

# **Application of Contingent Valuation Method (CVM) in Determining Demand for Improved Rainwater in Coastal Savanna Region of Ghana, West Africa**

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## **Abstract**

Coastal regions of Ghana are characterized by low annual rainfall ranging from 800mm to 900mm. This has contributed to water scarcity for domestic and agricultural use. In order for Ghana to meet the Millennium Development Goal of eradicating extreme poverty and hunger, alternative water sources must be exploited for domestic uses. This study uses the CV method as a valuation technique for non-marketed goods to estimate demand for clean rainwater for domestic use. In addition, the ordered probit model was used to determine the various factors that can influence respondents' willingness-to-pay for clean rainwater. The study found that about 93.2% of respondents are willing to pay GH¢0.025 daily for a 34cm container of clean rainwater and this amount was observed to be influenced by some socioeconomic factors. Government involvement is therefore recommended in the provision of the modern rainwater harvesting facilities because of the incidence of poverty within the coastal savanna areas of Ghana. It is also recommended that more education on the modern method of harvesting rainwater should precede the application of any rainwater harvesting strategy in Ghana.

**Key words:** Willingness-to-Pay, Rainwater Harvesting Technology, Ordered Probit, Marginal Effects.

## **1.0 Introduction**

Water plays a significant role in the life of all living things. Without water there would be no life for living things. Clean water is essential for human survival and satisfaction because human health depends on the provision of safe, adequate, accessible and reliable drinking water supplies (Porto, 2004). Gleick (1996) has indicated that the minimum total recommended basic water requirement in litres per person per day is 50. Health experts also consider clean water to be crucial for human health (Batmanghelidj, 2009).

As global population rises global market for water also keeps on increasing. In 2006, global water demand rose above the estimated value of \$400 billion per year (Black, 2007). Water occupied an increasingly important place on the international agenda since 1992; with questions about the impact of climate change on water resources, the possibility that disputes

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about access to water might exacerbate regional tensions, and whether large-scale planning projects are the best way to meet future needs, emerging as key issues (Love, 1999). One important goal of the Millennium Development Goals (MDGs) is to eradicate extreme and hunger globally. Poverty and hunger issues cannot be discussed in isolation without consideration of potable water. International community through the United Nations Millennium Declaration of 2000 has pledged to halve by 2015 the proportion of people who unable to access safe drinking water. As at two thousand and one (2001), almost half the population of Sub-Sahara Africa was struggling to survive on \$1 per day or less, the same proportion as in 1990. The Ghana Poverty Reduction Strategy (2003-2005) targets improved access to water as very critical for the country (Ghana). Provision of adequate clean water for human consumption is important in fulfilling global and national goals for poverty reduction.

In the developing world, rainwater harvesting for potable use is important both from the standpoint of water supply and health (Melby, 2006). The Virginia-US Rainwater Harvesting Manual compiled by The Cabell Brand Center in 2007 stated that rainwater can offer a sustainable alternative potable water source. Rainwater harvesting has again been recognized at the 2006 Climate Change Convention held in Nairobi-Kenya as an alternative option in addressing current water needs and provides water security against future droughts especially in African countries (Mashood et al., 2011).

Rainwater harvesting means capturing the rain where it falls or capturing the runoff and taking measures to store that water for domestic use and other purposes (Mashood et al., 2011). Generally, all fresh water resources come from rainwater, either surface water or ground water and, therefore rainwater can thus be said to be the source of all water sources. Rainwater harvesting technology can be inferred as the oldest man-made technology that provides potable water for domestic, agricultural and industrial use. In Ghana, rainwater harvesting started at the household level where small water storage containers were used to collect and store rain during storms (Siabi et al., 2008). The British colonists in Ghana introduced advanced methods of harvesting rainwater in their houses, public institutions among others. Ironically, some areas in Ghana, particularly houses with thatched roofing systems are still using pre-independence if not pre-colonial methods of harvesting rain.

The study used the Contingent Valuation Method (CVM) as a valuation technique for non-marketed goods to estimate how much people would be willing to pay for a good in a hypothetical market or under an imaginary circumstance. It also determines the factors collectively or individually influenced the respondent's decision either to be willing to pay or otherwise. Some studies in the 1980's have found that, 'when the CVM is used to estimate the use of goods and services with which the individuals are familiar...CV surveys that are carefully designed and administered can yield accurate and useful information on households' preferences' (Cummings et al., 1986). This study therefore used the CVM to determine how much respondents would pay for <sup>3</sup>clean or improved rainwater as harvested from a modern rainwater system in the coastal savanna regions of Ghana in West Africa. It also determines socioeconomic factors that influenced respondent's decision.

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<sup>3</sup> Clean or improved rainwater as used in this context means the water has been filtered to possess the following qualities: colourless, not sour or acidic or salty, odourless, potable without negative health implications.

## **Statement of the Problem**

The Coastal Savannah Region of Ghana stretches from Winneba in the Western Region through the Central and Greater Accra regions respectively to Keta in the Volta Region of the country. It is described as the driest part of Ghana compared to the other ecological zones of the country because it receives between 800mm to 900mm of rains annually depicting an average of 850mm annually. In spite of this challenge, less effort has been done on the part of government to expedite the process of introducing modern rainwater harvesting systems into Ghana's building code after the drafted rainwater strategy was introduced. Residents have also not invested enough in upgrading their traditional methods of harvesting rainwater to make it more potable for domestic use.

Formerly, water shortage was a national crisis especially during the dry season however water shortage in Ghana now is independent of the season. The total amount of water needed in the capital city of Ghana (Accra) alone is about 150 units however 90 units is produced and out of the 90 units produced, 45% of the water is lost through defective pipes and other equipments, and stealing (Asante, 2009). Since 2006 with its severity peaking from the first three months of 2010, people of Ghana without an exception to the coastal areas of Accra where the seat of government is located have been confronted with drinking water crisis until today.

Donor aid to economic services and infrastructure represents a substantial proportion of total expenditure of which water in 2001 is estimated as 76%. This level of donor support for poverty reduction and growth represents an unsustainable situation in the long term (GPRS, 2003-2006). The issue of growth and development can be envisaged in our policy framework if both the short term and long term effects are promising. Depending on donors for the provision and maintenance of rainwater harvesting systems can be envisaged to be unsustainable.

The general objective of the study is to determine how much Ghanaian households within the coastal savannah areas will be willing to pay (WTP) for improved rainwater as well as establishing the possible factors affecting their WTP. This is achieved by using the Contingent Valuation Method (CVM) which in recent years is commonly used in developing countries to elicit the individuals' preferences for the basic infrastructural projects such as water supply and sanitation (Whittington, 1998; Merrett, 2002).

## **2.0 Empirical Literature**

Shutz and Lindsay (1990) also estimated WTP for ground water in New Hampshire. The WTP was influenced by factors such as gender, age, the educational level, income level and number of settlement years in New Hampshire. These variables were statistically significant

Asenso-Okyere et al., (1997) applied the CVM to determine the WTP for health insurance by the informal sector in Ghana. The study adopted the ordered probit model for the estimation. The study found that over 90% of respondents are willing to join the scheme and up to 63.6% respondents were willing to pay a premium of about 5000 old cedis or \$3.03 a month for a household of five persons. Again, the study revealed that the amount that households are

willing to pay is influenced by income, sex, dependency ratio, health care expenditure and education.

According to Khorshiddoust (2004), one of the earliest researchers who adopted the CVM was Gramlich (1977). He adopted CVM for the estimation of public participation in an extraction of demand curve for fresh and clean water in Boston Metropolitan Area in USA. The primary objective of Gramlich's study was to calculate the amount of WTP. He applied statistical models for his estimation after collating data through questionnaire administration on a hundred and sixty five respondents. The findings of the study revealed appreciable WTP amounts showing a high demand for fresh and clean water in Boston.

Birol et al. (2007) employed the Contingent Valuation Approach to estimate farmers' demand for recycled wastewater in Cyprus. The study used a random sample of 100 respondents located in the Akrotiri aquifer area in Cyprus, a common-pool water resource with rapidly deteriorating water quality and quantity. The results reveal that farmers (93.8%) are willing to adopt this new water resource, and they derive the highest economic values from a recycled wastewater use program, which provides high quality recycled wastewater, and high water quantity in the aquifer.

Asfaw, et al. (2008) formulated two-stage probit econometric model following the log-likelihood function of Cameron and Quiggin(1994) and Haab (1998). The primary objective the model was to determine the willingness to pay for health insurance and hence the potential market for new low-cost health insurance product in Namibia, using the double bounded contingent valuation (DBCW) method. The results of the study showed that 87% of the uninsured respondents were willing to join the proposed health insurance scheme and on average were willing to insure 90% of the average family size. On the average respondents were willing to pay NAD 48<sup>4</sup> per capita per month and respondents in the poorest income quintile were willing to pay up to 11.4 percent of their income. They concluded that private voluntary health insurance schemes may be able to serve as a reliable income flow for health care providers considering the vulnerability of the poor.

Also, Mashood et al. (2011) at the 3rd Ghana Water Forum held in Accra-Ghana submitted a paper on 'Rainwater Harvesting (RWH) as a Complementary Approach to Improving Water Supply in Ghana'. The paper sought to find out the reason(s) why rainwater harvesting has been recognized at the 2006 Climate Change Convention held in Nairobi-Kenya as an alternative option in addressing current water needs and that, rainwater also provides water security against future droughts especially in African countries but it has not received the required support for adoption and expansion in Ghana. The study observed that initial capital investment is relatively high however given the lifespan, and operation and maintenance cost the rainwater harvesting storage tank and the borehole or hand dug well, the rainwater harvesting storage tank is cheaper in the long term. Other reasons for the low level of of rainwater harvesting technology included limited demonstration facilities, the perception that rainwater quality is suspect as compared to groundwater and treated surface water

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<sup>4</sup> Note: At the time of the study, exchange rate was NAD 7.20 to US\$1.00.

inadequate financing and inadequate building regulatory framework to support rainwater harvesting.

Quartey (2011) at the 3rd Ghana Water Forum held in Accra-Ghana on the theme Water and Sanitation Services Delivery in a Rapidly Changing Urban Environment, submitted a paper on “Towards a Sustainable Allocation of Potable Water in Ghana: Evidence from Kumasi”. The primary objective of the paper was to assess the sustainability of urban water distribution using the CVM. The willingness-to-pay values were obtained through the bidding game format by means of an administered questionnaire. The study revealed that consumers would be willing to pay about 300% to the main urban water distributor (Ghana Water Company Limited) in the form of an increase in tariffs once their water needs were going to be met. The degree of demand for potable water revealed a sizeable consumers’ surplus which make buyers susceptible to extortion by water vendors. The study recommended an urgent government intervention to save consumers from undue extortion and possible return to unwholesome water consumption with its accompanying health implications to consumers and the nation at large.

Based on the literature reviewed on the models, determinants, CV methodology and WTP in various countries with different projects, it can be inferred that the CVM is a recommended approach for investigating the economic benefits of the provision of non-marketed goods such as rainwater in the Coastal Savannah areas of Ghana.

### **3.0 Methodology**

Environmental Economics methodology describes six phases in the practical application of the CVM. These are the market description, elicitation, calculation, estimation, aggregation and validation phases (Bateman and Turner, 1995; Quartey, 2011).

#### **3.1 Sources of Data**

The study employed both primary data and some secondary data were used in this research. The primary data were collected through the use of questionnaire, observation and interview. The secondary data were also collected through reports, bulletins, articles and journals.

A team of five researchers were put together to constitute the interviewers who administered the questionnaire. Interviews were carried out to encourage respondents to tell their own stories in their own words. The team leaders of the interviewers have also lived in Accra and were abreast of the people’s cultural values and behavior, it helped them do the observation, interpretation and reported accordingly. Interviewers also helped the interviewees to understand any question they found difficult to comprehend on their own. This was intended to help the respondents answer all the questions enumerated by the researcher. Data collection for this survey requires that the market must first be described.

#### **3.2 The Hypothetical Market**

Demand for product warrants the existence of a market however, not a conventional market because values expressed by people are contingent upon their preferences. A key element of the contingent valuation approach involves specifying the target commodity. A hypothetical market is one in which the researcher asks respondents to indicate what they think they would

do under a particular imaginary situation. Again, it describes the services that could be made available and at what market value. An estimation of the demand for improved rainwater is contingent upon the existence of a hypothetical market. Willingness-to-pay by respondents in the study area was based on how the market was described. In this study, the researcher created a hypothetical market for the respondents to reveal their maximum WTP for the demand of improved rainwater.

Generally, hypothetical markets are intended to place the respondents in a real world market-like situation to be able to purchase the targeted products by expressing their preference for the good in question. In this regard, the purpose of the hypothetical market was to set up a market for the provision of improved rainwater. This is to serve the Coastal Savanna areas of Ghana, particularly Greater Accra Region-<sup>5</sup>Dangbe East and Volta Region-South Tongu districts respectively. The target commodity, that is improved rainwater was hypothetically described- ‘Assuming the modern rainwater harvesting technology or system has been installed for your household or neighbourhood with the principal characteristics as follows: having a filter, modern gutters, sizeable storage facility (say a polytank with pipe) for the house, the colour of the harvested water is like any clean or potable water, it is odour free, it is good for any domestic use’. A picture of the scenario was also shown to the respondents with the intention of helping them get a visual representation of the hypothetical market that has been orally described. These oral and pictorial descriptions explained the services that could be made available in real terms to the community and helped the respondents to reveal how much they were willing to pay for the improved rainwater.

The study observed from the pretest that, some respondents tend to appreciate the hypothetical market in picture form and some also appreciated the oral description without pictures. Respondents also found it difficult to believe in the possibility of having clean rainwater as they are used to the unfiltered traditional method of harvesting rainwater. In addition, it was realized that, if the oral description of the market is not properly done, the respondents will either understate or over state their value for the improved rainwater. For this reason, the study combined both the oral description method as well as the picture<sup>6</sup> method in this survey.

The question asked for the iterative bidding game was, “suppose you are supplied with a modern rainwater harvesting technology as orally and pictorially described, how much would you be willing to pay to fetch a bucket of water from the system?”

### **3.3 Obtaining Bids and Bidding Mechanism**

Among the options available to the study, person to person (thus in-person or personal interview or face to face) was adopted in this study. The use of interactive computer medium, mail questionnaire with follow ups, and telephone interview would not be appropriate for this work as the illiteracy rate as well as the incidence of poverty amongst the people in the area will not permit an excellent use of these other methods of eliciting information. The advantages of the face to face method used include increasing engagement and awareness of

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<sup>5</sup> Dangbe East has now been divided into Ada East and Dangbe East

<sup>6</sup> see appendix 3 for pictorial description



the respondent or interviewee, simplicity, reduces misunderstanding and makes spontaneous questions and answers possible.

There are several bidding mechanisms or elicitation mechanisms in determining willingness to pay. The 'bidding game iterative method' was employed by the study in this empirical work. According to Bateman et al. (1995) the iterative bidding game format and dichotomous choice CV surveys are of high priority relative to the open ended format which has a high level of uncertainty. They reiterated that, respondents experience significant uncertainty in answering open-ended questions and may exhibit free-riding or strategic overbidding tendencies (although this is less certain) hence the choice of the iterative bidding game format in this study.

This method asks the respondent a sequence of questions until the maximum bid is found. This method was applied by quoting higher amounts to the respondents until the maximum amount they were willing to pay was reached. However, it may suffer from starting point bias, and fatigue effects. The weaknesses of this bidding mechanism used by the study have been taken care of, as a pilot survey was undertaken by the study. A clear amount to start with was obtained as most of the respondents under the pilot survey gave GH¢0.05 (5 pesewas) as their starting point amount hence stultifying the problem of starting point biases. The team of interviewers made the questionnaire administration quite simple and straight forward. This minimized the severity of fatigue effects on the part of both the interviewer and the interviewee as this did not influence the validity of the data.

The bidding game iterative method with a starting point amount of GH¢0.050 per 34cm bucket was used. If the respondent's answer is 'yes' to the bid of GH ¢0.05, then the question is repeated with a higher bid; if the answer is 'no', the question is repeated with a lower bid. This continues until the respondent's maximum WTP is reached. Also, 'Pay as you fetch' was the bid-vehicle or mode of payment majority of the household heads preferred to express their WTP when the Iterative Bidding Game Method was applied. It is obvious that these bid vehicle(s) would best prevent free riders under the method.

### **3.4 Sample size and Sampling Frame**

In order for the respondents to give a true picture of their WTP, the study focused on two regions with a district each characterized by potable water problems. Based on the relatively high potable water challenge in the study area, twenty communities which yielded a sample size of 309 household heads or respondents were used for the study. The communities namely Tsofoli, Dawa, Sege, Tofluokpo, MatseKope, Hwakpo, Addokope, Kasseh Ada, Ada Foah, Tojeh, Kpotame, Vume, Tefle, Koji, Sokpoe, Sogakope, Hlevi, Alesikpe, Dabala were sampled from the districts based on the non proportional stratified sampling method. The coastal regions were put into strata of four namely Greater Accra, Central, Volta and Western regions. However, due to the water demands and the incidence of poverty of the districts, Volta (South Tongu) and the rural/peri-urban part of Greater Accra (Dangbe East) were selected for the survey. The random sampling within the selected strata was done on-site as the study sought to avoid pre-selected respondents who may probably not be available at the

time for the administration of the questionnaire by the interviewer. The on-site sampling was done in houses, offices, shops and markets.

### 3.5 Model Specification

#### 3.5.1 Ordered Probit (Oprobit) Model

According to Maddala (1983) and Green (2008) responses generated from a survey may not necessarily be the maximum WTP and that the true WTP may perhaps lie between the maximum value expressed by the respondent and the next possible highest value. This suggests that the oprobit model is preferred to multinomial probit model because the former accounts for the statistical significance between the dependent and the independent variables as well as the ordinal characteristic of the dependent variable (Duncan et al., 1998).

Lemieux (2012) listed the most common cases of limited dependent variable models, along with the popular estimators used to estimate these models. Inferring the structural model from the economic and econometric point of view, the oprobit model is stated as

$$y^* = \alpha + X_1\beta_1 + \dots + X_k\beta_k + e \quad \dots \dots \dots (5)$$

The latent variable (WTP\*) can therefore be specified as  $WTP_i^* = \alpha + X_i\beta + e_i \dots \dots \dots$

(6) Where  $\alpha$  is the constant parameter, “  $X_i = X_i'$ ” is a vector showing features of the household and attributes of the proposed improved rainwater harvesting system,  $\beta$  is the vector representing the model’s parameters, and  $e_i$  is error term in the model.

According to Wooldridge (2002), assuming WTP\* is the ordered responses taking on the values  $\{0, 1, 2, 3, \dots, J\}$ , we can derive the ordered probit as follows: Let  $R_1, R_2, \dots, R_J$  represent the ‘j’ prices which divide the range of willingness to pay space into ‘J+1’ categories and let  $WTP_i$  be the categorical variable such that;

$$WTP_i = 1 \text{ if } WTP_i^* \geq R_1 \dots \dots \dots (7)$$

$$WTP_i = 2 \text{ if } < WTP_i^* \geq R_2 \dots \dots \dots (8)$$

$$WTP_i = 3 \text{ if } < WTP_i^* \geq R_3 \dots \dots \dots (9)$$

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$$J + 1 = 1 \text{ if } R_J < WTP_i^* \dots \dots \dots (10)$$



Now  $WTP_i^*$  can be equated to 'j', if we assume  $j=1, 2, 3, \dots, J+1$ . Therefore

$$R_{j-1} < WTP_i^* \leq R_j \dots\dots\dots (11)$$

Equation (5) can be substituted into equation 11, to yield

$$R_{j-1} < \alpha + X_i\beta + e_i \leq R_j \dots\dots\dots (12).$$

This can be statistically manipulated to generate series of equations such as  $R_{j-1} - \alpha < X_i\beta + e_i \leq R_j - \alpha$  or  $R_{j-1} - \alpha - X_i\beta < e_i \leq R_j - \alpha - X_i\beta$ .

According to Wooldridge (2002), given that we have  $J+1$  categories, the probability of household 'i' choosing category 'j' ( $=1, 2, 3, \dots, J+1$ ) it can be represented as follows

$$P_i(1) = \Pr(WTP_i = 1) = \Pr(WTP_i^* \leq R_1) = \Pr(X_i\beta + e \leq \mu_1) = \Pr(e_i \leq \mu_1 - X_i\beta) \\ = \Phi(\mu_1 - X_i\beta) \dots\dots\dots (13)$$

$$P_i(2) = \Pr(WTP_i = 2) = \Pr(R_1 < WTP_i^* \leq R_2) = \Pr(e_i \leq \mu_2 - X_i\beta) - \Pr(e_i \leq \mu_1 - X_i\beta) \\ = \Phi(\mu_2 - X_i\beta) - \Phi(\mu_1 - X_i\beta) \dots\dots\dots (14)$$

$$P_i(3) = \Pr(WTP_i = 3) = \Pr(R_2 < WTP_i^* \leq R_3) = \Pr(e_i \leq \mu_3 - X_i\beta) - \Pr(e_i \leq \mu_2 - X_i\beta) \\ - \Pr(e_i \leq \mu_1 - X_i\beta) = \Phi(\mu_3 - X_i\beta) - \Phi(\mu_2 - X_i\beta) - \Phi(\mu_1 - X_i\beta) \dots\dots\dots (15)$$

$$P_i(J) = \Pr(WTP_i = J) = \Pr(R_{J-1} < WTP_i^* \leq R_J) = \Phi(\mu_J - X_i\beta) - \Phi(\mu_{J-1} - X_i\beta) \dots\dots\dots (16)$$

$$P_i(J + 1) = \Pr(WTP_i = J + 1) = \Pr(WTP_i^* > R_J) = 1 - \Phi(\mu_J - X_i\beta) \dots\dots\dots (17)$$

Given that  $\Phi(a) = 1 - \Phi(-a)$ , because the normal distribution is symmetric and

$\mu_j = \text{threshold parameters}$

To obtain 'β' and the 'j' parameters we maximize the log likelihood function to yield

$$\ln L = 1[WTP_i = 1] \ln[\Phi(\mu_1 - X\beta)] + 1[WTP_i = 2] \ln[\Phi(\mu_2 - X_i\beta) - \Phi(\mu_1 - X\beta)] + \dots \\ + 1[WTP_i = J + 1] \ln[1 - \Phi(\mu_J - X_i\beta)] \dots\dots\dots (18)$$

$$\text{In sum, } \ln L = \sum_{i=1}^N \sum_{j=1}^{J+1} WTP_{ij} \ln[\Phi(\mu_j - X_i\beta) - \Phi(\mu_{j-1} - X_i\beta)] \dots\dots\dots (19)$$

### 3.5.2 Marginal Effect of Ordered Probit Model

The differential of dependent variable WTP with respect to the vector “X” (which shows the features of the household and attributes of the proposed improved rainwater harvesting system) presents the marginal effects. The marginal effects show how the probability of each outcome changes with respect to changes in the explanatory variable.

$$\frac{\partial \text{Prob}(WTP_i = 1 | X)}{\partial X_i} = -\Phi'(\mu_1 - X_i' \beta) \beta \dots \dots \dots (20)$$

$$\frac{\partial \text{Prob}(WTP_i = 2 | X)}{\partial X_i} = [\Phi'(\mu_1 - X_i' \beta) - \Phi'(\mu_2 - X_i' \beta)] \beta \dots \dots \dots (21)$$

$$\frac{\partial \text{Prob}(WTP_i = 3 | X)}{\partial X_i} = [\Phi'(\mu_1 - X_i' \beta) - \Phi'(\mu_2 - X_i' \beta) - \Phi'(\mu_3 - X_i' \beta)] \beta \dots \dots \dots (22)$$

$$\frac{\partial \text{Prob}(WTP_i = J | X)}{\partial X_i} = [\Phi'(\mu_{J-1} - X_i' \beta) - \Phi'(\mu_J - X_i' \beta)] \beta \dots \dots \dots (23)$$

$$\frac{\partial \text{Prob}(WTP_i = J + 1 | X)}{\partial X_i} = [\Phi'(\mu_J - X_i' \beta)] \beta \dots \dots \dots (24)$$

**3.5.3 Functional Form of the Model**

Binam et al. (2003) indicated that in literature, some authors have concluded that the willingness-to-pay is influenced by economic characteristics, socio-demographic characteristics and the characteristics of the good itself (Whittigton et al., 1990; Flores and Richard, 1997; Bloom and Shenglan, 1999; Atim, 1999; Criel et al., 1999). Binam et al. (2003), added variables such as age, the level of education, the gender, religion, the family size, marital status in estimating WTP for community health prepayment scheme in Cameroon. The model used by Briscoe et al. (1990) in a CV study in Brazil was:

$$U_{ij} = \alpha_0 + \alpha_1 C + \alpha_2 V + \alpha_3 Y + \alpha_4 Z + \xi_{ij} \dots \dots \dots (25)$$

Where U= Utility, C= Monetary costs of obtaining water, V= perceived water quality, Y= Household income, Z= a set of socioeconomic variables used as proxies for the families tastes,  $\xi$ = the error term. Following the models adopted from Briscoe et al. (1990), and Binam et al. (2003), WTP depended on some economic and socio-demographic independent variables. This paper also adopted socio-economic variables based on the environmental good in question, the kind of people and how they live.

The valuation function used in this research is based on the consumer demand theory. Therefore, the functional form of the model to be determined is expressed as:

$$MWTP = f ( MS, G, Mi, E, Occ, Y, Urdu, Pfmt ) \dots\dots\dots ( 26 )$$

$$MWTP = \beta_0 + \beta_1 Ms + \beta_2 G + \beta_3 Mi + \beta_4 E + \beta_5 Occ + \beta_6 Y + \beta_7 Urdu + \beta_8 Pfmt + \mu \dots\dots\dots ( 27 )$$

Where  $\beta_0$  denotes the constant term in the model,  $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \dots\dots\dots$  and  $\beta_{13}$  are parameter estimates to be estimated using the ordered probit method of estimation. The error term ( $\mu$ ) is added to the function because the researcher does not observe all components of WTP for improved rainwater (Mcfadden, 1974). The WTP is the dependent variable used in the model. This deals with the amount that the respondents are willing-to-pay to be beneficiaries of clean rainwater. The fundamental principle of WTP is that the preferences of individuals must serve as base of evaluation for gains and losses of non-market goods and services.

**Table 1: Model Variables and their Description**

Variable	Marital Status of Respondent	Gender of Respondent	Occupation of Respondent by Sector	Education of Respondent	Usage of Rainwater for Domestic Purpose by Respondent	Preference of Modern Rainwater Technique by Respondent	Monthly Income Levels of Respondent (Gh¢)	Household Population below 18 Years
Abbreviations	Ms	G	Occ	Edu	Urdu	Pmrt	Income (Y) in Gh¢	Minors
Description	Dummy	Dummy	Dummy	Dummy	Dummy	Categorical	Continuous	Categorical
Code	Married=1, Otherwise=0	Male=1, Female=0	Unemployed=0, Employed=1	Educated=1, Otherwise=0	User=1, Otherwise=0	Preferred=1, Otherwise=0	Min=0, Max=2500	Min=1, Max=5
Apriori	+	+/-	+	+	+	+	+	+/-

#### 4.0 Analysis of Results

This section presents the results of the field survey as generated by both the statistical software(s) (STATA 11.0 & PASW 18) and researcher's computation. The descriptive statistics show that about 78% of the respondents are willing to harvest rainwater if it should rain. About 22% were not interested in rainwater with some giving reasons as they have adequate water from the pipe system, their companies supply them pipe water constantly and improper roofing sheets like thatched, dirty roof because of excessive dust in the areas and asbestos roofs.

Again, 99% of those who were willing to harvest preferred modern rainwater techniques with filters to the old method without filters. Unfortunately, 1% of the respondents were still

interested in their old method explaining that they are used to the old method and do not know any possible negative aspect of the modern method. Furthermore, 80% were willing to pay for the modern method whilst 20% declined willingness to pay citing financial constraints as their main reason. The factors that determine the respondents' willingness to pay are presented in section 4.1.

#### 4.1 Ordered Probit Regression Results

The formulated ordered probit model was able to identify certain socio economic variables associated with the WTP for improved rainwater.

**Table 4.0: Regression Results**

ordered probit regression		Number of obs = 307			
Log likelihood = -168.68569		LR chi2(8) = 153.86	Prob > chi2 = 0.0000		
		Pseudo R2 = 0.3132			
wtp	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]
gender	-.2401295	.184282	-1.30	0.193	-.6013156 .1210566
ms	.1963758	.1856867	1.06	0.290	-.1675634 .5603151
minors	.1016446	.0625263	1.63	0.104	-.0209048 .224194
education	-.3403554	.1928214	-1.77	0.078	-.7182785 .0375676
occupation~y	-.422118	.1851842	-2.28	0.023	-.7850723 -.0591637
income	-.0010561	.0518607	-0.02	0.984	-.1027012 -.1005889
urwdu	-.6265431	.2513638	-2.49	0.013	-1.119207 -.1338791
pfmt	2.675478	.2735347	9.78	0.000	2.13936 3.211596
/cut1	-.1664413	.3318117			-.8167804 .4838978
/cut2	3.044125	.3496137			2.358895 3.729355
/cut3	3.287359	.3514048			2.598619 3.9761
/cut4	3.636773	.3657474			2.919921 4.353624

Several diagnostic tests were conducted on the model to ascertain the authenticity and predictive justification of the model. The model presents the log likelihood value of 168.69<sup>7</sup> which is statistically significant at 1% significance level, suggesting that, model is correctly specified.

The Likelihood Ratio Index or Pseudo R<sup>2</sup> tests the goodness-of-fit of the model. A pseudo R<sup>2</sup> value of 0.31 shows how the model explains 31% of variations in the dependent variable. By this we say the model fits the set of observations. Amoah (2011) explained that “According to Mitchell and Carson (1989), the R<sup>2</sup> of 31% is quite reasonable in that, the reliability (reproducibility and stability) of CVM can be tested most easily by obtaining a respectable coefficient of determination (thus R<sup>2</sup> ≥ 0.15 or 15%). This shows how the WTP variable is influenced by set of independent variables (Arlinghaus and Mehner, 2004)”.

The study also tested for the existence of multicollinearity using the spearman's correlation test. The presence of one or more large bivariate correlations with rho coefficient of 0.8 and 0.9 are commonly used cutoffs which indicates strong linear associations, suggesting collinearity may be a problem (Mason and Perreault, 1991). The results as displayed in appendix 2b ruled out the presence of severe multicollinearity in the model as the coefficients of correlation (rho or ρ) were below the established rule (ρ < 0.8 and 0.9) for all other

<sup>7</sup> Rounded up

variables. Again, the VIF<sup>8</sup> calculation also justified the absence of severe multicollinearity in the model. Now, the model from the perspective of an entire bundle of independent variables as well as individual independent variable demonstrates its ability to predict the outcome variable.

From table 4.0, except marital status (ms) and number of household population under eighteen years (minors); all the other variables had negative signs. In the results, preference for modern technology (pfmt) and users/usage of rainwater for domestic purposes (urwdu) were significant at 1%, occupation was also significant at 5% and, minors as well as education were significant at 10% levels of significance. Income, gender and ms were however not significant. According to Hamath et al. (1997), since the utility of preference is an ordinal measure, the relative magnitude of the coefficients is more important than their absolute magnitude. The marginal effect results with their categories are shown in table 4.1<sup>9</sup>. The marginal effects show the relative changes in probabilities of the dependent variable to a unit change in an explanatory variable say income of respondents. In the case of dummy variables, the marginal effect of a dummy is the change in the predicted probability for a change in the variable from start value to end value holding all other variables at their sample mean (Long, 1997).

**Table 4.1: Marginal Effect of the Ordered Probit Estimates**

Variable	wtp≤Gh¢0.05	Gh¢0.05<wtp≤Gh¢0.10	Gh¢0.10<wtp≤ Gh¢0.15	wtp>Gh¢0.20
MS	0.0129	0.0059	0.0053	0.0046
Gender	-0.0100	-0.0078	-0.0073	-0.0066
Education	-0.0088	-0.0118*	-0.0112	-0.0105
Occupation	-0.0083	-0.0149**	-0.0143**	-0.0137**
Urwdu	0.0112	-0.0249**	-0.0251**	-0.0264*
Pfmt	-0.1447****	-0.0830****	-0.0759****	-0.0673****
Minors	0.0055	0.0032*	0.0029*	0.0026*
Income	-0.0001	-0.0000	-0.0000	-0.0000

\*\*\*\*=1%, \*\*\*=5%, \*\*=10%, \*=15% levels of significance respectively.

NB: The results are approximated to four decimal places. wtp=Willingness-to-pay, Gp=Ghana Pesewas

In discussing the results provided in table 4.1, marital status (ms) is positively related to willingness-to-pay for improved rainwater in the coastal savannah region of Ghana. This implies that the unmarried are more willing to pay for improved rainwater than the married. The probability of paying any amount less or equal to GH¢0.05 is 0.0129; greater than GH¢0.05 but less or equal to GH¢0.10 is 0.0059; greater than GH¢0.10 but less or equal to GH¢0.15 is 0.0053; greater than GH¢0.20 is 0.0046. The relationship could be attributed to the fact that, most of the household heads are males (65%), and for the males who are married, their domestic water supply responsibility depend mostly on their wives and children hence the unwillingness of husbands or married category to pay. However, because the burden of ensuring that there is water at home lies directly on individuals who are not

<sup>8</sup> See appendix 2a for Variance Inflation Factor (VIF) calculation.

<sup>9</sup> See appendix 1b for detailed tables as generated by STATA Version 11.

married, they demonstrated their willingness to pay for the improved rainwater. This has been supported by a study in Bushenyi (Western Uganda) by Wedgwood and Samson (2003) that male household heads have control over finances in most developing countries however, the burden of fetching water lies largely on women and children.

Gender is negatively related to willingness-to-pay for improved rainwater in the coastal savannah region of Ghana. By implication, the probability of men paying some money in their bid to obtain improved rainwater is higher than women. The probability of paying any amount less or equal to GH¢0.05 is 0.0100; greater than GH¢0.05 but less or equal to GH¢0.10 is 0.0078; greater than GH¢0.10 but less or equal to GH¢0.15 is 0.0073; greater than GH¢0.20 is 0.0066. This relationship could be based on the fact that, men are economically empowered in the cultural settings of Ghana hence expressing higher willingness-to-pay. This has been supported by World Bank study in 1993 suggesting that gender's influence on willingness-to-pay depends largely on the specific cultural settings or context.

The results also show an inverse relationship between income and wtp implying that a unit increase in income has the probability of decreasing the wtp for improved rainwater. This is confirmed by the first standard policy paradigm which holds that, rural households especially in developing countries where the incidence of poverty is very high can pay very little or nothing out of their income for improved water services (World Bank, 1993). Unfortunately, income, marital status and gender were not statistically significant at all in this study. Similar findings where socioeconomic factors were not statistically significant is seen in Soto Montes de Oca et al. (2003) where gender and family size were not statistically significant and Gwulyani et al. (2005) where only three variables were statistically significant with variables like household size, income level, gender of respondent, education level of household respondent, among others were not statistically significant.

Education exhibited an inverse relationship with wtp for improved rainwater. This suggests that educated people have a higher probability of paying for improved rainwater relative to the uneducated. It is generally accepted that an educated person who is informed about polluted water and its health implication will express a higher willingness to pay than an uninformed or uneducated person. The probability of paying any amount greater than GH¢0.05 but less or equal to GH¢0.10 is 0.0118 for this category is significant at about 15% level of significance.

Occupation of the respondent by sector also shows a negative relationship with wtp. This implies that those employed (Agricultural, Industrial and Services sectors) are more likely to express their willingness to pay relative to the unemployed. This is because those employed are financially better off relative to those who are unemployed. The employed can pay for services that will improve their welfare as compared to the unemployed. The probability of paying any amount greater than GH¢0.05 but less or equal to GH¢0.10 is 0.0149. This is significant at 10% level of significance.

Usage of rainwater for domestic purposes (urwdu) as a variable was negatively related to wtp. It means that those who use rainwater are expressing a higher probability of paying for improved rainwater relative to those who do not use rainwater for domestic purposes. This



could be attributed to the modern method which provides filtered water to the unfiltered traditional method whose quality cannot be guaranteed. In addition to the scarcity of water in the study area, users of rainwater were interested and expressed a higher probability of paying for improved rainwater because of the new method and its likely positive effects on their health. The probability of paying any amount greater than GH¢0.05 but less or equal to GH¢0.10 is 0.0249. Also, the probability of paying any amount greater than GH¢0.10 but less or equal to GH¢0.15 is 0.0251. These were significant at 10% level of significance. The amount less or equal to GH¢0.05 was also positive however, it was not significant.

Also, the number of persons in the household that were eighteen years and below (Minors) exhibited a positive relationship with the dependent variable implying that, a unit increase in the number of minors in a household has the probability of increasing the wtp for improved rainwater. This is particularly true for household heads who appreciate the ordeal the minors and women go through in ensuring that there is potable water at home for use. The probability of paying any amount greater than GH¢0.05 but less or equal to GH¢0.10 is 0.0031. This is significant at 15% level of significance.

Respondent's preference for modern rainwater harvesting technology or method (Pfmt) shows that those who said they preferred the modern rainwater technology are less likely to pay for the modern method as compared to those who declined preference for the modern method and are still comfortable with their traditional method. This ironic result came about simply because of fear of financial commitment coupled with failure of their crops within the period under consideration by majority of respondents who are within the agricultural sector. The probability of paying any amount less than GH¢0.05 is 0.6223; greater than GH¢0.05 but less or equal to GH¢0.10 is 0.0391; greater than GH¢0.10 but less or equal to GH¢0.15 is 0.0363; greater than GH¢0.20 is 0.0344. These values were statistically significant at even 1% level of significance.

In sum, the determinants of wtp in the ordered probit model revealed three major significant variables namely Occupation, Usage of rainwater for domestic purposes and Respondent's preference for modern rainwater technology.

**Table 4.2: TWTP and Expected Revenue for Clean Rainwater in Ghana Pesewas per**

Intervals (***GHP)	Freq.	Mid-WT P (***GHP)	% of HH*	Share of Populati on	Cumulativ e Population	Number of Buckets**** of water used per day by all	TWTP per day (***GHP)	Expected Revenue per day (***GHP)
A	B	C	D	E	F	G= F×8	H= C×E	I=C×G
0-0.05	287	0.025	93.2	196,414	210,786	1,686,288	4,910	42,157
0.06-0.10	7	0.08	2.3	4,791	14,372	114,974	383	9,198
0.11-0.15	5	0.13	1.6	3,422	9,581	76,649	445	9,964
0.16-0.20+	9	0.18	2.9	6,159	6,159	49,275	1,109	8,869
<b>TOTAL</b>	<b>308</b>		<b>100.0</b>	<b>210,786*</b>		<b>1,927,186</b>	<b>6,847</b>	<b>70,189</b>

\*Ghana Statistical Service, 2010 Population Census after adding the two districts, \*\*HH=Household, \*\*\*Gp=Ghana Pesewas, \*\*\*\*Average buckets used per day is from the study is 150 litres (8 Buckets)<sup>10</sup>, Willingness-to-Pay= WTP, TWTP =Total WTP

**Source: Author's Computation, 2012.**

The mean willingness-to-pay for improved rainwater in the two districts was determined by dividing the TWTP by the share of population. This yields  $(6,847 \div 210,786) \times 30 = \text{GH}¢0.032$  per day, per person. It is evident in table 4.2 that majority of the population representing 93.2% were willing to pay GH¢0.025 daily for a bucket of improved rainwater. This same amount provides the highest expected revenue of GH¢42,157 per day.

Quartey (2011) indicated that “According to Kauffman and Pérard, 2007, the Freshwater Country Profile of Ghana of the United Nations Organization has indicated that it costs Ghana US\$0.80 per cubic meter to produce, transport and distribute potable water”. Using freshwater case as a proxy, given the two district's population, the cost of efficient production, transportation and distribution of improved rainwater for 210,786 people will yield US\$168,628.8 per cubic meter (equivalent to Gh¢317,022.144<sup>11</sup>). It can be said that, barring the fact that all the eight buckets used for the computation may not be potable water, the mean cost per day can be determined as Gh¢317,022.144 divided by 210,786 which yields Gh¢1.504. The difference between the mean wtp value and the mean estimated cost value results in a net loss of GH¢1.47 per day.

An Ordinary Least Square linear regression was used to derive the demand function from the distribution provided in table 4.2. This is given as equation 24 and subsequently illustrates the curvature of the demand curve which is shown in figure 1.

<sup>10</sup> The bucket used in the field survey had about 18.75 litres per bucket

<sup>11</sup> Exchange rate used is \$1: ¢1.88

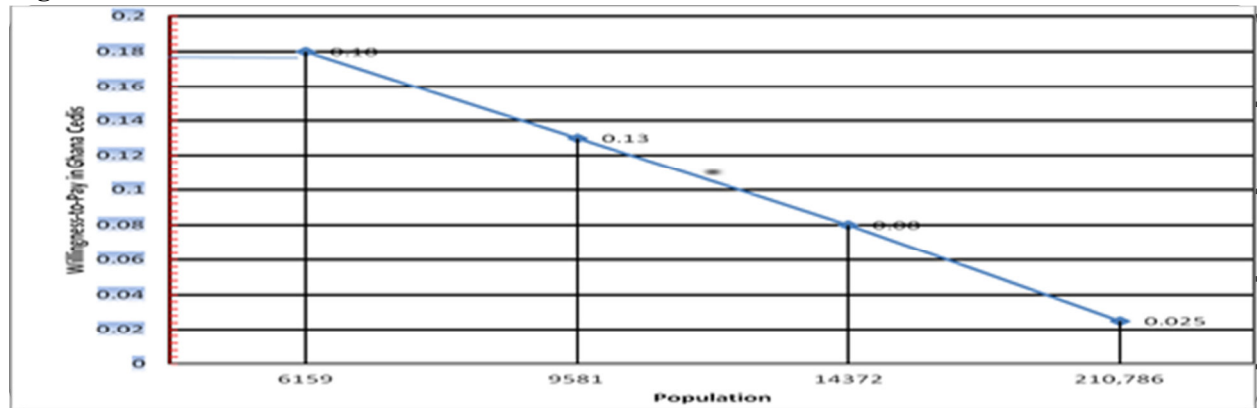
$$Y = 187047 \quad .4 - 1222389 \quad X \dots\dots\dots 24$$

$$SE = ( 74301 \quad .7 ) \quad ( 626992 \quad .2 )$$

$$t = [ 2 \quad .51 ] \quad [ - 1 \quad .95 ]$$

$$R^2 = 66 \%$$

**Figure 1.0: DEMAND CURVE FOR IMPROVED RAINWATER**



Author's Field Work (2012)

The demand curve in figure 1, shows the inverse relationship between the dependent variable and the independent variable as exists in economic theory. The demand curve confirms the findings of the study that most of the people in the study area are prepared to pay GH¢0.25 for a 34cm container of improved rainwater. This has been observed to be very high considering their current cost of pipe-borne water as GH¢0.05 and GH¢0.10 which is mostly unavailable. The study realized that except for the incidence of poverty in the study area, the bid would have been higher.

### 5.0 Conclusion and Policy Recommendations

In order to achieve the MDGs, the water supply crisis confronting the coastal savanna region of Ghana affecting domestic and agricultural uses need urgent attention since water should not be trivialized. The problem is central to most economic activities and the livelihood of the people in the study area. It is recommended that the government intervenes in addressing this problem since it has a multiplier effect on the national economy.

The improved rainwater harvesting system introduced to the people has been accepted by majority of the respondents with a very high demand. However, intensive education and awareness programmes to introduce government policies and plans on rainwater are required on sustainable basis.

The acceptance of improved rainwater harvesting system should not be seen as an alternative source of water supply but one which complements the pipe water supply system. This is because the annual rainfall for the coastal savanna areas is woefully inadequate for absolute reliance on rainwater.

Private direct investment is not strongly recommended for rainwater harvesting in poor areas like the coastal savanna region of Ghana because the recovery of investment will be very low due to the incidence of poverty. Some form of government intervention is required to enable the communities buy into the idea of adopting the new system.

Lastly, existing pipe-borne water supply system imposes additional cost to residents instead of assisting them. They are made to pay exorbitant prices for water sold to them by a few unscrupulous people who have monopoly over the existing sources. This situation is unfair, and the Ghana Water Company must be encouraged to improve the water delivery throughout the communities to alleviate their suffering.

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## References

1. Amoah, A. (2011) Determinants Of Willingness-To-Pay (Wtp) for The Restoration and Maintenance of Korle Lagoon in Accra, Ghana Journal of Business Research, Vol. 5 Issues 1 & 2, 2011
2. Arlinghaus and Mehner, (2004), Fisheries Management and Ecology, Blackwell Publishing Ltd., Berlin, Germany, pp 61-64.
3. Asante, K. B. Daily Graphic, 14th December 2009 09:16:15 accessed @ <http://www.graphicghana.com/dailygraphic/page.php?news=5660>
4. Asenso-Okyere, W. K., Osei-Akoto, I. and Appiah, E. N. (1997), —Willingness to pay for Health Insurance in a developing economy. A pilot study of the informal sector of Ghana using contingent valuation, Health Policy, Vol. 42, pp. 223-237.
5. Asfaw, A., Gustafsson-Wright, E. and van der Gaag, J. (2008), —Willingness to pay for Health Insurance: An Analysis of Potential Market for New Low Cost Health Insurance Products in Namibia, AIID RS 08-01/2.
6. Atim, C., (1999), Social movements and health insurance: a critical evaluation of voluntary, non-profit insurance schemes with case studies from Ghana and Cameroon. Social Science and Medicine 48, 881-896.
7. Bateman, I. J., Langford, I. H., Turner, K., Willis, K. G., & Garrod, G. D. (1995). Elicitation and truncation effects in contingent valuation studies. Ecological Economics, 12, 161-179
8. Bateman, I.J. and Turner, R.K. (1993) Valuation of the environment, methods and techniques: The contingent valuation method, in Turner R.K. (ed.) Sustainable

- Environmental Economics and Management: Principles and Practice, Belhaven Press, London, pp120-191.
9. Bateman, I.J., Willis, K.G. and Garrod, G.D. (1994) Consistency between contingent valuation estimates: A comparison of two studies of UK National Parks, *Regional Studies*, 28 (5): 457-474.
  10. Bateman, Ian J. and Turner, R. Kerry. (1995). "Valuation of the Environment, Methods and Techniques: The Contingent Valuation Method", in Turner (ed). *Sustainable Environmental Economics and Management: Principles and Practice*, England: J Wiley.
  11. Batmanghelidj F. MD, (2009) accessed at <http://www.health-benefit-of-water.com/benefit-of-drinking-water.html>
  12. Binam Joachim Nyemeck, Nkama Arsène and Nkendah Robertn (2003), 'Estimating the willingness to pay for community health prepayment schemes in rural area': A case study of the use of contingent valuation surveys in centre Cameroon. University of Yaoundé II, Faculty of Economic Sciences and Management. pp 1-25.
  13. Birol E, Koundouri P, Koundouri Y(2007) Farmers' Demand for Recycled Wastewater in Cyprus: A Contingent Valuation Approach, *Environmental Economy and Policy Research*, University of Cambridge, Discussion Paper No:24. USA
  14. Birol, E., and Das, S. (2010) Estimating the value of improved wastewater treatment: The case of River Ganga, India, *Journal of Environmental Management* 91 (2010) 2163-2171
  15. Birol, E.; Das, S. and Bhattacharya, N. R.(2009) Estimating the value of improved wastewater treatment: The case of River Ganga, India. *Environmental Economy and Policy Research*, University of Cambridge, Discussion Paper No:43.2009
  16. Black, R (June, 06,2007)Global Demand for Water to Grow, accessed at [seekingalpha.com/article/37467-global-demand-for-water-expected-to-grow](http://seekingalpha.com/article/37467-global-demand-for-water-expected-to-grow)
  17. Bloom, G., Shenglan, T., (1999). Rural Health Prepayment Schemes in China: towards a more active role for government. *Social Science and Medicine* 48, 951-960.
  18. Briscoe, J., Furtado de Castro, P., Griffen, C., North, J., Oslen, O., (1990) Towards Equitable and Sustainable Rural Water Supplies: A contingent Valuation Study in Brazil, *World Bank Economic Review*, Vol. 4. no.2. pp:115-134.
  19. Cameron, C. and Trivedi K. P. (2005) *Microeconometrics: Methods and Applications*, Cambridge University Press, New York, United States of America
  20. Cameron, T.A. 1991. Combining Contingent Valuation and Travel Cost Data for the Valuation of Nonmarket Goods. *Land Economics*. 68(3):302-17.
  21. Criel, B., Van der Stuyft, P., Van Lerberghe, W., (1999). The Bwamanda hospital insurance scheme: effective for whom? A Study of Its Impact on Hospital Utilization Patterns. *Social Science and Medicine* 48, 897-911.

22. Cummings, R. G., Schulze W. D., Gerking, S. D., and Brookshire, D. S. (1986), —Measuring the elasticity of substitution of wages for municipal infrastructure: A comparison of the survey and wage hedonic approaches, *Journal of Environmental Economics and Management*, Vol. 13 No. 3, pp. 269-276.
23. Duncan C. S., Khattak A. J., and Council F. M. (1998), —Applying the Ordered Probit Model to Injury Severity in Truck-Passenger Car Rear-End Collisions, *Transportation Research Record*, 1635, Paper No. 98-1237.
24. Flores, N.E. and Richard, T.C. (1997). The Relationship between the Income Elasticities of demand and Willingness to Pay. *Journal of environment Economics and Management* 33(3), 287-95.
25. Ghana Poverty Reduction Strategy (GPRS,2003-2006), Government of Ghana
26. Gleick, P.H (1996) Basic Water requirements for Human Activities: Meeting Basic Needs. *Water International*, Vol.21, No. 2, pp. 83-92
27. Gramlich, F.W (1977) The Demand for Clean Water the case of Charles River, *National Tax Journal* 30(2):183-194
28. Greene, W.H. (2008), *Econometrics Analysis*, Sixth Edition, New Jersey: Prentice Hall.
29. Gulyani, S. Talukdar, D and Kariuki, M. R. (2005) Water for the Urban Poor: Water Markets, Household Demand, and Service Preferences in Kenya, *Water Supply and Sanitation Sector Board Discussion Paper Series N o. 5*
30. Haab, T.C. 1998. Estimation Using Contingent Valuation Data from a ‘Dichotomous Choice with Follow-Up’ Questionnaire: A Comment. *Journal of Environmental Economics and Management* 35: 190-94.
31. Hamath, A.S., M.D. Faminov, G.V. Johnson, and G. Crow (1997), ‘Estimating the values of cattle characteristics using an ordered probit model’, *American Journal of Agricultural Economics* **79**: 463–476.
32. Hanley, N. and Spash, C.L., (1993): *Cost Benefit Analysis and the Environment*. Aldershot: Elgar Publishing Limited.
33. Holden, S.T. and Shiferaw, B. (2002). *Poverty and Land Degradation : Peasants ‘Willingness to Pay to Sustain Land Productivity*. In C. B. Barrett, F. M. Place, and A. A. Aboud (eds.), *Natural Resource Management in African Agriculture: Understanding and Improving Current Practices*. CABI Publishing in Association with International Centre for Research in Agroforestry, Oxon and New York.
34. Khorshiddoust, A.M (2004) *Contingent Valuation in Estimating the Willingness to Pay for Environmental Conservation in Tabriz, Iran*, *Environmental Studies* No.36accessed@ journals.ut.ac.ir
35. Lancaster, K.J. (1966), —A New Approach to Consumer Theory, *Journal of Urban Economics*, Vol. 74, pp. 132-157.



36. Lemieux, T (May, 2012) Econ 594: Lecture#6, Department of Economics, University of British Columbia.
37. Long, J. S. (1997), Regression Models for Categorical and Limited Dependent Variables. Advanced Techniques in the Social Sciences, Vol. 7, California: SAGE Publications, Inc.
38. Love, P(1999)Water Resources: Meeting Future Demand, Foresight Journal Volume 1, Issue 3,pg 275-278
39. Luce, R. (1959), Individual Choice Behavior: a Theoretical Analysis. New York: Wiley
40. Maddala, G. S. (1983), Limited-Dependent and Qualitative Variables in Economics, New York: Cambridge University Press, pp. 257-91
41. Mashood, Jemila; Ampadu-Boakye, Joseph & Nii Odai Anidaso Laryea (2011)Rainwater Harvesting (RWH) as a Complementary Approach to Improving Water Supply in Ghana, 3<sup>rd</sup> Ghana Water Forum, Accra, Ghana, 2011;accessed@  
<http://ghanawaterforum.org>
42. Mason, H.C. and Perreault, D.W. Jr. (1991) Collinearity, Power, and Interpretation of Multiple Regression Analysis, Journal of Marketing Research, Vol. 28, No.3 (Aug.,1991),270.
43. McFadden, D. (1974), "Conditional Logit Analysis of Qualitative Choice Behavior." Frontiers in Econometrics, ed. by P. Zarembka, Academic Press, New York.
44. McFadden, D. (1995) Computing Willingness-To-Pay in Random Utility Models, Department of Economics, University of California, Berkeley.
45. Melby, P. (2006), Rainwater Harvesting for Potable Water Use, Department of Landscape Architecture. Accessed@  
<http://fwrc.msstate.edu/housing/images/potable.pdf>
46. Merrett, S. (2002), 'Deconstructing Households' Willingness-to-pay for Water in Low-income Countries', Water Policy 4, 157–172
47. Mitchell, R.C. and Carson R. T. (1989). Using surveys to value public goods: the contingent valuation method. Washington, D.C.: Resources for the Future.
48. Nsiah-Gyabaah, K(2002), The Looming National Dilemma of Water Crisis in Peri Urban Areas in Ghana, accessed at [http://www.gg.rhul.ac.uk/kumasi/Project\\_Related\\_Papers/Cedar\\_IRNR/Paper\\_7/3/3.html](http://www.gg.rhul.ac.uk/kumasi/Project_Related_Papers/Cedar_IRNR/Paper_7/3/3.html)
49. Porto, M (2004) Human Health and Sanitation; Water and Ethics; Vol.:Essay 6, United Nations Educational, Scientific and Cultural Organisation, France.
50. Quartey, J.D. (2011) Towards a Sustainable Allocation of Potable Water in Ghana: Evidence from Kumasi Ministry of Water Resources, Works and Housing, Ghana Water Journal Forum 1<sup>st</sup> Edition, Pg 194.

51. Schmidt, M. and Murphy, K. (2010) Proceedings of the 13<sup>th</sup> International Conference on Artificial Intelligence and Statistics (AISTATS), Chia Laguna Resort, Sardinia, Italy. Volume 9 of JMLR: W&CP 9.
52. Shutz, S.D., Lindsay, B.E. (1990). The Willingness to pay for groundwater protection, *Water Resources Research*, 20(2):1869-75
53. Siabi W.K, Van-Ess R.K.D, Engmann C, Mensah T, Tagoe M. (Sept. 2008) Rainwater Harvesting, Last Water Supply Option for Small Communities and Institutions in Difficult Hydro-geological Formations. [www.cwsagh.Org/downloads/rainwater\\_harvesting.pdf](http://www.cwsagh.Org/downloads/rainwater_harvesting.pdf). Accessed on 13th Oct., 2012.
54. Smith, V.K., (1992). Non-market Valuation of Environmental Resources an interpretative essay in Bateman I.J., and Turner, R.K., (1992) Evaluation of the Environment: The Contingent Valuation Method, CSERGE Working Paper GEC 92-18.
55. Soto Monte de Oca, G., Bateman, J.I., Tinch, R., and Moffatt G.P (2003) Assessing the Willingness to Pay for Maintained and Improved Water Supplies in Mexico City, The Centre for Social and Economic Research on the Global Environment (CSERGE) Working Paper ECM 03-11
56. Turner, R.K., Bateman, I.J. and Pearce, D.W. (1992). United Kingdom. In. Navrud, S. (ed) Valuing the Environment: The European Experience, Scandinavian University Press, Oslo.
57. Wedgewood, A. and Samson, K. (2003) Willingness-to-pay Survey-A Streamlined Approach; Water, Engineering and Development Center, Loughborough University, UK.
58. Whittington, D. (1998), 'Administering Contingent Valuation Questions in Developing Countries', *World Development* 26(1), 21-30.
59. Whittington, D., Briscoe, J., Mu, X., Barron, W., (1990). Estimating the Willingness to pay for Water Services in Developing Countries: A Case Study of Contingent Valuation Surveys in Southern Haiti. *Economic Development and Cultural Change in Binam Joachim Nyemeck, Nkama Arsène and Nkendah Robertn* (2003), 'Estimating the willingness to pay for community health prepayment schemes in rural area': A case study of the use of contingent valuation surveys in centre Cameroon. University of Yaoundé II, Faculty of Economic Sciences and Management. pg 1-25.
60. Wooldridge J.M. (2002), *Econometric Analysis of Cross Section and Panel Data*, Massachusetts: MIT Press.
61. World Bank (Water Demand Research Team, Jan. 1993) *The Demand for Water in Rural Areas: Determinants and Policy Implications*, The World Bank Research Observer, vol.8, No. 1, pp. 47-70.

### Appendix 1a

Marginal effects after oprobit  
 $y = \text{Pr}(wtp=1)$  (predict, outcome(1))  
= .88738422

variable	dy/dx	Std. Err.	z	P> z	[ 95% C.I. ]	x
gender*	-.0100208	.00909	-1.10	0.270	-.02783 .007788	.648208
ms*	.0129661	.01574	0.82	0.410	-.01789 .043822	.67101
minors	.0055184	.00458	1.20	0.228	-.003459 .014496	2.41368
educat~n*	-.0088277	.01032	-0.86	0.392	-.029053 .011398	.736156
occupa~y*	-.0082737	.01298	-0.64	0.524	-.03371 .017163	.732899
income	-.0000573	.00282	-0.02	0.984	-.005577 .005463	2.07166
urwdu*	.0112204	.02848	0.39	0.694	-.044601 .067042	.827362
pfmt*	.6222925	.06653	9.35	0.000	.491889 .752696	.801303

(\*) dy/dx is for discrete change of dummy variable from 0 to 1

### Appendix 1d

Marginal effects after oprobit  
 $y = \text{Pr}(wtp=2)$  (predict, outcome(2))  
= .01664986

variable	dy/dx	Std. Err.	z	P> z	[ 95% C.I. ]	x
gender*	-.0078496	.00668	-1.18	0.240	-.020936 .005237	.648208
ms*	.0058523	.00553	1.06	0.290	-.004984 .016689	.67101
minors	.0031676	.00216	1.47	0.143	-.001066 .007401	2.41368
educat~n*	-.011776	.00812	-1.45	0.147	-.027685 .004133	.736156
occupa~y*	-.01493	.00846	-1.76	0.078	-.031521 .001661	.732899
income	-.0000329	.00162	-0.02	0.984	-.003201 .003135	2.07166
urwdu*	-.0249145	.01387	-1.80	0.072	-.052099 .00227	.827362
pfmt*	.0390957	.01222	3.20	0.001	.015138 .063054	.801303

(\*) dy/dx is for discrete change of dummy variable from 0 to 1

### Appendix 1e

Marginal effects after oprobit  
 $y = \text{Pr}(wtp=3)$  (predict, outcome(3))  
= .01327614

variable	dy/dx	Std. Err.	z	P> z	[ 95% C.I. ]	x
gender*	-.0073199	.00636	-1.15	0.250	-.019782 .005143	.648208
ms*	.0053201	.00503	1.06	0.290	-.004543 .015183	.67101
minors	.0029086	.00202	1.44	0.149	-.001046 .006863	2.41368
educat~n*	-.0111894	.00806	-1.39	0.165	-.026981 .004603	.736156
occupa~y*	-.0143187	.00851	-1.68	0.092	-.030998 .00236	.732899
income	-.0000302	.00148	-0.02	0.984	-.002939 .002878	2.07166
urwdu*	-.0250706	.015	-1.67	0.095	-.054479 .004337	.827362
pfmt*	.036289	.01256	2.89	0.004	.011675 .060902	.801303

(\*) dy/dx is for discrete change of dummy variable from 0 to 1

### Appendix 1f

Marginal effects after oprobit  
 $y = \text{Pr}(wtp=4)$  (predict, outcome(4))  
= .00933788

variable	dy/dx	Std. Err.	z	P> z	[ 95% C.I. ]	x
gender*	-.0066189	.00601	-1.10	0.271	-.018394 .005156	.648208
ms*	.0045871	.00433	1.06	0.290	-.003907 .013081	.67101
minors	.0025516	.00177	1.44	0.149	-.000911 .006014	2.41368
educat~n*	-.0104952	.00783	-1.34	0.180	-.025839 .004849	.736156
occupa~y*	-.0136909	.00855	-1.60	0.109	-.030446 .003064	.732899
income	-.0000265	.0013	-0.02	0.984	-.002578 .002525	2.07166
urwdu*	-.0264146	.01773	-1.49	0.136	-.061168 .008338	.827362
pfmt*	.0343508	.0127	2.71	0.007	.009462 .05924	.801303

(\*) dy/dx is for discrete change of dummy variable from 0 to 1

## Appendix 2: Diagnostic Test

### Appendix 2a

- **Multicollinearity with Variance Inflation Factor(VIF)**

VIF=1/tolerance, where tolerance is  $1-R^2=1-0.31=0.69$ .  $VIF=1/0.69=1.45$  or  $1.5$ .<sup>12</sup> where  $R_j^2$  is the coefficient of determination of a regression of explanator j on all the other explanators. A tolerance of less than 0.20 or 0.10 and/or a VIF of 5 or 10 and above indicates a multicollinearity problem (but see O'Brien 2007)”

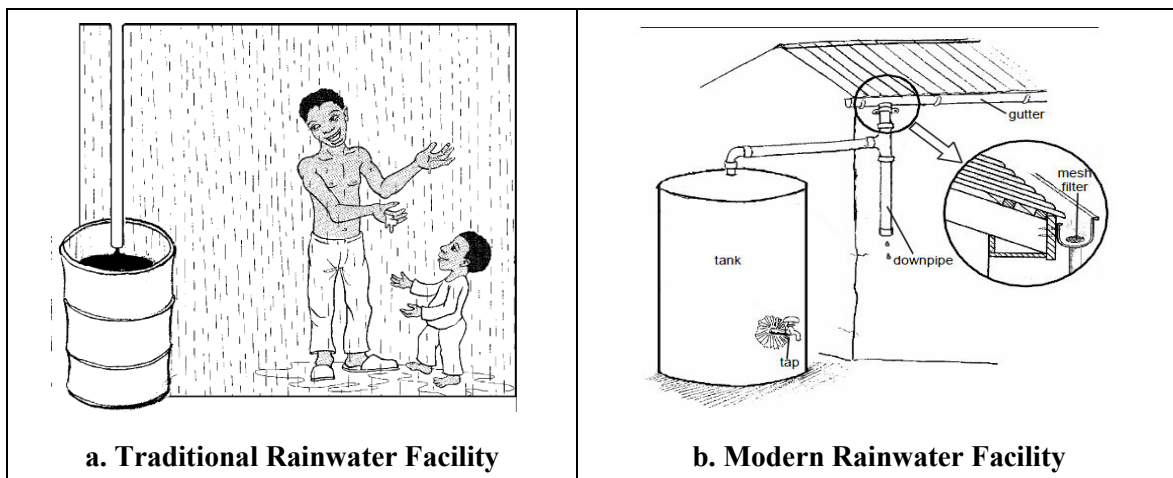
### Appendix 2b

- **Spearman’s Correlation Test**

. spearman gender ms minors education occupation income urwdu pfmt, stats(rho obs p)

Key									
rho									
Number of obs									
Sig. level									
	gender	ms	minors	educat-n	occupa-n	income	urwdu	pfmt	
gender	1.0000 307								
ms	0.2101 307 0.0002	1.0000 307							
minors	0.0953 307 0.0956	0.0330 307 0.5651	1.0000 307						
education	0.2555 307 0.0000	0.0213 307 0.7106	-0.0689 307 0.2284	1.0000 307					
occupation	-0.0131 307 0.8198	-0.0467 307 0.4154	-0.0626 307 0.2740	0.1731 307 0.0023	1.0000 307				
income	0.1737 307 0.0023	0.2688 307 0.0000	0.0164 307 0.7749	0.0621 307 0.2783	0.0333 307 0.5611	1.0000 307			
urwdu	-0.0477 307 0.4046	0.0837 307 0.1434	0.0979 307 0.0867	-0.0388 307 0.4983	-0.0420 307 0.4634	0.0103 307 0.8580	1.0000 307		
pfmt	0.0092 307 0.8719	0.0162 307 0.7776	0.0887 307 0.1211	-0.0017 307 0.9756	-0.0239 307 0.6771	0.0402 307 0.4833	0.5069 307 0.0000	1.0000 307	

### Appendix 3



Source: Janette Worm and Tim van Hattum. “Rainwater harvesting for domestic use”: Agromisa Foundation and CTA, Wageningen, 2006.

<sup>12</sup> <http://en.wikipedia.org/wiki/Multicollinearity>

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