VALUING THE BENEFITS OF IMPROVED LAKE QUALITY: AN APPLICATION OF CHOICE EXPERIMENT TO THE CASE OF LAKE AWASSA

By

Girma G.selassie

A thesis submitted to the School of Graduate Studies of Addis Ababa University in partial fulfillment of the requirements for the Degree of Masters of Science in Economics

(Resource and Environmental Economics)

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Table of Contents

Page

List of Tables

List of Figures and Appendices

List of Acronyms

ABMs	Attribute-Based Methods
ASC	Alternative specific constant
BT	Benefit Transfer
CA	Conjoint Analysis
CE	Choice Experiment
CS	Compensating Surplus
CVM	Contingent Valuation Method
EWNHS	Ethiopian Wildlife and Natural History Society
HPM	Hedonic Pricing Method
IBC	Institute of Biodiversity Conservation
IIA	Independence of Irrelevant Alternatives
MNL	Multinomial Logit
MoA	Ministry of Agriculture
MoWR	Ministry of Water Resources
MRS	Marginal Rate of Substitution
MWTP	Marginal Willingness to Pay
MXL	Mixed Logit
NOAA	National Oceanic and Atmospheric Administration
RP	Revealed Preference
RPL	Random Parameter Logit
RUT	Random Utility Theory
RVLS	Rift Valley Lakes System
SEK	Swedish Kroner
TCM	Travel Cost Method
TEV	Total Economic Value
WTA	Willingness to Accept
WTP	Willingness to Pay

Abstract

The Lake environment provides many goods and services depending on the different attributes of the surrounding environment. In this paper, we identified, among other things three attributes, i.e., two environmental attributes (Tilapia fish stock, Surrounding forest cover) and one monetary attribute (fishing permit).

We carry out a Choice experiment among fishermen of Awassa Lake to estimate the value of improvement of the lake quality in general in terms of the attributes selected. We analyzed the data using Multinomial logit model and derive important issues concerning the preferences of fishermen of Lake Awassa. Results confirm that fishermen of Awassa Lake have high levels of environmental concern and are willing to pay for the improvement of the lake environment in terms of the attributes selected in the Choice experiment.

According to our result the most preferred attribute is Tilapia stock and it is also a significant attribute and therefore the most urgent action is to firstly to prevent further depletion of the Tilapia fish stock of the lake. This is also reflected in their higher willingness to pay for Tilapia fish stock improvement. Very low willingness to pay is observed for improvement in the degraded surrounding vegetation and forest cover of the lake. The marginal willingness to pay(Implicit prices) for the environmental attributes Tilapia fish stock and Surrounding forest cover were estimated. The mean WTP for Tilapia fish stock improvement is estimated to be 8.83 birr per month. However, mean willingness to pay for improvements in the surrounding forest cover is almost insignificant. Compensating surplus estimates which reflect overall willingness to pay for a change from the status quo (current situation) to alternative improvement scenarios were also calculated. The estimate for the high impact scenario was estimated to be 31.42 birr, for medium impact scenario 28.62 birr and for low impact scenario it was 18.62 birr per month.

One important implication draw from the study is that since the fishermen are willing to support the plan for the environmental improvement, the introduction of fishing permit is promising feature for resource users and as well as to the management of the natural resources as the whole.

CHAPTER ONE

INTRODUCTION

1.1. Background

The Ethiopian Rift valley Lakes system (RVLS) including the basins of Lake Awassa and its surrounding are home for a large number of human population engaged in various activities which are, directly or indirectly, related to the well being of the ecosystem. The basins also host a diversity of plant, animal and microbial resources that require their specific niche to perpetuate. Any activity that disrupts the normal functions of the environment will influence these niches thereby affecting natural biological diversity. In the last few decades, a rapid population growth has been recorded in the RVLS. This is attributable to easy access to the areas from different corners of the country and to the attractive features such as permanent lake water, mineral hot springs, fertile soil and a wealth of biological resources that flourished in the warm climate of the valley (Lemlem, cited in Yilma et al., 2003)

Lake Awassa is one of the areas identified by the Ethiopian Wildlife and Natural History Society as an "*important bird area* ". It is a sanctuary for some palarctic birds immigrating during the northern winter season. Owing to the lake's bird diversity and beautiful scenery, the town is becoming an important area for national and international tourists (EWNHS, 1996).The Awassa lake basin, in particular, has come under an unprecedented pressure, ever since the beginning of 1950s. In the process together with population growth, changes in land use have occurred due mainly to expansion of subsistence agriculture, opening up large scale state farms, manufacturing plants or related developmental ventures including fishing in the lake. These developmental changes however, were promoted without any appraisal on their impacts on the environments. As a result land degradation, aquatic and terrestrial habitat destruction and signs of desertification

are observed. Some of the factors that worsened the situations are deforestation (for farming and charcoal making), emergence development and subsequent expansion of a number of urban centers, unsustainable resource utilization and lack of proper environmental management practices. The negative impacts of the "development" processes have manifested themselves in the form of increased soil erosion, siltation, water pollution, habitat destruction and degradation of natural ecosystems (IBC, 2000).

1.2. Statement of the Problem

Lake Awassa, center of attention of this study, is located at an altitude of 1640m a.s.l, 275 km south of Addis Ababa in the SNNP Regional state. It is the smallest lake among the group in the rift valley, with a surface area of about 90km^2. The community of Awassa and its environs has utilized the resources of these lake and the associated wetlands as a livelihood source for a very long time. The water of the lake is used for irrigation, bathing, recreation and as drinking water for domestic use and wildlife. The fishery of the lake supplies vital fish protein and incomes for the people of the area and beyond (Zerihun, 2000)

Continuous and fast increase in water level and subsequent expansion of the lake surface area are evident from recent observations. An increase of 3.8m in water level is reported during the last 30 years, with an accelerated rate of about 2m increase in the recent years since 1996 (MoWR, 1999). Several factors are mentioned as causes for this water level increase, including the closed nature of the lake with no out flowing river. But the catchments degradation and the resulting soil erosion washed into the lake is also an important factor in this respect. The continuous silt deposition at the lake's bottom reduces the depth showing apparent increase in water level. The water inflow to the closed lake is mainly from river *Tikur wuha* that receives water from north eastern catchments. The river system is connected to the *cheleleka* wetland at the foot of the

wondo Genet Mountains. However, small seasonal streams drain into the lake with high load of silt from the surrounding farmlands. Lake Awassa has a water catchments area of 1360km^2 (Elias, 2000). The chemical composition of the lake water has been reported by a study team from Ministry of Water Resources. According to the study, the lake water has high fluoride concentration, above the permissible limit for drinking water, though it is no harm for the fish production or industrial use (MoWR, 1999). Chemical pollution from the factories in town and domestic sewage is apparent. Lake Awassa is a productive lake that contains six fish species. There is intensive fishing in the lake, the main fishing methods being gill netting and long-line fishing using hooks. The high market demand for Tilapia (one type of fish species) in the fast growing urban population and free access to the lake has encouraged the fishing effort to increase far beyond proportion of the fish stock, which has apparently resulted in species depletion. Ministry of Agriculture's (MoA) report (2003) indicates that about 3000 gillnet, 1700 hooks and 120 fishing boats are deployed on the lake. The estimated fish landing from the lake exceeds the maximum sustainable yield. According to the MoA report the fish yield from the lake attained a maximum of 790ton/yr during 1998/99 and then decreased sharply (486 and 320 ton/yr) during the following two consecutive years, income from the fishing is in general declining due to low productivity of the lake in terms of daily fish catches. The fishing pressure is far beyond the capacity of the fish stock to maintain sustainable production. As a result, number of people engaged in fishing is reducing (MoA, 2003). Pollution from domestic and industrial waste, effluent from the textile and ceramic factories, sewage from hospital, etc, are threats to the lake biodiversity resources as they drain untreated into the lake by way of cheleleka wetland. The annual use of pesticide and herbicides from commercial farms and seed enterprise has increased eutrophication condition from high use and mismanagement of Nitrogenous and Phosphorus (NP) products.

The recently endorsed study by the Institute of Biodiversity conservation (IBC) called Biodiversity Strategic Action plan has enumerated a number of factors affecting the biodiversity resources and ecosystem of rift valley system including Lake Awassa and it's surrounding. Catchments degradation, municipal and industrial waste as well as uncontrolled fishing practices are among the major causes for resource degradation and ecosystem disturbances of the lake environment (IBC, 2005).

The IBC prepared the site action plan for development, conservation and sustainable use of the biodiversity resources of the lake and its surroundings. So far no attempt was made how individuals value the multiple services that this ecosystem provides. Particularly, such comprehensive investment plan for the improvement of the ecosystem should integrate people's preferences: the willingness to pay for the improvements to take place for sustainable and wise use of the resource, and identifying attributes of the lake environment which are greatest contributor to community's welfare. Therefore, this is highly suitable for choice experiment method to conduct. To our knowledge there is no study that tried to impute value to each attribute of the lake and the surrounding ecosystem. This paper using choice experiment approaches tries to value improvements on the different characteristics/attributes of Lake Awassa and the surroundings.

1.3. Objectives of the Study

Generally, this study focuses on using the choice experiment method in order to understand the preferences for different attributes that fishermen living in Awassa and surrounding community attach for the lake and aims at estimating individual's marginal *willingness to pay* for different attributes of the lake environment. The specific objectives of the study are to:

- Estimate the marginal willingness to pay and welfare impacts of improvements of each attribute of the lake and the surrounding. This will help to extract policy relevant

information on characteristics of the lake and its surrounding that individuals think are important.

- Estimate the marginal rate of substitution (MRS) between the different attributes of the lake and the surrounding.
- Identify the socioeconomic determinants of the willingness to pay for different attributes of the lake.

And finally the paper tried to provide policy makers with much needed information for further improvements of the lake and its surroundings and draw concluding remarks and policy recommendations relevant to the existing situations of the lake.

1.4. Significance of the Study

This paper is presented as a research work to elicit individual fisherman's preferences for different attributes of Lake Awassa and its surroundings, and that it provide useful information for policy makers concerning decisions of improving environmental quality of Lake Awassa and its surroundings. So far there is no study conducted in the context of attributes based environmental valuation technique for Lake Awassa, particularly using choice experiment or choice modelling. By doing so, the research work attempts to add to the empirical literature on the area and will provide a basis for further empirical study on the subject in Ethiopia. Moreover, the result of this study is expected to be of interest to the Regional government, and other concerned body in providing information for guiding policy in relation to the environment.

1.5. Limitation of the Study

This research work is subject to time and financial constraints. Therefore, the study is restricted to the application of choice experiment to value the benefits of improved environmental quality of Lake Awassa and its surroundings as a case study. Furthermore, a sample is drawn from two fishing market areas namely, *Amora Gadel* and *Tikur wuha* areas. The study also selected two environmental attributes of the lake surroundings by assuming that other attributes of the lake affecting environmental quality of the lake surroundings held constant. If it was not for financial, material and time constraints, its finding would be more relevant had the study be done a much bigger sample and many attributes.

1.6. Organization of the Paper

The remainder of the thesis proceeds as follows. Chapter two presents theoretical background of environmental valuation and the literatures on various methods of valuation techniques followed by a review of previous studies particularly empirical literatures related to the method of choice experiment. The theoretical and methodological framework of choice experiment is described in detail in chapter three. Chapter four discusses the development of the choice experiment survey, data collection and survey design issues. In chapter five samples descriptive are provided and the results of the choice experiment are presented and analyzed.

Finally, in chapter six, the main findings of the study are summarized and some important policy implications are discussed.

CHAPTER TWO

Literature Survey

2.1. Theoretical Background

2.1.1 The Economic Approach to Environmental Valuation

Efforts to value the environmental effects of economic activities lie at the heart of planning for sustainable development. In the past some environmental goods and services have been assigned zero or low values. This was due to difficulties involved in assigning economic values to such commodities or to the attitude that they are 'free goods'. It is important to integrate environmental values into economic decision making processes because failure to do so can have adverse implications not only for current generations but also future generations (Kolstad, 2000).

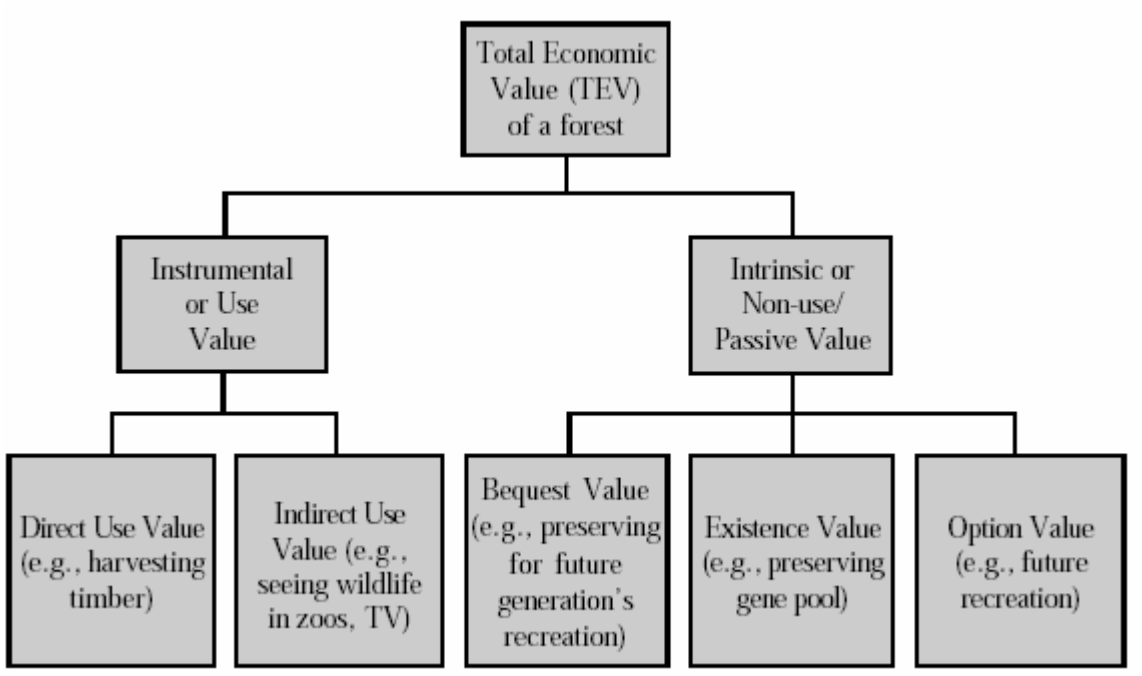
Ecosystem health in many parts of the world has deteriorated, in large part because of the loss of habitat from an ever-expanding world population. Virgin forests are being cleared for the purpose of selling the standing timber as well as providing farm land. Wetlands are drained to obtain more land for agriculture and housing. The number of endangered species of plants and animals grows annually. The world has yet to fully come to grips with how to appreciate and protect important ecosystems (ibid)

The economic concept of value is based on an anthropocentric, utilitarian approach to defining value based on individual preferences. As such, it does not encompass all possible sources of value. However, it is much broader than the narrow concept of commercial or financial value, and includes all values, tangible as well as intangible, that contribute to human satisfaction or welfare. This broad definition is reflected in the "total economic value" framework that underlies economic valuation and is described below.

2.1.2. The Total Economic Value Framework:

The *Total economic value* (TEV) framework is based on the presumption that individuals can hold multiple values for ecosystems. It provides a basis for taxonomy of these various values or benefits. Although any taxonomy of such values is somewhat arbitrary and may differ from one use to another, the TEV framework is necessary to ensure that all components of value are given recognition in empirical analyses and that "double counting" of values does not occur when multiple valuation methods are employed (Bishop et al., 1987). It is important to state that the TEV framework does not imply that the "total value" of an ecosystem should be estimated for each policy of concern. Even a marginal change in ecosystem services can give rise to changes in multiple values that can be held by the same individual, and the TEV framework simply implies that all values that an individual holds for a change should be counted.

Figure 2.1 Taxonomy of Economic Value



Adopted from Perman et al., (1999)

In the simplest form, TEV distinguishes between *use* values and *nonuse* values. The former refer to those values associated with current or future (potential) use of an environmental resource by an individual, while nonuse values arise from the continued existence of the resource and are unrelated to use. Typically, use values involve some human "interaction" with the resource whereas nonuse values do not. The distinction between use and nonuse values is similar but not identical to the distinction between instrumental and intrinsic value. Clearly, use values are instrumental and utilitarian, but the concept of existence value is not identical to the notion of intrinsic value, because the latter is deontological and includes non anthropocentric values while the former does not. Within the TEV framework an individual can hold both use and nonuse values for the services of an ecosystem.

To illustrate this with examples from (Barbier et al., 1997), consider an oil spill on a popular coastal beach resulting in forgone recreational trips to the beach—this is a lost use value. In addition, the oil spill could damage the ecosystem in ways that would not affect beach use and that beach users would never observe. It might, for example, kill marine mammals that live off the beach and are not seen by beach users, and beach users, as well as those who do not visit the beach, might experience a loss because of this ecosystem damage. The loss by those who do not visit the beach would be a loss of nonuse value, though there could also be a loss of nonuse value on the part of beach users.

The TEV framework implies that analysts proceed to investigate the potential loss in use and in nonuse values of beach users and in nonuse values of people who do not visit the beach. A number of TEV frameworks have been proposed in recent decades. Although varied in detail and application, the distinction between use and nonuse values is a fundamental theme. Distinctions are drawn between the components of TEV, but when people hold use and nonuse values, the literature argues for estimating peoples' TEV rather than estimating the components and then

adding the component estimates to compute a TEV (Bishop et al., 1987; Freeman, 1993). The TEV framework, as applied to typical aquatic system services for the purposes of this and of course relevant to this thesis, is illustrated in Table 2.1. The economic concept of value refers to measures in money terms of welfare or satisfaction of human preferences.

Theoretically, the total value/benefits of some environmental improvement such as improved lake environmental quality falls into two categories:

Total economic value= use value + non use value

TABLE 2.1 Classification and Examples of Total Economic Values for Aquatic Ecosystem Services (E.g. Lake Ecosystem)

Use Values		**Nonuse Values**
Direct	Indirect	Existence and Bequest Values
Commercial and recreational fishing Aquaculture Transportation Wild resources Potable water Recreation Genetic material Scientific and educational opportunities	Nutrient retention and cycling Flood control Storm protection Habitat function Shoreline and river bank stabilization	Cultural heritage Resources for future generations Existence of charismatic species Existence of wild places

Adopted from Barbier et al., (1997)

2.1.2.1. Use Values

Use values are generally grouped according to whether they are *direct* or *indirect*. The former refers to both *consumptive* and *non consumptive* uses that involve some form of direct physical interaction with the resources and services of the system. Consumptive uses involve extracting a component of the ecosystem for an anthropocentric purpose such as harvesting fish and wild

resources. In contrast, non consumptive direct uses involve services provided directly by ecosystems without extraction, such as use of water for transportation and recreational activities such as swimming. Although non consumptive uses do not involve extraction and hence reduction in the quantity of the resource available, they can diminish the quality of ecosystems through pollution and other external effects. It is also increasingly recognized that the livelihoods of populations in areas near aquatic ecosystems may be affected by certain key *regulatory ecological functions* (e.g., storm or flood protection, water purification, habitat functions) (Freeman, 1993). The values derived from these services are considered indirect, since they are derived from the support and protection of activities that have directly measurable values (e.g., property and land values, drinking supplies, commercial fishing).

2.1.2.2. Nonuse Values

Non–use values (sometimes called passive use value or intrinsic value) as the name suggests, are inherent in the good. That is, the satisfaction we derive from the good is not related to its consumption, *per se*. Non-use or passive use values consist of existence value, bequest value and option value.

Many natural environments are thought to have substantial existence values; individuals do not make use of these environments but nevertheless wish to see them preserved "in their own right" (Bishop and Welsh, 1992; Freeman, 1993). Nonuse values refer to all values people hold that are not associated with the use of an ecosystem good or service. Use values typically arise from a good or service provided by ecosystems that people find desirable. Nonuse values need not arise from a service provided by an ecosystem; rather, people may benefit from the knowledge that an ecosystem simply exists unfettered by human activity. Existence value arises from the benefit an individual derives from knowing that a resource exists or will continue to exist, regardless of the

fact that he or she has never seen or used the resource, or intends to see or use it in the future. A good example of the significance of non-use value is the international outcry over the whaling issue. There are many people who have never seen a whale or plan to see one, but are nevertheless willing to pay significant sums of money to ensure that whales are not hunted to extinction. Other motivations for nonuse values are bequest option and cultural or heritage values. Bequest value, as the name suggests, is derived from the benefits that individuals obtain from knowing that a resource will be available for future generations. The third type of non-use value, option value, is a little more complex. Option value may be defined as the amount of money an individual is willing to pay, at the current time, to ensure the future availability of the resource. To the extent that option value is the expected value of future use of the resource, it may also be classified as a use value.

The empirical literature generally does not attempt to measure values for individual aspects of nonuse values, but focuses on the estimation of nonuse values irrespective of the underlying motivations people have for holding this value component. The economic valuation of the impacts of the *Exxon Valdez* oil spill on the aquatic and related ecosystems of Prince William Sound, Alaska, highlights the importance of nonuse values in natural resource damage assessments and project appraisals. The *Exxon Valdez* study revealed that many Americans who have not visited Alaska and never intend to do so nevertheless place high values on maintaining the pristine and unique but fragile coastal and aquatic ecosystems of Alaska (Carson et al., 1992).

2.1.3. Measurement Using a Monetary Metric:

2.1.3.1. WTP versus WTA

Economic valuation is concerned with how to estimate the impact of changes in ecosystem services on the welfare of individuals and is based on the principles of utilitarianism. If ecosystem changes result in individuals' judging that they are worse off, one would like to have

some measure of the loss of welfare to these individuals. Alternatively, if the changes make people better off, one would want to estimate the resulting welfare gain.

The basic concept used by economists to measure such welfare gains and losses is rooted in the utilitarian notion that for any individual, the different sources of value that affect the individual's utility are potentially substitutable; that is, the individual is willing to trade a reduction in one source of value for an increase in another in a manner that leaves his or her overall utility unchanged. The essence of this approach is to value a change by determining what people would be willing to trade (i.e., to receive or to give up) so they would be equally satisfied or happy with or without the change.

Each measure looks at potential trade-offs between money and the good or service being valued that leave utility unchanged from some base level. They differ, however, in the base level of utility that is maintained when the hypothetical trade-off is made. In valuing an improvement in environmental quality or services, WTP considers trade-offs that would leave utility at the level that existed prior to the improvement (the pre-change utility level), whereas WTA considers the utility level that would exist after the improvement (the post-change utility level). Some cases such as when valuing small price changes, WTP and WTA measures of value can be expected to be quite close, differing only because of the different income levels implied by paying rather than receiving compensation (Willig, 1976 cited in Freeman, 1993). However, for many environmental goods and services, the two can be substantially different. In particular, Hanemann (1991) has shown that when valuing changes in the quantities of goods or services available for which there are no close substitutes (including many ecosystem services); the two measures of value can yield quite different results. For environmental improvements, the amount an individual is willing to accept to forgo that improvement will normally be greater than the amount he or she would be willing to pay to ensure it (WTA > WTP).

Because WTP and WTA measures of ecosystem services could differ significantly, a key issue in the use of economic valuation in this context is the choice between these two possible measures of value. As noted above, the conceptual difference lies in the base level of utility that each is designed to ensure. This reflects a difference in the assumption regarding the underlying allocation of property rights or, equivalently, the baseline levels of utility that society collectively agrees to ensure to each individual within that society. Although in theory economic valuation can seek to measure either WTP or WTA depending on the underlying assignment of property rights, it is common to use WTP as an empirically reliable measure. The primary reason is that most of the existing economic methods for estimating values capture WTP but not WTA. The use of WTP may be inappropriate in a given case because of the implicit property rights assumption embedded in it. However, even in cases where WTA would be the appropriate measure, WTP may still be a reasonable proxy for WTA. In theory and practice, the absolute value of willingness to accept usually exceeds the absolute value of willingness to pay (Hanemann, 1991). Thus, WTP can be viewed as a lower-bound for WTA and hence as a lower-bound for the value of the improvement. In some contexts, a lower-bound estimate of values will be sufficient to inform policy decisions.

In addition to the difference regarding the implicit assumption with respect to underlying property rights, WTP and WTA also differ in another important aspect, namely, the role of income limitations. Clearly, the amount that an individual is willing to pay for an environmental improvement depends on the amount that he or she is *able* to pay. In other words, WTP is constrained by an individual's income since he or she could never be willing to pay more than the amount available. WTA, on the other hand, is not income constrained. The amount of compensation that would be required to compensate an individual for accepting a lower level of environmental quality can exceed a person's income. This difference has important implications

in measures of aggregate net benefits. Income constraints imply that, all else being equal, low-income individuals will have a lower WTP than wealthier individuals simply because of their lower ability to pay. This implies that the preferences of wealthy people will get more weight than those of poorer people in net benefit calculations based on WTP. This feature of WTP should be borne in mind when using this measure of value (Hanemann, 1991).

2.1.4. Environmental Valuation Techniques

Society must choose the quantity of environmental goods it wishes to conserve or produce vis-à-vis other goods and services; and within this set of goods it must also select the desired quantity and quality of different environmental resources. Choices logically imply some form of valuation. A number of techniques are available to value environmental goods in economic terms.

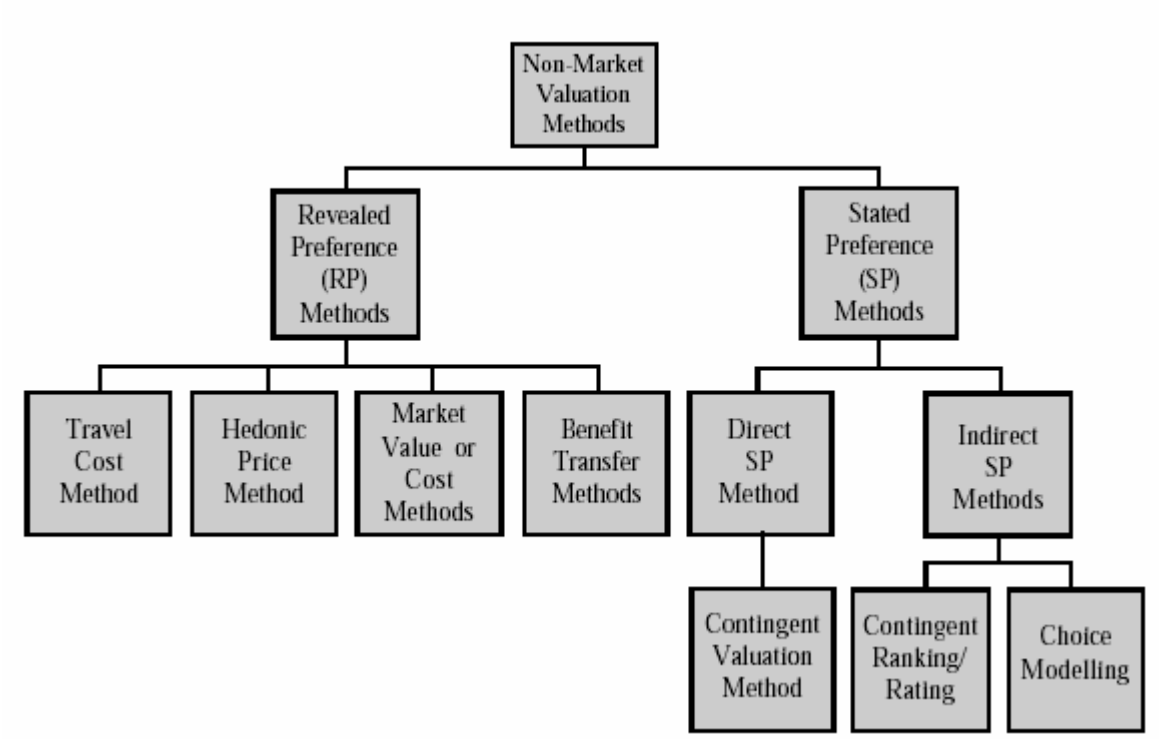
2.1.5. Non-market valuation methods

The methods of valuation of non-marketed goods have become crucial when determining the costs and benefits of public projects. Non- market valuation exercises have been conducted in many different areas, ranging from health and environmental applications to transport and public infrastructure projects. In the case of a good that is not traded in a market, an economic value of that good obviously cannot be directly obtained from the market. Markets fail to exist for some goods either because these goods simply do not exist yet, or because they are public goods, for which exclusion is not possible. Nevertheless, if one wants to compare different programs by using cost benefit analysis, the change in the quality or quantity of the non-market goods should be expressed in monetary terms. Another crucial application of valuation techniques is the determination of damages associated with a certain event. Under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 in the US, and after the events

that followed the Exxon Valdez oil spill in 1989, the methods of valuation have become a central part of litigation for environmental and health related damages in the United States and in several other countries.(Alpizar et.al.2001)

Over the years, the research on valuation of non-market goods has developed into two branches: Revealed preference (RP) (or indirect) approaches and Stated (or expressed) preference (SP) (or direct) approaches (see Figure 2.2). The revealed preference (i.e., indirect) approach infers value indirectly by observing individuals' behaviour in actual or simulated markets. For example, the value of wilderness area may be inferred by expenditures that recreationists incur to travel to the area. The value of, say, noise pollution may be inferred by analyzing the value of residential property near an airport. On the other hand, stated preference methods attempt to elicit environmental values directly from respondents by asking them about their preferences for a given environmental good or service. At the present time, only SP methods can be used to estimate total economic value (i.e., use and non-use values), whereas RP methods are only restricted to estimating use values.

Figure 2.2 Classifications of Non-Market Valuation Methods



Source: Garrod and Willis, (1999)

2.1.5.1. Revealed Preference Methods

Revealed Preference methods include the Travel Cost Method (TCM), Hedonic Pricing Method (HPM), Cost (or Expenditure) Methods, and Benefit Transfer (BT) Methods. The two most-well-known Revealed preference methods are the travel cost method and the hedonic pricing method (Braden and Kolstad, 1991).

(a) The Travel Cost Method

The TCM assumes that the costs that an individual incurs in visiting a recreational site are a measure of his or her valuation of that site. The approach involves asking visitors questions about where they have traveled from and the costs they have incurred.

This information is then related to the number of visits per annum, to generate a demand curve for the recreational site under question. Since we expect people living near the site to make more visits per annum compared to those living far away, the demand curve will be downward sloping. That is, travel cost will be inversely related to number of visits. The information requested in a travel cost survey includes the following: travel costs (petrol, food, and other travel-related expenses), income, alternative sites and personal motivations. Entrance fees to recreation sites are often non-existent or nominal. The demand curve drawn from the relationship between travel costs (a proxy for the price of recreation) and number of visits can be used to estimate the total recreation value of the given site (Freeman, A.M., 1979; Mahmud M. Yesuf, 1998)

Limitations of the TCM

The main assumption of the TCM is that the value of a recreational site can be proxied by the costs that the recreationist incurs in undertaking the recreational experience. The strength of the approach is that it is based on real rather than hypothetical data and as such can provide true values. However, the assumption that the recreational value of a place is directly related to travel costs incurred in getting there could be an oversimplification of reality. For example, people who live near the site may incur zero or minimal travel costs but may nevertheless have high values for the site.

Other limitations include the following:

(1) The TCM is suited to estimating the value of particular sites or locations and is unsuited for measuring other kinds of goods or services. For example, TCM cannot be used to value non-use or passive use values;

(2) Multiple destinations: a problem arises about the appropriate allocation of costs among multipurpose journeys. The allocation of such costs could be arbitrary. The issue of how to treat visitors from overseas is also problematic;

(3) Visits to certain sites could be seasonal and therefore the survey results could be biased unless it is conducted over a long period;

(4) Substitute sites: the current state-of-the-art methodology does not enable the TCM to account for substitute sites. In other words, travel costs of, say; two recreationists are given the same utility rating if they incur the same travel costs. However, it may be the case that one has a lower value for the site but has been compelled to go there due to lack of a nearby substitute site;

(5) Time and other factors: the TCM assumes that travel costs (e.g., fuel costs) are the major determinants of the value of a recreational site. However, other factors could affect the demand for recreation. For example, travel time is an opportunity cost because the time spent traveling is not available for other pursuits. Time should therefore be considered as a cost. However, there is no consensus as to how time should be accounted for in TCM. In some studies, a certain proportion of the wage rate is multiplied by travel time to provide an estimate of the opportunity cost of time. However, the choice of the weight is quite arbitrary and open to question; and

(6) It cannot be used to estimate non-use (or passive) values.

(b) Hedonic Pricing Method

Hedonic pricing (HP) derives from the *characteristics theory of value*, developed by Lancaster (1966) and Rosen(1974), with the first HP studies being published in the late 1960s and early 1970s. The method identifies environmental service flows as elements of a vector of characteristics describing a marketed good, typically housing. HP seeks to find a relationship between the levels of environmental services (such as noise levels or total suspended particulate

levels), and the prices of the marketed goods (houses). Here from the above empirical works we can understand that consumers consider the level of environmental quality (such as air quality) in addition to other characteristics of a house when deciding about their location for living and that house prices are expected to differ depending on the environmental quality.

Limitations of the HPM

The HPM is applicable to all environmental attributes that are likely to affect property prices. Examples of such attributes are water supply, noise and air quality. However, it also has some limitations. The main one is that it is only applicable in areas where the property market is well developed and the property owners are aware of the environmental attributes or impacts and take them into consideration in their assessment of property values.

Other limitations include:

(1) Statistical skills: a reasonable degree of statistical know-how is required to estimate the hedonic price function. Further skills are required to sort out the relevant variables for a suitable regression;

(2) A major assumption is that, given income constraints, people are free to select the characteristics of houses that satisfy their preferences and that the price they are willing to pay takes account of these factors. However, house prices can also be affected by external factors such as taxes and interest rates, which are not accounted for in the hedonic price equation; and

(3) The method cannot be used to estimate non-use values.

2.1.5.2 Stated Preference Methods

Stated preference method assesses the value of non-market goods by using individuals' stated behaviour in a hypothetical setting. The method includes a number of different approaches such as conjoint analysis, contingent valuation method (CVM) and choice experiments.

Stated Preference Methods can be either direct or indirect (see Figure 2.2). The direct form of SP method is referred to as the contingent valuation method (CVM). Indirect SP methods include a variety of approaches including contingent ranking and choice experiment -sometimes called- choice modelling.

(a) Contingent Valuation Method (CVM)

The CVM directly infers values by using surveys to ask people their maximum willingness to pay (WTP) to avoid and/or minimum willingness to accept compensation (WTA) for changes in environmental goods or services.

The term 'contingent' in CVM suggests that it is contingent on simulating a hypothetical market for the good in question.

The idea of CVM was first suggested by Ciriacy-Wantrup (1947), and the first study ever done was in 1961 by Davis (1963). Since then, CVM surveys have become one of the most commonly used methods for valuation of non- market goods.

A CV survey has a number of well-defined components. First, the interviewer describes the environmental good or service, including the change in the resource to be valued. The second element is a mechanism for eliciting the respondent's WTP or WTA. There are various formats for eliciting WTP (see Table 2). The dichotomous choice (or referendum) format is considered to be the state-of-the-art in CVM methodology. A National Oceanic and Atmospheric Administration (NOAA) panel of economic experts, chaired by Kenneth Arrow and Robert

Solow, recommended the referendum format over the open-ended format (Arrow et al., 1993). In all the formats, a payment method such as increased income taxes increased utility bills or voluntary donations are used.

Table 2.2 Formats for Eliciting WTP Values in the Contingent Valuation Method

Format	*Main features*
Bidding games	Respondents are offered progressively higher bids until they reach their maximum WTP
Payment card	A range of values is provided on a card and the respondent is requested to choose one
Open-ended questions	Respondents are asked to report their maximum WTP
Dichotomous choice (referendum)	A single amount is offered and respondents are asked to provide a 'yes' or 'no' answer, also referred to as the 'take it or leave it' or approach
Double-bounded referendum	Respondents who answer 'no' to the first amount are offered a lower amount, and those who answer 'yes' are offered a higher amount
Trichotomous choice	Respondents are offered three choices to the payment: 'yes', 'no' and 'indifferent'

The CVM survey also asks questions about respondents' socioeconomic characteristics, as well as other information about their environmental attitudes and other factors that might affect their WTP. The final part of the CVM study is the statistical analysis. The WTP responses are usually regressed against the socioeconomic and attitudinal characteristics and the estimated equation is used to provide aggregate estimates of mean or median consumer's surplus.

Limitations of the CVM

The method is quite versatile and can be applied to any environmental impact. As indicated earlier, it is the only method which can, so far, be used to estimate non-use values. The approach is fairly simple and relatively straightforward to apply. However, the CVM has many acknowledged problems.

These include hypothetical bias, strategic bias, embedding effects, information bias, and survey techniques bias. These biases are summarized in Table 2.3

Table 2.3 Some of the Biases Associated with the Contingent Valuation Method

Bias	*Description*
Hypothetical bias	It has been suggested that the hypothetical nature of the exercise might induce people to 'free ride', that is, understate their true WTP.
Strategic bias	Occurs when a person deliberately overstates (or understates) his or her true bid in order to influence the outcome. For example, some people who strongly support a proposed development may report a zero WTP for conservation even when they have a positive WTP.
Embedding effect	Occurs when an individual's WTP is lower when it is valued as part of a more inclusive good or service, rather than on its own. It has been suggested that embedding is caused by the existence of substitutes. That is, people will reduce their WTP if they are aware of substitutes.
Information bias	If insufficient information about the environmental good or service being values is given, the individual's WTP many not the same as the actual WTP.
Survey technique bias	Mail surveys generally have fewer respondents than face-to-face interviews, but interviewers could influence the responses. Also bias could result could arise from the use of inappropriate sampling techniques.

(b) Choice experiment

The basic idea behind any stated preference technique for estimating non-market environmental values is to quantify a person's willingness to bear a financial impost in order to achieve some potential (non-financial) environmental improvement or to avoid some potential environmental harm. Different stated preference techniques approach this task in different ways. In order to elicit passive use values, or values not associated with behavior or participation in an activity related to the environmental good, CE and CVM techniques would ask respondents about their choices of environmental quality settings (with and without an environmental improvement for example) along with a value or cost to their household of the options. For cases of use values-values for changes in environmental quality that can be inferred through examination of behavior-CE can be used to expand the range of existing environmental quality levels, and to reduce confounding of the environmental effects and other effects so as to isolate the value of the specific change (Bennett and Blamey, 2001)

The choice experiment method belongs to a family of Attribute Based Methods (ABMs). These are a special case of Conjoint Analysis (CA). By incorporating price as an attribute, ABMs can be used for the purpose of applied welfare analysis of changes and willingness to pay (WTP) (Louviere et al., (2000), Holmes and Adamowicz, (2003)). ABMs assume that a respondent's WTP consistently relates to his or her underlying preferences. The choice experiment method was originally developed by Louviere and Hensher (1982) and Louviere and Woodworth (1983).

Strengths and Weaknesses Choice Experiment

The applications of choice experiment (CE) reported in this paper demonstrate the capacity of the technique to provide policy relevant information on the values people hold for non-marketed environmental and social impacts. This information is important for a number of reasons. First,

with more complete information regarding the values of all the impacts, policy makers are better equipped to make decisions that are in the best interests of the whole community. Second, with improved information that is widely accessible to the public, the prospects of vested interest groups being able to "capture" the decision making process to their own advantage – and potentially to the disadvantage of the community as a whole – are diminished.

These are reasons for the estimation of non-market values. There are other reasons why CE can be regarded as superior to other techniques that have been designed and used to perform the same role (Adamowicz, Blamey et al., 2001).

A single application of the CE technique can produce estimates of value for many alternative policy outcomes. In addition, the composition of those value estimates can be examined through the analysis of the "part-worths" of the component attributes. This is in contrast to the most commonly used alternative non-market valuation technique, the contingent valuation method (CVM). Because CVM is based on a sample of affected people's responses to questions regarding their preferences for one alternative, it is capable of providing estimates of the value of that one alternative. That value estimate is therefore specific to a particular set of circumstances and cannot be "disaggregated" into the contributions made by the individual attributes that combine to constitute the alternative. The ability of CE to provide estimates of multiple scenarios makes it a more versatile and cost-effective technique.

An advantage of the "disaggregation" capability inherent to CE is that estimates of value derived from an application of CE at one site are more likely to be valid when "transferred" to another related site. This is because the different circumstances at the transfer site can be taken into account by adjusting the levels of the attributes accordingly. Again, because CVM results are circumstance specific, they do not offer this flexibility.

In this study of CE, only environmental attributes were included; however in other CE application both social and environmental attributes were included (see Morrison et al., 1999, Blamey et al., 2001; Ek, K., 2002 and Othman et al., 2004). The applications of choice experiment reported in these papers included social as well as environmental attributes as descriptors of the alternatives offered in the choice sets. These inclusions enabled the estimation of values associated with employment opportunities and regional income held by people not likely to benefit directly from the jobs or the income. These values can be compared to the "non-use" existence values held by people for endangered species: people are willing to pay to see other people employed and prosperous just as they are willing to pay to see endangered species protected. Choice experiment is capable of providing information that can be used to estimate these social values that are also non-marketed (ibid).

There are also reasons why choice experiment yields results that are less susceptible to "strategic behaviour" on the part of respondents. A continuing concern in regard to the use of stated preference techniques is that respondents deliberately misrepresent their preferences in order to bias the study's results in their favour. Specifically, if asked in a CVM application for the amount they are willing to pay to see an environmental good enhanced, a respondent who enjoys the environmental good may overstate their true willingness to pay in order to increase the chance of the good being provided. An advantage of CE in this respect is that it is much more difficult for respondents to identify a choice strategy that will influence the results in their favour. In the face of such uncertainty, it has been shown by Bohm (1972) that respondents are more likely to tell the truth. Some evidence of the reliability of CE responses has been reported by Blamey, Bennett, Morrison and Louviere (1998) who compare CE results with market generated data for a product with some environmental attributes – toilet paper.

Whilst CE demonstrates certain advantages, it is not without *challenges*. Foremost of these is the problem of respondent cognition. The choice sets that form the core of CE require respondents to select their most preferred option from an array of alternatives. Each alternative is described using a number of attributes. The amount of information a respondent must assimilate and act upon is significant and in environmental CE, the situation faced by respondents is unfamiliar. This places a significant cognitive burden on the respondent. If this is not carefully managed through questionnaire design and presentation the outcome can be biased sampling or results that are driven not be careful consideration of the choice but by decision heuristics.

The application of CE is also more complex than other stated preference techniques such as CVM. The complexity extends from the questionnaire design phase right through to the data analysis stage. The added complexity, at least during the time when the technique is being established will add to the costs of application. However, as the technique's application is refined and problems resolved, these cost disadvantages will be diminished.

What this somewhat brief treatment of the strengths and weaknesses of the CE technique demonstrate is that it affords substantial promise as a means of generating policy relevant information for decision makers dealing with issues involving environmental impacts.

2.2. Empirical Literature

Birol, E., Katia K., Phoebe K., (2005) conducted a choice experiment taking the case of cheimaditida wetland located 40 km southeast of Florina in North West Greece. This wetland includes Lake Cheimaditida, one of the few remaining fresh water lakes in Greece and constitutes a total wetland area of 168 km^2 surrounded by extensive marshes with reeds. The wetland is rich in flora, fauna and habitat diversity. They tried to value the non use value of the wetland and attributes were selected to reflect non use values generated by the wetland. Namely, *biodiversity*, *open water surface area*, *research and educational* values that can be extracted from the wetland and the values associated with environmentally friendly *employment opportunities*. Two wetland management scenarios were presented to the public. Finally, a choice experiment was employed to estimate the benefits of the non use values of the Cheimaditida wetland that accrue to the Greek public and to investigate heterogeneity in their preferences. Results from the choice experiment reveal that there is considerable preference heterogeneity across the public, and that they attach positive and significant values for the sustainable management of the wetland. In particular results from the conditional logit model indicated that all of the management attributes are significant factors in the choice of wetland management scenario, and ceteris paribus any single attribute increases the probability that a management scenario is selected. The Random parameter logit model (RPL), which accounts for unobserved, unconditional heterogeneity, was also used in order to account for preference heterogeneity. Random parameter logit model estimates of the sample result in significant derived standard deviations for the ASC and three attributes(*open water surface area, research and education, and retraining*) indicating that the data supports choice specific unconditional unobserved heterogeneity for these attributes and a similar result was found using *RPL model with interaction* (which fits the data best), based on this model, respondents are willing to pay 32 cents for an extra local re-trained in

environmentally friendly employment. Respondents' average willingness to pay for high levels of biodiversity was €36.68 and willingness to pay for an increase in the open water surface area from 20 percent to 60 percent was €20.26, and the average willingness to pay for an improvement in research and educational extraction from the wetland was €21.36.

A similar valuation technique was conducted by Carlsson, et al., (2003) to value attributes of a wetland. The choice experiment concerns a wetland area in staffanstorp, southern Sweden where the municipality of staffanstorp planned to develop a wetland in the area. They found that a choice experiment is essentially suitable for the design of the wetland. Through focus group discussion and pilot survey six attributes of the wetland that is about to be developed were selected. These attributes were: *surrounding vegetation, fish stock, introduction of Cray fish, biodiversity, walking facilities and fence*. And a choice experiment was conducted on 130 randomly chosen individuals. The study identified attributes that increase and decrease citizen's perceived value of wetlands. Using a *random parameter logit model* they found that biodiversity and walking facilities are the two greatest contributors to welfare, while a fenced waterline and introduction of crayfish decrease welfare. The important additional information they found from the Random parameter logit model was that, there was a strong heterogeneity in the preference for the attributes.

In Carlsson, F., Gunnar, K., Alemu M., Mahmud Y.(2005), a choice experiment /stated preference analysis survey was conducted in two zones in the Amhara regional state namely, East Gojjam and south Wollo. In the experiment, farmers were asked to make choices between an agricultural extension package and a local public good. The survey covered a total of 1520 house holds from the two zones. The situation in East Gojjam is generally considered to have a good

potential for agriculture, where as South Wollo is considered to be seriously affected by soil erosion and subjected to recurrent drought. Farmers were asked to make choices between an agricultural extension package and a local public good. Before the choice experiment, a scenario describing the attributes and the choice task was read out to them. The extension package was described as improved seed (maize and teff) and modern agricultural inputs. The extension package was described by two additional attributes: (i) the amount of money they have to pay back at harvest time, and (ii) an insurance scheme. The insurance was described as a system where they would not have to pay back the cost for the extension package if there is a crop failure. This extension package was to be compared with a local public good; the good is either a health station or a protected spring. The result from *random effects binary probit model* indicated that a large majority opted for the public good. The share of choices made in favor of the extension package was as low as 20 percent. The proportion of households that choose the health station and protected spring were 84 percent and 76 percent respectively. From these two public good, health station was preferred than protected spring. Another interesting result of the study was that when the extension package is combined with insurance in terms of no payback of the credit in case of crop failure, a significant increase in the choice of the extension package was observed. This result gives a clear indication of the importance of risk aversion in reducing the adoption rate of modern inputs in Ethiopian agriculture and gives evidence of how stated preference (choice experiment) methodologies can be utilized for development policy design.

Wikstrom, D (2003) studied a willingness to pay for sustainable coffee, using a choice experiment approach. The purpose of the study was to measure the willingness to pay for *KRAV*-certified (*ecologically/organically* grown coffee*)* and *fair*-certified and to find the underlying factors for an *ecological* and *fair* choice. The data was collected by a choice experiment executed

on 100 respondents. The results from the *random effects binary probit* model showed that the monetary attribute has a significant impact for the experienced utility of the consumer and the *KRAV*-certified attribute proved to generate a higher impact on utility for the consumer than did the *fair*-certified attribute. This was also reflected in a higher willingness to pay for *KRAV*-certified coffee. In addition, it was shown in the study that individuals being members in some non-profit organization tend to be more likely to buy ecological and fair coffee. From the analysis of the attitudinal variables it was made clear that consumers with the belief that *fair*-certified coffee is important also are probable to buy sustainable coffee. Results showed that there exist a clear market for both *KRAV*-certified and *fair* certified coffee. Consumers are ready to pay a premium for a coffee that has been produced in an *ecological* and *fair* manner. The study also elucidated that if the organizations behind *KRAV*-certified and *fair* certified coffees could lower the premiums they would have a major opportunity of increasing the market shares for their brands. Another fact that might be useful in the marketing of organic coffee is the fact almost 20 percent of the respondents expressed that they chose the alternative with organically grown coffee since they wanted to prevent to get any chemical substances in their coffee.

Hala Abou-Ali and Fredric Carlsson (2004), tried to analyze the *welfare effects* of improved health status through increased water quality using a choice experiment. The survey was administered to a random sample of 750 households in metropolitan Cairo, Egypt. Focus group discussion and a major pilot study were conducted to produce a final questionnaire. The questionnaire contained a number of sections, other than the choice experiment, including questions about the socio-economic characteristics of the household and questions about the water quality and health status of the household. Focus groups and pre-testing with a sample of individuals were used to determine some measurable attributes associated with the effect of the

quality of drinking water on health. These attributes are: (1) short run health effect. This was described as the number of ill days caused by water borne diseases during the year, e.g. diarrhea (2) long run health effect. This was related to the risk of contracting a dangerous disease in the future. A bundle of diseases such as hepatitis and cholera were mentioned in the scenario. (3) The cost attribute was formulated as an increase in the water bill due to the program. The descriptive statistics of the socio-economic characteristics of the interviewed respondents showed that, 40 percent of the sample chose the *status quo* in the four offered choice sets, while 38 percent never chose the *status quo*. Around 26 percent of the participants supported the positive short run effects of better water quality, while 51 percent of the respondents believed in the reduction of long run ill health effects by enhancing the water quality. Since better water quality may lead to better health, around 26 percent of the respondents were willing to contribute to the program. Results from the *random parameter logit model* they used showed that, households in metropolitan Cairo have a positive willingness to pay to reduce health risks related to water quality. The mean willingness to pay concerning a 50 percent decrease in the short run health effect due to poor water quality, and a reduction in the probability of contracting waterborne diseases in the long run to 2 percent is found to be almost 15 Egyptian pounds per every second month. They also found significant heterogeneity among the households, both in terms of observed characteristics such as whether they had contracted diarrhea in the last year or not, educational level, whether the household is female headed or not.

Bergman, A. Nick Hanley and Robert Wright (2004), tried to value the attributes of renewable energy investments in Scotland. The methodology used to do this was the choice experiment technique. Renewable technologies considered include hydro, on-shore and off-shore wind power and Biomass. Five key attributes were then identified from examining the focus groups,

government announcements and statements, and literature. These attributes were: *impacts on landscape, impacts on wildlife, impacts on pollution levels, creation of long-term employment opportunities and potential increase in electric prices* to pay for renewable sources. The combination attributes and their respective levels were created using an orthogonal design procedure. Four choice sets were then presented and the survey participants were requested to indicate their preferences. Results for all the 211 respondents from the Multinomial logit (MNL) model (the *simple model* shows results when only the choice experiment attributes are included in the regression) showed that all attributes coefficients have the expected sign. Price was negative and therefore in accord with standard economic theory. All of the environmental attributes were significant determinants of utility at some level: these were changes in air pollution, landscape effects and wildlife effects. However, they found that employment creation is not a significant attribute. In the *extended model* many socio-economic variables were included. The covariates used in the "expanded" model show either statistical significance; or are included on theoretical grounds. A likelihood ratio test was used to compare the "simple" and "expanded" models, and rejected the null hypothesis that the parameter values of the two models are equal at the 95% significance level.

They also derived implicit prices from the two models which are not statistically different. Households are willing to pay £8.10 to decrease high impact landscape change to having no landscape impact. They are willing to pay £4.24 to change a slight increase in harm to wildlife from renewable projects to a level that has no harm. However, households would be willing to pay £11.98 per annum to change a slight increase in harm to wildlife from renewable projects to a level that wildlife is improved from the current level. Households are also willing to pay £14.13 to have renewable energy projects that have no increase in air pollution compared to a programme which results in a slight increase in pollution. The conclusions of the paper indicate

that, renewable energy offers a partial solution to the problem of reducing greenhouse gas emissions whilst meeting future energy needs. Yet different renewable energy projects can have varying external costs in terms of impacts on the landscape, on wildlife and on air pollution. In addition, strategies vary in their likely impacts on jobs and electricity prices. The choice experiment method used in the paper enabled these effects to be jointly evaluated in welfare-consistent terms.

Hanley et al., (2005) studied the economic value of improvements in river ecology using choice experiment. They located their choice experiment in the context of improvements to the ecology of the River Wear, in County Durham, England; and the River Clyde, in Central Scotland. These were chosen as broadly representative of the kind of water bodies in the UK where moderate improvements in water quality are likely to be needed in order to meet Good Ecological Status. Focus groups were recruited from local residents living around the two rivers in both case study areas in order to (i) gauge local attitudes to the rivers and to their problems (ii) investigate current uses of the two rivers and (ii) identify the attributes by which the rivers could best be characterized. They also gauged reaction to the idea of the need to pay for improvements in river ecology. As a result of group discussions, three river quality attributes were chosen for the choice experiment. These were in-stream ecology, aesthetics/appearance, and bank side conditions; each attribute was set at one of two levels. The 'fair' level was described in such a way as to be consistent with current conditions on the Rivers Wear and Clyde. The 'good' level was consistent with regulators' expectations as to what will likely constitute good ecological quality status under the Water Framework Directive. These merely represent the characteristics of 'water quality' as perceived by the general public. A cost or price attribute was established as higher water rates payments by households to the local sewerage operator. Sampling was undertaken with a randomized quota sampling approach, using in-house surveys by trained market research

personnel. They collected 210 responses for each river. They used both *multi-nomial logit model* and a *random parameters logit model*. First, they conducted the Hausman test for IIA. This test was carried out on a pooled sample of both survey sites ('both river') and individually for each survey site ('River Wear' and 'River Clyde'). In all three cases the acceptance of IIA was firmly rejected with the Hausman statistic being very large and statistically significant well below the one per cent level. The random parameters logit model allows for such variation in preferences across individuals and adjusts for error correlation across the choices made by each individual. Turning first to the multi-nomial logit estimates, in all three samples the three attributes have the expected positive signs and all are statistically significant below the one percent level. Likewise, in all three samples, price has the expected negative sign. However, price is not statistically significant at even the generous ten per cent level in the River Clyde sample. Turning next to the random parameters logit estimates, in all three samples the three attributes have the expected positive signs and all are statistically significant below the one percent level. Therefore, with respect to the attributes both estimators are generating similar results. But in the river Clyde sample price is statistically significant at the five percent level. This result confirmed that people 'value' and are prepared to pay for water quality improvements and such improvements are valued 'even more' the lower the cost associated with obtaining them.

From the standard deviations and standard errors for the parameters of the random parameter logit estimates, they noted that the standard deviation for the 'river ecology' attribute is statistically significant at the five per cent level or lower in all three samples. The standard deviation for the 'aesthetics' attribute is only statistically significant (below the one percent level) in the River Clyde sample. The standard deviation of the 'bank sides' attributes is not statistically significant in any of the samples. Results suggested two things relating to preferences. The first is that the major component of preference heterogeneity is preferences towards 'river ecology'. The

second is that preference heterogeneity in the River Clyde sample compared to the River Wear sample is 'larger'. i.e. preferences appear to be more homogeneous amongst river wear respondents. They also reported the implicit prices along with their standard errors. These values are the amount of money individuals are willing-to- pay for the specified improvement. Most of these prices are statistically significant below the one percent. It was also indicated in the study that both the multi-nomial and random parameters logit models generate a set of implicit prices that are very similar for the river wear sample and this suggested according to them that preference heterogeneity is likely not a factor of much importance and the prices are robust. For the River Clyde sample, the multi-nomial logit model generates prices that are not statistically significant to zero. However, the random parameters logit model gives prices for the River Clyde sample that are statistically significant at the five per cent level. The fact that these prices are not significant in the multi-nomial logit model but are significant in the random parameters logit model demonstrates the potential importance of controlling for preference heterogeneity in choice experiments.

In Othman, J., Jeff Bennett and Russell Blamey (2004) – the choice modeling concerned about the matang mangrove wetlands located in the sub district of matang in the state of perk, Malaysia the wet land measures about 40000 hectares and represent 40 percent of the total mangroves in Malaysia. The study was specifically aimed at generating data on non-market values so that policy makers can better ascertain if the forest resources have been managed in the most desirable way from the perspective of society at large, i.e. to assist decision makers in determining the optimal management strategy. On the basis of focus group five forest attributes was identified including animal contribution to matang mangroves fund; namely, environmental forest area, direct employment, number of migratory bird species, visitation rates for recreation and annual

contribution. Each attribute has three levels and combined with the attributes using the fractional factorial design method. There were three management options presented to the respondents including the current management regime. Stratified random samplings of 571 respondents from three selected sub-district were undertaken.

Results from the multinomial logit model indicated that the coefficients for all of the attributes in the choice sets are significant at the 1 percent level and all have the a priori expected signs. The results from the extended multinomial logit model also indicated all the attributes and socioeconomic variables parameters are again strongly significant in explaining the performance of respondents for the improved plan relative to the status quo. Analysis of responses to the choice sets revealed that only 28 percent of all responses were in favor of the status quo. They also developed a nested logit model to avoid the problem of independent of irrelevant alternatives violation. Results from this model also showed that all the environmental and social attribute variable parameters showed positive signs and are significant at the 1 percent level, i.e. options with more area devoted to environmental forests, more migratory bird species, more employment and visitation rates are preferred. The negative cost coefficient implies that respondents were less likely to choose the more costly option. The explanatory power of the model (*adjusted rho square*) is satisfactory at 24 percent. The coefficients for the socioeconomic and attitudinal variables are also statistically significant, except for AGE, and the signs are consistent with expectations. All the signs are negative. Since the alternative specific constants for these variables relate to the baseline option in the nested logit model; negative coefficients reflect that respondents who had higher income and education levels, and were pro-environmental were less likely to choose the status quo option or the current management regime. Interestingly, their findings compare very well with that of the MNL model.

The estimates of implicit prices from the two models do not differ substantially. Using the nested logit model, they found that, non-user households were, on average, willing to pay RM0.81 for an additional 1 percent of environmental forest area and RM1.36 for an additional 1 percent of migratory bird species to be present in the matang mangroves, ceteris paribus. The models also enabled the estimation of welfare changes (CS) associated with an array of changes in wetland management away from the 'status quo' scenario. The results showed that the CS estimates from both models differ significantly, while the order of magnitude remains consistent.

Generally, the study showed that by weighing up these values along with the market values of benefits and costs for the available alternative plans, the relevant authority can identify a management plan that yields the greatest net benefit to society.

Eggert and Olsson (2003) – using choice experiments they estimated the benefits of improving coastal water quality with respect to fishing possibilities, bathing water quality and biodiversity levels for a random sample of individuals in the south western parts of Sweden. Water quality was represented by three different attributes: (1) fish stock level, (2) bathing water quality and (3) biodiversity level. They also consider the fourth attribute to be the cost associated with the improvement of the coastal water quality. They used standard MNL model and a more general model called mixed multinomial logit model (MXL) to incorporate a random taste variation. This is because one of their objectives was to see heterogeneous preferences for the attributes mentioned above among individuals and also the MXL does not exhibit the IIA property and it is well suited to explicitly account for unobserved heterogeneity in taste, since it allows parameters to have a distribution. Results of the MXL showed that the attributes and the cost parameter are significant at the 1 percent level for both MNL and MXL. Heterogeneous preferences in the population are confirmed by the statistical significance of the standard deviation of the random

parameters, which is significant at the 1 percent level. They also found that among the socioeconomic variables of age, owning a house or owning a summer cottage by the cost, (which were significant for the standard (MNL), it is only the summer cottage parameter that is significant for MXL model. The respondent age and whether or not he or she resides by the coast were not significant variables. They also calculated the marginal rates of substitution between the attributes and cost and interpreted the ratios as marginal willingness to pay for a change in the attribute in question. '*Fish'* relates to the level of cod in the sea and the results indicated an average WTP for improving cod level from the current level, which is the lowest level, to the highest level. Similarly, '*water'* relates to an improvement of bathing water quality from the worst to the best level. For the *biodiversity* level, the current level is the medium level and the estimates relate to an improvement or avoiding further deterioration of biodiversity respectively. The mean marginal willingness to pay (MWTP) calculated for each attribute together with a 95 percent confidence interval found to be fairly stable across models. With water, improved fish stock, high biodiversity; and avoiding lower biodiversity about SEK600, 1200, 600 and 1400 respectively.

The highest average MWTP value, SEK1400, was found for avoiding a reduction in biodiversity level. The corresponding figure for improved biodiversity level was SEK 600, the MWTP for improved bathing water quality was SEK 600, and an improved fish stock leads to an average marginal WTP of SEK1300. The most urgent action according to their findings was firstly to prevent further depletion of marine biodiversity and secondly to improve Swedish cod stocks.

The overall finding was that choice experiments offer a suitable way to assess multi-attribute values, as in the case of water quality. Up to now, almost all economic research has focused on stock and harvest effects; the results of their study indicated that non-consumptive benefits like biodiversity should be addressed as well. What generally these empirical works showed us that

choice experiment method enable projects to be preferred and evaluated based on their specific characteristics to maximize the welfare of society, i.e. choice experiment environmental valuation method can be used for the appraisal of the particular projects that can bring the maximum social benefit.

CHAPTER THREE

3. Theoretical Framework and Method of Choice Experiment

3.1. Methodology

Traditional microeconomic theory constitutes the basic theoretical foundation of the choice experiment application. Hence consumers are assumed to seek to maximize utility subject to a budget constraint. Specifically, the choice experiment approach combines the characteristics theory of value (Lancaster, 1966) and the random utility theory (McFadden, 1974). Choice experiment applications have been commonly used in marketing, psychology, and transport research, and have recently become increasingly popular in environmental valuation applications (see for instance, Admowicz et al., 1998; Boxall et al., 1996; Hanley et al., 1998). The theoretical framework and the empirical model specification presented in this chapter draw on this literature.

The estimation of the preferences for environmental non-market goods and for changes in environmental quality constitutes an important element of the environmental economics literature. Applications of non-market valuation techniques are common in public transport Infrastructure projects, and in different environmental studies damage assessment cases have also prompted considerable research activities in this area. The contingent valuation method (CVM) has been used extensively, during the last decade indifferent environmental applications, although it has also been questioned (Garrod and Willis, 1999).

Problems associated with the contingent valuation technique have made elicitation formats that ask respondents to choose between discrete alternatives rather than to state their maximum

willingness to pay for a particular environmental good increasingly popular.[1] Discrete choice CVM were the first to be applied in environmental economics context, but other stated preference techniques, such as *choice experiments* (CE), have also become increasingly common. Hence, there exist several different discrete choice methods, of which the *choice experiment* method is one.

In a choice experiment application, the respondents are asked to state their most preferred among two or more alternatives, where each alternative is described in terms of their different characteristics at different levels, rather than stating their maximum willingness to pay for an environmental good.

In this study, the choice experiment approach is used.[2] Traditional microeconomic theory constitutes the basic theoretical foundation of the choice experiment approach. Hence, consumers are assumed to seek to maximize utility subject to a budget constraint. Specifically, the theoretical basis of the choice experiment methodology is drawn from characteristics theory of value (Lancaster, 1966) and the random utility theory (McFadden, 1974). The major strength of the choice experiment approach is that it provides more information about the respondents' preferences than the CV approach (Adamowicz et al., 1998).

While a typical CV study generally examines the actual environmental scenario as a package, the CE approach permits the analyst to examine the preferences over the different attributes (or characteristic) included in the scenario. Hence for this purpose the choice experiment approach

[1] One of the recommendations of the National Oceanic and Atmospheric Administration (NOAA) report by Arrow et al. (1993) was that discrete choice formats should be used over open ended formats to elicit values for non-market environmental goods.

[2] A potential alternative approach would have been the so called contingent ranking approach. In contingent ranking study the respondents are asked to rank the alternatives instead of just choosing the alternatives that they prefer. The contingent ranking approach would have generated a richer data set. However, it would also have increased the cognitive burden on the respondents and would have imposed rather restrictive assumptions on the ranking behavior. It has also been discussed whether the responses from contingent ranking experiments are consistent with the axioms of consumer theory (see Bennett and Blamey, 2001).

facilitates the analysis of the perceptions about the different attributes of the lake environment. In addition, the marginal rates of substitution for each included attribute relative to a monetary attribute are useful outputs from choice experiments since they indicate the relative importance of each of the attributes included in the experiment.

In CE questionnaires, respondents are asked a series of questions in which *'Choice sets'* are presented. Each choice set usually contains three or more resource use options. Respondents are asked to choose their preferred option from each choice set. The options in each choice set are described using common attributes, which take on various levels. The combinations of attribute levels for each option in each choice set are established using experimental design techniques (See section 4.5). Similar to a contingent valuation (CV) study, before the choice sets are presented to respondents, there is a description of the study site, the research issues, the proposed policy changes, and the implication for the environmental attributes that are being modelled.

Choice Experiment sometimes called choice modelling has evolved from conjoint analysis in the marketing and transport literatures. Recently, it has been developed and applied in environmental economics context by (Adamowicz et al., 1994; Morrison et al., 1999) and others.

The theoretical basis of choice Experiments (CE) are based on the fundamental building blocks: *Lancaster's characteristics theory of value, and random utility theory.*

3.2. The characteristics theory of value

The basic assumption in choice experiment application is that consumers derive utility from the different characteristics that a good possesses, rather than from the good *per se.* The characteristics associated with the commodities are thus assumed to provide services to the individual (Lancaster, 1966).

According to the characteristics theory of value, the probability of choosing a specific alternative (i.e. a good) is a function of the utility linked to that same alternative. Moreover, the utility

derived from each alternative is assumed to be determined by the preferences over the levels of the characteristics (or services) provided by that alternatives. In the original model presented by Lancaster (1966), the goods consumed are transformed into objective characteristics, through the utility function, which is assumed to be objective and equal among all consumers. Hence, according to the characteristics theory of value, utility is a function of the services provided by the commodities. The assumption that individuals derive utility from the characteristics of a good rather than from the good itself, implies that a change in one of the characteristics (such as the price) may result in a discrete switch from one good to another will however affect the probability of choosing that specific commodity on the margin.

Hanemann (1984) states that many of the choices made by individuals can be divided into two parts: (a) which good to choose; and (b) how much to consume of the chosen good. The first part of the choice process represents the discrete aspect while the second part represents the continuous aspect of consumer choice. When choice experiments are applied in the valuation of non-market goods, the design of the experiment is in general carried out such that the discrete dimension of the choice situation is isolated.

3.3. Random utility theory (RUT)

Random utility theory (RUT) is the second building block. In choice experiment, where the respondent is asked to choose the most preferred among a set of alternatives, random utility theory can be used to model the choices as a function of attributes and attribute levels. According to the random utility theory, the individual is assumed to make choices based on the attributes of the alternatives with some degree of randomness. RUT says that utility derived by individuals from their choice is not directly observable, but an indirect determination of preferences is possible. The random utility theory thus, provides a link between the deterministic model outlined above and a statistical model (McFadden, 1974). In other words, under RUT it is

assumed that the utility function of a good can be broken down into two parts, one deterministic or systemic (V) and one stochastic part (ε).

3.4. Econometric Model specification

Utility of an option *i* for individual *n* (U_{in}) is assumed to depend on environmental attributes of the option (Z_i) and the socio-economic characteristics of the individual (S_n). Hence, the utility function through which the individual is assumed to derive utility can be expressed as (Louviere et al., 2000):

$$\mathbf{U_{in}=V\ (Z_i,\ S_n) + \varepsilon\ (Z_i,\ S_n)}$$

$$\mathbf{U_{in}=V_{in} + \varepsilon_{in}} \text{ ---------- (1)}$$

Where U_{in} is the latent, unobservable Utility held by consumer *n* for choice alternative *i*, V_{in} is the systemic or deterministic or observable portion of utility that individuals *n* has for choice alternative *i*, and ε_{in} is the random or unobservable portion of the utility that consumer *n* has for choice alternative *i*. Research is focused on a probability function defined over the alternatives which an individual faces, assuming that the individual will try to maximize their utility. Following (Bennett and Blamey, 2001), the probability that individual *n* will choose option *i* over another option *j* is given by:

$$\mathbf{Prob\ (\mathit{i}|C) = Prob\ \{V_{in}+ \varepsilon_{in} > V_{jn}+ \varepsilon_{jn}\ ;\ \mathit{j} \in C \text{ and } \mathit{i} \neq \mathit{j}\}}$$

Or

$$\mathbf{Prob\ (\mathit{i}|C) = Prob\ [(V_{in}- V_{jn}) > (\varepsilon_{jn} - \varepsilon_{in})],\ \ \mathit{i} \neq \mathit{j}} \text{ ---------- (2)}$$

Where C is the complete choice set. To empirically estimate the above probability function, and thus to estimate the observable parameters of the utility function, assumptions are made about the random component of the model. A typical assumption is that these stochastic components are

independently and identically distributed (IID) with a Gumbel distribution. This leads to the use of what is known as ***Multi-nomial logit models*** (MNL) to determine the probabilities of choosing *i* over *j* options (Hanley, Mourato and Wright, 2001), i.e.

$$Prob\,(U_{in} > U_{jn}) = \exp(\mu V_i) / \sum \exp(\mu V_j), \quad V_i \neq j;\ j \in C \text{---------- (3)}$$

Where **Vi = V (Z**$_i$**, S**), is the indirect utility function, $\mathbf{Z}_i$ is a vector of environmental attributes, **s** is a vector of socio-economic characteristics, and **μ** is a scale parameter inversely related to the standard deviation of the error term and not separately identifiable in a single data set, the implication of this are that the estimated **β**'s cannot be directly interpreted as to their contribution to utility since they are confounded with the scale parameter. When using the MNL models choices must satisfy the Independence from Irrelevant Alternatives (IIA) property, which means that the addition or subtraction of any option from the choice set will not affect relative probability of individual *n* choosing any other option (Louviere, Henscher and Swait, 2000).

Modelling constants known as Alternative specific constants (ASC) are typically included in MNL model. The most basic form of V_i is an additive structure, which includes the attributes from the choice sets only,

$$V_i = ASC + \sum \beta_k Z_{ik} \text{---------- (4)}$$

Where ASC is an alternative specific constant, β is a vector of coefficients, and Zs are attributes from the choice sets. The effects of attributes in the choice sets are captured by the Z variables, while the ASC captures any systematic variations in choice observations that are associated with

an alternative that are not explained either by the attribute variation or respondents' observed socio-economic characteristics(Ben-Akiva and Lerman, 1985). In a Multi-nomial logit with *l* options there are *l*-1 ASC_s.

It is possible to include socio-economic as well as attitudinal variables into the utility functions by estimating the variables interactively; either with the ASC or with any of the attributes from a choice set:

$$V_i = ASC + \sum_n \gamma_n ASC * S_n + \sum_k \beta_k Z_k \quad \text{---------- (5)}$$

Where, S_n represents socio-economic or environmental attitudinal variables for the n^{th} individual.

3.5. Implicit prices

In a linear statistical model, the β coefficients estimated under the MNL model can be used to estimate the rate at which respondents are willing to trade-off one attribute for another. The trade-off estimated is known as '*part-worth'* or an *'implicit price*' or the '*marginal willingness to pay'*. They demonstrate the amounts of money respondents are willing to pay in order to receive more of the non-marketed environmental attribute:

$$\textbf{Part-worth} = -\left(\beta_{\text{non-marketed attribute}} / \beta_{\text{monetary attribute}}\right) \quad \text{---------- (6)}$$

Estimates of implicit prices are made on a 'ceteris paribus' basis-that is, they are estimates of the willingness to pay of respondents for an increase in the attribute of concern, given that every thing else is held constant. Bennett and Blamey (2001), also pointed out that the principles

applying to the determination of part-worth can also be applied to derive the willingness to trade-off between any pairs of attributes. Hence by division of **β** coefficients, the marginal rates of substitution across all the attributes, monetary and non-monetary, can estimated. Such estimates may be useful when policy calls for environmental remediation efforts to be put into place that restore community well-being, not necessarily by the payment of financial compensation for environmental losses. The implicit prices are useful in that they demonstrate the trade-off between individual attributes. They allow an analysis of the composition of potential alternative allocations of resources. A comparison of the implicit prices of attributes affords some understanding of the relative importance that respondents hold for them. On the basis of such comparisons, policy makers are better placed to design resource use alternatives so as to favor those attributes which have higher (relative) implicit prices.

CHAPTER FOUR

SURVEY CONSTRUCTION, DATA COLLECTION AND DESIGN ISSUES

4.1. Data source and type

The data sources for this study were based on primary data collected from 200 randomly selected fishermen from two fishing cooperatives working on Lake Awassa. The study adopted a random sampling framework; which was based on two fishing market areas. The first one is *Amora Gadel*- the biggest fish market area near Awassa town. The fishermen here are mostly residing in rural district near Awassa town; namely, Tullo-loke and few others from the town. The second one is Tikur wuha fish market area; near Tikur Wuha district. The choice experiment therefore concerns the lake Awassa and its surroundings.

The survey was administered using a face to face (in-person) interview. Interviewers[3] were supervised by the researcher. Before the main survey interviewers were trained carefully on how they approach the problem to the respondents, explain the whole scenario and the attributes and their levels to be used in the survey.

[3] They are four in number and all are from Debub University, Department of Agricultural Resource Economics and Management.

Table 4.1 Definition of variables

variable	Definition
asc	Alternative specific constant taking the value of one for plan 1 and plan 2 and zero for status quo option
TILAPIA	Level of Tilapia fish stock to be enhanced.
FOREST	Number of trees to be planted surrounding Lake Awassa.
PERMIT	Monthly payment to the local authority by all fishermen working on lake Awassa.
INCOME	Respondent's(fishermen) monthly income
HHSEX	Dummy variable equaling: 0, if respondents sex is female 1, if respondents sex is male
AGE	Respondent's age(in years)
MSTATUS	Dummy variable equaling: 0, if respondent is unmarried. 1, if respondent is married
EDU	Dummy variable equaling: 0, if no formal education 1, if primary level attended 2, if secondary level attended 3, if college level is attended
WQUAL	Dummy variable equaling 0, if the fisherman perceive the lake water quality bad 1, if perceived as satisfactory 2, if water quality perceived as good 3, if water quality perceived as very good
NCATCH	Average Number of fish caught per day and brought to the fish market by the fisherman.
EXPER	Number of years in fishing activity
EAWARE	2, if concerned about environment 1, if less concerned 0, if indifferent.

4.2. The choice experiment scenario

The study was presented as a research project to elicit individuals' preferences for different aspects of Lake Awassa and its surroundings and that the study could provide useful information for policy makers concerning decisions of improving environmental quality of the lake. The choice experiment was introduced with a description of the three attributes and the cost levels. The financing of a potential improvement project was described as a *fishing permit* to be collected on a monthly basis which would be collected from all fishermen working on Lake Awassa. The fishermen were told about the current situation of Lake Awassa the challenges it faces. The choice scenario was read to them along with the attributes to be used in the choice experiment. Each respondent faced six choice sets. For each choice set they were asked to choose between three plans/alternatives, where the third alternative was always the baseline or opt-out alternative, i.e. no improvements and no extra costs. Including an opt-out alternative prevents 'forced choices' by respondents, which could bias the results (Banzhaf et al 2001). The two other alternatives offered various levels of improvements at various costs. The attributes and their levels are briefly described in Table 4.1. In Appendix A and Appendix B see a full description of the attributes, the scenario and an example of a choice set.

4.3. Defining attributes and levels

Clearly, choosing the attributes to be included in the choice set is a task of crucial importance. First, the attributes included in the experiment should, in one way or another, be relevant for the policy making process. For example, *tilapia fish stock* is one of the attribute we have identified and used in the study. The fish stock has declined because of over fishing, illegal instruments used by fishermen and other factors like chemicals discharged by factories.

Table 4.2 Attributes and attribute levels

Attributes	Description	Levels
Tilapia abundance/stock	The program rehabilitates and Improves the condition and the level of abundance for endangered Tilapia fish through introduction of the species, through improving the quality of the lake water, reducing the lake pollution from industries (through installing appropriate treatment plant) this will improve the quality of lake water& enhance the biodiversity of the lake and fish.	**Low**, medium, high
Lakeside afforestation/surrounding forest (vegetation) cover	It is possible to cover the lake surrounding with forest (vegetation and grass) in order to reduce siltation into the lake, restore bird habitat, improving the scenic view and encourage non agriculture activities including ecotourism.	**Degraded(very low cover)** 300,000 trees will be planted around the lake. 500,000 trees will be planted around the lake. 1,000,000 trees planted
Fish permit (a monthly payment.)	Introduction of fishing permit and allow fishing for registered fishermen and monthly payment	**0**,15,25,35

Note: bold levels are the current situation (Baseline/status quo level)

In this regard protecting the endangered tilapia fish and enhancing the stock is likely to be a highly relevant attribute. Surrounding forest cover is another highly relevant attribute. Because of the degraded forest cover of the lake surrounding, the lake become highly susceptible for sedimentation, which in turn affects the depth of the lake. The monetary attribute which is the

final attribute chosen, is also relevant attribute. We name it as a *fishing permit*. This fishing permit if it is introduced encourages legal fishermen to protect the lake from illegal fishermen. Clearly, these choices could also be influenced by the policy making process through regulation and/or different economic instruments. Secondly, the respondents must also perceive the attributes as relevant. What this implies is that the environmental impacts that are considered important by the respondent should also be included as attributes in the choice experiment. Furthermore, the attributes should very across levels that are considered realistic by respondents. If the included attributes or the levels of the attributes are not perceived as relevant by respondents or if an attribute considered as being important is excluded, this might influence the responses negatively and the number of valid responses would decline (Bennett and Blamey, 2001; Garrod and Willis, 1999)

4.4. The development and the design of the questionnaire

The questionnaire consisted of three parts; one with questions about socioeconomic status and habits of using the lake and its surroundings, and some attitudinal questions. This section of the questionnaire is devoted to questions seeking socio-economic data (age, sex, education status, occupation, income and so on) and information regarding attitudes (especially general sentiments regarding the environment). In order to examine to what extent respondents actually were triggered to express their preferences or not, they were also asked some attitudinal questions (about for example how they think that choices related to the lake environment and its improvement plans should be made). These data are required as inputs into the modeling phase of the application, for verifying data and for checking how well the sample represents the population of interest. The second section is the choice experiment, in this section attempt was made to make the choice sets clear to the respondents. Respondents need some help to comprehend the choice set questions that follow. Hence a section needs to be devoted to an explanation of the task they

will be asked to perform and some ground rules for their answers. usually this will involve stating that there are many variants to the solution just outlined and people's opinions as to which variant is best for them is a useful input to policy determination (Bennett et al., 2001). In other words, respondents are being asked to have a say in what future policy should look like. Finally, one with *debriefing questions* where the respondents could state certainty of choice, their motivations and other comments. These are questions which sometimes known as follow-up questions. Immediately after the choice set questions comes a series of questions designed to explore the motivations behind respondents' choices. In particular, these 'follow-up' questions should be targeted at picking up any response irregularity such as:

- Payment vehicle protests (a respondent always chooses the status quo option or 'other' option because of an objection to the way in which their cost is to be imposed);
- Lexicographic preferences (respondents always choose the alternative with the highest level of one attribute, or the lowest cost, or appear always to choose on the basis of a single characteristics of the task); and
- Perfect embedding (respondents agree to pay in order to experience the 'warm glow' of supporting a good cause rather than as a reflection of their value for the environmental benefits available). (Alpizar et al.,2001; Bennett et al., 2001)

In addition, follow-up questions can check to see if there were any specific problems faced by respondents in answering the choice set questions. Specifically these problems may relate to:

- Ability to understand the questions;
- The amount of information provided;
- The presence of bias in the questionnaire; perceived plausibility of the setting; and
- Confusion created.

4.5. Designing the Choice Experiment

Experimental design deals with how to create choice sets in an efficient way. i.e., how to combine attribute levels into alternatives and choice sets. The most common approach in economic applications has been to use orthogonal design, in which the levels of the attributes of the different alternatives are uncorrelated in the choice sets. The creation of the alternatives to be used in the choice sets is only the first phase of the creation of an experimental design. The second phase involves the combining of alternatives together to form the complete choice set. Commonly, choice sets comprise a constant base or status quo option that stays the same across all choice sets and two or more alternatives that involve varying attribute levels.

The three attributes included in the experiment, which can be between two and three different levels, resulted in a full factorial with 18 combinations[4]. This would be more than the respondents could be expected to cope with. According to (Louviere, Hensher and Swait), when designing the choice sets for a choice experiment, the aim is to ensure that all different attributes can be estimated independently of each other. On the other hand it is unrealistic to assume that respondents will carry out a high number of choices. To manage this trade off, a fractional factorial design was used (Louviere, Hensher and Swait, 2000); the choice sets were constructed using the OPTEX procedure in SAS (Kuhfeld, 2001). After reducing identical combinations and combinations that seemed unreasonable, 12 combinations remained. These 12 choice sets were then randomly assigned to two blocks such that a single respondent would be confronted with six choice sets.

[4] The number of lake environment improvement scenarios that can be generated from 3 attributes, 2 with 3 levels and 1with 2 levels, is $3^2*2=18$

CHAPTER FIVE

EMPIRICAL RESULTS AND DISCUSSION

5.1. Descriptive Results

In Table 5.1, the descriptive statistics of the sample used in the estimations are presented. On average, respondents have 6 years of formal education and are 29 years old. Most of the fishermen of Lake Awassa have low educational level. Most are in the primary level. The average family size for the sample respondents is about 6. This high family size may be due to the fact that most of the fishermen are married. The socioeconomic survey result indicates that about 90 percent of the fishermen are married.

Table 5.1 Descriptive Statistics

Variable	Mean	Std.Dev	Minimum	Maximum
All observations in current sample				
AGE	28.947	6.398	19.000	48.000
INC	607.853	268.463	100.000	1000.000
FAMSIZE	5.743	2.522	0.000	14.000
MSTATUS	.931	0.252	0.000	1.000
EDU	1.283	0.650	0.000	3.000
NCATCH	54.042	26.089	7.000	150.000
EXPER	13.063	6.199	1.000	36.000
OTHINC	.052	0.223	0.000	1.000

Responses in Choice experiment	No.
Improvement:	
Plan1	546
Plan2	600
No improvement Plan3 (status quo)	-

According to the survey results, all of the fishermen of the lake are males, it is also indicated in the survey results that the average monthly income of the fishermen is about 600 birr per month. This income level has been adjusted to include incomes from all other sources as reported by the respondents. For the majority (95 percent) of the fishermen of Lake Awassa fishing is the only

source of income, while others (about 5 percent) generate income from small agricultural activities. Most of the fishermen have good experience in fishing activity on Lake Awassa and hence felt the problems of the lake ecosystem in general. The average year of experience in fishing is about 13 years. This may be one indicator for them to support the improvement plans relative to continue current situation. On the part of perceptions of the fishermen concerning the lake water quality, most rate the water quality as good.

A majority of the respondents blame factories, farmers and illegal fishermen for the general quality of the lake in terms of lake quality and reduction in fish stock. Emission from factories is responsible for the reduction in the quality of the lake and fish population. Other illegal fishermen also contribute and aggravate the situation of fish population in Lake Awassa. These fishermen use narrow mesh size to catch fish. These harmful practices of fishermen do not care for small fish in particular 'tilapia' fish. As a result the fish breeding power diminishes. Other farmers and individuals who own near-by agricultural land damage the lake in many ways. According to the respondents, these farmers in order to get more agricultural land they clear the hedge plant around the lake as a result sediment brought by flood will directly join the lake, which adds to the sedimentation of the lake and affects the depth of the lake which is important for fish population , they also cut grass from the lake to feed their livestock and for construction of small boats, which affects small fish to danger as the grass in the lake serves both as shelter and source of food; farmers also use fertilizers, pesticide and other chemicals that pollute the lake and endangers the aquatic ecosystem. Similar information was observed from fishermen of Lake Chamo (Tsegaye, 2005).The survey result from the fishermen revealed that the major problem creators of the lake are factories, farmers and illegal fishermen.

5.2. Analysis of Debriefings

Results of the debriefing questions showed (Table 5.2) that as many as 37 per cent of the fishermen indicated that they could pay the higher *permit* if both the attributes, 'tilapia stock' and the surrounding 'forest cover', to be attained the highest level. In other words, they are willing to pay the stated amount for the aggressive rehabilitation plan[5] of the lake environment. The second most chosen attribute was *tilapia stock*. About 20 per cent of the fishermen chose only the alternative that gave them 'high' tilapia fish stock. About 22 percent of the fishermen expressed a wish to have both the attributes to be of a higher level but they could not afford it and about 19 per cent of the fishermen always choose the cheapest alternative. It can be seen from the analysis of the debriefing responses that respondents also have a lexicographic answering pattern. This kind of respondents always picked up that alternative that was better in just one of the attributes; some show an answering pattern that is characterized by always choosing for 'high' level of 'tilapia' fish and only the alternative with lower price level.

Table 5.2 Results of the Debriefing questions

[5] We specified the choice set that has both attributes of a higher level as aggressive rehabilitation plan.

Attitudinal variable	*% of total*
I find the *Tilapia fish stock* is important and chose exclusively such attribute in the alternatives.	20
I don't think fishermen should have to pay/contribute money to environmental quality improvement.	-
I exclusively chose the cheapest alternative.	21
I wish I could pay/contribute more for the *aggressive rehabilitation program*, but I cannot afford it.	22
I find surrounding vegetation/forest cover is important and chose such attribute in the alternatives.	-
I chose the aggressive rehabilitation program (both attributes).	37

The Basic Model

Two different Multi-nominal logit (MNL) models were estimated using the data collected from the lake Awassa survey. The first model is a basic specification which shows the importance of the choice set attributes in explaining respondents preferences for the three different lake environment rehabilitation plans/options: *Continue with the current plan (status quo option)* and improving the environmental quality of the lake in terms of its attributes*(Tilapia fish stock, surrounding Forest cover).* The second model incorporates socio-economic and environmental attitudinal variables in addition to the attributes in the choice sets.

There are three indirect utility functions derived from the Multinomial logit model, each representing the utility generated by the respective Rehabilitation Plan/option. Plan 3 is the status quo, while plan1 and 2 involve an improvement in Environmental attributes, relative to the 'status quo' plan3. The utility for each of the functions is determined by the level of attributes in

the choice sets: The choice experiment was designed with the assumption that the observable utility function would follow a strictly additive form.

The model was specified so that the probability of selecting a particular lake rehabilitation plan was a function of attributes of that alternative plan and of the alternative specific constant.

Model 1

$$V_i = ASC + \beta_1 \text{TILAPIA} + \beta_2 \text{FOREST} + \beta_3 \text{PERMIT} \quad \text{---------- (7)}$$

For i =1, 2, 3 and where *ASC* =0 for the status quo and 1 for plan1 and plan2, or more specifically the three indirect utility functions can be represented as,

$$V_1 = ASC_1 + \beta_{TILAPIA}\ \text{TILAPIA} + \beta_{FOREST}\ \text{FOREST} + \beta_{PERMIT}\ \text{PERMIT} \quad \text{- - - - - - - (8)}$$

$$V_2 = ASC_2 + \beta_{TILAPIA}\ \text{TILAPIA} + \beta_{FOREST}\ \text{FOREST} + \beta_{PERMIT}\ \text{PERMIT} \quad \text{- - - - - - - (9)}$$

$$V_3 = \beta_{TILAPIA}\ \text{TILAPIA} + \beta_{FOREST}\ \text{FOREST} + \beta_{PERMIT}\ \text{PERMIT} \quad \text{- - - - - - - - - - - - - -(10)}$$

The β values ($\beta_{TILAPIA}$, β_{FOREST}, and β_{PERMIT}) are the coefficients associated with each of the attributes TILAPIA, FOREST and PERMIT respectively[6]. There are two alternative specific constants (ASC_1 and ASC_2) in this model for plans/options1, and 2. The alternative specific constants for option/plan 1 and 2 (improvements in environmental quality options) is constrained to be equal because (Bennett et al., 2001; Carlsson et al., 2003) a generic format and an experimental design that was close to orthogonal were used to develop the choice sets and hence we included one common alternative specific intercept for the two alternatives that imply changes.

[6] The β coefficients cannot be interpreted as the contribution made to utility by each attribute in any absolute sense as they are each confounded by a scale parameter μ. Each CE data set will be characterized by a different value μ because it is determined by the variance of the statistical error inherent in the modeling (Swait and Louviere 1993).

Model 2: An extended MNL model with socio-economic and attitudinal interaction

In model 2 it is assumed that some socio-economic and attitudinal variables influence individual's intentions and behavior. Model 2 is specified as:

$$Vi = ASC + \gamma_1(S1 * ASC) + \gamma_2(S2 * ASC) + \gamma_3(S3 * ASC) + \gamma 5(Sn * ASC) + \beta_1 TILAPIA + \beta_2 FOREST + \beta_3 PERMIT \quad (11)$$

For i = 1, 2, 3 and where ASC= 0 for the status quo option and 1 for the alternative that imply changes (plan1 and plan2), Sn are socioeconomic characristics and other variables are defined as in Table 5.2

To introduce respondents' heterogeneity (that is, differences between the individual respondents) into the model, socio-economic variables can be used as independent variables in each of the equations estimated. This can be an important part of the model estimation process as the socioeconomic variables may help to overcome problems associated with violation of important assumptions that underpin the MNL model[7]. However, they cannot be introduced alone into the modeling. Because respondent characteristics do not vary across alternatives, 'Hessian singularities' arise in the model estimation process unless the socio-economic characteristics are introduced as interactions with either the attributes or the ASCs (Bennett and Blamey, 2001).

The socioeconomic and attitudinal variables can be modeled through the interactions of the variables for example, (AGE, INCOME, EDU, FAMSIZE, and EAWARE) with the alternative specific constant ASC or any of the attributes. These interactions attempt to capture the influence of the variables on the probability for a respondent to choose either plan 1 or 2.

[7] The MNL model uses an assumption that the error terms are 'independently and identically distributed'. This assumption gives rise to the independence of irrelevant alternatives (IIA) characteristic.

5.3. Discussion of Results

Before turning to the results, it is worth noting that in the survey almost all the fishermen answered the choice questions. None of the fishermen choose the current situation (status quo option) indicating that they want a policy change.

The data were coded according to the levels of the attributes. We have three attributes: For *tilapia fish stock*, we have *high* level coded as 2 and medium level was coded as 1.The levels for the forest attribute (*one million trees, half a million trees* and *three hundred thousand trees)* and the fishing permit *(15, 25, and 35)*, i.e. the *cost* attribute were entered in cardinal-linear form.

The attributes for the *neither rehabilitation/improvement scenario* i.e. *status quo* option were coded with zero values for each of the attributes. The alternative specific constants (ASC) were equal to 1 when either rehabilitation/improvement scenario 1 or 2 was selected and to 0 when the status quo option was selected.

Using 1146 choices elicited from 200 fishermen, a multinomial logit models with linear specification for the attributes and their levels were estimated using *Limdep 8.0 Nlogit 3.0.* In Table 5.3 column 1 and 2 are the parameter estimates for the simple Multinomial logit model (MNL)[8] represented as *model 1* (the model that does not include any individual specific covariates) and *model 2* with socioeconomic variables included. So, the first discussion below is based on the 'simple' model that includes only the three attributes including the monetary attribute-'*permit'* and '*alternative specific constant'(ASCs).* These constants can be thought of as

[8] The MNL model necessarily involves strong assumptions about the independence of irrelevant alternatives property. A standard Hausman test could not be completed as the difference matrix was not positive definite. If a violation of the IIA hypothesis is observed, and then more complex statistical models are necessary that relax some of the assumptions used. These include multinomial probit (Hausman and Wise, 1978), the nested logit (Wiseman and koppelman, 1993), the random parameters logit model (Revelt and Train, 1998; Train, 1998 and 2003) and heterogeneous extreme value logit (Allenby and Ginter, 1995).

representing all other determinants of utility for each option not captured by the attributes. They are not related to specific attributes so they can not easily be used to predict the effects of changes due to changes in attributes. ASCs do however improve the overall model performance and should therefore be included in the estimation (Adamowicz et al., 1997).

Table 5.3 Results of Multi-nomial logit model

Variable	*Basic model (model 1)*	
	Coefficients	Standard errors
Asc	35.26924	1484166.8
Tilapia	0.59824	0.07186***
Forest	0.6618E-06	0.1377E-06***
Permit	-0.07557	0.00563***
Summary statistics		
Log-likelihood	-655.867	
Rsq Adj	0.172	
Iteration completed	35	
Number of observations	1146	

***significance level at 1percent*

Turning first to the (basic) Multinomial logit estimates represented in Table 5.3 as *model 1*, the two environmental attributes (*tilapia and forest*) have the expected positive signs and all the coefficients of the attributes are statistically significant. Estimated coefficients of the attribute

with a positive sign imply that a change from the status quo option to the corresponding attribute increases the probability of choosing improvement plans over the status quo. i.e. the positive sign of the coefficient for the *tilapia fish* and *forest cover* attributes indicates that an increase in their levels considered being an improvement of the lake environmental quality. In other words, the fishermen value lake improvement scenarios which result in more tilapia fish stock and larger number of trees planted surrounding the lake. Like wise, the monetary attribute '*permit'* has the expected negative sign, which is in agreement with the hypothesis that "cheaper " alternatives or plan are preferred to 'more expensive' options after other characteristics are held constant. In other words, the sign of the price coefficient indicates that the effect on utility of choosing a choice set with a higher price level is negative and also it is statistically significant at less than 1 percent level.

Table 5.4 Results of Multi-nomial logit model

Variable	*Extended model (model 2)*	
	Coefficients	Standard errors
ASC	35.323	1475409.1
Tilapia	1.0899	0.30178 ***
Forest	0.69E-06	0.557E-06
Permit	-0.1235	0.02372***
TILAPIA*INC	-0.00159	0.00031***
FOREST*INC	0.705E-10	0.552E-09
PERMIT*INC	0.00008	0.00002***
TILAPIA*FAMSIZE	0.06048	0.03343*
PERMIT*FAMSIZE	-0.0033	0.000269
TILAPIA*NCATCH	0.00759	0.00288***
Summary statistics		
Log-likelihood	-635.51	
Rsq Adj	0.198	
Iteration completed	35	
Number of observations	1146	

*** *significance at 1 percent,* * *significant at 10 per cent*

In the extended MNL model (model 2), where the socio-economic characteristics are interacted with the attributes and alternative specific constants, all the attributes coefficients with the exception of the forest attribute are statistically significant at 1 percent level. Still the attributes have the expected signs. The forest attribute have a positive sign but not significant perhaps fishermen show more preference for the tilapia fish stock improvement as it has a direct use value. Therefore, with respect to the attributes both models are generating similar results. It is again important to note that in this model cost i.e. *permit* is still significant at 1 per cent level. These estimates confirm that fishermen of lake Awassa 'value' and are prepared to pay for improvements in the lake's attributes and such improvements are valued 'even more 'the lower the cost associated with obtaining them. The parameter estimates associated with the interaction of socioeconomic characteristics with the alternative specific constant (ASC) are not shown since they are of no direct substantive importance. However, the interaction of some of the socioeconomic variables like income (INC), family size (FAMSIZE) and average number of fish catch (NCATCH) per day with TILAPIA become significant at one percent, ten percent and one percent respectively. The interaction PERMIT*INCOME is also significant at one percent. These interactions show how the variables income, family size and fish catch modify the effects of tilapia and permit on the probability of choice. The inclusion of the socioeconomic variables improves the explanatory power of the model[9] and the magnitude of the coefficients. The point to note is that the parameter estimates associated with each of the attributes are very similar across the two specifications. The overall model is significant at the 1 per cent level and the explanatory power is also relatively high. Compared to the initial model, the explanatory power of the model has increased from 17 percent to 20 per cent.

[9] The ρ^2 value in multinomial logit models is similar to R^2 in conventional analysis, except that the significance occurs at lower levels. Hensher and Johnson (1981) comment that values of ρ^2 between 0.2 and 0.4 are considered to be extremely good fits.

5.4. Estimation of marginal willingness to pay

From the parameter estimates, the rate at which respondents are willing to trade off price for changes in any of the other attributes, were calculated, i.e., *the implicit price*.

Implicit prices reflect the *marginal rates of substitution* between each attribute and the monetary attribute (Morrison et al. 1998). They are calculated as the ratio of the coefficients for the attribute of interest and that of the monetary attribute (see equation 6. Implicit prices thus reflect individuals' willingness to pay for an additional unit of an attribute of interest to be present, *ceteris paribus*. The implicit price for *tilapia* attribute for instance, is the ratio of the *tilapia* coefficient and the *permit* (price) coefficient.

Estimates of Implicit prices (marginal willingness to pay) for each of the attributes in the choice sets associated with the MNL model are shown in Table 5.5 The corresponding t-statistics and standard errors were calculated using the delta method (Green, 2000)

Table 5.5 Estimates of mean marginal willingness to pay (birr) (model 2)

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]
WTP Tilapia	8.83	2.3243992	3.797	.0001
WTP Forest	.556641E-05	.430772E-05	1.292	.1963

Using the MNL model, these implicit prices suggest that, for instance, the local fishermen are, on average, willing to pay 8.83 birr per month for an improvement in the tilapia fish stock and while the willingness to pay for the forest attribute is very low, *ceteris paribus.* The marginal willingness to pay is highest for '*tilapia fish stock*' attribute compared to the forest attribute. i.e. fishermen gave more value for *tilapia* than the *forest* attribute. From the table we can also

observe that willingness to pay estimate is statistically significant at the 1 percent level for the tilapia attribute while the willingness to pay for the forest attribute was not significant.

5.5. Welfare measures in choice experiment

A particular strength of choice experiment according to (Alpizar et al, 2001, Adamowicz et al, 1994 and Bennett et al, 2001) is its ability to generate estimates of the values of many different alternatives from the one application. Hence from one set of choice data, the values of an array of alternative ways of reallocating resources can be estimated. This feature of choice experiment arises because it specifically investigates trade-offs between attributes. Thus, different combination of the attributes that are used to describe alternatives can be evaluated.

In theory, economic welfare measures are (a) the amount of money(given or taken away) that make a person as well off as they would be before a change, or (b) the amount of money(given or taken away) that make a person as well off as they would be after a change. Depending on how the choice experiment application is designed, it is also possible to use the results to derive estimates of the compensating surplus (CS) or the equivalent surplus (ES) that results from a change in resource use. The former measures the change in income that would make an individual indifferent between the initial (lower environmental quality) and subsequent situations (higher environmental quality) assuming the individual has the right to initial utility level. This change in income reflects the individual's willingness to pay (WTP) to obtain an improvement in environmental quality. On the other hand, ES assumes an individual has implied rights to the subsequent utility level. Hence, it represents individuals' WTP to avoid degradation in environmental quality (Freeman, 1993). Based on the indirect utility functions, the compensating surplus can be illustrated as follows:

$$\mathbf{V_0(G_i, Z_0, M) = V_1(G_i, Z_1, M\text{-}CS)} \text{----------(12)}$$

Where **M** is income, $\mathbf{Z_0}$ and **Z1** represents different sets of environmental attributes ($\mathbf{Z_0}$ being usually interpreted as the set of attributes prior to a policy change), and $\mathbf{G_i}$ represents other marketed goods.

Using the results from the Multinomial logit model, the CS can be estimated by employing the following equation (Adamowicz *et al.,* 1994).

$$CS = -1/(\beta_M)\{\ln(\sum \exp v_0) - \ln(\sum \exp v_1)\} \text{---------- (13)}$$

Where β_M is the coefficient of the monetary attribute and is assumed to be the marginal utility of income. Equation 13 allows for the valuation of multiple sites. This study considers only one site. Therefore, following Boxall et al., (1996) and Morrison et al., (1999), Equation 13 is reduced to

$$CS = \{-1/(|\beta_M|)\}(V_0 - V_1) \text{---------- (14)}$$

Where, V_0 and V_1 represent the initial and subsequent utility states respectively. The model also enables the estimation of welfare changes (compensating surplus) associated with an array of changes in environmental quality of the lake away from the "status quo" scenario (current situation). The attribute levels that characterize of alternative lake quality improvement scenarios are listed below, along with the current situation/ status quo attribute levels:

Current situation/ status quo scenario

- Tilapia fish stock is very low
- Forest cover surrounding the lake is low (degraded landscape)

Improvement scenario 1(high impact improvement scenario)

- Tilapia fish stock will be at high level
- One million trees to be planted in the surrounding

Improvement scenario 2(medium impact improvement scenario)

- Tilapia fish stock will be at high level
- Half a million trees planted surrounding the lake

Improvement scenario 3(low impact improvement scenario)

- Tilapia fish stock will be at medium level
- Three hundred thousand trees to be planted surrounding the lake

Table 5.6, Estimates of Compensating Surplus (CS)

Alternative improvement scenario	*WTP(birr per month) MNL model 2*
Improvement scenario 1	31.42
Improvement scenario 2	28.58
Improvement scenario 3	18.62

Estimates of compensating surplus (CS) are calculated using the above equation (Eq.14); to use this equation to estimate compensating surplus it is first necessary to calculate the utility associated with the current option and the option being considered. Using the model 1, this is

achieved by substituting the model coefficients and the attribute levels for the current option. The value of the utility of the alternative option is estimated in a similar way, except that the coefficient for the alternative specific constant for plan 1 and plan 2 is included and the attribute levels associated with the changed scenario are used. The compensating surplus for the change from the status quo to the new scenario is then estimated by calculating the difference between these two values, and multiplying this by the negative inverse of the coefficient for the *permit* attribute. Estimates of willingness to pay for the three scenarios are presented in Table 5.7. These are the marginal estimates, showing willingness to pay for a change from the current situation. It can be seen from the estimates that, the CS for the change from the status quo to the scenarios considered increases as we move towards improved environmental conditions of the lake. Based on model 2 which has a better fit, mean WTP for scenario 3 is 18.62 birr per month, whereas greater improvements in environmental conditions of the lake under the medium impact improvement scenario increases WTP to 28.58 birr per month, and under the high impact improvement to as high as 31.42 birr per month. The benefits derived from various improvement scenarios can be compared to cost of these improvement projects so that a benefit-cost analysis can be made. However, this is beyond the scope of this paper.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1. Conclusions

Choice experiment is a stated preference technique for the estimation of non-market values. It has some distinct advantages over other techniques such as the CVM-that has been more widely applied. Its ability to provide a disaggregated view of values is a key feature. With respondents' preferences broken down into components associated with the attributes that go to make up a good, it is possible to use choice experiment results to investigate the relative importance of attributes and estimate the values associated with various combinations of attribute levels. The purpose of this study was to measure fishermen's valuation of environmental quality improvements taking case of Lake Awassa and to examine the general attitudes towards Lake Environment, in particular to analyze how the fishermen values different environmental attributes associated with the lake by employing a choice experiment approach.

A combination of the characteristics theory of value and the random utility theory constitutes the theoretical underpinnings for choice experiments. We employed two different attributes as indicators of the lake environmental quality.

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The data is analyzed using two specification of the standard multinomial logit model. The analysis showed that the tilapia attribute proved to be generating a higher impact on the utility for the fishermen than did the forest attribute. This was also reflected in a higher willingness to pay for tilapia fish stock improvement. From the extended MNL model both the environmental attribute and the monetary attribute are also significant and they have the expected sign. The results of analysis of debriefing questions respondents stated, income and family size has been found to influence preferences among the alternatives.

Finally, the methodological implication of this study in the context of valuing environmental quality improvements and other resource management options is that choice experiment can be successfully applied in developing countries like ours with careful construction of the choice sets and effective field data collection (Jamal et al., 2004). In this regard, close consultation with the stakeholder was critical to understanding the nature of the resource problem and hence the selection of attributes and levels that are key to the choice experiment design.

6.2. Policy recommendations:

Our survey results show that fishermen of Lake Awassa are willing to pay for improvements in the quality of the lake as depicted by the two environmental attributes in general and for stock enhancement of tilapia and improving surrounding forest cover in particular. This result has interesting implication in that if local government introduce *fishing permit* for those who working on the lake, there would be a sustainable and efficient utilization of the natural resource. This fishing permit if it is introduced encourages legal fishermen to protect the lake from illegal fishermen.

Factories, near-by farmers and illegal fishermen are blamed to be the main polluters and intensive users of the lake. Therefore the concerned body should consider the case of these factories and farmers, appropriate treatment plants should be installed and also important to formalize the illegal fishermen in the form of fishery cooperatives.

The open access status of the natural resources surrounding the lake in general and the fishery and forest resources in particular led to the degradation of the surrounding ecosystem (poor environmental quality). Hence, there should be a mechanism to enhance awareness of resource users and promote participatory resource management system.

Training and awareness creation among the users and non users in the area should be given priority. For instance, local environmental protection bureau should teach resource users and set appropriate guiding on how to utilize the lake resources.

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Appendix A: Results of the Extended MNL Model (Interactions of Socioeconomic Characteristics with attributes and ASC.)

Variable	Coefficient	Stand. Error	b/St.Er.	P[|Z|>z]
ASC	35.14484431	6371001.8	.000	1.0000
BPERMIT	-.1234948948	.23716966E-01	-5.207	.0000
BTILAPIA	1.089858888	.30178720	3.611	.0003
BFOREST	.6874237152E-06	.55698816E-06	1.234	.2171
BTILINC	-.1596236894E-02	.31240529E-03	-5.110	.0000
BFI	.7050228817E-10	.55204669E-09	.128	.8984
BPERINC	.7808622160E-04	.23269668E-04	3.356	.0008
BTILFAM	.6047863270E-01	.33426736E-01	1.809	.0704
BFORFAM	.8935728962E-07	.64472715E-07	1.386	.1658
BPERFAM	-.3285191170E-02	.26920689E-02	-1.220	.2223
BTILNCAT	.7599265019E-02	.28784624E-02	2.640	.0083
BFORNCAT	-.3014147985E-08	.54979333E-08	-.548	.5835
BPERNCAT	.1128612812E-03	.22175469E-03	.509	.6108
BTILEXP	-.1539570579E-01	.12778758E-01	-1.205	.2283
BFOREXP	-.3165485258E-07	.25021938E-07	-1.265	.2058
BPEREXP	.5608192618E-03	.10180086E-02	.551	.5817
BASCFAM	-.3534947031E-01	659492.84	.000	1.0000
BASCEXP	.1806410278E-01	249756.66	.000	1.0000
BASCEDU	-.9029518290E-02	2333417.2	.000	1.0000
BASCI	.2468558440E-03	5773.5731	.000	1.0000

Log-likelihood	-635.5125
Rsq. Adj	0 .20
Number of observation	1146

Appendix B

Sample choice set

Which of the following lake environment improvement scenarios do you favor? Plan1 and plan2 would entail a cost to your household. No payment would be required for plan3 (status quo) options; but the conditions at the wetland would continue to deteriorate. [*Enumerator has to caution the respondent that choosing either option would require them to pay the prescribed amount to the local agricultural bureau]*

Question 1

	Effect of plan 1	**Effect of plan 2**	**No measures(today's level-plan3)**
Tilapia fish stock	High	Medium	Low
Forest cover	1 million trees	300000 trees	Low cover
Fishing permit(cost per month)	35 birr	15 birr	0 birr
I would prefer: (*Please tick as appropriate*)	☐	☐	☐

Appendix C: Questionnaire

ADDIS ABABA UNIVERSITY

DEPARTMENT OF ECONOMICS

A CHOICE EXPERIMENT SURVEY QUESTIONNAIRE

FOR VALUING IMPROVEMENTS IN ENVIRONMENTAL QUALITY OF LAKE AWASSA

AND THE SURROUNDING ENVIRONMENT

Date _____

Interviewer name _____

Interview started _____

Interview ended _____

Interviewee number _____

Supervisor _____

Hello, how are you. Thank you for giving me your time. My name is _____. This interview is a main body of a research **Mr. Girma G. Selassie** is working with and he is currently studying at the Addis Ababa University. This research is in partial fulfillment for the award of MSc. in Economics. He is conducting a survey which focuses on Lake Awassa and its surrounding Environmental problem and possible environmental quality improvements of Lake Awassa and its surroundings. I would like to ask you about your perception and observation regarding Lake Awassa and its surrounding environment. This information will help the government to plan for

the development, conservation and sustainable use of the biodiversity resources of the lake and its surroundings and help policy makers make conscious decisions about the lake environmental problem. The interview takes a few minutes to complete. Whatever information you provide will be kept strictly confidential and will not be shown to other persons.

SECTION ONE

GENERAL PERCEPTION AND OBSERVATION OF THE LAKE AND ITS SURROUNDING ENVIRONMENT

A1. Your perception of the lake water quality

1=Very good

2=Good

3=Satisfactory

4=Bad

A2. Major problem creator to the lake water and surrounding environment

1= Farmers

2= Factories

3= Other

A3. What measures should be made to safeguard fish and the quality of the lake?

_____

_____

A4. What do you think are the impacts of quality problem on the benefits obtained from the lake?

_____

_____

A5. What do you think about the impact of personal activities of anglers on fish and water quality?

1= Free of adverse impact

2= adversely affects

3= I don't know

A6. Rank environmental problem related to Lake Awassa and its environment in order of severity.

1= water contamination by chemicals and industrial wastes_____

2= lake side and associated landscape degradation_____

3= sedimentation_____

4= municipal waste_____

5= reduction in fish stock_____

A7. Have you ever participated in any environmental and resource use management workshop?

1=Yes

2=No

A8. Do you consider your self as a person

1= very concerned about environment

2= some what interested in the environment

3= less interested in the environment

4= indifferent?

A9. How long have you been staying in this business (fishing)? _____years/month

A10. Hours of fishing in a day_____

A10a.days of fishing per month_____

A11. For what purpose are you involved in fishing?

1= Commercial

2= House hold consumption

3= Both

4=Others_____ (specify)

A12. How many *kg* (any other unit of fish) is in your catch per day?

_____

A13. Which fish species is more abundant in your catch?

1=Tilapia (locally *Qoroso*)

2=Catfish (locally *Ambaza*)

3*='Bilcha' (local name)*

4='*Duba' (local name)*

A14. Which kind of fish command highest price?

_____

A15. What instruments you use to fish?

_____

_____

A16. Who are your customers? (Multiple answers are possible)

1= individuals

2= hotels

3= whole sellers

A18.For what other activities are you using the lake water? (Multiple answers are possible)

1=Bathing

2=Irrigation

3=Others_____

A19.Do you have other sources of income (other than fishing)?

1=YES

2=NO

A20.If YES, what is it? _____

INTERVIEWER: NOW READ THE CHOICE SCENARIO TO YOUR RESPONDENT

MAKE SURE THAT THEY PAY ATTENTION OF YOUR DESCRIPTION

SECTION TWO

Scenario of the choice experiment

You have been randomly selected from fishermen who are fishing on Lake Awassa to participate in this survey. We are investigating fishermen's choices for various measures affecting the lake quality and its surrounding environment (in terms of fish stock, lake pollution and lake side forestation). We ask you to consider these factors and the costs for carrying out various measures in the choice questions that follow. There are no "correct" or "wrong" answers. But priorities have to be made; we ask you to carefully choose between the alternatives below understanding this choices may be difficult. Please consider the attributes: *tilapia fish abundance, lake pollution* and *lake side forestation*. Assume that the levels of these three attributes are independent of each other. Please mark the preferred alternative as if it is the only choice you make. Please feel free to go back and change your choice in a previous question.

The government has prepared a program for the development, conservation and sustainable use of the biodiversity resources of the lake Awassa and its surrounding.

There are fundamentally two areas where the government plans to improve the environmental quality of Lake Awassa and its surroundings:

(1) Fishing possibilities in particular the endangered **Tilapia** fish species will be rehabilitated or introduced. This stock enhancement program will increase the Tilapia

fish species and increases the productivity of the lake. Improving the lake water quality and controlling lake pollution through installing appropriate treatment plants around various factories located near lake Awassa that discharges chemicals (e.g. Textile factory) into and around the lake and tributaries of the lake(Tikur wuha river) hence pollution of the lake water will be regulated. Such measure is important for maintaining the overall biodiversity of the lake including fish. Consequently, the fishermen and local communities will be benefited from such program.

(2) Surrounding vegetation cover – This includes afforestation of the degraded lake sides, covering the landscape with trees and grasses. This afforestation program helps to improve the lake water quality through reducing silt and sedimentation into the lake. These are problems which affect the lake water quality and quantity which in turn affects the fish population and other biodiversity in and around the lake. Having variety of trees surrounding the lake also increases the scenic view of the lake and its environment and increases the attractiveness of the area to tourists/visitors and hence other employment opportunities will be created.

However, all these plans of the program cost **money** for the implementation of the program. The government /authority will set appropriate implementation strategy. There will be fishery regulation management systems that will be put in place; only registered fishermen will be working on the lake. Some of the activities to be performed are restriction of fishing effort, fishing area, and season and introduce license for commercial fishing. Registered fishermen will be given **fishing permit** which will be

renewed every month upon payment. This payment will be collected and used to partially finance the project.

Consider that the program will be implemented; money will then be spent to improve the lake water quality in terms of reducing the lake pollution, enhancing the Tilapia abundance and lake side afforestation.

There are essentially two version of this rehabilitation program. Namely, the **aggressive program scenario** and a **medium program scenario** in which the **aggressive rehabilitation program** scenario, there will be a **high level** of Tilapia fish stock, and planting of **1000000 trees** around the lake. The **medium rehabilitation program** brings about **medium level** Tilapia stock and a lakeside planting of **300000 trees**. Currently, Tilapia fish is endangered (stock is depleted), meaning there is very **low level** of Tilapia population because of over fishing and lake being an open access.

there is no lake pollution reduction scheme (treatment plant) available, the forests surrounding the lake are **degraded**.(low tree coverage)

This study is not part of the project. Hence, we would like you to understand that the main objective of the questionnaire is to better understand what the major problems are in the Lake Awassa and the surrounding environment and how local fishermen respond and what could be done to alleviate these problems.

There are no “correct” or “wrong” answers. But priorities have to be made; we ask you to carefully choose between the alternatives below understanding this choices may be difficult. Please consider the attributes: **tilapia fish abundance**, and **lake side afforestation**. Assume that the levels of these two attributes are independent of each other. Please mark the preferred **alternative** as if it is the only choice you make. Please feel free to go back and change your choice in a previous question.

INTERVIEWER: NOW SHOW THE CARDS

AFTER THIS, PRESENT THEM WITH THE CHOICE SETS

PAY ATTENTION AND HELP IN CASE THEY HAVE ANY DOUBT

Explain the cards.

CHOICE 1

Of the three alternatives below, mark the alternative you prefer

Attributes	PLAN A	PLAN B	NO MEASURES (TODAYS LEVEL)

Tilapia fish abundance/stock	High	Medium	Low
Lake side afforestation/surrounding vegetation	1,000,000 trees	300,000 trees	Low forest cover
Fishing permit (monthly cost)	35 Br.	15 Br.	0 Br.
YOUR CHOICE: (please tick (✓) one only			

CHOICE 2

Of the three alternatives below, mark the alternative you prefer

Attributes	**PLAN A**	**PLAN B**	**NO MEASURES (TODAYS LEVEL)**
Tilapia fish abundance/stock	High	Medium	Low
Lake side afforestation/surrounding vegetation	1,000,000 trees	300,000 trees	Low forest cover
Fishing permit (monthly cost)	25 Br.	35 Br.	0 Br.
YOUR CHOICE: (please tick (✓) one only			

CHOICE 3

Of the three alternatives below, mark the alternative you prefer

Attributes	PLAN A	PLAN B	NO MEASURES (TODAYS LEVEL)
Tilapia fish abundance/stock	High	Medium	Low
Lake side afforestation/surrounding vegetation	500,000 trees	1,000,000 trees	Low forest cover
Fishing permit (monthly cost)	35 Br.	15 Br.	0 Br.
YOUR CHOICE: (please tick(✓) one only			

CHOICE 4

Of the three alternatives below, mark the alternative you prefer

Attributes	PLAN A	PLAN B	NO MEASURES (TODAYS LEVEL)
Tilapia fish abundance/stock	High	Medium	Low
Lake side afforestation/surrounding vegetation	500,000 trees	1,000,000 trees	Low forest cover
Fishing permit (monthly cost)	15 Br.	25 Br.	0 Br.
YOUR CHOICE: (please tick (✓) one only			

CHOICE 5

Of the three alternatives below, mark the alternative you prefer

Attributes	PLAN A	PLAN B	NO MEASURES (TODAYS LEVEL)
Tilapia fish abundance/stock	High	Medium	Low
Lake side afforestation/surrounding vegetation	300,000 trees	500,000 trees	Low forest cover
Fishing permit (monthly cost)	35 Br.	15 Br.	0 Br.
YOUR CHOICE: (please tick (✓) one only			

CHOICE 6

Of the three alternatives below, mark the alternative you prefer

Attributes	PLAN A	PLAN B	NO MEASURES (TODAYS LEVEL)
Tilapia fish abundance/stock	High	Medium	Low
Lake side afforestation/surrounding vegetation	300,000 trees	500,000 trees	Low forest cover
Fishing permit (monthly cost)	15 Br.	25 Br.	0 Br.

YOUR CHOICE: (please tick (✓) one only			

CHOICE 7

Of the three alternatives below, mark the alternative you prefer

Attributes	PLAN A	PLAN B	NO MEASURES (TODAYS LEVEL)
Tilapia fish abundance/stock	Medium	High	Low
Lake side afforestation/surrounding vegetation	1,000,000 trees	300,000 trees	Low forest cover
Fishing permit(monthly cost)	35 Br.	15 Br.	0 Br.
YOUR CHOICE: (please tick(✓) one only			

CHOICE 8

Of the three alternatives below, mark the alternative you prefer

Attributes	PLAN A	PLAN B	NO MEASURES (TODAYS LEVEL)
Tilapia fish	Medium	high	Low

abundance/stock			
Lake side afforestation/surrounding vegetation	1,000,000 trees	300,000 trees	Low forest cover
Fishing permit(monthly cost)	15 Br.	25 Br.	0 Br.
YOUR CHOICE: (please tick(✓) one only			

CHOICE 9

Of the three alternatives below, mark the alternative you prefer

Attributes	**PLAN A**	**PLAN B**	**NO MEASURES (TODAYS LEVEL)**
Tilapia fish abundance/stock	Medium	High	Low
Lake side afforestation/surrounding vegetation	500,000 trees	1,000,000 trees	Low forest cover
Fishing permit(monthly cost)	25 Br.	35 Br.	0 Br.
YOUR CHOICE: (please tick(✓) one only			

CHOICE 10

Of the three alternatives below, mark the alternative you prefer

Attributes	PLAN A	PLAN B	NO MEASURES (TODAYS LEVEL)
Tilapia fish abundance/stock	Medium	High	Low
Lake side afforestation/surrounding vegetation	500,000 trees	1,000,000 trees	Low forest cover
Fishing permit(monthly cost)	15 Br.	25 Br.	0 Br.
YOUR CHOICE: (please tick(✓) one only			

CHOICE 11

Of the three alternatives below, mark the alternative you prefer

Attributes	PLAN A	PLAN B	NO MEASURES (TODAYS LEVEL)
Tilapia fish abundance/stock	Medium	High	Low
Lake side afforestation/surrounding vegetation	300,000 trees	500,000 trees	Low forest cover
Fishing permit(monthly cost)	35 Br.	15 Br.	0 Br.
YOUR CHOICE: (please tick(✓) one only			

CHOICE 12

Of the three alternatives below, mark the alternative you prefer

Attributes	PLAN A	PLAN B	NO MEASURES (TODAYS LEVEL)
Tilapia fish abundance/stock	Medium	High	Low
Lake side afforestation/surrounding vegetation	300,000 trees	500,000 trees	Low forest cover
Fishing permit(monthly cost)	25 Br.	35 Br.	0 Br.
YOUR CHOICE: (please tick(✓) one only			

Debriefing questions

Which of the following statements describes best how you reasoned while choosing between the alternatives on the six cards? Mark one or more statements.

(1) I find the *Tilapia fish stock* enhancement is important and chose exclusively such attribute in the alternatives.

(2) I don't think the fishermen should have to pay or contribute money to environmental quality improvement and conservation of natural resources.

(3) I exclusively chose the cheapest alternative.

(4) I wish I could pay/contribute more for the *aggressive rehabilitation program*, but I cannot afford it.

(5) I find lake side afforestation (surrounding vegetation cover) is important and chose such attribute in the alternatives.

(6) I chose the aggressive rehabilitation program.

Section Three-socioeconomic characteristics of the respondent

No	Name	Sex[a]	Age	Marital status[b]	Occupation[c]				Average Monthly income(in birr	Monthly expenditure(in birr)	Educational status[d]		Living area (address)[e]
					Main occupation	code	Other occupation	code			Level	Grade	

a. 1=male, 2=female
b. 1=married, 2=not married,3=other
c. 1=fisherman 2=farmer 3=trade 4=student 5=others
d. 1=primary 2=secondary 3=higher
e. 1=town 2=rural

Date _____

Interviewer name_____
Signature _____
Address _____

Interview started _____
Interview ended _____
Interviewee number _____

Thank you for your time and assistance!!!

INTERVIEWER'S OBSERVATIONS

(To **INTERVIEWER**) Did the respondent carefully consider and answer these questions?

_____

Interviewer's opinion

Yes he took time and thought about it carefully.....1

Yes he took time and thought about it but he did not visual.....2

He/she seems visualizing.....3

He/she did not think about it.....4

Other.....5 (Specify)

TO BE FILLED IN AFTER COMPLETING INTERVIEW

COMMENTS ABOUT RESPONDENT:

COMMENTS ON SPECIFIC **QUESTIONS/ATTRIBUTE/ATTRIBUTE LEVELS**:

ANY OTHER COMMENTS:

SUPERVISOR'S OBSERVATIONS

NAME OF THE SUPERVISOR: _____DATE: _____