Domestic water uses and value in Swaziland: A contingent valuation approach

By

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DEDICATIONS

This dissertation is dedicated to my devoted and loving family; Mom, Dad, Thabani, Thapelo, my late sister Nellie and her husband and to my most beloved son Malungelo.

Special dedications to one extraordinary person in my life, without whom I think I would never have achieved this. Thank you very much for supporting me spiritually, emotionally and otherwise.

It is also dedicated to all my friends and colleagues.

"Thank you very much for the constant support, words of encouragement you provided and the constant love you have shown towards completion of this endeavour. May the almighty God release a torrent of wonderful blessing and be close to your hearts now and always. I love you all."

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Without your support, this project would not have been possible.

DECLARATION

I declare that the thesis hereby submitted in partial fulfilment for the requirements of the degree Master of Science (Agricultural Economics) at the University of Pretoria has not been submitted by me for any other degree at any other institution.

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DOMESTIC WATER USES AND VALUE IN SWAZILAND: A CONTINGENT VALUATION APPROACH.

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ABSTRACT

One of the greatest challenges facing developing countries is the provision of basic services and infrastructure. Provision of these services and infrastructure in these countries is often characterised by ineffectiveness, low quality, inaccessibility and unreliability**.** One basic service that has proven to be particularly problematic is the provision of water and sanitation, Poor delivery of this service affecting and is affected by the level of economic development of any nation.

The main objectives of this study are to determine how much Swazi households are willing to pay (WTP) for an improvement in their water quality and quantity[1] as well as establishing the possible factors affecting this WTP. This will help to put in monetary terms the value of good quality and quantity of domestic water in Swaziland as well as factors that affect this monetary value.

The study used the Contingent Valuation Method (CVM) to evaluate improvements in domestic water quality and quantity, based on households' perception of domestic water in Swaziland. The method involved an analysis of the factors determining households' WTP for improved domestic water quality, quantity and the health risk concern from using it. The project covered the eleven main towns of Swaziland with a sample taken from both the rural and urban areas of the towns.

[1] Improved quantity implies *increased* quantity

The results obtained indicated that the WTP for the domestic water quality and quantity improvements is small but significant. There were more households in the rural areas willing to pay for improvements in the quality (67%) of water than in the urban areas (20%). The same trend was observed for the willingness to pay for water quantity. Approximately 58% of households in the rural areas and 6% of households in the urban areas were willing to pay for increased water quantity. However, the rural households were willing to pay on average an amount of E6.44 for improved water quality per month, which was much lower than the average amount urban households were willing to pay (E16.40). In contrast households in the rural area were more willing to pay for increased quantities (E7.13) than households in the urban areas (E6.82), albeit the small difference between the figures.

On average the rural households were consuming less water ($0.92m^3$) per month than their urban counterparts ($6.92m^3$). Rural household heads earned an average income of E1269.49 made up a per capita mean income of E200[2]. Urban households heads' average income was E4830 and the per capita mean income was E1092.00. Moreover, the survey results show that people aware of health hazards brought about by using unhealthy water are inclined to conserve the water quality by paying a fee for it.

Not all the households were willing to pay for improvements in water services. In the urban areas, these were households that were satisfied with the status of the water condition (94%). And in the rural areas these were households that could not afford to pay for improvements (42%). In the latter case, the households mainly use non-monetary transactions for the exchange of services and goods and have never paid for water services before. They believed that access to adequate water quality and quantity was a basic right that should be provided by the government. In addition they did not trust their local authorities and believed that if they were to pay for improve water services their money would not be used accordingly.

[2] Mean income per household member

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIX

LIST OF ACCRONYMS

CEEPA	Centre for Environmental Economics and Policy in Africa
CVM	Contingent Valuation Method
DWA	Department of Water Affairs
DNWP	Draft National Water Policy
E	Emalangeni- Swaziland currency
FA	factor analysis
GOS	Government of Swaziland
GDP	Gross Domestic Product
LCA	latent class analysis
LPA	latent profile analysis
LTA	latent trait analysis
NGO	Non Governmental Organisations
NOAA	National Oceanic and Atmospheric Administration
NWA	National Water Authority
OLS	Ordinary Least Squares
RSA	Republic of South Africa
SACU	Southern African Customs Union
SEAP	Swaziland Environmental Action Plan
SNL	Swazi Nation Land
SWA	Swaziland Water Act

TDL	Title Deed Land
WRMP	Water Resources Master Plan
WHO	World Health Organisation
WTP	Willingness to Pay
WTA	Willingness to Accept.

CHAPTER 1

1 INTRODUCTION

1.1 Introduction and background

Swaziland is a water-stressed country that does not have adequate supply of water even though water is considered a very important natural resource that contributes a lot to national development. According to IIED (2000), about 40% of the people in Swaziland are living below the poverty datum line, especially those in rural areas. They do not have ready access to adequate and safe water supply and sanitation facilities. Consequently, about 20 000 people in the country are killed by water related or water borne diseases because of a combination of poor water quality and insufficient quantity (IIED, 2000).

Poor access to safe water is at the centre of the poverty trap in Swaziland (World Health Organisation (WHO), 2002). This is especially the case for women and children who usually have to carry the water over long distances. Consequently, this leads to a vicious cycle where the poor's access to safe and clean domestic water is one of the causes of poverty and poverty is also often the primary obstacle to the provision of domestic water (WHO, 2002). The issue of poor access and low quality water is therefore of considerable interest in the country, where the need to achieve sustainable development, the fulfilment of basic human needs as well as environmental requirements has been made a priority (Government of Swaziland (GOS), 2003). Some forty million hours are spent each year collecting domestic water and performing health risk avoidance measures such as boiling and filtering the water by households in rural Swaziland alone (World Bank, 1998).

A variety of physical, chemical and biological agents also render water sources less than wholesome for human consumption in Swaziland (WHO, 2003). This view is corroborated by evidence from a study by Simelane (2000), which concluded that residues of some herbicides (such as atrazine and metribuzin) were present in the surface water and groundwater of Swaziland. This study also concluded that the water is salty and usually contaminated with faecal sediments since the households in rural areas do not have proper sanitation measures. The bush is usually used as a substitute, thus the faecal sediments are washed into the river, giving rise to diseases such as cholera and dysentery. Generally, health hazards resulting from waterborne epidemics are due to poor management of water resources, although adverse natural conditions can also be causal factors (WHO, 2003).

The state of water in Swaziland is generally perceived as being contaminated, water stressed and that main users are competing for the resource (GOS, 2003). Considering this current state of water use, it becomes important to study the economic value that households place on domestic water quality and quantity. Thus the main objectives of this study are to determine how much households are willing to pay (WTP) for an improvement in their water quality and quantity as well as establishing the possible factors affecting this WTP. This will help to put in monetary terms the value of good quality and quantity of domestic water in the country as well as factors that affect this monetary value. This exercise is essential for providing information that policymakers may find useful in implementing the available Water Act (GOS, 2004).

1.2 Problem statement

Water is increasingly becoming a scarce resource in Swaziland (World Bank, 1993). Despite the fact that Swaziland is a country traversed by five major rivers with mean annual rainfall ranges of 550 to 625 mm in the lowveld and 850 to 1400 mm in the highveld, water is one of the major constraints to development (GOS, 2003a). A high proportion of the population (47%) residing in rural and peri-urban areas do not have access to safe and clean water (GOS, 2003b). According to the 2002 Demographic and Household Survey, only 28% of the rural residents had access to safe potable water as opposed to about 89% in the urban areas (GOS, 2003a). National health statistics in the country show that some infant mortality is related to water borne diseases, which is a reflection of the poor quality of water. This has also been evident from the 2003 outbreak of typhoid in rural areas, which resulted in the death of six people, four of whom were children (WHO, 2003).

As the population increases, both within Swaziland and in the surrounding regions, better management of water resources is required in order to ensure its continued availability. At the projected population growth of 0.4% and the low economic growth rates (GOS, 2003a), it is unlikely that the projected demand on water resources in Swaziland will be satisfied. According to WHO (2002), there is degradation of water catchment areas due to human settlement and development. Total dissolved solids in major rivers are less than 150 mg/l, which are within the WHO accepted standards[3]. However, surface waters are unsafe for human consumption due to faecal contamination and the presence of bilharzia blood fluke (Simelane, 2000; WHO, 2002). At present many water resources are polluted by industrial effluents, domestic and commercial sewage, acid mine drainage, agricultural runoff and litter (Simelane, 2000; Seetal and Perkins 2003). In addition, Swaziland's available freshwater resources are already almost fully utilized and under stress (Seetal and Quibell, 2003)

With regards to domestic water supplies in the urban areas, 83% of the population is provided with treated water and 60% of the population has access to water-borne sewerage systems or septic tanks. In the rural areas, in spite of substantial investment, coverage levels remain low largely because of poor maintenance of existing water systems (GOS, 2003a). Thus, real water coverage in rural areas is approximately 30%. The majority of river gauging stations are not functional and water equipment is outdated (WHO, 2002). Therefore regular monitoring of the levels of pollution is also poor.

1.3 Objectives of the Study

As mentioned before, water is becoming an increasingly limited resource in terms of both the quantity and the quality and that its supply will become a major restriction to the future socio-economic development of the country. Accessible and good quality water resources are therefore a major concern of this study. With this background in mind, the objective of this study is to evaluate in monetary terms a subjective value of domestic water based on the households' attitude to domestic water quality, quantity and an appropriate health risk concern.

[3] Total dissolved solids in rivers should be below200mg/l (WHO, 2002)

Changes in the quality of the environment brought about by reducing the pollution of water can lead to a decrease in the incidence of disease, reduced impairment of activities and possibly increased life expectancy. The purpose of this analysis is to describe the households' perceptions of the reduction in health risks that can be attributed to improved domestic water quality and quantity. According to economic models of an individual's choice, a household's observed trade-off between income and health is interpreted as a measure of the household's willingness-to-pay (WTP) for improvements in their health (Whittington et al. 1992). This study uses this same intuition to evaluate WTP for water. In other words, that a household's observed trade-off between income and improved water quality (quantity) can represent a measure of the household's WTP for improvements in water quality (quantity).

Very little is known about how specific attributes of water contribute to the amenity values people place on water services. Towards this end, this study collected and analysed survey data describing how household preferences and values for improvements in water quality and quantity are affected by different attributes[4] of the households. The study also seeks to identify policy issues underpinning the differences in water availability and utilisation at household level.

In summary, the study will:

1. Quantify the willingness to pay for improved water quality and quantity by the Swazi households in both rural and urban areas;
2. Investigate the determinants of this willingness to pay;
3. Suggest economic instruments to encourage mechanisms for facilitating this willingness to pay.

[4] Including socio-economic characteristics and perceptions

1.4 Hypotheses

Based on a survey of the literature, this study forms the following hypotheses:

1. Households without an immediate supply of water have a higher WTP for a more readily available and closer source than their counterparts with such a service (Banda et al. (2004); (Alaba, 2001) and (Altaf and Hughes, 1994)
2. Households that have poor quality water services have a higher WTP for improved water quality than their counterparts. Those with satisfactory water quality would be WTP less or none at all, thus maintaining their status quo (Whittington et al. 1989 and 1992).
3. Households that have a higher consumption of water have a higher WTP for a closer and readily available source of water to avoid travelling long distances to fetch the water (Altaf et al.1993).
4. Households that have higher income would demand better water services and thus have a higher WTP for its improvement (since financial resources are not a major constraint) (Whittington et al. 1991 and 1990).
5. Households' WTP depends on information available to the respondents during the interview. For instance, households that have information about negative effects and the current level of pollution would have a higher WTP for abatement technologies (Kolstad, 2002 and Choe et al. 1996).
6. WTP for quality and quantity of water depends on the opportunity cost of the time spent fetching water (Alaba, 2001 and Altaf and Hughes, 1994).

1.5 Organisation of the study

The study is organised into six chapters. Chapter 1 has laid out the background and objectives of this study. It has also discussed the hypotheses to be tested in this study.

Chapter 2 discusses the literature in this subject area. It focuses not only on the main method of contingent valuation used but also on studies that have been done elsewhere utilising this method. The chapter ends by drawing relevant lessons for this study drawn from the literature.

Chapter 3 gives a detailed explanation of the methodology used. It discusses issues pertaining to research design, data collection and analysis as well as the model used.

Chapter 4 is devoted to the results emanating from the study and their interpretations. It also contains a discussion of these results in terms of comparison to other researchers' findings as well as pointing to policy implications of these results.

Finally, Chapter 5 gives a summary of the study and discusses its policy implications. It concludes by pointing to possible areas of future research.

CHAPTER 2

2 LITERATURE REVIEW

2.1 Introduction

Environmental valuation and analysis of natural resources is important because natural resources often have the characteristics of public goods and generate externalities, which render their market prices unreliable (Whittington et al. 1991). There is a need to obtain values of environmental resources in order to identify or at least approximate a socially optimal decision (Kolstad, 2002). It is also important to demonstrate the net gains from environmental policy that do not show up as immediate monetary gains (Whittington et al. 1992). The main concern is with the economic value defined in a broad sense with a focus on utilitarian views (Morrison et al. 1996). This chapter reviews related literature on contingent valuation as it is applied to eliciting willingness to pay for water. The first part of the chapter will look at the theoretical basis of valuation. The second part will then give a review of the related empirical literature. In all instances, relevance to the current study is drawn.

2.2 Theoretical basis for the contingent valuation technique

Contingent valuation is a survey based economic technique for the valuation of non-market resources, typically environmental resources. While these resources do give consumers utility, certain aspects of them do not have a market value, as they are not directly sold. For example, consumers receive benefit from using uncontaminated and readily available water, but these attributes would be difficult to value. Contingent valuation surveys are one technique used to measure these aspects.

The method is called “contingent valuation” because it determines the value of a resource by asking how much they would be willing to pay for it under certain circumstances. It directly asks people what they are willing to pay for a benefit and or willing to receive in compensation for tolerating a cost through a survey or questionnaire. Personal valuations for increases or decreases in the quality of some good are obtained contingent upon a hypothetical market. The aim is to elicit valuations or bids that are close to what would be revealed if an actual market existed.

The contingent valuation method is referred to as a “stated preference” method, because it asks people to directly state their values, rather than inferring values from actual choices as the “revealed preference” methods do. According to Carson et al. (1994), the fact that contingent valuation is based on what people say they would do, as opposed to what people are observed to do, is the source of its greatest strengths and its greatest weaknesses.

In a CVM values are generally measured based on the WTP for improved environment or the willingness to accept (WTA) compensation for damaged environment or to accept a condition of being deprived of the improved environment (Frykblom, 1997). According to Frykblom (1997), the most appealing aspect of the contingent valuation method is that it allows an estimate of the total value rather than components of that total value, where the non market value of the environmental good can either be existence, option or bequest value.

A CVM usually involves designing a questionnaire where respondents are presented with material, often in the course of personal interviews conducted face to face. According to Frykblom (1997), the CVM should include a detailed description of the good(s) being valued and a hypothetical circumstance under which it is made available to the respondent; questions which elicit the respondents’ WTP (WTA) for the good(s) being valued; and questions about respondents’ characteristics, their preferences relevant to the good(s) being valued and their use of the good(s).

The contingent valuation method must be applied in a clear context and services provided by any improved environmental attributes have to be made known to respondents involved in the process of valuation. Emphasis must be paid on the design of the survey to make sure that aspects that could potentially affect the outcome of the contingent valuation method are taken into consideration (Oates, 1994).

Value elicitation formats include open ended; bidding game; payment cards; dichotomous or discrete choice contingent valuation. The survey may be administered in person (face-to-face); by telephone; mail or recently email. Issues to take into consideration include pre-testing, questionnaires, careful selection and training of interviewers, ethical considerations, role of culture and tradition of the area being surveyed (Whittington, 2002a).

One way of assessing the validity of results generated from the use of CVM is through the analysis of response sensitivity to factors expected to have an influence. Scope testing is done and it involves presenting at least two alternative impact scenarios to population sub-samples and testing for differences between estimates generated (Bennett et al. n.d.). There is also the problem of the embedding effect with CVM studies (Kahneman and Knetch, 1992a), which is said to occur when a CVM estimate of a non-market value is lower when it is valued as part of a more inclusive good than when it is valued alone. The impact of the embedding effect according to Kahneman and Knetch (1992a) is that CVM estimates of non-market values are unreliable. Specifically they hypothesise that people respond to CVM questions in order to enjoy from the warm glow of giving. Hence, their responses relate not simply to the value they enjoy from a non-marketed good, but rather are confounded by the value they enjoy from the process of participating (Bennett et al. n.d.). In Bennett et al. (n.d.), it is further explained that because of this confounding, values estimated through CVM applications are hypothesised to be largely invariant of factors that would be *a priori* be expected to have an influence.

Carson (1995) in seeking to clarify the notion of embedding argued that Kahneman and Knetsch's (1992a) view fail to specify correctly the nature of the issues involved. Carson (1995) then recognised two separate components of the embedding effect. The first one was the regular embedding effect, which rises when the embedding of substitute goods under an umbrella good results in respondents lowering their marginal values for successive units of the substitutes. Comparing marginal value estimates from different sequences will therefore produce apparent inconsistencies, which are simply reflections of the substitutability of the goods in question (Carson, 1995).

The second component of the embedding effect was the perfect embedding effect. This is the situation where only the warm glow of giving is reflected in individual CVM responses (Carson, 1995). Hence, if perfect embedding is present, respondents will be insensitive to the scope of the good they are asked to value (Bennett et al. n.d).

2.2.1 Historical development of CVM

The history of published references to the CVM can be traced back to 1947 when Ciriacy-Wantrup (1947) wrote about the benefits of preventing soil erosion. In this study it was observed that some of the complimentary effects, like reduced siltation of streams were public goods. It was then suggested that one way of obtaining information on the demand for these goods would be to ask individuals directly how much they would be WTP for successive increments. However, this was never implemented directly and it was almost two decades later that the CVM began to be applied in academic research (Portney, 1994). The first CVM was designed and implemented by Davis (1963), who was trying to elicit the value to hunters and wilderness lovers of a particular recreational area. To test how reasonable the findings of this study were, Davis (1963) compared them with an estimate of WTP that was based on the travel cost approach (Davis, 1963). The result was that the travel cost method of estimating WTP for visitors to a recreation area provided a similar answer to the CVM done.

The publication "Conservation Reconsidered" by Krutilla (1967) is considered by many to be one of the most influential papers in the natural resource and environmental economics sub discipline (Portney, 1994). Krutilla (1967) identified the importance of the essentially irreversible nature of the developments of natural environments and suggested that the divergence between WTP and willingness to accept (WTA) compensation may be especially large. The study also raised the possibility of what is known as existence value[5], which is sometimes referred to as non-use or passive value to suggest that the utility derived does not depend on any direct or indirect interaction with the resource or good in question.

[5] Existence value is the value individuals may attach to the mere knowledge that rare and diverse species, unique natural environments, or other goods exist even if they do not want to benefit directly from them.

Other researchers such as Ridker (1967) then followed and used the CVM to elicit individual's WTP for reduction in household soiling and cleaning. Similarly, Hammack and Brown (1974) conducted a CVM on the right to hunt waterfowl while Cicchetti and Smith (1973) looked at the WTP for reduced congestion in wilderness areas. Bishop and Heberlein (1979) used the method to get the value of duck hunting permits. The CVM has also been used in other branches of economics as well. These include Acton (1973) on the risk of death from heart attack, Krupnick and Cropper (1992) on reduced risk of respiratory disease and Devine and Marion (1979) on improved information about grocery store prices.

It is argued though in Portney (1994) that while such studies formed a sort of academic industry, none of them were designed or implemented with litigation in mind. It was not until the late 1980s that contingent valuation studies began to receive the kind of examination normally devoted to the evidence in other areas such as legal proceedings. In the 1980's the method rose to high prominence when government agencies were given the power to sue for damage to environmental resources that they were trustees over (Carson et al. 1994). These types of damages, which they were unable to recover, included non-use or existence values. It was difficult to assess existence values through market mechanisms thus the contingent surveys were suggested to assess them. During this time the United States Environmental Protection Agency (EPA) convened an important conference with an aim to recommend guidelines for survey design (Arrow et al. 1993). The Exxon Valdez Oil spill in Prince William Sound was the first case where contingent valuation surveys were used in a quantitative assessment of damages and the use of the technique has spread from there.

2.2.2 Controversies

Many economists question the use of stated preference to determine willingness to pay for a good, preferring to rely on people's revealed preferences in binding market transactions (Hanemann, 1994). Early contingent valuation surveys were often open ended questions of the form "how much compensation would you demand for the destruction of X area" or "how much would you pay to preserve X". Such surveys potentially suffer from a number of shortcomings; strategic behaviour, protest answers, response bias and respondents ignoring income constraints. Some surveys results seemed to indicate people were expressing a general preference for environmental spending in their answers, described as the embedding effect by detractors of the method (Diamond and Hausman, 1994).

2.2.3 The NOAA panel

In response to criticisms of contingent valuation surveys, a panel of high profile economists (chaired by Nobel Prize laureates Kenneth Arrow and Robert Solow) was convened under the auspices of the National Oceanic and Atmospheric Administration (NOAA) in 1993 to conduct hearings on the validity of the method in 1992. This was also to give guidelines on the use of CVM, especially regarding non-use values. The panel heard evidence from 22 expert economists and published its results in 1995 (NOAA, 1993). The importance of the scope sensitivity test was reinforced by this panel with the recommendation that contingent valuation surveys should be carefully designed and controlled due to the inherent difficulties in eliciting accurate economic values through survey methods (Hausman, 1993).

The NOAA panel also stated that CVM could produce estimates reliable enough to be the starting point of a sensible process of damage assessment, including lost passive (non-use) values (Arrow et al. 1993). They suggested that as long as the study is well designed, the CVM is a reliable tool. Specifically and amongst other recommendations, they suggested that unreliable findings would be generated if inadequate responsiveness to the scope of environmental damage were found.

The panel offered its approval of CVM methods subject to a number of guidelines. The guidelines as discussed by Arrow et al. (1993) were that for a single dichotomous question (yes or no type) format, a total sample size of at least 1000 respondents is required. However this figure was derived from the American context. Such a large sample may not be necessary for a small country like Swaziland.

Clustering and stratification issues should be accounted for and random sub-sampling will be required to obtain a bid curve and to test for interviewer and wording biases. The authors further added that face-to-face interviewing is likely to yield the most reliable results and cases with high non-response rates would render the survey unreliable. The report also concluded that pilot surveying and pre-testing are essential elements in any CVM study and underestimation of WTP/WTA is to be preferred to overestimation of WTP/WTA although a WTP format is favoured (Arrow et al. 1993).

The report concluded that accurate information on the valuation situation must be presented to respondents and they must be reminded of the status of any undamaged possible substitute commodities. Averaging across independently drawn samples taken at different points in time should reduce time dependent measurement noise. A "no-answer" option should be explicitly allowed in addition to the "yes" and "no" vote options on the main valuation question. Yes and no responses should be followed up by the open-ended question like "why did you vote yes/no?" For cross-tabulations the survey should include a variety of other questions that help to interpret the responses to the valuation question, such as income, distance to the site and prior knowledge of the site (Arrow et al. 1993).

2.2.4 Why Use the Contingent Valuation Method

The CVM was selected in this case because of the importance of non-use values and their potentially significant levels where other methods such as the travel cost method will underestimate the benefits of preserving the non market value, in this case water. It is worth noting that environmental valuation and analysis is important because in balancing the costs of public goods against their benefits, informed policy choices can be made (Mitchell and Carson, 1989).

The main problem is that it has proven difficult to value non-market goods such as water in the past. Yet it is important that these non market values are captured if policy recommendations on resource allocation are to be well grounded in economic principles. A similar view is shared by Carson et al. (1994) where it is stated that it was important for analysts to estimate the value of non-market commodities in order to fully assess the economic desirability of environmental policies. This is mainly because overlooking or ignoring the services provided by non-market commodities in cost-benefit analyses and other empirical economic studies severely undermine the accuracy and relevance of the results. The contingent valuation method (CVM) offers the most promising approach for determining public WTP for many public goods and is an approach likely to succeed if used carefully (Mitchell and Carson, 1989).

2.2.5 Sources of potential biases

Although the study was designed and carried out with utmost care, it is possible that it may have been affected by a number of factors. These factors will be outlined below. A study by Farrington (2003) has shown the possible experimental biases that can be expected from doing a CVM survey. These biases are outlined below:

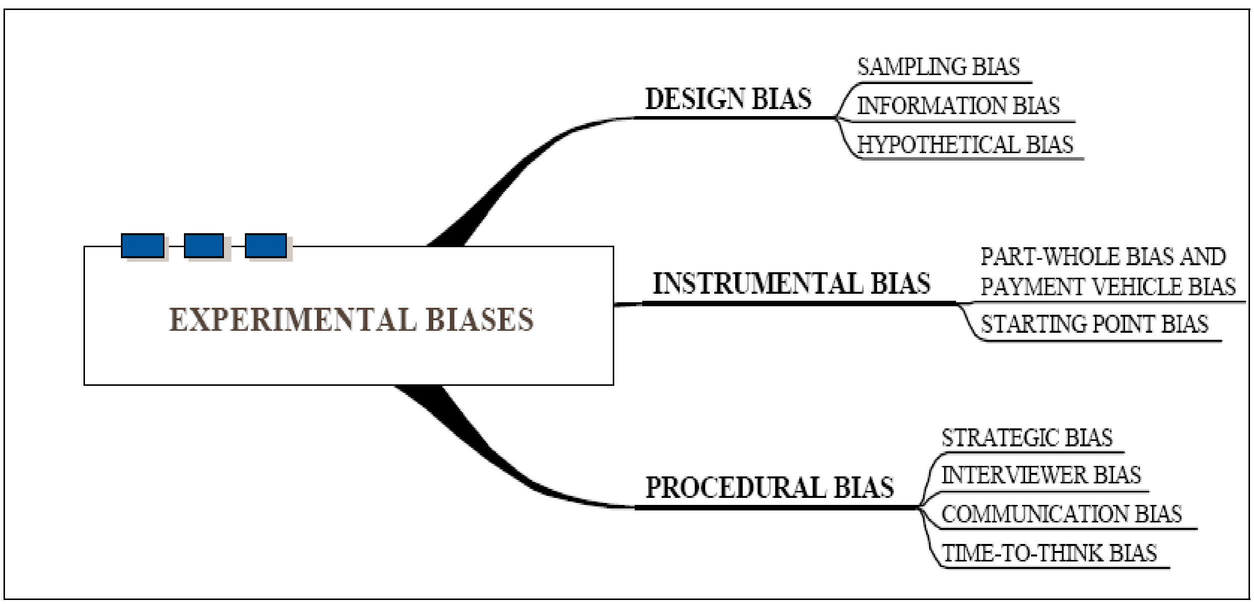

Figure 2.1: Sources of potential biases

(Adapted from Farrington, 2003)

2.2.5.1 Sampling bias

One major problem for CVM studies is small sample sizes. According to Farrington (2003) a small sample size means that each individual response has a much greater weighting in both calculations of the mean and in correlation analyses, such that underlying trends and relationships are not revealed. However, this was not a problem for this study as the sample size is large enough for the intended purpose, and thus overcoming the sampling bias.

2.2.5.2 Information bias

In Farrington (2003) information bias is usually the most significant bias. This is because an increase in information given to respondents would allow them to think more comprehensively about the cost and benefits accruing from the proposal for them and their families (Farrington, 2003). This was not likely to be the case for this study as enough information was given prior to the interview.

2.2.5.3 Hypothetical Bias

Whittington (1998) states that a good contingent valuation scenario is designed to be realistic and for respondents to take the hypothetical choice seriously. In practice, the more serious the respondent considers the choice posed, the less hypothetical the scenario is likely to seem (Whittington, 1998). Some of the respondents may have found the hypothetical scenario unrealistic and gave unrealistic WTP answers. This might explain the observed low WTP for improvements in water services by rural households. They could have viewed the prospect of having these improvements as being unlikely.

2.2.5.4 Strategic bias

When seeing that the interviewer was a student from the University of Swaziland, respondents may have modified their answers thinking that it would increase their chances of getting better water services. This is because respondents may perceive the university as being linked to or as a research arm of the government. Thus respondents may believe that strategically modifying facts may improve the chances of obtaining improved water services. Also, numerous other government surveys have been conducted in the same areas, which may lead to respondents in rural areas associating any survey with the government.

2.2.5.5 Part-whole bias

Part-whole bias occurs when the value estimates of whole goods (improved water services) or composite goods are found to be the same as the value estimates of parts of the goods. In other words the scope of water has no impact on the value estimates generated. The explanation of part whole bias is extended beyond the warm glow effect to include factors such as a lack of familiarity regarding the improvements in water services on the part of respondents, changes in the likelihood of provision and an inability of respondents to distinguish between small changes in a good (Farrington, 2003 and Bennett et al. n.d). This bias was however not likely to occur for this study as the respondents were familiar with the benefits and/ or consequences of improved water services in their communities, and thus gave answers that reflected their true feelings about the water situation.

2.2.5.6 Interviewer bias

Interviewer bias occurs when the respondent's impression of the interviewer affects the answers that the respondents give (Frykblom, 1997). University students are highly regarded in rural areas, this is likely to result in exaggerated responses. Evans (1992) states that using local interviewers is the best means of avoiding interviewer bias. He further argues that flaws in methodology become more damaging the greater the distance between the researcher and the subjects of research is. Thus trusted locals would have been the ideal enumerators for this study. However there were no suitably qualified (literate) individuals available. Further more, the university students selected to enumerate had some experience in enumeration, which meant that the questions were more likely to be accurately put across thus minimising the bias.

2.2.5.7 Communication bias

This kind of bias usually arises when there is need to make translations between respondents and interviewer. This was unlikely to be the case for this study as all interviewers were SiSwati speakers, the same language as the respondents.

2.2.5.8 Time to think bias

There was little time available to conduct the interviews leaving respondents with no much time to think about either the proposed hypothetical scenario or their WTP. More time may have allowed the respondents to give more thoughtful and accurate answers, as they would have thought about the costs and benefits of the proposal as well as their own budget constraints.

After a careful consideration of the possible biases outlined above, there was utmost satisfaction that they have been minimised, and thus rendering the study reliable.

2.3 Strengths and weaknesses of CVM

A contingent valuation survey constructs scenarios that offer different possible future actions. Under the simplest and most commonly used contingent valuation question format, the respondent is offered a binary choice between two alternatives, one being the status quo policy, and the other being the alternative policy having a cost greater than maintaining the status quo. The respondent would have to be WTP for an extra cost if the non status quo alternative is provided.

The key elements here are that the respondent provides a “favour/not favour answer” with respect to the alternative policy versus the status quo, what the alternative policy will provide, how it will be provided and how much it will cost and how they will be charged for it (payment vehicle), have been clearly specified. An alternative elicitation method is open-ended questions where respondents are asked directly about the most they would be willing to pay to get the alternative policy with or without the visual aid of a payment card. The respondent would have to randomly choose amounts ranging from zero to some expected upper amount.

One of the main challenges with the CVM is describing the change in the environmental or cultural amenity; that the alternative policy will be provided in a way that is understandable to the respondent and at the same time scientifically correct. As has been mentioned concerns raised by CV critics over the reliability of the CV approach led the NOAA panel to examine the issue and offering guidelines of conducting a CVM.

Since the panel issued the report, many empirical tests have been conducted and several key theoretical issues have been clarified. The simplest test corresponds to a well-known economic maxim, the higher the cost the lower the demand (Navrud, 2000). According to Navrud (2000), this price sensitivity test can easily be tested in the binary discrete choice format, by observing whether the percentage favouring the project falls as the randomly assigned cost of the project increases, which rarely fails in empirical applications. The other test is whether WTP estimates from contingent valuation studies increase in a plausible manner with the quantity or scope of the good being provided. Contingent valuation critics often argue that insensitivity to scope results from what they term “warm-glow” (Evans, 1992). There have now been a considerable number of tests of the scope insensitivity hypothesis, also termed “embedding” and recent review of the empirical evidence suggests that the hypothesis is rejected in a large majority of the tests performed (Carson 1997).

According to Arrow et al. (1993), producing a good CV survey instrument requires substantial development work; typically including focus groups, in-depth interviews, pre-test and pilot studies to help determine plausibility and understandability of the good and scenario being presented. The task of translating technical material into a form understood by the general public is often a difficult one. Adding to the high costs of contingent valuation surveys is the recommended mode of survey administration being in-person interviews. Mail and telephone surveys are cheaper, but mail surveys suffer from sample selection bias, with those returning the survey typically more interested in the issue than those who do not and phone surveys have severe drawbacks if the good is complicated or visual aids are needed (Arrow et al. 1993).

CV results can be quite sensitive to the treatment of potential outliers. Open-ended survey questions typically elicit a large number of so-called protest zeros and a small number of extremely high responses. In discrete choice CV questions, econometric modelling assumptions can often have a substantial influence on results obtained. Any careful analysis will involve a series of judgmental decisions about how to handle specific issues involving the data and these decisions should be clearly noted (Navrud, 2000).

However, Carson (2000) states that the recent debate surrounding the use of CV is, to some degree, simply a reflection of the large sums at stake in major environmental decisions involving passive use and the general distrust that some economists have for information collected from surveys. This study also mentions that outside of academic journals, criticism of contingent valuation surveys has taken a largely untrustworthy form, ridiculing the results of particular contingent valuation studies, many of which use techniques known to be problematic. The implication drawn is that all CV surveys produce unreliable results. However, Navrud (2000) contradicts the statement by Carson (2000), saying that in an academic context the debate over the use of contingent valuation has been more productive. The spotlight placed upon contingent valuation has matured it; its theoretical foundations and limits to its users are now better understood. The CVM has still not reached the routine application stage and all contingent valuation surveys should include new research/tests (Navrud, 2000). Carson (2000) concludes that perhaps the most pressing need is on how to reduce the costs of CV surveys while still maintaining a high degree of reliability and suggests combination telephone-mail-telephone surveys to reduce survey administration costs and implementation of research programs designed at solving some of the more generic representation issues such as low level risk and large scale ecosystems (Carson, 2000).

2.3.1 Willingness to pay theory

In assessing the costs and benefits of improved waters services, some of the key concepts involved are social costs, private costs and externalities**.** Underlying these concepts are the notions of willingness to pay (WTP) and / or willingness to accept (WTA). The WTP technique was pioneered by environmental economists as means of valuing non-traded goods with public characteristics and ill-defined property rights (Frew et al. 2003). According to Frew (et al. 2003), WTP valuation exercises poses a hypothetical question about a pre-specified, prospective change, with a view to eliciting the maximum amount individuals would be willing to pay to ensure that such a change takes place. This therefore means that the technique seeks to identify the compensation variations required to maintain individuals at their initial utility levels and thereby to estimate the likely impact of a change in utility.

It is argued though in Fisher et al. (1988) that despite the increasing usage of the WTP/ WTA technique, it is still weighed down by methodological controversy. These authors see the problem of inferring responses to hypothetical questions as "real" as an inevitable but necessary limitation because the technique will be employed only in circumstances where real choices are unobservable. And furthermore this concern about realism in response spills over into the more specific and practical matter of whether the WTP valuations elicited in surveys or interview are conditioned by the format in which the question has been conducted.

The question of validity and reliability of WTP is also raised by Stavins (2004). This author raises the question of whether neglected attributes influence the choice decisions of the respondents and hence bias the WTP values obtained. The argument is that it is often unclear what specific effects certain reform proposals will have in practice, thus intensifying the hypothetical character of the experiment. However, reliable and valid WTP values are of utmost importance if policy implications are to be derived (Ryan and Gerard, 2003). Moreover measuring WTP is of considerable importance because the funding agents or policy makers can use this information for the matching provision of products more closely with the preference of consumers, thus enhancing rationality of decision making (Zweifer 2001). This requires that measurements of WTP are valid in that they adequately reflect consumer's utility.

The conceptual foundation of all cost estimation is the value of the scarce resources to individuals (Andreoni, 1995). Thus values are based on individual preferences and the total value of any resource is the sum of the values of the different individuals involved in the use of the resource. This distinguishes this system of values from one based on 'expert' preferences, or on the preferences of political leaders (Markandya, 2000). These values are measured in terms of the WTP by individuals to receive the resource or by the willingness of individuals to accept payment (WTA) to part with the resource. The costs of WTP and WTA therefore play a critical part in the whole cost methodology. A frequent criticism of this basis of costing is that it is inequitable, as they give greater weight to the 'well off' (Willig, 1976). While acknowledging the validity of this criticism it is important to note that there is no rational and reliable method of valuation that can replace the existing one as a whole (Hazilla, M. and Kopp.,R.J. 1990). Where there is a concern about equity it should be addressed separately from that of cost estimation (Hanemann, 1991).

2.4 Empirical literature using CVM to value water services

As has been mentioned before, the main objective of the study is to elicit the households' willingness to pay for improvements in water quality and quantity, for both urban and rural households. There are several other studies that have carried a similar study and these studies are reviewed in this section of the chapter. The review exclusively targeted studies that were performed in developing countries. This was mainly to draw comparisons with the current study as it also a developing country.

The first study to be considered was that by Whittington et al. (1989), who conducted a CVM survey in three large Igbo villages in the Nsukka district of Anambra State, Nigeria. The study elicited WTP for a public tap or private connection to improved water supply in the district. Interviews were conducted in person and the method of elicitation was the dichotomous choice question with one follow-up and one open-ended question.
Enumerators were randomly interviewing people in the community. This was because there was no adequate list of household from which to draw random samples (Whittington et al. 1989). The econometric model used is not specified, but it is presumably sample averages of the open-ended WTP amounts.

The most outstanding result of this study is the low WTP for water, in spite of the fact that a great deal of time and money is used up during the dry season to get water. The reason explained for this finding by the authors was that the respondents did not trust the government to deliver or maintain an improved water system. Also these households believed it was the government's responsibility to provide this service for free. On the other hand, respondents had already paid their taxes and did not want to pay additional taxes for services that were not expected to work. Other reasons included cash flow restrictions and also respondents did not want to commit to a uniform flow of monthly payment when they felt the problem was a seasonal nature.

The following year, in 1990, Whittington et al. (1990) again used the CVM to estimate the WTP for water services in Laurent, a village in a rural area in Southern Haiti. The elicitation method used was the bidding game to mainly avoid the starting point bias. As expected the authors found no evidence of starting point bias after the study (Whittington et al. 1990). The majority of the households in Laurent were interviewed. Enumerators were instructed to try to interview someone in every house. Econometric modeling was done by the use of interval-data model estimated by maximum likelihood.

The researchers conducted a split-sample methodological survey, testing whether changes in the wording of the payment question as they were argued to contain potential for strategic responses resulted in different WTP data. The study concluded that no significant differences were found in mean WTP across the two independent sub-samples given the two different versions of the survey. Overall WTP was positively related to household income, occupation index, education and distance to alternative water sources. This suggested that WTP does depend, as economic theory suggests, on the opportunity cost of alternative sources of water (Rosado, 1998).

Whittington et al. (1991) again conducted a study on water vending and WTP for improvements in water quality in Onitsha, Nigeria. A sample of 235 was used for this study and face-to-face interviews were conducted. The bidding game was used as an elicitation method. There was no available list of households from which to draw a sample. As a result enumerators were placed in various districts of the city and instructed to interview every other person they came across.

The results of the survey were that the percentage of income spent on water is at least 5% and is higher in the dry season. For comparison, the authors noted that in Haiti poor people spend an average of 20% of their income on water and that in Addis Ababa, Ethiopia the fraction of income spent of water is about 9%. They concluded that the percentage found in Onitsha was high but not inconsistent with other places.

The paper then used the WTP results to estimate the number of private water connecting households and the anticipated revenue to the water authority at different prices. The authors concluded that WTP for improved water connection is high in Onitsha and that households can afford to pay for the full economic cost of private water connection, which in turn would generate enough revenue to cover the installation costs. Even the households who opted not to connect were predicted to benefit from the lower prices vendors would then charge.

The results in Whittington et al. (1989, 1990 and 1991) were supported by a study conducted by Altaf et al. (1993) in villages in the agricultural area of the Punjab, Pakistan. The main commodity valued in this survey was the connection of households to piped water supply system with a standard and improved reliability. The private water connections for the public would require that households incur the cost of connecting. A flat fee, independent of actual water usage, would be charged per month.

The interviews were conducted in person from a sample of 450 households. In villages without connections to public water system, households were asked to report WTP for private connection to a system with standard and improved reliability. In villages with connections, households were asked to report their WTP for connections to a system with improved reliability only. The elicitation method used was the dichotomous choice involving one dichotomous choice question and one final open-ended follow-up question.

Results of the survey revealed that villages without connections to public water systems were more WTP for a reliable private connection system. Reasons given by these authors were that these villages were spending significant periods of time collecting water thus the opportunity cost of the time was very high. These households would rather be taking care of their crops especially during the cropping seasons.

Singh (1993) also used the CVM in Kerala a rural area in India. The study elicited the WTP of the households for installing yard taps or house connections to the piped water supply. The elicitation method used was the one-way down double-bounded method and face-to-face interviews were conducted. Attributes of the alternative water supply systems were clearly described in the study so that respondents may better understand them. At each location, two types of household were selected: First it was households from areas where improved water supply has been available for years and then households from areas with no connections. A random-effects probit model was used for analysis.

To obtain the results, WTP figures were plugged into simulations to trace out revenues and number of connections as a function of the monthly tariff and the cost of the connection. The author reported that improved water supply does not elicit higher WTP, contrary to what had been found by the surveys above and that females, who bear the burden of getting water for domestic consumption bid significantly lower WTP amounts. The author did not explain reasons for these results, but it was recommended that the connection charges be included into the monthly payments (Singh, 1993).

The contingent valuation method was also used in a study by Altaf and Hughes (1994) in Ouagadougou, Burkina Faso. In Ouagadougou only 38% of the households were connected to the piped water supply system. The households were paying for their water, but with no sewer system and the most frequently used form of sanitation at the time of the study was the private pit latrine. Respondents were generally dissatisfied about the available sanitation measures. .

The study conducted 405 face-to-face interviews but could only use 393 for the survey. No explanation was given for the exclusions. The elicitation method used was the dichotomous choice with two dichotomous-choice follow-ups and a final open-ended question. For econometric analysis, the study used the ordered probit model. Results of the study showed that households with improved pit latrine had a WTP for an on-site sanitation almost twice as large as those without latrines. The authors concluded that even though almost all households have a positive WTP for off-site sanitation, from a financial perspective (by both government and the households), this type of plan still remains unachievable. However, on-site sanitation appeared to be feasible.

The workings of a CVM can also be seen by looking at a study by Choe et al. (1996). This survey was to elicit the WTP for surface water quality improvements in Davao City in the Philippines. A contingent valuation was carried out to determine the households' WTP for improved water quality in the nearby rivers and sea of the city. Surface water pollution aroused mainly from the discharge of household effluent into the Davao River, which in turn polluted the beaches near the city used by local and foreign visitors. Improvements in the quality of water in the rivers and sea would increase recreational opportunities and possible public health for residents of Davao City (Choe et al. 1996).

Numerous focus groups were held to discuss water pollution problems and a total of 581 in-person interviews were completed, representing a 65 percent response rate. The WTP issue was posed as a citywide plan to clean up the river and sea and make the country's most popular beach safe for swimming. Households were told that if the plan was adopted, they would have to pay a monthly fee and were then asked, on a priori basis if they would be willing to pay a specified amount. The results were presented as a probability of a household's WTP for water quality improvements, as a function of the specified amount. From this, the average and total WTP were estimated. The WTP was related to income and other socio-economic characteristics. In general, the study revealed a very low WTP for such water quality improvements both as a percentage of income and in absolute terms. An explanation given by the authors to this effect was that environmental quality was not a high priority for the residents of Davao. The households felt that other environmental problems such as deforestation and poor solid waste collection and disposal deserve higher priority that cleaning up the rivers and beaches.

Another study that used the CVM was by Hoehn (2000). The study sought to establish the perceived value of possible water and wastewater investments in Cairo, Egypt. The research examined an investment in an urban environment where substitute sources of water are limited and water use generated immediate wastewater externalities. These included installing water connections, improved reliability of the existing water service, installing wastewater connections and network maintenance to eliminate sewer overflows. The results provided an insight into the relative value of extending water services to new users versus improving the reliability of the service to existing users. It was clear that wastewater disposal was an almost essential complement to urban water service. Without adequate wastewater disposal, the externalities of urban water use were all too apparent in the city's streets, alleys and canals.

The questionnaire development began with a qualitative research to determine whether Cairo residents were sufficiently aware of water and wastewater services to be able to respond deliberatively to the questionnaires. The qualitative research consisted of a series of 15 focus groups. Participants were carefully selected to represent a cross-section of socio-economic backgrounds and a range of water and wastewater conditions. The final stratified survey sample was drawn from areas of Cairo that had water and wastewater services similar to pre-investment conditions. A separate stratum was selected for each of the four questionnaires.

On average, respondents from the water connection stratum mentioned separate impacts. Respondents who were offered the program appeared to have little difficulty relating the program to impacts on their daily lives. They mentioned primarily impacts on household chores and timesaving. Specific comments included items such as cleaning would be easier and done more frequently, clothes could be washed more often and would be cleaner and tea would taste better than tea made from salty water drawn from shallow wells. Specific comments also indicated that women would have more time for other activities, including caring for children. Basically households with small children at home had a high WTP for good quality water, thus leading to this variable chosen for this current study. Respondents also thought a water connection would make their neighbourhood and local environment cleaner. In conclusion the authors stated that these respondents were WTP for a better quality and quantity of water taking into consideration the impact it will have on their livelihoods.

Alaba (2001) also used the CVM to analyse the determinants of demand for water in Nigeria. The paper utilised household data obtained from a survey conducted in four local governments of Oyo State. The survey randomly selected the surveyed areas based on the state classification of health zones and then the zone was further classified into urban and rural areas. Household information was collected through the household heads. The information sought included sex, age, occupation, relationships to household heads, education of the head, major source of water, cost, quality, health implication and reliability.

With regards to the socio-economic and demographic characteristics, analysis of urban estimates showed that educated and high-income households were more likely to possess in-house water system. Household size was very insignificant in explaining in-house connection in urban areas. Households' education and income levels were both positive and significant variables. Household size was a negative and insignificant factor in explaining in-house connection in the urban sector. Analysis of alternative system, public stand-pipe, public bore-holes and protected wells[6] available to urban households revealed that the effect of income is negative and significant, while other socio-economic and demographic determinant, education and family size were not significant in explaining the use of public systems out of the house.

Results of characteristics of water systems in the urban sector revealed that time and quality were important factors informing households' choice of in-house connection. The former was a negative coefficient and the latter was positive and both significant in the regression. Costs and implication for health of households was not significant in in-house system. Users of in-house connection were also often less sensitive to government policies on water. As it was shown in an in-house system time and quality were also the most important consideration for choosing an out-door source. Health implication and cost was also less important in this respect. However, use of out-door connection was more sensitive to government policy on water. Effect of policy was positive and significant in influencing consumption from that source.

Results of the rural model showed that the effect of income was positive and significant as in urban analysis. This meant that households with more income had a higher WTP those poor

[6] Most hand pumped wells provided by the government

households. Education was also a positive and significant factor determining public sources in the rural sector. Households that were more educated had a higher WTP for a piped water system than less educated households. A similar hypothesis was expected for this current study.

Socio-economic determinants of untreated source in the rural sector reveal that household's income and education are significant in explaining the use of this source. Household size was negative and also less important in explaining the use of public water source in the rural areas. Estimates of characteristics of public-rural source show that time and quality are the major determinants of choice of public source. Cost of avoidance measures such as boiling and filtering water was very insignificant. The coefficient of health was also not significant but smaller compared with the cost of avoidance measures. Government policy on water was also very significant in public-rural source probably because government is usually the sole provider of such facilities. For the untreated rural source, health implication was an important factor. The costs of treating water related diseases were positive and significant. Time spent per litre/ bucket was also very important in explaining choice of untreated rural source. The coefficient of time was positive and significant. Quality and cost of source were insignificant in explaining the choice of untreated water system. Government policies do not affect the use of untreated sources in the rural areas. The data gave a rich database on which major determinants of water use is exhaustively analysed. Analysis of this study was carried out using multinomial logit technique.

Kolstad (2002) brought up a different variable as a determinant of WTP that had not been conveyed by the authors mentioned above, that of information. The survey was a contingent approach case study on coastal water quality used to estimate the non-marketed benefit of two environmental goods being. These were improved water salubrity and preservation of ecosystem against eutrophication. The study found that the willingness to pay for the salubrity was affected by the environmental sensibility and awareness. In such a case, the respondents' willingness to pay depends very much on information about negative effects and the current level of pollution. If they are not aware of being currently affected by this pollution, they tend to, of course, undervalue the non-marketed benefit of environmental improvement. Also the willingness to pay for the preservation of the ecosystem was very much related to the level of educational attainment of the respondents. The more the respondent has been educated, the higher value they tend to place on the preservation of the ecosystem and vice versus.

In support of what had already been found out by authors such as Alaba (2001), Hoehn (2000) and Choe, et al. (1996), Kolstad (2002) also found that whatever environmental goods, the willingness to pay observed rise with income of the respondents. An explanation to this was that to the rural poor in most developing nations, environmental protection would take the back seat while on the front one they are struggling to find enough food to just survive for the day, which was not the case for high income households (Kolstad, 2000). If they were asked for their willingness to pay for environmental protection or pollution abatement, they would say that those are not their immediate concerns. The result will, therefore, be underestimated or zero value will perhaps be placed on the environmental protection. But in cases where the household was satisfied with the quantity and quality of the water, they would not be WTP. This was mainly the case for urban households and not so for rural households (Kolstad, 2000).

Another variable that was thought to be important in eliciting WTP was the trust the households have on the project being implemented, as well as the delivery mechanism (Kaliba et al. n.d). These authors estimated the WTP to improve community-based rural water in a total of thirty villages in two regions of Tanzania. For one region (the Dodoma Region) the study found out that about 14% of respondents were satisfied with the status quo, 64% suggested increasing water discharge and watering points and 22% proposed other improvements relating to water quality. In the other region (Singida Region), 31% of the respondents were satisfied with the status quo, 59% wanted deeper boreholes and watering points and 10% indicated other types of improvement relating to water quality.

The study used both the multinomial logit function to estimate factors affecting demand for improved water related services and the tobit function to estimate the choice of improvement for theses water services. For the probit model family size and satisfaction in the performance of project activities were positive and statistically significant variables in Dodoma Region. Negative and statistically significant variables were age, income and cash contributions, implying that older people and richer respondents were thus more likely to choose to maintain the status quo. From the Singida region females were more willing to pay for improvement than male respondents. This was not surprising since they are primarily responsible for water fetching activities. For the Multinomial model, mean WTP for identified and desired improvements was estimated. Respondents who wanted to increase water supply in Dodoma Region were willing to pay well above the existing tariff. The conclusion made from this study was that in villages where there has been strong satisfaction on projects' performance, individuals were willing to contribute more resources for improvement.

On a different note Whittington et al. (1992) concluded that giving respondents time to think can affect their WTP responses. The study was conducted in the agricultural communities in Anambra State, Nigeria. It involved three large Igbo villages, with a population ranging between 10,000 and 25,000. The commodities of concern were the public taps and private water connections to the public water supply system. The survey carried out face-to-face interviews for a sample of 395 respondents, but the sampling frame is not mentioned.

The elicitation method used was the dichotomous choice question with one dichotomous choice follow-up question and one final open-ended question. Four alternative models were fit for this study to draw out the WTP responses. The first one was a regression model that used the responses to the last, open-ended question and treated them as continuous, then the double-bounded, ordered probit and lastly the single-bounded probit, using only the responses to the initial payment questions (Whittington et al. 1992).

For experimental design purposes, the respondents were divided into two sub-samples. The first one was asked to report information about WTP immediately, but was also interviewed after some time. The other was asked to go home and interviewed about WTP after a day or two. It was reported by the authors that the reason why they gave some households time to think was the fear that unfamiliarity with the commodity or the trade off required to produce WTP amounts would result in missing responses or strategic considerations on the part of the respondent.

Results were that WTP was lower in the group of respondents who were given time to think than those who responded immediately. The difference was huge for public taps than for private taps. The same trend was observed when the interval-data estimator for double-bounded data is used, as opposed to OLS or Probit.

This was in contrast with the hypothesis made earlier on in the study that WTP is non-decreasing in time. The authors did not give reasons to these results. The authors only commented that WTP for improved water must be constrained by cash restrictions resulting from restricted labour markets or by divergences between the individual's and the household's WTP (Whittington et al. 1992).

In contrast to the results of the study by Whittington et al. (1992), another study conducted by Whittington et al. (1993) found that time to think does not influence WTP. This was a contingent valuation study done to estimate the demand for improved sanitation services in Kumasi, Ghana. The study was to elicit WTP for improved sanitation systems. Interviews were conducted in person and a dichotomous choice, one dichotomous choice follow-up question, plus one final open-ended question elicitation method was used.

Households were selected using a two-stage stratified procedure, giving a sample of 1633 households. Interviews were completed for only 1524 households. Econometric modelling was through interval-data maximum likelihood estimation. Covariates include questionnaire characteristics such as a dummy for the time-to-think variant or high starting point for the bidding game, socio-economic characteristics of the households, characteristics of the individual respondent and existing water and sanitation conditions. Separate regressions were run for each of the commodities being valued. Different versions of the questionnaire were developed, including one that allowed the test of whether giving respondents one day to think about their WTP resulted in different WTP.

The study found out that the most important predictors of WTP are the current water usage and sanitation available to the household. As mentioned before the most remarkable result of this study is that giving households time to think does not seem to influence WTP, contrary to what had been found by the Whittington et al. (1992). The presence of other people at the interview also does not seem to influence WTP. The authors make the point that reported WTP bids reflect the respondents' private valuation. Had the respondents been aware of the public health externalities of improved sanitation, their valuation would have been much higher (Whittington et al. 1993).

Whittington et al. (1997) repeated the same study in Calamba in the Philippines. The commodity of interest involved three choices, a connection to sewer system only, a sewer system plus wastewater treatment plant and a wastewater treatment plant, plus regional plan to preserve surface water quality. Interviews were conducted in person from a stratified random sample of 1500 households. An initial bid of five different amounts was used followed by a series of follow-up questions (short bidding game). The ordinary least squares (OLS), tobit and probit model were used for analysis.

The study integrated the test of the hypothesis that giving respondents time to think lowers their WTP, based on an earlier study by Whittington et al. (1992). For each of these commodities, two different elicitation techniques were used. The first was a long questionnaire completed in one sitting of the average duration of 45 minutes and then the "time to think" variant, whereby the interview was completed over two or three days. As explained by Whittington et al. (1997), this was to test whether allowing respondents time to think makes them appreciate the differences between the "sizes" of the different commodities, resulting in scope effects and whether effects earlier noted by Whittington et al. (1992) are also seen in this particular survey.

Results found were that people were able to appreciate the difference in the size between the three plans whether or not they had been given time to think. This was the case even if one plan was a less comprehensive plan than the other. The reason given by the authors to this effect was that it was possible that respondents did not like government intervention, or that maybe the time to think had given them the opportunity to realize the potential for free riding.

More recently the CVM was conducted by Banda et al. (2004) to determine the quality and quantity values of water for domestic uses in the Steelpoort Sub-basin, in South Africa. A two-step model was followed in this study, where each respondent was presented with questions on whether or not he or she was WTP either for improved availability or quality of water in the basin. The total sample for this study was 374 households, of which 269 were from the rural areas and 105 from urban areas.

Four main domestic water sources were identified in the basin. These were private tap, collective tap, river water and vending. This study used the two-step model, where first step was used to obtain the probability of the outcome of the dichotomous choice problem using the latent variable (w_i) and the second step estimated the model to calculate the expected mean WTP. The general result of this study was that rural households stand to benefit from improved availability of water more than urban households (Banda et al. 2004). The authors also found that there are cost-recovery avenues that may provide budgetary relief. This was because, as explained by these authors, there were many households with access to private tap and collective tap water at zero cost, or at a cost not corresponding to the quality used.

There are also a number of CVM studies that have dealt with issues other than water improvements. These included a study by Navrud and Mungatana (1994). This study was conducted in the Lake Nakuru National Park in Kenya. The commodity in question was the recreational value of wildlife viewing, with specific reference to flamingos. The authors argue that this is a conservative estimate of the total economic value of the species of wildlife in the park, thus why the CVM method was suitable.

Interviews were conducted in person and open-ended questionnaires were used to elicit data. The study used a random sample of visitors, both Kenya nationals and non-nationals for a total of 185 respondents. The survey asked about the expenses incurred during this trip and then queried the respondent about how much higher the cost could be before the respondent cancel the trip altogether. The questionnaire was to elicit the respondent's surplus. Two measures were asked of the respondents, their WTP for a visit to the national park and both WTA and WTP for the flamingos alone.

The WTP figures were compared with surplus estimates from a travel cost analysis and the conclusion was that the two alternative approaches provide values that were an approximate of each other. The researchers worried that establishing effects could influence the results of the study and chose to ask first the question about the national park and then the question about the flamingos for this reason. They found that the item response rate to the valuation question was lower when the WTA format was used.

Another study was by Shultz et al. (1998), looking at the improvements in infrastructure and services in the Poas National Park and Miguel Antonio National Park in Costa Rica. In this particular case the exact nature of the improvements was not specified to the respondents.

The study used the single-bounded dichotomous choice model. Face to face interviews were conducted from a random sample of visitors to the two parks, for a total of 124 usable surveys. Analysis was done using the logit model.

The results of the study were that the mean WTP to Poas National Park is $11 for residents and $23 for foreigners; mean WTP for entrance to Miguel Antonio National Park is $13 for residents and $14 for foreigners. Separate analyses were performed for the two parks and for foreign nationals and residents. Of the various covariates of WTP that were regressed, hardly any was found significant. The researchers blamed this result on the small sample and on the focus on participants (visitors), as opposed to the general population. The NOAA panel suggested that for a CVM to be a reliable tool a sample of at least 1000 respondents is required (Arrow et al. 1993). The results also showed that the Costa Ricans had a high WTP relative to their income. An explanation given to this effect by the author was that this was a result of cultural and strategic bias related to their unfamiliarity with personal surveys and with providing truthful negative responses to interviewers (Shultz, 1998).

However, studies like Whitehead et al. (1998); Garrod and Willis (1999), Kirchhoff et al. (1997) have shown that most households are involved in averting behaviours. They have also shown that the economic effects of unsafe drinking water includes changes in expenditure and well-being in terms of medical costs, lost earnings, lost production in the home Averting behaviour studies have assumed that people make choices in order to maximize their level of well being when faced with increased health risk associated with exposure to unsafe drinking water (Cropper and Oates, 1992). No true averting behaviour studies have been conducted for valuing safe drinking water. But, a number of averting expenditure studies has measured averting expenditures after water contamination episodes (Abdalla, 1994). It has been noted that in some circumstances that data limitations exist. The data is available, but lacks a key variable, the variation in drinking water quality necessary to estimate a lower bound on willingness to pay for water quality (Whitehead et al. 1998). This is therefore important, especially for this study. This information can be used in policy formulation in Swaziland.

2.5 Lessons for this study

From the reviewed studies such as Whittington et al. (1991) and Kolstad (2002), it is evident that most environmental resources have characteristics of public goods and externalities, which render their market prices unreliable. This therefore gives a need to obtain values of these environmental resources to identify, or at least approximate a socially optimal decision.

The use of the CVM to elicit WTP has been identified and proven (Frykblom, 1997) as one economic tool that can be used for a direct estimate of the value that a person places on non-market goods and services, in this case water. Hence the use of CVM is appropriate in planning and decision making related to environmental or sustainable natural resources conservation and management. With Swaziland's water increasingly becoming the limiting resource and thus becoming a threat and major restriction to the future socio-economic development of the country, this study is therefore necessary. The studies reviewed above have also shown the extent to which the stated preference methods have been used to elicit WTP/ WTA for a change in the environmental good or service in question in other developing countries that are comparable to Swaziland.

CHAPTER 3

3 METHODS AND PROCEDURES

3.1 Introduction

This chapter will discuss the model, methods and procedures that were used to carry out the study. These will include designing and administering the contingent valuation survey, empirical analysis of responses and estimating and aggregating benefits (WTA and/or WTA).

3.2 Choice of Model

As has been mentioned in the literature review, the CVM was selected because of the importance of non-use values and their potentially significant levels where other methods such as the travel cost method will underestimate the benefits of preserving the non market value, in this case water. It is important that the valuation and analysis of water services (water quality and quantity) is done in Swaziland in order to balance the costs of water against its benefits so that informed policy choices can be made. The main problem is that it has proven difficult to value non-market goods such as water in the past (Mitchell and Carson, 1989). Yet it is important that the value of water be captured if policy recommendations on its allocation are to be well grounded in economic principles and also to fully assess the economic desirability of such environmental policies. The CVM offers the most promising approach for determining public WTP for many public goods such as water and is an approach likely to succeed if used carefully (Mitchell and Carson, 1989).

3.3 Strategy for empirical analysis of responses and estimating WTP

3.3.1 The Model development

A tobit model has been applied to the survey data to explain household preferences for quality and quantity of domestic water supply and derive estimates of willingness to pay for such a service. The use of the tobit model for econometric analysis of preferences was appropriate because a closed-ended value elicitation format was used in this case. In this format the respondents are asked to make a choice between more than two options (private tap water, collective tap water, river water or neither of them).

In addition, the tobit model has previously been successfully used for studying demand for public tap and private piped water connection in the study of Briscoe et al. (1990) for rural areas of Brazil and in a recent study undertaken by the Research Triangle Institute (2001) for the Katmandu valley, Nepal. This model has been applied in a number of other contingent valuation studies such as Whittington et al. (1992), Banda et al. (2004) and Kaliba et al. (n.d).

In conducting the CVM survey the 2-step model can be used. In the first step, which was also used for this study, eliciting willingness to pay involved presenting respondent with questions of whether they were willing or not to pay for improvement in quantity and quality of the commodity in question? The use of discrete models is quite common in eliciting willingness to pay in environmental economics (e.g. Haab and McConnell 2002 and Banda et al. 2004). This involves the outcome of a dichotomous choice problem (yes/no). The interest will be to assess the extent that variable 'X' explains the probability of an outcome 'Y'.

A censored regression or tobit model (Tobin, 1958) takes into account the perception of water quality and quantity by the households and the concern about water quality effects on health was estimated. A censored model was used because negative responses to the contingent valuation questions are not realised. The tobit model takes the following functional form:

$$\hat{y}_i = x_i^{'}\beta + \varepsilon_i \quad (1)$$

Where

$$y_i = \hat{y} \quad \text{if} \quad \hat{y}_i > 0 \quad (2)$$

Or

$$y_i = 0 \quad \text{if} \quad \hat{y}_i > 0 \tag{3}$$

Where y_i is the observed contingent valuation bid by individual I; $\hat{y}_i$ is the latent measure; x'_i are the independent variables; β is a vector of parameters and ε_i is the error term distributed as independent normal with mean 0 and variance σ_2. The explanatory variables in the regression model are a set of variables on demographic characteristics, socio-economic characteristics and a set of dummy variables on whether the household is practicing avoidance measures and availability of small children in the household.

The probability that an individual would be willing to pay for improved water quality and quantity is given by (Greene, 1997)

$$P(Y = 1) = \frac{e^{Zi}}{1 + e^{Zi}} \tag{4}$$

where

$$E(Y/X) = 0[1 - F(\beta' X)] + 1[F(\beta' X)] \tag{5}$$

Irrespective of the distribution used the marginal effect is obtained as follows (Greene, 1997):

$$\frac{\partial E(Y/X)}{\partial X} = \left[\frac{dF(\beta' X)}{d(\beta' X)}\right]\beta = f(\beta' X)\beta \tag{6}$$

Where f (.) is the density function corresponding to the cumulative density function F (.).
The response for WTP_i^* was a binary variable; 1 for yes and 0 for no. Let the binary variable be WTP and the underlying latent variable be WTP*. Then the general formulation of the empirical tobit model (Tobin, 1958) was given as:

$$WTP_i^* = \beta' X_i + \varepsilon_i \tag{7}$$

Where X_i is for the individual *i*, a vector of explanatory factors in the regression, β is a vector of fitted coefficients and WTP_i^* is the stated willingness to pay for individual *i*. Since we do not observe WTP*, it is the underlying latent variable that is related to the observed WTP as follows:

$$WTP_i = 1 \quad \text{if} \quad WTP_i^* > 0 \tag{8}$$

And

$$WTP_i = 0 \quad \text{if} \quad WTP_i^* \leq 0 \tag{9}$$

The second step involves using the estimated models to calculate the expected mean WTP. However this step was not done for this study, though it is recommended that it be considered for future research.

In an attempt to test the relationship between WTP and socio-economic factors, an econometric analysis was done. In the regression model, WTP for good quantity and quality of water was represented as a dependant variable for each case. Questions were asked in the ordered categorical form and then were transformed into binary variables. The variables were first tested if they were normally distributed using the Kurtosis tests for Normality (appendix 1). This was to make sure that the estimators are unbiased, have a minimum variance and are consistent. Only those that showed significant levels of normality were included in the model. The respondents were asked if they were willing to pay for a better quantity and improvement in the quality of water.

WTP was regressed on following variables:

WTP = f (WATCON, HHINC, HHSZ, EDN, SWR, HHR, SML, CLT, TYP)

Or in a linear regression form:

$$WTP = \beta0 + \beta1\ WATCON + \beta2\ HHINC + \beta3\ HHSZ + \beta4\ EDN + \beta5\ SWR + \beta6\ PAB + \beta7\ SML + \beta8\ CLT + \beta9\ TYP + \varepsilon$$

Where,

WTP is the probability that households will be WTP for quantity or quality in each case;

WATCON is water consumption expressed in m^3/month;

HHINC is household's monthly income expressed in emalangeni (E);

HHSZ is size of household expressed in units of individuals;

EDN is the level of education expressed in number of years spent in education;

SWR is the source of water;

PAB is the household practicing avoidance measures;

SML is availability of small children in the household;

CLT is the time in hours spent collecting water;

TYP is type of location (rural/ urban); and

ε is the error term representing the unpredicted or unexplained variation in the dependent variable. This is under the assumption that ε is normally distributed, has a zero mean, constant variance and is not correlated with the explanatory variables.

3.4 Socio-economic characteristics in the model

Household characteristics were entered into the model to enable the design of different levels of services for different demographic groups and also to estimate equity impacts across these demographic groups (such as income classes) and/or for forecasting the impact of changes in demographics. These tasks were part of the goals of the project as water utility is able to offer different service levels to different demographic groups and the estimated distribution of random coefficients in the model includes differences that relate to demographics as well as those that do not. With demographics included, the variance of random coefficients decrease since some of the variance is captured explicitly by the variation in demographics. It can be said that including demographics results in more accurate distributions of willingness to pay, since the specification of the distribution of random terms would be applicable to a smaller share of the overall distribution, such that the impact of specification error would perhaps be less (Whittington et al. 2002).

3.5 Designing and administering the contingent valuation survey

3.5.1 Research design

The questionnaire used for this study was developed by the Centre for Environmental Economics and Policy in Africa (CEEPA) for the study by Banda et al. (2004). The questionnaire used in the survey included four sections: 1) source of drinking water for the household; 2) opinions about the domestic water supply and quality; 3) willingness to pay for different types of improvement of the domestic water quantity and quality; 4) socio-demographic characteristics of respondents and households. In the first section, respondents were asked about the water source in their household. In the second section, their attitude towards the domestic water quality and relevant health risk was investigated and respondents were required to provide information about their dissatisfaction of the domestic water. The third section of the questionnaire included payment scale approach[7] about the household's WTP. Section 4 concludes the questionnaire with questions about socio-demographic

[7] Payment scale approach- each respondent chooses a value from a prespecified and ordered and all respondents choose from the same list (Heneman, 1994)

characteristics such as age, occupation and sex of the respondents, average household's income and educational level. The levels of education were divided into five[8].

Repeated pre-testing and focus group discussions helped to minimize biases often associated with a contingent valuation study. Constructing realistic and meaningful scenarios in accordance with the needs of the study minimised hypothetical/ scenario mis-specification bias. Information was provided about the symptoms of contamination, the health risks and the cost of treatment, both in the short-term and following prolonged use of contaminated water. Information was also provided about the different types of mitigation technologies that could be used in Swaziland. This was all done verbally during the course of the interview. Strategic bias is typically introduced when the respondent tries to influence the price of the commodity being valued and the outcome of the study. Using a closed ended referendum type elicitation format controlled this bias. But it is possible that giving respondents possible answers and limiting them to a certain number of answers introduced another bias.

3.6 Sampling design and methods

3.6.1 Determination of the population

The target population of this study was defined as households that use water for domestic purposes in Swaziland. The study was conducted in the 11 centres shown in Map 3.2. The centres included 1 city, 3 towns and 7 small towns. The first four towns are considered urban and the remaining seven rural (Department of Urban and Rural Development, 2002). Further characteristics such as type of dwelling and access to services (availability of telephone at home, availability of tap water at home, type of sanitation facility and electricity) were used to

[8] The first level was for the head of households that have never been to any formal school. The second level referred to those head of households that have only gone up to primary level of education. The third level was for those heads of household that have finished their ordinary level (GCE). Forth level was for those household heads that have a post ordinary level qualification especially that attended colleges including those that had gone to the university but only exited with a three year diploma. The fifth level referred to heads of household that had attained anything from first degree to post doctoral qualification.

confirm that these areas were either rural or urban (table 3.1). Data on population and number of households was obtained from Statistics Swaziland (2002).

Map 3.2: Towns of Swaziland

Source: The CIA World Fact book, U.S Department of State.

3.6.2 Sample selection method

There are many techniques that can be used for sample selection from a target population. These include simple random sampling, systematic sampling, stratified sampling, clustered sampling and multistage sampling. However, the selection of the sampling method depends on the objective of the study, the information available before the survey and the size of the population in the studied area (Acharya and Barbier 2000). Since the study defined two types of households in Swaziland, the sampling method selected for this study was the stratified and random sampling method with urban and rural households being the two strata. The households were categorised into rural and urban households based on the geographic and socio-economic characteristics of the towns. This was to identify issues that may be relevant in explaining the differences in water use between rural and urban households. These included the percentage of formal dwellings in the area, services delivered to the community, distance travelled to the source of water and level of literacy. This information is summarised in table 3.1.

Table 3.1: Service delivery in Swaziland.

Town	Households	Formal Dwellings (%)	Telephone at Home (%)	Electricity (%)	Sanitation (%)	Piped Water to Dwelling (%)	Classification of Urban/ Rural
Mbabane	31605	76.9	72.1	88.1	80.8	92.4	Urban
Manzini	70476	73.2	64.8	89.4	90.2	91.7	Urban
Nhlangano	41313	61.4	52.2	71.8	90.6	90.6	Urban
Lobamba	11244	76.2	60.7	32.3	80.6	95.5	Urban
Siteki	18762	19.6	1.4	1.3	10.7	13.7	Rural
Hlatikulu	14020	15.8	1.6	0.8	10.6	10.3	Rural
Big Bend	11240	19.4	1.8	0.4	20	20.1	Rural
Lavumisa	12265	18.5	0.3	0.4	11.4	10.3	Rural
Mankayane	2156	33.6	0	8.1	0.5	20	Rural
Mhlume	2643	28.1	0.2	6.3	0.9	0.2	Rural
Piggs peak	18119	21.5	0.7	2.4	0.5	0.7	Rural

Source: Statistics Swaziland, 2002.

The total number of households in Swaziland is estimated at 233 843 of which 79 205 live in rural areas and 154 638 live in urban areas (Statistics Swaziland, 2002). This amounts to a percentage of 34% households in the rural are and 66% households in the urban area. Because of the limitations in the budget, the sample size was not determined according to the guidelines laid by the NOAA panel, which recommends a minimum of 1000 respondents. Also Swaziland is relatively a small country, such a large sample may not be necessary.

Stratified sampling involved dividing the population into urban and rural subgroups and thereafter selecting a separate and independent sample from each subgroup using simple random sampling. Simple random sampling involves selecting a sample out of the total population such that each household had an equal chance of being selected. The sample was then divided into rural and urban households according to their proportions resulting from secondary data. A separate and independent sample for each subpopulation using a simple random sampling within each subpopulation was then selected.

To represent rural and urban households as strata, proportionate stratified random sampling (PSRS) technique is followed. In this technique, a uniform sampling fraction is calculated using the formula:

$f = n/N$

Where:

f = sampling fraction

n = sample size

N = mother population

From a mother population of 233 843 households, a uniform sampling fraction equal to 0.0016, leading to a total of 374 households to be interviewed. Of these 374 households, 127 were from the rural area and 247 from the urban area[9]. To have an equal number of households in each town, the total number of households was further divided by the number of towns for both the rural and urban area. This gave 18 households in each town in the rural area and 61.75, which is approximately 62 households for the urban area.

For each town in the urban areas, the list of households was obtained from the city councils of the area and from the chiefs in the rural towns. Thereafter households were selected randomly, making sure that every village is represented. Another ideal way of sampling would have been to take a larger proportion of the households from rural areas, because it is envisaged that water is more of a problem in rural than urban areas. The reason why this was not done was because household in rural areas are dispersed and it makes them difficult to reach.

The procedure of selecting the households in each village using the random criteria in rural areas was as follows:

[9] A similar approach was used by Myburgh (2003).

- Arrange the list of households alphabetically in each town;
- Divide them according to villages;
- Print the lists and tear them into strips
- Put the strips into the container and mix them up
- Pull out the first 18 households for the rural area and the first 62 for the urban area in each town.

After the careful and successful completion of data collection, the next step was data analysis. The data was cleaned and the statistical program "STATA" was used to analyse the data. Results of the study are shown in the following chapter.

CHAPTER 4

4 STATISTICAL RESULTS OF SURVEY

4.1 Introduction

The study interviewed mainly the heads of the households and they constituted 87% of the sample. The remaining 13% were anyone available in the households who were old enough to answer the questions satisfactorily. These were instances where the head of household was either not available or too busy to answer the questions. In such cases only individuals who could answer more than 90% of the questions were interviewed and in most cases it would either be the wife or the grandparents of the households. In cases where the individual found they could not answer the questions in a satisfactory manner that household would be taken out of the sample and another household would be selected. As a result of the head of household not being found at home, the response rate was 96% with 4% of the questions having no responses. Furthermore, variables that were found to have a direct effect on WTP were further discussed to establish how each of them affected the stated WTP, as well as the possible correlations between WTP and each variable. These variables were grouped under social and economic factors**.** The results of the survey are discussed in this chapter.

The results of the observed average characteristics are shown in table 4.1. From these results it can be seen that the urban households were more educated than the rural households with the average highest education attainment level being a degree (5) and for the rural area being Ordinary Level GCE[10] (3). On average, households in the rural areas have larger family sizes (9) than the household in the urban area (6). In both areas, mostly male-headed households were found, with 62% for the urban area and 64% for the rural areas. As is to be expected, average farm income was higher in the rural areas (E7 758) than in the urban areas (E474.00). However, the mean income of the households was higher in the urban areas (E15 846), than it was for the rural areas (E2 352). Public subsidies were comparatively the same between these two areas, that is, there is no statistically significant difference between subsidies obtained in

[10] GCE General Certificate of Education

the rural areas to those obtained in the urban areas, though the subsidies are slightly higher, on average, in the rural area in absolute levels.

Table 4.1: Mean characteristics of observed sample variables.

Variable	Rural	Urban
Age (years)	52.3	49.8
Level of education*	3	5
Family size	9	6
Farm income (E)	7758	474
Public subsidies (E)	928	926
State salaries (E)	3761	10 477
Domestic worker income (E)	151	550
Mining income (E)	1829	800
Industrial income (E)	1904	10 974
Pension income (E)	791	4167
Self-employment income (E)	1272	101 261
Other income (not specified) (E)	1157	13 418
Average household income (E)	2 352	15 846

*(Level of education 5= Degree, 4= Diploma, 3= O'level, 2= Primary, 1= none)

Table 4.2: Gender of head of household by urban or rural

Variable	Urban		Rural	
Gender	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Female	93	38	46	36
Male	154	62	81	64

Data obtained on the occupation of the head of household in both the rural and urban areas combined, showed that most of the head of households were employed by the public sector (22%). This was followed by the industrial sector, employing 14% of the household heads. Farm workers and pensioners constituted 13% of household heads respectively (table 4.3). This explains the lower levels of per capita monthly income earned by these households. Table 4.3 also shows that 5% of the heads of households were employed as miners in the neighbouring South African mines. The highest income categories from these households were from the self employed and other constituting 9% and 8% of the heads of households respectively. Only 3% of the heads of households were employed as domestic workers (table 4.3).

In the rural areas most of the household heads were either pensioners or working in the mines. Both occupations constituted 15% of the rural sample. Industry workers and the unemployed constituted 14% of the sample. There was also a substantial number of heads of households that are farmers (13%).

In the urban area 28% of the heads of households worked in the public sector, 21% were self-employed and 17% worked in the industries. None of the head of households were farmers in the urban area, with only 2% working in the mines and 4% being unemployed. This data is presented in table 4.3.

Table 4.3: Occupation of head of household

Variable	**Proportion of Sample (%)**	**Rural (%)**	**Urban (%)**
Farm worker	13	13	0
Pensioner	13	15	7
Domestic worker	3	5	7
Public sector	22	8	28
Mining worker	5	15	2
Industrial worker	14	14	17
Self-employment	9	7	21
Unemployed	12	14	4
Other (Not specified)	7	6	12
No response	2	3	2
Total	**100**	**100**	**100**

4.2 Water use

The different types of water users in Swaziland may be delineated according to their source of water used (table 4.4). In the urban areas most of the sampled households used private tap water (93%) while only 8% of sampled rural households had access to private tap water. A much smaller percentage of urban dwellers (7%) were using the collective tap water while 39% of rural households used this source. A majority of the households in the rural areas used river water for domestic purposes (53%). The households who used private tap water rarely had interruptions in water supply (except in cases of technical problems) and 63% of them paid less than E50.00 per month, with the rest (37%) paying above E200 per month for the service. About 58% of the household considered the payment too high, whilst 41% were satisfied with the price.

For those who used collective tap water, 98% paid less than E20.00 per month, with only 2% paying between E20.00 and E50.00. The most commonly used mode of transport for carrying water from the collective taps was the wheelbarrow (72% of users). The next popular mode of fetching water was balancing the containers on the head (26%). The most commonly used containers were those with a capacity of 20 litres and 25 litres. A summary of percentages of the source of water used by the households is shown in table 4.4.

Table 4.4: Source of water for the interviewed households

	Urban		**Rural**	
Source of water	**Frequency**	**Percent**	**Frequency**	**Percent**
Private tap water	229	93	10	8
Collective tap water	18	7.2	49	39
River water	-	-	68	53
Total	247	100	127	100

The per capita consumption of water was significantly different between the two surveyed areas (urban and rural), for all the water sources. With regards to private tap water, the consumption was higher in the urban areas than it was in the rural areas (table 4.5). Households in the urban area consumed an average a total of 5.4m^3 of water per month while rural households consumed on average a total of 3.9m^3 per month. The reasons cited were that in rural areas water from private taps was not always available and that they could not afford to pay if large amounts of water were consumed.

Generally the average use of less water in the rural areas (3.7 $m^{3)}$ as compared to (5.1m^3)in the urban areas (table 4.5), was because most of the households use the river source and they have to travel long distances (on average three kilometres or one hour per return trip). This would therefore force them to use the little water that they have sparingly. The wife and children or the children alone were typically (70%) responsible for fetching the water in rural areas. Furthermore in the urban areas households would be involved in activities like washing cars, watering the garden and using vast amounts of water for bathing in a bath tub or shower, which was not the case in the rural area.

The opposite trend was observed for households using collective tap water. Urban households had a lower per capita consumption of 0.3m^3 per month, whilst that of rural households had per capita consumption of 2.3m^3. The few urban households using collective tap water were those that were renting single room flats or shacks and their landlords usually restricted their water consumption. In one particular town (Lobamba) the households reported that they were only allowed 75 litres of water a day, regardless of the number of individuals living in the household.

The per capita incomes of users of also the three alternative water sources differed between urban and rural areas. It was observed (table 4.5) that per capita income of rural households using private tap water was lower (E1470.70) than that of their urban counterparts (E4951.90). In the case of collective tap water users, per capita income for the rural households was higher (E532.30) than for urban households (E123.90). The discrepancies between these two types of households could be due to the very high levels of income and the smaller average household sizes in urban areas as compared to low levels of income and high levels of household size in the rural areas. This result was expected though, given the reported mean incomes that are in favour of urban areas and also the observation that household sizes are larger in rural areas than urban areas (table 4.1).

Table 4.5: Per capita income and per capita consumption of water by source (per month)

	Rural		Urban	
Source of water	**Per capita income (E)**	**Per capita water consumption (m^3)**	**Per capita income (E)**	**Per capita water consumption (m^3)**
Private tap water	1470.7	3.9	4951.9	5.4
Collective tap water	532.3	2.3	123.9	0.3
River water	389.9	4.9	-	-
Average	261	3.7	2641	5.1

Most of the households in urban areas expressed satisfaction with the quality of water they received, with 77% of them saying the water is very good and only 2% saying the water was very poor. Reasons sited were that the water sometimes had scum that will be left on their sinks (table 4.6).

Table 4.6: User's appreciation for the quality of water by urban and rural.

Scale	**Percent**	
	Rural	**Urban**
Very poor	15.5	2.3
Poor	25.8	8.3
Just Ok	9.0	0.8
Good	7.7	12.0
Very good	42.1	76.5
Total	100.0	100.0

In the case of collective tap water, 34.8% felt the water was of very good quality while 30.3% of the sample found the water to be of poor quality (table 4.7). In the rural area about 70% of the households using river water were not happy with the quality. They felt it was poor, with only 5.1% saying it was just okay and 3.4% saying that the water is good. Further probing revealed that the residents in the rural areas felt government was not doing enough for them as far as developing water facilities was concerned. The households from Lavumisa complained that not only do they have to travel long distances to fetch water but that the river water was contaminated and salty. This poor quality water has been linked to health problems in rural areas including the frequent cases of diarrhoea and outbreaks of typhoid and cholera. It was also revealed that sanitary facilities were inadequate with the bush being the primary method of sanitation in rural areas. This leads to the additional contamination of river water through rainwater runoff sighted by Simelane (2000).

Table 4.7: User's perception of the quality of water by source.

Scale	Private tap water (%)	Collective tap water (%)	River water (%)
Very poor	2.8	13.5	35.6
Poor	10.1	30.3	37.3
Just Ok	3.8	12.4	5.1
Good	11.1	8.9	18.6
Very good	72.4	34.8	3.4

From a study conducted by Banda et al. (2004), it was found that water quality perception is heavily influenced by the source of water. These authors found that 87% of the households with private tap water consider the water good or very good, while only 57.1% of collective tap users and 7.1% of households fetching water from the river rank thought their water was good or very good (Banda et. al, 2004). This is similar to what was found in this study, where most of the households that considered the water good or very good were the ones using private tap water and the least percentage from those using river water.

4.3 Willingness to Pay

The main aim of this study was to elicit the households' willingness to pay for improved water quality and quantity for a sample from both urban and rural households. One of the objectives of the study was to investigate the possible factors determining WTP for the households for an improvement in both quality and quantity of water in Swaziland. Most of the reasons in this section are speculative, as it is impossible to know exactly what will be going through a respondent's mind as they answer the questions. However, using their statements and responses one was able to build a picture of their attitude and perceptions with regard to their WTP.

4.3.1 Estimating WTP for water

When estimating the willingness to pay for quantity, households in the rural area were more willing to pay than those in the urban area. Only 6% were willing to pay for an increase in quantity of water in the urban areas and these were exclusively among the few households that were receiving their water from the collective tap. From the rural area, 58% were willing to pay for more availability of water in the area. In both areas, the households were willing to pay for a better quality of water. But the figure was high in the rural areas (67%) than in the urban areas (20%) (table 4.8).

Table 4.8: WTP for quantity and quality of water

Willing to pay for improved quantity	**Urban**	**Rural**
	Percent	**Percent**
No	93.9	42.0
Yes	6.06	58.0
Willing to pay for improved quality		
No	80.1	33.3
Yes	19.9	66. 7

4.3.2 Mean and Standard deviation of key variables

The standard deviation is the average value of squared deviations from the mean. It is a measure of volatility. As expected the standard deviation from this study was not large. Table 4.9 summarizes the mean and standard deviation of some key variables of the survey. These variables are income of the household, WTP for quality, WTP for quantity and per capita consumption of water. As expected the mean income of the urban households is higher (E4830.21) than that of the rural households (E1269.49). The average per capita income was E1092.00 in urban areas and that E200.00 in rural areas. WTP for quality was higher in the urban areas than it is in the rural areas since was less of a constraint to the former (table 4.9). The same was expected to hold for WTP for quantity, but was not the case. The urban households were satisfied by the status of the quantity of water, given that they typically received their water all day everyday. This is evident from table 4.8 where they stated a very low value for WTP for quantity. Rural households were thus more willing to pay for increased water supplies than their urban counterparts.

Table 4.9: A summary of sample statistics of responses per month

Variable	Rural		Urban		Total	
	Mean	**Std. dev.**	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**
Household income (E)	1269.49	1135.05	4830.21	3641.73	3783.45	3516.76
Per capita income (E)	200	221	1092	1623	830	1427
WTP for quality (E)	6.44	7.93	16.4	27.73	12.99	23.47
WTP for quantity (E)	7.13	10.34	6.82	17.72	6.91	15.63
Per capita water consumption (m^3)	0.92	0.53	6.92	2.07	4.96	3.34
Collection time (minutes/day)	55.42	41.96	18.63	27.43	27.29	31.53

Rural households spent more time fetching their water. On average they travelled for about 45 minutes to the nearest source while urban households spent an average of 19 minutes. Rural households were therefore more willing to pay for a more readily available source of water despite the stronger income constraint. Consumption of water also varies significantly between these two areas. Households in the urban area consumed more water, on average 6.92m^3 per capita while rural households consumed only 0.92m^3 per capita, per month. An explanation for this was that urban households received their water without interruptions. This was not the case for the rural households. They had to travel long distances often on foot to fetch the water. This therefore makes them use the little water that they have very sparingly.

The respondent based factors affecting WTP could be divided into social and economic factors. Only the variables that showed some significant correlation (appendix 1- table 9) were discussed in further detail.

4.4 Contingent valuation approach

A regression analysis was conducted for the study where the probability that the household will be willing to pay, introduced as a dummy variable (1 for yes and 0 for no) was the dependent variable. A set of other variables was introduced as the explanatory variables. These included variables on demographic characteristics, socio-economic characteristics and dummy variables on whether the household is practicing avoidance measures and availability of small children in the household.

The probability of the regression equals zero, which is a good indicator for the Tobit model. This is because for these observations we know only the values of the X variables and the fact that Y*, the latent variable[11] is less than or equal to 0. Information obtained from analysis of households' WTP has shown that willingness to pay for water quality and quantity in Swaziland is influenced by the following factors: household income, water consumption, collection time, source of water and if the household practices any avoidance measures. The results of the model are summarised in table 4.10 and table 4.11. Insignificant variables were not reported. Table 4.10 summarised the Tobit results for WTP for quantity and table 4.10 summarised results for WTP for quality.

[11] Many constructs that are of interest to social scientists cannot be observed directly (Whitehead et al. 1998). Examples are preferences, attitudes, behavioural intentions and personality traits. Such constructs can only be measured indirectly by means of observable indicators, such as questionnaire items designed to elicit responses related to an attitude or preference. Various types of scaling techniques have been developed for deriving information on unobservable constructs of interest from the indicators. Latent variable models form an important family of these scaling methods (Van Houtven, et al. 1997).

Table 4.10: Tobit results for WTP for quantity

Tobit estimates		Number of obs = 332		
		LR chi2 (4) = 89.74		
		Prob > chi2 = 0.0000		
Log likelihood = -562.25188		Pseudo R2 = 0.0739		
WTP quantity	Coefficient	Std. Err.	t	P>| t |
Income	0.0023869	0.0006784	3.52	0.000***
Water consumption	-3.12434	0.918313	-3.40	0.001***
Collection time	0.5708033	0.0789491	7.23	0.000***
Source of water	-18.21501	5.284404	-3.45	0.001***
Age	0.2747466	2.275221	0.12	0.029**
Sex	1.759339	1.230838	1.43	0.061*
Cons	-18.97918	7.339519	-2.59	0.010
Se	31.83606	2.577452	(Ancillary parameter)	
Obs. summary: 234 left-censored observations at WTP quantity <=0 98 uncensored observations				

One, two or three asterisks (*) means significance at the 10%, 5% and 1% respectively

For WTP for quantity and quality, the coefficient household income had a positive and significant (in all three levels) impact on WTP for both quality and quantity. This showed that households with more income were willing to pay more for better services of water. This was more prevalent in urban areas than rural areas where the households were more educated and earning more income. Also because of the income effect, more affluent households are more likely to demand improved services, as resources are not a major constraint.

The variable water consumption was also significant, but with a negative sign when regressed with WTP for quantity. This result was peculiar as it was expected that at low levels of water consumption, the household would be willing to pay a marginally higher amount to improve water availability. An explanation to this could be that the households consuming little water are those from rural areas, with large family sizes and less income. They may be willing to pay more to better their chances of increasing consumption, but cannot afford (table 4.10).

The vector of variables "collection time" was also significant at all levels with a positive sign as expected from the literature (Marret, 2002b). This suggests a positive relationship between availability of water and the distance or time taken to collect the water. Households walking long distances to collect water on a daily basis were more willing to pay for a nearby source, than those with an immediate source of water. Private tap water users have a more regular supply of water and thus have an inferior impact on WTP.

The variable source of water (private, collective tap, river water) was significant and has a negative coefficient for WTP for both quantity and quality. This suggests a negative relationship between the source of water and WTP. Households that have private tap water, everyday all day, were less willing to pay for an improvement in this regard. That is, the more water was available to the household the less the household would be willing to pay for improvements in the quantity available it. Households with readily available water were more likely to choose to maintain the status quo. Furthermore, the worse the opinion of the household about the water quantity is, the more its WTP for its improvement. The households with private tap water have less WTP for improvement in water services. Similar results were found from Kolstad, (2000).

The variables age and sex of respondent both had a significant and positive effect on the household's WTP, thus suggesting a positive relationship between household's WTP and age/ sex of respondent.

In estimating the WTP for the households, the study did not use exactly the same variables for both WTP for quantity and quality. Some of the variables were not significant in explaining the variation in the dependant variable, hence the decision to exclude or include them in the two regression models. Other variables were significant for both WTP for quality and quantity regression models. These variables are income, water consumption, source of water, age and sex of the head of the household. The variables excluded from one model but included in the other included collection time, household practicing avoidance measures and type of house (rural/urban). The results of the two regression models are presented in table 4.10 and 4.11.

Table 4.11: Tobit results of WTP for quality

Log likelihood = -585.16578		Number of obs = 226		
		LR chi2(5) = 89.47		
		Prob > chi2 = 0.0000		
Tobit estimates		Pseudo R2 = 0.0710		
WTP quality	Coefficient	Std. Err.	t	P>| t |
Type (rural/urban)	-77.37195	11.69755	-6.61	0.000***
Practicing avoidance measures	38.68821	6.638338	5.83	0.000***
Age	0.1444255	0.0818122	1.77	0.078*
Sex	0.7601581	1.320938	0.58	0.066*
Income	0.005284	0.000762	6.93	0.000***
Water consumption	0.5685311	0.1794684	3.17	0.002**
Source of water	-30.77873	6.348799	-4.85	0.000***
Cons	15.47005	7.381161	2.10	0.037
Se	34.65609	2.607959	(Ancillary parameter)	
Obs. summary: 120 left-censored observations at WTP quality <=0 106 uncensored observations				

One, two or three asterisks (*) means significance at the 10%, 5% and 1% respectively

For WTP for quality (table 4.11), the type of the household became important. The coefficient was significant at all three levels and negative. This implies that the rural respondents had shown less WTP for water quality improvement than urban households, yet the former had more serious water quality problems than the latter. Reasons could be that these households are less educated and have less income to afford paying more for water quality. It can be said that education and income increases the probability of desiring improved water utility services. That is, a higher education may mean more income and there is evidence from this study that there is a positive linear correlation between income of households and WTP (figure 4.4 and figure 4.3). Therefore these households are less likely to know the dangers posed by using contaminated water for domestic purposes. In this case, urban households would be more willing to pay for improved water quality. This is evident from the results (table 4.11). The coefficient "practicing avoidance measures" was significant at all levels and positive.

The vector of variables for "presence of small children in the household" was dropped from the model because of a multicollinearity problem. This variable was perfectly collinear with the variable "household practicing avoidance measures". However households with small children seem highly concerned about the health risk posed by using contaminated water. Both these variables seemed to have a significant effect on WTP. The coefficient for "practicing avoidance measures" was significant at all three levels and positive. This might be because parents gain some utility from the well being of their children and thus would be more willing to pay for better quality water.

Water consumption was significant, but however positive when regressed with WTP for quality. This result is consistent with theoretical expectations that households that consume poor quality water would be willing to pay a marginally higher amount to improve the quality of the water. This is especially expected from households in the urban areas that have higher income.

Source of water and the type of location (urban/ rural) was significant but negative, thus suggesting a negative relationship between WTP for quality and these two variables. This meant that as the user's appreciation of the water quality increases, their marginal payment to WTP declines. In this particular case, households that were in the urban area, with a relatively good source of water, were not willing to pay more to improve the water quality, as opposed to households in the rural areas.

4.5 Non-willingness to pay

As has been noted a majority of the urban households (94%) were not WTP for any improvements in water quantity, whilst only 42% of the rural households refused to support offered public measures (table 4.8). In most cases, a respondent's refusal is usually associated with lack of interest in the topic of the survey (Stephens and Hall, 1983). Therefore, it seems reasonable to assume that people who are less interested in the good will value it differently than will their more interested counterparts. In this particular case urban households were receiving their water all day everyday, which means that they were not worried about availability of water. On the contrary, the rural households who were not willing to pay were not because they were satisfied by the status of the quantity of water. But it was a simple case that they could not afford to pay for such a service. In addition to that these households had never paid for water services before. They believed that water was a basic right and that the government of Swaziland should be responsible for providing good quality and quantity of water to its people. But in other cases especially for urban households, the reason to offering non-willingness to pay was the mistrust that the households had on their local authorities. These had a very great impact as households would not pay if their money is not accounted for.

Another important factor that contributed to a high percentage of households not willing to pay was that most of the rural households use non-monetary transactions for the exchange of services and goods. As been mentioned before, poor households are known to use their labour in exchange for food and other valuable goods and services. This has large implications on asking these people to put a monetary value on resources. Thus in many cases one ends up with lots of non-willingness to pay values, which was the case for this particular study.

To determine whether observed non-response resulted in any biases for the study, two questions were posed. These were whether there are differential response rates across some groups of households (different income levels and different education levels) and whether there are systematic differences between those within a particular group who responded and who did not. According to Desvousges et al. (1987), sample non-response bias occurs when these between and within group differences in response rates exist and related to the value of the good. The distribution of the sample distribution of predicting variables for WTP function would differ significantly from their joint population distribution (Desvousges et al. (1987)). Among those households who did not want to support water projects are mainly families with low income. This result is consistent with the hypothesis that assumed higher income to be an important factor influencing the WTP. The reasons cited by the households for not willing to pay were mistrust towards the local authorities that they will not spend the money properly (23%); budget constraint of the household (82%); satisfaction/ reconciliation with current situation (94%); preference for personal avoidance measures (37%).

The variables were further discussed to establish how each of them affected the stated WTP, as well as the possible correlations between WTP and each variable. These variables were grouped under social and economic factors.

4.6 Social factors

a. Collection time

It would be expected that the households who were forced to travel long distances to collect water would be willing to pay more for an improved supply than those with immediate access to supply. However analysis revealed no significant correlation between the respondent's collected time and WTP for improvement in water quantity. Figure 4.1 shows that WTP does not vary with average collection time. Households who were spending more time collecting water are not willing to pay more for improved water supplies. Possible reasons could be that these households were poor and could not afford to pay for any improvements in water services. These households had nothing else to do other than to do house work, which included fetching the water for domestic purposes. That is, collecting water for was considered an indispensable part of their day-to-day activities. The opportunity cost of collecting this water was therefore not an important factor to these households.

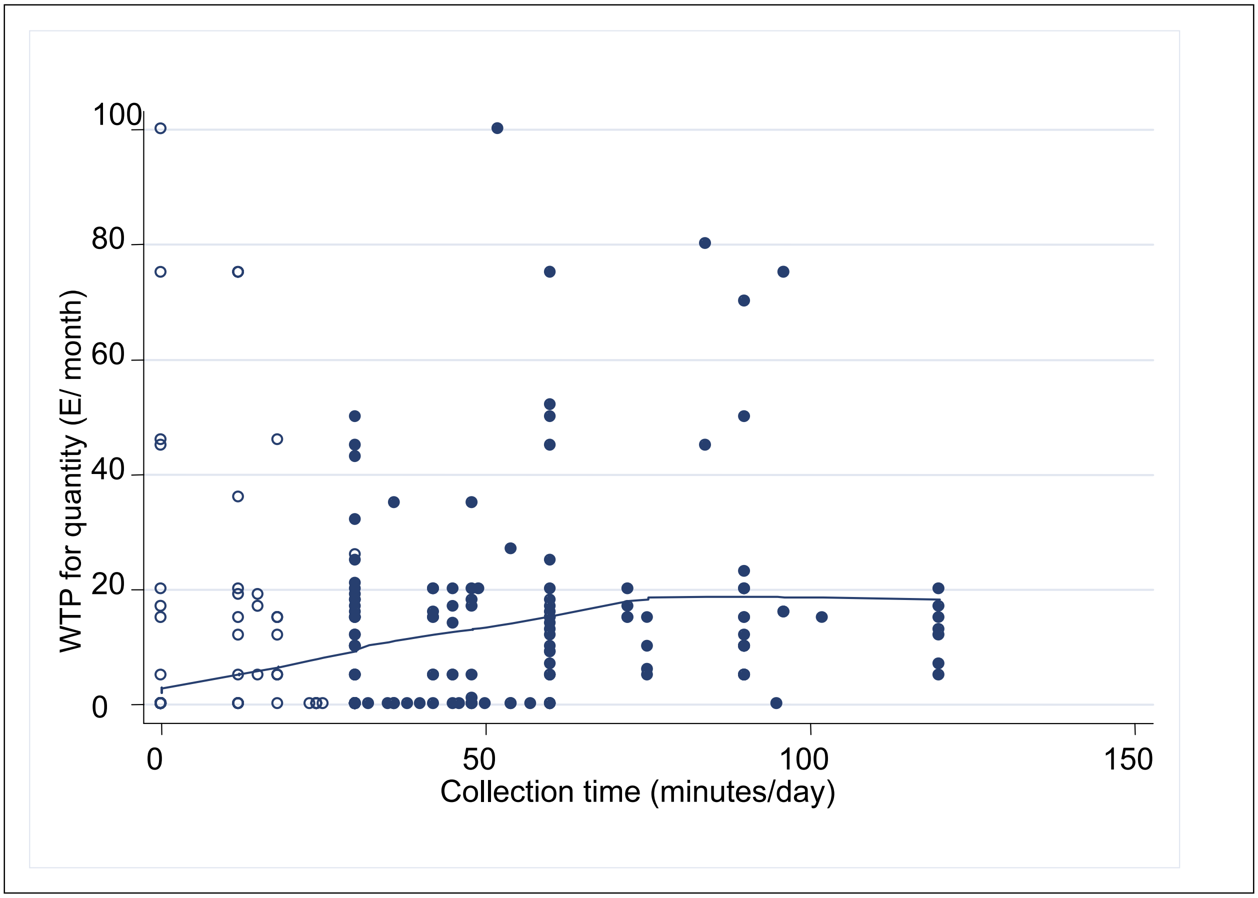

Figure 4.1: Correlation between WTP for quantity and collection time (minutes/day)

There was also a negative correlation between collection time and the amount of water consumed by the households, with a Pearson correlation of -0.21. Households travelling longer distances, measured in time, used less water than households that did not travel to collect their water. These findings are similar to those by Hofkes (1999). In Hofkes (1999) the typical water requirements of water differ per human use and the distance that the households have to travel to fetch the water.

The Pearson correlation test of +0.099 (Appendix 1- table 9) revealed no significant correlation between the respondents' stated collection time and WTP for quantity, indicating that at the household level, villagers that were forced to spend more time collecting water were however, not willing to pay more for improved water supplies.

b. Consumption of water

The amount of water consumed by a household can affect WTP for improved quantity either positively or negatively. Households that normally consume more water (say due to large household size) may be willing to pay more to make water more accessible and thus reduce the effort involved in collecting it. Conversely, households consuming less (say due to limited access) may be willing to pay more to improve quantity (access) to water. However, this study revealed no correlation between the consumption of water and WTP for improved quantity (figure 4.2). The Pearson correlation test indicated a +0.045 correlation coefficient.

A positive correlation coefficient of 0.29 was also observed between the household income of the households and their consumption of water (appendix 1- table 9). Households that were wealthier had a higher consumption of water than poor households.

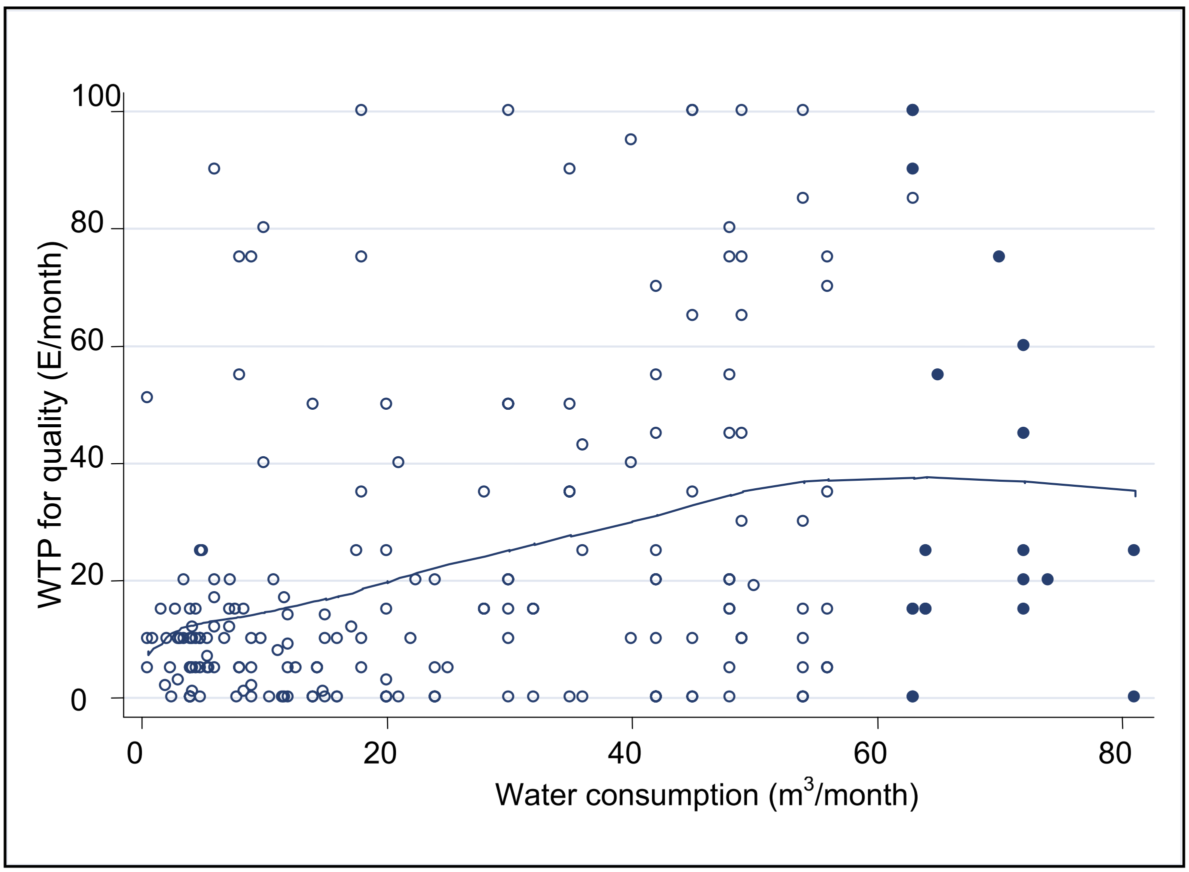

Figure 4.2: Correlation between WTP for quantity and consumption of water (m^3/month)

A similar absence of a relationship between WTP and the amount of water consumed was observed by Banda et al. (2004) and Hardner (1996), through their Pearson correlation tests and regression analysis. However, Hardner (1996) found that consumption - both in the wet or dry seasons - had a linear relationship with income. His Pearson correlation test indicated +0.48 for the wet season and +0.55 for dry season, both being significant at the 5% level.

c. Health risk avoidance measures

According to Bergstrom et al. (1996) if a respondent has experienced many cases of diseases because of consuming contaminated water, they are more likely to have a higher WTP for clean water supply. General discussions revealed this to be the case in Swaziland. Rural areas in Swaziland have suffered from a range of diseases; either water-borne, water based or water related vectors. Malaria was the most common disease especially in the west of Swaziland (areas sharing the border with Mozambique). It was the most prevalent water related disease by typhoid and cholera (World Bank, 2002). Households with a higher health risk concern were thus more WTP for good quality water.

The Pearson correlation coefficient suggested that there is a positive correlation between health risk concern and WTP for quality of 0.476, significant at the 5% level. Health risk concern was measured by whether the household was practicing any avoidance measures and their feelings towards practicing these avoidance measures. From further discussions it was discovered that these households not only value minimal water contamination, but also value other aspects of the service. These included provision of alternative sources of water for rural households, like water tanks and the provision of temporary sanitation measures. These attributes could affect households' willingness to pay to avoid using contaminated water for domestic purposes.

d. Belief in Water as a right

In the rural area 22% of the respondents were not WTP for quantity and 13% were not WTP for quality. They regarded water as a basic right and that it was the government responsibility that they had good water supply. However, they still stated positive, although less than overall average WTP amounts. These households were WTP on average E4.05 per month for improvements in quality. The fact that water was now to be considered an economic good for which payment was due was a relatively new concept in these areas. Thus the idea that people were being asked to consider paying for what had always been considered a free good could have affected the results.

e. Mistrust with the local authorities

Kaliba et al. (n.d) stated that if households have mistrust in the committees or authorities that are entrusted with project implementation, they are more likely not to be willing to pay for that project. This effect could have affected the observed WTP since a number of different statements from respondents (4% of sample both in rural and urban areas) suggested a low level of trust in the community committees. The most common comment was that they were not WTP because they were unsure about how the money would be spent. They cited examples of having paid some money in the past for other projects that was never materialised. At the end these projects were not implemented and no one explained anything to them. This shows how corruption within community committees can discourage people from corresponding towards anything controlled by that committee.

4.7 Economic factors

a. Household income and willingness to pay

Overall, households that had more income were more willing to pay improvements in both quality and quantity than the lower income households. This was mainly because these households were more able to pay for improvements in water services than the poorer households. As expected the correlation between the income of households and WTP was the strongest (see figure 4.3).

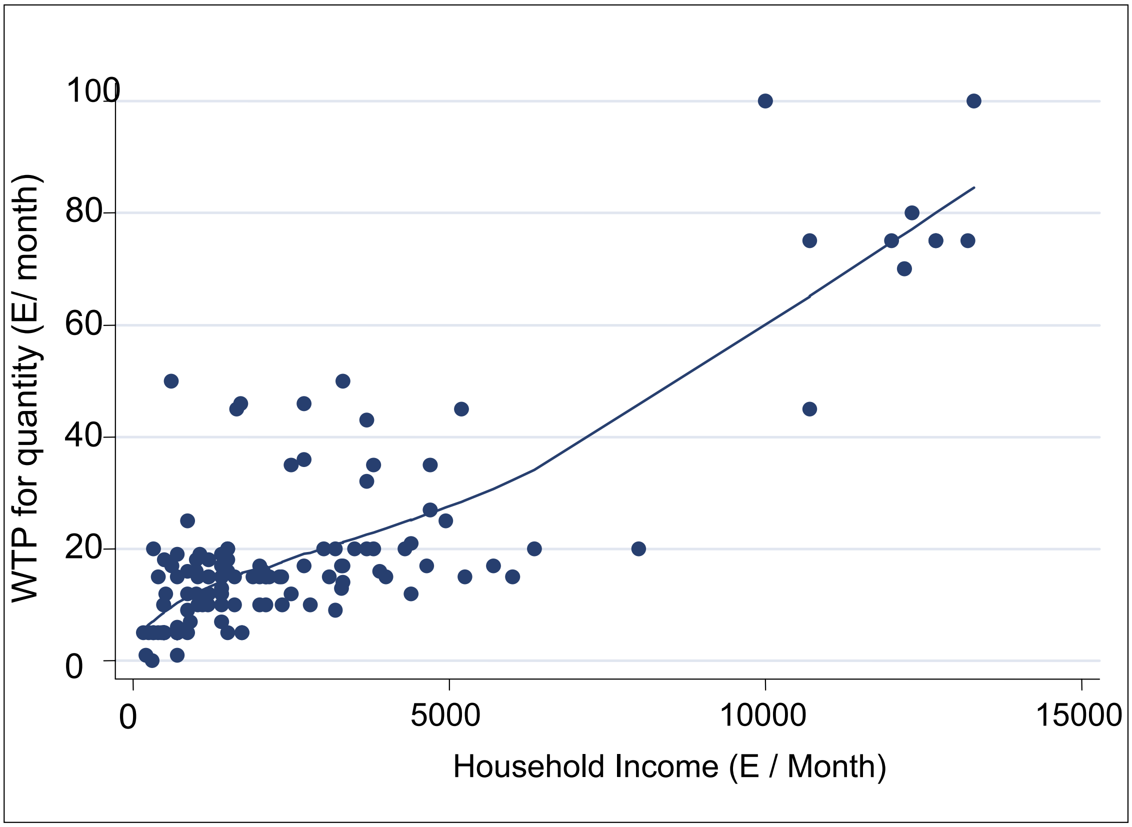

Figure 4.3: Correlation between WTP for quantity and income of households (E/ month)

The correlation coefficient between WTP for quantity and income was 0.23. This was lower than the correlation coefficient between WTP for quality and income (0.51). Figure 4.4 shows the relationship between WTP for quality and the income of the household. Reasons behind wealthier households having a higher WTP for quality than quantity could be that the former households were relatively more educated and were aware of the dangers posed by using unsafe water for domestic purposes. Also these households would generally have the head of household permanently employed and would not have the time to perform avoidance measures.

The lower coefficient for WTP for quality and income may be due to the fact that wealthier households had a readily available source of water and were satisfied with the status quo. On the other hand, even though the poor households were aware of dangers posed by using unsafe water for domestic purposes, they could not afford to pay for improved services. In fewer cases where the rural households would be aware of the dangers posed by drinking unsafe water, the women were typically unemployed and would have the time to do avoidance measures like boiling the water.

Correlation between WTP for quality and income of households

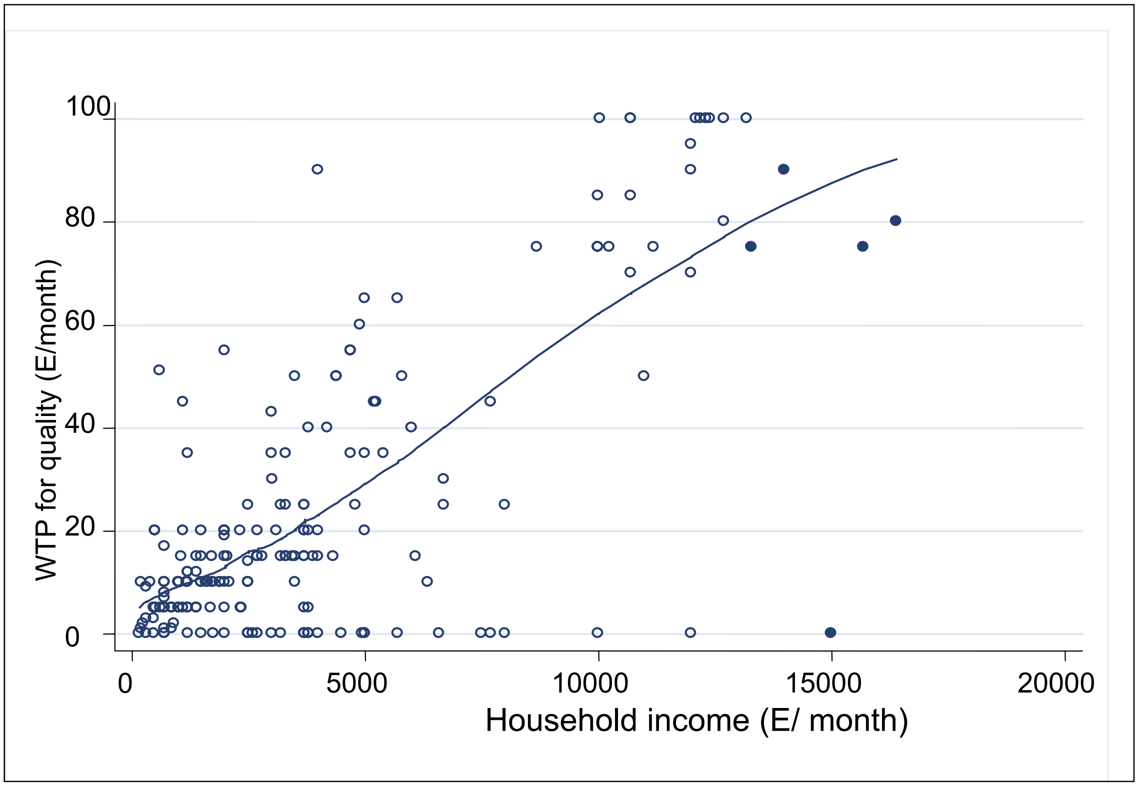

Figure 4.4: The relationship between WTP for quantity and Income of households

b. Non-monetary transactions

According to Farrington (2003), non-monetary transactions for the exchange of services and goods are very common in rural areas. Poor households are known to use their labour in exchange for food and other valuable goods and services. This has large implications on asking these people to put a monetary value on resources in this type of community. In developed countries, most goods and services are obtained through monetary transactions and so consumers are constantly making purchasing decisions. Consequently, when they are asked a WTP question, they easily think in monetary terms. However, in areas where many goods and services are obtained through non-monetary transactions, a WTP question may be much more difficult to answer and an unreliable indication of value (Farrington, 2003). This was evident in this study as some respondents indicated that although they could not afford to pay in monetary terms, they would be able to contribute through such things as labour. In such cases the households said that the only thing they could afford to do was to have some of their children involved in implementing the projects by providing their labour. For that reason it was difficult to put this variable in monetary terms.

c. Opportunity cost

Probing what the rural households would be doing with their time if not walking to collect water revealed that many women would be doing other household chores, such as cooking and cleaning the yard. Children (boys) would be herding cattle and girls would help their mothers. When asked if there was any income lost because of collecting water the response was that during the planting season instead of taking care of their crops they would have to take a break early so the women and children could go fetch water. This was because of a prevalent traditional belief that collecting water after dark would bring bad luck. However during the dry season water collection did not interfere because people would not be busy, especially because household chores are traditionally done very early in the morning. During this dry season, the feeling was therefore that they would not pay for a service they could access themselves for free. The opportunity cost could not be quantified, as these households could not put a value to them, but their responses highlighted that there was actually a low and seasonal opportunity cost to water collection.

A similar finding was found by Farrington (2003) who conducted a contingent valuation based field study of three rural communities on the Usungu plains in Tanzania. In that study it was concluded that for households that walk long distances and spend a lot of time collecting water the opportunity cost of the time was low. However, that did not mean that there was nothing that they can do and it was likely that because they had years of struggling to collect water, there have been few opportunities of setting up other industries (Farrington, 2003). Furthermore it was found that there were a number of existing dry season industries in this area such as brewing local beer, thatching, brick making, weaving, retailing and bee keeping. However, the idea that time is money can be confusing in contexts where other benefits, such as increased leisure and status, have more meaning (Farrington, 2003). Hence the opportunity cost of collecting water for these households was minimal.

d. Economic importance of water

Many households may associate the private tap water with the benefits that they may attain from it. A good quality water supply would indirectly benefit these households. This will be in cases of outbreak of diseases such cholera. In such instances medical costs could be very high, sometimes leading to the death of the head in the household (McConnell and Ducci, 1998). This might therefore make respondents realize the economic importance of water and thus be influenced to pay more for a good quality and quantity of water. Thus the variable, health risk concern, was perfectly collinear with the vector of variables small children at home, thus it was dropped out of the model. But there was a positive correlation between small children at home and WTP for quality, though the correlation was very weak. The correlation coefficient was 0.026 (Appendix 1- table 9). Bergstrom, et al. (1996) suggested that with more time to think and more information on factors such as health benefits of an improved water supply, respondents are much more likely to realise the direct and indirect household economic cost and benefits of access to improved water services.

4.8 Discussion

The results found from this survey are valuable as guidelines for further policy and in generating further debates on the issue. Results showed that the households in rural areas were willing to pay for an improvement in both quality and quantity of waters services. These households were willing to pay an average amount of about E20.00. This shows the level of desperation have improved water quality and quantity. Even though some of these household heads were not even employed, they were still willing to pay for an improvement in the water services, thus showing the value that these households place on the availability of clean domestic water.

This study has shown that factors such as income, amount of water consumed, location, source of water, presence of small children and water collection time are important determinants of willingness to pay for improvements in water services for these households (table 4.10 and table 4.11). As mentioned before, the wealthier the household is, the more they would demand better water services since they would be able to pay. The household heads were highly educated and hence would have more information on the risks posed by using unsafe water for domestic purposes. Consequently these households would have a higher WTP (figure 4.4 and figure 4.3). But these households were more willing to pay for quality than quantity. Reasons to that were that wealthier households are mainly in the urban area and have access to private tap water that is available all day, everyday. Quantity of water is not a problem for them. However they are still worried with quality of the water provided to them.

The location of the household (urban or rural) determined the source of water that will be used buy the household. As seen in table 4.4, 92% of the households that were using private tap water were from the urban area, with only 8% were in rural areas. Most of the households using river water (53.7%) were from the rural area, while none of them were from the urban area. The rural households were travelling long distances, an average of forty-five minutes single journey to collect their water from the nearest source (table 4.9). Since they had to travel long distances to the source, they felt it was stressful, thus they were willing to pay for a closer source. This was mostly evident where the households had to carry the water on their heads. On the other hand households in the urban area were not willing to pay for a closer source of water. These households have an immediate supply of water, all day everyday. They are satisfied with the status quo.

Age and sex of the respondent were also good determinants of WTP. Females proved to be less willing to pay, in rural areas, since most of them were unemployed, housewives and would prefer to do avoidance measures on their own. Younger head of households were more WTP especially for good quality of water. This was mostly evident with households that had small children at home. It has been shown in previous studies that children are more vulnerable to disease when exposed to unsafe domestic water, especially drinking water. Several studies have shown that access to clean domestic water and sanitation has positive results in the survival of small children (Woldemichael, 1998; Abou-Ali n.d; Checkely et. al. 2004; Trussell and Hammerslough, 1983). These studies concluded that improvements in water supply and sanitation benefit health and improve life expectancy of an individual. This supports the finding that households with small children favoured clean water sources.

Water consumption was also a good determinant of WTP. Rural households consuming little amounts of water were more willing to pay than their urban counterparts. These households were forced to consume little amounts of water because their water sources were far and had to use sparingly what they already had. Their willingness to pay was based more on bettering their chances of increasing consumption. These households were also travelling long distances to the source of water, which rendered collection time also an important determinant of WTP.

This study therefore shows that households in the urban areas were mostly concerned with the quality of the water and not quantity. These households have a higher WTP for quality than their rural counterparts. This is in line with the theory tested by this study. It was postulated that households that have low per capita income and access poor water services will because of their risk concern have a higher WTP than their counterparts for improvement in both water quality and quantity. This was evident in areas such as Lavumisa and Mankayane. Households living in these areas complained about the long distances they have to travel to fetch their water and the fact that the water is usually contaminated, dirty and salty, especially river water during the raining season. Part of the rural area, for example Lavumisa, Big Bend and Siteki are drought prone areas. The water is salty and usually contaminated with faecal sediments since the households in this area do not have proper sanitation measures. The bush is usually used as a substitute, thus the faecal sediments are washed into the river by rainwater.

These results compare well with those in Marret (2002b). The reasons as given by Marret (2002b) are that for importance of health if a respondent and his/her family have experienced many cases of disease and suffering they are likely to increase their WTP for clean water supply. In the case of collection time it would be expected that villagers forced to walk for great distances for water collection on a daily basis would be willing to pay more for an improved water supply than those with an immediate supply. For the variable consumption, households consuming more will be more WTP because they put more effort into collecting it.

Households in the urban areas were expected to be satisfied with their status quo, thus would be less willing to pay in improvements in water quality and quantity. Rural households would be less WTP for improvements because they cannot afford it. On valuing the economic importance of water it was expected that with more time to think and more information on factors of an improved water supply, respondents are much more likely to realize the direct and indirect economic costs and benefits to their household. Those that believed that water is a basic human right to be provided by government, were not willing to pay for any improvements. Poor households who could not afford to pay in monetary terms often preferred to used labour in exchange for improved services. These households would not be WTP more for improvements in water (Marret, 2002b).

CHAPTER 5

5 SUMMARY AND CONCLUSION

5.1 Summary

Measuring willingness-to-pay for environmental goods and services is of considerable importance because funding agencies and policy-makers can use this information for improving the provision of such services and better match the preferences of consumers, thus enhancing effectiveness of decision-making in this domain (Lee et al. 1997). This study was an example of such an attempt to elicit households' willingness to pay for improvement in water services in Swaziland. The major problem in this country was that water availability was increasingly becoming a scarce resource in Swaziland (World Bank, 1993). This was despite the fact that Swaziland is a country traversed by five major rivers with mean annual rainfall ranges of 550 to 625 mm in the lowveld and 850 to 1400 mm in the highveld (GOS, 2003a). A high proportion of the population (47%) residing in rural and peri-urban areas do not have access to safe and clean water (GOS, 2003b). National health statistics also show that some infant mortality was related to water borne diseases, which was a further reflection of the poor quality of water. The extent of the problem was evident from in the recent outbreak of typhoid from these areas, which resulted in the death of six people, four of which whom were children. According to the 2002 Demographic and Household Survey, only 28 % of the rural residents had access to safe portable water as opposed to about 89 % in the urban areas (GOS, 2003a).

The study was conducted in Swaziland from a sample obtained from a selection of both the urban and rural areas. The research followed the approach and method used by Banda et al. (2004), for the Steelpoort sub-basin of South Africa. The target population was defined as the households using water for domestic purposes in Swaziland. The sample included eleven of the country's centres including one city, three towns and seven small towns. Characteristics including type of dwelling and access to services (availability of telephone at home, availability of tap water at home, type of sanitation facility and electricity) were used to distinguish between rural and urban areas. This process duly classified the first city and towns as urban areas and the seven remaining small towns as rural areas. The total number of households in Swaziland is estimated at 233 848 of which 79 205 live in rural areas and 154 638 live in urban areas (statistics, 2002). The total number of households interviewed was 374, of which 127 were from the rural areas and 247 from the urban areas.

For data collection, the study used a questionnaire designed for a similar project by CEEPA (University of Pretoria) and recruited enumerators from the University of Swaziland. The questionnaire used in the survey included four sections: 1) source of drinking water for the household; 2) opinions about the domestic water supply and quality; 3) willingness to pay for different types of improvement of the domestic water quantity and quality; 4) socio-demographic characteristics of respondents and households. The questionnaire is attached as appendix 2.

This study used the contingent valuation method (CVM). This method was selected because of the importance of non-use values and their potentially significant levels where other methods such as the travel cost method would underestimate the benefits of preserving the non market value, in this case water. A tobit model (Tobin, 1958) was applied to the survey data to explain household preferences for quality and quantity of domestic water supply and derive estimates of willingness to pay for such a service. That is, a censored regression or tobit model that takes into account the perception of water quality and quantity by the households and the concern about water quality effects on health were estimated. Since a closed-ended value elicitation format was used in which the respondents were asked to make a choice between more than two options (private tap water, collective tap water, river water or neither of them), the use of Tobit model for econometric analysis of preferences was appropriate. From the 2-step model that could have been used for this study, only the first step was used, though it was recommended that the two-step analysis be performed in the future.

A regression analysis was conducted for the study where the probability that the household will be willing to pay introduced as a dummy variable (1 for yes and 0 for no) was the dependent variable. A set of other variables was introduced as the explanatory variables. These included variables on demographic characteristics, socio-economic characteristics and dummy variables on whether the household is practicing avoidance measures and presence of small children in the household. The variables were first tested for normality using the Kurtosis tests (appendix 1- table 8). This was to make sure that the estimators are unbiased, have a minimum variance and are consistent. Only those that showed significant results were included in the model.

Information obtained from analysis of household's WTP showed that willingness to pay for water quality and quantity in Swaziland was influenced by the following factors: household income, water consumption, collection time, source of water and if the household practices any avoidance measures.

The results obtained from the descriptive analysis of the data indicated that the WTP for the domestic water quality and quantity improvements is small but significant. There were more households in the rural area willing to pay for improvements in the quality (67%) of water than in the urban area (20%). The same trend was observed for the willingness to pay for quantity. Approximately 58% of households in the rural area and 6% of households in the urban area were willing to pay for water quantity. This was mainly because most households in the urban areas already had a reliable source of water provided by the Swaziland Water and Sewerage Board (SWSB). This water was adequately treated and free of pathogens rendering it fit for human consumption.

Most of the households in the rural areas use river water as the only source. Usually, this sole source was several kilometres away and was often contaminated. However, the rural households were willing to pay on average an amount of E6.44 for quality per month, which is much lower than the average amount urban households were willing to pay (E16.40). Further investigation revealed that this was mainly because households in the urban area had more income and were more educated than their rural counterparts. Higher education levels made these households more aware of the dangers posed by using contaminated water for domestic purposes. In contrast households in the rural area were more willing to pay for quantity (E7.13) than households in the urban areas (E6.82), even though the difference between the two figures is small. This was explained by the observation that rural households typically did not have reliable water sources nearby and thus were more willing to pay for them.

On average the rural households were consuming less water ($0.92m^3$) per month as compared to consumption by urban households ($6.92m^3$). This was because rural households struggled to get their everyday water. They had to travel long distances to the nearest source of water and use mostly 20 –25 litre containers to carry the water on their head and thus would use whatever little water they had sparingly. The average income for the household head in the rural households was E1269.49 corresponding to a mean per capita income of E200. For urban households the average income for the head of household was E4830 corresponding to a mean per capita income of E1092.00. Moreover, the survey results show that people aware of health hazards brought about by using unhealthy water are inclined to revere improved water quality. This therefore meant that the households were more willing to pay for better quality and quantity of water. Also there was a big gap between rural and urban behaviour due to socio-economic differences and differing access to water in the two areas.

What also added to the problem of non-willingness to pay was that the rural households had never paid for water services before. They believed that water was a basic right and that the government of Swaziland should be responsible for providing good quality and quantity of water to its people. In other cases the rural households less willing to pay due to the mistrust that they felt towards local authorities. These had a significant impact, as households would not pay if they felt that their money would be misappropriated.

Factors such as income, amount of water consumed, location, source of water, household practicing avoidance measures and water collection time proved to have an impact on WTP for improvements in water services for these households. However this study found that according to the Pearson correlation and regression analysis only household income was positively correlated with both willingness to pay for both quality and quantity. There was no relationship found between WTP (for both quality and quantity improvements) and any of the other variables.

However, not all the higher income households were willing to pay for the offered services. Households that were satisfied with the status of the water condition were not willing to pay.

This was especially seen with urban households where 94% of the households were not willing to pay for improvements in the quantity of water. These households already have a reliable water supply.

On the contrary, for the rural households who were not willing to pay (42%), the reason for non willingness to pay were not because they were satisfied with the status of the quantity of water but because they could not afford to pay for such a service. These households mainly use non-monetary transactions for the exchange of services and goods. For instance, they mentioned that they did not have money to pay for such services, but could provide labour instead. In such cases it was difficult to put monetary value as these households could not put a value to this labour they were willing to provide, thus leading to classification as non-willing to pay. It was also difficult to establish the opportunity cost of collecting water for these households, as they had nothing of monetary value they would rather be doing.

5.2 Policy discussion

The findings of this study offer insights to develop a framework to address the water problem in Swaziland. This study brings out the low level of knowledge and awareness of the health effects of contamination in rural areas. It is therefore very important that public awareness of contamination, its seriousness in terms of its effect on public health and various technology options be increased.

The estimates of WTP obtained in this study indicate the possibility of introducing a demand-driven program to expand the coverage of rural tap water schemes with the potential of raising even higher contribution from households. Promoting water pilots to enable active or action research can validate the hypothesis. Several pilot tap water projects have been initiated that could provide additional inputs to the government on the appropriateness of this technology and possible institutions that could ensure delivery and access to safe drinking water in rural Swaziland. The government should play a more important role in the domestic water sector because many issues that need to be addressed when tackling the contamination problem, such as dissemination of information, ensuring choice and options, monitoring of water quality and most importantly managing the introduction of a network system, require the government's involvement on a large scale.

5.3 Conclusion

Overall, the results confirm that water service levels are important to households. While the results indicate that householders' are willing to adapt to contamination and distance travelled to a degree, households also revealed that they were willing to pay for incremental changes in service levels. There is therefore scope to optimise water service levels with respect to price. This has been acknowledged for some time in the context of other services provided in the country such as electricity (Simelane, 2000), but has been unclear in the water sector.

Interestingly, the results indicate that households not only value minimal water contamination, but also value other aspects of the service – those that perhaps typically receive less attention by water utilities. Attributes such as provision of alternative sources of water for rural households, like water tanks and boreholes and the provision of temporary sanitation measures are very important. These attributes affect households' willingness to pay to avoid using contaminated water for domestic purposes and are clearly worthy of attention. Therefore, the study not only provides useful estimates of households' willingness to pay for capital and maintenance planning but it also brings to attention what should be done with regard to water utilities in the short to medium term.

As observed by Schultz (1998), this study finds that the sample size should have been larger to provide more robust results given the diversity of population in social and economic status. Moreover, valuation of public goods and services has been a difficult problem faced by economists for a long time (Nallathinga and Paravastu, n.d.). There exists an advantage in carrying out such studies in developed countries, where markets are well developed for variety of goods and services and general population is aware of economic costs and benefits. These populations are well informed, educated and positioned in social and economic terms. According to Nallathinga and Paravastu, n.d., all these conditions lack in developing countries, where social structures and cultural stigma associated with underdevelopment are another impediment to conducting studies and obtaining results consistent with theory. A more ideal way of sampling would have been to take a larger proportion of the households from rural areas, because it is envisaged that water is more of a problem in rural than urban areas, but this was not possible considering the fact that rural households are widely dispersed. This therefore made it very difficult to reach them.

5.4 Areas for future study

This study raises a number of issues that may guide future research. An important issue is to establish the extent that 'stated' willingness to pay could be translated into 'actual' willingness to pay and the role of institutional arrangements for service delivery in this regard. With the implementation of more private tap water projects in rural areas, it would be possible to study the responses of this issue. That is whether the households would pay the amount that they have stated.

From the two-step model usually used in CVM surveys, this study only used the first step. It would be recommended that further analysis be done in the future using the second step model.

The use of unskilled labour by rural households needs to also be looked at in the future to establish the impact that it would have on the households' willingness to pay.

Two other issues that need further study are the economic cost of avoidance measures and the risk perception of rural households in Swaziland. The economic cost of avoidance measures can be studied by looking at the activities done by these households and the costs related to them. These costs would be helpful to assess the wider economic significance of the problem. An important concern with regard to risk perception is why the value of contamination-free drinking water to rural people is low compared to household's income. It would be useful to study the reasons why households attach low value to contamination-free water and relate the findings to the time preference of rural households and their risk perception.

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7 APPENDICES

Appendix 1: Results

Abbreviations used in the appendix tables.

Wtpqt	Willingness to pay for quantity
Wtpql	Willingness to pay for quality
Sml	Availability of small children in the household
Pab	Household practicing avoidance measures
soe2	Gender of household head
soe3	Level of education
soe4	Value of family size
water_consum	Amount consumed by household, per day (m^3)
WTPquantity	Amount household WTP for quantity
WTPquality	Amount household WTP for quality
collection~e	Amount of time household spend to collection water
Source	Source of water for household (Private tap, collective tap or river water)

Test for significance and normality between categorical variables

Appendix 1 - Table 7.1: Test for significance and normality (WTP quality and type)

```
pweight:   <none>                                    Number of obs      =       371
Strata:    town                                      Number of strata   =        11
PSU:       <observations>                            Number of PSUs     =       371
                                                    Population size    =       371

-------------------------------
          |        type
    wtpqt |     0      1  Total
----------+--------------------
        0 | .0863  .5283  .6146
        1 | .2561  .1294  .3854
          |
    Total | .3423  .6577      1
-------------------------------
  Key:  cell proportions
Pearson:
    Uncorrected   chi2(1)         =  107.1738
    Design-based  F(1, 360)       =  127.2581     P = 0.0000***
```

Appendix 1 - Table 7.2: Test for significance and normality (WTP quality and type)

```
pweight:  <none>                                 Number of obs      =       373
Strata:   twn                                    Number of strata   =        11
PSU:      <observations>                         Number of PSUs     =       373
                                                 Population size    =       373

-------------------------------
          |        type
    wtpql |      0       1  Total
----------+--------------------
        0 | .1287   .3968   .5255
        1 | .2145   .2601   .4745
          |
    Total | .3432   .6568       1
-------------------------------
  Key:  cell proportions
Pearson:
    Uncorrected   chi2(1)         =   17.6944
    Design-based  F(1, 362)       =   19.0466     P = 0.0000***
```

Appendix 1- Table 7.3: Test for significance and normality (WTP quality & small children)

```
pweight:  <none>                                 Number of obs      =       373
Strata:   twn                                    Number of strata   =        11
PSU:      <observations>                         Number of PSUs     =       373
                                                 Population size    =       373

-------------------------------
          |         sml
    wtpql |      0       1  Total
----------+--------------------
        0 | .1689   .3566   .5255
        1 | .1984   .2761   .4745
          |
    Total | .3673   .6327       1
-------------------------------
  Key:  cell proportions
Pearson:
    Uncorrected   chi2(1)         =    3.7386
    Design-based  F(1, 362)       =    3.7553     P = 0.0534*
```

Appendix 1- Table 7.4: Test for significance and normality (WTP quality & PAB)

```
pweight:  <none>                                 Number of obs      =       242
Strata:   town                                   Number of strata   =         9
PSU:      <observations>                         Number of PSUs     =       242
```

```
                                                Population size    =       242
-------------------------------
          |         pab
    wtpql |     0      1  Total
----------+--------------------
        0 | .3595  .1488  .5083
        1 | .2934  .1983  .4917
          |
    Total | .6529  .3471      1
-------------------------------
  Key:  cell proportions
Pearson:
    Uncorrected   chi2(1)         =    3.2693
    Design-based  F(1, 233)       =    3.7987     P = 0.0525*
```

Appendix 1- Table 7.5: Test for significance and normality (WTP quantity and education)

```
pweight:  <none>                                Number of obs      =       371
Strata:   town                                   Number of strata   =        11
PSU:      <observations>                        Number of PSUs     =       371
                                                Population size    =       371

----------------------------------------------------
          |                  soe3
    wtpqt |     0      1      3      4      5  Total
----------+-----------------------------------------
        0 | .0404  .0458  .0081  .1105  .4097  .6146
        1 |  .097   .159      0  .0162  .1132  .3854
          |
    Total | .1375  .2049  .0081  .1267  .5229      1
----------------------------------------------------
  Key:  cell proportions
Pearson:
    Uncorrected   chi2(4)         =  109.5696
    Design-based  F(3.98, 1431.52)=   28.6689     P = 0.0000***
```

Appendix 1- Table 7.6: Test for significance and normality (WTP quality and education)

```
 pweight:  <none>                                Number of obs      =       373
Strata:   twn                                   Number of strata   =        11
PSU:      <observations>                        Number of PSUs     =       373
                                                Population size    =       373

----------------------------------------------------
          |                  soe3
    wtpql |     0      1      3      4      5  Total
----------+-----------------------------------------
        0 | .0483  .0804  .0054  .0751  .3164  .5255
```

```
        1 | .0885   .126  .0027  .0509  .2064  .4745
          |
    Total | .1367  .2064   .008   .126  .5228      1
----------------------------------------------------
  Key:  cell proportions

  Pearson:
    Uncorrected   chi2(4)         =   17.9209
    Design-based  F(3.99, 1445.58)=    4.5491     P = 0.0012***
```

Appendix 1- Table 8: Normality test for continuous variables.

```
Skewness test water_consumption WTPquantity  WTPquality collection_time source  soe4
soe3

                   Skewness/Kurtosis tests for Normality
                                                        ------- joint ------
    Variable |  Pr(Skewness)   Pr(Kurtosis)  adj chi2(2)    Prob>chi2
-------------+------------------------------------------------------
water consum |      0.004         0.000           62.25       0.0000***
 WTPquantity |      0.000         0.000               .       0.0000***
  WTPquality |      0.000         0.000               .       0.0000***
collection~e |      0.000         0.173           40.12       0.0000***
      source |      0.000         0.000           42.95       0.0000***
        soe4 |      0.000         0.004           23.11       0.0000***
        soe3 |      0.000         0.331           16.64       0.0002***
```

Appendix 1- Table 9: Correlation between variables

```
pwcorr WTPquantity income water_consumption collection_time type soe3 soe4 sml
pab source ,star(0.05)

             | WTP~tity   income water_~n collec~e     type     soe3     soe4
-------------+---------------------------------------------------------------
 WTPquantity |   1.0000
      income |   0.2318*  1.0000
water_cons~n |   0.0457   0.2903*  1.0000
collection~e |   0.2994* -0.2227* -0.2104*  1.0000
        type |  -0.0119   0.4619*  0.7499* -0.3979*  1.0000
        soe3 |  -0.0578   0.1372*  0.0520  -0.0614   0.1536*  1.0000
        soe4 |   0.0762  -0.1872*  0.1831*  0.1834* -0.3063* -0.1940*  1.0000
         sml |  -0.0922   0.0055   0.0339  -0.1084*  0.0467  -0.0180  -0.0067
         pab |   0.0247   0.0099   0.2496* -0.0918   0.3382* -0.0920  -0.0880
      source |   0.1051*  0.2534*  0.2916* -0.2724*  0.4255*  0.0528  -0.1911*
```

```
             |      sml      pab   source
-------------+---------------------------
         sml |   1.0000
         pab |   0.1567*  1.0000
      source |  -0.0698  -0.0989   1.0000

*******************************************************************************
pwcorr WTPquality income water_consumption collection_time type soe3 soe4 sml
             | WTP~lity   income water_~n collec~e     type     soe3     soe4
-------------+-------------------------------------------------------------
  WTPquality |   1.0000
      income |   0.5133   1.0000
water_cons~n |   0.2205   0.2903   1.0000
collection~e |   0.099  -0.2227  -0.2104   1.0000
        type |   0.2014   0.4619   0.7499  -0.3979   1.0000
        soe3 |   0.0576   0.1372   0.0520  -0.0614   0.1536   1.0000
        soe4 |  -0.0021  -0.1872   0.1831   0.1834  -0.3063  -0.1940   1.0000
         sml |  -0.0664   0.0055   0.0339  -0.1084   0.0467  -0.0180  -0.0067

             |      sml
-------------+---------
         sml |   1.0000
```

Appendix 1- Table 10: Tobit regression for WTP for improved quantity

```
Tobit estimates                                   Number of obs   =        332
                                                  LR chi2(4)      =      89.74
                                                  Prob > chi2     =     0.0000
Log likelihood = -562.25188                       Pseudo R2       =     0.0739

------------------------------------------------------------------------------
 WTPquantity |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      income |   .0023869   .0006784     3.52   0.000     .0010523    .0037214
     waterpc |   -3.12434    .918313    -3.40   0.001    -4.930866   -1.317814
collection~e |   .5708033   .0789491     7.23   0.000     .4154928    .7261138
         tap |  -18.21501   5.284404    -3.45   0.001    -28.61061   -7.819414
       _cons |  -18.97918   7.339519    -2.59   0.010    -33.41764   -4.540707
-------------+----------------------------------------------------------------
         _se |   31.83606   2.577452           (Ancillary parameter)
------------------------------------------------------------------------------

  Obs. summary:        234  left-censored observations at WTP~tity<=0
                        98     uncensored observations
```

```
**********************************************************************************
```

Appendix 1- Table 10.1: Test for marginal effects

```
mfx compute, dyex nonlinear force

Elasticities after tobit
      y  = Fitted values (predict)
         = -22.024741
------------------------------------------------------------------------------
variable |      dy/ex    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
  income |   9.251962      2.6296    3.52   0.000   4.09805  14.4059    3876.2
 waterpc |  -16.81266     4.94161   -3.40   0.001   -26.498 -7.12727   5.38119
collec~e |   14.50047     2.00559    7.23   0.000   10.5696  18.4314   25.4036
     tap |  -9.985339     2.89687   -3.45   0.001  -15.6631 -4.30758   .548193
------------------------------------------------------------------------------
```

Appendix 1- Table 11: Tobit regression for WTP for improved quality

```
Tobit estimates                                   Number of obs   =        226
                                                  LR chi2(5)      =      89.47
                                                  Prob > chi2     =     0.0000
Log likelihood = -585.16578                       Pseudo R2       =     0.0710

------------------------------------------------------------------------------
  WTPquality |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        type |  -77.37195   11.69755    -6.61   0.000     -100.425   -54.31893
         pab |   38.68821   6.638338     5.83   0.000     25.60567    51.77076
      income |    .005284    .000762     6.93   0.000     .0037824    .0067857
water_cons~n |   .5685311   .1794684     3.17   0.002     .2148426    .9222197
         tap |  -30.77873   6.348799    -4.85   0.000    -43.29067    -18.2668
       _cons |   15.47005   7.381161     2.10   0.037     .9235811    30.01652
-------------+----------------------------------------------------------------
         _se |   34.65609   2.607959          (Ancillary parameter)
------------------------------------------------------------------------------

  Obs. summary:        120  left-censored observations at WTP~lity<=0
                       106     uncensored observations
```

```
**********************************************************************************
```

Appendix 1- Table 11.1 Test for marginal effects.

```
 mfx compute, dyex nonlinear force
```

Elasticities after tobit
y = Fitted values (predict)
= -5.6060484

variable	dy/ex	Std. Err.	z	P>|z|	[95% C.I.	]	X
income	21.93798	3.16348	6.93	0.000	15.7377	28.1383	4151.74
water_~n	19.55684	6.17352	3.17	0.002	7.45697	31.6567	34.3989
tap	-14.29985	2.94966	-4.85	0.000	-20.0811	-8.51862	.464602
pab	14.03732	2.4086	5.83	0.000	9.31654	18.7581	.362832
type	-62.30838	9.42012	-6.61	0.000	-80.7715	-43.8453	.80531

Appendix 1- Table 12: Summary for minimum mean and maximum of variables

Summary of WTPquality, WTPquantity, water_consumption, collection_time and income.
By category: source (Source= private tap, collective tap and river water)

source	min	mean	max
1	0	8.787037	100
	0	4.985646	100
	.5	23.63876	74
	0	32.39904	120
	160	3153.392	31180
2	0	15.21875	100
	0	10.80645	80
	.5	37.45937	81
	0	29.53684	120
	300	3887.787	16400
3	0	24.72881	100
	0	7.644068	100
	6	37.28814	81
	0	5.644068	90
	1000	5689.492	15700
Total	0	12.98652	100
	0	6.919668	100
	.5	29.35483	81
	0	27.28729	120
	160	3783.545	31180

Appendix 1- Table 13: Summary for variables:

WTPquality, WTPquantity, water_consumption, collection_time and income

by categories of: type (rural)

type	p25	p50	p75
0	0	5	10
	0	5	12
	3.95	5.55	11
	18	45	60
	700	880	1600
1	0	0	20
	0	0	0
	28	42	54
	0	0	30
	2500	4000	5700
Total	0	0	15
	0	0	7
	9	28	48
	0	20.5	45
	1400	3000	4800

Appendix 2: Research Questionnaire

University of Pretoria

Centre for Environmental Economics and Policy in Africa (CEEPA)

Department of Agricultural Economics,

Extension and Rural Development

DOMESTIC USERS SURVEY QUESTIONNAIRE

A study on water use efficiency and economic values in Swaziland.

This project is an attempt to evaluate in monetary terms a subjective value of domestic water based on the household's attitude to domestic water quality, quantity and an appropriate health risk concern. That is the survey is specially designed to obtain data on the households' willingness to pay for the domestic water quality improvement. The study also seeks to identify policy issues underpinning the differences in water availability and utilization at household level.

This survey tends to collect information on many aspects of water use, including water charges currently paid by users and their willingness to pay for water supply.

Such information will be very valuable for policy design and water management in the region. Your assistance with this effort will be highly appreciated and most valuable water policy making in the study area for the benefit of all water users.

Name of town ……………………………………………………………….…………

Name of community …………..……………………………………………………….

Name of interviewer ……….……………………………………...………...……….

Date of interview ………………………………………………………..…………

Questionnaire ID#. ……………………………………………………………………...

SECTION 1

This section includes five aspects of the study: 1) source of drinking water for the household; 2) opinions about the domestic water supply and quality; 3) willingness to pay for improvement of the domestic water quantity and quality; 4) household's avoidance behaviour

From what sources do you get your water supply?

Private tap………….collective tap………….

river………..vendor……………other(specify).

Users of private tap water

How often is water available from your tap?

All day everyday……Once everyday………twice/everyday………Once/week………. Twice/week……… three times/week……… four times week…………… five times/week………….

How much water do you use per month?……………….m^3

Do you pay for the current water services?

Yes……………… No…………….

If yes,

How much are you paying per month for the current water supply service?

Less than E10………….. E10-E25………….. E25-E50………………..

E50-E75……………….. E75-E100 …………… More than E100………

Do you consider this payment too high for the services provided?

Yes………….. No……………….

What is the price /m^3 for the water used?

Less than E0.1………. E0.1-E0.5……………. E0.5-E1……………..

E1-E2………………. E2-E5………………… more than E5………….

If you do not have access to water all day, everyday, would you be willing to pay to have access to regular and more frequent water supply?

Yes…………… No…………

If yes, how much would you be willing to pay per month for more frequent and regular tap water?

Less than E20…………. E20-E50…………….. E50-E75…………… E75-E100…………
More than E150…………….

If you are willing to pay for having frequent and regular access of water, state why?

i) …………………………………………..

ii) ………………………………………….

iii) …………………………………………

How would you rate the quality of the water from your tap?

Very good……. Good……just ok……….poor ……..very poor ………..

Would you be willing to pay for better quality of your water?

Yes ………….. No …………..

If yes, how much would you be willing to pay per month for better tap water quality?

Less than E5……… E5-E10 ………..E10-E20 ………..E20-E50…………
More than E50…………..

If you are willing to pay for having better tap water quality, state why?

…………………………………………………………………

…………………………………………………………………

…………………………………………………………………

Users of collective water tap

How far is your collective tap from your home (consider round trip)?

Km ……………….. hrs ……………………….

What means of transport do you use for fetching water?

Walking…………… car …………. Donkey …………. Bicycle ……………. Other(specify)………….

How often do you collect water (no. of trips to the collective)

One trip/day ………. Two trips/day ………… three trips/day ………….
Once/week ………… twice/week …………… three times/ week ………….
Four times/week …………….. Other (specify) ………………………….

Who usually fetches the water from collective tap?

Husband ……………… wife ……………… husband & wife …………..…
Husband & wife& children …………….. children ……………. Other(specify) ……………..

How is water carried home from the collective tap?

Type of container

Bucket (10l)…………(20l)……….. (25l) …………..Other (specify) ………………….

# of containers per trip:

1 …………… 2……………… 3……………….. 4……………… 5…………………

6 ……………. 7 ……………… more than 7 ………………..

Do you pay for the current water services?

Yes …………… No………………..

If yes.

How much are you paying per month for current water supply services?

Less than E20 ………… E20-E50 …………… E50-E75 ………………

E75-E100 ………….. E100-E150 …………… More than E150 ………….

Do you consider this payment too high for the service provided?

Yes ……………… No …………….

Would you be willing to pay for a nearer and more regular access to water?

Yes …………… No ………………..

If yes, how much will you be willing to pay per month for a nearer and more regular access to water?

Less than E20 ………… E20-E50 …………. E50-E75 ………………..

E75-E100 ……………… E100-E150 ……………… More than E150 …………..

If you are willing to pay for having frequent and regular access of water, state why?

i) ………………………………………………………………………………

ii) ……………………………………………………………………………

iii) ……………………………………………………………………………

Users of river water

How far is the river from your home (consider round trip) ?

Km ………………. Hrs …………………..

What means of transport do you use for fetching water?

Walking …………. Car ……………….. donkey …………… bicycle …………… other(specify) …………………

How often do you collect water (no. of trips to the river)

One trip/day ………….. two trips/day ………… three trips/day ………………

Once/week …………… twice/week ……………three times/week ……………..

Four times/week …………… other(specify) ……………………..

Who usually fetches water from the river?

Husband ……………… wife ………… husband & wife ……………..

Husband & wife & children ………… children ……………..

others(specify) ……………..

How is water carried home from the river?

Type of container:

Bucket (10l)…………(20l)……….. (25l) …………..Other (specify) …………………

# of containers per trip:

1 …………… 2……………… 3……………….. 4……………… 5…………………

6 ……………. 7 ……………… more than 7 ………………..

Would you be willing to pay for a nearer and more regular access to water?

Yes ……………….. No…………………….

If yes, how much would you be willing to pay per month for a nearer and more regular access to water?

Less than E20 ………… E20-E50 …………… E50-E75 ………………

E75-E100 ………….. E100-E150 ……………

More than E150 …………

If you not willing to pay for having frequent and regular access of water, state why?

i) ……………………………………………………………………………

ii) …………………………………………………………………………

How would you rate the quality of the water from the river?

Very good …..... good ……. Just ok ……. Poor …… Very poor ………

Would you be willing to pay for better quality of river water?

Yes ……………… No ………………..

If yes, how much would you be willing to pay per month for better river water quality?

Less than E5 ……. E5-E10 ……... E10-E20 ……… E20-E50 …………

More than E50 ……………….

If not willing to pay for having better river water quality, state why?

i) ……………………………………………………………………………

ii) …………………………………………………………………………

iii) …………………………………………………………………………

SECTION 2

2.1 Household socio-economic characteristics.

2.2 Age of the head of the household (years) …………………………………

2.3 Gender of the head of the household: Female ………… Male ……………

2.4 Education level of the head of the household
None ……… Primary ……… Secondary ………. Diploma ………….
Degree ………… Other(specify) ……………….

2.5 What is the size of your family (no. of family members)? ……………….

2.6 Any small children in the household?
Yes ……….. No …………………

2.7 Occupation of the head of household
Farm worker ….... Pensioner …… Domestic worker ……. Public sector ……
Mining …….. Industrial……… self-employed ………. Unemployed ……..

2.8 How much is the head of household earning per month, indicate in which category his or her income falls.

<E1000 ….. E1000-E3000….. E3000-E6000 …… E6000-E10000 ……
E10000-E15000……… >E16000… ….

2.9 State the amount of the total household's income from each source.

Source	Amount per month
Farm income	
Public subsidies	
State salaries	
Domestic worker income	
Mining income	
Industrial income	
Pension	
Other(specify)	

Comments (respondent)

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Interviewer……………………………………………………………………………………

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