8-28-2012

Demand for Water Quality: Empirical Evidence from a Knowledge, Attitude, Behavior, and Choice Experiment Survey about the Bagmati River in Kathmandu, Nepal

Hari Katuwal

Hari B. Katuwal
Candidate

Economics
Department

This dissertation is approved, and it is acceptable in quality and form for publication:

Approved by the Dissertation Committee:

Alok K. Bohara , Chairperson

Jennifer A. Thacher , Co-chairperson

Robert P. Berrens

Bruce M. Thomson

DEMAND FOR WATER QUALITY: EMPIRICAL EVIDENCE FROM A KNOWLEDGE, ATTITUDE, BEHAVIOR, AND CHOICE EXPERIMENT SURVEY ABOUT THE BAGMATI RIVER IN KATHMANDU, NEPAL

by

HARI B. KATUWAL

BSc, Tribhuvan University, 1992
MSc, Mathematics, Tribhuvan University, 1995
M.A., Economics, Tribhuvan University, 1999
M.A., Economics,University of New Mexico, 2008

DISSERTATION

Submitted in Partial Fulfillment of the
Requirements for the Degree of

Doctor of Philosophy
Economics

The University of New Mexico
Albuquerque, New Mexico

July, 2012

DEDICATION

To my family,

for their patience and support

ACKNOWLEDGEMENTS

I would never have been able to finish this dissertation without the guidance of my committee members, help from friends, and support from my family. I owe my gratitude to all those people who have made this dissertation possible.

I would like to gratefully and sincerely thank my advisor Professor Alok K. Bohara for his patience, constant support and excellent guidance during my graduate studies at the University of New Mexico. His mentorship was paramount in providing well rounded experience. I would also like to thank the rest of my dissertation committee: Professor Jennifer A. Thacher, Professor Robert P. Berrens, and Professor Bruce M. Thomson. I am deeply grateful to Professor Thacher for the long and numerous insightful discussions that helped sort out the technical details and better my research work. I would like to thank Professor Berrens for his guidance over the years. I am also grateful to Professor Thomson for being part of my committee.

I would also like to thank the Nepal Study Center at the University of New Mexico and Kathmandu School of Management in Kathmandu, Nepal for providing support and space for my field research. Finally, I would like to thank my family, friends and all the teachers. They were always supporting and encouraging me with their best wishes.

DEMAND FOR WATER QUALITY: EMPIRICAL EVIDENCE FROM A KNOWLEDGE, ATTITUDE, BEHAVIOR, AND CHOICE EXPERIMENT SURVEY ABOUT THE BAGMATI RIVER IN KATHMANDU, NEPAL

by

HARI B. KATUWAL

ABSTRACT OF DISSERTATION

Submitted in Partial Fulfillment of the
Requirements for the Degree of

Doctor of Philosophy
Economics

The University of New Mexico
Albuquerque, New Mexico

July, 2012

Demand for Water Quality: Empirical Evidence from a Knowledge, Attitude, Behavior, and Choice Experiment Survey about the Bagmati River in Kathmandu, Nepal

by

Hari B. Katuwal

BSc, Tribhuvan University, 1992
MSc, Mathematics, Tribhuvan University, 1995
M.A., Economics, Tribhuvan University, 1999
M.A., Economics,University of New Mexico, 2008
Ph.D., Economics,University of New Mexico, 2012

ABSTRACT

Surface water ecosystems such as rivers and lakes provide many benefits to the society. These benefits include both market goods such as drinking water, outdoor recreation, fisheries, as well as non market goods such as habitats for aquatic life, biodiversity, aesthetic attributes, and religious values. Because people value both market and non market goods, benefits from both types of goods must be taken into account for any policy change. The primary objective of this dissertation is to assess public preferences and estimate the benefits of improving environmental quality, water quality in particular, using survey data from Kathmandu, Nepal.

Chapter 2 provides estimates of the benefits of improving water quality in the Bagmati River using choice experiment data collected from in-person interviews of 1200 households in Kathmandu, Nepal. Four attributes of river health and cost under different management scenarios are used to estimate willingness-to-pay for the improvements in river water quality. Results from a random parameter logit model show that residents of

Kathmandu are willing to pay NRS 1520 (NRS 75=US$ 1) per year to improve the river water quality to a level that is suitable for fish and other aquatic animals from a level that is suitable for walking on the river bank. Similarly, willingness to pay is NRS 1470 per year to improve the river water quality to a level that is suitable for swimming from a level that is suitable for walking on the river bank.

In Chapter 3, an attitude-behavior framework is used to investigate the relationship between knowledge, attitude, and behavior towards river conservation, rehabilitation and restoration using data collected from in-person interviews in Kathmandu, Nepal. Results from a bivariate ordered probit model show that pro-environmental attitudes have strong effects on environmental participation. Also, environmental knowledge strongly influences attitude, and participation behavior towards environmental quality. However, scientific and health knowledge do not always translate into pro-environmental behavior. Cultural attachment is strongly associated with pro-environmental attitude, and exposure to information has a strong effect on environmental participation.

In Chapter 4, the determinants of water treatment behavior are identified and examined. In particular, the focus is on the impact of knowledge, exposure to information, and community participation towards drinking water treatment behavior. Results from probit regression analyses suggest that knowledge, frequency of exposure to information, and community participation significantly increase the likelihood of utilizing drinking water treatment methods. Households connected to the distribution system are more likely to treat water as compared to those that are not connected to the system.

This study is first of its kind to elicit the benefits of improving river water quality in Nepal, and makes a significant contribution to the literature on nonmarket valuation of river water quality improvements in developing countries. Study results will be helpful for policy makers in determining the efficient management strategy, especially for the long term river conservation, rehabilitation, and restoration programs.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABREVIATIONS

2SLS	Two-Stage Least Squares
AC	Awareness of Consequences
AEM	Averting Expenditure Method
AIC	Akaike Information Criterion
ASC	Alternate Specific Constant
BBWMSIP	Bagmati Basin Water Management Strategy and Investment Program
BIC	Bayesian Information Criterion
CE	Choice Experiment
CI	Confidence Interval
CLM	Conditional Logit Model
CVM	Contingent Valuation Method
FIML	Full Information Maximum Likelihood
HPM	Hedonic Price Method
ICIMOD	International Center for Integrated Mountain Development
MDG	Millennium Development Goals
MLE	Maximum Likelihood Estimation
MNL	Multinomial Logit Model
NEP	New Environmental Paradigm
NRS	Nepali Rupees
RP	Revealed Preferences
RPL	Random Parameter Logit

RUM	Random Utility Model
SAS	Statistical Analysis System
SEM	Simultaneous Equation Modeling
SP	Stated Preferences
SUR	Seemingly Unrelated Regression
TCM	Travel Cost Method
TPB	Theory of Planed Behavior
TRA	Theory of Reasoned Action
UNESCO	United Nations Educational, Scientific and Cultural Organization
USA	United States of America
USD	US Dollar
WTP	Willingness To Pay

CHAPTER 1

Public Preferences and Demand for Environmental Quality

1.1. Introduction

Information based on people's preferences is important for any policy decision. For goods and services that are traded, such information is provided by the market. However, in numerous circumstances markets are inadequate or non-existent. These non market values, if unaccounted for, may be under-valued or over-valued in the decision making. Any policy changes without these considerations will be incomplete and misleading. In addition, sound assessment is at the heart of good policy making and it requires understanding public preferences and estimating monetary valuation of environmental quality to make an informed decision.

Surface water ecosystems such as rivers and lakes provide many benefits to the society. These benefits include both market goods such as drinking water, outdoor recreation, fisheries, as well as non market goods such as habitats for aquatic life, biodiversity, aesthetic attributes, and religious values. Because people value both market and non market goods, benefits from both types of goods must be taken into account for any policy change. This dissertation examines public preferences and estimates benefits of improving environmental quality in a developing country. The primary objective of this dissertation is to assess public preferences and estimate the benefits of improving water quality using survey data from Kathmandu, Nepal. Choice modeling is employed to assess public preferences in order to estimate the benefits of improving water quality. Knowledge, attitude and participation behavior towards the improvement of environmental quality are also examined.

1.2. Valuation of Environmental Quality

Over the last half century, there has been development of an extensive literature on estimating values associated with natural resource and environmental quality changes. The history of environmental valuation can be traced back to Ciriacy-Wantrup (1947), and Hotelling (1949). Ciriacy-Wantrup (1947) suggested a direct interview method for elicitation of benefits from preventing soil erosion. Similarly, Hotelling (1949) proposed a travel cost method to measure benefits provided by recreational sites. Since then several authors have employed non market valuation to measure the benefits of improving environmental quality.

Methods for estimating the value of natural resource services and environmental quality can be broadly categorized into two approaches; Revealed Preference (RP) and Stated Preference (RP) approaches. The SP approaches involve asking people directly or indirectly about the value they place on natural resources and environmental services. Contingent Valuation Method (CVM) and Choice Experiment (CE) are examples of SP methods. The RP approach is based on individuals' actual behavior reflecting utility maximization. Travel Cost Method (TCM), Hedonic Pricing Method (HPM), Averting

Expenditure Method (AEM), and Production Function Approach are RP methods. Economists have used both of these sets of approaches to estimate the benefits of improving environmental quality.

A significant number of valuation studies have been carried out to estimate the value of improved water resources**.** One of the initial studies to estimate the value of clean water was carried out by Gramlich (1977) for the Charles River in Boston, USA. Since then several authors have employed non market valuation to measure the benefits of improving water quality in the developed as well as developing world.

Perhaps more relevant, there have been a number of studies on river water quality in the developing world. Markandya & Murty (2004) used both market and non market valuation techniques to estimate the social benefits of cleaning the river Ganges in India. Choe et al. (1996) used CVM and the TCM to estimate the economic benefit of surface water quality improvement in Davao, Philippines. Alam & Marinova (2003) used CVM to estimate the total value for cleaning up the Buriganga River in Dhaka, Bangladesh. Referendum and double bounded dichotomous choice valuation questions were used to estimate the Willingness To Pay (WTP) to maintain river water quality in the Beijing River in China (Day & Mourato, 1998). These studies (Alam & Marinova, 2003; Carlsson et al., 2003; Choe et al., 1996; Gramlich, 1977) show that people value improvements in river water quality in both developed and developing countries. However, not many valuation studies have been carried out for surface water quality improvements in Nepal.

1.3. Choice Experiments in Developing Countries

Because of questions about the validity and consistency of CVM, the use of CE has significantly increased. Several authors (Adamowicz et al., 1994; Carlsson et al., 2003; Hanley et al., 2003; Bateman et al., 2006; Birol et al., 2006) have used CE to estimate the value of river water quality in developed countries. Adamowicz et al. (1994) were probably first to use CE to study the benefits of water quality improvements. In another study, CE was used for the valuation of wetland attributes in Southern Sweden by Carlsson et al. (2003). Hanley et al. (2006) used CE method to estimate the value of improvements in three different components of ecological status of river water quality. Bateman et al. (2006) compared the valuation of river water quality from CVM and Contingent Ranking (CR) methods. Biodiversity, open water surface area, research and education, retraining for farmers and cost were used as CE attributes in a study to estimate the value of changes in ecological and social function of wetland in Greece (Birol et al. 2006). Although, significant numbers of studies have used CE to estimate the benefits of surface water quality improvements in the developed world, the application of CE is relatively new for developing countries. Othman et al. (2004) and Do et al. (2009) are among the few studies that use CE to estimate the benefits of improving wetland biodiversity in the developing world.

The Bagmati River, which flows through the heart of Kathmandu, has significant aesthetic, cultural, and religious values. Quality of water in the river directly impacts the surrounding environment and health of local residents. Despite its relevancy to the quality of life of millions of people, the benefit of improved water quality in Bagmati has not been estimated monetarily. This dissertation estimates the benefits of water quality improvements in the Bagmati River using CE data.

1.4. Knowledge, Attitude and Behavior towards River

Greater participation of a community, and change in attitude and behavior of the residents are well recognized as prerequisites for the success of any long term sustainable management program. The sustainable management and quality of the environment depends on whether individuals are willing to contribute towards the conservation. Knowing what people think, understanding how the public perceives natural resources and what they are willing to do for the protection of natural resources is important for the identification and development of a program to address an environmental problem (Miller & Hobbs, 2002). Importance of incorporating the human dimension and understanding public support for the restoration of ecosystem has been emphasized by several studies (Connelly et al., 2002; Endter-Wada et al., 1998; Haney & Power, 1996). Thus, it is important to identify and address public opinion and concerns for the design and implementation of an ecosystem restoration program. However, understanding public attitudes and behavior towards environmental quality has been, and will remain, a prominent challenge for policy makers and social scientists.

There are several factors that shape attitudes and influence the way individual behave towards the environment. Behavioral intention towards the environmental quality, in addition to socioeconomic characteristics, depends critically on knowledge, attitudes, values, and practices of the consumers (Kotchen & Reiling, 2000; Spash, 2006; Spash et al., 2009). There are several studies on developed countries that have used an attitude-behavior framework to investigate the relationship between knowledge, attitudes and behavior. While there exists plenty of studies that apply the attitude-behavior framework for environmental quality, the studies that apply the attitude-behavior framework for a specific environmental quality such as river water quality has been neglected resulting in an important gap in the literature. Strikingly, little research has been conducted on this specific topic and it deserves a particular attention. In this context, an attempt is made to investigate the determinants of environmental participation, and understanding the relation between knowledge, attitude and participation behavior; specifically for a river conservation and rehabilitation program in a developing cities.

While there exists an extensive body of literature that explores the risks of poor water quality and household averting behavior to make water safe, studies that examine the impact of knowledge, information and community participation are scarce. Despite its critical importance, less attention has been paid to the impact of knowledge, information, and community participation on drinking water treatment behavior. An attempt is made in this dissertation to fill this gap by assessing the impact of knowledge, information and community participation towards water treatment behavior. An averting behavior approach is used to examine the impact of knowledge, information and community participation towards drinking water treatment behavior.

1.5. Structure of the Research

The primary objective of this dissertation is to assess public preferences and estimate the benefits of improving river health in Kathmandu, Nepal. Benefit of improving river health is estimated using CE data in Chapter 2. In Chapter 3, an attitude-behavior framework is used to examine the impact of knowledge and information towards the participation behavior for the conservation and restoration of river ecology. In Chapter 4, the determinants of drinking water treatment behavior are identified and examined. Each of the three main chapters contains specific conclusions. Avenues for the future research are discussed in Chapter 5.

1.6. Chapter Summaries

Chapter 1 provides the estimate of the benefits of improving water quality in the Bagmati River in Kathmandu, Nepal using EC data collected from in-person interviews of 1200 households in Kathmandu (with a response rate 75.29%). The Bagmati River is highly polluted and quality of water in the river directly impacts health of the residents as well as ecology, and development of the Kathmandu valley. Four attributes of the river health, with cost, under different management scenarios are used to estimate WTP for the improvements in river water quality. Results from a Random Parameter Logit (RPL) model show that residents of Kathmandu are willing to pay NRS 1520 (NRS 75=US$ 1) per year to improve the river water quality to a level that is suitable for fish and other aquatic animals from a level that is suitable for walking on the river bank. Similarly, WTP is NRS 1470 per year to improve the river water quality to a level that is suitable for swimming from a level that is suitable for walking on the river bank. The RPM with interactions shows that the preferences for improvements are significantly different across caste and ethnic group. Individuals who visit river for the agricultural purposes are willing to pay more for the improvements as compared to those who visit the river for other purposes. Home owners care more about improving the water quality as do those with a college degree. The results also indicate that individuals with higher level of income are willing to contribute less time for voluntary participation in the river clean-up program.

In Chapter 3, the relationship between knowledge, attitude and behavior towards the river ecology is examined. The relationship between human and the environment is driven by several factors. These factors include socioeconomic characteristics like income, education, culture, religion, and traditional practices. These characteristics along with knowledge and information affect the individual's attitude and behavior towards the environment. It is argued that knowledge and attitude directly and indirectly affect individual decisions for the use of natural resources. The importance and impact of knowledge, exposure to information, and cultural attachment towards environmental attitude and behavior are examined. In addition, any discrepancies between knowledge, attitude and behavior towards river health and restoration are brought to light. An attitude-behavior framework is used to investigate the relationship between knowledge, attitude and behavior towards the river conservation, rehabilitation and restoration using data collected from in-person in Kathmandu, Nepal. Results from a bivariate ordered probit model show that pro-environmental attitude has a strong effect on environmental participation. Environmental knowledge strongly influences attitude and participation behavior towards the environmental quality. However, scientific and health knowledge do not always translate into participation behavior. Cultural attachment is strongly associated with pro-environmental attitude, and exposure to information has a strong effect on environmental participation.

In Chapter 4, the determinants of water treatment behavior are identified and examined. Access to safe drinking water and sanitation is a key element for both economic development and population health. Consumers adopt several averting behaviors to protect from adverse health effects of poor water quality. This chapter examines the impact of knowledge, exposure to information and community participation towards drinking water treatment behavior using a survey data in Kathmandu, Nepal. The results from probit regression analyses suggest that knowledge, frequency of exposure to information, and community participation significantly increase the likelihood of utilizing water treatment methods. Households connected to the distribution system are more likely to treat water as compared to households that are not connected to the system. Household level water treatment behavior can be influenced through education, social marketing and community participation so that the number of people without access to safe water and sanitation can be reduced to half by 2015 to meet development goals.

CHAPTER 2

Public Preferences and Willingness to Pay for Improving Water Quality in Nepal's Bagmati River: Evidence from Choice Experiments

2.1. Introduction

The Bagmati River flows through the heart of Kathmandu valley and has significant aesthetic, cultural, and religious value. Water quality in the river directly impacts the surrounding environment and the health of local residents. It is also considered a holy river and worshiped by millions of Hindus. The Pashupatinath Temple, on the bank of the river, is a world-heritage site and one of the main tourist attractions[1]. According to Binnie and Partners et al. (1998), 4000 people visit Pashupatinath Temple on an ordinary day while 25,000 visit on special days. Rapid urbanization has pushed the river beyond its carrying capacity and it is now highly polluted. Contaminated by sewage, the water is black and emanates a foul odor. Consequences of the poor water quality include: devaluation of property, destruction of aesthetic values, adverse health impacts, ground-water contamination, and endangered livelihoods for farmers and fishermen.

---

[1] Casual observation reveals that many people visit the river daily for various purposes. Religious, cultural, recreation, household, agricultural are the main purposes of the trip. In addition, various festivals are celebrated on and around the river banks throughout the year.

Studies on specialized topics such as the pollution level, the health impacts, and the cost of reducing pollution in the Bagmati River (Ghimire, 1985; Pradhan, 1998; Shakya, 2001) show that there is significant loss of welfare due to degradation of the river water quality. Understanding residents' preferences towards the river health and estimating the benefits of the water quality improvements are important for the rehabilitation and sustainable management of the river. However, there are no studies that estimate the benefits of improving the health of the Bagmati River. This study attempts to fill this gap by estimating WTP for the improvements of water quality in the river using CE data.

Results from a Random Parameter Logit (RPL) model show that residents of Kathmandu are willing to pay NRS 1520 (NRS 75=US$ 1) per year to improve the river water quality to a level that is suitable for fish and other aquatic animals from a level that is suitable for walking on the river bank. Similarly, WTP is NRS 1470 per year to improve the river water quality to a level that is suitable for swimming from a level that is suitable for walking on the river bank. The RPM with interactions shows that the preferences for improvement are significantly different across castes and ethnic groups. Individuals who visit river for agricultural purposes are willing to pay more for the improvements as compared to those who visit the river for other purposes. Home owners care more about improving the water quality as do those with a college degree. The results also indicate that individuals with higher levels of income are willing to contribute less of their time for voluntary participation in the river clean-up program.

Households believe that a separate river clean-up fee is suitable and practical over an increase in the waste management fee or property tax for the collection of revenue for the clean-up program. Most of the respondents think that the river restoration program should be managed with the help of the community. Younger people are willing to pay more for the improvement of river water quality. Brahmins and Newars care more about the river water quality that is suitable for bathing as compared to Kshetris and other castes. Information on households' priorities regarding water-quality characteristics is an important tool for policy makers. Given the lack of similar studies in developing Southeast Asian countries, the results from this study can potentially be used in benefit transfer exercises to estimate the benefits of similar clean-up programs.

2.2. Background – The Bagmati River

The Bagmati River is the principal river of Kathmandu emerging from the Shibapuri range in the southern part of Mahabharata Mountain. Like most rivers in developing countries, the Bagmati River is used for irrigation, drinking water supply, and also as a sewer for domestic and industrial waste. Millions of Hindus in Nepal and India worship the Bagmati River as a holy river. People conduct daily rituals and bathe in the Bagmati to wash off physical, moral, and spiritual impurities. The river banks are also used for cultural, religious, and spiritual activities. Since it is the only cremation ceremony site for Hindus, people are burned and the residual is thrown into the river. Thus, the river is part of the daily life of the residents of Kathmandu from birth to death. Besides its economic value, the river has high cultural, social, and religious significance. However, rapid population growth and urbanization has pushed the river beyond its carrying capacity resulting in extensive degradation of the river and its water quality (Astra Development Network Pvt. Ltd., 2008). The river is destroyed by pollution; the water is black and emanates foul odors.

The pollution in the Bagmati River is one of the most widely discussed environmental issues in Kathmandu. Consequences of this pollution include: devaluation of property, destruction of aesthetic values, adverse health impacts, ground-water contamination, and endangered livelihoods for farmers and fishermen. A strong foul odor emanating from the river is one of the most directly felt consequences of this pollution, and is a major factor in property devaluation on the banks of the river. In addition, the health of the people living along the bank is at risk. The practice of performing holy ablutions in the river is about to vanish due to pollution.

Kathmandu, the capital city of Nepal, is the center of all socio-economic and political activities of the nation. There are four World Heritage Sites recognized by United Nations Educational Scientific and Cultural Organization (UNESCO) in the valley. Among these four, one is adjacent to the river. Tourism is a major source of foreign income because of these temples and world heritage sites. The pollution in the river that destroys the aesthetic value influences the tourism industry. Therefore, restoration and protection of the river is important for the protection and conservation of the natural resources as well as the cultural heritage of the valley (Astra Development Network Pvt. Ltd., 2008).

Several studies have examined pollution in the Bagmati and its effect on the environment and health (Paudel, 1998; Shakya, 2001; Stanley International Ltd. & Ltd., 1994). The Bagmati Basin Water Management Strategy and Investment Program (BBWMSIP) found that the water and river banks are extremely polluted with solid waste and the river bed has considerably dropped (Stanley International Ltd. & Ltd., 1994). The study concluded that the investment in river restoration and management is economically viable with a rate of return of more than 10 percent. Urbanization and industrialization at the headwaters are major contributors to the deterioration of the water quality that have far reaching impacts on the aquatic ecosystem as well as the health of downstream users (Paudel, 1998). Shakya (2001) suggested a wastewater treatment system to protect the aquatic environment and human health. An efficient and well managed waste disposal system, proper managed drinking water and sewage pipelines, implementation of environmental conservation management, and an increase in public awareness are some of the major recommendations made by Ghimire (1985).

The Bagmati River has enormous use and non use values. Degradation of water quality reduces use values, as well as, non use values and thus improvements in river water quality increase benefits to society. Total economic value gets underestimated without the inclusion of passive use value. Any policy changes without these considerations will be incomplete and misleading. However, there is a dearth of studies that assess society's preferences and determine the benefits from improving the quality of water in the river.

To the best of my knowledge, this study is the first to examine society's preferences for improving water quality in the Bagmati River by estimating households' WTP. A CE survey was administered to assess public preferences and to elicit WTP.

2.3. Research Questions and Hypotheses

The goal of this research is to estimate the benefits of improving water quality in the Bagmati River using CE data. Households' WTP is estimated for various components of a clean-up program that attains a given level of water quality. In a CE survey, individuals are presented with two or more alternatives and asked to choose their preferred one. The alternatives represent different possible river clean-up programs. A river clean-up program is defined by the state of the river's health (i.e., the water quality), tree coverage along the river banks, the cost to the individual (in both money and time), and the management mechanism (Table 2.1). Because of financial limitations in a developing country, previous studies have found that a substantial portion of households were prepared to contribute time instead of paying fees (Alam & Marinova, 2003). Therefore, in addition to including a fee attribute, a work attribute was also included to estimate willingness to contribute time.

In addition to estimating WTP, the following hypotheses are tested in this chapter. Kathmandu residents may prefer community trust funds over a municipal agency or other administrative bodies to manage the clean-up funds. Whether residents have significantly different preferences over who manages the cleanup funds is tested by estimating WTP.

$H1_0$: WTP is not different for different management systems.

Residents of Kathmandu visit river for various purposes. Preference for improved water quality depends on the purpose of visitation. Dummy variables for different visitation purposes are created and interacted with the water quality to test the hypothesis;

$H2_0$: Purpose visitation does not influence WTP.

The river is associated with day-to-day life of the residents of Kathmandu for several cultural and religious activities from birth to death. Because of the strong cultural and religious significance of the river, it is expected that the preferences of the households are also influenced by culture, religion, caste and ethnicity. Castes are used to examine this effect.

$H3_0$: WTP is not different across castes.

2.4. Methodological Approach

2.4.1. Choice Modeling

Over the last half century, an extensive body of literature has been developed in assessing public preferences and estimating values associated the goods that cannot be traded in the market. Revealed and stated preference methods are used to assess public preferences and to estimate the WTP for improvements in the environmental quality. The CVM and CE are examples of stated preference methods. The TCM, HPM, AEM, and production function approach are revealed preference methods (Freeman, 2003). Economists have used both SP and RP methods to estimate the benefits of river water quality improvements.

One of the initial studies to estimate the value of clean water was carried out by Gramlich (1977) for the Charles River in Boston, USA. Since then, a significant number of valuation studies have estimated consumer surplus related to water resources. Perhaps more relevant, a number of studies have been conducted for the benefit estimation of river water quality improvements in the developing world. Markandya & Murty (2004) used both market and non market valuation techniques to estimate the social benefits of cleaning the river Ganges in India; they found that a program for cleaning the river had positive net present social benefits at a discount rate of 10 percent. Choe et al. (1996) used CVM and TCM to estimate the economic benefits of surface water quality improvement in Davao, Philippines. The estimates from the two methods were similar. Alam and Marinova (2003) used CVM to estimate the total value for cleaning up the Buriganga River in Dhaka, Bangladesh. Referendum and double bounded dichotomous choice valuation questions were used to estimate WTP to maintain river water quality in the Beijing River in China (Day & Mourato, 1998). Thus, CVM has been one of the most frequently used methods for the benefit estimation of river water quality improvements. However, because of the questions on the validity and consistency of CVM, the use of CE has significantly increased (Bateman et al., 2006).

Several authors (Adamowicz et al., 1994; Carlsson et al., 2003; Hanley et al., 2003; Bateman et al., 2006; Birol et al., 2006) have used CE to estimate the value of river water quality in developed countries. Adamowicz et al. (1994) combined CE with TCM to study the benefits of water quality improvements. The authors concluded that CE is very flexible in terms of modeling complex tradeoffs between attributes. Hanley et al. (2003) combined the contingent behavior and revealed data to value coastal water quality improvements in Scotland using a random effects negative binomial panel model. The authors concluded that contingent behavior models are attractive when environmental changes are outside the range currently observed.

In another study, CE was used for the valuation of wetland attributes in southern Sweden by Carlsson et al. (2003). The authors identified different attributes of the wetland that increase and decrease citizen's perceived value of wetlands. Hanley et al. (2006) used CE to estimate the value of improvements in three different components of ecological status of river water quality. Along with price; in-stream ecology, aesthetic/appearance and bank side condition were used as attributes of river water quality. Random Parameter Logit (RPL) model was used to estimate the WTP. The authors concluded that people place significantly different values for different aspects of quality of river. Bateman et al. (2006) compared the valuation of river water quality from CVM and contingent ranking methods. One third of the respondents gave rankings consistent with utility maximization of water quality improvement and more than one fourth gave ranking consistent with payment minimization. From the estimate of consumer surplus associated with different scenarios in Greece, Birol et al. (2006) concluded that social welfare is maximized under the high-impact scenario that provides higher level of attributes.

Although, a significant number of CE studies have been used to estimate the benefits of surface water quality improvement, application of CE is relatively new for estimating benefits in developing countries. Othman et al. (2004) and Do et al. (2009) are among the few studies that use CE to estimate the benefits of improving wetland biodiversity in the developing world. Othman et al. (2004) used CE to estimate the non market values provided under different management scenario from Matang Mangrove Wetland in

Malaysia. The authors concluded that CE can be successfully employed in a developing world with careful construction of choice sets and effective data collection. Similarly, Do et al. (2009) used CE to estimate biodiversity protection values of Tram Chim National Park wetland ecosystem in Vietnam. The authors concluded that the role of focus group discussion, pre-tests, and the design of the questionnaire are important especially for developing countries. Authors estimated the total benefits and concluded that the benefits outweigh the cost of improving the wetland biodiversity.

These studies (Alam & Marinova, 2003; Carlsson et al., 2003; Choe et al., 1996; Gramlich, 1977) show that people value improvements in river water quality in both developed and developing countries. Moreover, it is well documented that CE can be successfully implemented for the estimation of the benefits of improving surface water quality in less developing countries (Do et al., 2009; Othman et al., 2004). However, not many valuation studies have been carried out for surface water quality improvements in the developing world.

2.4.2. Research Method

RP methods are not appropriate for the case of the Bagmati River. Because of underdeveloped markets and lack of availability of property sales data, a hedonic model would not capture all the variations in the value of the improvements in water quality in the price of the property. Similarly, there are hardly any recreational activities that can be used for the estimation using the TCM. In addition, it is difficult to estimate the marginal value of different attributes using CVM and other methods. But, using CE, the trade-off between different attributes can be modeled and the marginal value of different attributes under different changes in policies can be estimated. Moreover, CE is consistent with the Random Utility Model (RUM) and enables the researcher to collect comparable or higher quality information at a lower cost (DeShazo & Fermo, 2002). Due to these strengths, there has been an increasing trend in the use of CE. Since the objective, in addition to estimating benefit of improving quality of water in the river, is to examine the preferences of the household for other attributes; CE is used.

2.5. Theoretical Framework and Econometric Model

2.5.1. Conditional Logit Model

Following McFadden (1974), a RUM is assumed. The utility function can be broken into two components; deterministic and stochastic.

$$U_{ij} = V(X;\beta)_{ij} + \varepsilon_{ij} \tag{2.1}$$

where $V(X;\beta)_{ij}$ is the deterministic component and ε_{ij} is a random error term. X is a vector of explanatory variables for individual i. It is the vector of all attributes of alternatives j including cost and other socioeconomic characteristics. The vector β is a set of parameters to be estimated.

The deterministic indirect utility function in equation (2.1) can be expressed as,

$$V_{ij} = ASC + \sum_k \beta_k Z_{ijk} \tag{2.2}$$

where ASC is Alternative Specific Constant (ASC) which captures any systematic variation in choice observations that are associated with an alternative but not captured by attributes or individual characteristics, Z_{ijk} is k^{th} attribute value of j^{th} alternative, β_k is the coefficients of k^{th} attributes. The above model can be extended to capture the heterogeneity by including socio-demographic characteristics of the households and the respondents,

$$V_{ij} = ASC + \sum_k \beta_k Z_{ijk} + \sum_n \delta_n X_{ijn} \tag{2.3}$$

where X_{jni} is n^{th} socio-economic characteristics of i^{th} individual, and δ_n is the corresponding vector of coefficients associated with n^{th} socio-economic characteristics for i^{th} individual. Parameters β_k and δ_n can be estimated by maximizing the likelihood function. The indirect utility (V) can be calculated after estimating coefficients (β_k).

Under the assumption that the error terms are Independent and Identically Distributed (IID) and follow a type 1 extreme value distribution, the probability function can be written as:

$$\mathrm{P}_i(j) = \frac{e^{\mu V(X;\beta)_{ij}}}{\sum_{k=1}^{J} e^{\mu V(X;\beta)_{ik}}} \tag{2.4}$$

where μ is a scale parameter and is inversely related to the standard deviation of the error distribution which is normalized to unity for modeling purposes.

The probability of the choice made for individual i is:

$$P_i = \prod_{j=1}^{J} \mathrm{P}_i(j)^{d_{ij}} \tag{2.5}$$

where d_{ij} is binary indicator such that $d_{ij} = 1$ if individual i selects alternative j; 0 otherwise.

The Log Likelihood function for the choices made for all individual is;

$$\ln L = \sum_{i=1}^{N} \sum_{j=1}^{J} d_{ij} . \ln \mathrm{P}_i(j) \tag{2.6}$$

Above CLM function can be estimated by using Maximum Likelihood Estimation (MLE).

The Marginal Willingness To Pay (MWTP) for an attribute is the derivative of the utility with respect to attribute divided by the negative of the derivative of utility with respect to price (Greene, 2006; Hanemann, 1984; Hensher et al., 2007). Thus, the ratio of the coefficient of any attribute to the coefficient of cost attribute is;

$$MWTP = -\frac{\beta_k}{\beta_C} \tag{2.7}$$

where β_k and β_C are coefficients of k^{th} attribute and cost attribute respectively.

2.5.2. Random Parameter Logit Model

For CLM, ε_{ij} is assumed to be IID with extreme value 1 across individuals, alternatives, and choice situations. The IID assumption can be relaxed by introducing additional stochastic elements that will take into account the heteroscedasticity and autocorrelation across alternatives (Hensher et al., 2007).

$$U_{ij} = V(X;\beta)_{ij} + [\eta_{ij} + \varepsilon_{ij}] \tag{2.8}$$

In addition to the error term ε_{ij}, η_{ij} is introduced to take into account the heteroscedasticity and autocorrelation across alternatives. For a given value of η_{ij}, the remaining error term ε_{ij} is IID distributed with extreme value 1. Thus, the conditional probability is logit and the probability that individual i will choose alternative j is given by (Hensher et al. 2007);

$$P_i(\eta) = \frac{e^{V(X;\beta)_{ij}+\eta_{ij}}}{\sum_{k=1}^{J} e^{V(X;\beta)_{ik}+\eta_{ik}}} \tag{2.9}$$

The value of η_{ij} is not given. The unconditional probability can be found by integrating equation (2.9) over all values of η_{ij},

$$P_i(\eta) = \int P_{ij}(\eta) f(\eta \mid \theta) d\eta \tag{2.10}$$

$P_i(\eta)$ is the logit probability evaluated for different parameters of η and $f(\eta \mid \theta)$ is the density function and θ is the fixed parameter of the distribution η.

$$\mathrm{P}_i(j) = \int \frac{e^{V(X;\beta)_{ij}+\eta_{ij}}}{\sum_{k=1}^{J} e^{V(X;\beta)_{ik}+\eta_{ik}}} f(\eta \mid \theta) d\eta \tag{2.11}$$

The above integral has no closed form solution, and thus parameters are estimated using Simulated Maximum Likelihood Estimations (SMLE). For any value of θ, the average of the simulated probability that an individual i chooses alternative j is given by

$$S\,\mathrm{P}_i(j) = \frac{1}{R} \sum_{r=1}^{R} P_{ij}(\eta^r) \tag{2.12}$$

where R is the number of draws and $SP_i(j)$ is the unbiased estimators of P_i.

The probability of the choice made for one individual is,

$$P_i = \prod_{j=1}^{J} S\,\text{P}_i(j)^{d_{ij}} \tag{2.13}$$

where d_{ij} is binary indicator such that; $d_{ij} = 1$ if the individual selects alternative j; 0 otherwise.

The above probability in log form can be written as;

$$\ln P_i = \sum_{j=1}^{J} d_{ij} \ln S\,\text{P}_i(j)$$

The log likelihood function of the simulated probability is given by,

$$SlnL = \sum_{n=1}^{N} \sum_{j=1}^{J} d_{nj} \ln S\,\text{P}_i(j) \tag{2.14}$$

2.6. Research Design and Implementation of CE

2.6.1. Sample Design

Kathmandu valley includes 345,562 households in five major cities: Kathmandu, Lalitpur, Bhaktapur, Kirtipur, and Madhyapur Thimi (ICIMOD, 2007). Since the river flows through the middle of the valley, water quality in the river has a direct impact on the city residents. Thus, the target population of this study is all households in these cities. The households were selected using a multistage cluster sampling. The households in the valley were divided into 8 strata and then to 206 clusters. Forty clusters were selected from 206 clusters based on the number of households in each stratum. Thirty households were selected from each of the 40 clusters. Twelve hundred households were selected for the final survey[2].

2.6.2. Focus Group Discussions and Pre-testing

Following Mansfield & Pattanayak (2007), a rapid appraisal method was used to design the survey. This involved discussions with key informants, focus group discussions, discussion with experts, and a pre-test survey. Since little is known about the cost and management of a cleanup program, an in-depth review was carried out from available literature and documents available in the concerned institutions. This was followed by interviews and meetings with stakeholders and experts. These stakeholders and experts included personnel from a municipality, waste water control authorities, Non Governmental Organizations, and International Non Governmental Organizations working on river management.

Three focus group discussions (one each in upstream, midstream, and downstream sections) were conducted to collect preliminary information on attitudes towards river quality improvements and to identify important attributes. Seven to nine individuals attended each of the focus groups. The purpose of these discussions was to collect information on participants' views on the different attributes of water quality, payment, and funding mechanism. The information was used to refine the questionnaires and make them easier to understand. Focus groups were followed by a pre-test to estimate the

---

[2] Calculation of sample size and discussion are provided in Appendix A.

completion time, identify any deficiency in questionnaires, and identify any sources of confusion. A total of 40 households were interviewed for pre-testing. Necessary modifications in the survey design were made after a comprehensive analysis of the pre-test. In-person interviews were conducted to collect the CE data and respondents were over the age of 18 years old. All questionnaires were administered in Nepali[3]. In-person interviews were undertaken at the respondents' homes and each interview took about 45 minutes. The final version of the questionnaire included five parts: environmental attitude and concerns, choice experiments, knowledge, attitude and behavior concerning Bagmati River, health status behavior and socio-economic characteristics.The response rate for the survey was 75.29%[4].

2.6.3. Choice Experiment Design and Implementation

Selection of attributes and their levels is an important part of choice set design. As indicated in Table 2.1, three levels for water quality, tree plantation, and management were used in addition to the current situation (status quo). Six levels were used for cost, and three levels were used for time contribution attributes. The range for cost and time

[3] Questionnaires used for the survey is presented in Appendix B

[4] The response rate is the proportion of completed interviews and the number of households selected and approached for the interview.

contribution attributes were determined after the discussion with key informants and focus groups. The payment vehicle included in the survey was a yearly payment of a "river clean-up fee" for five years. It was also explained to the respondents that half of the cost will be paid by the government, and remaining half will be collected from local residents.

Table 2.1: Attributes and Levels Used in the Choice Sets

Attributes	Levels
Improvement in water quality	The water is black, emits a foul odor, and is not suitable for fish and other aquatic animals. Contact with the water is dangerous to human health*.
	Walkable on the riverbank.
	Walkable on the riverbank, suitable for fish and plants.
	Walkable on the riverbank, suitable for fish and plants, and suitable for swimming and bathing.
Plantation (% cover in the river banks)	20*, 40, 60, and 80
Management	Community, Municipality, and Government
Cost(NRS/yr)	0*, 600, 1200, 1800, 2400, and 3000
Time contribution (days/yr)	0*, 5, 10, and 15

* Denotes the status quo

A linear D-optimal design procedure was used to create choice sets (Kuhfeld, 2005). Altogether, eighteen choice sets were created. The total choice sets were divided into six different blocks with three choice sets in each block; in other words, there were six different survey versions and each version included three choice sets. Each choice set has three alternatives, two alternatives for the river cleanup program and one for the current situation.

Figure 2.1: An Example of a Choice Set

Suppose alternatives A, B and C are the only available choices.			
Attributes	Alternative **A**	Alternative **B**	Alternative **Z-** Current situation
Water quality	Walkable on the riverbank	Walkable on the riverbank, suitable for fish and plants and, suitable for swimming and bathing	The water is black, emits a foul odor, and is not suitable for fish and other aquatic animals. Contact with the water is dangerous to human health.
Riverside tree plantation	40 percentage	80 percentage	20 percentage
Who is incharge of managing funding?	Municipality	Government	Not applicable
My annual payment for 5 years	NRS 3000 per year	NRS 600 per year	NRS 0 per year
Time Contribution per year	10 days	15 days	0 days

Which do you prefer?

1. Alternative A ☐
2. Alternative B ☐
3. Current situation Z ☐

2.7. Results and Discussions

2.7.1. General Characteristics of Households

Definitions of all the attributes and descriptive statistics of respondents are reported in (Table 2.2). A typical household that responded to the survey has 5.7 members in the family. Of the total respondents, 64 percent are male. Average age of the respondents is 36 years. Average education level of the respondents is 12 years. About two thirds of the households own their house. About 44 percent households belong to the Newar caste. Brahmin and Kshetri castes constitute 22 and 16 percent of the sample. The survey also collected information on household income. Average monthly household income is NRS 19,990. Seventy two percent of the total residents have visited the river at least once during previous month. About 3 percent of the respondents' visitation purpose was agricultural.

Table 2.2: Descriptive Statistics and Definition of the Variables

Variables	Definition	Mean	Std dev	Max	Min
Attribute Variables					
W_QUALITY2	Water quality level that is suitable for fish and aquatic life (1=Yes, 0=No)	0.24	0.43	1	0
W_QUALITY3	Water quality of level that suitable for swimming (1=Yes, 0=No)	0.20	0.40	1	0
PLANTATION	Percent of area on banks of the river covered with trees and vagetation	27.39	23.53	60	0
M_MUNICIPALITY	The clean-up program is managed by Municipal authority (1=Yes, 0=No)	0.22	0.42	1	0
M_GOVT	The clean-up program is managed by Governmental authority (1=Yes, 0=No)	0.22	0.41	1	0
COST	Cost (NRS Thousand per year)	1	1.09	3	0
TIME	Time contribution for the clean-up program (days per year)	6.84	5.87	15	0
Demographic Variables					
INCOME	Monthly income of the household (Thousands NRS)	19.99	15.01	100	3
MALE	Respondent is male (1=Yes, 0=No)	0.65	0.48	1	0
AGE	Age of the respondents	35.83	12.61	78	18
AGRI	Visit river for agricultural purposes (1=Yes, 0=No)	0.03	0.17	1	0
OWN	Own home (1=Yes, 0=No)	0.72	0.45	1	0
COLLEGE	College (1=Yes, 0=No)	0.05	0.21	1	0
NEWAR	Caste (1=Newar, 0=Others)	0.45	0.5	1	0
BRAHMIN	Caste (1=Brahmin, 0=Others)	0.22	0.42	1	0
KSHETRI	Caste (1=Kshetri, 0=Others)	0.16	0.37	1	0
MID_INCOME	Income Level (1=Middle Income, 0= Others)	0.22	0.41	1	0
HIGH_INCOME	Income Level (1=High Income, 0= Others)	0.17	0.37	1	0

Socio-demographic characteristics were compared with Kathmandu's population to examine the representativeness of the sample (CBS, 2001). In addition, the sample was also compared with similar survey carried out by Central Bureau of Statistics, Nepal (CBS, 2005). Socio-demographic characteristics indicate that the samples were biased towards Newar caste with relatively large household size (Table 2.3). This might be due to the fact that the target population of the survey was beyond the urban area of the Kathmandu Valley. The large proportions of the homeowners also indicate that more households own home in rural part of the Kathmandu Valley.

Table 2.3**:** Comparison of Socio-demographics of the Respondents

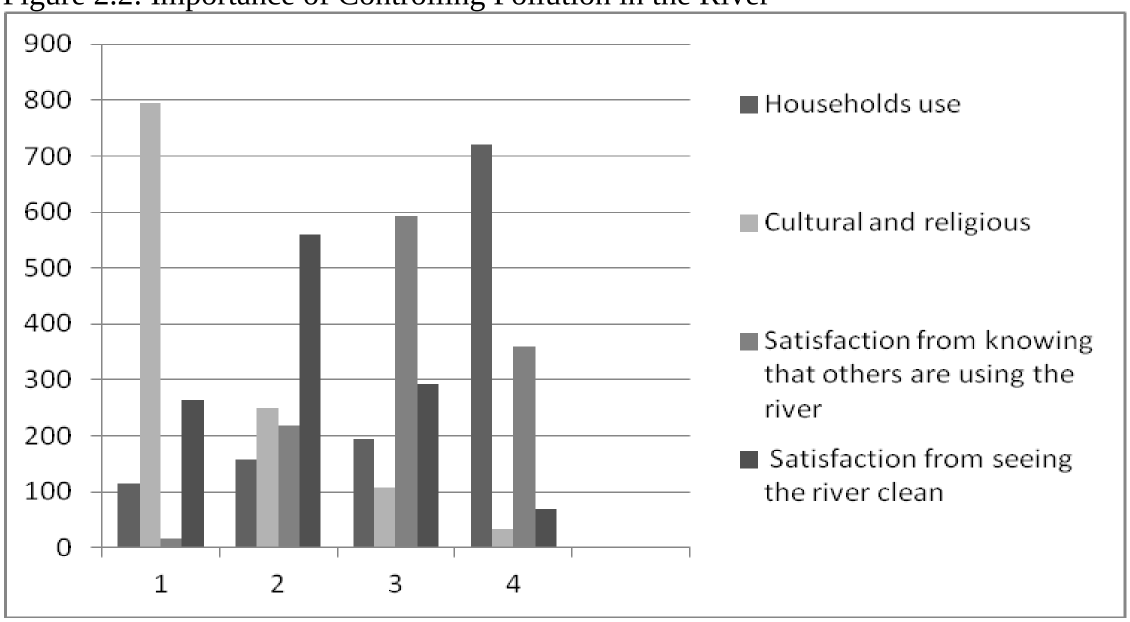
Household Characteristics	Sample mean (Current Survey)	Sample mean (Water Survey 2005)*	Population Mean (Census 2001)**
Household Size	5.7	4.6	4.6
Home Ownership	72.2	54.7	48.4
Brahmin	22.2	25.2	20.8
Kshetri	16.0	18.1	18.6
Newar	44.6	26.9	29.9

*Population Census 2001, Central Bureau of Statistics, Kathmandu, Nepal (CBS, 2001)
**Drinking Water Survey (CBS, 2005)

2.7.2. Households' Preferences towards River Water Quality

Several questions were asked to assess the households' preferences towards river water quality. Sixty seven percent of the households reported that use of the river for cultural and religious purposes is the most important reason for controlling pollution. In contrast, 22 percent reported that the pollution in the river should be controlled because they get satisfaction from knowing that the river is being used by others (Figure 2.2). Only 1.5 percent of households reported that controlling pollution in the river is most important because they use the river for household purposes such as agriculture, washing and cleaning.

Figure 2.2: Importance of Controlling Pollution in the River*



*(1-most important, 4-least important)

Respondents were also asked about possible changes in spending to improve the river water quality. About 64 percent of households believe that much more than current should be spent to improve the quality of water in the river. Twenty two percent of households believe that a little more than current should be spent while only 4.5 percent of household believe that current spending is sufficient.

Concerning households' willingness to contribute for cleaning the river, a little more than half (53%) are willing to pay higher taxes, 86 percent are willing to volunteer in the clean-up program, 74 percent are willing to meet and talk with neighbors, and 55 percent of households are willing to join water conservation groups. Almost half of the respondents' water quality preference is improvements to a level that is suitable for swimming. Similarly, a little more than one third respondents think that improving water quality to a level that is suitable for fish and other aquatic life is practical. The most popular payment mechanism is a separate river clean-up fee. This is followed by a sewerage and waste management fee. Respondents were also asked about the most suitable basis for collecting a river clean up fee. Income is the most preferred basis followed by use of water and distance of the house from the river.

2.7.3. Model Results

Two CLMs are estimated. The first model is a basic model with all the attributes. Socio-economic characteristics are interacted with the attributes in the second model.

2.7.3.1. Basic Conditional Logit Model

Three utility functions that represent indirect utility derived from the corresponding level of attributes are used for the basic model (equation 2.15). Alternative-3 is status quo, and alternative-1 and alternative-2 represents improvement scenarios. The indirect utility function in equation (2.2) is estimated using following set of equations:

$$V_1 = \beta_1 * W\_QUALITY2_1 + \beta_2 * W\_QUALITY3_1 + \beta_3 * PLANTATION_1 + \beta_4 * (PLANTATION_1)^{1/2} + \beta_5 * M\_GOVT_1 + \beta_6 * M\_MUNICIPALITY_1 + \beta_7 * COST_1 + \beta_8 * TIME_1 + \beta_9 * (TIME_1)^{1/2}$$

$$V_2 = \beta_1 * W\_QUALITY2_2 + \beta_2 * W\_QUALITY3_2 + \beta_3 * PLANTATION_2 + \beta_4 * (PLANTATION_2)^{1/2} + \beta_5 * M\_GOVT_2 + \beta_6 * M\_MUNICIPALITY_2 + \beta_7 * COST_2 + \beta_8 * TIME_2 + \beta_9 * (TIME_2)^{1/2} \quad (2.15)$$

$$V_3 = ASC$$

Three different levels of water quality, in adition to current scenarios, were presented to the respondents. Dummy variables (*W_QUALITY2*=1 if water is improved to a quality that is suitable for fish and other aquatic animals, 0 otherwise; *W_QUALITY3*=1 if water is improved to a quality that is suitable for swimming and taking bath, 0 otherwise) are created. The *W_QUALITY1* is used as a base category for estimation. The second attribute, percentage of plantation coverage on the river banks (*PLANTATION*) has three levels (40%, 60% and 80%) in addition to status quo (20%). Three alternative management scenarios were used and presented in the choice sets. Dummy variables (*M_MUNICIPALITY*=1 if managed by municipality, 0 otherwise and *M_GOVT*=1 if managed by central governmental authority, 0 otherwise) are created and used for the management attributes. *M_ COMMUNITY* is used as a base category. Cost (*COST*) and time contribution (*TIME*) have six (0, 600, 1200, 1800, 2400 and 3000) and three (5, 10, 15) levels. Status quo level for money and time contribution is 0.

Results from the basic CLM are presented in Table 2.4. Coefficients for all the attributes are as expected *a priori*. *ASC* is specified to equal one if the status quo is chosen[5]. Since *ASC* is associated with the status quo, the negative and highly significant coefficient of the *ASC* indicates that improved water quality is preferred by the households. The *ASC* under this scenario represents the utility difference between current situation (current quality of water, current management, no plantation[6], no money and no time contribution), and the base category of attribute levels for improved scenarios. Base category of attribute levels for improved scenarios include; quality of water that is suitable for walking (*W_QUALITY1*), clean-up program that is managed by community (*M_COMMUNITY*), no time contribution (*TIME*=0), and no monetary contribution (*COST*=0).

Positive and highly significant coefficients of improved water quality (*W_QUALITY2* and *W_QUALITY3*) indicate that the utility derived from the quality of water that is suitable for fish and other aquatic animals is higher than the utility derived from the quality of water that is walkable on the river banks. Similarly, utility from the quality of water that

[5] Very few respondents chose status quo. CLMs were also estimated by removing observations for those who chose the status quo to examine the consistency. Results are consistence and presented in Appendix C.

[6] Although the status quo level for PLANTATION is 20%, it is converted to 0% by subtracting 20% from the entire plantation for estimation purpose to avoid multicolinearity.

is swimmable and bathable is higher than the utility from the quality of water that is walkable on the river banks. The negative and significant coefficient of government and municipal management attributes indicates that the households prefer and are willing to pay more if the clean-up project is managed by community as compared to municipal and governmental management. The negative cost coefficient in all the models are as expected indicating that respondents are less likely to choose the option if the cost they have to pay is higher (Table 2.4). Coefficients for the plantation is not significant indicating that households do not get additional welfare and are not willing to pay for the increase in the plantation coverage on the river banks.

2.7.3.2. Conditional Logit Model with Interaction

In addition to attribute levels, socio-economic characteristics also influence utility derived from environmental quality. These individual and household specific characteristics that are expected to affect the utility cannot be included directly in the linear model because they do not vary across the alternatives. Interaction models are estimated by incorporating attributes with several socio-economic characteristics'. These interactions capture utility preferences for different attribute levels, and the influence of socio-economic characteristics on the probability of choosing the particular alternative. Several socio-economic characteristics are significant in explaining varying preferences for different attributes level. Series of variables are included in the model by interacting them with different attributes and attributes levels. Inclusion of socio-economic characteristics interaction in the final model is based on extensive testing of various interactions of the attribute level with respondents' socio-economic characteristics. Socio-economic variables that have significant coefficients are used in the final model. Households' and respondents' characteristics such as income (*MID_INCOME and HIGH_INCOME*), education (*COLLEGE*), gender (*MALE*), age of the respondents (*AGE*), and purpose of visitation (*AGRI*) are included to capture the households' and respondents' heterogeneity. One of the unique characteristics of the Bagmati River is its religious and cultural significance. Caste and ethnicity of the residents are used to examine the cultural preferences[7]. The sample is divided into four categories; (*BRAHMIN, KSHETRI*, *NEWAR* and *OTHER)*, and dummy variables are used for these caste variables with *OTHER* as reference category. Results of the extended model are presented in last column of the Table 2.4.

[7] The practice of religion is very important in Nepal, and it depends on the caste system in addition to other factors. Brahmins are relatively more educated and respected. Kshetris are the warrior and ruler caste group. Newars are one of the indigenous communities in the Kathmandu Valley

Table 2.4: Results of Conditional Logit Models

Variables	Model1	Model2
ASC	-2.4319*** (0.9335)	-2.6844*** (0.8973)
W_QUALITY2	0.5094*** (0.0513)	0.3091*** (0.0933)
W_QUALITY3	0.4463*** (0.0552)	0.2626 (0.1815)
PLANTATION_C	-0.0104 (0.0174)	0.0464* (0.0242)
PLANTATION_C^.5	0.1237 (0.2139)	-0.4616 (0.2855)
M_GOVT	-0.2415*** (0.0534)	-0.0936 (0.0977)
M_MUNICIPALITY	-0.2001*** (0.0516)	-0.1138 (0.0963)
COST	-0.3185*** (0.0234)	-0.3184*** (0.0238)
TIME	-0.1347* (0.0696)	-0.1204* (0.0689)
TIME^.5	0.8911** (0.4275)	0.8205* (0.4222)
W_QUALITY3:AGRI	-	0.641** (0.2843)
W_QUALITY2:OWN	-	0.2887*** (0.1104)
W_QUALITY3:OWN	-	0.4658*** (0.1305)
W_QUALITY3:COLLEGE	-	0.321 (0.2243)

Table 2.4 (contd): Results of Conditional Logit Models

Variables	Model1	Model2
W_QUALITY3:AGE_10	-	-0.1141*** (0.0388)
W_QUALITY3:NEWAR	-	0.2768* (0.1415)
W_QUALITY3:BRAHMIN	-	0.4274*** (0.1534)
W_QUALITY3:KSHETRI	-	0.0987 (0.1637)
PLANTATION_C:AGE_10	-	-0.015*** (0.0047)
PLANTATION_C^.5:AGE_10	-	0.1542*** (0.0537)
M_GOVT:OWN	-	-0.2177* (0.1157)
M_MUNICIPALITY:OWN	-	-0.1378 (0.1138)
TIME:MID_INC	-	0.01 (0.0127)
TIME:HIGH_INC	-	-0.0222 (0.0135)
N	9963	9963
Log-Likelihood	-2285.25	-2256.38
McFadden R^2	0.0726	0.0843
AIC	4590.5	4560.77
BIC	4662.57	4733.73

Significance codes: '***' 0.01 '**' 0.05 '*' 0.1
Numbers in parentheses indicate standard errors

Results from the interaction CLM suggest that preference for water quality is significantly different for different visitation purposes. Individuals, who visit the Bagmati River for agricultural purposes, care more about the level of water quality that is suitable for bathing as compared to visitation for recreation, cultural and cleaning purposes. Respondents who own their home care more about the water quality as do more educated people. Result also indicates that younger people are willing to pay more for the improvement of river water quality that is suitable for bathing. Brahmins and Newars care more about the river water quality that is suitable for bathing as compared to Kshetris and other caste. The results from the interaction model also indicate that individuals with higher level of income are willing to contribute less time for the voluntary participation towards the river clean-up program.

2.7.3.3. Basic Random Parameter Logit Model

CLM assumes IIA. If IIA property is violated, the CLM estimates will be misleading (Hensher et al., 2007; Train, 2008). IIA property is tested using Hausman- McFadden (1984) test. Hausman-McFadden tests are conducted by dropping one choice option from the choice sets. The result of Hausman-McFadden (Hausman, 1984) test is reported in Table 2.5

Table 2.5: Test of Independent of Irrelevant Alternatives

Alternative dropped	X^2	Degree of freedom	Probability
Alternative A	1728.22	10	$2.2e^{-16}$
Alternative B	785.2727	10	$2.2e^{-16}$

The Hausman-McFadden test of IIA property (Table 2.5) shows that acceptance of IIA property is rejected if one of the alternatives is dropped (Hanley et al., 2006). In addition, CLM also assumes the homogeneous preferences across respondents. RPL is used to account the heterogeneous preferences and avoid the violation of IIA (Train, 2008; Hensher et al., 2007). Like CLM, a series of respondents' socio-demographics, spatial characteristics are also included in the RPL models in different model specification. The variables that are significant in CLM models are included in RPL models.

RPL model estimation requires an assumption to be made about the preferences for each of the attributes. There are several candidates for such distributions: uniform, normal, lognormal, and triangular distribution. Based on the utility function, the cost coefficient is expected to be negative. In such case, a negative log normal distribution is suggested to be appropriate (Train, 1998). All the coefficients except cost are assumed to be normally distributed and random[8]. All the attribute coefficients except cost are used as random

[8] Carlsson et al. (2003) discuss comparative advantage of letting cost remain fixed. According to the authors, restricting cost variable to be fixed would allow to generate MWTP with the same distribution as rest of the random parameters.

parameters in the initial RPL model estimation (Train, 2008; Carlsson et al., 2003; Birol et al., 2006).

Results from RPL model, based on a simulation of 1000 Halton draws, show that the respondents have heterogeneous preferences over quality of water in the river[9]. In general, attributes with significant standard errors are included in the RPL models (Hensher et al., 2007). Several versions of the models were estimated with all attributes except cost as a random parameter. Since standard errors of water quality attributes were consistently significant, water quality attributes are included as random parameters in final models (Hensher et al., 2007).

Results from the basic RPL model are presented in Table 2.6. Results from basic CLM and basic RPL are similar and consistent. The estimated coefficients from basic CLM and

---

[9] Several versions of models with different numbers of draws were estimated. Presented estimation results are based on the goodness of fit (pseudo R-squared), consistency and stable parameters estimates from the several numbers of draws. Sensitivity of parameters estimates with different numbers of Halton draws was tested. RPMs were also estimated with 500 and 2000 Halton draws. Results are presented in Appendix C (Table C2 and Table C3). Goodness of fit ($\text{Pseudo}-R^2 = 1 - \frac{LL_{\text{estimated model}}}{LL_{\text{base model}}}$) value in CLM is similar to R^2 in conventional analysis, except that the significance occurs at a lower level. Hensher et al. (2007) argue that the pseudo-R^2 value of 0.3 is equivalent to R^2 of 0.6 in a linear regression model.

basic RPL have same sign with similar magnitudes. The highly significant standard deviation of water quality attributes indicates that there is significant heterogeneity in preferences among the respondents.

2.7.3.4. Random Parameter Logit Model with Interaction

To capture the variances and estimate MWTP of individual and demographic characteristics, RPLs with interaction are estimated. Results from the RPL with interaction are reported in the second column of Table 2.6. Similar to the interaction CLM, interaction RPL model (Model4) shows significant heterogeneity in preferences among the respondents.

Table 2.6: Results of Random Parameter Logit Models

Variables	Model3	Model4
ASC	-2.8294**	-3.1603***
	(1.1613)	(1.1922)
W_QUALITY2	0.5567***	0.3357***
	(0.0595)	(0.1018)
W_QUALITY3	0.5299***	0.3016
	(0.0878)	(0.2385)
PLANTATION_C	-0.02	0.0422
	(0.0214)	(0.0319)
PLANTATION_C^.5	0.2516	-0.3673
	(0.2653)	(0.3835)
M_GOVT	-0.2717***	-0.1371
	(0.0638)	(0.1103)
M_MUNICIPALITY	-0.2433***	-0.1835
	(0.0669)	(0.1159)
COST	-0.377***	-0.3791***
	(0.0506)	(0.0501)
TIME	-0.049	-0.0271
	(0.1064)	(0.1083)
TIME^.5	0.3885	0.2682
	(0.6441)	(0.6546)
W_QUALITY3:AGRI	-	0.8054**
		(0.3673)
W_QUALITY2:OWN	-	0.3208***
		(0.1195)
W_QUALITY3:OWN	-	0.575***
		(0.1802)
W_QUALITY3:COLLEGE	-	0.4155
		(0.282)

Table 2.6 (contd): Results of Random Parameter Logit Models

Variables	Model3	Model4
W_QUALITY3:AGE_10	-	-0.1472*** (0.0554)
W_QUALITY3:NEWAR	-	0.3685* (0.197)
W_QUALITY3:BRAHMIN	-	0.5739** (0.2282)
W_QUALITY3:KSHETRI	-	0.137 (0.2179)
PLANTATION_C:AGE_10	-	-0.0165** (0.0066)
PLANTATION_C^.5:AGE_10	-	0.1628** (0.0762)
M_GOVT:OWN	-	-0.2002 (0.1298)
M_MUNICIPALITY:OWN	-	-0.1054 (0.134)
TIME:MID_INC	-	0.015 (0.0149)
TIME:HIGH_INC	-	-0.0234 (0.0156)
sd.W_QUALITY2	0.0013 (30.3557)	-0.0012 (30.5987)
sd.W_QUALITY3	1.2766** (0.5568)	1.3123** (0.5404)
N	9963	9963
Log-Likelihood	-2284.09	-2255.12
McFadden R^2	0.073	0.0848
AIC	4592.19	4562.24
BIC	4678.67	4749.62

Significance codes: '***' 0.01 '**' 0.05 '*' 0.1
Numbers in parentheses indicate standard errors

Whether or not the interaction model is better than the basic model can be tested using the log-likelihood ratio test (Greene, 2006). Accordingly, the log-likelihood ratio between the basic RPL and the interaction RPL (-2[(-2284.09)-(-2255.12)] = 57.94) is significantly greater than the critical chi-squared value (23.68) for 14 degrees of freedom at the 5 percent significance level. Thus, the interaction RPL model provides significant improvement over the basic RPL model. Similarly, the log-likelihood ratio between the interaction CLM and the interaction RPL model (-2[(-2256.38)-(-2255.12)] = 2.52) is not greater than the critical chi squared value (5.99) for 2 degrees of freedom at the 5 percent significance level. However, the interaction RPL has slightly greater goodness of fit.

Results from the interaction RPL model (Table 2.6) suggest that preference for water quality is significantly different for different visitation purposes. Positive coefficient of *W_QUALITY3*AGRI* indicates that individuals, who visit the Bagmati River for agricultural purpose, care more about the level of water quality that is suitable for bathing as compared to visitation for recreation, cultural and cleaning purposes. Home owners care more about the water quality as do more educated people. The negative and significant coefficient of *W_QUALITY3*AGE* indicates that younger people are willing to pay more for the improvement of river water quality that is suitable for bathing. Brahmins and Newars care more about the river water quality that is suitable for bathing as compared to Kshetris and other caste. The results from the interaction model also indicate that individuals with higher level of income are willing to contribute less time for the voluntary participation towards the river clean-up program.

2.7.4. Marginal Willingness to Pay

MWTP are calculated from the coefficients from all four models. MWTP and confidence intervals for all the attributes are presented in Table 2.7. All four models show that improvement in water quality is preferred over status quo, and results are consistent and significant. MWTP for ASC from basic RPL model of NRS -8.41(CI:-14.56, -2.34)[10] indicates that the households are willing to pay NRS 8,410 per year for the improvement from the current level of water quality (status quo) to a level that is walkable, management is community and plantation is 20% with no time and money contribution. Interaction model estimates provides relatively higher estimates than the basic models.

Coefficients of water quality and corresponding costs are consistent and highly significant across both CLM and RPL models. The interaction RPL model results indicate that MWTP for the improvements in river water quality from walkable to suitable for fish and aquatic plants is NRS 1.52 (CI:0.95, 2.20) thousand per year. MWTP from RPL models are relatively smaller than that of CLM counterparts. Similarly, the MWTP for the improvement of quality of water from walkable to suitable for swimming and taking bath is NRS 1.47 (CI: 0.22, 2.83) thousands per year. As compared to CLM, this MWTP is relatively higher. Major differences between the two models (CLM and RPL) are with regard to alternative specific constant, and water quality.

[10] Confidence Intervals are calculated using Krinsky and Robb approach with 100,000 draws (Krinsky & Robb, 1986)

Table 2.7: Marginal Willingness to Pay*

Attributes	Basic CL Model	Basic RPL Model	CLM with Interaction	RPL with Interaction*
ASC	-7.68 (-13.65, -1.90)	-7.53 (-13.55, -1.58)	-8.48 (-14.27, -2.94)	-8.35 (-14.46, -2.31)
W_QUALITY2	1.61 (1.24, 2.03)	1.50 (1.13, 1.99)	1.63 (1.03, 2.28)	1.52 (0.95, 2.20)
W_QUALITY3	1.41 (1.02, 1.85)	1.42 (1.01, 1.89)	1.45 (0.32, 2.63)	1.47 (0.22, 2.83)
PLANTATION	0.00 (-0.11, 0.11)	0.01 (-0.10, 0.14)	0.00 (-0.15, 0.15)	0.01 (-0.16, 0.19)
M_GOVT	-0.76 (-1.11, -0.43)	-0.73 (-1.08, -0.40)	-0.79 (-1.41, -0.19)	-0.75 (-1.38, -0.18)
M_MUNICIPALITY	-0.63 (-0.97, -0.31)	-0.65 (-0.99, -0.32)	-0.67 (-1.29, -0.08)	-0.69 (-1.33, -0.09)
TIME	0.11 (-0.32, 0.55)	0.05 (-0.58, 0.55)	0.11 (-0.32, 0.55)	0.05 (-0.59, 0.57)

*MWTP is calculated using Krinsky and Rob method

**Numbers in the parentheses indicates 95% confidence interval

Results from the interaction RPL model indicate that households in Kathmandu prefer community management over governmental and municipal management for the improvements in river water quality. The RPL model with interaction results show that households are willing to pay NRS 750 per year more if the cleanup program is managed by the community as compared to governmental management, and NRS 690 more for community management as compared to municipal management. The positive coefficient of plantation indicated that households derive positive utility from plantation on the river banks. However, results are not significant in any model. MWTP for time contribution is not significant.

Results from all four models are consistent and Kathmandu residents are willing to pay significant amount for the improvement of the river health. However, several caveats are in order. First, MWTP for the improved scenario is significant percentage of household income. Economists have estimated MWTP for different levels of RIVER water quality. For example, MWTP for improvement of surface water quality to a level that is swimmable in USA was estimated to be 1.13% of residents' monthly income (Mitchell & Carson, 1993). Similarly, Beijing residents' WTP was estimated to be from 0.8% to 1.3 % of their income (Day & Mourato, 1998). More relevant, WTPs of residents in Davao, Philippines were less than 1% (0.63% to 0.87%) of the monthly income (Choe et al., 1996). This study shows that Kathmandu residents are willing to pay 3.5% of their monthly income to improve river water quality from current level to a level that is walkable, and 0.61% to improve from walkable to swimmable. This might be because of the fact that that quality of water in river is exremly degraded. In addition, the significant value might also be associated with the cultural and religious attachment of Kathmandu resident.

Furthermore, it was explained in the survey that quality of water that is suitable for swimming (W_QUALIITY3) is better than the level that is suitable for fish (W_QUALIITY2). Theoritically, MWTP for the water quality that is suitable for swimming should be higher than MWTP for the water quality that is suitable for fish and other aquatic animals. However, results indicate that MWTP for water quality that is suitable for swimming is not significantly higher than MWTP for water quality that is suitable for fish and aquatic animals. Results also indicate that there is significant heterogeneity among respondents. For example, respondents who visit the river for agricultural purposes are willing to pay significantly higher anount for water quality that is swimmable (Table 2.6). Simillarly, homeowner's willingness to pay for water quality that is swimmable is significantly higher than for the water quality that is suitable for fish and aquatic aplants. Majority of the caste in the Kathmandu Valley (Newar, Brahmin and Kshetri) are also willing to pay significantly higher amount for the water quality that is suitable for swimming. On the other hand, older people's WTP for water quality that is suitable for swimming is less than that of their younger counterpart. As the data was collected in the developing countries, significant numbers of respondents were illiterate. Thus, it is possible that the sensitivity of scope is coming from old respondents without college education. It could also reflect the fact that the difference in scenarios was not clear enough for the respondents to distinguish between different levels of water quality.

2.8. Policy Implications

Society's preferences towards the improvements in water quality in the Bagmati River were examined using CE data. Benefits of improving the water quality in the river were estimated. Results show that households do benefit from the improvements in quality of water in the river and are willing to pay for the clean-up program. Moreover, the interaction results also indicate that there is significant heterogeneity across different groups of people and for different purposes of visitation. These benefits and preference heterogeneity are important, and should be taken into consideration when designing any policy changes. Thus, benefit estimation from this study is an important policy tool for the river clean-up program, specifically for the wastewater treatment facilities. Society's attitude and preferences for payment methods and funding mechanism is useful, not only for river water clean-up but also for other waste management programs. Information on WTP, the preference for payment and management are important inputs for the implementation of river restoration and rehabilitation programs.

This study is the first of its kind to elicit the benefits of water quality improvements of a river in Nepal and makes significant contributions to the literature on the valuation of river water quality improvements in developing countries. It can be used for benefit transfers for other similar polluted rivers for benefit-cost analysis. In addition, this study adds to the CE literature by providing an evidence that CE can be successfully applied to assess the preferences of society, and to estimate benefits of improving quality of river water in the developing the world.

CHAPTER 3

Public's Knowledge, Attitude and Behavior towards River

3.1. Introduction

Environmental problems are among the most serious challenges of the 21st century. Air and water pollution, global warming and climate change, loss of biodiversity and rain forest destruction are some examples of current environmental problems. They constitute a local as well as a global threat to the future. The relationship between human beings and environment is driven by several factors. These include socioeconomic characteristics like income, education, culture, religion and traditional practices. Socioeconomic characteristics along with knowledge and information affect individual's attitude and behavior towards environment.

Degradation of surface and ground water quality is one of the most serious environmental problems; and the need for the conservation, rehabilitation and restoration[11] of degraded urban river ecosystem is widely recognized. Greater participation of a community, and a

---

[11]Environmentalists and hydrologists define restoration as the complete recovery of the natural ecosystem whereas rehabilitation is the condition where elements of biophysical system are returned, but not all. See Rutherfurd et al. (2000) for the discussion of river restoration and rehabilitation.

change in attitude and behavior of the residents are well recognized as prerequisites for the success of any long term sustainable management program. The sustainable management and quality of the environment depends on whether or not individuals are willing to contribute towards the conservation. A number of researchers have explored the relationship between individual attitude and behavior towards environment. Success of a conservation, rehabilitation and restoration program depends on the acceptance and support of the public towards the program (Connelly et al., 2002). Public support of natural resource management can be predicted through a better understanding of public values and attitude towards such management (Bright et al., 2002). Moreover, encouraging people to engage and participate has been one of the several strategies adopted for the environmental conservation by policymakers[12]. Knowing what people think, understanding how the public perceives natural resources and what they are willing to do for the protection of natural resources is important for the identification and development of a program to address an environmental problem and to achieve the goal of environmental quality (Miller & Hobbs, 2002). The importance of incorporating the human dimension and understanding public support for the restoration of an ecosystem has been emphasized by several studies (Connelly et al., 2002; Endter-Wada et al., 1998; Haney & Power, 1996). Thus, it is important to identify and address public opinion and

[12] Assigning property right, implementing polluter pay principle are some of the key strategies to solve the environmental problem that arises because of negative externalities. However, under certain circumstances, participation can be very effective for the conservation and improvement of environmental quality (Ostrom, 1990).

concern for the design and implementation of such policies targeted for ecosystem restoration. However, understanding public attitude and behavior towards environmental quality has been, and will remain, a prominent challenge for policy makers and social scientists.

Why are some people so concerned about environmental problems while others are not? Why do some people support and contribute towards policies to improve environmental quality while others do not? What are the factors that guide these beliefs, attitudes and behaviors and how can these behaviors be changed or modified towards more favorable behavior? This study attempts to answer these questions by exploring this aspect; which is critical in understanding public views and solving environmental problems. More specifically, relationships between attitude and behavior towards the river ecology are examined using survey data from Kathmandu, Nepal.

There are several factors that shape attitude and influence the way individuals behave towards environment. Behavioral intention towards environmental quality, in addition to socioeconomic characteristics, depends critically on knowledge, attitude, values, and practices of consumers (Kotchen & Reiling, 2000; Spash, 2006; Spash et al., 2009). Since attitude-behavior framework has been applied to several psychological and economic studies, it is not surprising that there exists an extensive body of literature that examines the relationship between knowledge, attitude and behavior towards environmental quality. The psychological model of attitude and behavior trace back to the Theory of Planned Behavior (TPB) by Ajzen (1985) based on Theory of Reasoned Action (TRA) by Fishbein and Ajzen (1980). According to TPB, people systematically use the information to shape their beliefs, and attitudes about a certain action before taking any action. A series of studies have used TPB to examine attitude-behavior relation over the last several decades. For example, Kaiser et al. (1999) used TPB to establish the relation between the attitude and behavior of members of Swiss transportation associations. Authors supported TPB by establishing the fact that environmental knowledge and environmental values are preconditions of behavioral intention. The authors further found that environmental knowledge and environmental values captures 40 percent of the variance of the behavioral intention and 75 percent of the actual behavior. Similarly, Solecki (1998) examined the attitude of southern New Jersey residents towards an economic management plan. The author found that individual familiarity and direct involvement with the restoration program are important predictors of their support for implementation of the program. The author further concluded that more attention should be given in assessing and understanding the public's attitude in relation to a specific restoration program.

More recently, several studies in economics have incorporated the attitude-behavior framework in non market valuation studies to elicit the value of the environmental quality. Several authors have applied attitude-behavior framework to examine behavioral intention, WTP in particular, for the improved environmental quality (Ajzen & Driver, 1992; Bernath & Roschewitz, 2008; Bright et al., 2002; Ojea & Loureiro, 2007; Pouta & Rekola, 2001; Spash, 2006). Ajzen & Driver (1992) examined the relationship between knowledge, attitude and intended behavior (WTP for engaging in leisure activities in this case) using TPB. The author concluded that the behavioral intention i.e. WTP can be predicted by attitude towards the act, subjective norms and perceived behavioral control. Another study by Pouta & Rekola (2001) measured and used attitude towards forest regeneration to predict WTP using TPB. Attitude was estimated from belief and information. Furthermore, attitude and perceived behavioral control were found to influence WTP significantly. Similarly, Bright et al. (2002) examined the relationship between attitude and behavior towards urban ecological restoration in the Chicago Metropolitan Region. Authors found that the positive and negative attitudes were related to the perceived outcome of ecological restoration.

Spash (2006) used non-economic motive such as rights and attitudinal beliefs in particular to compare the effect of psychological and economic factor and to examine WTP for environmental quality. According to the author, environmental attitude is significant in explaining WTP. However, authors argue that the attitude is based on egoistic and right based motive rather that consequential or utilitarian belief. Ojea & Loureiro (2007) used environmental concern framework to measure attitude and belief towards preservation of a threatened marine bird in Spain. The authors concluded that ethical aspects play an important role in shaping environmental attitude which eventually affect WTP. In a more recent paper, Bernath & Roschewitz (2008) extended CVM with attitude-behavior framework to improve the descriptive and predictive power of a model. The authors concluded that inclusion of psychological behavior significantly improves the explanations for protest votes but their predictive ability for the explanation of bid levels was limited.

This brief review of literature suggests that beliefs, values, and knowledge affect the attitude which consequently affects behavior towards environmental quality. One of the key findings is that the inclusion of psychological variables such as attitude increases the explanatory power of the model.

There is another strand of literature that deals with attitude and environmental behavior for specific environmental quality. Several studies from this strand have on focused participation behavior for specific areas such as curb side recycling (Cheung et al., 1999; Gamba & Oskamp, 1994), household waste management (Barr, 2007), electronic waste recycling (Saphores et al., 2006). Several psychological factors such as belief, attitude and values along with socioeconomics characteristics are identified as important determinants of the pro-environmental behavior. The focus of these studies has been to study the link between attitude and behavior. However, most of these studies fail to integrate economic arguments towards the participation behavior.

There are several studies in developed countries that have used an attitude-behavior framework to investigate this relationship in the context of river rehabilitation and restoration. Connelly et al. (2002) used TPB to understand the relationship between environmental beliefs and WTP for restoration and protection goals in Hudson River, New York USA. The authors found that beliefs and past behavior are better in explaining support for restoration and protection goals than are socioeconomic characteristics. Authors concluded that beliefs and past behavior influence the support and must be considered for development and implementation of restoration activities.

While there exists plenty of studies that apply attitude-behavior framework to environmental quality, the studies that apply attitude-behavior framework on river water quality have been neglected. Strikingly, very little research has been conducted on this specific topic and deserves a particular attention. In addition, understanding attitude and behavior towards a specific environmental quality is more appealing than the general environmental attitude for effective management of specific environmental programs. The focus of this study is to fill this gap by gaining a better understanding of the relation between knowledge, attitude and participation behavior towards river conservation.

The goal of this paper is to examine the influence of knowledge and attitude towards pro-environmental behavior. The importance and impact of knowledge and attitude towards behavior are examined and any discrepancies between knowledge, attitude and behavior towards river health and restoration are brought to light. An attitude-behavior framework is used to investigate the relationship between knowledge, attitude and behavior towards the improvement of quality of water in the Bagmati River in Kathmandu, Nepal. Impact of knowledge on the attitude-behavior relationship is also examined. The role of information and cultural attachment in the formation of attitude and behavior is also investigated. Attitude and behavior is jointly estimated using bivariate ordered Simultaneous Equation Model (SEM). The model is extended by including cultural attachment. The results from a bivariate probit model show that the environmental attitude has strong effect on environmental participation. Results show that attitude and information are important components in determining participation behavior. Knowledge, cultural attachment and education are important in shaping positive attitude towards environmental conservation. Environmental knowledge strongly influences attitude, and participation behavior towards the environmental quality. However, scientific and health knowledge does not always translate into pro-environmental behavior. Cultural attachment is strongly associated with pro-environmental attitude, and exposure to information has a strong effect towards environmental participation.

3.2. Research Questions and Hypotheses

The objective of this study is to examine the relationship between the public's knowledge, attitude and participation behavior regarding conservation and improvement of river health in Kathmandu, Nepal. Based on previous research and theoretical framework, the following hypotheses are proposed and tested;

One of the common conclusions of attitude-behavior model is that strong environmental attitude is positively related with higher level of pro-environmental behavior. It is hypothesized that this statement holds true for participation in river restoration and conservation. Thus, the following null hypothesis is proposed;

Hypothesis 1 (H1): Positive environmental attitude does not influence participation behavior towards the improvement of river health.

The link between knowledge and environmental behavior such as recycling has been well documented. In addition, participation behavior depends on specificity of knowledge (Oskamp et al., 1991). The impact of environmental, scientific and public health knowledge towards attitude and on participation behavior are examined using following null hypotheses.

Hypothesis 2a (H2a): Environmental, scientific and public health knowledge do not influence pro-environmental attitude.

Hypothesis 2b (H2b): Environmental, scientific and public health knowledge do not influence participation behavior.

Individual behavior also depends on cultural context and the inclusion of cultural attachment is critical in understanding attitude and participation towards environmental behavior. The null hypothesis, that the cultural attachment does not influence attitude and participation behavior, is tested using hypotheses H3a and H3b, respectively.

Hypothesis 3a (H3a): Cultural attachment to the river has no effect on pro-environmental attitude.

Hypothesis 3b (H3b): Cultural attachment to the river has no effect on participation behavior.

Familiarity and experience with environmental goods is influenced by exogenous information provided in the survey instrument as well as endogenously determined by past behavior and exposure to information (Cameron & Englin, 1997). Moreover, information is an important component of belief and thus affects behavioral intention (Pouta & Rekola, 2001). It is hypothesized that the statement holds true for the participation towards river conservation and rehabilitation.

Hypothesis 4a (H4a): Exposure to information does not influence pro-environmental attitude.

Hypothesis 4b (H4b): Exposure to information does not influence participation behavior.

3.3. Theoretical Framework and Econometric Estimation

3.3.1. Theoritical Framework

Social psychologists and economists have used several approaches to examine the relationship between knowledge, attitude and behavior. Neoclassical theory (e.g. RUM) and its tools (e.g. CVM), interpret WTP for environmental quality as a purchase of a public good (Spash, 2006). It is also well established that people voluntarily contribute to public goods. Economists incorporate altruism, morality and motivation to explain such behavior (Andreoni, 1990; Brekke et al., 2003; Owen & Videras, 2007; Popp, 2001; Torgler et al., 2009a; Torgler et al., 2009b). Individuals' voluntary participation towards environment is seen as private provision of public good from an economic perspective. Private provision of public good, in addition to providing utility from the increased supply, also provides utility from the act itself because of warm glow effect (Andreoni, 1990). Moreover, voluntary contribution for a public good is motivated by social responsibility (Brekke et al., 2003; Popp, 2001)[13]. Thus, for the purpose of this study,

[13] Random Utility Model has also been applied to examine attitude and behavior towards environmental quality. According to this approach individual participate in the pro-environmental behavior if utility with respondent participation is greater than the utility

environmental participation is considered as a private provision of public good. Altruism and moral motivation for a public good is followed to model participation behavior. Attitude-behavior framework from psychology is used to merge psychological factors into the model.

Following Brekke et al. (2003) and Torgler et al. (2009a), the individuals' utility function U_i is defined as,

$$U_i = U(x_i, l_i, G, \lambda_i) \quad (3.1)$$

where x_i represents consumption of private goods, l_i represents leisure, G represents public provision of public good (improved environmental quality), and λ_i is the utility derived from participating voluntarily in environmental conservation[14].

Given the limited time available, time constraint of the individual is;

$$T = l_i + P_i \quad (3.2)$$

---

without participation (Owen & Videras, 2007). Psychological and socioeconomic characteristics create the difference in the utility.

[14] Andreoni (1990) include gift to the public good to examine the utility gained from the act of giving; Brekke et al. (2003) argue that individual utility is also function of an individual's self image of a socially responsible person; Torgler (2008a) assumes that individual utility is also function of utility derived from participating voluntarily in environmental organization.

where T is total time available, l_i is time spent on leisure activities, P_i is time spent for environmental voluntary work.

Because of time spent in participation, private consumption is reduced, and is given by;

$$x_i = w_i(T - l_i - P_i) \qquad (3.3)$$

where w_i is wage rate. Total consumption of public good i.e. environmental quality is sum of public provision G_p and private provision of public goods $\sum g_i$ i.e. $G = G_p + \sum g_i$ where $g_i = \alpha P_i$ and g_i is individual production function that depends on the level of participation P_i and level of efficiency α that is exogenous to consumer and depends on institutional and technical set up.

Under the assumption that all individuals are identical, $\sum g_i = Ng_i$

$$G = G_p + N\alpha P_i \qquad (3.4)$$

Again, following Torgler et al. (2009a), it is argued that utility from voluntary participation is given by,

$$\lambda_i = \lambda(A_i, P_i)^{15} \qquad (3.5)$$

---

[15] Torgler et al. (2009a) and Torgler et al. (2009b) use a specific functional form such as $\lambda_i = \ln\left(\frac{e_i}{m_i}\right)$ and $\lambda_i = m_i e_i - (m_i - e_i)^2$ in their study; m_i and e_i are motivation and participation towards environmental quality respectively. The authors use utility from participation as a function of participation and motivation.

where A_i is individuals' attitude towards the environment. It is also assumed that $\frac{\partial \lambda}{\partial P_i} > 0$

i.e. greater participation leads to better environmental quality.

Substituting values of x_i, G, and λ_i from equation (3.3), (3.4), and (3.5), utility maximization under the first order condition ($\frac{\partial U}{\partial P} = 0$) is given by,

$$P_i = p(w_i, \alpha, A_i) \tag{3.6}$$

The estimation is based on the assumption that participation behavior systematically varies with attitude along with other individual and household characteristics. One of the null hypotheses (H1) is $\frac{\partial P_i}{\partial A_i} > 0$.

Attitude is integrated into the model using attitude-behavior framework from psychology. According to TPB, people systematically use the information available to shape their beliefs and attitude about certain actions before taking these actions (Ajzen, 1991; Fishbein & Ajzen, 1975)[16]. Furthermore, attitude is endogenously determined along with behavior. It is argued that the attitude is formed on the basis of knowledge, information

---

[16] According to TPB attitude is the degree to which the individual has favorable or unfavorable evaluation of the behavior. Moreover, antecedent of any behavior is the intention to perform the behavior. Three major determinants of the behavioral intention are; attitude towards the behavior, subjective norms, and degree of perceived behavior (Ajzen & Driver, 1992). Subjective norms refer to the social pressure to perform the behavior and perceived behavior control refers to the difficulty of performing the behavior in question.

and cultural attachment along with other factors. Following Cameron & Englin (1997), the equation for attitude is specified as;

$$A_i = A(K_i, I, C_i; \theta) \qquad (3.7)$$

where K_i, I_i and C_i represent knowledge, exposure to information and cultural attachments respectively. θ represents other socio-economic characteristics.

The analysis is extended to a two-equation model (equation (3.6) and(3.7)) and jointly estimated using SEM approach[17].

3.3.2. Econometric Analysis

Studies have shown that attitude, in addition to socioeconomic characteristics, influences participation behavior significantly. Researchers have also shown that attitude also depends on, and is consistent with past behavior i.e. attitude and behavior are interdependent (Bright et al., 2002). Furthermore, since there are several explanatory variables that influence attitude and participation behavior simultaneously, corresponding error terms are subject to contemporaneous correlation. This correlation is not captured if two equations are estimated separately. In such circumstances, estimating two separate equations leads to consistent but inefficient coefficient values (Cameron & Englin, 1997;

---

[17] Cameron & Englin, (1997) used similar approach to examine if WTP for environmental resources is systematically related with respondents' own experience. The authors concluded that inclusion of endogenous experience provides more precise WTP.

Greene, 2006). Under the assumption that error terms for attitude and participation equation are correlated, SEM is used to jointly estimate attitude and behavior. Since the participation variable is ordered; the bivariate ordered probit[18] approach is used to capture the seemingly related effect (Greene, 2006; Sajaia, 2008)[19].

Two latent variables; attitude $\left(y*_{1i}\right)$ and participation $\left(y*_{2i}\right)$ are determined by,

$$y*_{1i} = x'_{1i}\beta_1 + \varepsilon_{1i} \tag{3.8}$$

$$y*_{2i} = x'_{2i}\beta_2 + \lambda y*_{1i} + \varepsilon_{2i} \tag{3.9}$$

where x_{1i} and x_{2i} are set of explanatory variables; β_1, β_2 and λ are unknown parameters; ε_{1i} and ε_{2i} are error terms. Although researcher does not observe the latent variables ($y_{1i}*$ and $y_{2i}*$), researcher observe two categorical variables y_1 and y_2 such that;

$$y_{1i} = \begin{cases} 1 \text{ if } y*_{1i} \le C_{11} \\ 2 \text{ if } C_{11} < y*_{1i} \le C_{12} \\ 3 \text{ if } C_{12} < y*_{1i} \le C_{13} \\ 4 \text{ if } C_{13} < y*_{1i} \le C_{14} \end{cases} \text{ and } y_{2i} = \begin{cases} 1 \text{ if } y*_{1i} \le C_{21} \\ 2 \text{ if } C_{21} < y*_{1i} \le C_{22} \\ 3 \text{ if } C_{22} < y*_{1i} \le C_{23} \\ 4 \text{ if } C_{23} < y*_{1i} \le C_{24} \end{cases} \tag{3.10}$$

---

[18] Full Information Maximum Likelihood (FIML) is implemented using *bioprobit* in STATA. FIML produces unbiased and more efficient estimates compared to the other approaches such as two steps and 2SLS (Sajaia, 2008).

[19] Park and Loomis (1996) used similar approach to jointly estimate the WTP and concluded that WTP estimates are more efficient with a narrower confidence interval. Similarly Mozumder et al. (2009) used SUR to integrate risk perception in estimating WTP for wild fire risk information.

where the cut off values satisfy the condition; $C_{11} < C_{12} < C_{13} < C_{14}$ and

$C_{21} < C_{22} < C_{23} < C_{24}$

The probability that $y_{1i} = j$ and $y_{1i} = k$ is given by,

$$\begin{aligned} \Pr(y_{1i} = j,\ y_{2i} = k) &= \Pr(C_{1j-1} < y^*_{1i} \le C_{1j},\ C_{1k-1} < y^*_{2i} \le C_{2k}) \\ &= \Pr(y^*_{1i} \le C_{1j},\ y^*_{2i} \le C_{2k}) - \Pr(y^*_{1i} \le C_{1j-1},\ y^*_{2i} \le C_{2k}) \\ &\quad - \Pr(y^*_{1i} \le C_{1j},\ y^*_{2i} \le C_{2k-1}) + \Pr(y^*_{1i} \le C_{1j-1},\ y^*_{2i} \le C_{2k-1}) \end{aligned} \tag{3.11}$$

The log-likelihood to estimate the above equation can be written as,

$$\ln L_i = \sum_{i=1}^{n} \sum_{j=1}^{J} \sum_{k=1}^{K} I(y_{1i} = j, y_{2j} = k) \ln \Pr(y_{1i} = j, y_{2j} = k) \tag{3.12}$$

The above log-likelihood function can be used to jointly estimate the system of equations (3.6) and (3.7).

3.4. Survey and Data

In addition to the descriptive and correlation analysis, a multivariate quantitative analysis using ordered bivariate SEM[20] approach is employed to examine the impact of knowledge and attitude toward the participation behavior for the improvement of river health.

---

[20] Error terms are allowed to correlate but explanatory variables are still assumed to be uncorrelated in Seemingly Unrelated Regression (SUR). Error terms as well as explanatory variables are allowed to be correlated in SEM. Thus the difference between SUR and SEM comes from the correlation of dependent variables.

Data for this study comes from an in-person interview that was conducted in Kathmandu valley in the summer of 2009. The survey was based on structured questionnaires. The survey was conducted to assess public preferences and to determine the degree to which residents are willing to support the conservation, rehabilitation, and restoration of the Bagmati River in Kathmandu. Three focus group discussions were conducted prior to the main survey. A pilot survey of 40 randomly selected households was also conducted before the main survey. The purpose of the pilot survey was to understand the clarity of the questionnaires. Twelve hundred households were selected for the in-person interviews in the final survey. In addition to knowledge, attitude and participation, information on other socioeconomic characteristics such as age, sex, education level were also collected. Responses of the individual with missing relevant information were dropped, leaving a total of 1009 observations to be used for the most extended model.

Behavioral intention and actual behaviors are frequently used as the dependent variables in exploring the relation between attitude and behavior. WTP is one of the most frequently used as the actual behavior as well as behavioral intentions. Since the focus in this study is to examine the relationship between attitude and behavior, environmental participation behavior and attitude are used as the dependent variables for the joint estimation.

Participation behavior *(ENV_PARTICIPATION)* is measured using frequency of self reported past participation in river conservation and rehabilitation. Respondents were asked to indicate how often they have voluntarily participated in clean up and restoration program on the Bagmati River using a four-point scale from never participated to frequently participated[21]. Ranked order of the frequencies of participation is used as one of the ordered dependent variables.

Attitude towards the behavior is the degree to which the performance is positively or negatively valued (Ajzen, 1991). Values, beliefs, social norms, individual perceptions and institutional norms shape the attitude. Researchers have used different kinds of scales and indices to measure environmental attitude. Among several attitude scales, New Environmental Paradigm (NEP) and Awareness of Consequences (AC) [22] are most employed measures (Ojea & Loureiro, 2007). NEP was developed by Dunlap & Van

---

[21] Exact wording of the question for participation was; Have you participated/volunteered in any kind of cleanup/restoration program on the Bagmati River? (Check one);
1. Frequently, 2. Sometimes, 3. Rarely, 4. Never

[22] Environmental sociologists use attitude and concern interchangeably. NEP is a 12-item scale created by Dunlap & Van Liere, (1978) to measure environmental concern. The scale was further modified to include 15 item (Dunlap et al., 2000). It measures concepts such as limits to growth, balance of nature, human domination over nature, human exemption, and eco-crisis etc. AC scale is based on the fact that awareness of consequences induces behavior, influenced by three kinds of values or value orientations: egoistic, altruistic and biospheric (Stern et al., 1995). Use of such scales might be problematic while analyzing specific behavior. There exist several other measures; see Tarrant and Cordell, (1997) for further discussion of other scales.

Liere (1978) and used by several authors including Stern et al. (1995); Kotchen and Reiling (2000); Cooper et al. (2004). Similarly, AC was developed by Stern et al. (1993) and used by Novotny et al. (2001); Tarrant & Cordell (1997) and others. According to TPB, the best way to create the attitude index is to add the products of beliefs and corresponding evaluations (Ajzen, 1991). However, several other studies (e.g. Pouta & Rekola, 2001; Spash et al., 2009) have also used beliefs statements alone to create the index. Accordingly, attitude *(ENV_ATTITUDE)* towards the quality of water in the Bagmati River is measured using eleven three-point scales[23]. While neither of the specific scales (such as NEP, AC) was available, the items that lie at the intersection of NEP and AC are used[24]. These items are; seriousness of environmental problem ("*very serious*" to "*not at all serious*"), importance of protecting natural resources and controlling pollution ("*very important*" to "*not at all important*"), and harmfulness of water pollution in the river ("*strongly agree*" to "*not at all agree*"). Thus, for the purpose of this study, attitude means the extent of the respondents' belief that; environmental quality is serious, controlling the pollution is important and poor water quality is harmful. Values from

---

[23] Questionnaires used to create attitude index are presented in Appendix D.

[24] One of the limitations of NEP and AC is the generality of the scales. According to Kaisar et al. (1999) specific environmental attitudes are better predictor of specific behavior than global attitude. Since our focus in this study is on specific behavior towards the ecological health of a river we use specific attitude river health in addition to general environmental attitude. The measure of the environmental attitude, while not ideal, is sufficient enough to test the hypotheses.

answer of all the questions are added to create the attitude index (Chronbach alpha 0.73[25]). The attitude scale is created such that higher scores represent stronger environmental attitudes. The normalized attitude scale is divided into four quartiles for estimation purpose[26].

Inclusion of psychological explanatory variables in this study is based on theoretical framework and literature from psychology and economics (Ajzen & Driver, 1992; Bright et al., 2002; Pouta & Rekola, 2001; Tarrant & Cordell, 1997). These variables include; knowledge, information, cultural attachment and several other socio-economic characteristics of the respondents and the households.

Knowledge is a precondition, and one of the key determinants of attitude and behavior (Arcury, 1990; Kaiser et al., 1999; Schahn & Holzer, 1990). Moreover, knowledge is recognized as vital to sustainable development and environmental management (Magrath, 2007). The influence of knowledge towards participation is linked through attitude. Thus, knowledge is included in both the equations of the SEM. Furthermore, different types of

---

[25] It is a measure of how well each individual item is correlated with the sum of the remaining item. It is used as a measure of consistency among individual items used in the scale. It is suggested that alpha should be greater than 0.70 for internal consistency (Nunnaly, 1978 among others)

[26] Construct indices are normalized using min-max normalization such that the normalized scale ranges from zero to one $\left(\text{Attitude}_{normalized} = \frac{\text{Attitude}_{actual} - \text{Attitude}_{\min}}{\text{Attitude}_{\max} - \text{Attitude}_{\min}} \right)$.

knowledge might influence attitude and participation differently. Three types of knowledge; environmental knowledge (*KNOW_ENV*), factual or scientific knowledge *(KNOW_SCIENTIFIC)*, and knowledge regarding health (*KNOW_HEALTH*) are included in the estimation[27]. Environmental knowledge is measured using three three-point scale (Chronbach alpha 0.77). Environmental knowledge is created from answers of water pollution, waste management and waste recycling related questions. Factual knowledge is measured using answers from five multiple choice questions (Chronbach alpha 0.39). Factual knowledge is measured by asking the respondents whether they know about diseases related poor water quality and e-coli. Similarly, health knowledge is measured using four three-point scales (Chronbach alpha 0.89). Answers related to knowledge about the effect of poor river water quality on bathing, washing and walking are used to create health knowledge scale. All knowledge scales are normalized such that values range from 0 to 1 and higher values represent higher levels of knowledge.

Information is an important component of belief and thus affects behavioral intention (Pouta & Rekola, 2001). Frequency of exposure to information related to poor water quality and treatment method (*INFO_EXPOSURE*) is included as another explanatory variable to capture this effect. Religious and cultural values are important components of systems of norms and values and thus influence the efforts to contribute to public goods (Owen & Videras, 2007). Several studies have also shown that culture, in the form of religious belief, affects attitude and pro-environmental behavior towards the protection of natural resources (Enserink et al., 2007; Owen & Videras, 2007; Wohl, 2005). Worship of

[27] Questionnaires used to create knowledge index are presented in Appendix D.

nature has been integral part of Nepalese society and the river is associated with day-to-day life of residents of Kathmandu for several cultural and religious activities from birth to death. Thus, there are many residents in Kathmandu for whom the cultural relevance of the river continues to be important. Given the strong cultural attachments, it is argued that attitude and behavioral responses towards river is significantly influenced by the cultural attachment. To examine the effect of this cultural attachment, cultural attachment (*CULT_ATTACH*) is included as another explanatory variable in the simultaneous model. Frequency of monthly visit to the Bagmati River for cultural and religious purpose is used as the measure for cultural attachment.

Individuals might be attached to a place or community because of their physical, psychological or emotional bond. The level of environmental concern depends on geographical context (Blake, 2001). Moreover, studies have also shown that attitude and behavior are different among rural and urban residents. It is expected that geographical attachments encourage pro-environmental attitude and more participation towards the management of the corresponding natural resources. A number of geographic and community related variables are included to capture these effects. Included variables are distance from the closest river (*DISTANCE*), length of residency (in years) in the community (*RESIDENCY*), ownership of the house (*OWN*), and caste of majority of the residents (*NEWAR*) in the community.

Previous research has demonstrated that socioeconomic characteristics are also important, although inconsistent, in determining attitude and behavior of the individuals (Tarrant & Cordell, 1997). Several respondent and household characteristics are included in order to control the heterogeneity of the respondents and the households. Income (*INCOME*), gender (*FEMALE*), number of member in the household (*HHSIZE*), highest education level in the (*EDU_MAX*), education level of the respondents (*EDU_RESP*), and age of the respondents (*AGE*) are included to control the heterogeneity of the respondents.

3.5. Results

3.5.1. Descriptive Statistics

The definition of the variables and descriptive statistics are presented in (Table 3.1). A typical household of Kathmandu has 5.7 family members. Of the total respondents, 36 percent are female. Average education level of the respondents is 12 years where as highest education level in the household is almost 14 years. Average age of the residents is 36 year. About 11 percent of the residents have a profession that is health related. Average residency is 9 years and about 46 percent are Newars. The survey also collected information on household income. Average monthly reported income of a household is NRS 19,800.

Table 3.1: Definition of Variables and Corresponding Descriptive Statistics

Variables	Definition	Mean	Sd	min	max
ENV_PARTICIPATION	Voluntary participation in river cleanup/restoration program(0= Never, 1=Rarely, 2=Sometimes, 3=Frequently)	0.30	0.75	0.0	3
ENV_ATTITUDE	Construct index of attitude (normalized and divided into 4 quartiles such that higher value represents the strongest environmental attitude)	2.21	1.07	1.0	4
KNOW_SCIENTIFIC	Construct index of scientific knowledge (normalized such that values range from 0 to 1 and higher value represents higher level of knowledge)	0.70	0.18	0.0	1
KNOW_ENV	Construct index of environmental knowledge (normalized such that values range from 0 to 1 and higher value represents higher level of knowledge)	0.70	0.27	0.0	1
KNOW_PUBHEALTH	Construct index of public health knowledge (normalized such that values range from 0 to 1 and higher value represents higher level of knowledge)	0.80	0.25	0.0	1
INFO_EXPOSURE	Exposure to information on water treatment method (0= Never, 2=Sometimes, 3=Frequently)	0.97	0.64	0.0	2
CULT_ATTACH	Frequency of last month's visit to Bagmati River for cultural and religious purpose	0.92	3.45	0.0	30

Table 3.1 (contd): Definition of Variable and Corresponding Descriptive Statistics

	Definition	Mean	Sd	min	max
L_INC	Log of yearly income of the household	9.67	0.65	8.0	12
FEMALE	Gender (1=Yes, 0=No)	0.36	0.48	0.0	1
HHSIZE	Number of members in the household	5.71	2.23	1.0	19
EDU_MAX	Education level of the member with maximum level of education	13.81	2.56	1.0	18
EDU_RESP	Education level of the respondent	11.95	2.99	0.0	18
AGE	Age of the respondent	35.69	12.60	18.0	78
PROFESSION_HEALTH	Member associated with health profession (1=Yes, 0=No)	0.11	0.31	0.0	1
DISTANCE	Distance of the household from the closest river (Km)	1.22	1.61	0.0	24
RESIDENCY	Number of years living in the community	8.95	1.71	0.5	10
NEWAR	Caste (1 = Yes, 0= No)	0.46	0.50	0.0	1
OWN	Ownership of the household (1=Yes, 0=No)	0.72	0.45	0.0	1
Observations		1200			

Seventy two percent of the total residents have visited the river at least once during last month. About eighteen percent of the total sample have participated at least once in past towards the river conservation and restoration program (*frequently*-7.5%, *sometimes*-4.9%, and *rarely*-4.4%).

3.5.2. Regression Results

Initially, two independent ordered probit regression analyses for attitude and participation behavior were estimated[28]. Behavior equation (3.6) and attitude equation (3.7) are estimated using jointly estimated using bivariate SEM. Chi-squared test of independent equation suggests that the two equations are not independent ($p<0.01$). The results of ordered bivariate SEM are presented in Table 3.2.

[28] Results are presented in Appendix E (Table E1 and Table E2)

Table 3.2: Results of Simultaneous Equations Model

Variables	Model 1		Model 2		Model 3	
	ENV_ PARTICIPATION	ENV_ ATTITUDE	ENV_ PARTICIPATION	ENV_ ATTITUDE	ENV_ PARTICIPATION	ENV_ ATTITUDE
ENV_ATTITUDE	0.6955***		0.8105***		0.8302***	
	(0.2065)	-	(0.1528)	-	(0.1678)	-
KNOW_SCIENTIFIC	0.1996	0.2801	0.4072	0.0837	0.3603	0.2266
	(0.2737)	(0.1879)	(0.2864)	(0.2159)	(0.2971)	(0.2212)
KNOW_ENV	0.1998	1.3189***	-0.0161	1.3202***	0.0141	1.2755***
	(0.3714)	(0.1491)	(0.2993)	(0.1655)	(0.3043)	(0.1670)
KNOW_PUBHEALTH	-0.9269***	1.4843***	-0.9529***	1.3769***	-0.9364***	1.3526***
	(0.2362)	(0.1566)	(0.1890)	(0.1596)	(0.1866)	(0.1685)
INFO_EXPOSURE	0.3521***	-0.1970***	0.3729***	-0.1356*	0.3652***	-0.1087
	(0.0673)	(0.0553)	(0.0770)	(0.0612)	(0.0786)	(0.0629)
CULT_ATTACH	0.0025	0.0296**	-0.0039	0.0315**	0.0022	0.0277*
	(0.0143)	(0.0099)	(0.0139)	(0.0112)	(0.0149)	(0.0119)
L_INC	-	-	0.1426*	-0.0619	0.1446	-0.0522
			(0.0722)	(0.0552)	(0.0741)	(0.0569)
FEMALE	-	-	-0.4806***	0.1354	-0.5201***	0.1698*
			(0.1118)	(0.0782)	(0.1110)	(0.0787)
HHSIZE	-	-	0.0050	0.0162	-0.0164	0.0286
			(0.0190)	(0.0157)	(0.0199)	(0.0161)

Table 3.2 (contd): Estimation Result from Simultaneous Equation for Attitude and Participation Behavior

	Model 1		Model 2		Model 3	
	ENV_ PARTICIPATION	ENV_ ATTITUDE	ENV_ PARTICIPATION	ENV_ ATTITUDE	ENV_ PARTICIPATION	ENV_ ATTITUDE
EDU_MAX	-	-	-0.0057 (0.0217)	0.0453** (0.0170)	-0.0043 (0.0219)	0.0445** (0.0169)
EDU_RESP	-	-	-0.0495** (0.0162)	0.0310* (0.0132)	-0.0460** (0.0174)	0.0329* (0.0131)
AGE	-	-	0.0024 (0.0044)	0.0061* (0.0030)	-0.0014 (0.0049)	0.0094** (0.0031)
PROFESSION_HEALTH	-	-	-0.1532 (0.1419)	0.1214 (0.1101)	-0.2082 (0.1438)	0.1273 (0.1122)
DISTANCE	-	-	-	-	0.0165 (0.0335)	-0.0574* (0.0252)
RESIDENCY	-	-	-	-	-0.0046 (0.0313)	-0.0414 (0.0272)
NEWAR	-	-	-	-	0.0696 (0.1271)	0.3440*** (0.0818)
OWN	-	-	-	-	0.6050*** (0.1386)	-0.5583*** (0.1037)

Table 3.2 (contd): Estimation Result from Simultaneous Equation for Attitude and Participation Behavior

	Model 1		Model 2		Model 3	
	ENV_ PARTICIPATION	ENV_ ATTITUDE	ENV_ PARTICIPATION	ENV_ ATTITUDE	ENV_ PARTICIPATION	ENV_ ATTITUDE
Observations	1137		1012		1009	
Log lik.	-2075		-1790		-1741	
Chi-squared	117***		220***		240***	
Rho	-0.5921		-0.6925		-0.6716	
Chi-sq-indep	3***		7***		6***	
AIC	4187		3645		3562	
BIC	4277		3802		3759	

Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Three regressions models are estimated; first using knowledge, information and cultural attachment (Model 1), than socioeconomics characteristics are included (Model 2), and finally geographical attachments variables are included (Model 3). In each model the dependent variable of the first equation is attitude and dependent variable of the second equation is participation behavior. Results from all three models are consistent. The results show that several explanatory variables are statistically significant. The results from the first equation show that environmental knowledge is positive and significant for participation behavior. Public health knowledge is significant and positive for attitude but not for participation. However, scientific knowledge does not show any significant impact.

Generally, economic status of the household is positively related with contributions towards the improvement of environmental quality as shown by higher WTP. Results indicate that income does not show any significant impact on attitude and participation. Women show stronger environmental attitude but are less likely to participate. The number of members in the household does not show any significant impact towards attitude and participation. Well-educated citizens are expected to have stronger environmental attitudes because of their knowledge and exposure to information. This is supported by the result which indicates that more educated respondents tend to show stronger environmental attitudes. However, education level does not show any significant impact on participation. Although educated respondents have strong positive attitudes, the effect on participation is moderated by higher opportunity cost. The result indicates that attitude is stronger for older people but participation behavior is lower as compared to younger.

The farther the house is from the closest river, the less they value water quality and the less they participate. The number of years living in the community does not show any impact towards attitude and participation. Newar, one of the major and oldest communities show stronger pro-environmental attitude and higher level of participation behavior. Interestingly, respondents who own the house do not show pro-environmental attitudes but they tend to participate more.

3.6. Discussion

Results and hypotheses from the joint estimate of attitude and behavior are discussed in this section. The regression results strongly reject the first null hypothesis (H1), that attitude does not influence participation ($p \leq 0.001$). This is consistent with the result from previous studies. It is often assumed that higher levels of knowledge are associated with stronger environmental attitudes and higher levels of participation. The results support this, but only partly. The results show that knowledge is important determinant of attitude and behavior. However, not all kinds of knowledge contribute equally towards attitude and behavior. For example, environmental knowledge is a very strong determinant of attitude and behavior. However, scientific knowledge is not significant towards attitude and behavior. Knowledge related to public health influences the attitudes but has very strong negative effect on participation behavior.

The third hypothesis, (H3a**),** that the cultural attachment towards the river does not enhance attitude is rejected. However, the probability of participation does not change with an increase in cultural attachment. Although information is negatively associated with pro-environmental attitude, it is positively associated with participation behavior. Thus, respondents who are exposed to information about causes and consequences of poor water quality tend to participate more for the improvement of water quality in the river.

It is interesting to note that there are some socioeconomic characteristics that are significant determinants of one of the dependent variables (attitude or behavior) but not significant towards the other. Unlike monetary contribution (WTP), which is positively associated income, participation behavior does not show any significance association with income. This reflects the fact (as shown in model), that participation towards the voluntary contribution is associated with lost wages. Higher income is associated with higher level of wages which increases the opportunity cost of participation. Thus, higher level of wages might be associated with lower levels of participation because of the higher opportunity cost. The gender effect is also particularly interesting in that women have stronger attitudes towards the environment but they are less likely to participate. This might be because of the unique characteristics and social structure of the community. Not surprisingly, this limitation towards participation is coming from less exposure of women to working culture in Kathmandu. Another result that deserves particular attention is the relation between education level and participation. Negative or no influence of education may be because of the "cynicism effect" i.e. more educated people have less faith in action. Another result that draws attention is the relationship between home ownership and attitude, and ownership and participation. Although ownership is associated with negative attitudes, respondents who own the home tend to participate more. To sum up, the result shows that attitude is positively associated with higher levels of environmental participation. However, there are some determinants that influence attitude in one direction but the participation in opposite direction. Further research is required to explore these relationships.

3.7. Policy Implications

Understanding public attitude and behavior towards natural resources is fundamental for identifying a clearer path towards integrated and sustainable management of natural resources. Findings from this study provide several policy implications for shaping stronger pro-environmental attitudes and promoting environmentally sound behavior. This study identifies several important factors that influence the attitude and behavior towards the improvement of river health in a developing city. The factors, identified by this study can be used to shape pro-environmental attitudes and influence behavior towards environmental management. Better understanding of these relationships will help enhance participatory management that is more efficient and produces sustainable results.

Exposure to information is an important component for the formation of pro-environmental attitude and also of the decision making process for individual participation. Thus, media that provides information about the cause and consequences of environmental quality can be effective in increasing respondents' participation in pro-environmental behavior. Intervention and policy can be designed to change behavioral intention by affecting attitudes so as to promote pro-environmental behavior.

It is widely accepted that the success of a policy change depends on its acceptance by the local residents. Community participation has become one of the critical components of environmental and natural resource management. Community participation in general depends on voluntary involvement of the members. Given the scarcity of studies available for in less developed cities, determinants of voluntary participation can be used to enhance community participation. In sum, empirical findings from this study will provide policymakers with insight into how to change environmental attitude so as to increase participation for the protection of the environment and the sustainable management of natural resources.

3.8. Conclusions

The aim of this chapter was to gain insight and a better understanding of attitude and participation behavior towards conservation, rehabilitation and restoration of a river ecosystem. The knowledge, attitude and behavior framework was used to estimate ordered SEM. The results draw several important conclusions about the factors that influence attitude and the participation behavior. The results support the view that participatory behavior can be predicted by attitudes towards environmental quality. In addition, results also suggest that increase in participation behavior can be achieved through increase in education and information.

The study shows that there is clear and strong effect of knowledge and cultural attachment on attitude and behavior. In contrast, socioeconomic characteristics such as age and income appear to have little or no effect on attitude and behavior. Stronger environmental attitude is generally associated to higher level of participation. However, the study shows some gaps between attitude and behavior such as; stronger attitude but lower participation shown by women. It is necessary and critically important to fill these gaps between attitude and behavior so that women's stronger attitude can be translated into higher level of participation.

While there exists several studies that uses attitude-behavior framework, studies that use a specific environmental quality such as a river ecosystem is rare. Result from this study is expected to provide a clear pathway for the design and implementation of long term river management and conservation programs such as the Bagmati Action Plan. In addition, this study also makes methodological contribution by integrating theory from economics and psychology to estimate attitude and behavior simultaneously using SEM.

Nevertheless, several caveats are in order. First, although several well established scales such as NEP and AC for attitude and behavior have been used be several researchers, such scales were not used because of different the structure of the questionnaires. In addition, use of behavioral control and subjective norms with actual behavior would be an interesting direction for future research. Another limitation of this study is the use of self-reported behavior. Researchers have shown that self-reported behaviors in general are over reported. Although this study uses residents in the Kathmandu Valley as the respondents, there are other significant stake holders responsible for the management of the river. Result would be more effective with the inclusion of attitude of other stake holders for the river management.

Despite these limitations the result of this study suggests that there are several factors that shape the attitude of individuals towards environmental quality. These factors consequently influence the participation behavior which is critical for the conservation and sustainable management of the river. Above all, the factors that can be used to shape the attitude that consequently influences the behavior needs to be identified to ensure sustainable management of the scarce natural resources.

Since the focus of this research was to identify important determinants of attitude and behavior of general residents towards voluntary participation, similar studies for decision making in planning and implementation would be another interesting facet for future research. Moreover, attitude and behavior may change over time. Continuous survey and analysis would be necessary for understanding change in attitude and behavior over time.

CHAPTER 4

Knowledge, Information and Water Treatment Behavior of Residents in the Kathmandu Valley, Nepal

4.1. Introduction

Access to safe drinking water and sanitation plays a crucial role in the overall social and economic development of a community. It is one of the most important factors related to good health. Unfortunately, more than a billion people lack safe drinking water, 2.6 billion people lack adequate sanitation and 1.8 million die every year as a result of diarrheal disease. More than 1.5 million deaths of children per year mostly in developing countries can be attributed to unsafe water and poor sanitation (WHO, 2005). Poor and unsafe water quality is one of the main causes of diarrheal diseases, accounting for 4.3% of the global disease burden (Jalan et al., 2009; Wright et al., 2009) and continues to be a major health threat. In addition, many communities also suffer from poor reliability of water supply systems (Hunter et al., 2009). The situation is worse in developing cities where most urban water supply systems are not reliable and do not deliver safe drinking water. Unsafe water delivered to household taps increases the risk of water borne diseases and threatens population health.

Consumers adopt several averting behaviors to protect from the adverse health effects of poor water quality. A variety of methods exists for the treatment of drinking water at the household level. These methods include filtering, boiling and use of chemicals. These approaches are proven to make substantial progress in providing safe water. Moreover, treating water at the household level has been found be one of the most effective and affordable ways of preventing water borne diseases. However, not all households utilize treatment methods and are exposed to health risks. Since household water treatment can reduce the consequences of poor water quality's health risk significantly, understanding factors that influence treatment behavior is critical to avoid the health risks of poor water quality. Poverty could be one obvious barrier for not adopting the treatment behavior. However, studies have shown that household treatment methods such as boiling, filtering, solar disinfection systems and chlorination are affordable and effective. One of the reasons for households not adopting the treatment behavior could be the lack of knowledge and information. For example, Jalan et al. (2009) in their randomized trial experimental study in India have shown that provision of information on water quality significantly increases the treatment behavior. In sum, information, knowledge and awareness are critical in determining the treatment behavior to avoid the health risk.

Households engage in averting behavior if degraded environmental quality poses a health risk (Abrahams et al., 2000). Accordingly, consumers undertake several strategies to make water safe and potable if water delivered to the household is not safe. Averting behavior and its determinants in response to poor water quality has been examined by several authors (Abdalla et al., 1992; Katuwal & Bohara, 2011; Larson & Gnedenko, 1999; Pattanayak et al., 2005). The effectiveness and importance of safe storage and treatment at point of use is well documented. Simple strategies such as boiling and filtering significantly reduce the risk of water- born illnesses (Brick et al., 2004; Sobsey, 2006). Household and social behavior towards the quality and treatment of water depends on socio-cultural beliefs, practices, and perceptions along with water quality, quantity, affordability and accessibility (Sobsey, 2006).

A systematic review of these studies suggests that treatment behaviors are significantly and strongly influenced by knowledge, information and other psychological factors on water quality and health risks associated with it. Perception about water quality, attitude towards treatment method and social influence are some of the important psychological factors. Thus, communication and social marketing and could be critical in helping people to understand the causal relation between quality of water and water borne diseases.

While there exists an extensive body of literature that explores the risks of poor water quality and household averting behavior to make water safe; studies that examine the impact of knowledge, information and community participation is scarce. Despite its critical importance, less attention has been paid to investigate the impact of knowledge, information and community participation. This chapter attempts to fill this gap by assessing the impact of knowledge, information and community participation towards water treatment behavior using 2009 survey data from Kathmandu, Nepal. The treatment behaviors of the household if water is obtained from different sources are also examined.

Averting behavior approach is used to examine the impact of knowledge, information and community participation towards water treatment behavior. The results from probit regression analysis suggest that knowledge and frequency of exposure to information, and community participation significantly increase the likelihood of utilizing water treatment methods. Households connected to the distribution system are more likely to treat water as compared to households that are not connected to the system. Thus, household level water treatment behavior can be influenced through education, social marketing and community participation so that the number of people without access to “safe” water and sanitation can be reduced to half by 2015 to meet development goals.

The rest of the chapter is organized as follows. Relevant literature is discussed in next section followed by a theoretical framework and some testable hypotheses for the treatment behavior. A brief discussion of the survey and the data set is presented in section 4.4. Probit model is used to estimate the impact of several factors in the treatment decision in section 4.5. Policy implications are discussed in the last section.

4.2. Treatment Behavior: An Approach to Safe Drinking Water

Averting behavior has been recognized as an important response to avoid health risks because of poor environmental quality (Abrahams et al., 2000; Smith & Desvousges, 1986). Several studies have examined determinants of averting behavior[29] (Abrahams et al., 2000; Smith & Desvousges, 1986; Pattanayak et al., 2005; Whittington et al., 2002;

[29] Literature in averting behavior has focused in estimating averting expenditure (Abdalla et al., 1992; Abrahams et al., 2000), choice between different behaviors (Abrahams et al., 2000) and determinant of averting behavior.

Zerah, 2000). One of the initial studies by Smith & Desvousges (1986) examined the averting behavior of Boston residents in response to hazardous waste. The authors found that averting behavior depends mainly on perceived health risk in addition to socioeconomic characteristics. Similarly, Abdalla et al. (1992) investigated determinants and cost of averting behavior towards water contamination. The authors concluded that the households' knowledge of contamination, perceived health risks, and number of children in the household are some of the important determinants of averting behavior. Using a survey of the Georgia residents, Abrahams et al. (2000) examined the determinants of averting behavior in response to water contamination risks. Information regarding tap water problems, perceived risks from tap water, and income were identified as some of the main determinants of water filtration selection.

Quality is one of the important dimensions of the water supply system. However, water supply authorities in the developing world have not been able to provide safe quality of water to the consumers. Households adopt different strategies to make drinking water safe if water delivered to the tap is not safe. Several past studies (Jalan et al., 2009; Katuwal & Bohara, 2011; Larson & Gnedenko, 1999; Wright et al., 2009) have identified various key factors that impact water treatment behavior of the households in developing countries. Income, educational level, awareness and exposure to the media are some of the major factors that impact the individual-level decision to treat water before using it. Using survey data from Brazil, Larson & Gnedenko (1999) examined the averting behavior of consumer towards unsafe drinking water. Treatment behavior was significantly and positively influenced by income, personal opinions about water quality and educational level. Madajewicz et al. (2005) in their study from Bangladesh found that information alone can significantly influence behavioral change to avoid the risks. Authors further argued that information spread through community can have very strong influence. In a similar study, Jalan et al. (2009) used national survey data from Delhi, India to examine the impact of awareness on treatment behavior. Wealth, education, awareness and quality of water were found to impact the decision of treating water before consumption.

In a more closely related work, Pattanayak et al. (2005) investigated coping strategies with unreliable water supplies and concluded that collecting, pumping, storing and purchasing are some of the major strategies adopted by households in Kathmandu. More recently, Katuwal & Bohara (2011) examined different treatment behaviors adopted by residents in the Kathmandu Valley and concluded that income, education and perceptions on the quality of water are some of the important factors that influence household water treatment behavior. These studies show that households in developing countries use several coping strategies to make water safe if they believe that water delivered to their tap is unsafe. Studies also show that the treatment behavior is affected by several factors such as awareness, quality of water along with household characteristics such as income and education level of the household head.

4.3. Theoretical Background and Hypotheses

4.3.1. The Conceptual Model

A simple model of water treatment behavior is constructed to examine the impact of knowledge, information, and community involvement on the water treatment behavior using an averting behavior approach. If available water in the household is not safe, households use other inputs such as boiling, filtering etc., to make it safe and potable. The theoretical model is based on microeconomic theory that the household maximizes utility by adopting averting behavior. Households maximize utility by consuming treated water, and utility from water quality is obtained through a health production function. Following Bartik (1988); Larson & Gnedenko (1999) and Katuwal & Bohara (2011), the household production function for intended water quality is given by,

$$S_1 = S(Y, S_0) \tag{4.1}$$

where S_1 is intended quality of water, S_0 is opinion on initial water quality, Y is averting behavior. A household minimizes expenditure based on opinion on initial quality of water S_0 to achieve the intended water quality S_1.

$$\underset{\{y\}}{MinE = PY} \quad \text{subject to } S_1 = S(Y, S_0) \tag{4.2}$$

The above minimization problem can be solved for minimum expenditure. Let $E^* = E(p, S_1, S_0)$ be the minimum expenditure on avoidance measures required to obtain the intended quality S_1, given the initial quality S_0. With the consumption of intended optimal quality (S_1^*) of water and other composite goods, the household maximizes its utility given the budget constraint.

$$\underset{\{S_1,Z\}}{Max}U(S_1, Z; X) \quad \text{subject to } pY + Z \le I \tag{4.3}$$

where Z is composite goods and I is income available to the household, X is vector of household characteristics. The two stage problem of minimizing expenditure and maximizing utility can be combined as,

$$\underset{\{S_1,Z\}}{Max}U(S_1*, Z; X) \quad \text{subject to E}(p, S_1*, S_0) + Z \le I \tag{4.4}$$

The above utility maximization problem can be solved to obtain an indirect utility function V^*,

$$V* = V(p, I, S_1; X) \tag{4.5}$$

Optimal averting behavior can be obtained from the above indirect utility using Roy's identity,

$$Y^* = -\frac{\partial V / \partial p}{\partial V / \partial I} = \frac{\partial E}{\partial p} = Y(p, S_0, S_1^*(p, I, S_0; X)) \tag{4.6}$$

where Y^* is optimal avoidance behavior which maximizes utility and minimizes the averting expenditure. The equation above shows that the optimal averting behavior depends on the price of avoidance (*p*), income (*I*), household opinions about tap water (S_0), opinion about improved water quality (S_1) and other household characteristics (X). According to Um et al. (2002) household averting behavior is better explained by the perception of quality than by objective measurement. The authors further emphasize that the perception of initial water quality depends on the age and the education level of respondents. Based on these studies, the original model of optimal behavior is revised to integrate household's knowledge, information and community participation towards water treatment behavior. Household's decision to treat or not to treat water is assumed to be affected by their knowledge of risks, exposure to information and community involvement, in addition to treatment costs and other household and individual characteristics. Under these assumptions, optimal treatment behavior can be expressed as,

$$Y_i = f(Z_{ik}; X_{ij}) \tag{4.7}$$

$$Y_i = \alpha + \sum \delta'_k Z_{ik} + \sum \gamma' X_{ij} + \varepsilon_i \tag{4.8}$$

where Y_i is the optimal treatment behavior that maximizes utility given the optimal expenditure for health production function, X_i is a vector of household characteristics and Z_i is a vector capturing knowledge, exposure to information and community involvement variables. δ_k are the vector of parameters for knowledge, exposure to information and community involvement, and γ_j the other socioeconomic and demographic variables. The above model, for estimation purpose, can be written in more general form as;

$$Y_i = \beta' x_i + \varepsilon_i \tag{4.9}$$

4.3.2. Hypotheses

In addition to examining the factors that influences the treatment behavior, the following hypotheses are proposed and tested. First, it is expected that knowledge about water quality as well as knowledge about the risk and causes of water borne diseases influence the treatment behavior. The more individuals know about these issues the more likely it is that they would treat water. Thus, the null hypothesis is;

H1₀: Household treatment behavior is not affected by knowledge i.e.

$$\frac{\partial Y_i}{\partial Z_{i1}} = 0 \text{; where } Z_{i1} \text{ is knowledge index.}$$

Provision of public information through different media such as radio, television etc. influences the behavior of the household. It is stipulated that an increase in the frequency of exposure to information increases the likelihood of using at least one treatment method. The statement is tested using the null hypothesis;

H2₀: Exposure to information does not affect the treatment behavior i.e.

$$\frac{\partial Y_i}{\partial Z_{i2}} = 0 \text{; where } Z_{i2} \text{ is information index.}$$

It has been well documented that involvement and participation of individuals in environmental and sanitation programs increase awareness about the risk of unsafe water consumption which consequently enhances the water treatment behavior. The statement is tested using following hypothesis;

H3₀: Community involvement has no influence on treatment behavior i.e.

$$\frac{\partial Y_i}{\partial Z_{i3}} = 0 \text{; where } Z_{i3} \text{ is community involvement.}$$

Provision of public water supplies increases access to drinking water. However, "access" does not necessarily guarantee the access to "safe" drinking water. The last hypothesis tests if increases in access to drinking water guarantee access to "safe" drinking water.

H4: Provision of access to public water supplies does not affect treatment behavior

$$\frac{\partial Y_i}{\partial X_{ij}} = 0 \text{; where } X_{ij} = 1 \text{ if private tap is the primary source of drinking water in the}$$

household, and zero otherwise.

4.4. The Survey and Data

4.4.1. The Survey

The data for this study comes from a survey that was conducted in the summer of 2009. The survey was conducted to collect information on residents' knowledge, information and treatment behaviors towards drinking water quality. Altogether, 1,200 households from the Kathmandu Valley were chosen for in-person interviews. Three focus group discussions were conducted followed by pre-testing before conducting the main survey. The pretesting of the survey instrument was conducted in 40 households. The survey was conducted in Nepali after back translation from the original English language survey instrument.

A total of 337,298 households from the Kathmandu Valley were divided into eight strata and 206 clusters. Forty clusters, based on the proportion of number of households, were selected from a total of 206 clusters. Thirty households were randomly chosen from each of the 40 clusters, for a total of 1,200 households. The survey was administered in person and the respondents were adults (18 years of age and older) who were available to complete the survey. A structured questionnaire was used as the survey instrument for the face-to-face interview. The response rate for the survey was 75.29%.

4.4.2. Survey Sample Profile

Main descriptive statistics are presented in Table 4.1. A typical household of the Kathmandu Valley has about 6 family members. Of the total respondents, 36 percent are female. Average education level, in years, of the respondents is 12 where as education level of most educated person in the household is about 14 years. About 8 percent of the residents have a profession that is health related. About one third of the households own their house. A little less than half (46%) of the families are Newars. Average monthly reported income of a household is NRS 19,800.

Table 4.1: Definition of Variables and Corresponding Descriptive Statistics

Variables	Definition	mean	Sd	Min	Max
TREATMENT	Household treats water (1=Yes, 0=No)	0.74	0.44	0.0	1
TREAT_MODE	0 if a household does not treat	0.26	0.44	0	1
	1 if a household filters	0.40	0.49	0	1
	2 if a household boils	0.07	0.26	0	1
	3 if a household boils and filters	0.24	0.43	0	1
	4 if a household uses chemicals	0.09	0.29	0	1
INCOME	Monthly income in thousands	19.80	14.94	3.0	100
EDU_MAX	Education level of the member with maximum level of education	13.81	2.56	1.0	18
KNOWLEDGE	Construct index of knowledge (normalized such that values range from 0 to 1 and higher value represents higher level of knowledge)	0.67	0.19	0.0	1
INVOLVEMENT	Community involvement (normalized such that values range from 0 to 1 and higher value represents higher level of involvement)	0.12	0.25	0.0	1
INCOME	Monthly income in thousands	19.80	14.94	3.0	100
EDU_MAX	Education level of the member with maximum level of education	13.81	2.56	1.0	18
KNOWLEDGE	Construct index of knowledge (normalized such that values range from 0 to 1 and higher value represents higher level of knowledge)	0.67	0.19	0.0	1
INFO-EXPOSURE	Exposure to information (0= Never, 2=Sometimes, 3=Frequently)	0.97	0.64	0.0	2

Table 4.1 (contd): Definition of Variables and Corresponding Descriptive Statistics

Variables	Definition	mean	Sd	Min	Max
PUBLIC_CONNECTION	Source of drinking water (1=Yes, 0=No)	0.63	0.48	0.0	1
HEALTH_PROFESSION	Associated with health profession (1=Yes, 0=No)	0.08	0.28	0.0	1
HHSIZE	Number of members in the household	5.71	2.23	1.0	19
FEMALE	Gender (1=Yes, 0=No)	0.36	0.48	0.0	1
YOUNG_CHILDREN	Children under the age of 5 (1=Yes, 0=No)	0.39	0.49	0.0	1
RESIDENCY	No of years in the community	8.95	1.71	0.5	10
NEWAR	Caste (1 = Newar, 0= Others)	0.46	0.50	0.0	1
OWN	Ownership of the household (1=Yes, 0=No)	0.72	0.45	0.0	1
DIARRHEA	Frequency of occurrence of diarrhea during the last month	0.31	0.69	0.0	10
Observations		1200			

Eight percent of the household has at least one member associated with health profession. Thirty nine percent of household has at least one child below 5 years. Average residency of the household is 9 years. The knowledge index[30] ranges from 0 to 1 with a mean value of 0.67. Similarly, involvement index ranges from 0 to 1 with a mean value of 0.12.

Boiling, filtering, use of chemical tablets and solar disinfection system are some of the treatment methods frequently used by households in Kathmandu Valley. About three out of every four households in the Kathmandu Valley use at least one treatment method before consuming water. Information on different types of treatment behaviors were also collected in the survey. Slightly more than three out of every five households receive water through their private tap.

4.5. Empirical Estimation

The survey does not provide information on exact quantities (such as how much water is boiled) of treatment behaviors. Instead, it provides information on which particular water treatment method was adopted in a binary form (yes/no). Moreover, the theoretical model suggests that each household chooses whether or not to treat and then selects from several treatment methods based on the number of explanatory variables. The probability of using at least one treatment method is estimated using a probit model. Under the assumption

[30] Knowledge and involvement indices are normalized such that value range from 0 to 1.

that the error term in equation (4.8) is normally distributed, the probability of adopting at least one treatment method is given by,

$$\Pr(Y_i = 1) = \Phi(\beta' X) \qquad (4.10)$$

The parameters of the model (β) are estimated using the maximum likelihood method.

$$\ln L = \sum_{i=1}^{N} \left(d_i . \ln \Phi(\beta' X) + (1 - d_i) \ln(1 - \ln \Phi(\beta' X) \right)$$

$d_i = 1$ for $Y_i = 1$; 0 otherwise.

These treatment behaviors are examined and hypotheses mentioned above are tested using binomial probit model in the following section.

4.5.1. Dependent Variables

Respondents were asked if they adopted any treatment method before drinking water delivered to their households. Boiling, filtering, both boiling and filtering, use of chemical tablets and solar disinfection system are some of the frequent treatment methods adopted by most households. The survey data shows that about 74 percent of households in the Kathmandu Valley use at least one treatment method routinely if they think the water they receive is not safe for drinking. A binary choice model (*TREATMENT*=1 if at least one treatment method was adopted, and 0 otherwise) is used to estimate the association between several explanatory variables and water treatment behavior. A multinomial probit model is used to examine the impact of explanatory variables on specific treatment methods. Accordingly, each household decides whether or not to treat water and which method to use to make it safe. A treatment method variable (TREAT_MODE) is created such that TREAT_MODE is; 0 for not treating water at all (base category), 1 for filtering, 2 for boiling, 3 for boiling and filtering both, and 4 for the use of chemicals.

4.5.2. Explanatory Variables

The objective of this study is to examine the impact of knowledge, information and community involvement towards the treatment of drinking water. The knowledge index (*KNOWLEDGE)* is created from information available in the survey. Knowledge about water pollution, knowledge about diseases caused by unsafe drinking water, knowledge about e-coli and knowledge on prevention of diarrhea are used to create the knowledge index. All the components except knowledge about water pollution are binary (1/0). Knowledge about water pollution is rescaled and summed with all the variables to create the knowledge index. The knowledge scale is further normalized such that the values range from 0 to 1 for the estimation purpose.

Consumers, provided with information about health risks, adopt their behavior accordingly. Advertisement through radio, TV, posters, brochure, and social marketing are some of the tools for the provision of information. As far as the risk of drinking water quality is concerned, advertisement through radio and TV is one of the major sources of information. Thus, the frequency of respondents listening to advertising on drinking water treatment methods is used to create an information index, and is denoted by

INFO_EXPOSURE. This information variable[31] describes how frequently ("Frequently", "Sometimes", and "Never") the respondents were exposed to advertisements that brought to light the importance of filtering or boiling water.

Community participation through knowledge sharing can help improve water and sanitation condition. Thus, the adoption of water treatment technology can also be influenced by the extent of community participation. To examine the impact of community participation, community participation is also included as one of the explanatory variables in regression analysis. The community involvement variable (*INVOLVEMENT*) is created using information on family member's involvement in environmental institutions and participation in environmental and sanitation programs. Since the first component is binary (1/0), second component is rescaled such that the value ranges from zero to one and summed with the first component to create the community involvement variable. Finally involvement scale is normalized such that the values range from 0 to 1.

[31] Jalan et al. (2009) also included the exposure to information variable in their analysis. But, the variable included in their study describes frequency of any female member listening to the radio or reading the newspaper. The variables included in our study, however, are more specific in that they specify the frequency of household members watching TV or listening to radio, where water quality and treatment methods are discussed.

Several water sources and profession-related characteristics are included to capture the heterogeneity of the households. A dummy variable *(PUBLIC_CONNECTION=1* if household receives water from private tap; 0 otherwise*)* is used to capture the effect of household being connected to the distribution system on treatment behavior. The respondents that chose private household tap as their primary source for drinking water contributed to the variable. Similarly, a dummy variable is used for health professional (*HEALTH_PROFESSION*=1; 0 otherwise) if any member of the household is associated with any kind of health related professional such as doctor, nurse or pharmacist.

Evidence suggests that the treatment behavior is significantly influenced by household and respondent characteristics (Jalan et al., 2009; Katuwal & Bohara, 2011; Larson & Gnedenko, 1999). Several household and respondent characteristics are included to control for heterogeneity. Included variables are monthly income of the household (*INCOME*), education level of the most educated person in the household (*EDU_MAX*), and household size (*HHSIZE*). Previous studies have found that the averting behavior also depends on the number of children in the household (Abdalla et al., 1992). Moreover, families with children under the age of five might be more prone to treatment of drinking water. Thus, it is expected that a households with children under the age of five would impact the treatment decision. Accordingly, *YOUNG_CHILDREN* (*YOUNG_CHILDREN* =1 if household has at least one child below 5 year, 0 otherwise) is used to control this effect. Ownership of the house (*OWN*), and cast of majority of the residents (*NEWAR*) in the community are also expected to influence the treatment behavior. Households with higher occurrences of diarrhea might have different treatment behavior. Frequency of occurrence of diarrhea (*DIARRHEA*) is included as another explanatory variable to capture this effect.

4.5.3. Results

Each household's decision and marginal effects of explanatory variables on whether to treat (TREATMENT) water to make it safe is estimated using a binary probit model. There are several options available in the market for the point of use treatment of water in the Kathmandu valley. Boiling, filtering, use of chemical are some of the frequently used treatment methods. Each treatment method differs in effectiveness as well as cost. Moreover, use of some specific method is also guided by individuals' opinion about quality of water and belief on the effectiveness of the method. Accordingly, each household decides which method (TREAT_MODE) to use. A multinomial probit model is used to investigate the impact of explanatory variables on specific mode of treatment (e.g. boil vs. filter etc.).

4.5.3.1. Binomial Regression Results

Three different probit models are estimated and the full specification model is used for the estimation of marginal effects. The specification of the probit model selected is based on the Akaike's Information Criteria (AIC) and Bayesian Information Criteria (BIC) criterion. According to these criteria, the model with the minimum AIC and BIC value is the best fitting model (Greene, 2006). The signs of the coefficients for all the models are as expected a priori. The log-likelihood ratio between the basic model and most extended model (-2[(-563)-(-464)] = 198) is significantly greater than the critical chi-squared value (12.59) for 7 degree of freedom at 5 percent significance level. Thus, the most extended model provides significant improvement over the basic model.

Results of the three probit models are presented in Table 4.2. The result from the most extended probit regression model shows that income[32] is not an important factor for the determination of the decision to treat or not to treat water. It is interesting to note that income appears to be significant in the first model (Model 1). However, the impact of income wanes out after the inclusion of household characteristics. As expected a priori, highest level education in the household positively affects the treatment decision and is highly significant ($p<0.01$).

[32] Most of the past studies on treatment behavior (Jalan et al., 2009; Katuwal & Bohara, 2011; Larson & Gnedenko, 1999) have found income to be one of the most important factors behind the decision of adopting treatment behavior for drinking water. Most of these studies, including one from the Kathmandu Valley (Katuwal & Bohara, 2011) used income in terms of different categories (i.e. quartiles). Income is used as a continuous variable in this study.

Table 4.2: Binomial Probit Regression Results

Variables	Model 1 TREATMENT	Model 2 TREATMENT	Model 3 TREATMENT
INCOME	0.0079**	0.0046	0.0058
	(0.0033)	(0.0036)	(0.0037)
EDU_MAX	0.0793***	0.0836***	0.0909***
	(0.0180)	(0.0194)	(0.0204)
KNOWLEDGE	0.7127***	0.6947***	0.5395**
	(0.2362)	(0.2510)	(0.2661)
INVOLVEMENT	0.4854**	0.5525***	0.5999***
	(0.1960)	(0.2106)	(0.2208)
INFO_EXPOSURE	0.1361*	0.1449*	0.1549*
	(0.0717)	(0.0768)	(0.0801)
PUBLIC_CONNECTION	-	1.0423***	1.0126***
		(0.0916)	(0.0949)
HEALTH_PROFESSION	-	-0.0550	-0.0143
		(0.1765)	(0.1863)
HHSIZE	-	-	-0.0513**
			(0.0226)
YOUNG_CHILDREN	-	-	-0.0309
			(0.1031)
RESIDENCY	-	-	-0.0942**
			(0.0379)
NEWAR	-	-	0.2361**
			(0.1017)
OWN	-	-	-0.1784
			(0.1404)
DIARRHEA	-	-	0.0757
			(0.0800)
Constant	-1.2144***	-1.7835***	-0.5993
	(0.2598)	(0.2844)	(0.4128)
Observations	1068	1068	1043
Log lik.	-563	-496	-464
Chi-squared	81***	216***	233***
AIC	1139	1008	956
BIC	1169	1048	1025

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Knowledge and community involvement positively affect the treatment behavior and are highly significant. The null hypothesis that treatment behavior is not influenced by knowledge about the causes and consequences of poor water quality is strongly rejected. The probit analysis result strongly rejects the null hypothesis that community participation has no effect on treatment behavior. Thus, greater the numbers of members of the household involved in the sanitation program greater the probability of adopting treatment behavior. Information, in terms of frequency of advertising, is statistically significant at the 10 percent level. The null hypothesis that exposure to information has no impact on utilization of at least one treatment method is strongly rejected. These results confirm the findings from previous studies (Jalan et al., 2009; Katuwal & Bohara, 2011).

The hypothesis that access to public water supplies does not affect the treatment behavior (H4) is also rejected. Contrary to the general assumption, being connected to the public distribution system influences treatment behavior positively and the effect is strong ($p<0.01$). The highly significant and positive coefficient of private water source suggests that households that are connected to the distribution system and have private tap water tend to treat their water more than to those that are not connected to the distribution system. Health professions do not show any significant influence in the adoption of treatment behavior.

The coefficient of household size is negative, as expected a priori. The negative sign of the coefficient for household size indicates that households with more family members are less likely to treat water before drinking. This reflects the fact that the cost of treating more water is higher for a larger family, which reduces the treatment behavior. Residency shows a negative effect towards treatment behavior. Ownership of the household shows a negative tendency towards treatment adoption. Being Newar increases the treatment behavior. Occurrence of diarrhea does not show any impact towards averting behavior.

4.5.3.2. Multinomial Regression Results

Table 4.3 summarizes the multinomial probit regression results. The results indicate that wealthier households use more than one method. Educated and knowledgeable households are more likely to adopt almost all the treatment methods. Exposure to information does not show effect on the use of specific treatment methods. Household connected to the public distribution system adopts almost all the treatment methods. Health profession does not show any significant impact. Number of years in the community has negative effect towards the adoption of all treatment methods. Home owner are less likely to adopt multiple treatment methods. The probability of the use of these treatment methods decreases with increased household size.

Table 4.3: Multinomial Probit Regression Results

	Model 1				Model 2				Model 3			
	FILTER	BOIL	BOIL_ FILTER	CHEMIC AL	FILTER	BOIL	BOIL_ FILTER	CHEMIC AL	FILTER	BOIL	BOIL_ FILTER	CHEMIC AL
INCOME	-0.0016	0.0104*	0.0181***	0.0129**	-0.0043	0.0078	0.0140***	0.0095*	-0.0034	0.0078	0.0166***	0.0106*
	(0.0047)	(0.0056)	(0.0047)	(0.0053)	(0.0050)	(0.0060)	(0.0051)	(0.0057)	(0.0051)	(0.0063)	(0.0053)	(0.0058)
EDU_MAX	0.0681***	0.1233***	0.1607***	0.0649**	0.0766***	0.1357***	0.1723***	0.0730**	0.0793***	0.1327***	0.1867***	0.0712**
	(0.0253)	(0.0353)	(0.0289)	(0.0324)	(0.0268)	(0.0371)	(0.0312)	(0.0343)	(0.0280)	(0.0393)	(0.0329)	(0.0357)
KNOWLEDGE	0.6481*	0.8887*	1.4754***	1.0612**	0.6702*	0.9411**	1.4916***	1.0983**	0.5097	0.7591	1.1303***	0.8276*
	(0.3353)	(0.4559)	(0.3828)	(0.4392)	(0.3502)	(0.4735)	(0.4080)	(0.4570)	(0.3685)	(0.4991)	(0.4318)	(0.4772)
INVOLVEMENT	0.1307	0.5749*	0.2802	0.8785***	0.1925	0.6432*	0.3382	0.9354***	0.1838	0.6856*	0.3337	1.0261***
	(0.2654)	(0.3233)	(0.2832)	(0.2951)	(0.2787)	(0.3402)	(0.3045)	(0.3118)	(0.2890)	(0.3537)	(0.3212)	(0.3234)
INFO_EXPOSURE	0.1175	0.1361	0.2104*	0.1920	0.1271	0.1511	0.2422**	0.2013	0.1538	0.2442	0.2637**	0.2424*
	(0.1009)	(0.1364)	(0.1128)	(0.1293)	(0.1063)	(0.1422)	(0.1207)	(0.1347)	(0.1104)	(0.1492)	(0.1257)	(0.1389)
PUBLIC_CONNECTION					1.1058***	1.4089***	1.8107***	1.3467***	1.0730***	1.4431***	1.7799***	1.3000***
					(0.1289)	(0.1846)	(0.1624)	(0.1715)	(0.1332)	(0.1921)	(0.1698)	(0.1762)
HEALTH_PROFESSION					-0.1075	-0.4042	-0.0197	-0.0375	-0.0777	-0.3097	0.0381	0.0481
					(0.2453)	(0.3311)	(0.2610)	(0.2869)	(0.2564)	(0.3451)	(0.2755)	(0.2993)
HHSIZE									-0.0404	0.0224	-0.1012***	-0.0496
									(0.0319)	(0.0389)	(0.0372)	(0.0397)
YOUNG_CHILDREN									-0.1113	0.1219	-0.0688	-0.0748
									(0.1432)	(0.1891)	(0.1662)	(0.1815)
RESIDENCY									-0.1035**	-0.1375**	-0.1352**	-0.1147*
									(0.0515)	(0.0634)	(0.0573)	(0.0604)
NEWAR									0.3246**	-0.3631*	0.3534**	0.2317
									(0.1406)	(0.1989)	(0.1666)	(0.1792)
OWN									-0.1905	-0.0338	-0.5777***	-0.3790
									(0.1935)	(0.2447)	(0.2147)	(0.2307)

Table 4.3(contd): Multinomial Probit Regression Results

	Model 1				Model 2				Model 3			
	FILTER	BOIL	BOIL_ FILTER	CHEMIC AL	FILTER	BOIL	BOIL_ FILTER	CHEMIC AL	FILTER	BOIL	BOIL_ FILTER	CHEMIC AL
DIARRHEA									0.0629	0.0857	0.3120***	0.0248
									(0.1102)	(0.1397)	(0.1165)	(0.1396)
Constant	-1.1398***	-3.5003***	-4.0194***	-2.8091***	-1.8010***	-4.4531***	-5.2674***	-3.6468***	-0.5136	-3.1994***	-3.2724***	-1.9291***
	(0.3660)	(0.5284)	(0.4429)	(0.4892)	(0.3932)	(0.5686)	(0.4987)	(0.5278)	(0.5663)	(0.7638)	(0.6660)	(0.7042)
Observations	1068				1068				1043			
Log lik.	-1477				-1392				-1325			
Chi-squared	137***				263***				308***			
AIC	3003				2848				2761			
BIC	3122				3007				3038			

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.5.4. Marginal Effects

Given that the coefficients from the probit model are difficult to interpret and do not provide the quantitative impact of the explanatory variables on the dependent variable, marginal effects are estimated to assess the impact of the explanatory variables on treatment behavior. The marginal effect of explanatory variable (X_k) on the probability of adopting treatment method (P_i) is given by product of marginal effect on P_i of $\beta'\overline{X}$ and effect of X_k on $\beta'\overline{X}$. Furthermore, the marginal effect varies with different values of explanatory variable, so it is evaluated for the mean value of rest of the explanatory variables (Greene, 2006).

$$\frac{\partial P_i}{\partial X_k} = \frac{\partial P}{\partial(\beta'\overline{X})}\frac{\partial(\beta'\overline{X})}{\partial X_k} = f(\beta'\overline{X})\beta_k$$

The most extended version of the models are used for the estimation of the marginal effects and results are presented in Table 4.4 and Table 4.5.

Table 4.4: Marginal Effects for Binomial Probit Regression Model

Variables	TREATMENT
INCOME	0.0016
	(0.0010)
EDU_MAX	0.0251***
	(0.0056)
KNOWLEDGE	0.1487**
	(0.0734)
INVOLVEMENT	0.1654***
	(0.0605)
INFO_EXPOSURE	0.0427*
	(0.0221)
PUBLIC_CONNECTION (d)	0.3059***
	(0.0292)
HEALTH_PROFESSION (d)	-0.0040
	(0.0519)
HHSIZE	-0.0141**
	(0.0062)
YOUNG_CHILDREN (d)	-0.0086
	(0.0286)
RESIDENCY	-0.0260**
	(0.0104)
NEWAR (d)	0.0643**
	(0.0273)
OWN (d)	-0.0474
	(0.0358)
DIARRHEA	0.0209
	(0.0220)
Observations	1043
Log lik.	-464
Chi-squared	233***
AIC	956
BIC	1025

Marginal effects; Standard errors in parentheses
(d) for discrete change of dummy variable from 0 to 1
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The signs of the marginal effects for all the coefficients in the probit regression model are as expected and consistent throughout all three models. However, some important variables such as income are not significant and exposure to information is significant only at the 10 percent level. Education level of the household seems to be one of the strongest factors that influence the treatment behavior. For every one year increase in education level of the most educated member in the household increases the probability of using treatment behavior by about 3 percentage points. For one point increase in knowledge of water pollution and diarrheal disease, the probability of treatment increases by about 4 percentage points. The marginal effect of community involvement suggests that the greater the engagement in community environment and sanitation programs, the more likely it is that they treat water. Exposure to information in the form of frequency of advertising of environmental sanitation and treatment methods such as filtration also seems to play a significant role in increasing the adoption of treatment behavior. Exposure to information increases the likelihood of adoption by about 4 percent points.

It is interesting to note that the households that are connected to the municipal distribution system and have private connection at home are more likely to use at least one treatment method to make water safe before consuming it. The results provide strong evidence that households connected to the distribution system are almost 3 times more likely to use at least one treatment method to avoid the risk of publicly distributed drinking water as compared to the households that are not connected to the municipal distribution system.

The marginal effect of household size is negative. An increase of one member in the household decreases the likelihood of treatment adoption by about 1 percentage point. This is consistent with the theory that increases in cost leads to reductions in adoption of treatment behavior. Another interesting result of the probit model is that time of residency influences the treatment behavior in a negative direction. It indicates that the longer people have been living in their community, the less likely it is that they adopt water treatment. An increase in year of residency decreases the probability of treatment by about 3 percentage points. This is consistent with the previous studies in the Kathmandu Valley (Katuwal & Bohara, 2011). Being a Newar family increases the probability of utilizing treatment behavior by about 6 percent point.

Marginal effects of the explanatory variables on the adoption of specific treatment methods are presented in Table 4.5. Most extended version of the model is used for the calculation of marginal effects. Marginal effect of income is positive and significant for boiling and filtering both. The probability of using both methods increases by 3 percent for each thousand increase in their monthly income. This implies that people tend to use both boiling and filtering instead of one one method, if they are wealthier.

One additional year of education of the most educated member increases the probability of boiling and filtering by 2.6 percent. Similar is the effect of knowledge on the adoption of boiling and filtering together. Exposure to information does not show any effect for the selection of specific treatment methods. Households connected to the public distribution system are more likely to adopt almost all methods. A household connected to the distribution system is 18 percent more likely to adopt boiling and filtering as compared to the households that are not connected to the distribution system. Household size does not matter as far as boiling and filtering only are concerned. However, size of the household decreases the probability of using both treatment methods by about 2 percent. For a Newar family, the probability of boiling decreases by 7 percent. Ownership of households has negative effects towards the adoption of both methods. Households who own their homes are 9.6 percent less less likely to adopt boiling and filtering simultaneously. Occurrence of diarrhea has strong and positive effect towards the adoption of boiling and filtering together.

Table 4.5: Marginal Effects of the Multinomial Probit Regression Model

	FILTER	BOIL	BOIL_ FILTER	CHEMICAL
INCOME	-0.0037***	0.0005	0.0033***	0.0011*
	(0.0012)	(0.0006)	(0.0008)	(0.0007)
EDU_MAX	-0.0034	0.0059	0.0263***	-0.0026
	(0.0069)	(0.0039)	(0.0055)	(0.0044)
KNOWLEDGE	-0.0337	0.0228	0.1447**	0.0419
	(0.0915)	(0.0491)	(0.0726)	(0.0590)
INVOLVEMENT	-0.0693	0.0456	0.0031	0.1182***
	(0.0674)	(0.0326)	(0.0511)	(0.0362)
INFO_EXPOSURE	-0.0028	0.0106	0.0271	0.0138
	(0.0268)	(0.0145)	(0.0205)	(0.0168)
PUBLIC_CONNECTION (d)	0.0533	0.0509***	0.1785***	0.0484**
	(0.0331)	(0.0155)	(0.0228)	(0.0189)
HEALTH_PROFESSION (d)	-0.0197	-0.0292	0.0211	0.0156
	(0.0602)	(0.0245)	(0.0459)	(0.0380)
HHSIZE	-0.0010	0.0077**	-0.0164**	-0.0019
	(0.0080)	(0.0037)	(0.0064)	(0.0049)
YOUNG_CHILDREN (d)	-0.0302	0.0226	-0.0044	-0.0040
	(0.0354)	(0.0193)	(0.0278)	(0.0222)
RESIDENCY	-0.0065	-0.0059	-0.0115	-0.0039
	(0.0118)	(0.0057)	(0.0089)	(0.0069)
NEWAR (d)	0.0707**	-0.0669***	0.0439	0.0080
	(0.0354)	(0.0182)	(0.0288)	(0.0222)
OWN (d)	0.0264	0.0246	-0.0960**	-0.0239
	(0.0449)	(0.0199)	(0.0388)	(0.0289)
DIARRHEA	-0.0159	-0.0011	0.0571***	-0.0117
	(0.0243)	(0.0127)	(0.0169)	(0.0166)
Observations		1043		
Log lik.		-1325		

Table 4.5 (contd): Marginal Effects of the Multinomial Probit Regression Model

	FILTER	BOIL	BOIL_ FILTER	CHEMICAL
Chi-squared		308***		
AIC		2761		
BIC		3038		

Marginal effects; Standard errors in parentheses
(d) for discrete change of dummy variable from 0 to 1
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The results from binomial and multinomial are consistent with theory. Most of the explanatory variables are statistically significant for the selection of treatment and for the selection of a particular treatment method. Thus income, education, and exposure to information influence the choice of treatment. More specifically, wealthier households tend to use more than one method. Another interesting result is that the household connected to the distribution system tends to use more treatment methods. The households with connection to the distribution system are supposed to have access to safe water. But our results show that this is not the case, at least for Kathmandu. In fact, households connected to the distribution system are more likely to use one or more than one treatment method.

4.6. Discussion and Policy Implications

Poor water quality poses health risks from water borne disease and imposes high costs to society. Water supply services in developing countries are not efficient enough to provide safe drinking water to the community. Health risks from water borne disease caused by poor quality of water can be significantly reduced through point-of-use water treatment such as filtering, boiling and the use of chemicals.

The objective of this chapter was to investigate the impact of knowledge, exposure to information and community participation towards the water treatment behavior of households in Kathmandu Valley. The determinants of the water treatment behavior were examined using averting behavior approach. The results from binary probit model show that knowledge, information and community participation significantly influence household behavior towards water treatment by helping people understand the importance of treating drinking water. In addition to household characteristics, knowledge about water borne diseases and community participation seem to play an important role in influencing treatment behavior. The results provide strong potential of knowledge, information, and community participation in increasing adoption of treatment behavior. Thus, this study provides several pragmatic policy relevancies towards the reduction of health risk because of the poor water quality in a developing country.

It is generally assumed that income is one of the most important factors behind the demand for environmental quality. However, the result shows that knowledge and exposure to information are stronger determinants for the treatment behavior. Thus, in order to increase the treatment behavior and reduce the health risks of poor water quality, improving knowledge about quality of water and related health risks through formal and informal education needs to be emphasized. This can be done by integrating more information on water related health risks in school and college education curricula. Similarly, treatment behavior can be influenced through media intervention by increasing the frequency of information about consequences of poor quality of water and effectiveness of treatment method.

The result also demonstrates that the community involvement and social networks have a strong influence in water treatment behavior. Policy makers can use the community participation through local clubs and NGOS as tools of social marketing to enhance the treatment behavior.

Another interesting finding is that households treat more if water is delivered from the distribution system. One of the measures to avoid the health risks of poor water quality is provision of piped water. However, it has not been the case in most of the developing world. Most of the water distribution authorities in developing cities have not been able to provide good quality of water that is free of health risks. Kathmandu is no exception to this. The results that the treatment behavior is more frequent for the household that are connected to the distribution system highlights another important supply side issue in the drinking water supplies in developing countries. Although these households are connected to the distribution system and have access to improved water supply, safe water is not guaranteed. This calls for improvement in the operation and maintenance of the distribution system. This includes rejuvenating and repairing the distribution system continuously. Policy makers and water managers should aim at improving water quality before delivering it to the consumers.

Once knowledge of the importance of clean water is widespread, there will be numerous benefits and reductions in the cost of water borne diseases to society. The effects of diseases such as diarrhea will wane causing overall improvement in health of the residents in the region. Fewer numbers of days that are taken off from work because a worker or a child is sick. This would result in improved productivity. Thus, the benefits of treating household water will make an extremely large impact on the health and wellbeing of society.

This study is based on a survey that was carried out in the capital city of Nepal. Most of the households have access to drinking water from public water supply system in Kathmandu. Unfortunately, vast majority of the rural household are not yet connected to the public distribution system in Nepal. Thus the result might not hold true for other rural parts of Nepal and cannot be generalized. It should also be noted that this study focuses in the household level analysis. The survey does not include water distribution to institutions such as business, schools, hospitals etc. Moreover, several other averting behaviors such as hauling and storing drinking water are not discussed.

These caveats acknowledged, the result provides strong evidence that education, knowledge, information, and community involvement are crucial in determining adoption of water treatment behavior. Thus, these factors are critical in avoiding health risk caused by poor water quality and reducing large health burden of unsafe drinking water. The water treatment behavior can be enhanced to ensure the safe water consumption through policy intervention. As targeted by the Millennium Development Goals (MDGs), one of the goals is to reduce number of people without access to "safe" water and sanitation to half by 2015 (MDG, 2006). The results, as well as previous studies, show that water supply services in the Kathmandu Valley have not been able to provide good quality water to the community. In other words, people have access to drinking water, but it does not guarantee access to “safe” drinking water. This is very important for planners and policy makers who design policies to achieve the MDGs. Thus, the water treatment behavior of the household must be influenced through education, social marketing and community participation until the water supply services can provide high quality, safe water that does not compromise health.

CHAPTER 5

Summary Comments and Avenues for Future Research

5.1. Chapter Summaries

The objective of this dissertation was to examine demand for environmental quality, water quality in particular, using a knowledge, attitude, behavior and CE survey in Kathmandu, Nepal.

Society's preferences towards the improvement in water quality in the Bagmati River using CE data was examined in Chapter 2. The benefit of improving water quality in the river was estimated CE data. Results indicate that there is a significant benefit associated with improved water quality in the Bagmati River. Moreover, results also indicate that there is significant heterogeneity across different group of people and for different purposes of visitation. These benefits and preference heterogeneities are important, and should be taken into consideration when designing any policy changes.

Benefit estimation from this study can be an important policy tool for the river clean-up program, specifically for wastewater treatment facilities. Society's attitude and preferences for payment methods and funding mechanism is useful, not only for river water clean-up but also for other waste management programs. Information on WTP, the preference for payment vehicle and management can be an important input for the implementation of a river restoration and rehabilitation program.

This study is the first of its kind to elicit the benefits of water quality improvement of a river in Nepal and makes significant contribution to the limited literature on valuation of river water quality improvement in less developed countries. It can be used for benefit transfer for other similar polluted rivers for benefit-cost analysis. In addition, this study adds to the CE research by providing the evidence that CE can be successfully applied to assess the preferences of the society, and to estimate benefits of improving river water in developing world.

The aim of third chapter was to gain insight and better understanding of attitude and participation behavior towards conservation, rehabilitation and restoration of a river ecosystem. Knowledge, attitude and behavior framework was used in an ordered SEM. The result draws several important conclusions about the factors that influence attitude and participation behavior. Results show that there is clear and strong effect of knowledge and cultural attachment towards the attitude and behavior. In contrast socioeconomic characteristics such as age and income appear to have little or no effect on attitude and behavior. Stronger environmental attitude is generally associated with higher level of participation. However, the study shows some gaps between attitude and behavior such as, stronger attitude but lower participation shown by women. It is necessary and critically important to fill these gaps between attitude and behavior so that stronger attitude can be translated into higher levels of participation.

While there exist several studies that uses attitude-behavior framework, studies that use specific environmental quality such as river ecosystem are rare. The attitude-behavior approach was used to examine voluntary participation for the improvements in the river ecosystem. Results from this study will provide a clear pathway for the design and implementation of long term river management and conservation programs such as the Bagmati Action Plan. In addition, this study also makes methodological contribution by integrating theory from economics and psychology to estimate attitude and behavior simultaneously using SEM.

Results from this study provide the evidence that knowledge, information and cultural attachment are critical in shaping attitude. These factors consequently influence the participation behavior which is critical for the conservation and sustainable management of the river. Thus more emphasis should be given to provide information and knowledge through formal and informal education. This may also include providing information through social marketing using environmental organizations. Above all, the factors that can be used to shape the attitude that consequently influence the behavior need to be identified to ensure sustainable management of the scarce natural resources.

The objective of the fourth chapter was to investigate the impact of knowledge, exposure to information and community participation towards the drinking water treatment behavior of households in the Kathmandu Valley. The results from binary probit model show that knowledge, information and community participation significantly influence household behavior towards water treatment by helping people understand the importance of treating drinking water. In addition to household characteristics, knowledge about water borne diseases and community participation seem to play an important role in influencing treatment behavior. The results provide strong evidence of knowledge, information, and community participation in increasing adoption of treatment behavior.

Thus, in order to increase the treatment behavior and reduce the health risks of poor water quality, improving knowledge about quality of water and related health risks through formal and informal education needs to be emphasized. This can be done by integrating more information on water related health risks in school and college education curricula. Similarly, treatment behavior can be influenced through media intervention by increasing the frequency of information about consequences of poor quality of water and effectiveness of treatment method.

Another interesting finding is that households treat more if water is delivered from the distribution system. One of the measures to avoid the health risks of poor water quality is provision of piped water. However, it has not been the case in most of the developing world. Most of the water distribution authorities in developing cities have not been able to provide good water quality that is free of health risks. Kathmandu is no exception to this. Although these households are connected to the distribution system and have access to an improved water supply, safe water is not guaranteed. This calls for the improvements in the operation and maintenance of the distribution system. This includes rejuvenating and repairing the distribution system continuously. Policy makers and water managers should aim at improving water quality before delivering it to the consumers.

5.2. Avenues for Future Research

This dissertation examined public preferences and estimated benefits of improving river water quality in Kathmandu, Nepal using CE data. In addition, impact of information, knowledge, and attitude towards the river conservation and drinking water treatment behavior were examined. This manuscript may be complete in its current form, but there remain additional revenues for future research. Briefly, some research avenues include; (1) combining stated preference data with revealed data in Chapter 2; (2) including and comparing CE data from policy makers and managers with household level data in Chapter 2; (3) combining CE data from Chapter 2 with attitude and behavior data from Chapter 3; (4) continuous survey and analysis for participation behavior to better understand the change in behavior over time in Chapter 3; (4) extending drinking water treatment behavior analysis for rural households in Nepal.

Hypothetical bias is one of the major concerns of using SP data. SP data combined with RP data do not suffer from the hypothetical bias. Because of this desirable benefit, there has been an increasing trend of combining SP and RP data to estimate the benefits of improving quality of river water (Englin and Cameron, 1996; Eiswerth et al., 2000; Hanley et al., 2003). Thus, combining RP data with SP would an interesting future avenue for Chapter 1. Several well established scales such as NEP and AC for attitude and behavior have been used by several researchers. In addition, information for behavior control and subjective norms was not available. Use of behavioral control and subjective norms with actual behavior would be interesting direction for future research (Ajzen & Driver, 1992; Pouta & Rekola, 2001)

.

The focus of third chapter was to identify important determinants of attitude and behavior of general residents towards voluntary participation. A similar study of decision makers would be another interesting facet for future research. Moreover, attitude and behavior may change over time. Continuous survey and analysis would be necessary for understanding changes in attitude and behavior over time.

Another avenues for future research may includes combining SP data with attitude and behavior data for better estimation of WTP. Several authors have applied attitude-behavior framework to examine behavioral intention, willingness-to-pay (WTP) in particular, for the improved environmental quality (Ajzen & Driver, 1992; Bernath & Roschewitz, 2008; Bright et al., 2002; Ojea & Loureiro, 2007; Pouta & Rekola, 2001; Spash, 2006). It is argued that inclusion of attitude and behavior data provides more robust estimates for WTP. An opportunity of combining RP data would definitely provide more accurate estimates for WTP estimates.

This dissertation is based on a survey that was carried out in capital city of Nepal. Most of the households have access to drinking water from public water supply system in Kathmandu. Unfortunately, vast majority of the rural household are yet not connected to the public distribution system in Nepal. Thus the result might not hold true for other rural parts in Nepal and cannot be generalized. Moreover, several other averting behaviors such as hauling and storing drinking water are not discussed. Thus, extending the study of treatment behavior for drinking water in rural areas would be another interesting facet for future research.

APPENDICES

APPENDIX A: Sampling Design

As a rough approximation the necessary sample size N can be determined from the formula (Mitchell & Carson, 1993)[33];

$$N = \left[\frac{z_{\frac{\alpha}{2}} \hat{\sigma}}{\delta . \overline{RWTP}} \right]^2 \quad (1)$$

where $z_{\frac{\alpha}{2}}$ is t statistics for the given confidence interval, $\hat{\sigma}$ is the estimated standard deviation to the WTP, δ is the percent difference between true willingness to pay and estimated willingness to pay, $\overline{RWTP}$ is the mean of estimated willingness to pay.

Because of large variance in WTP responses, large sample size is required for SP studies. Since researcher's interest is on relative error i.e. the percent of the true mean. In such situation researcher needs to know prior estimate of the coefficient of variation V where,

$$V = \frac{\sigma}{\overline{TWTP}} \quad (2)$$

where σ is the standard deviation of the WTP and $\overline{TWTP}$ is true i.e. population mean of WTP.

From equation (2),

$$V = \frac{\sigma}{\overline{RWTP}} \quad (3)$$

Substituting value of $\hat{\sigma}$ in equation (1),

[33] This derivation is based on (Bateman et al., 2002)

$$N = \left[\frac{z_{\frac{\alpha}{2}} V}{\delta} \right]^2 \qquad (4)$$

For $\alpha = 95\%$ and $z_{\frac{\alpha}{2}}$ =1.96, relative error V =1.5 and δ = .15, $n_0 = 385$

In SP surveys non response rate of 20 to 30% is not uncommon (Mitchell and Carson 1989). In developing countries response rate for face to face interview for SP survey is found to be considerably high. For example response rate in Alam et al. (2003) study was 85% and in Choe et al. (1996) it was 65%. Inflating the above starting sample size by 20% non response rate,

$$n = 385 * 1.25 = 481.25$$

Thus, approximately 481 households are required to estimate WTP from SP method. It is also suggested that smaller sample size can be employed for CE, because of the multiple information per household (Bateman et al, 2002).

Ormne (1998) provides a rule of thumb for the calculation of sample size for Conjoint Analysis.

$$N = 500.\frac{NLEV}{NALT.NREP} \qquad (5)$$

where N is respondent sample size, NREP is the number of choice questions per respondent, NALT is the number of alternatives per choice, and NLEV is the largest number of level in any attribute including the interactions.

Assuming, NREP = 3, NALT = 3 and NLEV = 6

The sample size should be greater than 333.33. Considering 20% non response rate, the total sample size is 416.66.

Champ and Welsh (in Kanninen 2007) opine that a sample size of approximately is required to provide a 5% sampling error a size of population between 10,000 to 100,000,000.

Based on these studies ((Mitchell & Carson, 1993; Kanninen, 2007; Orme, 1998) 400 households are used. Since focus the study is to study the impact of being upstream, midstream, and downstream on WTP, we use 400X3=1200 households.

Sampling Design for Household Survey

The Kathmandu Valley consists of 5 municipalities and 97 VDCs considering watershed area of the valley. The Kathmandu Valley comprises of 337,298 households (CBS, 2001).

The total number of households to be sampled has been determined as 1,200 households for the study area of Kathmandu Valley. Here, the sampling unit is households. The sample size is about 0.36% with maximum sampling error of 2.8% (Cochran, 2007).

The designing of sampling technique for such study is quite challenging. In general, stratified random sampling or cluster sampling are used for household survey which requires one or two stage only for sample selection. But, this study needs multi stages of sampling in order to incorporate municipalities as well as VDCs of three districts of the Valley as mentioned in the Report of Development of Bagmati Action Plan. Considering this, the Multi Phase Sampling Technique has been designed for the study. It consists of following stages:

Stage 1-

- The whole study area of Kathmandu Valley is divided into 8 strata in such a way that the sampling units within the stratum are as much homogenous as possible and sampling units between strata are as much heterogeneous as possible. Here, the 8 strata consist of five urban areas (i.e., municipalities) and each rural area of three districts. The list of 8 strata is given in Table 1.

- Further each stratum is divided into number of clusters of wards/VDCs. If the stratum consists of municipality, the clusters will be wards, and if the straum consists of rural area, the clusters will be VDCs. The number of wards/VDCs of each stratum is shown in Table 1. There are altogether 206 clusters in 8 strata which consist of 337,298 households.

Table A1. List of Strata with number of cluster and number of households

Strata	Name	No. of households	Number of wards/ VDCs (Clusters)	Number of clusters to be sampled (n_h)	Number of households to be sampled
1	Kathmandu Municipality	152,155	35	18	540
2	Lalitpur Municipality	34,996	22	4	120
3	Bhaktapur Municipality	12,133	17	2	60
4	Thimi Madhyapur Municipality	9,551	17	1	30
5	Kirtipur Municipality	9,487	18	1	30
6	Kathmandu VDCs	71,373	56	8	240
7	Lalitpur VDCs	26,677	25	3	90
8	Bhaktapur VDCs	20,926	16	3	90
	Total	**337,298**	**206**	**40**	**1,200**

Stage 2 -

- The n_h clusters are selected from each stratum with probability proportional to size of households so that the total number of clusters is 40 and household is 1200, where n_h is the number of cluster for h^{th} stratum.
- The selected cluster is divided into number of sub clusters, each sub cluster containing 30 households.
- Then one sub cluster of 30 households is selected from each selected cluster using simple random sampling technique. The list of 40 selected clusters is given in Table 2.
- Then all 30 households of the selected sub clusters are enumerated for survey.

Table A2. List of Selected Cluster

N	Cluster (Ward/VDC)	Number of household sampled
1	Bhaktapur Municipality - Ward 8	30
2	Bhaktapur Municipality - Ward 17	30
3	Thimi Madhyapur Municipality – Ward 12	30
4	Lalitpur Municipality - Ward 8	30
5	Lalitpur Municipality - Ward 10	30
6	Lalitpur Municipality - Ward 17	30
7	Lalitpur Municipality - Ward 18	30
8	Kathmandu Municipality - Ward 1	30
9	Kathmandu Municipality - Ward 2	30
10	Kathmandu Municipality - Ward 4	30
11	Kathmandu Municipality - Ward 8	30
12	Kathmandu Municipality - Ward 10	30
13	Kathmandu Municipality - Ward 11	30
14	Kathmandu Municipality - Ward 12	30
15	Kathmandu Municipality - Ward 16	30
16	Kathmandu Municipality - Ward 20	30
17	Kathmandu Municipality - Ward 21	30
18	Kathmandu Municipality - Ward 24	30
19	Kathmandu Municipality - Ward 27	30
20	Kathmandu Municipality - Ward 28	30
21	Kathmandu Municipality - Ward 29	30
22	Kathmandu Municipality - Ward 30	30
23	Kathmandu Municipality - Ward 31	30
24	Kathmandu Municipality - Ward 32	30
25	Kathmandu Municipality - Ward 34	30
26	Kirtipur Municipality - Ward 10	30
27	Bhaktapur – Chhaling VDC	30
28	Bhaktapur – Sipadol VDC	30
29	Bhaktapur – Baad Bhanjyang VDC	30
30	Kathmandu - Chhaimale VDC	30
31	Kathmandu - Gagalphedi VDC	30
32	Kathmandu - Goldhunga VDC	30
33	Kathmandu - Gothatar VDC	30
34	Kathmandu - Kabhresthali VDC	30
35	Kathmandu - Manmaiju VDC	30
36	Kathmandu - Pukhulachhi VDC	30
37	Kathmandu - Sundarijal VDC	30
38	Lalitpur - Chapagaun VDC	30
39	Lalitpur - Harisiddhi VDC	30
40	Lalitpur - Thecho VDC	30
	Total	1,200

APPENDIX B: Survey Questionnaires

Water Quality, Health Risks and the Benefit Estimation of Water Quality Improvements in the Bagmati River:

A Knowledge, Attitude, Behavior, and Choice Experiments Survey[34]

What do you think?

[34] Nepali version of the questionnaires were used in the actual survey

Introduction-

Namaste,

I am …………………………………….from the Nepal Study Center located at the University of New Mexico, USA. We are asking community residents about their opinion on the environment and water quality. The purpose of this survey is to collect information on environmental quality, especially river water quality and health risks. We want to know the health risks associated with poor water quality, potential for water quality improvements in the Bagmati River and how much people value the river water quality. Your views will help policy makers to make informed decisions on these issues. Most of the questions have to do with your attitudes and opinions; therefore, there are no right or wrong answers. Your opinion is valuable for the study to enable us to understand residents' attitudes and involvement towards the environment and water quality. Participation is voluntary, and if you do not want to take part in this research, you can quit this interview any time you want. Your answers to these questions are completely confidential and results will not be used in anyway in which they can be associated with your name or address.

Thank you very much for your kind cooperation.

To be filled by enumerators

Respondent agreed to participate in the survey after verbal consent.

Yes ☐ (continue the interview)

No ☐ (Please move to the next household)

Respondents:

Name: Mr./Mrs./Miss…………………………….

Address …………………………….

Date ………………….

Time………………….

Study # ……………………

Location # ……………………….

Supervisor's Name: …………….

Part 1: Environmental Attitudes and Concerns

1. Rank the following in order of their importance to you and your household, with 1 being the most important. (Assign priority 1 to 4)
    1. Peace and security ☐
    2. Environment ☐
    3. Economic development ☐
    4. Others, (Please specify)…………………………………………………….

2. For the following list of environmental issues, indicate how serious you consider each one to be in your own community.

	Very serious	Somewhat Serious	Not at all
1. Water pollution	☐	☐	☐
2. Air pollution	☐	☐	☐
3. Traffic congestion	☐	☐	☐
4. Household waste	☐	☐	☐

In your opinion, how important are the following;	Very Important	Somewhat Important	Not at all Important	Do not know
3. To protect the natural environment	☐	☐	☐	☐
4. To control pollution?	☐	☐	☐	☐
5. To conserve Nepal's cultural and religious heritage	☐	☐	☐	☐
6. To conserve the Bagmati River for cultural and religious activities	☐	☐	☐	☐
7. Bagmati River to your households' religious activities	☐	☐	☐	☐

8. Some people believe that controlling water pollution in the Bagmati River is of great value, while other people feel that controlling water pollution in the river is not important. Do you think controlling water pollution in the river is important? (Check one)
    1. Yes ☐
    2. No (If no go to question 10) ☐

9. You said that controlling water pollution in the river is important. Why is it important to you and your family? (Rank in order of their importance, with 1 being the most important)
    1. For household use such as agricultural, washing, cleaning etc. ☐
    2. For religious and cultural purpose ☐
    3. Get satisfaction from knowing other people use and enjoy fresh water ☐

4. Get satisfaction from knowing that the river is clean ☐

10. How do you think, your household would benefit from improving water quality in the Bagmati River? (Check either "A Benefit" or "No Benefit" for each part)

	A Benefit	No Benefit
1. Improved health	☐	☐
2. Able to swim, bath	☐	☐
3. Improved quality of water supply	☐	☐
4. Improved ecosystem and aquatic lives	☐	☐
5. Improved quality of agriculture and fisheries	☐	☐
6. Increased tourism activities	☐	☐
7. Increase in price of housing and land near river	☐	☐
8. Cultural and religious activities	☐	☐

11. In your opinion, how much do you think should be spent on reducing water pollution in the Bagmati River? (Check one)
    1. Much more than is currently being spent ☐
    2. A little more than is currently being spent ☐
    3. The same as is currently being spent ☐
    4. Do not know ☐

12. What would you be willing to do to improve quality of water in the Bagmati River? (Check all that apply)
    1. Pay higher taxes ☐
    2. Volunteer in clean up program ☐
    3. Attend meeting and talk with neighbor about river ☐
    4. Join local water conservation group ☐

13. The structure of payment also matters. For example you currently pay your water bill to the Water Supply Corporation, and a yearly property tax to the municipal office. Which do you think is the most suitable method for collecting revenue for the clean up program?(Check only one)
    1. Through sewer/waste management fee ☐
    2. Through property tax ☐
    3. Charge as specific river cleaning up fee ☐
    4. Others (please specify)…………………………………………………………………

Part 2: Choice Experiments

For interviewer: - Before asking the next set of questions, please read Cards 1 through 7 to explain details about the clean up program. Make sure that respondents clearly understand the proposed clean up program, its outcomes and costs associated with it. If it is not clear, please read again.

Following is information about the proposed project, its potential outcome, and associated cost. Potential outcomes and associated cost are discussed in detail.

Card 1-Introduction-the proposed project

The Bagmati River is the main river running through the heart of Kathmandu. Baghmati's water quality is very poor. For the past several years the water quality of the Bagmati River has been continuously getting worse and has become polluted. The water is black, emits a foul odor, contains raw sewage, and dead animals. Contact with the water is dangerous to human health. The bank of the river is also highly polluted due to different kinds of waste. The Bagmati River Water Quality Improvement Project is currently being considered. The project is a potential program that will clean up the Bagmati River. The project is expected to be completed in 5 years. The Project will have both environmental and economic benefits. The benefits may include improved community health, increased property values on the bank of the river, and increased social and cultural values of the river. The project will improve the quality of river water by building more waste water treatment plants, and restricting solid waste dumping on the river banks. In addition, more trees will be planted on the riverbanks which will promote the natural ecosystem of the river and its territory by improving biodiversity in terms of fish, plants, birds etc.

Card 2-Outcomes of the project

Different management option will produce different outcomes. The project will improve the quality of water in the river by constructing more waste water treatment plants. Under this project, the water quality could be improved to number of possible stages. The following three factors will be affected by the proposed plan.

- **Improvement in Water Quality in the River**
- **River Side Tree Plantation**
- **Fund Management**

You will be asked to choose between different options. The option that is chosen by the majority will be selected for policy making. Before asking you to choose an option, I would like to give you more details of about the three different water quality improvement levels.

Card 3-Improvements in water quality

Under this project, the water quality could be improved to three possible levels.

1. Walkable: The River could be cleaned to a point where it is walkable on the banks of the river. Meaning there will be substantial improvements in color and odor of water and water in the river is cleaner and odorless. At this stage water is not clean enough for fish and other aquatic animal to live and is not safe enough for human emersion.

2. Walkable, and suitable for fish and plants: The River could be cleaned to a point where it is suitable for aquatic animal and plants. In addition to being walkable, the river is clean enough for fish and plants to live in. At this stage water is not safe enough for human emersion.

3. Walkable, suitable for fish and plants, and Bathable: The River could be cleaned to a point where it can be used safely for bathing and swimming. This means that the water is clean enough to be safe for human emersion. A river that is safe for bathing and swimming is also safe for walking on the banks, it also suitable for aquatic animal and plants.

1. Which of the above levels do you think is the most suitable and practical for Bagmati River?
   1. Walkable ☐
   2. Walkable, and suitable for fish and plants ☐
   3. Walkable, suitable for fish and plants, and Bathable ☐
   4. Other (please specify)……………………………………………………………......................

Card 4-River side tree plantation

Considering the initiation of Riverside Park and Green Belt in Bagmati River, the project proposes to plant trees along the riverbanks. This will enhance the visual image of the city. This will also stabilize the river bank by preventing erosion, and help reducing surface runoff. Approximately 20% of the river bank is already covered with trees. The project proposes three different levels of plantations based on the bank of the river bank covered with trees:

1. 40% of the river bank will be covered with trees
2. 60% of the river bank will be covered with trees
3. 80% of the river bank will be covered with trees.

In general, more trees planted on the riverbanks leads to less soil erosion, improved biodiversity and enhance the visual image of the city.

2. Which of the above options do you think is the most suitable and practical?
   1. 40% of the river bank will be covered with trees ☐
   2. 60% of the river bank will be covered with trees ☐
   3. 80% of the river bank will be covered with trees ☐
   4. Others (please specify)………………………………………..

Card 5-Costs

The financial structure and source of financing are crucial for the implementation of the project. By itself the government can not cover the full cost. The program will partially be funded by the government and partially paid for by people like you. To obtain the funding you will be charged an annual '**Bagmati River Clean Up Fee'** for 5 years.

Card 6-Fund management-who is incharge of managing the fund?

People sometimes have preferences over who is incharge of managing projects funding. There are many different projects in Nepal that are managed by different organizations. For example solid waste is managed by the municipal authority. Many communities are managing the forest in different parts of the country. Three possible types of organization could manage the funding for the Bagmati River. The option which is chosen by majority will be considered for implementation of the project.

Community trust fund-A community trust fund would receive and administer the fund to implement the proposed project

Government -The proposed project will be administered by a central government body

Municipal Fund - Municipality would receive the fund and would be responsible to administer the proposed project

3. Which institution would you prefer to be incharge of managing the proposed fund?
   1. Community trust fund ☐
   2. Municipal/Government fund ☐
   3. NGO/INGO ☐
   4. Other (Please specify) ……………………………………………………………………

Card 7-Time Contribution

For some programs, people pay through a contribution of their time. For example, people contribute their time in constructing roads and other social activities. It has also been observed that people contribute their time for cleaning up the Bagmati River. Thus, contributing your time for the river clean up can be an alternative way to support the project.

4. Would you be willing to contribute your time for the river clean up program? (Cleaning up river includes cleaning up bank of the river, tree plantation, training other people etc)
   1. Yes ☐
   2. No ☐

Cheap Talk[35]

Before you answer the following questions, I would like to remind you of the following.

1. Given your household budget, paying these costs means you have less money to pay for other requirements.
2. Here we are talking about only the Bagmati River. There are several other rivers in Kathmandu that require clean up.
3. Other surveys have found that the options chosen by people are sometimes different than the option they actually chose when the project takes place and requires the real payment. So while choosing the option, please imagine that you are really paying for the option you choose.

Which Alternative Do You Prefer?

Now we will present you with several sets of alternatives and ask you make your choice.
In the card below, we have presented several combinations of different levels of improvement in water quality in the Bagmati River, funding management mechanism, the cost you have to pay for the clean up program and the amount of time you contribute to the program. Please consider the following alternatives carefully.

5. Suppose alternatives A, B and C are the only one available.

Attributes	Alternative **A**	Alternative **B**	Alternative **Z-** Current situation
Water quality	Walkable on the banks of the river	Walkable on the banks of the river, suitable for fish and plants, and suitable for bathing and swimming	The water is black, emits a foul odor, and is not suitable for fish and other aquatic animals. Contact with the water is dangerous to human health.
Riverside tree plantation	40 percentage	80 percentage	There are no trees along the banks except in a few places.
Who is incharge of managing funding?	municipal fund	Government/	Not applicable
My annual payment for 5 years	Rs 3000per year	Rs 600per year	Rs 0 per year
Time Contribution per year	10days	15 days	0 days

Which do you prefer?

1. Alternative A ☐
2. Alternative B ☐
3. Status quo Z ☐

[35] Only half of the sample received the 'Cheap Talk' version of the questionnaires. The other half will receive questionnaires without cheap talk.

6. Suppose alternatives C, D and Z are the only one available?

Attributes	Alternative **C**	Alternative **D**	Alternative **Z-** Current situation
Water quality	Walkable on the banks of the river, suitable for fish and plants, and suitable for bathing and swimming	Walkable on the banks of the river, suitable for fish and plants	The water is black, emits a foul odor, and is not suitable for fish and other aquatic animals. Contact with the water is dangerous to human health.
Riverside tree plantation	40 percentage	60 percentage	There are no trees along the banks except in a few places.
Who is incharge of managing funding?	Community	Government	Not applicable
My annual payment for 5 years	Rs 00 per year	Rs 1200 per year	Rs 0 per year
Time Contribution per year	5 days	10 days	0 days

Which do you prefer?

1. Alternative C ☐
2. Alternative D ☐
3. Status quo Z ☐

7. Suppose alternatives E, F and Z are the only one available

Attributes	Alternative **E**	Alternative **F**	Alternative **Z-** Current situation
Water quality	Walkable on the banks of the river, suitable for fish and plants, and suitable for bathing and swimming	Walkable on the banks of the river	The water is black, emits a foul odor, and is not suitable for fish and other aquatic animals. Contact with the water is dangerous to human health.
Riverside tree plantation	80 percentage	60 percentage	There are no trees along the banks except in a few places.
Who is incharge of managing funding?	Community	Government	Not applicable
My annual payment for 5 years	Rs 1800 per year	Rs 2400 per year	Rs 0 per year
Time Contribution per year	15 days	5 days	0 days

Which do you prefer?

1. Alternative E ☐
2. Alternative F ☐
3. Status quo Z ☐

For interviewer: - Before asking the next set of questions, please make sure that respondents chose at least one option for questions 5 through 7. If respondents chose status quo for all (5 through 7) go to question no 8, otherwise go to question no 9.

8. When answering the questions 5 to7, you always choose option C (status quo). Which of the following most closely describes your reason for doing so?
   - I do not want to pay for the clean up project at all ☐
   - I support the project but cannot afford to pay extra fee ☐
   - Option you provided were confusing, so I always choose no change ☐
   - I think government should pay for the project ☐
   - I do not trust that the project would be implemented ☐
   - I do not understand the questions ☐
   - Other (Please specify) ……………………………………………………………………………….

What factors were important to you?

9. In choosing above options (5 through 7), you
   - Considered all factors the same ☐
   - Considered only some of the factors ☐
   - Did not consider any, but chose randomly ☐

   If you considered some factors, what factors did you consider?
   - Water quality ☐
   - Tree plantation ☐
   - Fund Management ☐
   - Cost ☐
   - Time Contribution ☐
   - Other (Please specify)………………………………………………………………………………

About options

10. Did you find above options?
    - Confusing, you did not understand ☐
    - Did not understand at all ☐
    - Clear ☐
    - Not according to my preference ☐

11. Instead of a fixed rate, what do you think would be the most suitable basis to charge the fee?
    1. Income ☐
    2. Number of members in the household ☐
    3. Volume of water used ☐
    4. Type of house ☐
    5. Location of house (living upstream pays more) ☐
    6. Distance from the river (living close to the river pays more) ☐
    7. Others (please specify)…………………………………………………………………….

Part 3: Knowledge, Attitude, and Behavior Concerning the Bagmati River

Now we would like to ask some more questions about the Bagmati River. Specifically, we are interested in how you and your household use the river and what you know about water pollution in the river.

1. What are your households' major uses of the Bagmati River? (Check all that apply)
    1. Recreation ☐
    2. Cultural and religious ☐
    3. Washing cloths and bathing ☐
    4. Agriculture ☐
    5. Other (Please specify)……..…………………………………………………………

2. How many times did you visit the Bagmati River during the last month for each of the following activities?
    1. Recreation ☐
    2. Cultural and religious ☐
    3. Washing cloths and bathing ☐
    4. Agriculture ☐
    5. Never been to river ☐ (go to question 6)
    6. Have not been to the river recently ☐
    7. Other (Please specify)…………………………………………………………………

3. How many times did you bathe in the Bagmati River last year for cultural and religious reasons? ________ (If 0 go to question 6)

4. When you bathe in the Bagmati River for cultural and religious purposes, do you normally drink a few drops of river water? (Check one)
    1. Yes ☐
    2. No ☐

5. After you bathe in the Bagmati River for cultural and religious purposes do you normally bathe again on the same day using non-river water? (Check one)
    1. Yes ☐
    2. No ☐

6. Has your household ever dumped garbage or sewage into the Bagmati River or onto its banks? (Check one)
    1. Yes ☐
    2. No ☐ (If no go to question 8)

7. How often does your household dumped garbage or sewage into the Bagmati River or onto its banks? (Check one)
    1. Daily ☐
    2. Weekly ☐
    3. Monthly ☐
    4. Never ☐

5. Other ☐

8. Are any members of your household actively involved in any kind of environmental institution? For example: Environmental Club, Environmental NGO, INGO etc. (Check one)
   1. Yes ☐
   2. No ☐

9. Have you participated/volunteered in any kind of cleanup/restoration program on the Bagmati River? (Check one)
   1. Frequently ☐
   2. Sometimes ☐
   3. Rarely ☐
   4. Never ☐

10. How many organizations can you name that are working to clean the water or banks of the Bagmati River? (Check one)
   1. 0 ☐
   2. 1 to 5 ☐
   3. 6 to 10 ☐
   4. More than 10 ☐

11. What is your main source of information regarding environmental issues? (Check one)
   1. School, campus, university ☐
   2. TV ☐
   3. Radio ☐
   4. News paper ☐
   5. Brochure / flier ☐
   6. Family ☐
   7. Friends ☐
   8. Others (Please specify)………………………………………………………………

How much would you say you know about the following;	Know A Lot	Know A Little	Do Not Know Anything
12. Water pollution?	☐	☐	☐
13. Air pollution?	☐	☐	☐
14. Traffic congestion and traffic noise?	☐	☐	☐
15. Waste disposal?	☐	☐	☐
16. Recycling?	☐	☐	☐

17. Do you think that it is illegal to discharge wastewater into the Bagmati River? (Check one)
   1. Yes ☐
   2. No ☐

3. Do not know ☐

18. Which of the following would you say are major sources of pollution in the Bagmati River? (Assign priority 1 to 3)
    1. Household sewage ☐
    2. Waste from hospitals and hotels ☐
    3. Industrial waste ☐

19. Fertilizers and pesticides are harmful because they cause algae to grow, which then destroys waters plants. (Check one)
    1. Yes ☐
    2. No ☐
    3. Do not know ☐

20. Does polluted water carry diseases? (Check one)
    1. Yes ☐
    2. No ☐
    3. Do not know ☐

21. Which of the following diseases or health conditions is caused by the ingestion of water contaminated with pathogenic bacteria, viruses, or parasites? (Check one)
    1. Cancer ☐
    2. Diarrhea ☐
    3. Diabetes ☐
    4. All of the above ☐
    5. None of the above ☐

22. Have you heard of the bacteria called e-coli? (Check one)
    1. Yes ☐
    2. No ☐

23. Do you think that water in the Bagmati Rive meets accepted World Health Organization standards for bathing?(Check one)
    1. Yes ☐
    2. No ☐
    3. Do not know ☐

24. How do you rate the quality of water in the Bagmati River? (Check one)
    1. Acceptable ☐
    2. Acceptable sometimes ☐
    3. Not acceptable ☐
    4. Others (Please specify) ……………………………………………………………………

25. How do you feel when walking around or crossing the Bagmati River? (Check all that apply)
   1. Afraid of bad odor ☐
   2. Afraid of diseases ☐
   3. Do not worry ☐
   4. Do not walk near river ☐

How much do you agree or disagree with the following statements;	Strongly Agree	Somewhat Agree	Do Not Agree	Do not know
26. Pollution in the Bagmati River harms fish and plants living in the Bagmati River.	☐	☐	☐	☐
27. Pollution in the Bagmati River harms the tourism industry in Katmandu.	☐	☐	☐	☐
28. Pollution in the Bagmati River harms cultural and religious practices.	☐	☐	☐	☐

29. How much do you think pollution in the Bagmati River detracts from your households' religious activities? (Check one)
   1. A lot ☐
   2. A little ☐
   3. Not at all ☐
   4. Do not know ☐

In your opinion, how likely do you think;	Very Likely	Somewhat Likely	Not at all Likely	Do not know
30. Bathing in the Bagmati River on a regular basis will cause health problems?	☐	☐	☐	☐
31. Drinking a few drops of water from the Bagmati River for religious purposes on a regular basis will cause health problems?	☐	☐	☐	☐
32. Washing cloths in the Bagmati River on a regular basis will cause health problems?	☐	☐	☐	☐
33. Walking along or across the Bagmati River on a regular basis will cause health problems?	☐	☐	☐	☐
34. Pollution from the Bagmati River adversely affects drinking water or agriculture around Katmandu?	☐	☐	☐	☐

Part 4: Health Status and Behavior

Now we would like to ask you some questions concerning your health and the health of other members of your household.

1. How would you describe you general health status. (Check one)
   1. Excellent ☐
   2. Very good ☐
   3. Good ☐
   4. Fair ☐
   5. Poor ☐

2. Now thinking about your physical health, which includes physical illness and injury, how many days during the past 30 days was your health not good? ________days

3. Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good? _______ days

4. Please answer the following questions concerning specific diseases?

Disease/Illness	4a. How many children, under fiver years of age, in your household experienced this disease or illness in the last month?	4b. How many member of your household over 5 years of age experienced this disease in the last month?
Diarrhea		
Worms		
Cold and cough		
Fever		
Skin disease		
Other (Specify)		

5. Please answer the following questions concerning the impact of diseases on household activities?

Disease/Illness	5a. How many days of work did you miss last month due to the following diseases or illness?	5b. How many days of work did the other member of your household miss last month due to the following diseases? Please provide the total number of days for all other household members.	5c. How many days of school did the children in your household miss last month due to the following diseases? Please provide the total number of days for all children.
Diarrhea			
Worms			
Cold and cough			
Fever			
Skin disease			
Other (Specify)			

6. Where do you usually seek medical treatment? (Check one)
   1. Public Hospital ☐
   2. Community Clinic ☐

3. Private Hospital ☐
4. Private Clinic ☐
5. NGO ☐
6. Ayurbedic hospital ☐
7. Traditional Healer ☐

7. Approximately, what is the distance to the place you usually seek medical treatment?
   1. About ________ meters
   2. Or about________ minutes walking
   3. Do not know ☐

8. Approximately, how much did your household spend on medical treatments last month? ________

9. In your household, when a child under the age has diarrhea disease what do you do? (Check all that apply)
   1. Take the child to the hospital ☐
   2. Give the child a rehydration drink such as Geevan jal. ☐
   3. Do not know ☐
   4. Other (Please specify)……………………………………………………………………

10. Please answer the following questions concerning your households' use of water.

	16A. What is your households' primary source of water for the following activities? 1. Private household tap 2. Stone spouts 3. Communal tap 4. Water tanker 5. Tube well 6. Other	16B. Approximately, what is the distance from your house to the water source for each activity? (Enter 0 if water source is inside the house)	16C. Does your household normally treat water before using it for the following activities? 1. Yes 2. No	16D. What method does your household use to treat water for the following activities? 1. Filtration 2. Boiling 3. Filtration and boiling 2. Chemical disinfection 4. Other 5. None
Drinking		meters____or min. walking___		
Bathing		meters____or min. walking___		
Washing dishes		meters____or min. walking___		
Preparing food		meters____or min. walking___		

11. Do you use soap when washing your hands after using the latrine? (Check one)
   1. Always ☐
   2. Sometimes ☐
   3. Never ☐
   4. Do not know ☐

12. Do you use soap when washing your hands before eating? (Check one)
   1. Always ☐
   2. Sometimes ☐

3. Never ☐
4. Do not know ☐

13. Does your house where you are currently living have sewage facilities? (Check one)
    1. Yes ☐
    2. No ☐

14. Which of following would you say are causes diarrhea disease? (Check all that apply)
    1. Eating more food ☐
    2. Infections from viruses, bacteria and worms ☐
    3. Eating in restaurant ☐
    4. Poor Sanitation ☐
    5. Religious belief ☐
    6. Polluted air ☐
    7. Contaminated water ☐
    8. Poor nutrition ☐

15. Which of the following would you say are symptoms of diarrhea disease? (Check all that apply)
    1. Loose or watery stool ☐
    2. Dehydration ☐
    3. Fever ☐
    4. Cough ☐
    5. Headache ☐

16. Which of the following would you say are ways of preventing diarrhea disease? (Check all that apply)
    1. Filtering or boiling drinking water
    2. Washing hands after using the latrine
    3. Good nutrition
    4. Others

17. Taking all things together, would you say you are (Check one)
    1. Very happy ☐
    2. Rather happy ☐
    3. Not very happy ☐
    4. Not at all happy ☐

18. All things considered, how satisfied are you with your life as a whole these days? (Check one)
    1. Very Satisfied ☐
    2. Rather Satisfied ☐
    3. Not very satisfied ☐
    4. Not at all satisfied ☐

Part 5: Socioeconomic Characteristics of Household

Now I would like to ask you several questions about you and your household

1. Gender (respondent's)
   1. Male ☐
   2. Female ☐

2. Age of (respondent's)- Yrs. ________

3. Caste/ethnicity of household head ________

4. Marital status
   1. Single ☐
   2. Married ☐

5. Number of member in the household
   1. Number of Males ________
   2. Number of Females ________
   3. Number of household members below 18 years old ________
   4. Number of children under 5 years old ________

6. Education level

	Respondent	Most educated Female	Male
1. Primary	☐	☐	☐
2. Secondary	☐	☐	☐
3. Intermediate	☐	☐	☐
4. Bachelor	☐	☐	☐
5. Higher than Bachelor	☐	☐	☐

   6. Others (Please specify)…………………………………………………………………

7. Occupation of household head
   1. Government Employee ☐
   2. Private Employee ☐
   3. Private Business ☐
   4. Daily Labor ☐
   5. Unemployed and looking for work ☐
   6. Other (Please specify)…………………………………………………………………

8. Is anyone in your household employed as a:
   1. Doctor ☐
   2. Nurse ☐
   3. Pharmacist ☐
   4. Nobody employed in any kind of medical profession ☐
   5. Other medical professional ……………………………………………………………

9. Approximately, what was your last (monthly) water supply bill? NRS________

10. Approximately, what was your last (monthly) electricity bill? NRS________

11. Does your household own or rent the house where you are currently living?
    1. Own (go to question 12) ☐
    2. Rent (go to question 13) ☐

12. How much do you pay for rent a month? NRS________

13. How many years have you been living in this community?
    1. Less than 1 year ☐
    2. 1 – 5 years ☐
    3. 5 – 10 years ☐
    4. More than 10 years ☐

14. What is the type of toilet used by household members
    1. Flush connected with sewage ☐
    2. Flush connected with septic tank ☐
    3. Simple connected with sewage ☐
    4. Simple connected with septic tank ☐
    5. Simple with no drainage ☐
    6. Others (Please specify)………………………………………………………………………..

15. Indicate distance from your house to river. (House adjacent to river should be 0 meters)
    1. About ________ meters
    2. Or about ________ minutes
    3. Do not know ☐

16. At the end, I would like to ask about the household facility you have in your household

	Facilities	Yes	No	If yes, write numbers
1.	No. of rooms	☐	☐	________
2.	Radio	☐	☐	________
3.	TV	☐	☐	________
4.	Telephone	☐	☐	________
5.	Mobile Phone	☐	☐	________
6.	Computer	☐	☐	________
7.	Motorbike	☐	☐	________
8.	Car	☐	☐	________
9.	Washing machine	☐	☐	________

17. How often do you read the newspaper?

1. Very often
2. Quite often
3. Occasionally
4. Never
5. Not applicable

18. How often do you listen to radio or watch TV?
    1. Very often
    2. Quite often
    3. Occasionally
    4. Never
    5. Not applicable

19. When listening to the radio or watching TV last month were you exposed to advertisements on the importance of filtering or boiling water?
    1. Frequently
    2. Sometimes
    3. Never
    4. Do not know

20. I am now going to ask your annual household income. I need to know only an approximate amount. This includes salary of all household members and income from other sources such as agriculture, business, investment and savings.
    Total income of household per year is (NRS) ________

    For interviewer:- In case respondent doesn't want to disclose his/her income then ask to check the range of income.
    Total monthly income of household (NRS)
    1. <5000
    2. 5001-10000
    3. 10001-20000
    4. 20001-30000
    5. 30001-40000
    6. 40001-50000
    7. 50001-70000
    8. 70001-100000
    9. More than 100000
    10. Do not know
    11. Refused

Thank you very much for your kind co-operation!

********************************End of Survey********************************

APPENDIX C: CLM and RPL Model Results

Table C1: Results of Conditional Logit Models

Variables	Model1	Model2
W_QUALITY2	0.5097*** (0.0514)	0.3415*** (0.0949)
W_QUALITY3	0.4491*** (0.0554)	0.261 (0.1829)
PLANTATION_C	-0.0121 (0.0175)	0.1564*** (0.0525)
PLANTATION_C^.5	0.1452 (0.2147)	-1.8209*** (0.6431)
M_GOVT	-0.2379*** (0.0536)	-0.0557 (0.0994)
M_MUNICIPALITY	-0.2003*** (0.0518)	-0.0907 (0.0977)
COST	-0.3197*** (0.0234)	-0.3202*** (0.024)
TIME	-0.1393** (0.0699)	-0.1215* (0.0705)
TIME^.5	0.9221** (0.4291)	0.8465* (0.4325)
W_QUALITY3:V_AG01	-	0.6225** (0.2863)
W_QUALITY2:OWN	-	0.2429** (0.1125)
W_QUALITY3:OWN	-	0.4201*** (0.1328)
W_QUALITY3:COLLEGE	-	0.2928 (0.2263)
W_QUALITY3:AGE_10	-	-0.1089*** (0.0391)

Table C1 (contd) : Results of Conditional Logit Models

Variables	Model1	Model2
W_QUALITY3:NEWAR	-	0.2867**
		(0.1424)
W_QUALITY3:BRAHMIN	-	0.4757***
		(0.1551)
W_QUALITY3:KSHETRI	-	0.1317
		(0.1649)
PLANTATION_C:AGE_10	-	-0.046***
		(0.0138)
PLANTATION_C^.5:AGE_10	-	0.5366***
		(0.1687)
M_GOVT:OWN	-	-0.2667**
		(0.1179)
M_MUNICIPALITY:OWN	-	-0.1686
		(0.1156)
IME:MID_INC	-	0.0019
		(0.0133)
TIME:MID_INC	-	-0.0275*
		(0.0142)
N	6576	6576
Log-Likelihood	-2100.63	-2070.36
McFadden R^2	0.0767	0.09
AIC	4219.25	4186.73
BIC	4280.37	4342.92

Significance codes: '***' 0.01 '**' 0.05 '*' 0.1
Numbers in parentheses indicate standard errors

Table C2: Results of Random Parameter Logit Models with 500 Halton Draws

Variables	Model3	Model4
ASC	-2.8388**	-3.1668***
	(1.1714)	(1.1972)
W_QUALITY2	0.5578***	0.3363***
	(0.0796)	(0.1044)
W_QUALITY3	0.5319***	0.3032
	(0.0971)	(0.2398)
PLANTATION_C	-0.0202	0.0421
	(0.0217)	(0.0319)
PLANTATION_C^.5	0.2541	-0.3656
	(0.2693)	(0.3844)
M_GOVT	-0.2724***	-0.1376
	(0.0704)	(0.1111)
M_MUNICIPALITY	-0.2439***	-0.184
	(0.0685)	(0.1164)
COST	-0.3783***	-0.38***
	(0.066)	(0.0591)
TIME	-0.0471	-0.0258
	(0.107)	(0.1086)
TIME^.5	0.3778	0.2607
	(0.648)	(0.6565)
W_QUALITY3:V_AG01	-	0.8061**
		(0.3731)
W_QUALITY2:OWN	-	0.3211***
		(0.1219)
W_QUALITY3:OWN	-	0.5768***
		(0.1855)
W_QUALITY3:COLLEGE	-	0.4157
		(0.286)
W_QUALITY3:AGE_10	-	-0.1478***
		(0.0568)

Table C2 (contd): Results of Random Parameter Logit Models with 500 Halton Draws

Variables	Model3	Model4
W_QUALITY3:NEWAR	-	0.3692* (0.2002)
W_QUALITY3:BRAHMIN	-	0.5757** (0.2332)
W_QUALITY3:KSHETRI	-	0.1368 (0.2191)
PLANTATION_C:AGE_10	-	-0.0165** (0.0066)
PLANTATION_C^.5:AGE_10	-	0.1628** (0.0762)
M_GOVT:OWN	-	-0.2001 (0.1306)
M_MUNICIPALITY:OWN	-	-0.1052 (0.1343)
TIME:MID_INC	-	0.0151 (0.0149)
TIME:HIGH_INC	-	-0.0233 (0.0157)
sd.W_QUALITY2	0.0213 (11.3865)	0.0159 (11.5219)
sd.W_QUALITY3	1.2935** (0.6079)	1.3244** (0.5707)
N	9963	9963
Log-Likelihood	-2283.96	-2255.03
McFadden R^2	0.0731	0.0848
AIC	4591.93	4562.06
BIC	4678.41	4749.43

Significance codes: '***' 0.01 '**' 0.05 '*' 0.1
Numbers in parentheses indicate standard errors

Table C3: Results of Random Parameter Logit Models with 2000 Halton Draws

Variables	Model3	Model4
ASC	-2.5206**	-3.1622***
	(1.0922)	(1.1962)
W_QUALITY2	0.5292***	0.3358***
	(0.1122)	(0.1043)
W_QUALITY3	0.476***	0.3023
	(0.1018)	(0.2393)
PLANTATION_C	-0.0138	0.0422
	(0.0213)	(0.0319)
PLANTATION_C^.5	0.1688	-0.3669
	(0.2633)	(0.3836)
M_GOVT	-0.2535***	-0.1372
	(0.085)	(0.1112)
M_MUNICIPALITY	-0.2156***	-0.1836
	(0.0663)	(0.1164)
COST	-0.3394***	-0.3792***
	(0.0904)	(0.058)
TIME	-0.1102	-0.0269
	(0.0945)	(0.1086)
TIME^.5	0.7493	0.2668
	(0.5736)	(0.6564)
W_QUALITY3:V_AG01	-	0.8048**
		(0.3724)
W_QUALITY2:OWN	-	0.3208***
		(0.1213)
W_QUALITY3:OWN	-	0.5751***
		(0.1839)
W_QUALITY3:COLLEGE	-	0.4154
		(0.2843)

Table C3 (contd): Results of Random Parameter Logit Models with 2000 Halton Draws

Variables	Model3	Model4
W_QUALITY3:AGE_10	-	-0.1474*** (0.0567)
W_QUALITY3:NEWAR	-	0.3685* (0.1991)
W_QUALITY3:BRAHMIN	-	0.5741** (0.2319)
W_QUALITY3:KSHETRI	-	0.1368 (0.2182)
PLANTATION_C:AGE_10	-	-0.0165** (0.0066)
PLANTATION_C^.5:AGE_10	-	0.1628** (0.0764)
M_GOVT:OWN	-	-0.2003 (0.1303)
M_MUNICIPALITY:OWN	-	-0.1054 (0.134)
TIME:MID_INC	-	0.015 (0.0149)
TIME:HIGH_INC	-	-0.0234 (0.0157)
sd.W_QUALITY2	0.0114 (41.1628)	-0.0034 (51.3777)
sd.W_QUALITY3	0.9175 (0.7803)	1.3139** (0.5645)
N	9963	9963
Log-Likelihood	-2284.51	-2255.1
McFadden R^2	0.0729	0.0848
AIC	4593.01	4562.2
BIC	4679.49	4749.57

Significance codes: '***' 0.01 '**' 0.05 '*' 0.1
Numbers in parentheses indicate standard errors

APPENDIX D: Construction of Knowledge, Attitude and Behavior Indices

Attitude (ATTITUDE) towards the quality of water in the Bagmati River is measured using **eleven** three-point scales.

For the following list of environmental issues, indicate how serious you consider each one to be in your own community: (Very serious, somewhat serious, not at all serious)

1. Water pollution
2. Air pollution
3. Household waste

In your opinion, how important are the following; (Vey important, Some-what important, Not at all important)

4. To protect the natural environment
5. To control pollution
6. To conserve Nepal's cultural and religious heritage
7. To conserve the Bagmati River for cultural and religious activities
8. Bagmati River to your households' religious activities

How much do you agree or disagree with the following statements; (Strongly agree, Somewhat agree, Not at all agree. Do not know)

9. Pollution in the Bagmati River harms fish and plants living in the Bagmati River
10. Pollution in the Bagmati River harms the tourism industry in Katmandu.
11. Pollution in the Bagmati River harms cultural and religious practices.

Three types of knowledge; environmental knowledge (*KNOW_ENV*), factual or scientific knowledge (KNOW_SCIENTIFIC), and knowledge regarding health (*KNOW_HEALTH*) are included in the estimation.

Environmental knowledge is measured using three three-point scales (Chronbach's alpha 0.77). Environmental knowledge is created from answers of water pollution, waste management and waste recycling related questions.

How much would you say you know about the following; (Know a lot, Know a little, Do not know anything)

1. Water pollution
2. Air pollution
3. Waste disposal
4. Recycling

Factual knowledge is measured using answers from five multiple choice questions (Chronbach's alpha 0.39). Factual knowledge is measured by asking the respondents whether they know about diseases related poor water quality and e-coli.

1. Fertilizers and pesticides are harmful because they cause algae to grow, which then destroys waters plants. (Yes, No, Do not know; Check one)
2. Does polluted water carry diseases? (Yes, No, Do not know; Check one)
3. Which of the following diseases or health conditions is caused by the ingestion of water contaminated with pathogenic bacteria, viruses, or parasites? (Cancer, Diarrhea, Diabetes, All of the above, None of the above; Check one)

4. Have you heard of the bacteria called e-coli? (Yes, No; Check one)

5. Do you think that water in the Bagmati Rive meets accepted World Health Organization standards for bathing? Yes, No; Check one)

Health knowledge is measured using four three-point scale (Chronbach's alpha 0.89). Answers related to knowledge about the effect of poor river water quality on bathing, washing and walking are used to create health knowledge scale. All knowledge scales are normalized such that values range from 0 to 1 and higher value represents higher level of knowledge.

In your opinion, how likely do you think; (Very likely, Somewhat likely, Not at all likely, Do not know)

1. Bathing in the Bagmati River on a regular basis will cause health problems?
2. Drinking a few drops of water from the Bagmati River for religious purposes on a regular basis will cause health problems?
3. Washing cloths in the Bagmati River on a regular basis will cause health problems?
4. Walking along or across the Bagmati River on a regular basis will cause health problems?

APPENDIX E: Attitude and Participation Model Results

Table E1: Results of Ordered Probit Model for Attitude

	Model 1 ATTITUDE	Model 2 ATTITUDE	Model 3 ATTITUDE
KNOW_SCIENTIFIC	0.2686	0.0518	0.1848
	(0.1918)	(0.2107)	(0.2136)
KNOW_ENV	1.3244***	1.3356***	1.2907***
	(0.1415)	(0.1561)	(0.1585)
KNOW_PUBHEALTH	1.5317***	1.4471***	1.4293***
	(0.1542)	(0.1628)	(0.1681)
INFO_EXPOSURE	-0.1939***	-0.1341*	-0.1097$^{\cdot}$
	(0.0538)	(0.0589)	(0.0595)
CULT_ATTACH	0.0277**	0.0291**	0.0256**
	(0.0092)	(0.0099)	(0.0099)
L_INC		-0.0591	-0.0494
		(0.0582)	(0.0588)
FEMALE		0.1350$^{\cdot}$	0.1670*
		(0.0809)	(0.0818)
HHSIZE		0.0184	0.0315$^{\cdot}$
		(0.0163)	(0.0167)
EDU_MAX		0.0475**	0.0467**
		(0.0165)	(0.0167)
EDU_RESP		0.0328*	0.0344*
		(0.0140)	(0.0141)
AGE		0.0059$^{\cdot}$	0.0090**
		(0.0031)	(0.0032)
PROFESSION_HEALTH		0.1431	0.1520
		(0.1098)	(0.1114)
DISTANCE			-0.0629*
			(0.0254)
RESIDENCY			-0.0385
			(0.0260)

Table E1 (contd): Results of Ordered Probit Model for Attitude

	Model 1 ATTITUDE	Model 2 ATTITUDE	Model 3 ATTITUDE
NEWAR			0.3565***
			(0.0797)
OWN			-0.5701***
			(0.0999)
Observations	1140	1015	1012
Log lik.	-1412	-1222	-1187
Chi-squared	257***	268***	331***
Chi-sq-indep			
AIC	2839	2475	2412
BIC	2880	2549	2505

Standard errors in parentheses

· $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table E2: Results of Ordered Probit Model for Participation

	Model 1 PARTICIPATION	Model 2 PARTICIPATION	Model 3 PARTICIPATION
ATTITUDE	0.1689***	0.1800***	0.2089***
	(0.0460)	(0.0510)	(0.0528)
KNOW_SCIENTIFIC	0.3665	0.5428$^{\cdot}$	0.5606$^{\cdot}$
	(0.2562)	(0.2895)	(0.2945)
KNOW_ENV	0.8829***	0.7673***	0.7286**
	(0.2083)	(0.2318)	(0.2336)
KNOW_PUBHEALTH	-0.3800*	-0.4108*	-0.4636*
	(0.1928)	(0.2035)	(0.2079)
INFO_EXPOSURE	0.3026***	0.3799***	0.3828***
	(0.0725)	(0.0812)	(0.0829)
CULT_ATTACH	0.0218*	0.0203$^{\cdot}$	0.0240*
	(0.0104)	(0.0112)	(0.0113)
L_INC		0.1074	0.1105
		(0.0789)	(0.0795)
FEMALE		-0.4862***	-0.5070***
		(0.1209)	(0.1230)
HHSIZE		0.0154	-0.0029
		(0.0211)	(0.0216)
EDU_MAX		0.0203	0.0199
		(0.0223)	(0.0226)
EDU_RESP		-0.0342$^{\cdot}$	-0.0294
		(0.0188)	(0.0193)
AGE		0.0089*	0.0061
		(0.0042)	(0.0043)
PROFESSION_HEALTH		-0.0830	-0.1448
		(0.1514)	(0.1552)
DISTANCE			-0.0228
			(0.0363)

Table E2 (contd): Results of Ordered Probit Model for Participation

	Model 1 PARTICIPATION	Model 2 PARTICIPATION	Model 3 PARTICIPATION
RESIDENCY			-0.0285
			(0.0382)
NEWAR			0.2671^{*}
			(0.1114)
OWN			0.3937^{*}
			(0.1530)
Observations	1137	1012	1009
Log lik.	-670	-575	-561
Chi-squared	87^{***}	116^{***}	137^{***}
AIC	1358	1181	1163
BIC	1403	1260	1261

Standard errors in parentheses

$^{\cdot}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

APPENDIX F: Stata and R Codes

Appendix F1: R-Code for Willingness to Pay for Improvements in River Water Quality Study

```
#june2012
#code written by hari katuwal for WTP CE paper
library(numDeriv)
library(xtable)
library(zoo)
library(lmtest)
library(MASS)
library(stats)
library(splines)
library(survival)
library(Formula)
library(statmod)
library(mlogit)
library(memisc)
library(psych)          #is used for correlation and others
library(gmodels)
library(support.CEs)
library(pastecs)
########################Modelling structure##########################
#1a-Basic CLM
#1aa Basic CLM/MLT MWTP
#1aaa IIA test
#1b CLM/MLT interaction
#1bb CLM.MLT interaction MWTP
#2a Basic RPL
#2a Basic RPL MWTP
#2b RPL interaction
#2bb RPL interaction MWTP
#Table 2.2: Descriptive Statistics
#Table 2.3: CLM and CLM interaction result
#Table 2.5: RPL Results
#Table 2.6: MWTP all
#Table C2: Appendix, RPL 500 draws
#Table C3: Appendix, RPL 1000 draws
#No SQ result Tble C11 is in another file 10_clogit_canned_noSQ
###############################################################################
rm(list = ls())
setwd("G:\\11th_semester\\Sodhpatra\\Bagmati_benefit_estimation\\Estimation\\Bagmati2
2\\with_withoutSQ")
c.data <- read.csv("long.datab.csv", header = T, sep = ",")    ## this is with all obvs
```

```
#c.data <- read.csv("long.datab_without_status_quo.csv", header = T, sep = ",")  ## I
remove those respondents who picked SQ
#c.data <- read.csv("long.datab_without_status_quo_noalt3.csv", header = T, sep = ",")
attach(c.data)
#c.data[1:5,]
###################Descriptive stat###################
data_socio<-data.frame(W_QUALITY2, W_QUALITY3, PLANTATION_C,
M_MUNICIPALITY,  M_GOVT, PAY_THOU, WTC,
    INC_THOU, MALE, AGE,V_AG01,OWN, COLLEGE, NEWAR, BRAHMIN,
KSHETRI, MID_INC, HIGH_INC,
    M_COMMUNITY, FAMILY_SIZE, UP_STREAM, MID_STREAM,
DOWN_STREAM, INVOLVEMENT, AWARE_INDEX, VISITATION,
    PLANTATION,AGE_10)
#corr.test (data_socio)
des.stat<-stat.desc(data_socio)    #data.stat in pastecs, but it gives several stat, out of
which 9th is mean etc
mean<-round(des.stat[9,], 2)
sd<-round(des.stat[13,], 2)
max<-round(des.stat[5,], 2)
min<-round(des.stat[4,], 2)

##################tabulation of descriptive state Table 2.2##################
cat("Table 2.2: Descriptive Statistics and Definition of the Variables", "\n",
 "Variables", "\t", "Definition", "\t", "Mean","\t","Std dev", "\t", "Max", "\t", "Min", "\n",
 "Attribute Variables", "\n",
 "W_QUALITY2", "\t","Water quality level that is suitable for fish and aquatic life
(1=Yes, 0=No)", "\t", mean[1,1],"\t", sd[1,1], "\t", max[1,1], "\t", min[1,1], "\n",
 "W_QUALITY3", "\t",          "Water quality of level that suitable for swimming (1=Yes,
0=No)", "\t", mean[1,2],"\t", sd[1,2], "\t", max[1,2], "\t", min[1,2], "\n",
 "PLANTATION", "\t",          "Percent of area on bank of the river covered with trees",
"\t", mean[1,3],"\t", sd[1,3], "\t", max[1,3], "\t", min[1,3], "\n",
 "M_MUNICIPALITY", "\t",  "The clean-up program is managed by Municipal authority
(1=Yes, 0=No)", "\t", mean[1,4],"\t", sd[1,4], "\t", max[1,4], "\t", min[1,4], "\n",
 "M_GOVT", "\t",       "The clean-up program is managed by Governmental authority
(1=Yes, 0=No)", "\t", mean[1,5],"\t", sd[1,5], "\t", max[1,5], "\t", min[1,5], "\n",
 "COST", "\t", "Cost (Thousand NRS per year)", "\t", mean[1,6], "\t", sd[1,6], "\t",
max[1,6], "\t", min[1,6], "\n",
 "TIME",         "\t", "Time contribution for the clean-up program  (days per year)", "\t",
mean[1,7],"\t", sd[1,7], "\t", max[1,7], "\t", min[1,7], "\n",
 "Demographic Variables",  "\n",
 "INCOME", "\t", "Monthly income of the household (Thousands NRS)", "\t",
mean[1,8],"\t", sd[1,8], "\t", max[1,8], "\t", min[1,8], "\n",
 "MALE", "\t", "Respondent is male (1=Yes, 0=No)", "\t", mean[1,9],"\t", sd[1,9], "\t",
max[1,9], "\t", min[1,9], "\n",
```

```
 "AGE", "\t", "Age of the respondents", "\t", mean[1,10],"\t", sd[1,10], "\t", max[1,10],
"\t", min[1,10], "\n",
 "AGRI", "\t","Visit river for agricultural purposes (1=Yes, 0=No)", "\t", mean[1,11],"\t",
sd[1,11], "\t", max[1,11], "\t", min[1,11], "\n",
 "OWN", "\t","Own home (1=Yes, 0=No)", "\t",mean[1,12],"\t", sd[1,12], "\t", max[1,12],
"\t", min[1,12], "\n",
 "COLLEGE", "\t","Education level (1=Yes, 0=No)", "\t",mean[1,13],"\t", sd[1,13], "\t",
max[1,13], "\t", min[1,13], "\n",
 "NEWAR", "\t","Caste (1=Newar, 0=Others)", "\t",mean[1,14],"\t", sd[1,14], "\t",
max[1,14], "\t", min[1,14], "\n",
 "BRAHMIN", "\t","Caste (1=Brahmin, 0=Others)", "\t",mean[1,15],"\t", sd[1,15], "\t",
max[1,15], "\t", min[1,15], "\n",
 "KSHETRI", "\t","Caste (1=Kshetri, 0=Others)", "\t",mean[1,16],"\t", sd[1,16], "\t",
max[1,16], "\t", min[1,16], "\n",
 "MID_INCOME", "\t","Income Level (1=Middle Income, 0= Others)",
"\t",mean[1,17],"\t", sd[1,17], "\t", max[1,17], "\t", min[1,17], "\n",
 "HIGH_INCOME", "\t","Income Level (1=High Income, 0= Others)",
"\t",mean[1,18],"\t", sd[1,18], "\t", max[1,18], "\t", min[1,18], "\n",
file="Table2.2_Descriptive_Statistics.txt", sep="")

###################canned logit (CLM.1a)1a###################
c.data <- read.csv("long.datab.csv", header = T, sep = ",")
t<-nrow(c.data)
CLM.1a<-
clogit(RESPONSE~ ASC3 +
        W_QUALITY2 + W_QUALITY3 + #W_QUALITY4 +
        PLANTATION_C + I(PLANTATION_C^0.5) +
        #PLANT_40 + #PLANT_60 + #PLANT_80 +
        M_GOVT + M_MUNICIPALITY + #M_COMMUNITY +
        PAY_THOU +
        WTC + I(WTC^0.5)-1+
        strata(STR), data=c.data)
#summary(CLM.1a)
#gofm(CLM.1a)

##################multinomial logit (mlt.1a)##################
mlt.data<-mlogit.data(c.data, choice = "RESPONSE", shape = "long",
           alt.var="ALTERNATIVE")           #Preparing data for mlogit
mlt.1a<-
mlogit(RESPONSE~ ASC3 +
                W_QUALITY2 + W_QUALITY3 + #W_QUALITY1 +
                PLANTATION_C + I(PLANTATION_C^0.5) +
                #PLANT_40 + #PLANT_60 + #PLANT_80 +
                M_GOVT + M_MUNICIPALITY + #M_COMMUNITY +
                PAY_THOU +
```

```
            WTC + I(WTC^0.5)-1,
            data=mlt.data, alt.var="ALTERNATIVE", method = "bfgs", shape="long",
chid.var="STR",
            choice="RESPONSE", reflevel="3")
summary(mlt.1a)
####################Goodness of fit for mlt.1a####################
mlt.1a_const<-
  mlogit(RESPONSE~ ASC3 -1,
        data=mlt.data, alt.var="ALTERNATIVE", shape="long", chid.var="STR",
        choice="RESPONSE", reflevel="3")
#summary(mlt.1a_const)
loglik.1a <- mlt.1a$logLik[1]
loglik.1a_const <- mlt.1a_const$logLik[1]
theta.1a <- mlt.1a$coef
k.1a<-length(theta.1a)
n.1a<-(nrow(c.data))
aic.1a <- -2*mlt.1a$logLik[1]+2*k.1a
bic.1a <- -2*mlt.1a$logLik[1] + k.1a*log(n.1a)
R.sq.1a <- 1 - (mlt.1a$logLik[1]/mlt.1a_const$logLik[1])
#############generation of star and p-value for presentation table##########
SEs.1a <- sqrt(-diag(solve(mlt.1a$hessian)))
tval.1a <- theta.1a/SEs.1a
pval.1a <- 2*(1-pt(abs(tval.1a), n.1a-k.1a))
star.1a <- rep(" ,k.1a)
for(j.1a in 1:k.1a){
  star.1a[j.1a] <- #if(pval.1[j.1]<0.001){"***"}
    #else
    if(pval.1a[j.1a] <0.01){"***"}
  else if(pval.1a[j.1a] < 0.05){"**"}
  else if(pval.1a[j.1a] < 0.1){"*"}
  else {""}
}


#Note that CLM (CLM1.a) and MLT (mlt.1a) produce exactly same results that matche
with longhand diff utility.
#This also matches with long hand with different utility model
#if constant is suppressed, it does not give you McFaddon R2
#R.sq.1a is same as McFaddon R2 computed by clogit
############################################################################


####################CLM with interaction CLM.1c####################
CLM.1c<-
```

```
 clogit(RESPONSE~ ASC3 +
 W_QUALITY2 + W_QUALITY3 + #W_QUALITY4 +
 PLANTATION_C + I(PLANTATION_C^0.5) +
 #PLANT_40 + #PLANT_60 + #PLANT_80 +
 M_GOVT + M_MUNICIPALITY + #M_COMMUNITY +
 PAY_THOU +
 WTC + I(WTC^0.5) + #L.WTC + #WTC_10 + WTC_15 +
 #W_QUALITY2:MID_STREAM + W_QUALITY3:MID_STREAM
+W_QUALITY2:DOWN_STREAM + W_QUALITY3:DOWN_STREAM +
 #W_QUALITY2:MID_INC + W_QUALITY3:MID_INC +
 #W_QUALITY2:HIGH_INC + W_QUALITY3:HIGH_INC +
 #W_QUALITY2:V_REC01 + W_QUALITY3:V_REC01 +
W_QUALITY2:V_CULT01 + W_QUALITY3:V_CULT01 +
 #W_QUALITY2:V_CLEANING01 + W_QUALITY3:V_CLEANING01 +
W_QUALITY2:V_AG01 +
 W_QUALITY3:V_AG01 +
 W_QUALITY2:OWN +
 W_QUALITY3:OWN +
 #W_QUALITY2:SOME_COLLEGE +
 #W_QUALITY3:SOME_COLLEGE +
W_QUALITY2:COLLEGE +
 W_QUALITY3:COLLEGE +
W_QUALITY2:AGE_10 +
 W_QUALITY3:AGE_10 + #W_QUALITY2:I(AGE^.5) + W_QUALITY3:I(AGE^.5) +
W_QUALITY2:NEWAR +
 W_QUALITY3:NEWAR +
W_QUALITY2:BRAHMIN +
 W_QUALITY3:BRAHMIN +
W_QUALITY2:KSHETRI +
 W_QUALITY3:KSHETRI +
 PLANTATION_C:AGE_10 + I(PLANTATION_C^.5):AGE_10 +
 #PLANTATION:V_REC01 + PLANTATION:V_CULT01
+PLANTATION:V_CLEANING01 + PLANTATION:V_AG01 +
 M_GOVT:OWN + M_MUNICIPALITY:OWN +
 #M_GOVT:V_REC01 + M_GOVT:V_CULT01 +M_GOVT:V_CLEANING01 +
M_GOVT:V_AG01 +
 #M_MUNICIPALITY:V_REC01 + M_MUNICIPALITY:V_CULT01
+M_MUNICIPALITY:V_CLEANING01 + M_MUNICIPALITY:V_AG01+
 WTC:MID_INC + WTC:HIGH_INC -1 +
 #WTC:MALE + I(WTC^.5):MALE +
 #WTC:V_REC01 + I(WTC^.5):V_REC01 + WTC:V_CULT01 +
I(WTC^.5):V_CULT01 +
 #WTC:V_CLEANING01+ I(WTC^.5):V_CLEANING01 + WTC:V_AG01+
I(WTC^.5):V_AG01 +
 #PLANTATION:MALE + I(PLANTATION^.5):MALE +
```

```
  strata(STR), data=c.data)
#summary(CLM.1c)

#################### MLT with interaction (1b)####################
rm(list = ls())
setwd("G:\\11th_semester\\Sodhpatra\\Bagmati_benefit_estimation\\Estimation\\Bagmati2
2\\with_withoutSQ")
c.data <- read.csv("long.datab.csv", header = T, sep = ",")
mlt.data<-mlogit.data(c.data, choice = "RESPONSE", shape = "long",
                      alt.var="ALTERNATIVE")    #Preparing data for mlogit
mlt.1b<-
  mlogit(RESPONSE~ ASC3 +
  W_QUALITY2 + W_QUALITY3 + #W_QUALITY1 +
  PLANTATION_C + I(PLANTATION_C^0.5) +
  #PLANT_40 + #PLANT_60 + #PLANT_80 +
  M_GOVT + M_MUNICIPALITY + #M_COMMUNITY +
  PAY_THOU +
  WTC + I(WTC^0.5) +
  #W_QUALITY2:MID_STREAM + W_QUALITY3:MID_STREAM
+W_QUALITY2:DOWN_STREAM + W_QUALITY3:DOWN_STREAM +
  #W_QUALITY2:MID_INC + W_QUALITY3:MID_INC +
  #W_QUALITY2:HIGH_INC + W_QUALITY3:HIGH_INC +
  #W_QUALITY2:V_REC01 + W_QUALITY3:V_REC01 +
W_QUALITY2:V_CULT01 + W_QUALITY3:V_CULT01 +
  #W_QUALITY2:V_CLEANING01 + W_QUALITY3:V_CLEANING01 +
#W_QUALITY2:V_AG01 +
  W_QUALITY3:V_AG01 +
  W_QUALITY2:OWN +
  W_QUALITY3:OWN +
  #W_QUALITY2:SOME_COLLEGE +
  #W_QUALITY3:SOME_COLLEGE +
#W_QUALITY2:COLLEGE +
  W_QUALITY3:COLLEGE +
#W_QUALITY2:AGE_10 +
  W_QUALITY3:AGE_10 + #W_QUALITY2:I(AGE^.5) + W_QUALITY3:I(AGE^.5) +
#W_QUALITY2:NEWAR +
  W_QUALITY3:NEWAR +
#W_QUALITY2:BRAHMIN +
  W_QUALITY3:BRAHMIN +
#  W_QUALITY2:KSHETRI +
  W_QUALITY3:KSHETRI +
  PLANTATION_C:AGE_10 + I(PLANTATION_C^0.5):AGE_10 +
  #PLANTATION:V_REC01 + PLANTATION:V_CULT01
+PLANTATION:V_CLEANING01 + PLANTATION:V_AG01 +
  M_GOVT:OWN + M_MUNICIPALITY:OWN +
```

```
  #M_GOVT:V_REC01 + M_GOVT:V_CULT01 +M_GOVT:V_CLEANING01 +
M_GOVT:V_AG01 +
  #M_MUNICIPALITY:V_REC01 + M_MUNICIPALITY:V_CULT01
+M_MUNICIPALITY:V_CLEANING01 + M_MUNICIPALITY:V_AG01+
  WTC:MID_INC + WTC:HIGH_INC -1, # +
  #WTC:MALE + I(WTC^.5):MALE +
  #WTC:V_REC01 + I(WTC^.5):V_REC01 + WTC:V_CULT01 +
I(WTC^.5):V_CULT01 +
  #WTC:V_CLEANING01+ I(WTC^.5):V_CLEANING01 + WTC:V_AG01+
I(WTC^.5):V_AG01 +
  #PLANTATION:MALE + I(PLANTATION^.5):MALE +       ,
  data=mlt.data, alt.var="ALTERNATIVE", shape="long", chid.var="STR",
  choice="RESPONSE", reflevel="3")
#summary(mlt.1b)

###############Goodness of fit of clm/mlt interaction 1b##############
mlt.1b_const<-
  mlogit(RESPONSE~ ASC3 -1,
        data=mlt.data, alt.var="ALTERNATIVE", shape="long", chid.var="STR",
        choice="RESPONSE")
#summary(mlt.1b_const)
loglik.1b <- mlt.1b$logLik[1]
loglik.1b_const <- mlt.1b_const$logLik[1]
theta.1b <- mlt.1b$coef
k.1b<-length(theta.1b)
n.1b<-(nrow(c.data))
aic.1b <- -2*mlt.1b$logLik[1]+2*k.1b
bic.1b <- -2*mlt.1b$logLik[1] + k.1b*log(n.1b)
R.sq.1b <- 1 - (mlt.1b$logLik[1]/mlt.1b_const$logLik[1])
#############generation of star and p-value for presentation table##########
SEs.1b <- sqrt(-diag(solve(mlt.1b$hessian)))
tval.1b <- theta.1b/SEs.1b
pval.1b <- 2*(1-pt(abs(tval.1b), n.1b-k.1b))
star.1b <- rep(" ,k.1b)
for(j.1b in 1:k.1b){
  star.1b[j.1b] <- #if(pval.1[j.1]<0.001){"***"}
    #else
    if(pval.1b[j.1b] <0.01){"***"}
  else if(pval.1b[j.1b] < 0.05){"**"}
  else if(pval.1b[j.1b] < 0.1){"*"}
  else {""}
}
#############################################################################
```

```
##############Results of RPL (mlt.1a and mlt.1b) Combined#############
cat("Table 2.3: Results of Conditional Logit Models ", "\n",
 "Variables",      "\t", "Model1",                     "\t", "Model2",                     "\n",
 #"ASC1",          "\t", round(theta.1[1], 4), star.1[1],                                  "\n",
 #                 "\t", "(", round(SEs.1[1], 4), ")",                                     "\n",
 #"ASC2",          "\t", round(theta.1[2], 4), star.1[2],                                  "\n",
 #                 "\t", "(", round(SEs.1[2], 4), ")",                                     "\n",
 "ASC3",           "\t", round(theta.1a[1], 4), star.1a[1],    "\t", round(theta.1b[1], 4),
star.1b[1],    "\n",
 "\t", "(", round(SEs.1a[1], 4), ")",        "\t", "(", round(SEs.1b[1], 4), ")",        "\n",
 "W_QUALITY2",      "\t", round(theta.1a[2], 4), star.1a[2],    "\t", round(theta.1b[2], 4),
star.1b[2],    "\n",
 "\t", "(", round(SEs.1a[2], 4), ")",        "\t", "(", round(SEs.1b[2], 4), ")",        "\n",
 "W_QUALITY3",      "\t", round(theta.1a[3], 4), star.1a[3],    "\t", round(theta.1b[3], 4),
star.1b[3],    "\n",
 "\t", "(", round(SEs.1a[3], 4), ")",         "\t", "(", round(SEs.1b[3], 4), ")",       "\n",
 "PLANTATION_C",    "\t", round(theta.1a[4],4), star.1a[4],     "\t", round(theta.1b[4],4),
star.1b[4],     "\n",
 "\t", "(", round(SEs.1a[4],4),")",         "\t", "(", round(SEs.1b[4],4),")",          "\n",
 #"PLANT_40",      "\t", round(theta.1[3],4), star.1[3],
"\n",
 #                 "\t", "(", round(SEs.1[3],4),")",                                       "\n",
 #"PLANT_60",      "\t", round(theta.1[5],4), star.1[5],
"\n",
 #                 "\t", "(", round(SEs.1[5],4),")",                                       "\n",
 #"PLANT_80",      "\t", round(theta.1[4],4), star.1[4],
"\n",
 #                 "\t", "(", round(SEs.1[4],4),")", "\n",
 "PLANTATION_C^.5", "\t", round(theta.1a[5],4), star.1a[5],    "\t", round(theta.1b[5],4),
star.1b[5],      "\n",
 "\t", "(", round(SEs.1a[5],4),")",        "\t", "(", round(SEs.1b[5],4),")",           "\n",
 "M_GOVT",          "\t", round(theta.1a[6],4), star.1a[6],    "\t", round(theta.1b[6],4),
star.1b[6],      "\n",
 "\t", "(", round(SEs.1a[6],4),")",        "\t", "(", round(SEs.1b[6],4),")",           "\n",
 "M_MUNICIPALITY",  "\t", round(theta.1a[7],4), star.1a[7],    "\t", round(theta.1b[7],4),
star.1b[7],      "\n",
 "\t", "(", round(SEs.1a[7],4),")",        "\t", "(", round(SEs.1b[7],4),")",           "\n",
 #"M_COMMUNITY",    "\t", round(theta.1[7],4), star.1[7],
"\n",
 #                 "\t", "(",round(SEs.1[7],4),")",                                        "\n",
 "COST",        "\t", round(theta.1a[8],4), star.1a[8],   "\t", round(theta.1b[8],4), star.1b[8],
"\n",
 "\t", "(",round(SEs.1a[8],4),")",         "\t", "(",round(SEs.1b[8],4),")",            "\n",
 #"L.TIME",        "\t", round(theta.1[9],4), star.1[9],                                   "\n",
```

```
 #              "\t", "(",round(SEs.1[9],4),")",                                         "\n",
 "TIME",            "\t", round(theta.1a[9],4), star.1a[9],   "\t", round(theta.1b[9],4),
star.1b[9],       "\n",
 "\t", "(",round(SEs.1a[9],4),")",        "\t", "(",round(SEs.1b[9],4),")",            "\n",
 #"TIME_10",        "\t", round(theta.1[8],4), star.1[8],
"\n",
 #              "\t", "(",round(SEs.1[8],4),")",                                         "\n",
 #"TIME_15",        "\t", round(theta.1[9],4), star.1[9],
"\n",
 #              "\t", "(",round(SEs.1[9],4),")",                                         "\n",
 "TIME^.5",         "\t", round(theta.1a[10],4), star.1a[10], "\t", round(theta.1b[10],4),
star.1b[10],    "\n",
  "\t", "(",round(SEs.1a[10],4),")",       "\t", "(",round(SEs.1b[10],4),")",           "\n",

 #" W_QUALITY3:V_AG01",  "\t",                              "\t", round(theta.1b[11], 4),
star.1b[11],    "\n",
 #"\t",                              "\t", "(", round(SEs.1b[11], 4), ")",        "\n",
 " W_QUALITY3:V_AG01",  "\t",                              "\t", round(theta.1b[11], 4),
star.1b[11],    "\n",
 "\t",                              "\t", "(", round(SEs.1b[11], 4), ")",        "\n",

  "W_QUALITY2:OWN",      "\t",                              "\t", round(theta.1b[12], 4),
star.1b[12],    "\n",
  "\t",                              "\t", "(", round(SEs.1b[12], 4), ")",        "\n",
  "W_QUALITY3:OWN",      "\t",                              "\t", round(theta.1b[13], 4),
star.1b[13],    "\n",
  "\t",                              "\t", "(", round(SEs.1b[13], 4), ")",        "\n",

  #"W_QUALITY3:COLLEGE",  "\t",                              "\t", round(theta.1b[15], 4),
star.1b[15],    "\n",
  # "\t",                              "\t", "(", round(SEs.1b[15], 4), ")",        "\n",
  "W_QUALITY3:COLLEGE",  "\t",                              "\t", round(theta.1b[14], 4),
star.1b[14],    "\n",
  "\t",                              "\t", "(", round(SEs.1b[14], 4), ")",        "\n",

 #"W_QUALITY2:AGE_10",   "\t",                              "\t", round(theta.1b[17], 4),
star.1b[17],    "\n",
 #"\t",                              "\t", "(", round(SEs.1b[17], 4), ")",        "\n",
 "W_QUALITY3:AGE_10",   "\t",                              "\t", round(theta.1b[15], 4),
star.1b[15],    "\n",
  "\t",                              "\t", "(", round(SEs.1b[15], 4), ")",        "\n",

 #"W_QUALITY2:NEWAR",    "\t",                              "\t", round(theta.1b[19], 4),
star.1b[19],    "\n",
 #"\t",                              "\t", "(", round(SEs.1b[19], 4), ")",        "\n",
```

```
   "W_QUALITY3:NEWAR",    "\t",                              "\t", round(theta.1b[16], 4),
star.1b[16],    "\n",
   "\t",                              "\t", "(", round(SEs.1b[16], 4), ")",         "\n",

 #"W_QUALITY2:BRAHMIN",  "\t",                              "\t", round(theta.1b[21], 4),
star.1b[21],    "\n",
 #"\t",                              "\t", "(", round(SEs.1b[21], 4), ")",         "\n",
  "W_QUALITY3:BRAHMIN",  "\t",                              "\t", round(theta.1b[17], 4),
star.1b[17],    "\n",
  "\t",                              "\t", "(", round(SEs.1b[17], 4), ")",         "\n",

 #"W_QUALITY3:KSHETRI",  "\t",                              "\t", round(theta.1b[23], 4),
star.1b[23],    "\n",
 #"\t",                              "\t", "(", round(SEs.1b[23], 4), ")",         "\n",
  "W_QUALITY3:KSHETRI",  "\t",                              "\t", round(theta.1b[18], 4),
star.1b[18],    "\n",
  "\t",                              "\t", "(", round(SEs.1b[18], 4), ")",         "\n",

  "PLANTATION_C:AGE_10", "\t",                              "\t", round(theta.1b[19], 4),
star.1b[19],    "\n",
  "\t",                              "\t", "(", round(SEs.1b[19], 4), ")",         "\n",
  "I(PLANTATION_C^.5):AGE_10", "\t",                        "\t", round(theta.1b[20], 4),
star.1b[20],    "\n",
  "\t",                         "\t", "(", round(SEs.1b[20], 4), ")",         "\n",

  "M_GOVT:OWN",              "\t",                          "\t", round(theta.1b[21], 4),
star.1b[21],    "\n",
                              "\t",                         "\t", "(", round(SEs.1b[21], 4), ")",         "\n",
  "M_MUNICIPALITY:OWN",       "\t",                          "\t", round(theta.1b[22], 4),
star.1b[22],    "\n",
                              "\t",                         "\t", "(", round(SEs.1b[22], 4), ")",         "\n",

  "TIME:MID_INC",             "\t",                          "\t", round(theta.1b[23], 4),
star.1b[23],    "\n",
  "\t",                         "\t", "(", round(SEs.1b[23], 4), ")",         "\n",
  "TIME:HIGH_INC",            "\t",                          "\t", round(theta.1b[24], 4),
star.1b[24],    "\n",
  "\t",                         "\t", "(", round(SEs.1b[24], 4), ")",         "\n",

 "N",                "\t", n.1a,                        "\t", n.1b,                              "\n",
 "Log-Likelihood",     "\t", round(loglik.1a, 2),            "\t", round(loglik.1b, 2),
"\n",
 "McFadden R^2",       "\t", round(R.sq.1a, 4),              "\t", round(R.sq.1b, 4),
"\n",
 "AIC",              "\t", round(aic.1a, 2),               "\t", round(aic.1b, 2),                    "\n",
```

```
 "BIC",              "\t", round(bic.1a, 2),              "\t", round(bic.1b, 2),                    "\n",

 "Significance codes:  '***' 0.01 '**' 0.05 '*' 0.1",                                           "\n",
 "Numbers in parentheses indicate standard errors",
"\n",
 file="Table 2.3_new_Results_of_CLM_Models.txt", sep="")


#############################IIA test############################
################Removing the observation who chose altA and B###########
data2_noaltA<-subset(c.data,!(ALTERNATE=="A")) #I remove the observation who
chose alternative 3
f=nrow(data2_noaltA)
mlt.noaltA<-mlogit(RESPONSE~ ASC3 +
  W_QUALITY2 + W_QUALITY3 + #W_QUALITY1 +
  PLANTATION_C + I(PLANTATION_C^0.5) +
  #PLANT_40 + #PLANT_60 + #PLANT_80 +
  M_GOVT + M_MUNICIPALITY + #M_COMMUNITY +
  PAY_THOU +
  WTC + I(WTC^0.5)-1,
      data=data2_noaltA, alt.var="ALTERNATIVE", shape="long", chid.var="STR",
      choice="RESPONSE", reflevel="3")
#summary(mlt.noaltA)
hmftest(mlt.1a, mlt.noaltA)

################Removing the observation who chose altB################
data2_noaltB<-subset(c.data,!(ALTERNATE=="B")) #I remove the observation who
chose alternative 3
f=nrow(data2_noaltB)
mlt.noaltB<-mlogit(RESPONSE~ ASC3 +
  W_QUALITY2 + W_QUALITY3 + #W_QUALITY1 +
  PLANTATION_C + I(PLANTATION_C^0.5) +
  #PLANT_40 + #PLANT_60 + #PLANT_80 +
  M_GOVT + M_MUNICIPALITY + #M_COMMUNITY +
  PAY_THOU +
  WTC + I(WTC^0.5)-1,
  data=data2_noaltB, alt.var="ALTERNATIVE", shape="long", chid.var="STR",
  choice="RESPONSE", reflevel="3")
hmftest(mlt.1a, mlt.noaltB)


###################Removing the observation who chose altB################
data2_noaltC<-subset(c.data,!(ALTERNATE=="C")) #I remove the observation who
chose alternative 3
f=nrow(data2_noaltC)
```

```
mlt.noaltC<-mlogit(RESPONSE~ ASC3 +
  W_QUALITY2 + W_QUALITY3 + #W_QUALITY1 +
  PLANTATION_C + I(PLANTATION_C^0.5) +
  #PLANT_40 + #PLANT_60 + #PLANT_80 +
  M_GOVT + M_MUNICIPALITY + #M_COMMUNITY +
  PAY_THOU +
  WTC + I(WTC^0.5)-1,
  data=data2_noaltC, alt.var="ALTERNATIVE", shape="long", chid.var="STR",
  choice="RESPONSE")
hmftest(mlt.1a, mlt.noaltC)

###############################RPL basic 2a##############################
setwd("F:\\11th_semester\\Sodhpatra\\Bagmati_benefit_estimation\\Estimation\\Bagmati2
2\\with_withoutSQ")
c.data <- read.csv("long.datab.csv", header = T, sep = ",")
mlt.data<-mlogit.data(c.data, choice = "RESPONSE", shape = "long",
          alt.var="ALTERNATIVE")        #Preparing data for mlogit
RPL.2a<-
  mlogit(RESPONSE~ ASC3 +
  W_QUALITY2 + W_QUALITY3 + #W_QUALITY4 +
  PLANTATION_C + I(PLANTATION_C^0.5) +
  #PLANT_40 + #PLANT_60 + #PLANT_80 +
  M_GOVT + M_MUNICIPALITY + #M_COMMUNITY +
  PAY_THOU +
  WTC + I(WTC^0.5)-1,
   data=mlt.data, alt.var="ALTERNATIVE", shape="long", chid.var="STR",
   choice="RESPONSE", reflevel="3", halton = NA,
   R=2000,
   rpar=c(W_QUALITY2='n'
    ,W_QUALITY3='n'
    #,PLANTATION_C ='n'
    #,M_GOVT='n'
    #,M_MUNICIPALITY='n'
    #,PAY_THOU='u'
    #,WTC='n'
    ))
#summary(RPL.2a)

##########################Goodness of fit of basic RPL 2a####################
RPL.2a_const<-
  mlogit(RESPONSE~ ASC3 -1,
    data=mlt.data, alt.var="ALTERNATIVE", shape="long", chid.var="STR",
    choice="RESPONSE")
#summary(RPL.2a_const)
loglik.2a <- RPL.2a$logLik[1]
```

```
loglik.2a_const <- RPL.2a_const$logLik[1]
theta.2a <- RPL.2a$coef
k.2a<-length(theta.2a)
n.2a<-(nrow(c.data))
aic.2a <- -2*RPL.2a$logLik[1]+2*k.2a
bic.2a <- -2*RPL.2a$logLik[1] + k.2a*log(n.2a)
R.sq.2a <- 1 - (RPL.2a$logLik[1]/RPL.2a_const$logLik[1])
#############generation of star and p-value for presentation table##########
SEs.2a <- sqrt(-diag(solve(RPL.2a$hessian)))
tval.2a <- theta.2a/SEs.2a
pval.2a <- 2*(1-pt(abs(tval.2a), n.2a-k.2a))
star.2a <- rep(" ,k.2a)
for(j.2a in 1:k.2a){
  star.2a[j.2a] <- #if(pval.1[j.1]<0.001){"***"}
  #else
  if(pval.2a[j.2a] <0.01){"***"}
  else if(pval.2a[j.2a] < 0.05){"**"}
  else if(pval.2a[j.2a] < 0.1){"*"}
  else {""}
  }


####################RPL with interaction (2b)####################
mlt.data<-mlogit.data(c.data, choice = "RESPONSE", shape = "long",
                  alt.var="ALTERNATIVE")
RPL.2b<-
  mlogit(RESPONSE~ ASC3 +
  W_QUALITY2 + W_QUALITY3 + #W_QUALITY1 +
  PLANTATION_C + I(PLANTATION_C^0.5) +
  #PLANT_40 + #PLANT_60 + #PLANT_80 +
  M_GOVT + M_MUNICIPALITY + #M_COMMUNITY +
  PAY_THOU +
  WTC + I(WTC^0.5) +
  #W_QUALITY2:MID_STREAM + W_QUALITY3:MID_STREAM
+W_QUALITY2:DOWN_STREAM + W_QUALITY3:DOWN_STREAM +
  #W_QUALITY2:MID_INC + W_QUALITY3:MID_INC +
  #W_QUALITY2:HIGH_INC + W_QUALITY3:HIGH_INC +
  #W_QUALITY2:V_REC01 + W_QUALITY3:V_REC01 +
W_QUALITY2:V_CULT01 + W_QUALITY3:V_CULT01 +
  #W_QUALITY2:V_CLEANING01 + W_QUALITY3:V_CLEANING01 +
#W_QUALITY2:V_AG01 +
  W_QUALITY3:V_AG01 +
  W_QUALITY2:OWN +
  W_QUALITY3:OWN +
  #W_QUALITY2:SOME_COLLEGE +
```

```
 #W_QUALITY3:SOME_COLLEGE +
#W_QUALITY2:COLLEGE +
 W_QUALITY3:COLLEGE +
#W_QUALITY2:AGE_10 +
 W_QUALITY3:AGE_10 + #W_QUALITY2:I(AGE^.5) + W_QUALITY3:I(AGE^.5) +
#W_QUALITY2:NEWAR +
 W_QUALITY3:NEWAR +
#W_QUALITY2:BRAHMIN +
 W_QUALITY3:BRAHMIN +
#W_QUALITY2:KSHETRI +
 W_QUALITY3:KSHETRI +
 PLANTATION_C:AGE_10 + I(PLANTATION_C^.5):AGE_10 +
 #PLANTATION:V_REC01 + PLANTATION:V_CULT01
+PLANTATION:V_CLEANING01 + PLANTATION:V_AG01 +
M_GOVT:OWN + M_MUNICIPALITY:OWN +
 #M_GOVT:V_REC01 + M_GOVT:V_CULT01 +M_GOVT:V_CLEANING01 +
M_GOVT:V_AG01 +
 #M_MUNICIPALITY:V_REC01 + M_MUNICIPALITY:V_CULT01
+M_MUNICIPALITY:V_CLEANING01 + M_MUNICIPALITY:V_AG01+
 WTC:MID_INC + WTC:HIGH_INC -1, # +
 #WTC:MALE + I(WTC^.5):MALE +
 #WTC:V_REC01 + I(WTC^.5):V_REC01 + WTC:V_CULT01 +
I(WTC^.5):V_CULT01 +
 #WTC:V_CLEANING01+ I(WTC^.5):V_CLEANING01 + WTC:V_AG01+
I(WTC^.5):V_AG01 +
 #PLANTATION:MALE + I(PLANTATION^.5):MALE +       ,
   data=mlt.data, alt.var="ALTERNATIVE", shape="long", chid.var="STR",
   choice="RESPONSE", reflevel="3", halton =NA,
    R=2000,
    rpar=c(W_QUALITY2='n'
    ,W_QUALITY3='n'
    #,PLANTATION_C ='n'
    #,M_GOVT='n'
    #,M_MUNICIPALITY='n'
    #,PAY_THOU='n'
    #,WTC='n'
   ))
#summary(RPL.2b)

################Goodness of fit RPL with interaction 2b################
RPL.2b_const<-
 mlogit(RESPONSE~ ASC3 -1,
       data=mlt.data, alt.var="ALTERNATIVE", shape="long", chid.var="STR",
       choice="RESPONSE")
#summary(RPL.2a_const)
```

```
loglik.2b <- RPL.2b$logLik[1]
loglik.2b_const <- RPL.2b_const$logLik[1]
theta.2b <- RPL.2b$coef
k.2b<-length(theta.2b)
n.2b<-(nrow(c.data))
aic.2b <- -2*RPL.2b$logLik[1]+2*k.2b
bic.2b <- -2*RPL.2b$logLik[1] + k.2b*log(n.2b)
R.sq.2b <- 1 - (RPL.2b$logLik[1]/RPL.2b_const$logLik[1])

#############generation of star and p-value for presentation table##########
SEs.2b <- sqrt(-diag(solve(RPL.2b$hessian)))
tval.2b <- theta.2b/SEs.2b
pval.2b <- 2*(1-pt(abs(tval.2b), n.2b-k.2b))
star.2b <- rep(" ,k.2b)
for(j.2b in 1:k.2b){
  star.2b[j.2b] <- #if(pval.1[j.1]<0.001){"***"}
  #else
  if(pval.2b[j.2b] <0.01){"***"}
  else if(pval.2b[j.2b] < 0.05){"**"}
  else if(pval.2b[j.2b] < 0.1){"*"}
  else {""}
    }


###############Results of RPL (RPL.2a and RPL.2b)
Combined####################
cat("Table 2.5: Results of Random Parameter Logit Models ", "\n",
 "Variables",       "\t", "Model3",                        "\t", "Model4",                          "\n",
 #"ASC1",           "\t", round(theta.1[1], 4), star.1[1],                                           "\n",
 #                "\t", "(", round(SEs.1[1], 4), ")",                                          "\n",
 #"ASC2",           "\t", round(theta.1[2], 4), star.1[2],                                           "\n",
 #                "\t", "(", round(SEs.1[2], 4), ")",                                          "\n",
 "ASC",            "\t", round(theta.2a[1], 4), star.2a[1],    "\t", round(theta.2b[1], 4),
star.2b[1],    "\n",
                 "\t", "(", round(SEs.2a[1], 4), ")",        "\t", "(", round(SEs.2b[1], 4), ")",
"\n",
 "W_QUALITY2",      "\t", round(theta.2a[2], 4), star.2a[2],    "\t", round(theta.2b[2], 4),
star.2b[2],    "\n",
                 "\t", "(", round(SEs.2a[2], 4), ")",        "\t", "(", round(SEs.2b[2], 4), ")",
"\n",
 "W_QUALITY3",      "\t", round(theta.2a[3], 4), star.2a[3],    "\t", round(theta.2b[3], 4),
star.2b[3],    "\n",
                 "\t", "(", round(SEs.2a[3], 4), ")",         "\t", "(", round(SEs.2b[3], 4), ")",
"\n",
```

```
 "PLANTATION_C",    "\t", round(theta.2a[4],4), star.2a[4],     "\t", round(theta.2b[4],4),
star.2b[4],     "\n",
                "\t", "(", round(SEs.2a[4],4),")",         "\t", "(", round(SEs.2b[4],4),")",
"\n",
 #"PLANT_40",       "\t", round(theta.1[3],4), star.1[3],
"\n",
 #                "\t", "(", round(SEs.1[3],4),")",                                            "\n",
 #"PLANT_60",       "\t", round(theta.1[5],4), star.1[5],
"\n",
 #                "\t", "(", round(SEs.1[5],4),")",                                            "\n",
 #"PLANT_80",       "\t", round(theta.1[4],4), star.1[4],
"\n",
 #                "\t", "(", round(SEs.1[4],4),")", "\n",
 "PLANTATION_C^.5", "\t", round(theta.2a[5],4), star.2a[5],    "\t", round(theta.2b[5],4),
star.2b[5],      "\n",
                "\t", "(", round(SEs.2a[5],4),")",        "\t", "(", round(SEs.2b[5],4),")",
"\n",
 "M_GOVT",          "\t", round(theta.2a[6],4), star.2a[6],    "\t", round(theta.2b[6],4),
star.2b[6],      "\n",
                "\t", "(", round(SEs.2a[6],4),")",        "\t", "(", round(SEs.2b[6],4),")",
"\n",
 "M_MUNICIPALITY",  "\t", round(theta.2a[7],4), star.2a[7],    "\t", round(theta.2b[7],4),
star.2b[7],      "\n",
                "\t", "(", round(SEs.2a[7],4),")",        "\t", "(", round(SEs.2b[7],4),")",
"\n",
 #"M_COMMUNITY",    "\t", round(theta.1[7],4), star.1[7],
"\n",
 #                "\t", "(",round(SEs.1[7],4),")",                                             "\n",
 "COST",        "\t", round(theta.2a[8],4), star.2a[8],   "\t", round(theta.2b[8],4), star.2b[8],
"\n",
                "\t", "(",round(SEs.2a[8],4),")",        "\t", "(",round(SEs.2b[8],4),")",
"\n",
 #"L.TIME",         "\t", round(theta.1[9],4), star.1[9],                                          "\n",
 #                "\t", "(",round(SEs.1[9],4),")",                                             "\n",
 "TIME",            "\t", round(theta.2a[9],4), star.2a[9],   "\t", round(theta.2b[9],4),
star.2b[9],       "\n",
                "\t", "(",round(SEs.2a[9],4),")",        "\t", "(",round(SEs.2b[9],4),")",
"\n",
 #"TIME_10",        "\t", round(theta.1[8],4), star.1[8],
"\n",
 #                "\t", "(",round(SEs.1[8],4),")",                                             "\n",
 #"TIME_15",        "\t", round(theta.1[9],4), star.1[9],
"\n",
 #                "\t", "(",round(SEs.1[9],4),")",                                             "\n",
```

```
 "TIME^.5",          "\t", round(theta.2a[10],4), star.2a[10], "\t", round(theta.2b[10],4),
star.2b[10],     "\n",
                 "\t", "(",round(SEs.2a[10],4),")",        "\t", "(",round(SEs.2b[10],4),")",
"\n",

# " W_QUALITY3:V_AG01",  "\t",                              "\t", round(theta.2b[11], 4),
star.2b[11],    "\n",
#                   "\t",                            "\t", "(", round(SEs.2b[11], 4), ")",         "\n",
 " W_QUALITY3:V_AG01",  "\t",                              "\t", round(theta.2b[11], 4),
star.2b[11],    "\n",
                    "\t",                            "\t", "(", round(SEs.2b[11], 4), ")",         "\n",

 "W_QUALITY2:OWN",      "\t",                              "\t", round(theta.2b[12], 4),
star.2b[12],    "\n",
                    "\t",                            "\t", "(", round(SEs.2b[12], 4), ")",         "\n",
 "W_QUALITY3:OWN",      "\t",                              "\t", round(theta.2b[13], 4),
star.2b[13],    "\n",
                    "\t",                            "\t", "(", round(SEs.2b[13], 4), ")",         "\n",

# "W_QUALITY3:COLLEGE",  "\t",                              "\t", round(theta.2b[15], 4),
star.2b[15],    "\n",
#                   "\t",                            "\t", "(", round(SEs.2b[15], 4), ")",         "\n",
 "W_QUALITY3:COLLEGE",  "\t",                              "\t", round(theta.2b[14], 4),
star.2b[14],    "\n",
                    "\t",                            "\t", "(", round(SEs.2b[14], 4), ")",         "\n",

# "W_QUALITY2:AGE_10",   "\t",                              "\t", round(theta.2b[17], 4),
star.2b[17],    "\n",
#                   "\t",                            "\t", "(", round(SEs.2b[17], 4), ")",         "\n",
 "W_QUALITY3:AGE_10",   "\t",                              "\t", round(theta.2b[15], 4),
star.2b[15],    "\n",
                    "\t",                            "\t", "(", round(SEs.2b[15], 4), ")",         "\n",

# "W_QUALITY2:NEWAR",    "\t",                              "\t", round(theta.2b[19], 4),
star.2b[19],    "\n",
#                   "\t",                            "\t", "(", round(SEs.2b[19], 4), ")",         "\n",
 "W_QUALITY3:NEWAR",    "\t",                              "\t", round(theta.2b[16], 4),
star.2b[16],    "\n",
                    "\t",                            "\t", "(", round(SEs.2b[16], 4), ")",         "\n",

# "W_QUALITY2:BRAHMIN",  "\t",                              "\t", round(theta.2b[21], 4),
star.2b[21],    "\n",
#                   "\t",                            "\t", "(", round(SEs.2b[21], 4), ")",         "\n",
 "W_QUALITY3:BRAHMIN",  "\t",                              "\t", round(theta.2b[17], 4),
star.2b[17],    "\n",
```

```
                   "\t",                          "\t", "(", round(SEs.2b[17], 4), ")",       "\n",

# "W_QUALITY3:KSHETRI",  "\t",                              "\t", round(theta.2b[23], 4),
star.2b[23],    "\n",
#                    "\t",                          "\t", "(", round(SEs.2b[23], 4), ")",       "\n",
 "W_QUALITY3:KSHETRI",  "\t",                              "\t", round(theta.2b[18], 4),
star.2b[18],    "\n",
                   "\t",                          "\t", "(", round(SEs.2b[18], 4), ")",       "\n",

 "PLANTATION_C:AGE_10", "\t",                              "\t", round(theta.2b[19], 4),
star.2b[19],    "\n",
                   "\t",                          "\t", "(", round(SEs.2b[19], 4), ")",       "\n",
  "I(PLANTATION_C^.5):AGE_10", "\t",                       "\t", round(theta.2b[20], 4),
star.2b[20],    "\n",
                        "\t",                     "\t", "(", round(SEs.2b[20], 4), ")",       "\n",

 "M_GOVT:OWN",              "\t",                        "\t", round(theta.2b[21], 4),
star.2b[21],    "\n",
                        "\t",                     "\t", "(", round(SEs.2b[21], 4), ")",       "\n",
 "M_MUNICIPALITY:OWN",       "\t",                         "\t", round(theta.2b[22], 4),
star.2b[22],    "\n",
                        "\t",                     "\t", "(", round(SEs.2b[22], 4), ")",       "\n",

 "TIME:MID_INC",             "\t",                        "\t", round(theta.2b[23], 4),
star.2b[23],    "\n",
                        "\t",                     "\t", "(", round(SEs.2b[23], 4), ")",       "\n",
 "TIME:HIGH_INC",            "\t",                        "\t", round(theta.2b[24], 4),
star.2b[24],    "\n",
                        "\t",                     "\t", "(", round(SEs.2b[24], 4), ")",       "\n",


 "sd.W_QUALITY2",   "\t", round(theta.2a[11],4), star.2a[11], "\t", round(theta.2b[25],4),
star.2b[25],     "\n",
                "\t", "(",round(SEs.2a[11],4),")",       "\t", "(",round(SEs.2b[25],4),")",
"\n",
 "sd.W_QUALITY3",   "\t", round(theta.2a[12],4), star.2a[12], "\t", round(theta.2b[26],4),
star.2b[26],     "\n",
                "\t", "(",round(SEs.2a[12],4),")",       "\t", "(",round(SEs.2b[26],4),")",
"\n",
 #"sd.PLANTATION_C", "\t", round(theta.2a[13],4), star.2a[13], "\t",
round(theta.2b[27],4), star.2b[27],      "\n",
  #               "\t", "(",round(SEs.2a[13],4),")",       "\t", "(",round(SEs.2b[27],4),")",
"\n",
 #"sd.M_GOVT",      "\t", round(theta.2a[14],4), star.2a[14], "\t", round(theta.2b[28],4),
star.2b[28],     "\n",
```

```
 #               "\t", "(",round(SEs.2a[14],4),")",       "\t", "(",round(SEs.2b[28],4),")",
"\n",
 #"sd.M_MUNICIPALITY","\t", round(theta.2a[15],4), star.2a[15],"\t",
round(theta.2b[29],4), star.2b[29],      "\n",
 #               "\t", "(",round(SEs.2a[15],4),")",       "\t", "(",round(SEs.2b[29],4),")",
"\n",
 #"#sd.TIME",         "\t", round(theta.2a[16],4), star.2a[16], "\t", round(theta.2b[30],4),
star.2b[30],     "\n",
 #               "\t", "(",round(SEs.2a[16],4),")",       "\t", "(",round(SEs.2b[30],4),")",
"\n",

 "N",               "\t", n.2a,                        "\t", n.2b,                            "\n",
 "Log-Likelihood",     "\t", round(loglik.2a, 2),           "\t", round(loglik.2b, 2),
"\n",
 "McFadden R^2",       "\t", round(R.sq.2a, 4),             "\t", round(R.sq.2b, 4),
"\n",
 "AIC",             "\t", round(aic.2a, 2),              "\t", round(aic.2b, 2),                  "\n",
 "BIC",             "\t", round(bic.2a, 2),              "\t", round(bic.2b, 2),                  "\n",

 "Significance codes:  '***' 0.01 '**' 0.05 '*' 0.1",                                    "\n",
 "Numbers in parentheses indicate standard errors",
"\n",
 #file="Table2.5_new_Results_of_RPL_Models.txt", sep="")
file="TableC3_Results_of_RPL_Models_all_attributes_randomized_2000R.txt", sep="")


####################Simulated WTP Krinsky and Rob with normal
draws####################
library(mvtnorm)
library(bit)
library(coda)
library(xtable)
library(MSBVAR)
library(boot)

####################Basic mlt (mlt1a) and basic RPL
(RPL2a)####################
coef <-  RPL.2a$coef
src <- c(7,8)               #index row and column to extract
sbeta <- coef[src]                #extract just regression coeffs
cov_coef <- (-solve(RPL.2a$hessian))
scov_b <- cov_coef[src,src]      #cov_coef
#normally draw betas
sbeta_sim <- rmultnorm(100000, mu=sbeta, vmat=scov_b, tol = 1e-10)
#defines sbeta_sim
```

```
swtp <- function(sbeta_sim){
  b2 <- sbeta_sim[,1]
  b8 <- sbeta_sim[,2]
  fb = -(b2)/b8
  return( fb )
  }
swtp <- eval(swtp(sbeta_sim))       #swtpvalues
#mean(swtp)     #'mean of simulated WTP'
quantiles <- quantile(swtp, c(.025, .975)) #'Quantiles calulation of simulated series'
#quantiles  #"Confidence Interval of WTP_simulated"
#summary(quantiles) #'summary quantiles info'
#"Mean and Confidence Interval of WTP_normal"
m<-round(mean(swtp), 2)
l<-round(min(quantiles), 2)
h<-round(max(quantiles), 2)
c<-c(m,l,h)
c

#################for interaction model mlt.1b and RPL.2b#################
coef <-  mlt.1b$coef
src <- c(9,8)               #index row and column to extract
sbeta <- coef[src]                  #extract just regression coeffs
cov_coef <- (-solve(mlt.1b$hessian))
scov_b <- cov_coef[src,src]      #cov_coef
#normally draw betas
sbeta_sim <- rmultnorm(100000, mu=sbeta, vmat=scov_b, tol = 1e-10)
#defines sbeta_sim
swtp <- function(sbeta_sim){
  b2 <- sbeta_sim[,1]
  b8 <- sbeta_sim[,2]
  fb =-(b2+0.5*0.82051*6.844^-0.5+0.00998*0.22-0.0222*0.17)/b8
  return( fb )
}
swtp <- eval(swtp(sbeta_sim))       #swtpvalues
#mean(swtp)     #'mean of simulated WTP'
quantiles <- quantile(swtp, c(.025, .975)) #'Quantiles calulation of simulated series'
#quantiles  #"Confidence Interval of WTP_simulated"
#summary(quantiles) #'summary quantiles info'
#"Mean and Confidence Interval of WTP_normal"
m<-round(mean(swtp), 2)
l<-round(min(quantiles), 2)
h<-round(max(quantiles), 2)
c<-c(m,l,h)
c
```

```
###################CI of MWTP of MLT basic 1a other
method###################
library(numDeriv)
theta.1a <- mlt.1a$coef
wtp.fn <- function(beta){
  a <- beta[1]
  aa <- beta[2]
  fb =- a/aa                    #this does not work for PLANTATION and WTC though
  return(fb)
  }
erc<-matrix(c(NA, 8), nrow=10, ncol=2, byrow=T) #index row and column to extract the
coeff
for (i in 1:10){
  erc[i,1]<-i
  }
ci.calc <- function(x){          #defining a function to calculate wtp and ci of wtp
  ebeta <- theta.1a[x]           #extract just regression coeffs
  cov_coef <- ((-solve(mlt.1a$hessian)))
  ecov_b <- cov_coef[x,x]           #extract cov of b2 and b8
  ewtp <- eval(wtp.fn(ebeta))
  numd1 <- grad(wtp.fn, ebeta)      #returns gradient i.e. partial derivatives (1Xk)
  stderr_WTP <- sqrt(numd1%*%(ecov_b)%*%numd1)      #lists errr of WTP([df1 df2]
[cov of b1b2] [df1 df2]')
  left1 <- ewtp-1.96*stderr_WTP
  right1 <- ewtp+1.96*stderr_WTP
  CI_WTP.1a <- c(ewtp,left1, right1)    #gives the CI of first coeff
  return(CI_WTP.1a)
}
WTP.1a <- matrix(c(NA),nrow=10,ncol=3,byrow=T)
for(i in 1:10){
  WTP.1a[i,] <- ci.calc(erc[i,])
}
# WTP.1a[1,1]
#WTP.1a[1, 2:3]

###################Marginal WTP and CI ###################
cat("Table 2.6: Marginal Willingness to Pay and 95% Confidence Interval for Conditional
and Random Parameter Logit Models", "\n",
 "Attributes",   "\t", "Basic CL Model", "\t", "Basic RPL Model",
   "\t", "CLM with Interaction", "\t", "RPL with Interaction*","\n",
"ASC3", "\t", round(WTP.1a[1,1], 2), "(",round(WTP.1a[1, 2:3], 2),")",       #first lineis
for 1a, basic clm
      "\t", round(WTP.2a[1,1], 2), "(",round(WTP.2a[1, 2:3], 2),")",       #this one is for
2a, basic RPL
```

```
        "\t", round(WTP.1b[1,1], 2), "(",round(WTP.1b[1, 2:3], 2),")",        #this one is for
basic RPL, 1b
        "\t", round(WTP.2b[1,1], 2), "(",round(WTP.2b[1, 2:3], 2),")", "\n",  #this is for
interaction RPL, 2b

"W_QUALITY2", "\t", round(WTP.1a[2,1], 2), "(",round(WTP.1a[2, 2:3], 2),")",
              "\t", round(WTP.2a[2,1], 2), "(",round(WTP.2a[2, 2:3], 2),")",
              "\t", round(WTP.1b[2,1], 2), "(",round(WTP.1b[2, 2:3], 2),")",
              "\t", round(WTP.2b[2,1], 2), "(",round(WTP.2b[2, 2:3], 2),")","\n",

"W_QUALITY3", "\t", round(WTP.1a[3,1], 2), "(",round(WTP.1a[3, 2:3], 2),")",
              "\t", round(WTP.2a[3,1], 2), "(",round(WTP.2a[3, 2:3], 2),")",
              "\t", round(WTP.1b[3,1], 2), "(",round(WTP.1b[3, 2:3], 2),")",
              "\t", round(WTP.2b[3,1], 2), "(",round(WTP.2b[3, 2:3], 2),")","\n",

"PLANTATION", "\t", round(WTP.1a[4,1], 2), "(",round(WTP.1a[4, 2:3], 2),")",
              "\t", round(WTP.2a[4,1], 2), "(",round(WTP.2a[4, 2:3], 2),")",
              "\t", round(WTP.1b[4,1], 2), "(",round(WTP.1b[4, 2:3], 2),")",
              "\t", round(WTP.2b[4,1], 2), "(",round(WTP.2b[4, 2:3], 2),")","\n",

"PLANTATION^.5","\t", round(WTP.1a[5,1], 2), "(",round(WTP.1a[5, 2:3], 2),")",
                "\t", round(WTP.2a[5,1], 2), "(",round(WTP.2a[5, 2:3], 2),")",
                "\t", round(WTP.1b[5,1], 2), "(",round(WTP.1b[5, 2:3], 2),")",
                "\t", round(WTP.2b[5,1], 2), "(",round(WTP.2b[5, 2:3], 2),")","\n",

"M_GOVT",       "\t", round(WTP.1a[6,1], 2), "(",round(WTP.1a[6, 2:3], 2),")",
                "\t", round(WTP.2a[6,1], 2), "(",round(WTP.2a[6, 2:3], 2),")",
                "\t", round(WTP.1b[6,1], 2), "(",round(WTP.1b[6, 2:3], 2),")",
                "\t", round(WTP.2b[6,1], 2), "(",round(WTP.2b[6, 2:3], 2),")","\n",

"M_MUNICIPALITY","\t", round(WTP.1a[7,1], 2), "(",round(WTP.1a[7, 2:3], 2),")",
                 "\t", round(WTP.2a[7,1], 2), "(",round(WTP.2a[7, 2:3], 2),")",
                 "\t", round(WTP.1b[7,1], 2), "(",round(WTP.1b[7, 2:3], 2),")",
                 "\t", round(WTP.2b[7,1], 2), "(",round(WTP.2b[7, 2:3], 2),")","\n",

"COST",     "\t", round(WTP.1a[8,1], 2), "(",round(WTP.1a[8, 2:3], 2),")",
                "\t", round(WTP.2a[8,1], 2), "(",round(WTP.2a[8, 2:3], 2),")",
                "\t", round(WTP.1b[8,1], 2), "(",round(WTP.1b[8, 2:3], 2),")",
                "\t", round(WTP.2b[8,1], 2), "(",round(WTP.2b[8, 2:3], 2),")","\n",

"TIME",         "\t", round(WTP.1a[9,1], 2), "(",round(WTP.1a[9, 2:3], 2),")",
                "\t", round(WTP.2a[9,1], 2), "(",round(WTP.2a[9, 2:3], 2),")",
                "\t", round(WTP.1b[9,1], 2), "(",round(WTP.1b[9, 2:3], 2),")",
                "\t", round(WTP.2b[9,1], 2), "(",round(WTP.2b[9, 2:3], 2),")","\n",
```

```
"TIME^.5",       "\t", round(WTP.1a[10,1],2), "(",round(WTP.1a[10, 2:3], 2),")",
              "\t", round(WTP.2a[10,1],2), "(",round(WTP.2a[10, 2:3], 2),")",
              "\t", round(WTP.1b[10,1],2), "(",round(WTP.1b[10, 2:3], 2),")",
              "\t", round(WTP.2b[10,1],2), "(",round(WTP.2b[10, 2:3], 2),")","\n",
 "*MWTP is calculated using Krinsky and Rob method", "\n",
 file="Table2.6_MWTP_CLM_all.txt", sep="")

####################end of the file####################
```

Appendix F2: Stata-Code for Knowledge, Attitude and Behaviour towards River Study

```
/*code written by hari katuwal for KABB river water paper*/
/*revisit: April 2011*/
/*Public's Knowledge Attitude and Behavior towards River Restoration*/

clear
cap log close
log using
"G:\11th_semester\Sodhpatra\KABB_river_water\Estimation\output_KABB.log", replace
insheet using "G:\11th_semester\Sodhpatra\KABB_river_water\Estimation\Bagmati-
Survey-final(26-08-09).csv"
set more off

/* results tables
Table E2: Results of Ordered Probit Model for Participation- e1.oprobit_PART.rtf
Table E2: Results of Ordered Probit Model for Participation- e2.oprobit_PART.rtf
Table 23: Bioprobit for PAST_PARTICIPATION with attitude_01 0720-
23.Bioprobit_PART_ATT_01_0720.rtf
*/

******Participation
**willness to contribute for improving water quality in Bagmati a11
**4 catagories: more tax(a), volunteer(b), meetings(c), conservationgroup(d)
**2 answer for each catagories
*******Intended Behavior
gen pay_more_tax1=a12a
*tab pay_more_tax1
gen volunteer1=a12b
*tab volunteer1
gen participation1=a12c
*tab participation1
gen incolvment_conservation1= a12d
*tab incolvment_conservation1
g I_BEHAVIOR1=pay_more_tax1
g I_BEHAVIOR2=pay_more_tax1+volunteer1
g I_BEHAVIOR3=pay_more_tax1+volunteer1+participation1
g
I_BEHAVIOR4=pay_more_tax1+volunteer1+participation1+incolvment_conservation1
g I_BEHAVIOR5=pay_more_tax1+volunteer1+incolvment_conservation1
*tab I_BEHAVIOR4

**time contribution b4
```

```
** 2 catagories-yes(1), no(2)
g TIME_CONTRIBUTION=2-b4
*tab TIME_CONTRIBUTION

**have you participated in cleaning up and conservation for Bagmati
**4 catagories (frequently(1), sometimes(2), rarely(3), not at al(4)
g PAST_PARTICIPATION=4-c9
g PAST_PARTICIPATION1=(PAST_PARTICIPATION==1 |
PAST_PARTICIPATION==2 | PAST_PARTICIPATION==3)

g ENV_ASSOC=c8
g ENV_ASSOC1=(ENV_ASSOC==1)
g T_PARTICIPATION=PAST_PARTICIPATION1+ENV_ASSOC1
g T_PARTICIPATION1=(T_PARTICIPATION>0)
*tab T_PARTICIPATION1
g MEMBERSHIP = (c8==1)
g WASTE_DISPOSAL =(c6==2)

***************Scientific knowledge******************************
g INSECTISITE_POL=c19
g INSECTISITE_POL1=(INSECTISITE_POL==1)
*tab INSECTISITE_POL1
g DISEASE=c20
g DISEASE1=(DISEASE==1)
*tab DISEASE1
g DISEASE_DIRTYWATER=c21
g DISEASE_DIRTYWATER1=(DISEASE_DIRTYWATER==2)
*tab DISEASE_DIRTYWATER1
g ECOLI = c22
g ECOLI1=(ECOLI==1)
*tab ECOLI1
g WHO = c23
g WHO1=(WHO==2)
*tab WHO1
g DIARRHEA = d9b
g DIARRHEA1 = (DIARRHEA==1)
g KNOW_SCIENTIFIC=INSECTISITE_POL1 + DISEASE1 +
DISEASE_DIRTYWATER1 + ECOLI1 /*+ WHO1*/
quietly alpha INSECTISITE_POL1 DISEASE1 DISEASE_DIRTYWATER1 ECOLI1
WHO1 /*.39*/
**rescaled=(actual-min))/(max-min)
quietly sum KNOW_SCIENTIFIC
g KNOW_SCIENTIFIC01 = (KNOW_SCIENTIFIC- r(min))/(r(max)-r(min))
*tab KNOW_SCIENTIFIC01
```

```
quietly pca INSECTISITE_POL1 DISEASE1 DISEASE_DIRTYWATER1 ECOLI1
WHO1
predict KNOW_SCIENTIFIC_PCA

*****************Environmental Knowledge************************
**How much would you say you know about the; Know A Lot Know A Little Do Not
Know Anything
g know_waterpollution = 3-c12
g know_wastemanagement = 3-c15
g know_recycling = 3-c16
g KNOW_ENV=know_waterpollution + know_wastemanagement + know_recycling
*tab KNOW_ENV
quietly alpha know_waterpollution  know_wastemanagement know_recycling /*alpha for
know env .77*/
quietly sum KNOW_ENV
g KNOW_ENV01 = (KNOW_ENV- r(min))/(r(max)-r(min))
*tab KNOW_ENV01
quietly pca know_waterpollution  know_wastemanagement know_recycling
predict KNOW_ENV_PCA
*corr KNOW_SCIENTIFIC KNOW_ENV

**********Public Health Know
**What are the possibilities of following problems-
**4 catagories; a lot(1), a little(2), not at al(3), DK(4)
replace c30=3 if c30==4
g HEALTH_BATHING=3-c30
replace c31=3 if c31==4
g HEALTH_DRINKING=3-c31
replace c32=3 if c32==4
g HEALTH_WASHING=3-c32
replace c33=3 if c33==4
g HEALTH_WALKING=3-c33
replace c34=3 if c34==4
g POLUTE_WATER_RESOURCES=3-c34
*tab POLUTE_WATER_RESOURCES
g KNOW_PUBHEALTH =HEALTH_BATHING + HEALTH_DRINKING +
HEALTH_WASHING + HEALTH_WALKING
quietly alpha HEALTH_BATHING  HEALTH_DRINKING  HEALTH_WASHING
HEALTH_WALKING /* alpha .89*/
quietly sum KNOW_PUBHEALTH
g KNOW_PUBHEALTH01 = (KNOW_PUBHEALTH- r(min))/(r(max)-r(min))
quietly pca HEALTH_BATHING  HEALTH_DRINKING  HEALTH_WASHING
HEALTH_WALKING
quietly predict KNOW_PUBHEALTH_PCA
```

```
*****knowledge Scientific and enviromental
g KNOW=KNOW_SCIENTIFIC+KNOW_ENV
g KNOW01=KNOW_SCIENTIFIC01+KNOW_ENV01

*******Attitude-A2-7, A11, C24****************
**how sensitive are the following-
**3 catagories; too(1), somewhat(2), not at all(3)
replace a2a=3 if a2a==4 /* DNK are considered as not at all*/
g SENSITIVE_WATERPOL=3-a2a /*reversing the ranking order*/
*tab SENSITIVE_WATERPOL
g SENSITIVE_AIRPOL=3-a2b
*tab SENSITIVE_AIRPOL
g SENSITIVE_VEHICLECROWD=3-a2c
*tab SENSITIVE_VEHICLECROWD
replace a2d=3 if a2d==4
g SENSITIVE_HOUSEHOLDWASTE=3-a2d
*tab SENSITIVE_HOUSEHOLDWASTE
g SENSITIVE = SENSITIVE_WATERPOL+SENSITIVE_AIRPOL ///
/*SENSITIVE_VEHICLECROWD*/+SENSITIVE_HOUSEHOLDWASTE
quietly alpha SENSITIVE_WATERPOL SENSITIVE_AIRPOL ///
SENSITIVE_VEHICLECROWD SENSITIVE_HOUSEHOLDWASTE /*.89*/
*tab SENSITIVE
quietly sum SENSITIVE
g SENSITIVE01 = (SENSITIVE- r(min))/(r(max)-r(min))
quietly xtile SENSITIVE4=SENSITIVE, nq(4)
*tab SENSITIVE4

**how important are the following-
**4 catagories; too(1), somewhat(2), not at all(3), DK(4)
replace a3=3 if a3==4 /*DNK are considered as not at all*/
g IMP_NATURE_CONSERVATION=3-a3
*tab IMP_NATURE_CONSERVATION
replace a4=3 if a4==4 /*DNK are considered as not at all*/
g IMP_POLUTION_CONTRL=3-a4
replace a5=3 if a5==4
g IMP_CULT_RELIG_CONSERVATION=3-a5
replace a6=3 if a6==4
g IMP_BAG_CULT_RELIG_ACTIVITIES=3-a6
replace a7=3 if a7==4
g IMPORTANCE_BAGMATI=3-a7
g
IMPORTANCE_RELIG=IMP_CULT_RELIG_CONSERVATION+IMP_BAG_CULT_
RELIG_ACTIVITIES
quietly alpha IMP_CULT_RELIG_CONSERVATION
IMP_BAG_CULT_RELIG_ACTIVITIES /*.66*/
```

```
g
IMPORTANCE_ENV=IMP_NATURE_CONSERVATION+IMP_POLUTION_CONTR
L
*tab IMPORTANCE_ENV
g
IMPORTANCE=IMPORTANCE_RELIG+IMPORTANCE_ENV+IMPORTANCE_BA
GMATI
quietly alpha IMPORTANCE_RELIG IMPORTANCE_ENV
IMPORTANCE_BAGMATI /*.71*/
quietly sum IMPORTANCE
g IMPORTANCE01 = (IMPORTANCE- r(min))/(r(max)-r(min))
quietly xtile IMPORTANCE8=IMPORTANCE, nq(8)
*tab IMPORTANCE8

*******risks-C26,27,28,*****************
**Problems due to polution in Bagmati
**how much do you agree with the following-
**4 catagories; absolotely(1), somewhat(2), no(3) DK(4)
*tab c26
replace c26=3 if c26==4
g HARMS_AQUATICS=3-c26
*tab HARMS_AQUATICS
replace c27=3 if c27==4
g HARMS_TOURISM=3-c27
*tab HARMS_TOURISM
replace c28=3 if c28==4
g HARMS_RELIGIOUS=3-c28
*tab HARMS_RELIGIOUS
g RISK = HARMS_AQUATICS+HARMS_TOURISM+HARMS_RELIGIOUS
quietly alpha HARMS_AQUATICS HARMS_TOURISM HARMS_RELIGIOUS
quietly xtile RISK8=RISK, nq(8)
*tab RISK8

**above defined RISK is not significant wrt to PAST_PARTICIPATION
g ATTITUDE=SENSITIVE+IMPORTANCE+RISK
quietly alpha IMP_CULT_RELIG_CONSERVATION
IMP_BAG_CULT_RELIG_ACTIVITIES ///
SENSITIVE_WATERPOL SENSITIVE_AIRPOL SENSITIVE_VEHICLECROWD
SENSITIVE_HOUSEHOLDWASTE /*.78*/
quietly alpha SENSITIVE_WATERPOL SENSITIVE_AIRPOL
SENSITIVE_HOUSEHOLDWASTE ///
                                        IMP_CULT_RELIG_CONSERVATION
IMP_BAG_CULT_RELIG_ACTIVITIES IMP_NATURE_CONSERVATION
IMP_POLUTION_CONTRL IMPORTANCE_BAGMATI ///
```

```
                              HARMS_AQUATICS HARMS_TOURISM
HARMS_RELIGIOUS  /* alpha for attitude .73*/
quietly xtile ATTITUDE4=ATTITUDE, nq(4)
quietly sum ATTITUDE
g ATTITUDE01 = (ATTITUDE- r(min))/(r(max)-r(min))
*hist ATTITUDE01
tab ATTITUDE01
quietly xtile ATTITUDE4_01=ATTITUDE01, nq(4)
*tab ATTITUDE4_01
*sum ATTITUDE4_01
quietly pca SENSITIVE IMPORTANCE RISK
quietly predict ATTITUDE_PCA
quietly xtile ATTITUDE_PCA4=ATTITUDE_PCA, nq(4)
quietly sum ATTITUDE_PCA

quietly pca SENSITIVE_WATERPOL SENSITIVE_AIRPOL
SENSITIVE_HOUSEHOLDWASTE ///
                              IMP_CULT_RELIG_CONSERVATION
IMP_BAG_CULT_RELIG_ACTIVITIES ///
                              IMP_NATURE_CONSERVATION
IMP_POLUTION_CONTRL IMPORTANCE_BAGMATI ///
                              HARMS_AQUATICS HARMS_TOURISM
HARMS_RELIGIOUS
quietly predict ATTITUDE_PCA_FROMALL

**How much should we spend in controlling bagmati pol
**-4 catagories; way more(1), a liitle more(2), current(3), DK(4)
replace a11=3 if a11==4
g SPENDING_BAGMATI_POL=3-a11
*tab SPENDING_BAGMATI_POL
quietly sum SPENDING_BAGMATI_POL
g SPENDING_BAGMATI_POL01 = (SPENDING_BAGMATI_POL- r(min))/(r(max)-
r(min))
*tab SPENDING_BAGMATI_POL01

**c24 Acceptibility of BAGMATI WATER-
**4 catagories; acceptable, somewhat, not, other
replace c24=1 if c24==4
g ACCEPTIBILITY_BAGMATI_WATER=c24
*tab ACCEPTIBILITY_BAGMATI_WATER
quietly sum ACCEPTIBILITY_BAGMATI_WATER
g ACCEPTIBILITY_BAGMATI_WATER01 =
(ACCEPTIBILITY_BAGMATI_WATER- r(min))/(r(max)-r(min))
*tab ACCEPTIBILITY_BAGMATI_WATER01
```

```
quietly alpha SPENDING_BAGMATI_POL01
ACCEPTIBILITY_BAGMATI_WATER01
quietly alpha SENSITIVE01 IMPORTANCE01 ///
 SPENDING_BAGMATI_POL01 ACCEPTIBILITY_BAGMATI_WATER01 /*.29*/

****Subjective norm- not used yet
**example-Most people important in my life think that I should support the proposed
plan-pouta2001
**spending ca11 and accpetability c24 could be norms
g SUB_NORM1 =  SPENDING_BAGMATI_POL
g SUB_NORM2 =  ACCEPTIBILITY_BAGMATI_WATER
g SUB_NORM = ACCEPTIBILITY_BAGMATI_WATER +
SPENDING_BAGMATI_POL
*tab ACCEPTIBILITY_BAGMATI_WATER
*tab SPENDING_BAGMATI_POL
quietly alpha ACCEPTIBILITY_BAGMATI_WATER  SPENDING_BAGMATI_POL


gen INCOME=e20a/12
replace INCOME=5000 if e20b==1
replace INCOME=7500 if e20b==2
replace INCOME=15000 if e20b==3
replace INCOME=25000 if e20b==4
replace INCOME=35000 if e20b==5
replace INCOME=45000 if e20b==6
replace INCOME=60000 if e20b==7
replace INCOME=80000 if e20b==8
replace INCOME=100000 if e20b==9
replace INCOME=. if e20b==10
replace INCOME=. if e20b==11
*sum INCOME
g INC_000=INCOME/1000
g L_INC=log(INCOME)

g EDU_RESP = e6a
replace EDU_RESP = 3  if EDU_RESP==1
replace EDU_RESP = 10 if EDU_RESP==2
replace EDU_RESP = 12 if EDU_RESP==3
replace EDU_RESP = 15 if EDU_RESP==4
replace EDU_RESP = 18 if EDU_RESP==5
replace EDU_RESP = 1  if EDU_RESP==6
g EDU_RESP_INTER = (EDU_RESP>10)

g EDU_FEMALE = e6b
replace EDU_FEMALE = 3  if EDU_FEMALE==1
```

```
replace EDU_FEMALE = 10 if EDU_FEMALE==2
replace EDU_FEMALE = 12 if EDU_FEMALE==3
replace EDU_FEMALE = 15 if EDU_FEMALE==4
replace EDU_FEMALE = 18 if EDU_FEMALE==5
replace EDU_FEMALE = 1  if EDU_FEMALE==6
g EDU_FEMALE_INTER = (EDU_FEMALE>10)

gen EDU_MALE = e6c
replace EDU_MALE = 3  if EDU_MALE==1
replace EDU_MALE = 10 if EDU_MALE==2
replace EDU_MALE = 12 if EDU_MALE==3
replace EDU_MALE = 15 if EDU_MALE==4
replace EDU_MALE = 18 if EDU_MALE==5
replace EDU_MALE = 1  if EDU_MALE==6

g EDU_MAX = max(EDU_FEMALE,EDU_MALE)
g EDU_MAX_INTER = (EDU_MAX>10)
g HHSIZE = e5
g AGE_RES = e2
g FEMALE=(e1==2)
g BATH_RELIGIOUS = c3
g PROFESSION_HEALTH=(e8==1 |e8==2 |e8==3 | e8==5)
g OWN=(e11==1)
*tab OWN
g BATH_RELIGIOUS1=(BATH_RELIGIOUS>0)
*tab BATH_RELIGIOUS1

g NEWAR=(e3==3)
*tab NEWAR
g FREQ_DIARRHEA=d4a1+d4b1
*tab FREQ_DIARRHEA
g FREQ_WORM=d4a2+d4b2
g FREQ_COLD=d4a3+d4b3
g FREQ_FEVER=d4a4+d4b4
g FREQ_SKIN=d4a5+d4b5
g
FREQ_DISEASE=FREQ_DIARRHEA+FREQ_WORM+FREQ_COLD+FREQ_FEVER
+FREQ_SKIN
*tab FREQ_DISEASE

g CULT_ATTACH=c2b
*tab CULT_ATTACH
g CULT_ATTACH1=(c2b>0)
*tab CULT_ATTACH1
g DRINK_WATER_CULT=(c4==1)
```

```
*tab DRINK_WATER_CULT

**distance from the river-there are two units, meter and minutes, I change the minutes to meter by multiplying by 80
**assuming that average speed is 80 mters per minutes (wikipedia, need to find the reliable source)
g distance_meter1=e15a1
replace distance_meter1 =0 if distance_meter1==.
*sum distance_meter1

**distance_meter1[is.na(distance_meter1)]<-0
g distance_meter2=e15a2*80
replace distance_meter2 =0 if distance_meter2==.
*sum distance_meter2
g DISTANCE=max(distance_meter1,distance_meter2)
g LDISTANCE=log(1+DISTANCE)
*sum DISTANCE
g DISTANCE_KM= DISTANCE/1000
g NEWARxDISTANCE_KM=NEWAR*DISTANCE_KM

**Information-radio tv
replace e17=4 if e17==5
g freq_newspaper = 4-e17
replace e18=4 if e18==5
g freq_radiotv = 4-e18
g INFORMATION = freq_newspaper+freq_radiotv
alpha freq_newspaper freq_radiotv

**exposure to information about filtering and boiling water
replace e19=3 if e19==4        /* changing do not know to never*/
g INFORMATION2=3-e19           /* reversing the order*/
tab INFORMATION2

g RESIDENCY = e13
replace RESIDENCY=.5 if RESIDENCY==1
replace RESIDENCY=3 if RESIDENCY==2
replace RESIDENCY=7.5 if RESIDENCY==3
replace RESIDENCY=10 if RESIDENCY==4

****labaling of the variables
label variable PAST_PARTICIPATION  "PARTICIPATION"
label variable ATTITUDE4_01 "ATTITUDE"
label variable KNOW_SCIENTIFIC01 "KNOW_SCIENTIFIC"
label variable KNOW_ENV01 "KNOW_ENV"
label variable KNOW_PUBHEALTH01 "KNOW_PUBHEALTH"
```

```
label variable INFORMATION2 "INFO_EXPOSURE"
label variable CULT_ATTACH "CULT_ATTACH"
label variable L_INC "L_INC"
label variable FEMALE "FEMALE"
label variable HHSIZE "HHSIZE"
label variable EDU_MAX "EDU_MAX"
label variable EDU_RESP "EDU_RESP"
label variable AGE_RES "AGE"
label variable PROFESSION_HEALTH "PROFESSION_HEALTH"
label variable DISTANCE_KM "DISTANCE"
label variable RESIDENCY "RESIDENCY"
label variable NEWAR "NEWAR"
label variable OWN "OWN"
**/

/************Descriptive statistics****************************
quietly estpost sum PAST_PARTICIPATION ATTITUDE4_01 ///
    KNOW_SCIENTIFIC01 KNOW_ENV01 KNOW_PUBHEALTH01
INFORMATION2 CULT_ATTACH ///
    L_INC FEMALE HHSIZE EDU_MAX EDU_RESP AGE_RES
PROFESSION_HEALTH ///
    DISTANCE_KM RESIDENCY NEWAR OWN

 esttab using
"E:\11th_semester\Sodhpatra\KABB_river_water\Estimation\Results\00.DescriptiveStats.
rtf", label ///
     labcol2("Voluntary Participation in river cleanup/restoration program (0= Never,
1=Rarely, 2=Sometimes, 3=Frequently)" ///
     "Construct index of attitude (normalized and divided into 4 ///
          quartiles such that higher value represents the strongest environmental attitude)"
///
     "Construct index of scientific knowledge (normalized such that values range from 0
to 1 ///
          and higher value represents higher level of knowledge)"  ///
     "Construct index of environmental knowledge (normalized such that values range
from 0 to 1 ///
          and higher value represents higher level of knowledge)"  ///
     "Construct index of public health knowledge (normalized such that values range from
0 to 1 ///
          and higher value represents higher level of knowledge)"  ///
     "Exposure to knformation (0= Never, 2=Sometimes, 3=Frequently)"  ///
     "Frequency  of last month's visit to Bagmati River for cultural and religious purpose"
///
     "Log of yearly income of the household"  ///
     "Gender (1=Yes, 0=No)"  ///
```

```
    "Number of members in the household"  ///
    "Education level of the member with maximum level of education"  ///
    "Education level of the respondent"  ///
    "Age of the respondent"  ///
    "Member associated with health profession (1=Yes, 0=No)"  ///
    "Distance of the household from the closest river (Km)"  ///
    "Number of years living in the community"  ///
    "Caste (1 = Yes, 0= no)" ///
    "Ownership of the household (1=0, 0=No)", ///
    title(""Definition)) ///
    title("Table 1: Definition of Variable and Corresponding Descriptive Statistics") ///
    cells("mean(fmt(2)) sd(fmt(2)) min(fmt(1)) max(fmt(0))") nonumber ///
    replace
****/

*******************Oprobit results for Attitude****************
eststo clear
quietly eststo: oprobit ATTITUDE4_01 KNOW_SCIENTIFIC01 KNOW_ENV01
KNOW_PUBHEALTH01 INFORMATION2 CULT_ATTACH
quietly eststo: oprobit ATTITUDE4_01 KNOW_SCIENTIFIC01 KNOW_ENV01
KNOW_PUBHEALTH01 INFORMATION2 CULT_ATTACH ///
                L_INC  FEMALE HHSIZE EDU_MAX EDU_RESP AGE_RES
PROFESSION_HEALTH
quietly eststo: oprobit ATTITUDE4_01 KNOW_SCIENTIFIC01 KNOW_ENV01
KNOW_PUBHEALTH01 INFORMATION2 CULT_ATTACH ///
                L_INC  FEMALE HHSIZE EDU_MAX EDU_RESP AGE_RES
PROFESSION_HEALTH ///
                DISTANCE_KM RESIDENCY NEWAR OWN
esttab using
"G:\11th_semester\Sodhpatra\KABB_river_water\Estimation\Results\e1.oprobit_ATTIT
UDE.rtf", label unstack b(%9.4f) se(4) onecell replace ///
title("Table E1: Results of Ordered Probit Model for Attitude ") ///
        noconstant ///
        mtitles("Model 1" "Model 2" "Model 3") nonum ///
        stats(N ll chi2 chi2_c aic bic, star(chi2 chi2_c) ///
        labels("Observations" "Log lik." "Chi-squared" "Chi-sq-indep" "AIC" "BIC")
fmt(0))///
        star(. 0.10 * 0.05 ** 0.01 *** 0.001)      /*this will show significance at 10% as
well*/


*******************Oprobit results forparticipation****************
        eststo clear
```

```
quietly eststo: oprobit PAST_PARTICIPATION ATTITUDE4_01
KNOW_SCIENTIFIC01 KNOW_ENV01 KNOW_PUBHEALTH01 INFORMATION2
CULT_ATTACH
quietly eststo: oprobit PAST_PARTICIPATION ATTITUDE4_01
KNOW_SCIENTIFIC01 KNOW_ENV01 KNOW_PUBHEALTH01 INFORMATION2
CULT_ATTACH ///
                  L_INC  FEMALE HHSIZE EDU_MAX EDU_RESP AGE_RES
PROFESSION_HEALTH
quietly eststo: oprobit PAST_PARTICIPATION ATTITUDE4_01
KNOW_SCIENTIFIC01 KNOW_ENV01 KNOW_PUBHEALTH01 INFORMATION2
CULT_ATTACH ///
                  L_INC  FEMALE HHSIZE EDU_MAX EDU_RESP AGE_RES
PROFESSION_HEALTH ///
                  DISTANCE_KM RESIDENCY NEWAR OWN
esttab using
"G:\11th_semester\Sodhpatra\KABB_river_water\Estimation\Results\e2.oprobit_PART.rt
f", label unstack b(%9.4f) se(4) onecell replace ///
title("Table E2: Results of Ordered Probit Model for Participation ") ///
        noconstant ///
        mtitles("Model 1" "Model 2" "Model 3") nonum ///
        stats(N ll chi2 chi2_c aic bic, star(chi2 chi2_c) ///
        labels("Observations" "Log lik." "Chi-squared" "Chi-sq-indep" "AIC" "BIC")
fmt(0)) ///
        star(. 0.10 * 0.05 ** 0.01 *** 0.001)     /*this will show significance at 10% as
well*/


*********table 23 Bioprobit with Attitude 0 TO 1 and Participation THIS IS THE ONE
I AM USING**********************
eststo clear
quietly eststo: bioprobit (PAST_PARTICIPATION = ATTITUDE4_01
KNOW_SCIENTIFIC01 KNOW_ENV01 KNOW_PUBHEALTH01 INFORMATION2
CULT_ATTACH) ///
        (ATTITUDE4_01  = KNOW_SCIENTIFIC01 KNOW_ENV01
KNOW_PUBHEALTH01 INFORMATION2 CULT_ATTACH), robust
quietly eststo: bioprobit (PAST_PARTICIPATION = ATTITUDE4_01
KNOW_SCIENTIFIC01 KNOW_ENV01 KNOW_PUBHEALTH01 INFORMATION2
CULT_ATTACH ///
                  L_INC  FEMALE HHSIZE EDU_MAX EDU_RESP AGE_RES
PROFESSION_HEALTH) ///
        (ATTITUDE4_01  = KNOW_SCIENTIFIC01 KNOW_ENV01
KNOW_PUBHEALTH01 INFORMATION2 CULT_ATTACH ///
                  L_INC  FEMALE HHSIZE EDU_MAX EDU_RESP AGE_RES
PROFESSION_HEALTH), robust
```

```
quietly eststo: bioprobit (PAST_PARTICIPATION = ATTITUDE4_01
KNOW_SCIENTIFIC01 KNOW_ENV01 KNOW_PUBHEALTH01 INFORMATION2
CULT_ATTACH ///
                    L_INC  FEMALE HHSIZE EDU_MAX EDU_RESP AGE_RES
PROFESSION_HEALTH ///
                    DISTANCE_KM RESIDENCY NEWAR  OWN) ///
          (ATTITUDE4_01  = KNOW_SCIENTIFIC01 KNOW_ENV01
KNOW_PUBHEALTH01 INFORMATION2 CULT_ATTACH ///
                    L_INC  FEMALE HHSIZE EDU_MAX EDU_RESP AGE_RES
PROFESSION_HEALTH ///
                    DISTANCE_KM RESIDENCY NEWAR OWN), robust
esttab using
"E:\11th_semester\Sodhpatra\KABB_river_water\Estimation\Results\23.Bioprobit_PART
_ATT_01_0720.rtf", label unstack b(%9.4f) se(4) onecell replace ///
title("Table 23: Bioprobit for PAST_PARTICIPATION with attitude_01 0720") ///
          noconstant ///
          mtitles("Model 1" "Model 2" "Model 3") nonum ///
          stats(N ll chi2 rho chi2_c aic bic, star(chi2 chi2_c) ///
          labels("Observations" "Log lik." "Chi-squared" " Rho" "Chi-sq-indep" "AIC"
"BIC") fmt(0)) ///
          star(. 0.10 * 0.05 ** 0.01 *** 0.001)      /*this will show significance at 10% as
well*/
************************end of the model****************************
```

AppendixF3: Stata_Code for Drinking Water Treatment Behavior Study

```
/*code written by hari katuwal, Sept 10, 2010*/
/*revised on Sept 2011*/
/*Drinking water treatment behavior in Kathmandu Valley*/

clear
cap log close
log using "G:\11th_semester\Sodhpatra\KABB_drinking_water\estimation\output.log",
replace
insheet using "G:\11th_semester\Sodhpatra\KABB_drinking_water\estimation\Bagmati-
Survey-final(26-08-09).csv"
set more off

gen INCOME=e20a/12
*gen INCOME=e20b
replace INCOME=5000 if e20b==1
replace INCOME=7500 if e20b==2
replace INCOME=15000 if e20b==3
replace INCOME=25000 if e20b==4
replace INCOME=35000 if e20b==5
replace INCOME=45000 if e20b==6
replace INCOME=60000 if e20b==7
replace INCOME=80000 if e20b==8
replace INCOME=100000 if e20b==9
replace INCOME=. if e20b==10
replace INCOME=. if e20b==11
sum INCOME
gen INC_000=INCOME/1000
gen L_INC=log(INCOME)

/*Here I generate categorical income*/
quietly xtile INC_0003=INC_000, nq(3)
g LOW_INCOME =(INC_0003==1)
g MID_INCOME =(INC_0003==2)
g HIGH_INCOME =(INC_0003==3)

gen EDU_RESP = e6a
replace EDU_RESP = 3  if EDU_RESP==1
replace EDU_RESP = 10 if EDU_RESP==2
replace EDU_RESP = 12 if EDU_RESP==3
replace EDU_RESP = 15 if EDU_RESP==4
replace EDU_RESP = 18 if EDU_RESP==5
replace EDU_RESP = 1  if EDU_RESP==6
```

```
gen EDU_FEMALE = e6b
replace EDU_FEMALE = 3  if EDU_FEMALE==1
replace EDU_FEMALE = 10 if EDU_FEMALE==2
replace EDU_FEMALE = 12 if EDU_FEMALE==3
replace EDU_FEMALE = 15 if EDU_FEMALE==4
replace EDU_FEMALE = 18 if EDU_FEMALE==5
replace EDU_FEMALE = 1  if EDU_FEMALE==6

gen EDU_MALE = e6c
replace EDU_MALE = 3  if EDU_MALE==1
replace EDU_MALE = 10 if EDU_MALE==2
replace EDU_MALE = 12 if EDU_MALE==3
replace EDU_MALE = 15 if EDU_MALE==4
replace EDU_MALE = 18 if EDU_MALE==5
replace EDU_MALE = 1  if EDU_MALE==6

g EDU_MAX = max(EDU_FEMALE,EDU_MALE)
g HHSIZE = e5
g AGE_RES = e2
g FEMALE=(e1==2)
g RESIDENCY = e13
replace RESIDENCY=.5 if RESIDENCY==1
replace RESIDENCY=3 if RESIDENCY==2
replace RESIDENCY=7.5 if RESIDENCY==3
replace RESIDENCY=10 if RESIDENCY==4

g SOURCE_PRIVATE = (d10a1==1)
*sum SOURCE_PRIVATE
*so 63.16 have private piped water
g OWN=(e11==1)
*tab OWN
g NEWAR=(e3==3)
*tab NEWAR
g FREQ_DIARRHEA=d4a1+d4b1

*e8 is if anyone is associated with health profession, less than 3 is yes
g HEALTH_PROF = (e8<=3)
*watertreat if treat for drinking and food prep (Note that it (watertreatd) should be
consistent
*with sum of all treatment behavior)
g WATERTREAT= (d10c1==1)
*tab WATERTREAT
*so 74.17% do treat
g CHILD_UNDER5 = (ed>=1)
```

```
g baddays = d2
qui sum baddays
g dbaby = d4a1
g dkid = d4b1
g work= (e7==1|e7==2|e7==3|e7==4)
g lostdays = d5a1
g lostdays_yn= (lostdays>0)
**tab lostdays_yn if work==1
**tab lostdays
g inc_e20b = (e20b)

*how serious is water pollution
gen water_pol= a2a

*how imp is natural env, cont pol, rel heritage
g impo_natenv = a3
g impo_contpol = a4
g impo_reliheritage = a5

*source of env information
g info_family=(c11f==1 |c11f==1)
qui sum info_family

g watertreatb=  (d10c1==1 | d10c4==1)
**tab watertreatb

*****different treatment methods
g FILTER = (d10d1a==1)
tab FILTER /*40.25*/
g BOIL = (d10d1b==1 | d10d1b==2) /* 2 is included because of the problem with
coding*/
tab BOIL  /*7.25*/
g FILTER_BOIL = (d10d1c==1 | d10d1c==3)
tab FILTER_BOIL /*23.17*/
g CHEMICAL = (d10d1d==1 | d10d1d==4)
tab CHEMICAL /*9.08*/
g OTHER = (d10d1e==1 | d10d1e==5)
tab OTHER /*0.75*/

g MORE_THAN_ONE = (FILTER + BOIL + FILTER_BOIL + CHEMICAL +
OTHER>1)
sum FILTER BOIL FILTER_BOIL CHEMICAL OTHER MORE_THAN_ONE
*total percentage using all method is 80.9%, which is little higher than total watertreatd
(74%)
```

```
*but there are 7.25% who still use more than one method, an
*40.25+7.41+23.83+9.42=80.9-7.25=73.4 which is pretty close to 74%

g TREAT_MD =(FILTER==1)
replace TREAT_MD =2 if BOIL==1
replace TREAT_MD =3 if FILTER_BOIL==1
replace TREAT_MD =4 if CHEMICAL==1
replace TREAT_MD = 0 if TREAT_MD == (.)
tab TREAT_MD /*0=26.33, 1=37.25, 2= 7.25, 3= 19.75, 4= 9.42, Discrepancy  in no eg
% for Filter is 40.25
but after I create different treatment mode, it is reduced to 37 because of some of the
repetition  which is
replaced by other categories*/

*adfrequency e19 is the frequency you listened ad related to water treatment
*1-frequently, 2-sometimes, 3-Never, 4-do not know
*I generate ad frequency by doing 4-e19, and change the value to 3 if frequently, 2 if
sometimes and 1 if never,
*so that higher no is more frequently
gen INFO_FREQUENCY=3-e19
replace INFO_FREQUENCY=0 if INFO_FREQUENCY==-1
*I change the adfrequency to dummy, but it is not significant even with dummy
*gen INFO_FREQUENCY=(INFO_FREQUENCY1>0)
*tab INFO_FREQUENCY

g tv_radio = (e18==1|e18==2)
g newspaper = (e17==1|e17==2)
g media_tv_r_news = (tv_radio + newspaper)
qui sum c9

**Here i gen community involvment by adding involvment in env isntitute and frequency
of participation in env rogram
g envinst_part = c8==1
g volunt = (c9==1|c9==2)
*initially freq-1, sometimes-2, rarely-3 and never-4, to make it other way I subtract from5
g volunt_1 = 5-c9
*rescaling-volunt_rescaled =(volunt_1-min(volunt_1))/(max(volunt_1)-min(volunt_1))
qui sum volunt_1
g volunt_rescaled = (volunt_1- r(min))/(r(max)-r(min))
qui sum volunt_rescaled
g COM_INVOLVEMENT = envinst_part + volunt_rescaled
qui sum COM_INVOLV
g COM_INVOLV = (COM_INVOLVEMENT- r(min))/(r(max)-r(min))

*gen comminv = (envinst_part + volunt)
```

```
*sum comminv
*gen comminv_binary = (comminv>=1)
*sum comminv_binary

g female=(e1==2)
g childunder5 = (ed>=1)
g fwithkids = female*childunder5
g sickkids_yn = dbaby>0
g feduc = (e6b==4|e6b==5)
g meduc = (e6c==4|e6c==5)
*Sick Days
g sickdays = d2
*Treatment decision
g source_prv = (d10a1==1|d10a4==1)

********Here I gen KNOWLEDGE index using c12a-how much do you know abt water
pol,
*c21-diseases because of pol water, c22-about e-coil and d16-filtration and hand washing
g know_wpol=4-c12
*minus 3 is to reverse thew order
**g know_wpol_scaled=(know_wpol-1)/(3-1)
g know_wpol_scaled = (know_wpol- r(min))/(r(max)-r(min))

* here I rescale the index
g know_disease=(c21==2)
g know_ecoli=(c22==1)
g know_treat=(d16a==1)
g know_treat1=(d16a==1)
g KNOWLEDGE_INDEX_SUM =
(know_wpol+know_disease+know_ecoli+know_treat)
qui sum KNOWLEDGE_INDEX_SUM
g KNOWLEDGE_INDEX = (KNOWLEDGE_INDEX_SUM- r(min))/(r(max)-r(min))
g KNOWLEDGE = (d16a==1)

****labeling  of the variables
label variable WATERTREAT  "TREATMENT"
label variable INC_000 "INCOME"
label variable MID_INCOME "MID_INCOME"
label variable HIGH_INCOME "HIGH_INCOME"
label variable EDU_MAX "EDU_MAX"
label variable KNOWLEDGE_INDEX "KNOWLEDGE"
label variable COM_INVOLV "INVOLVEMENT"
label variable INFO_FREQUENCY "EXPO_INFOMATION"
label variable SOURCE_PRIVATE "PUBLIC_CONNECTION"
label variable HEALTH_PROF "HEALTH_PROFESSION"
```

```
label variable HHSIZE "HHSIZE"
label variable FEMALE "FEMALE"
label variable CHILD_UNDER5 "YOUNG_CHILDREN"
label variable RESIDENCY "RESIDENCY"
label variable NEWAR "NEWAR"
label variable OWN "OWN"
label variable FREQ_DIARRHEA "DIARRHEA"

**************************correlation**********************************
*pwcorr WATERTREAT INC_000 EDU_MAX KNOWLEDGE_INDEX
COM_INVOLV INFO_FREQUENCY ///
*        SOURCE_PRIVATE HEALTH_PROF HHSIZE FEMALE CHILD_UNDER5
RESIDENCY OWN FREQ_DIARRHEA, sig

/******Descriptive statistics****************
quietly estpost sum WATERTREAT INC_000 EDU_MAX KNOWLEDGE_INDEX
COM_INVOLV INFO_FREQUENCY SOURCE_PRIVATE HEALTH_PROF ///
                HHSIZE FEMALE CHILD_UNDER5 RESIDENCY NEWAR OWN
FREQ_DIARRHEA

esttab using
"E:\11th_semester\Sodhpatra\KABB_drinking_water\estimation\Results\00.DescriptiveSt
ats.rtf", label  ///
   labcol2(                          ///
        "Households treats drinking water (1=Yes, 0=No)" ///
   "Monthly income in thousands" ///
   "Education level of the member with maximum level of education"  ///
   "Construct index of knowledge (normalized such that values range from 0 to 1 ///
        and higher value represents higher level of knowledge)"  ///
        "Construct index of community involvement (normalized such that values range
from 0 to 1 ///
         and higher value represents higher level of involvement)" ///
   "Exposure to information (0= Never, 1=Sometimes, 2=Frequently)"  ///
   "Private tap connected to the public distribution system is the major source of drinking
water"  ///
        "Association with the health profession (1=Yes, 0=No)"  ///
   "Number of members in the household"  ///
        "Female (1=Yes, 0=No)"  ///
   "Children under the age of 5 (1=Yes, 0=No)"  ///
   "No of years living in the community"  ///
        "Caste (1 = Yes, 0= No)" ///
   "Own home (1=Yes, 0=No)" ///
        "Frequency of of diarrhea events during the last month", ///
        title(""Definition)) ///
```

```
        title("Table 1: Definition of Variable and Corresponding Descriptive Statistics")
///
   cells("mean(fmt(2)) sd(fmt(2)) min(fmt(1)) max(fmt(0))") nonumber ///
        replace
*/

/*
******************************Model 1 Probit ****************************
eststo: quietly ///
probit WATERTREAT /*INC_000 INC_0003*/ MID_INCOME HIGH_INCOME
EDU_MAX KNOWLEDGE_INDEX COM_INVOLV INFO_FREQUENCY
estat ic
******************************Model 2 Probit ****************************
eststo: quietly ///
probit WATERTREAT /*INC_000 INC_0003*/ MID_INCOME HIGH_INCOME
EDU_MAX KNOWLEDGE_INDEX COM_INVOLV INFO_FREQUENCY ///
                SOURCE_PRIVATE /*HEALTH_PROF*/
estat ic
******************************Model 3 Probit ****************************
eststo: quietly ///
probit WATERTREAT /*INC_000 INC_0003*/ MID_INCOME HIGH_INCOME
EDU_MAX KNOWLEDGE_INDEX COM_INVOLV INFO_FREQUENCY ///
        /*SOURCE_PRIVATE*/ HEALTH_PROF ///
        HHSIZE /*FEMALE*/ CHILD_UNDER5 RESIDENCY NEWAR OWN
FREQ_DIARRHEA

**************************probit for treatment result********************
esttab using
"E:\11th_semester\Sodhpatra\KABB_drinking_water\estimation\Results\01.probit_result_
10_10.rtf", unstack b(%9.4f) se(4) onecell ///
        title("Table 2: Binomial probit regression results (y{\sub i} =1 if household adopts
at least one treatment method; = 0 otherwise)") ///
        mtitles("Model 1" "Model 2" "Model 3") nonum ///
        stats(N ll chi2 aic bic, star(chi2) ///
        labels("Observations" "Log lik." "Chi-squared" "AIC" "BIC") fmt(0)) ///
        varwidth(16) modelwidth(15) ///
        star(* 0.10 ** 0.05 *** 0.01) ///
        label replace
eststo clear

******************************Here I store marginaleffect***************
quietly probit WATERTREAT /*INC_000*/ MID_INCOME HIGH_INCOME
EDU_MAX KNOWLEDGE_INDEX COM_INVOLV INFO_FREQUENCY
SOURCE_PRIVATE HEALTH_PROF ///
```

```
HHSIZE /*FEMALE*/ CHILD_UNDER5 RESIDENCY NEWAR OWN
FREQ_DIARRHEA
eststo mfx: quietly mfx
esttab using
"E:\11th_semester\Sodhpatra\KABB_drinking_water\estimation\Results\02.mfx_result_1
0_10.rtf", unstack b(%9.4f) se(4) margin onecell ///
	title("Table 3: Marginal effects for binomial probit regression model") ///
	nomtitle nonum ///
	stats(N ll chi2 aic bic, star(chi2) ///
	labels("Observations" "
	Log lik." "Chi-squared" "AIC" "BIC") fmt(0)) ///
	varwidth(16) modelwidth(15) ///
	star(* 0.10 ** 0.05 *** 0.01 ) ///
	label replace
eststo clear
log close
************************* Modeling ends here*************************
Some notes:
	In eststo for marginal effect, notice the margin at last, required for the esttab for
marginal effects
*/

****************** MNLModeling starts from here***********************
eststo clear
eststo: quietly ///
mprobit TREAT_MD MID_INCOME HIGH_INCOME EDU_MAX
KNOWLEDGE_INDEX COM_INVOLV INFO_FREQUENCY,  baseoutcome(0)
eststo: quietly ///
mprobit TREAT_MD MID_INCOME HIGH_INCOME EDU_MAX
KNOWLEDGE_INDEX COM_INVOLV INFO_FREQUENCY ///
		SOURCE_PRIVATE HEALTH_PROF , baseoutcome(0)
eststo: quietly ///
mprobit TREAT_MD MID_INCOME HIGH_INCOME EDU_MAX
KNOWLEDGE_INDEX COM_INVOLV INFO_FREQUENCY ///
	SOURCE_PRIVATE HEALTH_PROF ///
	HHSIZE CHILD_UNDER5 RESIDENCY NEWAR OWN FREQ_DIARRHEA ,
baseoutcome(0)
esttab using
"F:\11th_semester\Sodhpatra\KABB_drinking_water\estimation\Results\F1.mnprobit_res
ult_10_10.rtf", unstack b(%9.4f) se(4) onecell ///
	title("Table F1: Multiomial Probit Regression Results") ///
	mtitles("Model 1" "Model 2" "Model 3") nonum ///
	stats(N ll chi2 aic bic, star(chi2) ///
	labels("Observations" "Log lik." "Chi-squared" "AIC" "BIC") fmt(0)) ///
	varwidth(16) modelwidth(15) ///
```

```
	star(* 0.10 ** 0.05 *** 0.01) ///
	label replace
eststo clear
******************* MNLModeling starts from here************************
mfx, predict(p outcome (1))
mfx, predict(p outcome (2))
mfx, predict(p outcome (3))
mfx, predict(p outcome (4))
************************end of the model*****************************
```

REFERENCES

Abdalla, C., Roach, B. & Epp, D. (1992), 'Valuing environmental quality changes using averting expenditures: an application to groundwater contamination', *Land Economics* **68**(2), 163–169.

Abrahams, N., Hubbell, B. & Jordan, J. (2000), 'Joint production and averting expenditure measures of willingness to pay: do water expenditures really measure avoidance costs?', *American Journal of Agricultural Economics* **82**(2), 427–437.

Adamowicz, W., J. Louviere, M. & Williams (1994), 'Combining revealed and stated preference methods for valuing environmental amenities', *Journal of Environmental Economics and Management* **26**, 271–292.

Ajzen, I. (1991), 'The theory of planned behavior', *Organizational Behavior and Human Decision Processes* **50**(2), 179–211.

Ajzen, I. & Driver, B. (1992), 'Contingent value measurement: On the nature and meaning of willingness to pay', *Journal of Consumer Psychology* **1**(4), 297–316.

Alam, M. & Marinova, D. (2003), 'Measuring the total value of a river cleanup', *Water Science and Technology* **48**(7), 149–156.

Andreoni, J. (1990), 'Impure altruism and donations to public goods: a theory of warm-glow giving', *The Economic Journal* **100**(401), 464–477.

Arcury, T. (1990), ‘Environmental attitude and environmental knowledge’, *Human Organization* **49**(4), 300–304.

Astra Development Network Pvt. Ltd., Geospatial System Pvt. Ltd., I. S. P. L. (2008), Bagmati action plan (2009-2014), a draft report submitted to National Trust for Nature Conservation (NTNC)), Technical report, Astra Development Network Pvt. Ltd., Geospatial System Pvt. Ltd., Innovative Solution Pvt. Ltd.

Barr, S. (2007), ‘Factors influencing environmental attitudes and behaviors’, *Environment and Behavior* **39**(4), 435–473.

Bartik, T. (1988), ‘Evaluating the benefits of non-marginal reductions in pollution using information on defensive expenditures’, *Journal of Environmental Economics and Management* **15**(1), 111–127.

Bateman, I., Carson, R., Day, B., Hanemann, M., Hanley, N., Hett, T., Jones-Lee, M., Loomes, G., Mourato, S., Özdemiroglu, E. et al. (2002), *Economic Valuation with Stated Preference Techniques: A Manual.*, Edward Elgar Publishing Ltd.

Bateman, I., Cole, M., Georgiou, S. & Hadley, D. (2006), ‘Comparing contingent valuation and contingent ranking: A case study considering the benefits of urban river water quality improvements’, *Journal of Environmental Management* **79**(3), 221–231.

Bernath, K. & Roschewitz, A. (2008), ‘Recreational benefits of urban forests: Explaining visitors’ willingness to pay in the context of the theory of planned behavior’, *Journal of Environmental Management* **89**(3), 155–166.

Binnie & Partners (1998), Water supply for Kathmandu and Lalitpur from outside valley, prefeasibility study for His Majesty Government of Nepal, Technical report, Binnie and Partners.

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

Blake, D. (2001), ‘Contextual effects on environmental attitudes and behavior’, *Environment and Behavior* **33**(5), 708–725.

Brekke, K., Kverndokk, S. & Nyborg, K. (2003), ‘An economic model of moral motivation’, *Journal of Public Economics* **87**(9-10), 1967–1983.

Brick, T., Primrose, B., Chandrasekhar, R., Roy, S., Muliyil, J. & Kang, G. (2004), ‘Water contamination in urban south India: household storage practices and their implications for water safety and enteric infections’, *International Journal of Hygiene and Environmental Health* **207**(5), 473–480.

Bright, A., Barro, S. & Burtz, R. (2002), ‘Public attitudes toward ecological restoration in the Chicago metropolitan region’, *Society & Natural Resources* **15**(9), 763–785.

Cameron, T. & Englin, J. (1997), ‘Respondent experience and contingent valuation of environmental goods’, *Journal of Environmental Economics and Management* **33**(3), 296–313.

Carlsson, F., Frykblom, P. & Liljenstolpe, C. (2003), ‘Valuing wetland attributes: an application of choice experiments’, *Ecological Economics* **47**(1), 95–103.

CBS (2001), *National Population Census 2001*, Central Bureau of Statistics, CBS.

CBS (2005), A Report on Water Survey of Kathmandu – 2005, Technical report, Central Bureau of Statistics, Nepal.

Cheung, S., Chan, D. & Wong, Z. (1999), ‘Reexamining the theory of planned behavior in understanding wastepaper recycling’, *Environment and Behavior* **31**(5), 587–612.

Choe, K., Whittington, D. & Lauria, D. (1996), ‘The economic benefits of surface water quality improvements in developing countries: a case study of Davao, Philippines’, *Land Economics* **74**(4), 519–537.

Ciriacy-Wantrup, S. (1947), ‘Capital returns from soil-conservation practices’, *Journal of Farm Economics* **29**(4), 1181–1196.

Cochran, W. (2007), *Sampling techniques*, Wiley-India.

Connelly, N. A., Knuth, B. & Kay, D. (2002), ‘Public support for ecosystem restoration in the Hudson River Valley, USA’, *Environmental Management* **29**(4), 467–476.

Cooper, P., Poe, G. & Bateman, I. (2004), 'The structure of motivation for contingent values: a case study of lake water quality improvement', *Ecological Economics* **50**(1), 69–82.

Day, B. & Mourato, S. (1998), 'Willingness to pay for water quality maintenance in Chinese rivers', *Centre for Social and Economic Research on Global Environment (CSERGE) Working Paper, WM* pp. 93–02.

DeShazo, J. & Fermo, G. (2002), 'Designing choice sets for stated preference methods: the effects of complexity on choice consistency', *Journal of Environmental Economics and Management* **44**(1), 123–143.

Do, T., Bennett, J. et al. (2009), 'Estimating wetland biodiversity values: a choice modelling application in Vietnam's Mekong River Delta', *Environment and Development Economics* **14**(2), 163–186.

Dunlap, R. & Van Liere, K. (1978), 'The new environmental paradigm: a proposed instrument and preliminary results', *Journal of Environmental Education* **9**(4), 10–19.

Dunlap, R., Van Liere, K., Mertig, A. & Jones, R. (2000), 'New trends in measuring environmental attitudes: measuring endorsement of the new ecological paradigm: a revised NEP scale', *Journal of Social Issues* **56**(3), 425–442.

Endter-Wada, J., Blahna, D., Krannich, R. & Brunson, M. (1998), ‘A framework for understanding social science contributions to ecosystem management’, *Ecological Applications* **8**(3), 891–904.

Enserink, B., Patel, M., Kranz, N. & Maestu, J. (2007), ‘Cultural factors as co-determinants of participation in river basin management’, *Ecology and Society* **12**(2), 24.

Fishbein, M. & Ajzen, I. (1975), *Belief, attitude, intention and behaviour: An introduction to theory and research*, Addison-Wesley.

Freeman, A. (2003), *The Measurement of Environmental and Resource Values: Theory and Methods*, Resources For the Future Press, Washington, DC.

Gamba, R. & Oskamp, S. (1994), ‘Factors influencing community residents’ participation in commingled curbside recycling programs’, *Environment and Behavior* **26**(5), 587–612.

Ghimire, G. (1985), ‘Water policy: a major crisis in Nepal’, *Environmentalist* **5**, 193–195.

Gramlich, F. (1977), ‘The demand for clean water: the case of the Charles River’, *National Tax Journal* **30**(2).

Greene, W. (2006), *Econometric Analysis*, Pearson Education, Upper Saddle River, NJ.

Hanemann, W. (1984), ‘Welfare evaluations in contingent valuation experiments with discrete responses’, *American Journal of Agricultural Economics* **66**(3), 332–341.

Haney, A. & Power, R. (1996), 'Adaptive management for sound ecosystem management', *Environmental Management* **20**(6), 879–886.

Hanley, N., Bell, D. & Alvarez-Farizo, B. (2003), 'Valuing the benefits of coastal water quality improvements using contingent and real behaviour', *Environmental and Resource Economics* **24**(3), 273–285.

Hanley, N., Colombo, S., Tinch, D., Black, A. & Aftab, A. (2006), 'Estimating the benefits of water quality improvements under the water framework directive: are benefits transferable?', *European Review of Agricultural Economics* **33**(3), 391–413.

Hausman, J.A., M. D. (1984), 'Specification tests for the multinomial logit model', *Econometrica* **52**, 1219–1240.

Hensher, D., Rose, J. & Greene, W. (2007), *Applied choice analysis: a primer*, Cambridge University Press.

Hotelling, H. (1949), 'An economic study of the monetary evaluation of recreation in the national parks', *Washington, DC: US Department of the Interior, National Park Service and Recreational Planning Division* .

Hunter, P., Zmirou-Navier, D. & Hartemann, P. (2009), 'Estimating the impact on health of poor reliability of drinking water interventions in developing countries', *Science of the Total Environment* **407**(8), 2621–2624.

ICIMOD (2007), Kathmandu valley environmental outlook, Technical report, International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal.

Jalan, J., Somanathan, E., Chaudhuri, S. et al. (2009), ‘Awareness and the demand for environmental quality: survey evidence on drinking water in urban India’, *Environment and Development Economics* **14**(6), 665–692.

Kaiser, F., Wölfing, S. & Fuhrer, U. (1999), ‘Environmental attitude and ecological behaviour’, *Journal of Environmental Psychology* **19**(1), 1–19.

Kanninen, B. (2007), *Valuing Environmental Amenities Using Stated Choice Studies: A Common Sense Approach to Theory and Practice*, Vol. 8, Kluwer Academic Publication.

Katuwal, H. & Bohara, A. (2011), ‘Coping with poor water supplies: empirical evidence from Kathmandu, Nepal’, *Journal of Water and Health* **9**(1), 143–158.

Kotchen, M. & Reiling, S. (2000), ‘Environmental attitudes, motivations, and contingent valuation of nonuse values: a case study involving endangered species’, *Ecological Economics* **32**(1), 93–107.

Krinsky, I. & Robb, A. (1986), ‘On approximating the statistical properties of elasticities’, *The Review of Economics and Statistics* pp. 715–719.

Kuhfeld, W. (2005), ‘Marketing research methods in SAS’, *Experimental Design, Choice, Conjoint, and Graphical Techniques. Cary, NC, SAS-Institute TS-722* .

Larson, B. & Gnedenko, E. (1999), ‘Avoiding health risks from drinking water in Moscow: An empirical analysis’, *Environment and Development Economics* **4**(4), 565–581.

Madajewicz, M., Pfaff, A., van Geen, A., Graziano, J., Hussein, I., Momotaj, H., Sylvi, R. & Ahsan, H. (2005), ‘Can information alone both improve awareness and change behavior? arsenic contamination of groundwater in Bangladesh’, *Journal of Development Economics* .

Magrath, J. (2007), ‘Water: A shared responsibility–the United Nations World Water Development Report 2’, *Development in Practice* **17**(2).

Mansfield, C. & Pattanayak, S. (2007), Getting started, *in* K. J. B., ed., ‘Valuing Environmental Amenities Using Stated Choice Studies; A Common Sense Approach to Theory and Practice’, Kluwer Academic Publications.

Markandya, A. & Murty, M. (2004), ‘Cost–benefit analysis of cleaning the Ganges: Some emerging environment and development issues’, *Environment and Development Economics* **9**(01), 61–81.

McFadden, D. (1974), Conditional logit analysis of qualitative choice behavior, *in* P. Zarembka, ed., ‘Frontiers in Econometrics’, Academic Press, New York.

MDG (2006), *The Millennium Development Goals Report 2006*, United Nations Pubns.

Miller, J. & Hobbs, R. (2002), ‘Conservation where people live and work’, *Conservation Biology* **16**(2), 330–337.

Mitchell, R. & Carson, R. (1993), *Using surveys to value public goods: the contingent valuation method*, Resources for the Future.

Mozumder, P., Helton, R. & Berrens, R. (2009), 'Provision of a wildfire risk map: informing residents in the wildland urban interface', *Risk Analysis* **29**(11), 1588–1600.

Novotny, V., Levinson, B., Perovich, G., for Urban Environmental Risk management, M. U. I., University, M., Agency, U. S. E. P., (US), N. S. F. & of Agriculture. STAR Watershed Program, U. S. D. (2001), *Risk Based Urban Watershed Management-Integration Of Water Quality And Flood Control Objectives*, Institute for Urban Environmental Risk Management, Marquette University.

Nunnally Jum, C. & Bernstein Ira, H. (1978), *Psychometric Theory*, New York: McGraw-Hill.

Ojea, E. & Loureiro, M. (2007), 'Altruistic, egoistic and biospheric values in willingness to pay (WTP) for wildlife', *Ecological Economics* **63**(4), 807–814.

Orme, B. (1998), 'Sample size issues for conjoint analysis studies', *Sawthooth Software Research paper Series. Squim, WA, USA: Sawthooth Software Inc* .

Oskamp, S., Harrington, M., Edwards, T., Sherwood, D., Okuda, S. & Swanson, D. (1991), 'Factors influencing household recycling behavior', *Environment and Behavior* **23**(4), 494–519.

Ostrom, E. (1990), *Governing the commons: The evolution of institutions for collective action*, Cambridge University Press.

Othman, J., Bennett, J. & Blamey, R. (2004), 'Environmental values and resource management options: a choice modelling experience in Malaysia', *Environment and Development Economics* **9**(06), 803–824.

Owen, A. & Videras, J. (2007), 'Culture and public goods: The case of religion and the voluntary provision of environmental quality', *Journal of Environmental Economics and Management* **54**(2), 162–180.

Park, T. & Loomis, J. (1996), 'Joint estimation of contingent valuation survey responses', *Environmental and Resource Economics* **7**(2), 149–162.

Pattanayak, S., Yang, J., Whittington, D. & Bal Kumar, K. (2005), 'Coping with unreliable public water supplies: averting expenditures by households in Kathmandu, Nepal', *Water Resources Research* **41**(2), 1–11.

Paudel, A. (1998), *UNEP EIA Training Resource Manual*, UNEP.

Popp, D. (2001), 'Altruism and the demand for environmental quality', *Land Economics* **77**(3), 339–349.

Pouta, E. & Rekola, M. (2001), 'The theory of planned behavior in predicting willingness to pay for abatement of forest regeneration', *Society & Natural Resources* **14**(2), 93–106.

Pradhan, B. (1998), Water quality assessment of the Bagmati River and its tributaries, Kathmandu Valley, Nepal, PhD thesis, Department of Hydrobiology, Institute of Water Provision, Water Ecology and Waste Management, BOKU.

Rutherfurd, I., Jerie, K. & Marsh, N. (2000), *A rehabilitation manual for Australian streams*, Land and Water Resources Research and Development Corporation (Australia) and Cooperative Research Centre for Catchment Hydrology.

Sajaia, Z. (2008), 'Maximum likelihood estimation of a bivariate ordered probit model: implementation and Monte Carlo simulations', *The Stata Journal* **4**(2), 1–18.

Saphores, J., Nixon, H., Ogunseitan, O. & Shapiro, A. (2006), 'Household willingness to recycle electronic waste', *Environment and Behavior* **38**(2), 183–208.

Schahn, J. & Holzer, E. (1990), 'Studies of individual environmental concern', *Environment and Behavior* **22**(6), 767–786.

Shakya, S. (2001), 'Alarming trends of river pollution in Kathmandu, Nepal', *Environment* **6**, 96–109.

Smith, V. K. & Desvousges, W. (1986), 'Averting behavior: Does it exist?', *Economics Letters* **20**(3), 291–296.

Sobsey, M. (2006), 'Drinking water and health research: a look to the future in the United States and globally', *Journal of Water and Health* **4**, 17.

Solecki, W. (1998), 'Local attitudes on regional ecosystem management: A study of New Jersey Pinelands residents', *Society & Natural Resources* **11**(5), 441–463.

Spash, C. (2006), 'Non-economic motivation for contingent values: Rights and attitudinal beliefs in the willingness to pay for environmental improvements', *Land Economics* **82**(4), 602–622.

Spash, C., Urama, K., Burton, R., Kenyon, W., Shannon, P. & Hill, G. (2009), 'Motives behind willingness to pay for improving biodiversity in a water ecosystem: Economics, ethics and social psychology', *Ecological Economics* **68**(4), 955–964.

Stanley International Ltd., M. M. L. & Ltd., E. C. P. (1994), Bagmati Basin Water Management Strategy and Investment Program, Final Report, His Majesty's Government, Ministry of Housing and Physical Planning/JICA/The World Bank., Technical report, Stanley International Ltd., Mott MacDonald Ltd. and East Consult (P) Ltd.

Stern, P., Dietz, T. & Guagnano, G. (1995), 'The new ecological paradigm in social-psychological context', *Environment and Behavior* **27**(6), 723–743.

Tarrant, M. & Cordell, H. (1997), 'The effect of respondent characteristics on general environmental attitude-behavior correspondence', *Environment and Behavior* **29**(5), 618–637.

Torgler, B., Garcá-Valiñas, M. & Macintyre, A. (2009*a*), 'Environmental participation and environmental motivation', *Foundazione Eni Enrico Mattei, Working Paper 254* .

Torgler, B., Garcá-Valiñas, M. & Macintyre, A. (2009*b*), 'Environmental participation and environmental motivation', *Center for Research in Economics, Management and the Arts Working Paper* .

Train, K. (1998), 'Recreation demand models with taste differences over people', *Land Economics* **74**, 230–239.

Train, K. (2008), *Descrete Choice Models with Simulation.*, Cambridge University Press, Cambridge.

Whittington, D., Pattanayak, S., Yang, J. & Bal Kumar, K. (2002), 'Household demand for improved piped water services: evidence from Kathmandu, Nepal', *Water Policy* **4**(6), 531–556.

WHO (2005), 'Progress towards the millennium development goals 1990-2005.'. http://unstats.un.org/unsd/mi/goals_2005/goal_4.pdf

Wohl, E. (2005), 'Compromised rivers: understanding historical human impacts on rivers in the context of restoration', *Ecology and Society* **10**(2), 2.

Wright, J., Gundry, S. et al. (2009), 'Household characteristics associated with home water treatment: an analysis of the Egyptian Demographic and Health Survey', *Journal of Water and Health* **7**(1), 21–29.

Zerah, M. (2000), 'Household strategies for coping with unreliable water supplies: the case of Delhi', *Habitat International* **24**(3), 295–307.