***	0.008
INCOME	.091***	0.001	.006***	0.000	.0003***	0.004
CHAT	−.448	0.230	5.432***	0.000	−.755***	0.001
Constant	2.774**	0.029	1.502***	0.000	7.624***	0.000

***** Significant at 1%**
**** Significant at 5%**
*** Significant at 10%**

Table A3. Description of some selected variables for commercial households

Variable	Logiya			Assayta			Dubti		
	Mean	Min.	Max.	Mean	Min.	Max	Mean	Min.	Max.
WTP	16.9	5	60	16.7	5	40	14.7	2	50
AGE	31.7	14	64	34.9	24	75	35.1	20	60
EDUC	7.5	0	16	8	0	13	7.6	0	16
NOWRKR	2.5	1	10	2	1	7	2.4	1	12
WRKYR	5.4	0.5	40	8.7	1	30	10.2	0.5	37
INCOME	2576.1	500	12,000	2525.5	1000	5000	2750	600	10,000

Table A4. Regression results for commercial households

Variable	Logiya		Assayta		Dubti	
	Number of obs = 74 F(9, 64) = 40.09 Prob > F = 0.0000 R-squared = 0.6952		Number of obs = 75 F(9, 65) = 62.39 Prob > F = 0.0000 R-squared = 0.7835		Number of obs = 74 F(9, 64) = 18.90 Prob > F = 0.0000 R-squared = 0.8106	
	Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|
SWAMT	.043***	0.000	.011***	0.009	.019***	0.000
AGE	−.213***	0.000	−.087***	0.000	−.175***	0.000
SEX	.986	0.369	3.565***	0.000	1.940	0.389
MARSTAT	2.301***	0.007	.891***	0.001	.127	0.917
EDU	.318***	0.005	.189***	0.000	3.605***	0.000
NOWRKRS	.579	0.138	.078***	0.002	2.163***	0.000
HOMOWN	2.448***	0.000	1.337***	0.000	1.633	0.218
WRKYRS	.45***	0.000	.022	0.080	.047***	0.000
INCOME	.003***	0.000	.003***	0.000	.002***	0.003
Constant	16.946***	0.000	.217***	0.000	9.316***	0.000

***** Significant at 1%**
**** Significant at 5%**
*** Significant at 10%**

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