NMBU

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Krishna Dhanusk

Ås, July 20, 2014

Dedication

To my parents,

who devote their life for my accomplishment

ABSTRACT

The Contingent Valuation Method (CVM) was used to reveal the households` willingness to pay (WTP) for a water supply system improvement in Kathmandu Valley, Nepal. In-person interviews of random sample of 240 households were conducted in Kathmandu Metropolitan of Kathmandu district, Latitpur sub-metropolitan of Lalitpur district and Madyapur Thimi Municipality of Bhaktapur district of Kathmandu Valley. Cross-sectional ramdom sampling method is used to collect 80 samples from each district; 20 from each wards of respective district. Both households that are currently connected (piped) and those that are not (non-piped) were asked their WTP in terms of the monthly income, water bill, electricity bill, education etc. Melamchi Water Supply Project (MWSP) is going to complete by June, 2016. Maximum capacity of the project is 170 mld. It is supposed that MWSP will help to reduce water scarcity problem by 50% in Kathmandu Valley. So, they would pay for an improvement in the water supply services. The mean WTP of piped and non-piped households were NRs 562 (US$ 5.9) and NRs 590 (US$ 6.2) per month, respectively. Currently piped households are paying NRS 225 (US$ 2.4) per month for drinking water and sanitation. According to my research, I found that piped households are ready to pay 102% more if they will get improved water service of 10 hours per day. On the other hand, I quantified from my analysis that non-piped households are also willing to pay NRs 590 (US$ 6.2) which is little bit surprising. But ground reality is that people of Kathmandu Valley, Nepal are facing shortage of more than 200 mld per day. Its shows that non-piped households are desperately looking for option of consistent water supply service as compared to present system (i.e well water, jar water, tanker water, tube well etc). Due lack of purity and consistency in present drinking water system, non-piped households might be higher WTP than piped households.

Both piped and non-piped households are looking for consistent and purifying water service from Kathmandu Upatyaka Khanepani Limited (KUKL); main body drinking water supply in Kathmandu Valley.

Ordinary Least Square (OLS) was used to regress WTP on the explanatory variables. OLS results showed that not all of the socio-economic characteristics employed in the model have significant effects in determining the households' WTP. Moreover, the effects of explanatory variables on WTP significantly vary between the piped and non-piped households. The analysis also revealed that the income elasticites of WTP of the piped and non-piped households were

0.147 and 0.115, respectively. These results provide important inputs to cost-benefit analyses of water supply improvement projects in Kathmandu Valley.

Key words: Contingent Valuation, Water supply, Ordinary Least Square

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CURRENCY EQUIVALENT

(As of July, 2014)

Currency Units = Nepalese Ruppes (NRs)

1 US$ = 96.35 Rs

1 NOK= 15.58 Rs

ABBREVIATIONS AND ACRONYMS

ADB	:	Asian Development Bank
BLUE	:	Best Linier Unbiased Estimation
CBA	:	Cost and Benefit Analysis
CLRM	:	Classical Linear Regression Model
CS	:	Consumer Surplus
CV	:	Compensating Variation
CVM	:	Contingent Valuation Method
EV	:	Equivalent Variation
GoN	:	Government Of Nepal
HDR	:	Human Development Report
KUKL	:	Kathmandu Upatyaka Khanepani Limited
MBDC	:	Multiple Bounded Discrete Choice
MLD	:	Million Litres Per Day
MWSP	:	Melamchi Water Supply Project
NOAA	:	National Oceanic and Atmospheric Administration
NOK	:	Norwegian Kroner
NPH		Non-Piped Household
NPHC	:	National Population and Housing Census
NWSC	:	Nepal Water Supply Corporation
OLS	:	Ordinary Least Square
PH	:	Piped Household
RP	:	Revealed Preference
NRS	:	Nepalese Ruppess
SP	:	Stated Preference
UN	:	United Nations
UNDP	:	United Nations Development Program
USD	:	United States Dollar
VIF	:	Variance Inflation Factor
WB	:	World Bank
WHO	:	World Health Organization
WTA	:	Willingness to Accept
WTP	:	Willingness to Pay

CHAPTER 1: INTRODUCTION

"Water is essential for all dimensions of life. Over the past few decades, use of water has increased, and in many places water availability is falling to crisis levels. More than eighty countries, with forty percent of the world's population, are already facing water shortages, while by year 2020 the world's population will double. The costs of water infrastructure have risen dramatically. The quality of water in rivers and underground has deteriorated, due to pollution by waste and contaminants from cities, industry and agriculture. Ecosystems are being destroyed, sometimes permanently. Over one billion people lack safe water, and three billion lack sanitation; eighty per cent of infectious diseases are waterborne, killing millions of children each year."

Institute, W. B. (Nov, 1999)

1.1 **Background**

Water scarcity is the lack of sufficient available water resources to meet the demands of water usage. It has been already observed in about 2.8 billion people around the world at least one month in a year. About 1.2 billion people and more are in lack accessing drinking water (Shivakoti 2014).

Like many developing countries, Nepal faces a plethora of problems regarding both its drinking water quality and availability. Kathmandu Valley is currently suffering from chronic water shortages and inefficient service delivery. In spite of government effort in 90`s, they were unable to decrease shortage of improve water problem in Kathmandu Valley. Nepal Government executed its policy in 9th five year plan to involve local government and private sectors in the development of water supply and sanitation with an objective to make such agencies more autonomous and also to reduce political interference in the day to day administration of the then Nepal Water Supply Corporation (NWSC). On the basis of this, the Government of Nepal privatized the NWSC by forming the Kathmandu Upatyaka Khanepani Limited (KUKL), a water utility operator, to solve the water problems in the Kathmandu Valley three years ago. The main objective of KUKL, to reform and improve the water supply services in the Kathmandu Valley qualitatively and quantitatively. However, this effort is always influenced by instable political scenario and pressure.

Large numbers of people do not have access to water. Even those people who have access to tap water do not get safe and quality water. Historically, the water supplied from local sources such as wells, and water spouts were adequate because the population was geographically dispersed and per capita water demand was comparatively low. However increase in per capita water demand, population density and related development activities, water has become a serious problem for the people of Kathmandu both in quality and quantity. Present demand of water of the city has increased tremendously because of the rapid growth of population and urbanization. Kathmandu Upatyaka Khanepani Limited (KUKL) Kathmandu Upatyaka Khanepani Limited (KUKL) is a public company whose objective is to undertake and manage the water supply and sanitation system of the Kathmandu. The main target of KUKL is to distribute improved water service with consistency to its customers at an affordable price. KUKL provides its service to Kathmandu valley. KUKL is the main body to operate and manage water and waste water services in the Valley (Adhikari 2005).

1.2 Kathmandu and Its Water Supply Service

Currently KUKL is providing water service in Kathmandu vally through 34 service stations in Kathmandu Metropolitancity, 10 service stations in Lalitpur Sub-metropolitancity, 6 service stations in Bhaktapur Municipality, 1 service station in Madhyapur Municipality and 8 service stations in Kirtipur Municipality. Besides this, KUKL provides water services using tankers. At present total numbers of tankers are 27. Mainly tanker services available in those areas where piped water service is not available or in emergency cases.

Kathmandu city alone needs 350 million liters of water per day for drinking purpose only. Kathmandu Upatyaka Khanepani Limited (KUKL) is providing 84 mld (Millions litre per day) in dry season and 144 mld in wet season (Annual report KUKL, 2013).

KUKL, itself accepting that Kathmandu valley is lacking atleast 200 mld drinking water which is catastrophe. To fulfill remaining demand of drinking water people are relying on ground water like private well, boring water, jar water, water from public stand pipe and last but not the least private water tanker suppliers. Currently, KUKL is shortage with 200 million litre per day. The Melamchi Water Supply Project (MWSP) has been in under contruction since 20 years. It was expected to be completed 10 years ago but due political instability and maoist insurgency, it has beed delayed. Now, it is supposed that if everything will goes according to plan than MWSP water may come to Kathmandu valley by developmentJune, 2016.

According to census 2011, total population of Kathmandu valley, it consists Kathmandu, Lalitpur and Bhaktapur, is 2.5 million. Due to centralized governance system, most citizens from all over the country are centralized in Kathmandu valley because of education, health and other facilities. Thus, it is expected that atleast 3.5 million people aare living in Kathmandu valley.

Accoding to Annual Report KUKL, 188 thousands of households have inhouse water connection. Out of 188 thousands household, 50 thousands household are deprived of regular service. They are only paying minimum water bill without getting drinking water.

In June, 2013, KUKL increased the minimum water charge per month for metered customer by 225%. Earlier it was Rs 85 ($0.9) per month, out of Rs 85; 50 for water service and 35 for sewage. After increasing in price it is around Rs 225 ($2.3) per month.

To improve the present conditions of water supply and wastewater services in Kathmandu Valley, the Government of Nepal (GoN), with the assistance of several development agencies, has pointed on a two-long term improvement strategy that includes capital investments for social infrastructure, i.e. supply and system improvement and institutional reforms. To improve the present conditions of water supply and wastewater services in Kathmandu Valley, the Government of Nepal (GoN), with the assistance of several development partners, has pointed out on a two-long term improvement strategy that includes capital investments for infrastructure development, i.e. improvement in supply & system for institutional reforms.

The groundwater of Kathmandu Valley is under immense pressure as it is being heavily utilized for both drinking and non-drinking purposes. Although groundwater overexploitation is recognized as a serious problem.

In Kathmandu, total storage of ground water is 15 billion cubic meters. Out of total storage of water only 3 billion cubic meters are able to absorb. KUKL has divided the ground water of Kathmandu valley into three major regions, viz, Northern, Central and Southern. Among these entire regions, northern region has good water storage. Likewise, in Kathmandu valley only 40 million liters ground water can be absorbed daily. But in 2002, daily 60 million liters ground water was absorbed and in 2009, daily 70 million liters ground water was absorbed. Due to the over absorption of ground water, the level of ground water is depleting by 1.5 meters (in average) but in some places by 2.5 meters annually (Annual Report KUKL 2009).

The Kathmandu Valley on average receives 1,400 millimeters of rainfall per year. Most of this rainfall flows out of the valley as surface runoff. Rainwater harvesting at the community and household level is not practiced and storage to supplement the public supply in the dry season is only available in-house. The main problem is that the valley receives most of its rainfall in July-

September, thus requiring a large storage to ensure water for use over the rest of the year. The other problem is that the removal of vegetative cover in the past, and the nature of the soils and geology prevent most rainwater from seeping into underground aquifers to allow its use throughout the year. Water conservation is not practiced and within the valley, there is a number of competing water uses (Pandey & Kazama 2011).

Tap Water Supply Station in Kathmandu Valley

Graph 1.1

Source: Google map

1.3 Statement of the Purpose

Only 40% of households are using inhouse connection water service in Kathmandu valley. Still half of the households in Kathmandu valley are using unreliable and poor quality piped water. Lack of capital and ineffective management has limited the city's ability to utilize existing water resources to provide its population with clean and safe water. For that reason, a need based assessment of the housqeholds for a quality in-home water supply is required (KUKL 2013).

Contingent valuation method (CVM) is important tool for this analysis.

This assessment questions the value of both environmental services (e.g. good quality water) and public goods (e.g. good water availability). A good quality of water supply has both use and non-use values. The use value refers to the use of water for every household's purpose; meanwhile the non-use value refers to the option that the household has for the easy and reliable water supply. If the use value appears easier to understand, the non-use value might need more elaboration. It is the value that does not involve market transaction or direct participation.

As the use value can be approached by the cost of providing them, the non-use value cannot be easily derived. Even though it is obvious that people are WTP for passive use or non-use value, unless their value is revealed, these benefits are implicitly considered as zero. Therefore, asking questions to them is the only option we have for estimating the values as people do not reveal their WTP through their behavior.

1.4 Objectives of the Study

The main objectives of this study is to assess household`s WTP based on the CVM to get access to the improved in-home water supply in Kathmandu Valley. The specific objectives are:

1. To examine whether there is a significant difference in WTP for improved water supply between piped households and non-piped households in Kathmandu Valley

2. To examine which factors determine WTP for improved water supply in Kathmandu Valley and examine whether there is a difference in effect in regard to these factors in WTP between piped and non-piped household

1.5 Hypotheses

The following hypotheses are tested for piped and non-piped households, respectively:

1. WTP for the piped household is significantly higher than the non-piped household.

2. Household's income has a significant positive effect on the WTP

3. Gender of respondent significantly affects WTP; women (responsible for getting water) has a significantly higher WTP than men

4. Educational level of the respondent affects WTP positively

5. Household's size affects the WTP positively

People are collecting water from standing stone pipe at Kathmandu Metropolitan

Graph 1.2

Source: Google map

1.6 Organization of the Study

This study contains 6 chapters. The first chapter includes the introduction covering the background and situation of Kathmandu Valley and its water supply, problem statement, objectives and hypotheses. The second chapter will be literature review. The third chapter is devoted to the theoretical framework. Description about data and methodology is carried out in chapter four. Chapter five presents the analysis of the data and the discussion of the results. Finally, chapter six will close this study with the conclusion.

CHAPTER 2: LITERATURE REVIEW

KUKL Annual Report (2013), describes the present scenario and water supply and sewage conditions. According to annual report 188 thousands households are connected with KUKL service. Additional 30 thousands households will be connected with KUKL by the end of 2014. Maximum production is 144 mld in wet season and minimum production is 84 mld in dry season. KUKL increases it water bill by 225% in June 2013.

In Rezza (2007), the Contingent Valuation Method (CVM) was used to reveal the households` willingness to pay (WTP) for a water supply system improvement in Jakarta, Indonesia. In-person interviews of random sample of 350 households were conducted in five cities within the administrative Province of Jakarta. Both households that are currently connected (piped) and those that are not (non-piped) were asked their WTP in terms of the monthly water bill they would pay for an improvement in the water supply services. He used three econometric approaches were used to regress WTP on the explanatory variables; Ordinary Least Square (OLS), Interval Regression (IR) and Quantile Regression (QR). I have followed his work as my main refrence while writing my thesis. It is because context and objectives of the studies are very much similar in nature.

Wang et al. (2010), pointed out that policy makers frequently need to use demand-side information rather than only rely on supply-side data as usually do, where as household surveys are often implemented to collect information on the demand side. Their paper presents a multiple bounded discrete choice (MBDC) survey model for collecting information about acceptability of different water prices by different types of households and estimating households' willingness to pay for progress in water service. The outcomes of the MBDC surveys can be directly utilized in the development of water pricing and subsidy. This MBDC study is executed in Chongqing, China, where water service was seriously inadequate, but financial resources were insufficient to improve the service quality. For survey 1500 households were selected from five suburban districts in Chongqing Municipality, this study reflects that a notifiable increase in water price is economically feasible as long as the poorest households are properly subsidized. The results of survey also shown that the order in which hypothetical prices are presented to the respondents with the MBDC method can systematically affect the answers and should be taken into account when designing such survey instrument.

Vásquez et al. (2009) used a Contingent valuation (CV) survey is used to elicit household willingness to pay responses for safe and reliable drinking water in Parral, Mexico where Households are using variety of averting and private investment choices like bottled water consumption, local water treatment, and installation of water storage facilities to adapt to the existing water supply system. These kinds of revealed preference behavior shows that the possible demand for improved and believable water services, which is identified by the CV survey evidence. This paper described results that households are willing to pay from 1.8% to 7.55% of reported household income above their current water bill for safe and reliable drinking water services.

Awad and Holländer (2010) attempted to apply CVM in Ramallah Governorate which consists urban, rural, and refugee camps. The CVM was employed to get estimates of Willingness to Pay (WTP) for improved domestic water supply services for current and coming generations. In their CV survey, they adopted a dichotomous choice with follow-up questions, also open-ended follow-up question to measure individual's WTP. Also, Tobit econometric model and OLS were used.

Kanayo et al. (2013) used the CVM as analytical tool, their study sought to identify the determinants of the people`s WTP for improved water supply in Nsukka, ascertain what they would pay to assist government, and identify the amount of revenue that government could generate. This study is perform by using primary and secondary data. The estimation of the Tobit (censored) model showed that most of the variables included in the model individually and collectively provided basic information on the nature of household utilization of water. Outcomes of the study described that WTP for water was sensitive to the level of education and occupation of head of the household, prices for private water supplier, installation cost and the average monthly income of the households.

Pandey et al. (2010) stated that urban development with in Kathmandu Valley has progressed without any planning or control. As a result, none of the distribution means or household connections has been designed for present day population and water demands. Thus, most existing distribution pipes are undersized for both present and future water demands and need to be replaced to provide equitable pressure and water supply service policy Understanding of the impact of natural resource scarcity and poverty on fertility, and hence population growth rates is important in programming and formulating policies.

CHAPTER 3: THEORETICAL FRAMEWORK

The main objective of my research work is getting information about WTP for improved drinking water from direct questions. According to (Haab & McConnell 2002), compensating variation (CV) & equivalent variation (EV) and willingness to pay (WTP) & willingness to accept (WTA) are two equally valid ways to describe money welfare measures. Both quantify that increase in income that makes a person indifferent to an exogeneous changes. Contingent valuation is a technique which is used to explore non-market valuation, stated preferences and bahavioral approaches. Non-market valuation consist microeconomics, welfare economics and econometrics.

I have divided my theorical framework portion in three part. They are as follows:

i) Contingent Valuation Method

ii) Welfare Measurement and Willingness to Pay

iii) Aggregating WTP

3.1 Contingent Valuation Method

After the publication of Hotelling` paper on public utility price; the concept of "new welfare economics" developed. Later Samuelson`s theory of public goods emerged. Later again Economists identified that non-market valuation is also eminentt part of economic analysis. Thus, they elaborated non-market valuation method in two parts i.e indirect and direct method where CVM is direct method.

Contingent valuation method (CVM) is a non-market valuation method where stated preference technique is used to measure individual`s preferences.

The main objective of the CVM is to estimate individual`s WTP/WTA when changes occurs in the quantity or quality of goods or services or effect of co-variates on WTP. CVM study faced lots of criticism. National Oceanic and Atmosphere Administration (NOAA) panel was rejected. After simultaneous improvement in CVM, experts had excepted that for measurement of public valuation; a well contructed CVM is best solution (Hanemann 1994). When we sum up the net gain of the society then we can get estimates (O'Doherty 1996) cited in Rezza 2007).

O`Doherty classified CVM under the direct and hypothetical categorization which is shown in following table 3.1 below:

Behavoiur Based Methods for Valuing Public Goods

	Result is Directly obtained by Observing valuations	Result is Indirectly obtained by observing valuation
Observed Market Behaviour	Direct and Observed: Referenda, Simulated Market, Parallel Private Markets	Indirect and Observed: Household Production, Travel Cost, Hedonic Price, Actions of Beauucrats and Politician
Response to Hypothetical Market	Direct and Hypothetical: CVM, Allocation Game with Tax Refund, Spend More-Same-Less Survey Question	Indirect and Hypothetical: Contingent Ranking, Willing-to-(Behaviour), Allocation Games, Priority Evaluation Techique, Conjoint Analysis, Indifference Curve Mapping

Table 3.1 (O`Doherty 1996 cited in Rezza 2007)

CVM is operated by taking interviews with respondents. Interview might be taken as in-person interview, mail interview, or telephone based interview. When researcher asked WTP questions to respondent then respontents are insisted to answer only WTP related questions but also questions comprised with socioeconomic background (income, gender, level of education, etc.) of the respondents. First of all, all the collected answers are processed then it can be utilized to measure their relationship with WTP (Rezza 2007).

CVM becomes very popular analytical tool while valuing non-market goods because of its flexibility and easy to estimate the total value. Problem of CVM can be decreased if researcher is focused on his study design and implementation (Carson 2000).

3.2 Welfare Measurement and the Willingness to Pay (WTP)

Contingent valuation method (CVM) is supposed as very important economic tool while measuring value of non-market goods and non-use goods & services. It is described as one of the influencial valuation method which consists survey of personal opinions of value regarding hypothesis (Duberstein & De Steiguer 2003). Due to changes in income or prices, consumer may be either better off or worse off. Economists concluded that ideal welfare effects might be the change in utility (Varian 1992). (Varian 1992) simplify it in mathematical form which is as follows :

Let (p_0,m_0) is initial budget and (p_1,m_1) is budget after increase in price or income. We measure welfare effect by taking difference in indirect utility, i.e

$$\boldsymbol{u} * (\boldsymbol{p_i}, \boldsymbol{m_i}) - \boldsymbol{u} * (\boldsymbol{p_o}, \boldsymbol{m_o}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{(A)}$$

On one hand we can derive indirect utility function from an ordinal utility function and on other hand difference in utility resulted in arbitory monotonic transformation. Thus, we are unable to get true quantitative measure of utility (Varian 1992). Welfare measurement is useful if moneytary measure is used. Monetary measure means consumer surplus (CS), compensating variation (CV) and equivalent variation (EV). We can calculate the CV and EV by using expenditure component in the indirect utility function, expenditure function and money metric utility function (Varian 1992).

Contingent Valuation is employed to estimate the change in the expenditure function or indirect utility function (Haab & McConnell 2002). Although the measurement of welfare change in my research was based on household level, but theoretical framework is defined as there is no contrast between household and individual. Smith and Van Houtven (2004) researched a lot to simplify this study. To describe precisely, I have divided study of CS, CV and EV separately. They are as follows:

3.2.1 Consumer Surplus

Consumer surplus is defined as difference between WTP and actual payment.in another way, WTP is described as the amount that leaves the consumer indifferent between new and initial situation (Varian 1992).

Utility function of consumer is the main tool to quantify consumer surplus in demand theory. Consumer`s behavior can be explained primarily by incorporating demand theory through the utility function. Based on the expression below:

$$\max \boldsymbol{u} = \boldsymbol{u(q)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

subject to

$$\boldsymbol{pq} = \boldsymbol{m} \ldots\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(2)}$$

Where,

u= utility, p= price of goods, q= quantity of goods, m= total amount of budget

Consumer`s are supposed to maximize their utility (1) given their level of income (2) that is exactly spent. In (1), $\boldsymbol{q} = (\boldsymbol{q_i})$ is taken as level of commodities consumed. Meanwhile in (2), $\boldsymbol{p} = (\boldsymbol{p_i})$ is the price of good consumed and $\boldsymbol{m}$ is consumer income.

When we solve the first order condition of equation (1) and (2) by using the Lagrangian method. which gives us the indirect utility function ***v(p,q,m)*** as

$$v(p,q,m) = u[q(p,m)] \text{...} (3)$$

Equation (3) denotes that maximum attainable utility level for a set of prices and certain income. Now, we differenciate the equation (3) with respect to price and income. And we use Roy's identity which provides us:

$$\frac{\left[\frac{\partial v(p,m)}{\partial p_i}\right]}{\left[\frac{\partial v(p,m)}{\partial m}\right]} = q_i(p,m) \quad \text{...} (4)$$

Where i= 1,2,…,n

Equation (4) is known as the Marshallian demand function which describes quantity demanded as a function of price, holding income constant and allows the utility level to change. Since we can`t measure the consumer's gain in terms of utility, as utility is not cardinal, the monetary measurement of utility change can be obtained by the total differentiation of (3) and the application of Roy's identity such that

$$dv = \Sigma\left(\frac{\partial v}{\partial p_i}\right)dp_i + \left(\frac{\partial v}{\partial m}\right)dm..$$

$$dv = \lambda[dm\Sigma q_i(p,m)dp_i] \text{...} (5)$$

where λ is the Lagrangian multiplier. This expression is assumed to be constant. It interprets the marginal utility of income. The welfare change, **dw**, can be obtained by dividing both sides of equation (5) by λ so that:

$$dw = \frac{dv}{\lambda} = dm[\Sigma q_i(p,m)dp_i] \text{...} (6)$$

For discrete changes in p and m, Eq^n (6) can be rewritten as

$$\Delta w = \Delta m[\Sigma q_i(p,m)dp_i]$$

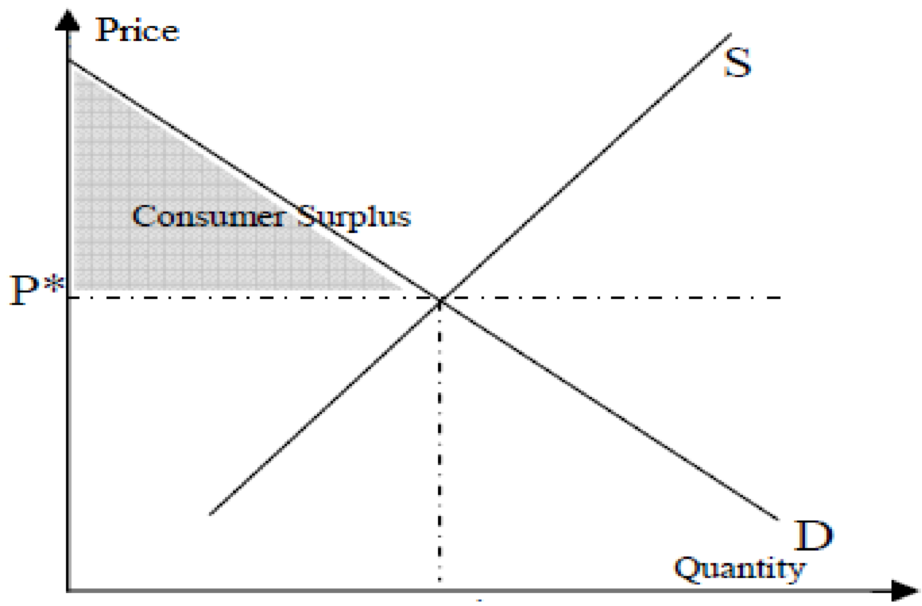
$$= \Delta m[\sum_{i=1}^{n} \int_0^1 (p,m)dp_i \text{.......................} (7)$$

(Hassan 1995) figured the equation (7) as mathematical expression of Marshall for consumer surplus.

Graphically,

We can show it by graph 3.1 :

Consumer Surplus



Graph 3.1

Shaded portion in graph 3.1 explained the consumer surplus. The difference between the amount of money which consumer is willing to pay for good and the actual price which he pays for good is called consumer surplus (Boardman & Boardman 2010).

Two concerns have emerged in regard to the uniqueness of CS's concept According to (Hassan 1995) cited from Rezza (2007), two things comes out as a unique regarding concept of consumer surplus.

At first, the line integral in (7) is not path independent since it depends on how price and income change. Secondly, the derivation from (5) to (6), and so this concept, is firmly based on the constancy of λ (i.e. the marginal utility of income). It is possible for λ to be constant with respect to all prices but not to income. Therefore, both conditions imply that the uniqueness of CS concept can only be held under certain conditions.

In addition, environmental (or public goods) have a particular characteristic that makes the concept of the Marshallian demand function and CS difficult to be applied. The unpriced environmental public goods can not be traded as they do not have private property characteristics. It makes one can not directly observe the price and other information required to estimate the Marshallian demand curve. Although we can approach this problem using, for instance, a surrogate market, the accuracy of CS was often disrupted by the presence of income effect mean (Bateman & Turner 1992). Moreover, unpriced environmental (or public) goods frequently have much higher income elasticities than other market goods (Bateman & Turner

1992) cited in Rezza (2007). Consequently, the welfare's change measurement using CS may be undermined. Thus, there is a need to develop a more accurate welfare change measurement technique that is free from ambiguity. This can be done by compensating the income effect and holding real income constant. By doing this, we move from the Marshallian demand curve to the Hicksian (compensated) demand curve (Rezza 2007).

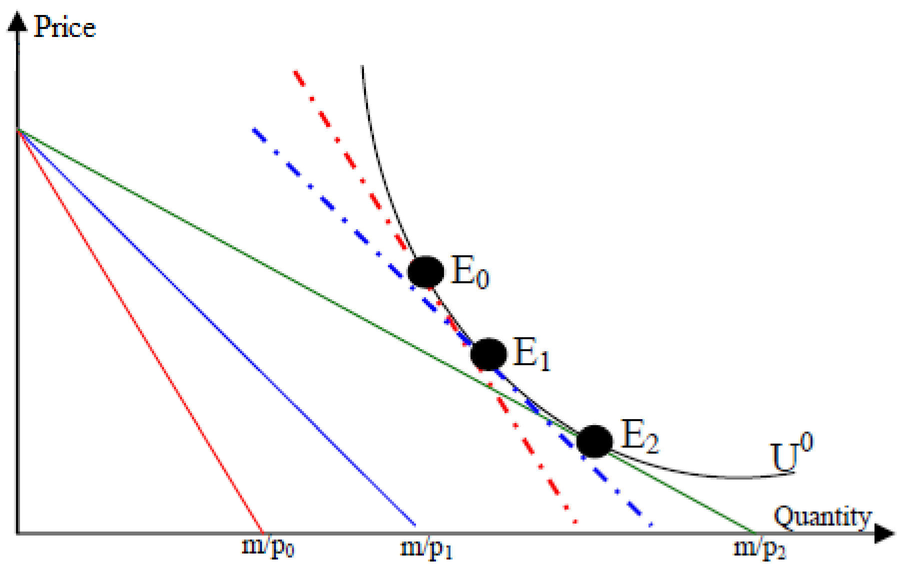
3.2.2 Hicksian Demand Function CV, EV and WTP

The Hicksian demand function is usually stated as the 'compensated' demand function. It states to the fact that in order to hold consumers in the same utility level (i.e. indifference curve) as prices vary so that we need to adjust their income, i.e., by giving them compensation Bateman & Turner 1992 cited in Rezza 2007).

We can derive the Hicksian demand function by substituting the indirect utility function in equation (3), by solving it for **m** in terms of **u** and a set of **p**. Finally we apply Shepard's Lemma from the result of the second step. The Hicksian demand curve, hence, can be expressed as:

$$\boldsymbol{q_i = q_i(u, p)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

Graphically,



Graph 3.2: Hicksian Approach

Based on the concept of the Hicksian approach, change in welfare change can be measured by two ways. They are as follows:

a) Compensating Variation (CV)
b) Equivalent Variation (EV)

Compensating Variation: CV is defined at initianl level of utility. Its is explained as the amount of income that mest be taken away from the consumer after economic changes to restore him to the original welafare level (Hassan 1995). CV analysis is used when anyone can try to fix some compensating scheme at the new prices. CV will use different base prices for each new policy change (Varian 1992). CV expounds that amount of income which is either given or taken that places individual remains on his initial level of utility (U_0), where as EV is the amount of income which is either given or taken that leaves the individual on his final level of utility (U_1) (Haab & McConnell 2002).

Equivalent Variation: EV is defined as the new level of utility. EV is interpret as the amount of income that must be given to consumer which might be either positive or negative in place of an economic change to make him/her as better off as with the change (Hassan 1995). EV may be better alternate if we are going to compare more than one proposed policy change because EV keeps base price at status quo (Varian 1992).

The definitions of EV and CV are quite complex but I am very much clear that my study is mainly based on CV.

By substituting the indirect utility function in (3) to both CV and EV, a change in price from initial value $\mathbf{p_0}$ to final value $\mathbf{p_1}$ can be expressed as:

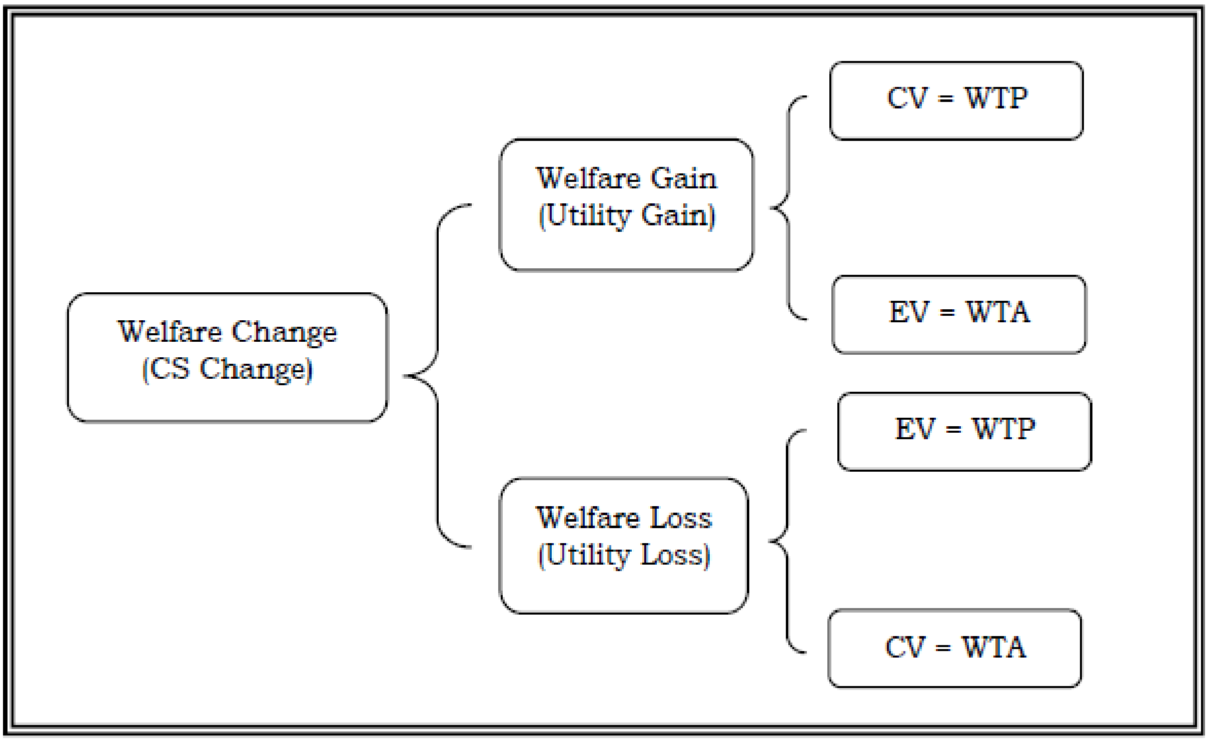
$$v(p_0, m_0) = v(p_1, m_0 + CV) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

$$v(p_1, m_1) = v(p_0, m_0 + EV) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

Since the changes in welfare can be either positive (welfare gain) or negative (welfare loss). In CV, change in price makes the individual better off (i.e. a change in public or environmental goods increased the utility, e.g. cleaner water, less pollution, etc), and the compensation will take him back to his initial level which might be negative. In this case, individual should be willing to give up some amount of money, i.e. the willingness to pay (WTP). On the other hand, if the change in price makes him worse off, then the compensation has to be done to make his utility level reverse of what it was, i.e. the willingness to accept (WTA) (Hassan 1995).

EV explains that how much extra money would have to be given to an individuals (WTA) so that he can achieve the final level of utility without a provision change occurring. EV can also used to estimate how much an individual is WTP to avoid the welfare loss. The four possibilities of these Hicksian measurements can be figured as in Graph 3.3:

Relationship among CV, EV, WTP and WTA



Graph 3.3

By integrating the above described concepts in equation (9) and (10) then we can measure the changes in $\boldsymbol{q}$, then we get

$$\boldsymbol{v(p_0, q_0, m_0) = v(p_0, q_1, m_0 - WTP)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(11)}$$

Where $\boldsymbol{q_1 > q_0}$ and increases of $\boldsymbol{q}$ are desirable $\left(\frac{\partial v}{\partial q_i} > 0\right)$. The WTP can also be expressed by the expenditure function as

$$WTP = m(p_0, q_0, u_0) - m(p_0, q_1, u) \text{ .... (12)}$$

where $u = v(p,q,m)$

Equatin (12) interprets that WTP is the amount of income which an individual would sacrifice to make him indifferent between the initial state: income at **m** and the environmental (or public) good at q_0 and the changed state: income decreased to **m – WTP** and the environmental public good increases (Haab & McConnell 2002).

3.3 Aggregating WTP

Various types of bias in the CVM have been explained in earlier studies. Nevertheless, aggregation of the benefits estimated is also one type of bias that has only received limited attention (Morrison 2000). The different types approaches made by the researcher at this point could deliver a substantial effect upon the size of the measures (Bateman et al. 2001).

The aggregation of WTP in contingent valuation studies have usually been performed by multiplying either the median or the mean WTP with the total number of individuals (or households) in the population (de Oca et al. 2003). The use of the median measurement has been proposed by (Hanemann 1989) and (Haab & McConnell 2002) as median aggregation is less sensitive to the distributional misspecification and estimation method. Though it violates the Kaldor-Hicks potential compensation criterion, the median measurement is believed to be more equitable for aggregation purposes in social rule consideration (Hanemann 1989). The aggregation through the mean of the WTP, on the other hand, is consistent with the cost and benefit analysis and gives the social benefit for the offered project (de Oca et al. 2003).

(Morrison 2000) interprets that there is possibility that characteristics of sample might be different from the population, it might be due to fault in sampling or non-random responses. Researcher`s can deal with these types of biases by adjusting the mean of the sample value and by examining non-responses (Morrison 2000). The following table tabulated the views of (Morrison 2000) which is shown in table 3.2:

Approach to Biases in WTP Aggregation

Approaches	Method
Adjustment of the mean sample values	Substitute population average in regression equations
	Put weight on regression analysis based on the proportion of people in the sample stratum and population stratum
	Put weight on regression analysis based on the population proportions for a given socio-economic characteristics
Examining non-responses	Assuming the WTP of non-respondents is equal to zero
	Extrapolation using the relationship between respondent`s preference and the time of response
	Use of sample selection models
	Classifying non respondents

Table 3.2

CHAPTER: 4 DATA COLLECTION AND METHODOLOGY

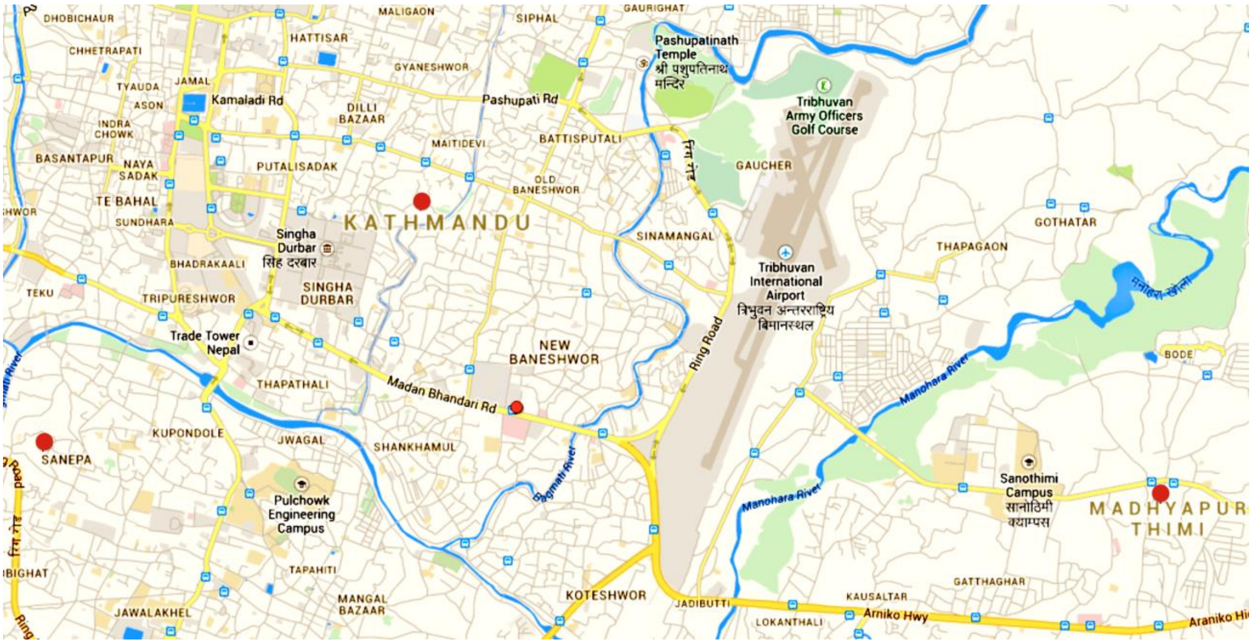
Cross-sectional data will use for research and data will be collected from individual households of different parts of Kathmandu Valley.The study will be conducted in Kathmandu valley` s Kathmandu, Lalitpur and Bhaktapur districts are situated in the study area. And they used as deep tube well for fulfilling the requirement of water demand. Similarly, various housing and apartment projects are under construction in these areas, so there is high demand of water resources on the contrary institutional supply of water in these area are very low. Therefore people are highly dependent upon ground water.

This chapter presents the study area, the methods employed for data collection, the variables used, the methods of data analysis, and the problem of mis-specifications.

4.1 Study Area

Field study is conducted in Kathmandu valley which consists three districts. They are: Kathmandu, Lalitpur and Bhaktapur. Kathmandu is the capital of the Republic of Nepal. Kathmandu valley is located in the central part of Nepal (27° 43’ 0” North Latitude, 85° 19’ 0” East Longitude), it has an area of 220 square miles and more than 2.5 million in population (Census, 2011). Along with Kathmandu, I also conducted my cross sectional data collection in Lalitpur and Bhanktapur also. I had choosen Kathmandu Metropolitan Municipality (ward no: 5, 16, 34, 35) in Kathmandu district. Lalitpur sub-Metropolitan Municipality (ward no: 2, 7, 8, 11) in Lalitpur District. And Madhyapur Thimi Municipality (ward no: 4, 7, 8, 17) of Bhaktapur district.

Map of the study area



Graph 4.1

Source: Google map

4.2 Data Collection Activities

The survey was done in Kathmandu Metropolitan City of Kathamnadu district, Lalitpur Sub-Metropolitan City of Lalitpur district and Madhyapur Thimi Municipality Bhaktapur district. Primary data were collected by myself alone. The target was to get a minimum of 300 households. I had collected exactly 300 households data. Exactly 100 households from each districts and 25 from 4 wards of each municipality of each district respectively. Later while evaluating data I found some questionnaires are incomplete, some had homogeneous type of answer and some were answered by tenant instead of house owner. I eliminated those answer from my study. Thus, I planned to use 80 households from each district i.e 240 households in total (I talked with my supervisor Prof. Ståle Navrud regarding reduction of households numbers and he granted permission to me). Definitely, the more samples collected would be better. But, the time and budget availability was not possible to support a larger sample. In total, a number of 240 samples of households were successfully pooled. That amount contains 102 household with an in-house water connection, and the other 138 without it. Indeed, the sample size is relatively small in comparison with other CV studies. The sample is also very small in comparison with the total population of Kathmandu Valley. Altogether the sampled households represent 0.01% of total households in the study area (Kathmandu Valley)**.**

I had randomly selected 4 wards from each municipality/metropolitan city/sub-metropolitan city. I had selected 20 households from each ward. Thus, 80 households from each municipality/metropolitan city/sub-metropolitan which are briefly presented in table 4.1 below.

Total Population, Households And Sample Size

	Total Popolation, Households and Sample Size			
Districts	Municipality	# of Ward	# of Households	Sample Size
Kathmandu	Kathmandu Metropolitan City	4	975,453	80
Lalitpur	Lalitpur Sub-Metropolitan City	4	220,802	80
Bhaktapur	Madhyapur Thimi Municipality	4	83,036	80

Table: 4.1

Source: National Population and Housing Census 2011, Volume 02

Before conducting the survey, the following steps were carried out:

1. A focus group discussion was conducted with a representative from the Kathmandu Upatyaka Khanepani Limited (KUKL).

2. A hypothetical scenario for the contingent valuation question was written down and included in the questionnaire. I asked to recite to the respondent the scenario written. This was done to make sure that the entire respondents got the same understanding on the (hypothetical) scenario.

3. The questionnaire was pre-tested and, based on the results, was revised.

4. Four wards were selected randomly in each Metropolitan city/ Sub-Metropolitan City/ Municipality.

5. 20 households were selected randomly in each ward.

The survey was targeted only to the head of household or the house wife because both are considered to be the decision maker in the household. It was also aimed only at the respondent who owns the house where s/he is living.

I asked the question no B15 to non-piped user households to findout their willingness to pay if they will get improved piped water 10 hours/day.

Box 4.1: Hypothetical Scenario and Willingness To Pay Question

As we all know, the present water supply system in Kathmandu Valley has been unreliable and it has not been possible to improve the service level due to lack of financial funds.

The reality is that Kathmandu Valley still has nearly 77% of households that don't have piped water provided by the Kathmandu Upatyaka Khanepani Limited (KUKL). The households are using unreliable water from wells; Some are using motors for extracting water from underground, some others have to buy from small water vendor.

Present demand of drinking water in Kathmandu Valley is 400 million litters water per day where as KUKL is providing almost 170 million litters in peak season and 100 million litters in dry season.

Total capacity of Melamchi Water Supply Project is 170 million litters water per day.

Suppose that the water supply service is now improved. For example, Melamchi Water Supply Project (MWSP) is going to complete by the end of 2016 that can make this area connected with the piped water system. The quality of water will also be good. There is no chemical smell coming from the water. It will also be available 10 hours a day in every day of the year, water pressure is strong enough to use shower and can get to your first floor. As a result, your family doesn't need to buy tank to store water, you don't need to spend money on filter, you don't need to boil water before drinking, you don't have to waste your time and patience for collecting water when it is only available at night, and you don't have to pay electricity cost for pumping.

Now, I'm going to ask you some questions to learn whether your household is interested in having a connection and would be willing to pay to make use of the water supply system. It is important that you answer the questions as truthfully as you can so that we can really know whether you wish to have a better quality of service or not, and which amount you can afford and are willing to pay for it. If you and the other people we interview say that you cannot pay anything or anything more than you are currently paying, even if these statements are not true, then perhaps it is not possible to improve and extend the water supply system. It is therefore important to answer the questions honestly.

Think about how bothered, disturbed or annoyed you are by reliability, quality, and availability of

the water supplied you are having right now, and how much it is worth to you personally to avoid this. What is the most your household is willing to pay in connection fee bill in order to get the piped water connection in your house (Rezza 2007)?

Like earlier one, I asked the same question (Question C20 in questionnaire) to piped water user households for checking their willingness to pay (WTP).

Box 4.2: Hypothetical Scenario and Willingness To Pay Question:

Melamchi Water Supply Project (MWSP) is going to complete by the end of 2016 that can make this area connected with the piped water system. This project will serve 170 million litters water per day. The quality of water will also be good. There is no chemical smell coming from the water. It will also be available 10 hours a day in every day of the year, water pressure is strong enough to use shower and can get to your first floor. As a result, your family doesn’t need to buy tank to store water, you don’t need to spend money on filter, you don’t need to boil water before drinking, you don’t have to waste your time and patience for collecting water when it is only available at night, and you don’t have to pay electricity cost for pumping.

4.3: DESCRIPTION OF THE VARIABLES

There are various ways to define the term of "household". (Sadoulet & De Janvry 1995) assert that the concept of household varies widely across cultures. This study defines household as the group of people living together and sharing the same kitchen or, in the case of piped water households, using the same piped water.

The independent variables in this study are the determinants of WTP for water service improvements. They were chosen based on the previous study on WTP of water service improvements in several other places as well as the consumer theory. The variables are:

Willingness to Pay (WTP): The maximum amount of income a respondent will pay in exchange for an improvement in their water supply services as it is mentioned in the hypothetical scenario. In this study, WTP acts as a dependent variable and measured in monetary units (NRs).

Income (Income): This variable is a combination of income from all household members. It includes the money received from labor or service activities, as well as profit from financial investments and other benefits (insurance, scholarships, etc). This variable is expected to have a positive sign as the more income households have, the more ability they have to afford water service improvements.

Sex (Sex): This dummy variable represents respondents' gender difference. SEX is defined as SEX=1 if the respondent is female and SEX=0 if otherwise. The variable predicted parameter is expected to have a positive sign to indicate that females are likely to have a higher WTP. This hypothesis is based on the fact that women usually deal with domestic affairs; including water fetching. As a consequence, they are expected to have a higher WTP.

Total Family Size (TotFam): It is the number of individuals that live in a household. It is expected that a larger household size will increase the tendency to have a higher WTP. The household is likely to need more water if they have more people living in a household.

Year of Education (Edu): This is representing human capital endowment and knowledge. It is expected that an increase in individual years of education will increase the understanding of water importance and, therefore, the respondent's WTP will be higher.

Installation Cost (Inscost): In Kathmandu, normally all individual household store their water either in tank or drum or bucket and etc. This variable shows the cost of installation of place where they reserve the stored water.

Electricity Cost (Elecost): This variable represent the monthly electricity bill of individual house either they have piped water or non-piped water. It shows monthly bill in Nepali currency i.e Rupees (Rs).

Pipe Dummy (pipe_dum): This variable represents new dummy variable pipe_dum where 1= for piped water households and 0=non-piped households. If this dummy is significant it would mean that piped and non-piped households have significantly different WTP.

In particular, both INCOME and WTP variables are provided in monetary units and were transformed to natural logarithms in order to minimize normality problems, as well as to avoid heteroscedasticity (Masiye & Rehnberg 2005). As a consequence, the coefficient from the regression results of ln-INCOME should be interpreted as income elasticity of WTP. This tells us how much, in per cent, the WTP will change due to the effect of changes in total household income. Concretely described by the following table 4.2 as below :

Description of Variables for WTP for Water Service Improvement

Variable	Variable Type	Variable Description	Expected Sign
Dependent Variable			
WTP	Continuous	Monetary Units, Households WTP	
Independent Variable			
SEX	Dummy	Sex of household head 1=F, 0=M	positive
INCOME	Continuous	Total Monthly Income of household	positive
TOTFAM	Continuous	Total Family Member	negative
INSCOST	Continuous	Total Installtion Cost Of Water Storage	positive
ELECOST	Continuous	Total Monthly Electricity Cost	positive
EDU	Dummy	Years of Schooling	positive
PIPE_DUM	Dummy	1=piped and 0=non-piped	negative

Table 4.2

4.4 ECONOMETRICS ESTIMATION METHOD

An estimation methodology under certain assumptions is required to estimate coefficients and testing their significance. Assumptions, detection and estimation problems in Classical linear regression model (CLRM) and Classical Normal Linear Regression Model (CNLRM) are:

Normality assumption:

The classical normal regression model assumes that each ui is distributed normally with Mean = 0, Variance = σ^2 and Cov (u_i , u_j) = 0, where i is not equal j. The assumptions given above can be more compactly stated as $u_i \sim N(0, \sigma^2)$ (Gujarati 2008). With the normality assumption, the probability distribution of the OLS estimators can be derived and also help us to use the t, F and χ.statistical tests for regression models. Holding the normality assumption the use of statistical tests (t & F) is valid. Therefore it is very important to detect the presence or absence of normality of the disturbance terms in the model. It can be detected using Jarque –Bera (JB) test (Gujarati 2008). The JB test of normality is based on OLS residuals. It is employed to compute the skewness and kurtosis measures of the OLS residuals and uses thefollowing test statistic.

JB = n { S2/6 + (k –3)2/24} where n = sample size, K= kurtosis coefficient and S = skewness coefficient. When a variable is normally distributed, the values of S and K are 0 and 3, respectively. And thus, the JB statistics becomes zero, which is expected in a normal distribution, formulation of a hypothesis for normality test is useful. With the hypothesis that residuals are normally distributed, the JB statistics follows Chi-square distribution with 2 degrees of freedom. Under the hypothesis that the error terms follow a normal distribution, JB statistic must be sufficiently close to zero or the p value must be reasonably high in order to accept the hypothesis that the disturbance term are normally distributed.

Multicollinearity:

Multicollinearity is the exercise of linear relationship among some or all explanatory variables of a regression model. When the variables are multicollinear it is difficult to separate their effects on the dependent variable. The regression coefficients cannot be estimated with great precision. We can detect multicollinearity using the following rule of thumb.

a) High R^2 but few significant t ratios

If R^2 is high, say, excess of 0.8, the F test in most cases will reject hypothesis that the partial slope coefficients are simultaneously equal to zero where as the individual t tests shows that none or very few of the partial slope coefficients are statistically different from zero.

Heteroskedasticity:

For the detection of heteroskedasticity, we will run the "hettest" command in Stata and in result we will see the p-values of Harvey test, Glesjer test and White test to decide about the presence of heteroskedasticity.

The t-test as noted earlier, the assumption that the disturbance terms are normally distributed, with mean zero and variance σ., is essential to make inference about individual partial regression coefficients. We can use the t-test to test a hypothesis about any individual partial regression coefficient. It helps to test whether the individual slope coefficient is zero or different from zero. The t-statistic is normally distributed and can be calculated as follows:

$$t = \beta(hat)/se\{\beta(hat)\} \sim t\alpha/2\ (n-k)df$$

Where n = sample size and k = number of estimated parameters. If the calculated value is greater than the tabulated value, we will reject the null hypothesis that the individual partial coefficient is significantly different from zero.

The F test Unlike the t test, the F test provides versatile tests. It helps to test individual slope coefficient, the joint effect of many regression coefficients in the model and tests under two or more linear restrictions. Under the assumption of CNLRM where ut ~ (0, σ.), the hypothesis that individual regression coefficient is zero or many of the partial regression coefficients are jointly equal to zero can be tested using the F test. This test also enables us to test regression coefficients under certain restriction.Therefore, it tests the overall significance of the model or whether the partial regression coefficients are significantly different from zero. This test approach involves the analysis of variance (ANOVA) technique and its test statistic is calculated asfollows.

$$F = \frac{ESS/df}{RSS/df} = \frac{ESS/(k-1)}{RSS/(n-k)} \sim F\alpha/2\ (k-1, n-k)$$

WhereESS, RSS, n and k are the explained sum of squares, residual sum of squares, number of observations and number of estimated parameters, respectively.

If calculated value of Fcal is greater than the tabulated value Fα/2 (k-1, n-k), then we reject the null hypothesis that all the partial regression coefficients are jointly equal to zero.

Multiple coefficient of Determination (R^2)

In the estimation of multiple regression line, the residuals lie around the estimated line, some are negative and othersare positive. It is very seldom that there is a perfect fit of the estimated line to the data. Multiple coefficient of determination (R^2) is a summary measure that tells how well the multiple regression line fits data or it is the goodness of fit of the fitted regression line to set of data. R. tells us whether the fitted regression model fits actual data good or poor. Alternatively, it measures the variation in the dependent variable explained by the independent variable which is calculated as:

R^2. = ESSor 1 –RSSwhere $0 \leq R^2. \leq 1$

RSS TSS

When R^2= 0, then it implies that the independent variables do not explain the dependent variable. But a higher value of R^2 may not necessarily show that all the explanatory variables selected are appropriate to explain the model. As more explanatory variables are added to the model, then R^2 increases and as a result it is not a good measure of the fitness of the model (Gujarati 2008). There it is usually reported with the weighted R^2 or adjusted R^2. It is calculated as:

Adjusted R^2 = RSS/ (n-ki)

The specification of the equation below was primarily motivated by theory and relevant literature (Moffat et al. 2011). In the model, WTP is endogeneously determined by the following independent variables income level (Income), gender of head of the household (sex), education level (edu), total no of family member (totfam), total installation cost of water storage (inscost), monthly electricity bill (elecost), pipe dummy where 1=piped households, 0=nonpiped households (pipe_dum)

Estimated regression model is as follows:

WTP= f(Income, Sex, Edu,Totfam, Inscost, Elecost, Pipe_dum)

I used the linear regression model to determine the effect of explanatory variables on the dependent variable. Hence our model will be as follows:

I have tried to analyze the WTP of piped households, non-piped households of my study area. On the other hand, I also attemed to compare there the WTP of both households on the basis of income and other similar control variables. At last, I assumed piped house (households which have water connection) as a dummy variable.

Thus, my main regression equations are follows:

Econometric model for Piped Household is:

$$WTP(PH) = \beta_1 + \beta_2 Income + \beta_3 Sex + \beta_4 Edu + \beta_5 TotFam + \beta_6 Inscost + \beta_7 Elecost$$

Where,

PH= Piped Household

WTP: Willingness of Kathmandu Valley`s residents to pay for improved water quality and reliable supply (in monetary terms, Rupees)

B_1=Constant

B_i= Coefficients where i=2 to 7

Income= It household`s total monthly income.

Sex= This dummy variable represents respondent`s gender. Sex is defined as Sex=1 if respondent is female and Sex=0 if otherwise

Edu= Education level of respondent (in terms of schooling years)

TotFam= It is the number of individuals that live in house.

Inscost= It is the total amount of cost while installing water storage.

Elecost= It is households total monthly electricity bill.

Econometric model for Non-piped Households is as:

$$WTP(NPH) = \beta_1 + \beta_2 Income + \beta_3 Sex + \beta_4 Edu + \beta_5 TotFam + \beta_6 Inscost + \beta_7 Elecost$$

Where

NPH= Non-Piped Households

Econometric model for Combined Analysis is as:

$$WTP = \beta_1 + \beta_2 Income + \beta_3 Sex + \beta_4 Edu + \beta_5 TotFam + \beta_6 Inscost + \beta_7 Elecost + \beta_8 pipe\_dum$$

Where,

WTP: Willingness of Kathmandu Valley`s residents to pay for improved water quality and reliable supply (in monetary terms, Rupees)

B_1=Constant

B_i= Coefficients where i=2 to 8

Income= It household`s total monthly income.

Sex= This dummy variable represents respondent`s gender. Sex is defined as Sex=1 if respondent is female and Sex=0 if otherwise

Edu= Education level of respondent (in terms of schooling years)

TotFam= It is the number of individuals that live in house.

Inscost= It is the total amount of cost while installing water storage.

Elecost= It is households total monthly electricity bill.

Pipe_dum= This is a dummy variable which shows1=piped water households and 1=non-piped households

4.5 Priori Expectations:

Income: Income is supposed to be positively related to WTP. Environmental economic theory described that the demand for an improved environmental quality increases with income. Consequently, those with a higher income are expected to be more WTP for an improved water quality and reliability of supply than those who have little or no source of income (Moffat et al. 2011).

Sex: Gender (1 = female and 0 otherwise) is suppose to affect WTP. A positive relationship between WTP and GEN might exist when the respondent is female because they are the ones who take care of domestic household chores such as travelling to other places to fetch water in times of need, hence they will be willing to pay (Moffat et al. 2011).

Edu: WTP for improved water quality and reliability of supply is expected to be positively related to education. The longer time in formal schooling (years), the more people understand better the consequences of using unsafe water and the need to have reliable water supply. Therefore, the educated will be more willing to pay than the illiterate (Moffat et al. 2011).

Totfam: Household size is expected to be inversely related to WTP. It is assumed that big households will be willing to pay relatively less due to the associated high running costs (i.e. budgetary constraints). Thus, the study expects the sign of its coefficient to be negative (Moffat et al. 2011).

Inscost: It is the total amount of cost while installing water storage. We expect positive relationship between WTP and Inscost because households invest huge amount to make storage place for water.

Elecost: It is average monthly electricity bill of individual households. We expect positive relationship between electricity bill and WTP because almost every households are using electricity motor to extract water from storage place.

Pipe_dum: we assume 1=pipe water household and 0=non-piped user household. We expect negative sign here because willingness to pay piped and non-piped households might be different than each other.

4.6 Problems of Misspecification and Goodness of Fit

Model misspecification in regression has long been a well-recognized research problem. This chapter explains about the major problems of misspecification in Classical Linear Regression Model (CLRM). Our main concern will me multicollinearity, heteroscedasticity and normality. We must have to fulfill this condition to go towards further analysis (Rezza 2007).

Multicollinearity: "OLS is said to have the smallest variance among many other linear unbiased estimators. If two or more explanatory variables exhibit a perfectly linear relationship between (among) them, the variance will be infinite. Thus the problem of perfect multicollinearity arises. One that works with STATA should not be worrying this problem since STATA will automatically drop such variables. What about non-perfect linear relationship? A Variance Inflation Factor (VIF) is calculated to detect the highly, but less than perfect, linear relationship between independent variables. The VIF, computed as $(1-R_i^2)$-1, is a diagonal element of the inverse of the correlation matrix. Since the high value of VIF indicates a collinearity, this study considered VIF of more than 10 as a harmful collinearity as it was suggested by Hamilton (2003)" (Rezza 2007).

Heteroscedasticity: There is a heteroscedasticity problem in the model if variances of the error term, u_i, are not constant across observations (Rezza 2007). The problem of heteroscedasticity is commonly found in the cross-sectional data (Gujarati 2008). The White's test procedure is used to check the model. It tests the null hypotheses that the variance of residuals is homogenous. If the p-value attained from the regression is less than α used, one should reject the null-hypothesis and accept that the variances are not homogenous (Rezza 2007).

Normality: "the CNLRM is strongly based on the normality condition of the error term's distribution. The Shapiro – Wilk W test for normality is used to check this problem. The decision rule is based on the p-value. A large value of it will indicate that we can not reject the null hypotheses that the residual is normally distributed. this study also assessed the goodness of fit value of the regression (i.e. R^2) in the purpose of knowing how far the independent variables used can explain the variation that happens in the dependent variables. STATA provides the R^2 value of OLS " (Rezza 2007). Ri^2 is the artificial goodness of fit that can be obtained by regressing the i^{th} independent variable on all other independent variables (Hamilton 2012).

CHAPTER 5: RESULTS AND DISCUSSION

This section is divided into results and discussion. Finding of this study are based on the cross-sectionally collected data from Kathmandu Valley, Nepal in July and August, 2013. Out of total 240 households, 138 households are non-piped user and 102 households are piped households. According to National Population and Housing Census (NPHC 2011) of Nepal, 2.5 million people are permanent residents of Kathmandu Valley (district Kathmandu, Lalitpur and Bhaktapur). Besides this, thousands of people from all over the Nepal are come every day for their better opportunities. Altogether the sampled households represent 0.01% of total households in the study area (Kathmandu Valley)**.**

5.1: Descriptive Statistics

Descriptive statistics of the dataset is shown by table 5.1

Descriptive Statistics of the Datasets

Variable	Observation		Mean		St. Dev.		Min		Max	
	Piped	Non	Piped	Non	Piped	Non	Piped	Non	Piped	Non
WTP	102	138	575	590	331.42	282	100	150	2000	2500
Income (RS)	102	138	44509	28768	25040	22971	10000	10000	100000	100000
Sex (dummy)	102	138	0.33	0.2	0.48	0.4	0	0	1	1
Inscost	102	138	40718	32150	52436	31966	1000	0	242000	200000
Elecost	102	138	1063	747	694	477	100	250	4000	3000
Totfam	102	138	5.67	5.25	2.12	1.82	2	2	13	13
Edu (dummy)	102	138	0.75	0.623	0.322	0.48	0	0	1	1

Table 5.1

Where,

WTP: Willingness of Kathmandu Valley`s residents to pay for improved water quality and reliable supply (in monetary terms, Rupees)

B_1=Constant

B_i= Coefficients where i=2 to 7

Income= It is household`s total monthly income.

Sex= This dummy variable represents respondent`s gender. Sex is defined as Sex=1 if respondent is female and Sex=0 if otherwise

Edu= Education level of respondent (in terms of schooling years)

TotFam= It is the number of individuals that live in house.

Inscost= It is the total amount of cost while installing water storage.

Elecost= It is households total monthly electricity bill.

Pipe_dum= This is a dummy variable which shows1=piped water households and 1=non-piped households

Statistical test were conducted to check the difference of some independent variable between piped and non-piped households group. Since the samples were randomly chosen from the normally distributed population of Kathmandu Valley. P-value can be carried out for satisfying.

5.2: Measuring Willingness to Pay (WTP)

5.2.1 Income as a single determinant of WTP

From welfare theory, we expect income affects WTP. Hence at the first stage of analysis we consider only income; as a single explanatory variables of WTP. While doing so, we obtained the following results.

a) Piped

In order to find out the WTP of 102 piped households only on the basis of income; I had run a regression in stata where the following results came which is precisely described in table 5.2 as follows:

Results WTP of Piped Households on the Basis of Income

Variable	Coefficient	P-Value
Income	0.0031	0.017
Constant	436.53	0.00

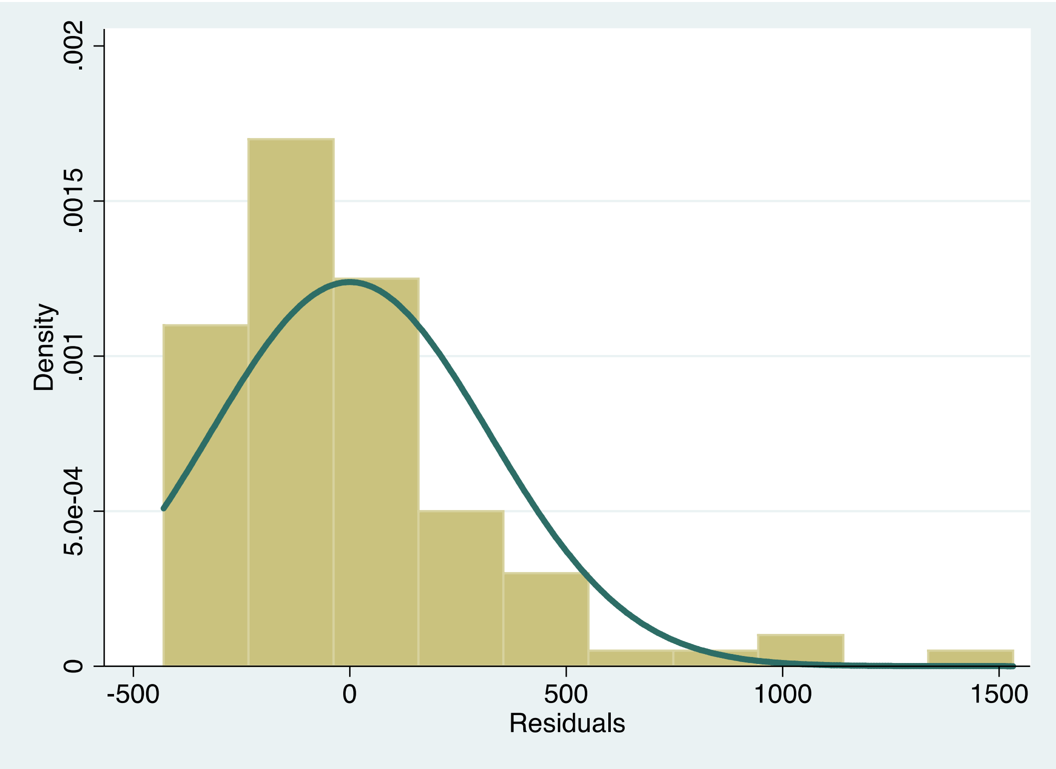
Table 5.2

From the test results, we explored that Rs. 100 increase in income results into Rs. 0.31 increase in WTP for household with piped water supply and this result is found to be statisticaly significant. Other econemtrics assumptions are found as follows:

Normality:

The pattern of residual is found nearly to be normal as shown in the graph 5.1 below.

Pattern of Income Residual of Piped Households



Graph 5.1

Heteroskadasticity:

The dataset is found to be free from heteroskadasticity. Since p-value of hettest is greater than 0.05. thus, we accept the null hypothesis of constant variance. The test result can be seen from the test result below in table 5.3

Heteroskadascity Test Results of WTP to Income of Piped Households

```
. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of wtp

         chi2(1)      =     0.00
         Prob > chi2  =   0.9453
```

Table 5.3

b) Non-Piped

Again in order to find out the WTP of 138 non-piped households on the basis of their income; I run the regression in stata where the dataset is not found to be free from heteroskadasticity. Hence I run Robust standard error to get correct result with heteroskadasticity problem which is shown by table 5.4

Table 5.4 : Results of WTP of Non-Piped Households on the Basis of Income

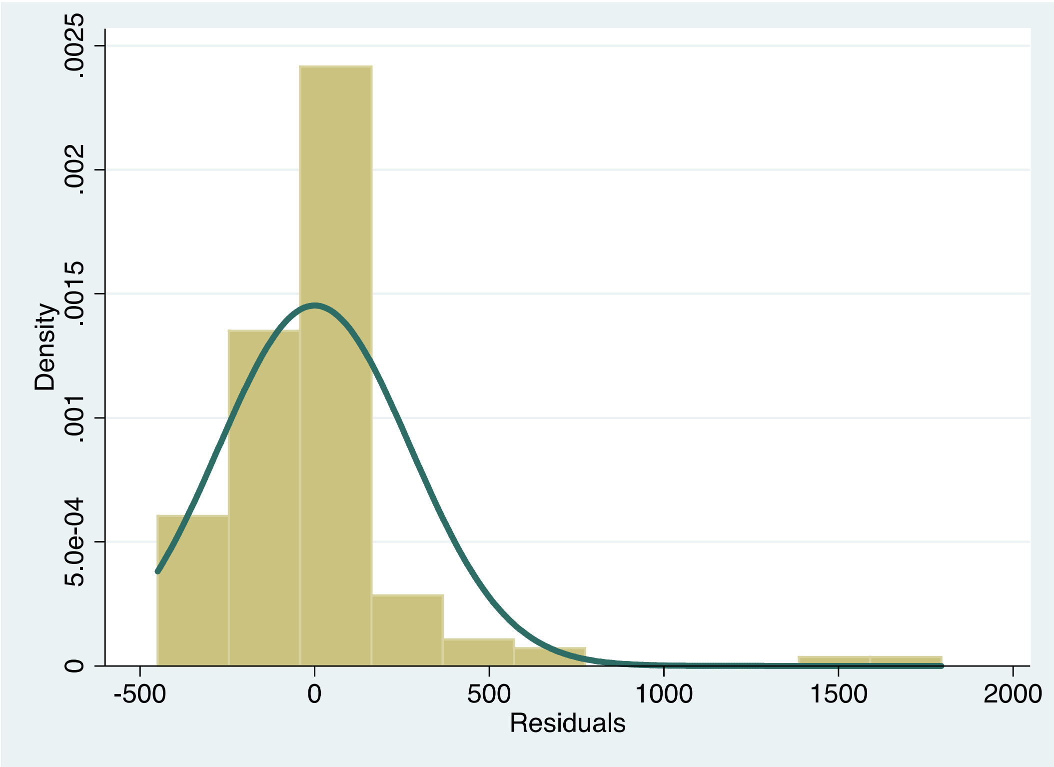
Variable	Coefficient	Robust Std. Error	P-value
Income	0.0028	0.0013	0.044
Constant	508.532	31.13	0.00

From the test result, we can explain that if income is increased by NRs. 100 resulted that WTP for non-piped household is increased by NRs. 0.28. Results of WTP for household with non-piped water supply is found to be statisticaly significant at 5% level.. Other econometric assumptions are found as follows:

Normality:

The pattern of residual is found nearly normally distributed as shown in the graph 5.2 below.

Pattern of Residuals of Income of Non-Piped Households



Graph 5.2

Heteroskadasticity:

The dataset is not found to be free from heteroskadasticity. Hence we run Robust standard error to get true result with heteroskadasticity problem. Since p-value of hettest is less than 0.05 we reject the null hypothesis of constant variance which is shown in table 5.5

Heteroskadascity Test of Income to WTP of Non-Piped Households

```
. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of wtp

         chi2(1)      =    48.84
         Prob > chi2  =   0.0000
```

Table 5.5

c) Comparision of piped and non-piped

By the comparison we see that the income coefficeint to wtp of piped is found to be greater than non-piped. The results are shown in the table 5.6 below.

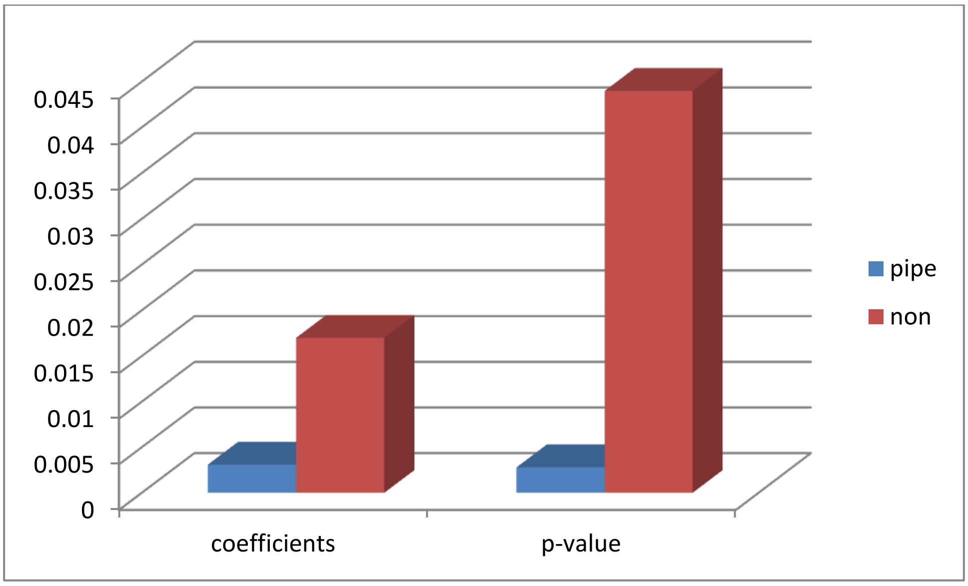
Comparision of WTP of Piped and Non-Piped Households To Income

Variable	Observation		Coefficient		P-value	
WTP	Piped	Non-Piped	Piped	Non-Piped	Piped	Non-Piped
Income	102	138	0.0031	0.0028	0.017	0.044
Constant	102	138	436.53	508.53	0.00	0.00

Fig 5.6

Graphical comparision of piped and non-piped households is shown by graph 5.3 below:

Graphical Comparision Piped Households & Non-Piped Households



Graph 5.3

Where y-axis shows numerical value

5.2.2 Elasticity of Income to WTP

After analyzing the income effect on WTP of households. Now I am trying to check the elasticity of income to WTP. Basically, “elasticity of income is used to measure the responsiveness of the demand for a good to a change income of the people demanding the good, ceterus paribus” (Wikipedia). In our case, it means responsiveness of the people for wtp to a change of income to obtain regular water supply.

Mathmatically we take log(wtp+1) and log(income) and run the regression model as follows to obtain the elasticity of income to wtp.

$$\ln(wtp + 1) = b_0 + b_1 \ln(income)$$

In above equation b_1 represents the elasticity of income to wtp.

a. **Piped**

To measure the elasticity of income to WTP of piped households, I run the regression of linlog (WTP+1) and log of income. Which is shown in the table 5.7 below

Elascity of Income to wtp of Piped Households

Variable	Coefficient	P-value
Ln_Income	0.147	0.054
Constant	4.66	0.00

Table 5.7

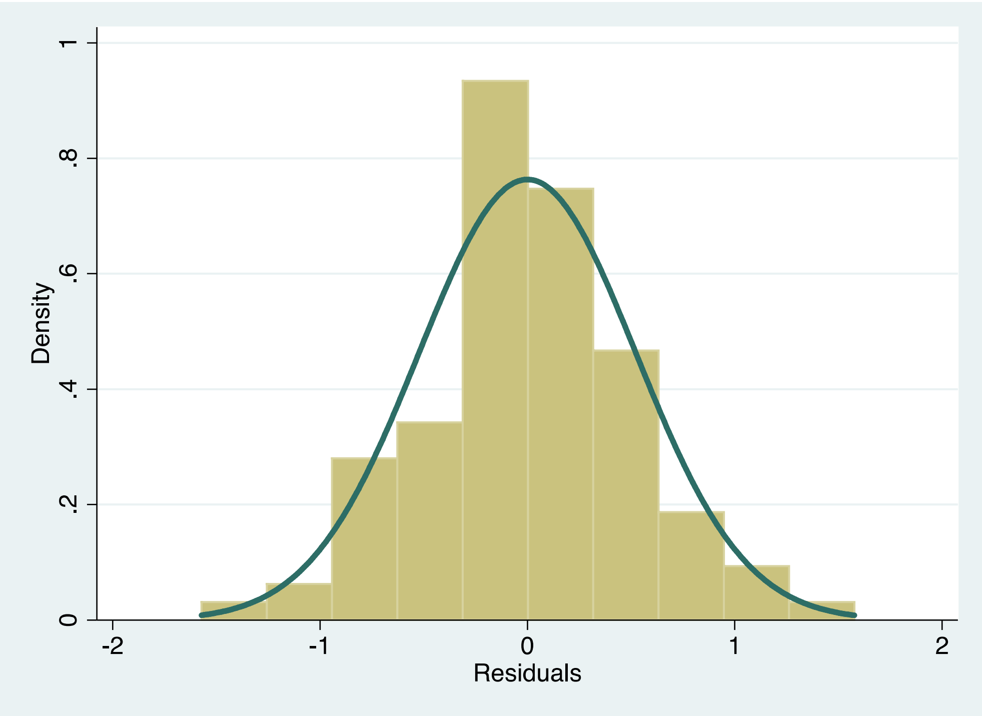
From the test result of linlog regression for the non-piped households (ln _WTP = b_o+ b_1_Inc) shows an income elasticity (b_1) of WTP of 0.147 meaning that when income increase by 1% WTP increases by 0.15 % . P-value is 0.054 which is significant in 10% level of significance.

Other econemtrics assumptions are found as follows:

Normality:

The pattern of residual is found nearly to be normal as shown in the graph 5.4 below.

Graph 5.4 Pattern of Residuals of Elasticity of Income of Piped Households



Heteroskadasticity:

The dataset is found to be free from heteroskadasticity since p-value of hettest is greater than 0.05 and we accept the null hypothesis of constant variance. The test result is shown in the table 5.8 below.

Heteroskadascity Test of Elascity of Income to WTP of Piped Households

```
. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of ln_wtp

         chi2(1)      =     1.63
         Prob > chi2  =   0.2014
```

Table 5.8

b. Non-piped households:

In order to find out the elasticity of income to WTP of 138 non-piped households; I again run the regression in stata where I found that dataset is not found to be free from heteroskadasticity. Hence I run Robust standard error to get true result with heteroskadasticity problem which is shown by table 5.9:

Elasticity of income of non-piped households which is shown by table 5.9

Elasticity of log income to ln(wtp+1) of non-piped households

Variable	Coefficient	Robust Std. Error	P-value
Income	0.115	0.047	0.016
Constant	5.14	0.465	0.00

Table 5.9

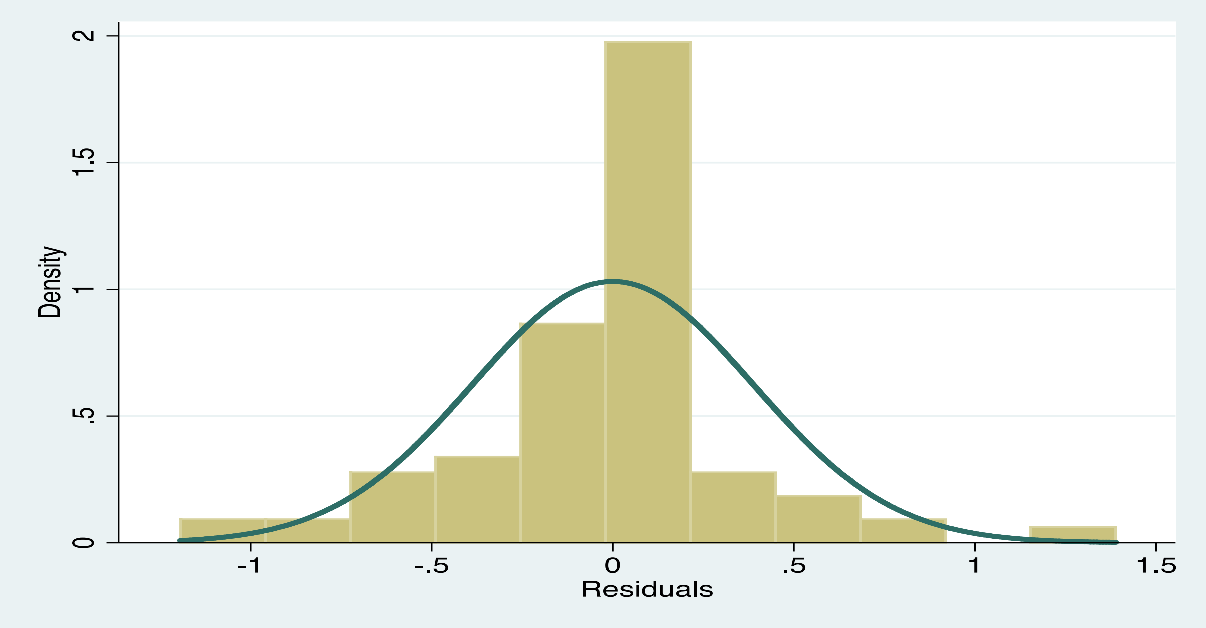
This linlog regression analysis for the non-piped households ($\ln\_WTP = b_o + b_1 \ln\_Inc$) shows an income elasticity (b_1) of WTP of 0.115 meaning that when income increase by 1% WTP increases by 0.115 % . P-value is 0.016 which is significant in 5% level of significance.

Other econometrics assumptions are found as follows:

Normality:

The pattern of residual is found almost to be normal as shown in the graph 5.5 below:

Graph 5.5 Pattern of Residuals of Elasticity of Income of Non-Piped Households



Graph 5.5

Heteroskadasticity:

The dataset is not found to be free from heteroskadasticity since p-value of hettest is less than 0.05 and we reject the null hypothesis of constant variance. The test result is shown in the table 5.10 below:

Heteroskadascity Test of Elascity of Income to WTP of Non-Piped Households

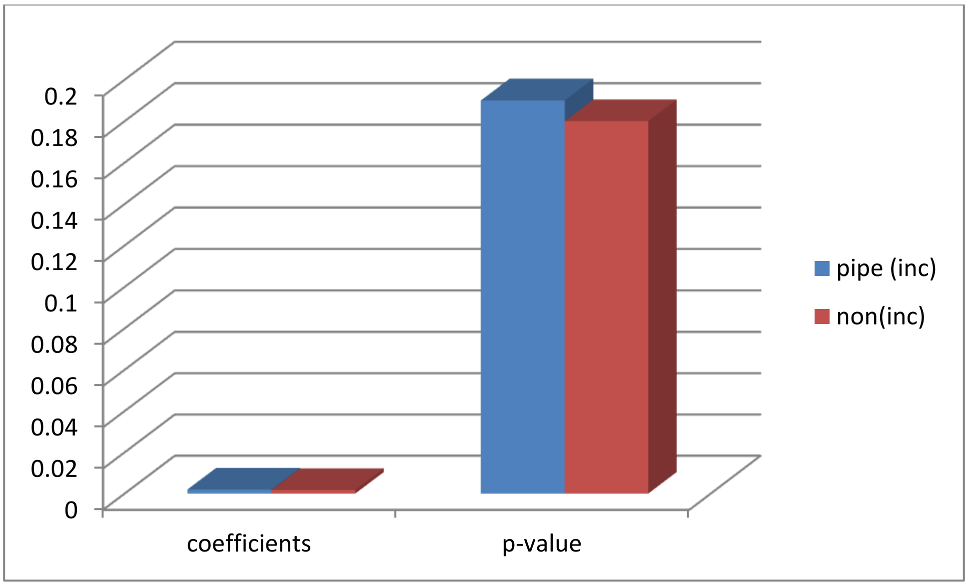
```
. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of ln_wtp

         chi2(1)      =     6.90
         Prob > chi2  =   0.0086
```

Table 5.10

c. **Comparision of piped and non-piped:**

By the comparison we see that the income coefficeint to wtp of non-piped is found to be greater than piped. The results are shown in the graph 5.6 below:

Comparision of Elasticity of Income to WTP of Piped and Non-piped households.



Graph 5.6

(y-axis describes the unitary value)

5.2.3: Multiple Regression Analysis To Obtain WTP of Piped & Non-Piped

Now, I am trying to analyse the WTP of piped and non-piped households separately; along with income(inc) and other control variables like education level of head of the household (edu), gender (sex), installation cost of the water storage (inscost), monthly electricity expenses (elecost), total size of family (TotFam) and pipe_dum on willingness to pay of individual household but also trying to compare the respective variables of both houeholds.

Firstly, I strated with piped water households which is shown by table 5.11

Comparision of OLS Results of Piped and Non-piped Households

Variable	Piped		Non-Piped	
WTP	Coefficient	P-value	Coefficient	P-value
Income (inc)	0.002	0.19	0.0017	0.18
Total Family Size (TotFam)	-6.51	0.68	-2.197	0.82
Electricity Cost (Elecost)	0.082	0.15	0.074	0.21
Installation Cost (Inscost)	-0.0003	0.63	-0.0006	0.39
Sex of the Head of the Household (Sex)	-73.204	0.298	136.05	0.097
Education of the head of the Household (Edu)	-48.911	0.53	113.48	0.009
Constant Term	505.65	0.00	420.48	0.00
Observation	102		138	
R^2	0.091		0.14	

Table 5.11

Interpretation of the results:

a) Piped water households:

INCOME: From the test result I explored that NRs. 100 increase in **income** increases wtp by Rs. 0.17 of piped household, ceterus paribus but the test result is found to be stastically insignificant.

TOTFAM: From the test results from stata, I explored that increase in 1 member in family, piped household decreases their WTP by Rs. 6.51, ceterus paribus but the test result is found to be stastically insignificant.

ELECOST: From the test results, I explored that Rs. 100 increase in electricity cost results into Rs. 8.2 increase in WTP for household with piped water supply, ceterus paribus but this result is found to be statisticaly insignificant.

INSCOST: From the test results, I explored that Rs. 100 increase in installation cost results into Rs. 0.03 decrease in WTP for household with piped water supply, ceterus paribus but the test result is found to be statisticaly insignificant.

SEX: From the test result we can say that the pipe household with female household head has less wtp than the household with male household head but the test result is found to be statisticaly insignificant.

EDU: From the test result we can say that the pipe household with more educated household head has less wtp than the household with less educated household head but the test result is found to be statisticaly insignificant.

b) Non-piped water households:

INCOME: From the test result I identified that NRs. 100 increase in **income;** increases wtp by Rs. 0.2 of non-piped household, ceterus paribus but the test result is found to be stastically insignificant.

TOTFAM: From the test results from stata, I explored that increase in 1 member in family, household decreases their WTP by Rs. 2.2, ceterus paribus but the test result is found to be stastically insignificant.

ELECOST: From the test results, I explored that Rs. 100 increase in electricity cost results into Rs. 7.4 increase in WTP for household with non-piped water supply, ceterus paribus but this result is found to be statisticaly insignificant.

INSCOST: From the test results, I explored that Rs. 100 increase in installation cost results into Rs. 0.06 decrease in WTP for household with non-piped water supply, ceterus paribus but the test result is found to be statisticaly insignificant.

SEX: From the test result, we can say that the non-piped household with female household head has high wtp than the household with male household head and the test result is found to be statisticaly significant at 10% level of significance.

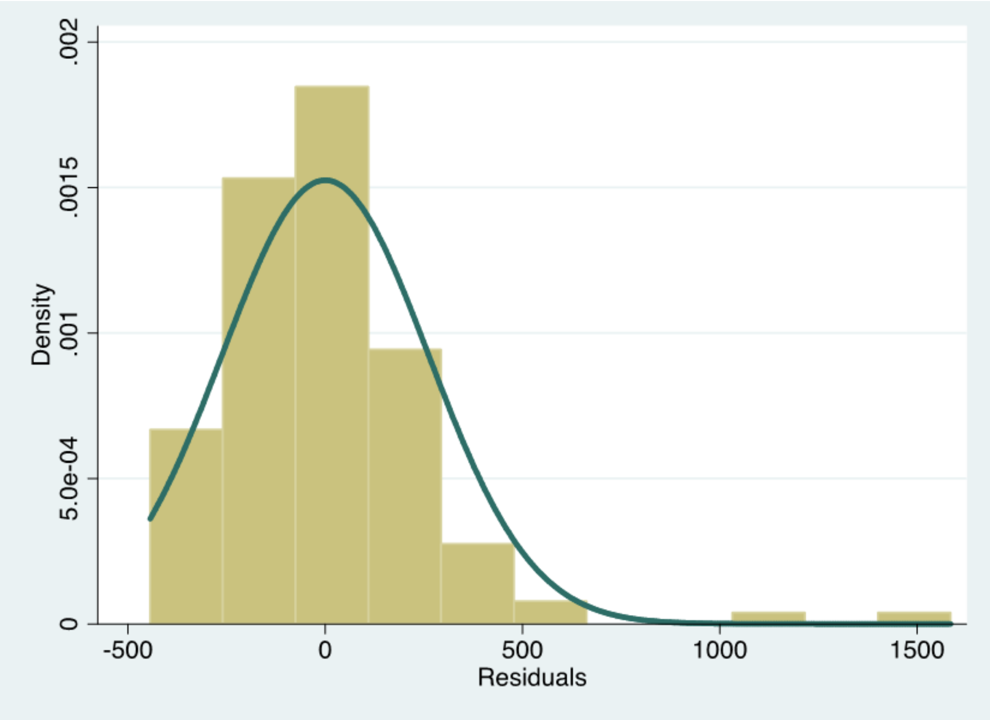
EDU: From the test result, we can say that the non-piped household with more educated head of the households has high wtp than the household with less educated household head and the test result is found to be statisticaly significant at 5% level of significance.

Comparision of other econometrics assumptions which are found as follows while analyzing results of piped households & non-piped households.

Test of Normality of residuals:

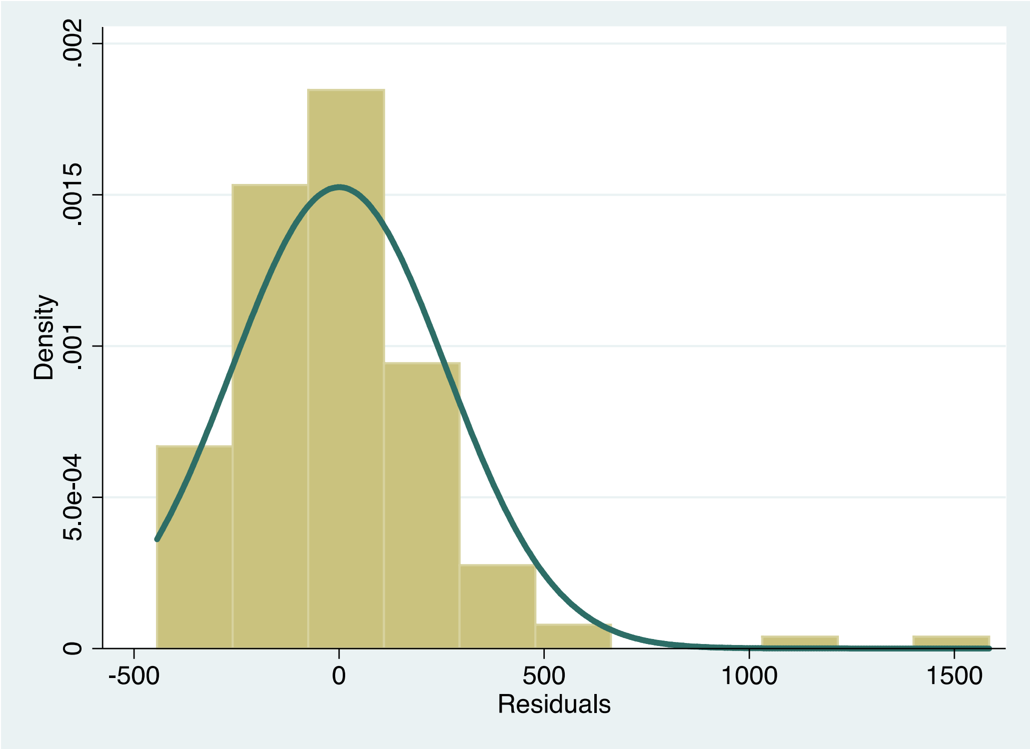
i) Piped Household

Graph 5.7 The Pattern of Residual of Piped Households (Multiple Regression)



ii) Non-Piped Household:

The Pattern of Residual of Non-Piped Households



Graph 5.8

Heteroskadasticity test of piped & non-piped households

i) Piped Household:

The dataset is found to be free from heteroskadasticity which can be seen from the test result in table 5.12 below:

Result of Heteroskadascity of Piped Household

```
. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of wtp

         chi2(1)      =     3.39
         Prob > chi2  =   0.0658
```

Table 5.12

ii) Non-Piped Household:

Heteroskadasticity: The dataset isn`t found to be free from heteroskadasticity. Hence we run Robust standard error to get true result with heteroskadasticity problem which can be seen from the test result in table 5.13 below:

Result of Heteroskadasticity of Non-Piped Household

```
. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of wtp

         chi2(1)      =    39.57
         Prob > chi2  =   0.0000
```

Table 5.13

Colliniarity:

Both the dataset of piped and non-piped households are found to be free from colliniarity problem which can be seen from test result in table 5.14 below:

Results of Colliniarity of Piped & Non-Piped Household

Variable	VIF		Tolerance = 1/VIF	
WTP	Piped	Non-Piped	Piped	Non-Piped
Income	1.52	1.56	0.6572	0.6428
Elecost	1.52	1.56	0.6582	0.6429
Inscost	1.09	1.30	0.9162	0.7703
Edu	1.12	1.21	0.8915	0.8290
TotFam	1.09	1.08	0.9138	0.9252
Sex	1.04	1.01	0.9571	0.9856
Mean VIF	1.23	1.29	-	-

Table 5.14

If mean VIF is less than 10 then we can say that model is free from collinearity.

5.2.4: Combined Analysis

To take advantage of total sample (and get above the rule-of-thumb number of minimum 200 observations in my regression model) I had run the multiple regression with both the piped and non-piped households and include a new explanatory dummy variable called pipe_dummy such is 1 = piped and 0=non-piped. According to theory, if this dummy is significant; it would mean that piped and non-piped households have significantly different WTP.

To become more clear in analysis, I have put the STATA results in table where I put the coefficients of income and other control variables along with p-values of respectives variables which is clearly explained by the table 5.15 as below:

Results of Stata for Combined Analysis where Pipe Household is Dummy

Variable	Coefficient	P-Value
Income	0.0017	0.076
TotFam	-1.92	0.848
Elecost	0.0900	0.025
Inscost	-0.0006	0.457
Sex	37.55	0.039
Edu	56.48	0.200
Pipe_dum	-103.42	0.048
Constant	459.27	0.00
R^2	0.0838	

Table 5.15

INCOME: From the test result I explored that NRs. 100 increase in **income** resulted that WTP is increased by Rs. 0.17, ceterus paribus. The test result is found to be stastically significant at 10% level of significance.

TOTFAM: Above test results described that increase of 1 member in the family, piped household decreases their WTP by Rs. 1.93, ceterus paribus but the test result is found to be stastically insignificant.

ELECOST: From the test results, I quantified that NRs. 100 increase in electricity cost results into Rs. 9 increase in WTP, ceterus paribus and this result is found to be statisticaly significant.

INSCOST: From the test results, I explored that NRs. 100 increase in installation cost results into Rs. 0.06 decrease in WTP for household with piped water supply, ceterus paribus but the test result is found to be statisticaly insignificant.

SEX: From the test result we can say that the household with female household head has more wtp than the household with male household head but the test result is found to be statisticaly insignificant.

EDU: From the test result we can say that the household with more educated household head has more wtp than the household with less educated household head but the test result is found to be statisticaly insignificant.

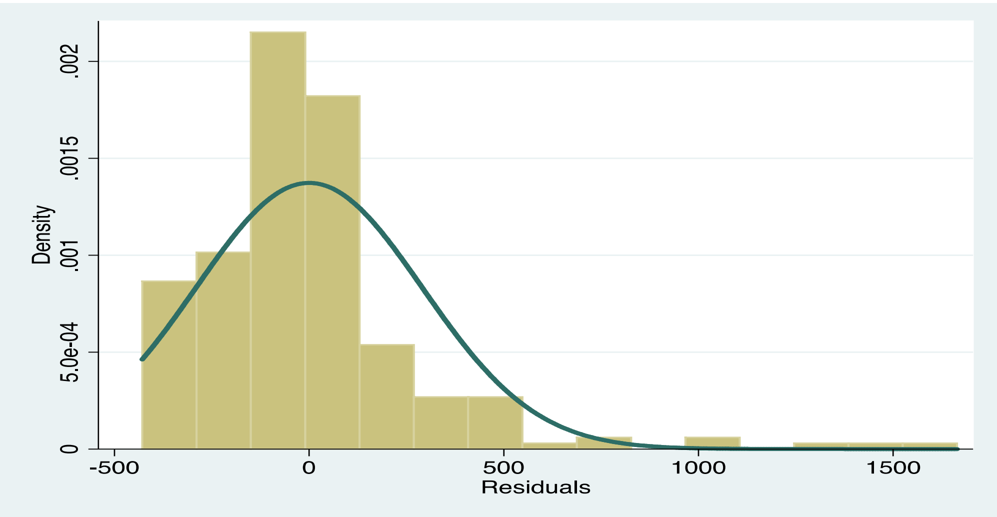
PIPE_DUM: From the test result we can say that the household with piped water supply has less wtp than the household with non-piped water supply and the test result is found to be statistically significant in 5% level. Here p-value is significant at 5% level. On this note, we can explain that WTP of piped and non-piped household for improved water service is different.

Other econemtrics assumptions are found as follows:

Normality:

The pattern of residual is found almost to be normal as shown in the graph 5.9 below:

Graph 5.9 Pattern of Residual of Combined Study



The dataset is found to be free from heteroskasticity which can be seen from the test result table 5.16 below:

Result of Heteroskadasticity of Combined Study where Piped Households is Dummy

```
. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of wtp

         chi2(1)      =     0.00
         Prob > chi2  =   0.9453
```

Table 5.16

Collinearity:

Collinearity: The dataset is found to be free from colliniarity problem which can be seen from test result in table 5.17 below:

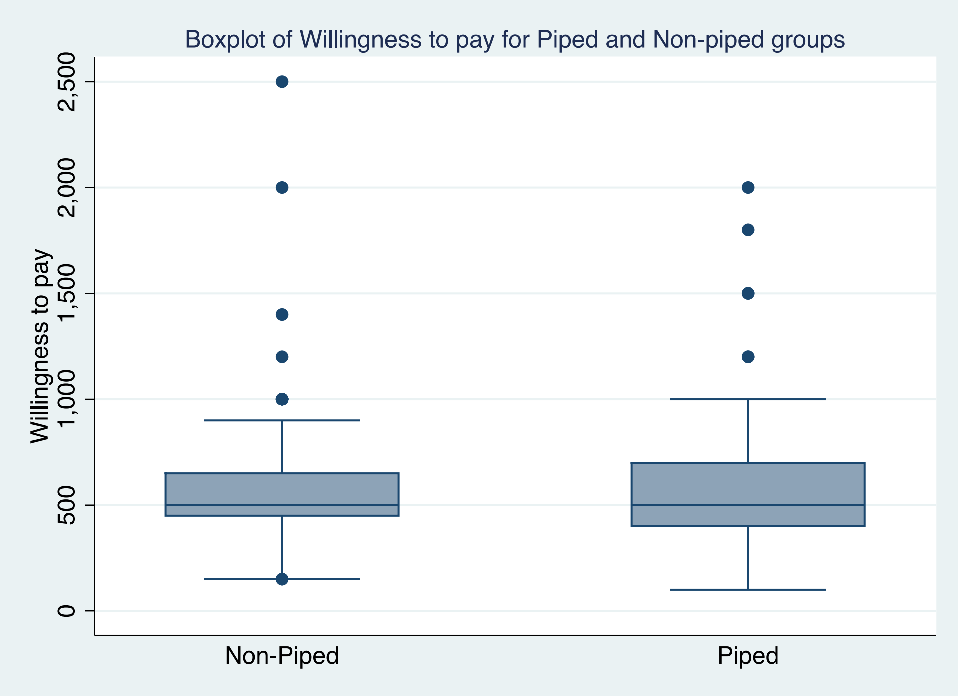
Results of Colliniarity of Combined Study where Piped Household is Dummy

Variable	VIF	1/VIF=Tolerance
Pipe_dum	1.83	0.5462
Income	1.69	0.5908
Inscost	1.65	0.6067
Elecost	1.57	0.6363
Edu	1.16	0.8610
TotFam	1.07	0.9343
Sex	1.03	0.9684
Mean VIF	1.43	-

Table 5.17

5.2.5 Comparision By Using Boxplot

Graph 5.10 WTP For Piped & Non-Piped Households



5.3: Results Of Hypothesis and Explanation:

1. WTP for the piped household is significantly higher than the non-piped household.

Average WTP of households with piped water service is found to be NRs. 562 and average WTP of household with non-piped water service is found to be NRs. 590. Hence we can say that WTP of non-piped household for improved water service is greater than WTP of piped household. It is opposite to our expectation. To test the significance of the difference we formed the dummy variable by creating piped-household=1 and non-piped household=0 and while running the multiple regression of WTP with pipe_dummy with other control variables; I got the negative coefficient meaning that the WTP of piped household is less than the non-piped household, matching our difference in average WTP of piped and non-piped household and the test result was found to be statistically significant. This means that we can`t reject the null hypothesis.

2. Household's income has a significant positive effect on the WTP.

To findout the impact of income on WTP of both piped and non-piped households, I run different regressions, firstly income as a single determining variable of WTP. Secondly, income elasticity to WTP. In both cases, I found that both coefficients and p-values are significant. Thus, we can`t the reject null hypothesis.

3. Gender of respondent significantly affects WTP; women (responsible for getting water) has a significantly higher WTP than men.

I created the dummy variable of sex such that sex(female)=1, if the head of the household is female and sex(male)=0 if the head of household if male. On running the multiple regression including we get different results as follows:

WTP of piped households when head of the household is female; found that WTP of household with female head has less than wtp of head of the household with male but this result was found to be statistically insignificant.

For non-piped household WTP of head of the household with female is found to be more than wtp of head of the household with male and this result was found to be statistically significant.

In combined form including both piped and non-piped household`s WTP of head of the household with female is found to be more than wtp of head of the household with male but this result was found to be statistically insignificant. I think the insignificance have occurred due to high demand of water supply as compared to present water supply and lack of alternative source of water supply than our proposed project.

4. Educational level of the respondent affects WTP positively

To analyse this I create the dummy variable Edu; in terms of schooling year of head of the households such that higher education (more than secondary level)=1, if the schooling of head of the household is less than secondary level=0. On running the multiple regression including we get different results as follows:

For piped household, WTP of head of the household with higher education level of is found to be less than wtp of head of the household with less schooling but this result was found to be statistically insignificant.

For non-piped household wtp of head of the household with higher level of education is found to be more than wtp of head of the household with less schooling year and this result was found to be statistically significant at 5% level.

In combined analysis, both piped and non-piped household`s WTP with higher educated head of the household was found to be more than WTP of head of the household with less years of schooling. This result was found to be statistically insignificant. I think the insignificance have occurred due to high demand of water supply as compared to present water supply and lack of alternative source of water supply than our proposed project (MWSP). It is because alternative sources are more costlier.

5. Household’s size affects the WTP positively

For analyzing this hypothesis, I had created new variable called TotFam which describes about total number of family size. On running the multiple regressions including we get different results as follows:

For piped household, WTP of the household is found to be less whenever there is increased in households size. Thus, we can say there is negative relationship between wtp and totfam. So as result was found to be statistically insignificant.

For non-piped household, WTP of the household is found to be less if family size is increased. Thus, we can say there is negative relationship between wtp anf totfam. So as result was found to be statistically insignificant.

In combined form including both piped and non-piped household, WTP of the household which has larger no of family size are less willing to pay for improved water service. We got inverse relationship between family size and WTP. Results was found to be statistically insignificant too. I think this insignificance occurred due to high demand of water supply as compared to present water supply and lack of alternative sources of water supply. People want drinking water from our proposed MWSP because alternative sources are costly.

CHAPTER 6: CONCLUSIONS

This research was conducted in Kathmandu Valley, Nepal. The main objective of the study was to access the household demand for improved water service. Currently, Kathmandu Valley needs around 350 mld (Million litres water per day) where as KUKL (responsible authority) is only able to supply 144 mld in wet season & 84 mld in dry season. It is very pathetic, on the one hand KUKL has limited supply of water, on the other they are facing severe problem of water leakage which consists 15% of total supply (KUKL 2013).supply of is very limited Due to this vast gap in demand and supply, People of Kathmandu Valley are heavily affected. Thus, people are heavily rely on ground water. It is supposed that around 70 mld water extracted from under ground source to fulfill the basic nessecities the households. It is very common to see water well as alternative source water in the most of the house in the Kathmandu Valley.

To measure the willingness to pay of the consumer from random sampling is not an easy job. I have used Contingent Valuation Method (CVM) as main instrument while doing analysis. It is seen that people often raises the questions against its authenticity and accuracy. It is because in comparision to sample size and its population, we often found huge differences. In this thesis work, CVM is used to quantify the WTP for improved water service among the both households. I had used total 240 final data households which consists both piped and non-piped households. 240 households cover three districts; Kathmandu, Lalitpur, Bhaktapur which have one metropolitan, one sub-metro plitan and and one municipality respectively. I had used cross-sectional stratified random samplingmethod while collecting data.

OLS was used which is the one of the most convincing estimates of parameters. The results showed that the non-piped households of Kathmandu Valley are willing to pay a significantly higher monthly water charges than piped households. Piped households have relatively little lower WTP for improved water service incomparision to piped households.

WTP of Piped households is NRs 562 (US$ 5.8) per month and WTP of non-piped household is NRs 590 (US$ 6.1) per month for improved and quality water services and sanitation. Inn present scenario, piped households are paying NRs 225 (US$ 2.4) per months. It indicates that piped households are looking for consistant water supply service as well non-piped households is also desperately looking for alternative source of water supply.

The second objective of this research was to test ordinary least square method to set up the econometric model of the WTP function. I employed OLS method through statistical software STATA to examine the WTP of the piped and non-piped households. In order to measure the impact of control variables on both households are as follows:
Is there is any significance difference difference in how explanatory variables influence WTP when applying OLS. The OLS results explains that Income, Sex (dummy if 1= head of

households is female otherwise zero), Education (dummy 1= if head of the household is gained higher education, otherwise zero) has a impact on the WTP of piped household but test results are insignificant. It may be the reason that piped households are still getting water from KUKL but that is not enough to fulfil the basic requirements. Also quality of water is not satisfactory. Thus, I had found that more than 90% piped households have another source of water supply either is well water, jar water, boring water or water from private water supplier. Most of them had well water and boring water.

On the other hand, the education level (Edu), gender (Ses) and income (Income) are the only socio-characteristics that have significant effects on the WTP for non-piped households. In further analysis, gender differences (Sex) has influence the WTP for piped and non-piped households both. Generally, in developing countries, female is the person who is solely responsible for the households affair. Male is supposed to bring income in the house. Thus, it might be the reason the significance of dummy variable where 1=female and 0=male is valid.

While doing comparition, I noticed that both households either piped or non-piped, they are seriously looking for alternative source or any kind of project which can them in terms of enough supply of drinking water. Most of the variables has insignificant p-values but they are willing to pay higher amount of money which are US$ 5.8 of piped and US$ 6.1 of non-piped. I think this might be the reason that both households have higher WTP but test results are insignificant.

To take advantage of my total 240 samples and get above the rule-of-thumb number of minimum 200 observations in this regression. I run the same multiple regression with both the piped and non-piped households and include an explanatory variable (dummy) which is 1 = piped and 0=non-piped; and I noticed that varibles like income, sex and electricity cost (Elecost) are then significant. Also this dummy is significant it means that piped and non-piped households have significantly different WTP.

6.1 Policy Recommendations

The obtained results of this study can be used to as a key strategy for supplying improved water service and water pricing policies in Kathmandu Valley. They can prepare the conceptual framework before choosing choosing a particular set of scenario including different levels of attributes and WTP.

The main body of KUKL has to follow three main steps as a master plans which are as follows:

a) Firstly, Policy makers quantified the exact amount of money which they need for wholesome investment which might be used wholesome improvement of supply system.

b) Secondly, Policy makers must make a plan which is related to water service. It is belived in Kathmandu that KUKL is one of the most corrupted organization of Nepal, which only knows to take money from people but don't know anything regarding giving service.
c) Thirdly, Policy makers should do the self assessmentment in every 6 months of interval. If they do the self assessment then they can identify the weakness and storng part of their service.

Melamchi Water Supply Project (MWSP) is one of the mega project of Nepal. It has been under construction since 20 years. Political instability and moist insurgency are the main cause for its delaying. Thus, MWSP needs political stability. Without it there is no way. Now, it is supposed that project will complete by the end of June, 2016. Its maximum capacity is 170 mld. Kathmandu Valley is facing shortage of 266 mld in dry season and 206 mld in wet season (KUKL 2013).

WTP of piped and non-piped households can be utilized when the time will come to review water bill. According to my research, people of Kathmandu Valley are ready to pay high as a water bill if they are promised for clean, improved and regular supply of water. Till now, 188000 (one hundred eighty eight thousands) are connected with piped water system of KUKL, which is only 50% of total households of Valley. After completion of MWSP, KUKL will have capacity to supply improved water to those households which are willing to connect but deprived of the connection due to limited supply of KUKL.

At that time government will follow the aggregation of WTP based on the mean of revealed WTP. Thus, government will accumulate huge amount of money annually. The annual benefits from improved water services will become higher. It will be resulted as the expected economic growth of Nepal will be increased.

6.2 Shortcomings

This is my first attempt so that I accept that I may had done some mistakes. While collecting data, I hadn`t ask as much as questions to non-piped households which I asked to piped households. As a results, I was unable to make comparable variable as much as I need for doing comparision of piped and non-piped households. The aggregation can further be done based on multiplication between the WTP of each income group and its number of population. In my opnion, for this kind of research we need atleast 1% sample from total population. If population. If sample size is less then there is higher chance of getting insignificant test values. We have to make sure that each of income groups has been represented by an adequate number of samples during the survey . If its not then results might mislead the researcher.

The explanatory variables and analysis of the determinant of WTP can be expanded by integrating another wide range of variables.

Finally, the further research of water pricing should consider the other non-market valuation methods.

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8. Appendix:

I) QUESTIONNAIRE

Confidential	
Assessing Household Demand for Improved Water Services in Kathmandu Valley: **Contingent Valuation Method (CVM)** ***Research for Master Thesis: Krishna Dhanusk, 2013***	
Date of Interview:	**Day/ Month**
Time Begin	**Hour/ Minute**
Time End	**Hour/ Minute**
Interviewer	**..**
Data Entry Status (filled by Controller)	

How many years have you been lived in your present house?	.... Years
Does your family own this house? 1. Own	1

2. Belongs to family member/relatives 3. State-Owned 4. Rent	2 3 4
Are you the head of the household? 1. Yes 2. No	 1 2

Introduction:

Hello, my name is **Krishna Dhanusk** from Nepal, currently studying MS in Economics at Norwegian University of Life Sciences, Norway. We are conducting a survey on water supply conditions and would like to ask you some questions. This survey is part of a student's master thesis from the Norwegian University of Life Sciences. The interview will take between 40 and 45 minutes.

When you answer the questions, remember that it is your opinions where we are interested in, and there are no right or wrong answers. All answers will be treated confidentially and will be used solely for research purposes.

Introductory Questions

How many years have you lived in your present house?	.... Years
Does your family own this house? 1. Own 2. Belongs to family member/relatives 3. State-Owned 4. Rent	 1 2 3 4
Are you the head of the household? 1. Yes 2. No	 1 2

Part A: Household Water Supply Condition

We want to ask about water resources in this section.

A0	A1	A2	A3	A4
WATER SOURCE	Where does the household get water for drinking And cooking?	Among the aforementioned water sources for drinking and cooking sources, which is the predominant source?	Among the aforementioned water sources for bathing and washing water source, which is the predominant source?	For other Household activity like garden watering, cleaning motorcycles and car, which is the predominant source?
1a. Piped water directly to the house	1. Yes 2. No	1a	1a	1a
1b. Piped water from a public stand pipe	1. Yes 2. No	1b	1b	1b
1c. Piped water purchased from private water supplier	1. Yes 2. No	1(c_drink)	1(c_bathe)	1(c_bathe)
2. Pump water (electrical/manual)	1. Yes 2. No	2	2	2
3. Well water	1. Yes			

	2. No	3	3	3
4. Mineral water (purchased)	1. Yes 2. No	4	4	4
5a. Other, drinking and cooking water, please Mention............................	1. Yes 2. No	5a		
5b. Other, bathing and washing water, please mention.............................	1. Yes 2. No		5b	

Part B

For Household which are consuming Non-Piped Water

B1 How would you describe the current situation of water supply? 1. Sufficient all year 2. Insufficient during dry season 3. Sometimes insufficient 4. Insufficient mostly	1 2 3 4
B2 During the last month, how was the water quality been in your household: 1. Water was clean.	1

2. Water was chlorine smell or taste. 3. Water was not normal colour. 4. Water was residues, such as soil. 5. Water smells bad. 6. Others (specify). 7. Don't know.	2 3 4 5 6 7
B3 Is your household using a pump? 1. Yes 2. No	 1 2 ......Go to B7
B4 How many pumps is your household using? (in number)	
B5 How much electricity load needs to operate the pump?	.... watt
B6 On average, how many minutes does the pump work a day?	...........minutes
B7 Do you take any of the following storage regarding the quantity of water received: 1. Store water in tanks 2. Store water in cistern 3. Drum 4. Bucket/vessel 5. Others 6. None	 1 2 3 4 5............................. 6

B8 How much was the installation cost of the storage: 1. Store water in tanks 2. Store water in drum 3. Bucket/vessel 4. Others 5. Non	 1. Rs 2. Rs 3. Rs 4. Rs 5. Rs
B9 How do you treat drinking water? 1. Boil and filter 2. Boil 3. Filter 4. using chlorine/medicine for purifying water 5. None	 1 2 3 4 5
B10 Does the member of household been ill because of consuming Water? 1. Yes 2. No 3. Don't Know	1 2 3
B11[Enumerator provides card listing waterborne diseases] How many persons in your household were ill during the last year due to the consumption of unsafe water? 1. Don't know 0. No sickness due to unsafe water	1 0

B12 [Focus Group Discussion here, to develop the possibility answer] What was the treatment on the ill household member? 1. Doctor Treatment 2. Self (Family treatment) 3. Doing Nothing 4. Don't Know	 1 2 3 4
B13 How much was the average cost, per person, per illness, spent for? (ie. Doctor consultation cost, medicine, etc) 0 = don't know	Rs.................. 0
B14 Reason for not having in-house connection: 1. Connection fee too high 2. Monthly charges too high 3. Connection is not available 4. Present arrangement satisfactory 5. Rented house 6. Waiting list 7. Others (specify)....................................	 1 2 3 4 5 6 7................................

Scenario:

As we all know, the present water supply system in Kathmandu Valley has been unreliable and it has not been possible to improve the service level due to lack of financial funds.

The reality is that Kathmandu Valley still has nearly 77% of households that don't have piped water provided by the Kathmandu Upatyaka Khanepani Limited (KUKL). The households are using unreliable water from wells; Some are using motors for extracting water from underground, some others have to buy from small water vendor.

Present demand of drinking water in Kathmandu Valley is 400 million litters water per day where as KUKL is providing almost 170 million litters in peak season and 100 million litters in dry season.

Total capacity of Melamchi Water Supply Project is 170 million litters water per day.

Suppose that the water supply service is now improved. For example, Melamchi Water Supply Project (MWSP) is going to complete by the end of 2016 that can make this area connected with the piped water system. The quality of water will also be good. There is no chemical smell coming from the water. It will also be available 10 hours a day in every day of the year, water pressure is strong enough to use shower and can get to your first floor. As a result, your family doesn't need to buy tank to store water, you don't need to spend money on filter, you don't need to boil water before drinking, you don't have to waste your time and patience for collecting water when it is only available at night, and you don't have to pay electricity cost for pumping.

Now, I'm going to ask you some questions to learn whether your household is interested in having a connection and would be willing to pay to make use of the water supply system. It is important that you answer the questions as truthfully as you can so that we can really know whether you wish to have a better quality of service or not, and which amount you can afford and are willing to pay for it. If you and the other people we interview say that you cannot pay anything or anything more than you are currently paying, even if these statements are not true, then perhaps it is not possible to improve and extend the water supply system. It is therefore important to answer the questions honestly.

Think about how bothered, disturbed or annoyed you are by reliability, quality, and availability of the water supplied you are having right now, and how much it is worth to you personally to avoid this. What is the most your household is willing to pay in connection fee bill in order to get the piped water connection in your house?

B15[Enumerator starts with the card contains the range of payment can be made by the household. The options will be developed after MWSP]. Enumerator says," If connection will be free then ask yourself how much you are willing to pay per month for consuming good quality, reliable, and strong pressure of pipe water supply in your house? Put a tick next to the amount you are willing to pay, and continue down the card. Stop when you get uncertain about whether you would pay an amount, and tell me the highest amount you almost certainly are willing to pay. If you are uncertain about the lowest amount, tick "I am not willing to pay anything".	Enumerator records the highest amount the respondent willing to pay below: Rs............................ A. Willing to pay B. Not willing to pay

B16[Enumerator shows card contains the range of certainty,1-10] How certain are you willing to pay for consuming improved water service from KUKL? Assume that there are 10 levels of certainty, where 0 is very uncertain and 10 is very certain,	[ ] [ ]

what level do you think your answer falls in? (0 – 10)	
B17[Enumerator shows card contains the possibility of answer, developed from MWSP. It is also possible for the household to choose more than one answer] Why would you decide to pay? 1. To guarantee having water in the future 2. To prevent a possible problem 3. Water is a primary necessity 4. Other (specify)..................	1 2 3 4...
B18[Enumerator shows card contains the possibility of answer, developed from MWSP. It is also possible for the household to choose more than one answer] Why would you decide NOT to pay? 1. Your family income does not allow it 2. Distrust the authorities, corruption 3. Doubts on the programme's results 4. It is government's obligation, taxes are paid 5. Need more information 6. Other (specify).......................	1 2 3 4 5 6....................................
B19[Enumerator shows card contains the	

range of certainty, 1-10] How certain are you not willing to pay for the improved water service? Assume that there are 10 levels of certainty, where 0 is very uncertain and 10 is very certain, what level do you think your answer falls in? (0 – 10) B20[**Enumerator shows card contains the possibility of answer, developed from MWSP. It is also possible for the household to choose more than one answer]** What is the reason that you are uncertain? 1. Need more information 2. Need to consult other family members 3. Do not know if the income is enough 4. Other (specify)	[ ] [ ] 1 2 3 4

Part C: **For Household whose primary source of water is piped water**

C1 Two most important reasons for having in-house connection: 1. Convenient	1 2

2. Health 3. Reliability 4. Modernization 5. Alternative source is not sufficient 6. Cheaper 7. Others	3 4 5 6 7..
C2 When did you connect to the pipe system?	[ ] [ ] [ ] [ ] Year
C3 Last monthly bill – consumption per month (m3) [Enumerator ask the respondent to show the latest water bill, if it is possible]	Rs...........
C4 How would you describe your in-house connection water supply service? 1. Good 2. Fair 3. Bad	1 2 3
C5 How would you describe the current quantity of water supply Availability? 1. Ample 2. Moderate 3. Reduced	1 2 3

C6 How frequently does the household experience water Shortfalls? 1. Water shortages some hours during the day 2. Water shortages one or more days a week 3. Water shortages few times a year 4. Water shortages during dry season 5. Other (specify) 6. Don’t know 7. No shortage	 1 2 3 4 5................... 6 7
C7 How is the water pressure? 1. Strong 2. Generally strong 3. Weak 4. Sometimes weak 5. Very weak 6. Don’t know	 1 2 3 4 5 6
C8 Do you take any of the following storage regarding the quantity of water received: 1. Store water in tanks 2. Drum 3. Bucket/vessel 4. Others 5. None	 1 2 3 4 5

C9 How much was the installation cost of the storage: 1. Store water in tanks 2. Drum 3. Bucket/vessel 4. Others 5. None	 1. Rs. 2. Rs. 3. Rs. 4. Rs. 5. Rs.
C10 Do you have any secondary source of your water supply? 1. Yes 2. No	1 □ Go to C11 2 □ Go to C13
C11 What is your secondary source of your water supply? 1. Neighbour 2. Private water pump/ Boring water 3. Public stand pipe 4. Private water supplier 5. Stone stand pipe 6. Jar water 7. Others (specify	 1 2 3 4 5 6 7......................................
C12 [**Focus Group Discussion is needed to develop the answer** **possibility of this question**] How much does the monthly cost you spend to fund your secondary source of your water supply? (i.e. operation and maintenance cost, payments made to the delivery person,	

cost of electricity, etc.) 1. Neighbour 2. Private Tube well 3. Public stand pipe 4. Private Water Supplier 5. Stone stand pipe 6. Jar water 7. Others (specify	 1. Rs. 2. Rs. 3. Rs. 4. Rs. 5. Rs. 6. Rs. 7. Rs.
C13 During the last year, how was the water quality been in your household: 1. Water was clean 2. Water was chlorine smell or taste 3. Water was not normal colour 4. Water was residues, such as soil 5. Water smells bad 6. Others (specify) 7. Don't know	1 2 3 4 5 6 7
C14 Have the member of household been ill because of consuming water from the pipe? 1. Yes 2. No	1 2

3. Don't Know	3
C15**[Enumerator provides card listing waterborne diseases]** How many persons in your house were ill during the last year due to the consumption of unsafe water? 1. No sickness because of unsafe water consumption 0. Don't Know	[ ] [ ] ---go to C16 1. -----go to C18 0
C16 [Focus Group Discussion here, to develop the possible answer] What was the treatment of the ill household member? 1. Doctor Treatment 2. Self (Family treatment) 3. Doing Nothing 4. Don't Know	1 2 3 4
C17 How much was the average cost, per person, per illness, spent for? (ie. Doctor consultation cost, medicine, etc) 0 = Don't Know	Rs. 0

Scenario:

I would like you to know the following information. As I mentioned some neighbourhoods are receiving little water. This happens because the volume of available water is insufficient.

Although, the government has recovered water from leaks and it is in the process of

Installing water meters to discourage extreme consumption by household, the problem is that even with these measures there is neither more water to improve the current

service, nor for the new household that will settle in the city in the coming years. **Currently almost all the expenditure for supplying this service is paid by the government, which is financed through the taxes money paid by the citizens. Nevertheless, this current amount of money is not enough to implement the actions that provide more water, but only to maintain the current system working.** **[Enumerator show some collections of news from the newspaper or magazine, related to water condition in Kathmandu Valley]**

C18 Why do you think the city has got have this water scarcity problem?	
1. Due to the population increase, we are a lot of people	1
2. Due to the lack of citizens' awareness, water waste	2
3. Due to the government's bad administration, corruption	3
4. Due to water leaks	4
5. Other (specify	5

Scenario: **It is foreseen that in 10 years time the city will need more water, however if the situation is maintained there is a great possibility that the water shortfalls will start to be extended to several other city areas, and that in 10 years time all households will suffer water shortfalls more frequently.** **[Enumerator show some collections of news from the newspaper or magazine, related to water condition in Kathmandu Valley**

C19 Please think in ten years time, how do you think this water scarcity may affect your household? 1. The quality of your family's life will be deteriorated 2. Water will be scarce 3. The cleaning habits of your household and personal care will change, hygiene 4. You will have to pay more for water supply/Ration water 5. Other (specify) 6. Do not know	1 2 3 4 5............................ 6

Scenario: **Melamchi Water Supply Project (MWSP) is going to complete by the end of 2016 that can make this area connected with the piped water system. This project will serve 170 million litters water per day. The quality of water will also be good. There is no chemical smell coming from the water. It will also be available 10 hours a day in every day of the year, water pressure is strong enough to use shower and can get to your first floor. As a result, your family doesn't need to buy tank to store water, you don't need to spend money on filter, you don't need to boil water before drinking, you don't have to waste your time and patience for collecting water when it is only available at night, and you don't have to pay electricity cost for pumping.**

C20. [Enumerator starts with the card contains the range of payment can be made by the household. The options will be developed after MWSP]. Enumerator says," If connection will be free then ask yourself how much you are willing to pay per month for consuming good quality, reliable, and strong pressure of pipe water	Rs.........................

supply in your house? Put a tick next to the amount you are willing to pay, and continue down the card. Stop when you get uncertain about whether you would pay an amount, and tell me the highest amount you almost certainly are willing to pay. If you are uncertain about the lowest amount, tick "I am not willing to pay anything".	A. Willing to pay B. Not willing to pay

Finally, I would like to take a few personal details. These are needed to make sure that we have interviewed a representative sample of the population. Remember, all of these answers will be treated completely confidentially.

Part D:

General Information for All Households

D1 Respondent Name:	....
D2 Age of respondent	....
D3 Sex 1 Male 2 Female	 1 2
D4 Marital Status 1. Single 2. Married 3. Divorced/Separated	 1 2 3

4. Widowed	4
D5 The head of the household (or his/her spouse) highest education completed 1. No schooling 2. Primary education (6 years) 3. Secondary education 4. Bachelor 5. Masters 6. PhD.	 1 2 3 4 5 6
D6 Occupation of the head of the household 1. Professional 2. Employee 3. Labour 4. Businessman 5. Pensioned 6. House worker 7. Unemployed 8. Other (specify)	 1 2 3 4 5 6 7 8................................
D7 Number of adult persons living in the households (15-65 years old); including yourself. A. Total B. Male	A. ---------- B. ---------- C. ----------

C. Female	
D8 Number of children living in the households (≤15 years old) A. Total B. Male C. Female	 A. ---------- B. ---------- C. ----------
D9 Number of elderly living in the households (>65 years old) A. Total B. Male C. Female	 A.---------- B. ---------- C. ----------
D10 How much is your household's combined net income per month? A. 0 - 20000 B. 20000-40000 C. 40000-60000 D. 60000-80000 E. more than 80000	A. B. C. D. E.
D11 Concerning your current standard of living, which of the following is true? 1. It is less than adequate for my needs 2. It is just adequate for my needs 3. It is more than adequate for my needs 4. Don't know	1 2 3 4

D12 Concerning your food consumption last month, which of the following is true? 1. It is less than adequate for my needs 2. It is just adequate for my needs 3. It is more than adequate for my needs 4. Don't know	 1 2 3 4
D13 How much your average monthly electricity cost?	Rs.
D14 Amount of household monthly expenses for: 1. Fooding 2. Clothing 3. Housing (rent, repair, etc) 4. Transportation 5. Education 6. Health service 7. Others......................................	 Rs Rs Rs Rs Rs Rs Rs

I) INFORMATION COLLECTED FROM NON-PIPED HOUSEHOLDS

Total Observations : 138

AA1: Average live in house : 16.4 years

AA2(O): Total numbers of own owned households : 137

AA2(R)Total numbers of house belongs to family member/relatives : 0

Total state-owned house : 0

Total rented out house : 1

Total No. of head of the household : 124

Total No. of non-head of the household : 14

B1 How would you describe the current situation of water supply?

1. Sufficient all year (S)	42
2. Insufficient during dry season	70
3. Sometimes insufficient	2
4. Insufficient mostly	24

B2 During the last month, how was the water quality been in your household:

1. Water was clean.	63
2. Water was chlorine smell or taste.	13
3. Water was not normal colour.	38
4. Water was residues, such as soil.	17
5. Water smells bad.	6
6. Others (specify).	1
7. Don’t know.	0

B3 Is your household using a pump?

1. Yes	99
2. No	39

B4 How many pumps is your household using ? (in number) Total No. 103

B5 How much electricity load needs to operate the PumP : Average Watt per pump = 882.52 watt

B6 On average, how many minutes does the pump work a day : 66 minutes

B7 Do you take any of the following storage regarding the quantity of water received:

1. Store water in tanks	113
2. Store water in cistern	0
3. Drum	23
4. Bucket/vessel	3
5. Others	0
6. None	0

B8 How much was the installation cost of the storage:

1. Store water in tanks	(Average)	NRs	38250
Min value			0
Max Value		NRs	200000
2. Store water in drum		NRs	4935
Min		0	
Max		NRs	8000
3. Bucket/vessel		NRs	333
Min			0
Max		NRs	500
4. Others			0
5. Non			0

B9 How do you treat drinking water?

1. Boil and filter	42
2. Boil	4
3. Filter	86
4. using chlorine/medicine for purifying water	4
5. None	3

B10 Does the member of household been ill because of consuming water?

1. Yes	60
2. No	78
3. Don’t Know	5

B11 How many persons in your household were ill during the last year due to the consumption of unsafe water?

1. Don’t know	41
0. No sickness due to unsafe water	75

B12 [Focus Group Discussion here, to develop the possibility answer]

What was the treatment on the ill household member?

1. Doctor Treatment	54
2. Self (Family treatment)	8
3. Doing Nothing	16
4. Don't Know	45

B13 How much was the average cost, per person, per illness, spent for? (ie. Doctor consultation cost, medicine, etc)

Rs 2093 per person in average

Min		0
Max	NRs	10000

B14 Reason for not having in-house connection:

1. Connection fee too high	0
2. Monthly charges too high	0
3. Connection is not available	91
4. Present arrangement satisfactory	2
5. Rented house	1
6. Waiting list	0
7. Others (specify)	65

B15[Enumerator starts with the card contains the range of payment can be made by the household.The options will be developed after MWSP]. Enumerator says," If connection will be free then ask yourself how much you are willing to pay per month for consuming good quality, reliable, and strong pressure of pipe water supply in your house? Put a tick next to the amount you are willing to pay, and continue down the card. Stop when you get uncertain about whether you would pay an amount, and tell me the highest amount you almost certainly are willing to pay. If you are uncertain about the lowest amount, tick "I am not willing to pay anything".

Average of highest amount of WTP : Rs. 590 Per month

```
. sum b15
```

Variable	Obs	Mean	Std. Dev.	Min	Max
b15	**138**	**589.5652**	**282.1654**	**150**	**2500**

B16[Enumerator shows card contains the range of certainty,1-10]

How certain are you willing to pay for consuming improved water service from KUKL? Assume that there are 10 levels of certainty, where 0 is very uncertain and 10 is very certain,

what level do you think your answer falls in? (0 – 10)

8.67 in average

B17[Enumerator shows card contains the possibility of answer, developed from MWSP. It is also possible for the household to choose more than one answer]

Why would you decide to pay?

1. To guarantee having water in the future	114
2. To prevent a possible problem	5
3. Water is a primary necessity	19
4. Other (specify).................	0

B18[Enumerator shows card contains the possibility of answer, developed from MWSP. It is also possible for the household to choose more than one answer]

Why would you decide NOT to pay?

1. Your family income does not allow it	2
2. Distrust the authorities, corruption	20
3. Doubts on the programme's results	65
4. It is government's obligation, taxes are paid	1
5. Need more information	9
6. Other (specify)......................	0

B20[**Enumerator shows card contains the possibility of answer, developed from MWSP. It is also possible for the household to choose more than one answer**]

What is the reason that you are uncertain?

1. Need more information	43
2. Need to consult other family members	1
3. Do not know if the income is enough	1

4. Other (specify)	0
5. Do not know	4
D3 Sex	
1 Male	110
2 Female	28
D4 Marital Status	
1. Single	16
2. Married	120
3. Divorced/Separated	1
4. Widowed	1
D5 The head of the household (or his/her spouse) highest education completed	
1. No schooling	4
2. Primary education (6 years)	14
3. Secondary education	34
4. Bachelor	42
5. Masters	42
6. PhD.	2
D6 Occupation of the head of the household	
1. Professional	13
2. Employee	50
3. Labour	26
4. Businessman	23
5. Pensioned	6
6. House worker	10
7. Unemployed	5
8. Other (specify)	5

D7 Number of total persons living in the households; including yourself.

A. Total	666
B. Male	354
C. Female	312

D10 How much is your household's combined net income per month?

A. 0 – 20000	64
B. 20000-40000	40
C. 40000-60000	20
D. 60000-80000	09
E. more than 80000	05

D11 Concerning your current standard of living, which of the following is true?

1. It is less than adequate for my needs	100
2. It is just adequate for my needs	28
3. It is more than adequate for my needs	09
4. Don't know	1

D12 Concerning your food consumption last month, which of the following is true?

1. It is less than adequate for my needs	96
2. It is just adequate for my needs	25
3. It is more than adequate for my needs	17
4. Don't know	00

D13 How much your average monthly electricity cost?

Rs. 747 in average

II) INFORMATION COLLECTED FROM PIPED HOUSEHOLDS

Total Observations :	102
AA1: Average live in house :	16.36 years
AA2(O): Total numbers of own owned households :	87
AA2(R)Total numbers of house belongs to family member/relatives :	3
Total state-owned house :	0
Total rented out house :	12
Total No. of head of the household :	70
Total No. of non-head of the household :	32

C1 Two most important reasons for having in-house connection:

1. Convenient	84
2. Health	61
3. Reliability	10
4. Modernization	5
5. Alternative source is not sufficient	21
6. Cheaper	19
7. Others	0

C3 Last monthly bill – consumption per month (m3)

[Enumerator ask the respondent to show the latest water bill,

if it is possible]

NRs. 271 in average

```
. sum c3
```

Variable	Obs	Mean	Std. Dev.	Min	Max
c3	**102**	**270.598**	**335.8661**	**0**	**2000**

C4 How would you describe your in-house connection water supply service?

1. Good	13
2. Fair	63
3. Bad	26

C5 How would you describe the current quantity of water supply Availability?

1. Ample	0
2. Moderate	55
3. Reduced	47

C6 How frequently does the household experience water shortfalls?

1. Water shortages some hours during the day	14
2. Water shortages one or more days a week	39
3. Water shortages few times a year	13
4. Water shortages during dry season	31
5. Other (specify)	0
6. Don’t know	2
7. No shortage	2

C7 How is the water pressure?

1. Strong	2
2. Generally strong	32
3. Weak	43
4. Sometimes weak	18
5. Very weak	5
6. Don’t know	2

C8 Do you take any of the following storage regarding the quantity of water received:

1. Store water in tanks	64
2. Drum	36
3. Bucket/vessel	3
4. Others	2
5. None	0

C9 How much was the installation cost of the storage:

1. Store water in tanks	(Average)	NRs. 55,153

C10 Do you have any secondary source of your water supply?

1. Yes	82
2. No	20

C11 What is your secondary source of your water supply?

1. Neighbour	0
2. Private well water/ Boring water	72
3. Public stand pipe	12
4. Private water supplier	03
5. Stone stand pipe	02
6. Jar water	13
7. Others (specify)	00

C12 [**Focus Group Discussion is needed to develop the answer possibility of this question**]

How much does the monthly cost you spend to fund your secondary source of your water supply? (i.e. operation and maintenance cost, payments made to the delivery person, cost of electricity, etc.)

1. Neighbour	0
2. Private well	1910
3. Public stand pipe	88
4. Private Water Supplier	1455
5. Stone stand pipe	38
6. Jar water	862
Others (specify)	100

C13 During the last year, how was the water quality been in your

household:

1. Water was clean	18
2. Water was chlorine smell or taste	50
3. Water was not normal colour	10
4. Water was residues, such as soil	19
5. Water smells bad	3
6. Others (specify)	2
7. Don’t know	0

C14 Have the member of household been ill because of consuming water from the pipe?

1. Yes	10
2. No	76
3. Don’t Know	16

C15**[Enumerator provides card listing waterborne diseases]**

How many persons in your house were ill during the last year due to the consumption of unsafe water?

1. No sickness because of unsafe water consumption	57
0. Don't Know	33

C16 [Focus Group Discussion here, to develop the possible answer]

What was the treatment of the ill household member?

1. Doctor Treatment	10
2. Self (Family treatment)	1
3. Doing Nothing	23
4. Don't Know	37

C17 How much was the average cost, per person, per illness, spent for? (ie. Doctor consultation cost, medicine, etc)

0 = Don't Know

NRs. 3850 in average

C18 Why do you think the city has got have this water scarcity problem?

1. Due to the population increase, we are a lot of people	57
2. Due to the lack of citizens' awareness, water waste	04
3. Due to the government's bad administration, corruption	32
4. Due to water leaks	09
5. Other (specify	0

C19 Please think in ten years time, how do you think this water scarcity may affect your household?

1. The quality of your family's life will be deteriorated	25
2. Water will be scarce	41
3. The cleaning habits of your household and personal care will change, hygiene	10
4You will have to pay more for water supply/Ration water	22
5. Other (specify)	0
6. Do not know	4

C20. [Enumerator starts with the card contains the range of payment can be made by the household. The options will be developed after MWSP]. Enumerator says," If connection will be free then ask yourself how much you are willing to pay per month for consuming good quality, reliable, and strong pressure of pipe water supply in your house? Put a tick next to the amount you are willing to pay, and continue down the card. Stop when you get uncertain about whether you would pay an amount, and tell me the highest amount you almost certainly are willing to pay. If you are uncertain about the lowest amount, tick "I am not willing to pay anything".

NRs. 562 in average

D3 Sex

1 Male	68
2 Female	34

D4 Marital Status

1. Single	18
2. Married	77
3. Divorced/Separated	4
4. Widowed	3

D5 The head of the household (or his/her spouse) highest education completed

1. No schooling	3
2. Primary education (6 years)	2
3. Secondary education	20
4. Bachelor	33
5. Masters	39
6. PhD.	5

D6 Occupation of the head of the household

1. Professional	22
2. Employee	31
3. Labour	1
4. Businessman	27

5. Pensioned	6
6. House worker	10
7. Unemployed	2
8. Other (specify)	3

D7 Number of total adult persons living in the households including yourself.

A. Total	456
B. Male	236
C. Female	220

D8 Number of children living in the households (≤15 years old)

A. Total	82
B. Male	41
C. Female	38

D9 Number of elderly living in the households (>65 years old)

A. Total	39
B. Male	22
C. Female	17

D10 How much is your household's combined net income per month?

A. 0 – 20000	17
B. 20000-40000	31
C. 40000-60000	29
D. 60000-80000	17
E. more than 80000	8

D11 Concerning your current standard of living, which of the following is true?

1. It is less than adequate for my needs	37
2. It is just adequate for my needs	59
3. It is more than adequate for my needs	2
4. Don’t know	4

D12 Concerning your food consumption last month, which of the following is true?

1. It is less than adequate for my needs	25
2. It is just adequate for my needs	69
3. It is more than adequate for my needs	4
4. Don’t know	4

D13 How much your average monthly electricity cost?

NRs. 1052 in average

D14 Amount of household monthly expenses in average

1. Food	NRs. 10420 in average
2. Clothing	NRs. 3506 in average
3. Housing (rent, repair, etc)	NRs. 3047 in average
4. Transportation	NRs. 4060 in average
5. Education	NRs. 10760 in average
6. Health services	NRs. 3171 in average
7. Others	NRs. 2324 in average

IV) STATA ANALYSIS OF PIPED HOUSEHOLDS

```
. reg wtp income

      Source |       SS           df       MS      Number of obs   =       102
-------------+----------------------------------   F(1, 100)       =      5.85
       Model |  612849.579         1  612849.579   Prob > F        =    0.0174
    Residual |  10480900.4       100  104809.004   R-squared       =    0.0552
-------------+----------------------------------   Adj R-squared   =    0.0458
       Total |    11093750       101  109839.109   Root MSE        =    323.74

------------------------------------------------------------------------------
         wtp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      income |   .0031109   .0012865     2.42   0.017     .0005585    .0056633
       _cons |   436.5339   65.62365     6.65   0.000     306.3385    566.7294
------------------------------------------------------------------------------

.

. reg ln_wtp ln_inc

      Source |       SS           df       MS      Number of obs   =       102
-------------+----------------------------------   F(1, 100)       =      3.79
       Model |  1.04650325         1  1.04650325   Prob > F        =    0.0543
    Residual |  27.5965237       100  .275965237   R-squared       =    0.0365
-------------+----------------------------------   Adj R-squared   =    0.0269
       Total |   28.643027       101  .283594326   Root MSE        =    .52532

------------------------------------------------------------------------------
      ln_wtp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      ln_inc |   .1478149   .0759058     1.95   0.054    -.0027801    .2984098
       _cons |    4.66296   .7992163     5.83   0.000     3.077337    6.248582
------------------------------------------------------------------------------
```

```
. reg wtp sex TotFam edu inscost income elecost

      Source |       SS       df       MS              Number of obs =     102
-------------+------------------------------           F(  6,    95) =    1.60
       Model |  1016063.93     6  169343.988           Prob > F      =  0.1566
    Residual |  10077686.1    95  106080.906           R-squared     =  0.0916
-------------+------------------------------           Adj R-squared =  0.0342
       Total |    11093750   101  109839.109           Root MSE      =   325.7

------------------------------------------------------------------------------
         wtp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         sex |  -73.20454   69.92452    -1.05   0.298    -212.0223    65.61319
      TotFam |  -6.519466   15.94342    -0.41   0.684    -38.17116    25.13223
         edu |  -48.91172   79.40293    -0.62   0.539    -206.5465     108.723
     inscost |   -.000308   .0006457    -0.48   0.634    -.0015898    .0009739
      income |   .0020761   .0015965     1.30   0.197    -.0010933    .0052454
     elecost |   .0825241   .0575559     1.43   0.155    -.0317388    .1967869
       _cons |   505.6561   138.7222     3.65   0.000     230.2577    781.0546
------------------------------------------------------------------------------
```

V) STATA ANALYSIS OF NON-PIPED HOUSEHOLDS

```
. reg wtp income, r

Linear regression                                      Number of obs =     138
                                                       F(  1,   136) =    4.15
                                                       Prob > F      =  0.0436
                                                       R-squared     =  0.0526
                                                       Root MSE      =  275.65

------------------------------------------------------------------------------
             |               Robust
         wtp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      income |   .0028168    .001383     2.04   0.044     .0000818    .0055518
       _cons |    508.532   31.13059    16.34   0.000     446.9694    570.0946
------------------------------------------------------------------------------
```

```
. reg ln_wtp ln_inc, r

Linear regression                                      Number of obs =     138
                                                       F(  1,   136) =    5.94
                                                       Prob > F      =  0.0161
                                                       R-squared     =  0.0501
                                                       Root MSE      =   .3884
```

ln_wtp	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_inc	.1158828	.0475442	2.44	0.016	.0218613	.2099043
_cons	5.143633	.4656894	11.05	0.000	4.222704	6.064562

```
. reg wtp income totfam elecost inscost sex edu, r

Linear regression                                      Number of obs =     138
                                                       F(  6,   131) =    2.54
                                                       Prob > F      =  0.0234
                                                       R-squared     =  0.1401
                                                       Root MSE      =  267.57
```

wtp	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
income	.0017021	.0012817	1.33	0.186	-.0008334	.0042377
totfam	-2.197606	9.724359	-0.23	0.822	-21.43471	17.03949
elecost	.0746968	.0914203	0.82	0.415	-.1061544	.255548
inscost	-.0006968	.0012051	-0.58	0.564	-.0030808	.0016873
sex	136.0593	81.42683	1.67	0.097	-25.0224	297.141
edu	113.4855	42.93192	2.64	0.009	28.55587	198.415
_cons	420.4812	69.64932	6.04	0.000	282.6982	558.2641

VI) COMBINED ANALYSIS

. reg wtp income totfam elecost inscost sex edu pipe_dum

Source	SS	df	MS
Model	**1844516.98**	**7**	**263502.425**
Residual	**20175882.6**	**232**	**86965.0112**
Total	**22020399.6**	**239**	**92135.5631**

Number of obs	=	**240**
F(7, 232)	=	**3.03**
Prob > F	=	**0.0046**
R-squared	=	**0.0838**
Adj R-squared	=	**0.0561**
Root MSE	=	**294.9**

wtp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
income	**.0017629**	**.0009901**	**1.78**	**0.076**	**-.0001877**	**.0037136**
totfam	**-1.928962**	**10.04031**	**-0.19**	**0.848**	**-21.71081**	**17.85288**
elecost	**.0900071**	**.0399335**	**2.25**	**0.025**	**.0113285**	**.1686857**
inscost	**-.0006312**	**.000848**	**-0.74**	**0.457**	**-.002302**	**.0010396**
sex	**37.55128**	**44.19159**	**0.85**	**0.396**	**-49.51685**	**124.6194**
edu	**56.48805**	**43.94741**	**1.29**	**0.200**	**-30.09898**	**143.0751**
pipe_dum	**-103.4254**	**52.10011**	**-1.99**	**0.048**	**-206.0752**	**-.7755588**
_cons	**459.2755**	**70.56577**	**6.51**	**0.000**	**320.2439**	**598.3072**

Norwegian University
of Life Sciences

Postboks 5003
NO-1432 Ås, Norway
+47 67 23 00 00
www.nmbu.no