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THE VALUE OF AN IMPROVEMENT TO LAKE CHAMO  
TO THE FISHERMEN OF THE LAKE

By:

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**ADDIS ABABA UNIVERSITY  
SCHOOL OF GRADUATE STUDIES**

**The Value of An Improvement to Lake Chamo to  
the Fishermen of the Lake**

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### *Abstract*

*Water quality is a major factor that affects fish and thus an improvement to Lake Chamo would benefit fishermen of the lake directly. An improvement proposed in this study is improving the quality of the lake one step from how the fishermen of the lake perceived existing water quality and maintaining the current depth of the lake.*

*To elicit the willingness to pay (WTP) of the fishermen to this improvement the study used CVM by applying the double-bounded dichotomous choice value elicitation format.*

*The results suggest that the probability of saying yes for a given bid increases with the education level of the respondent, income of the household, and it also increases if Lake Chamo is the only lake for the respondent to catch fish. On the other hand this probability declines as the perception of the respondent goes from bad to excellent. In addition, this probability decreases if the respondent is member to Arbaminch fishermen association and the reason for this inverse relationship between the probability of yes response and membership to the association may be due to the payment vehicle, i.e, since the registered fishermen have already been paying taxes, they may not be willing to pay additional taxes.*

*The average WTP obtained in the study is 4.63 birr per month.*

*Key words: Water quality, CVM, lake Chamo, Ethiopia, fishermen.*

## I. INTRODUCTION

### 1.1. Background of the study

Usually, for a good to have value it should pass through the market and it should have a price, which is determined by the interaction of buyers and sellers. The problem, however, is that there are commodities which are not traded in the market and left unpriced by the market. Environmental goods are the case in point. In spite of this, environmental economists have developed methods of valuing such commodities. If the values of environmental commodities were not considered in the cost benefit analysis of a project involving some environmental goods, costs and/or benefits would be understated and/or overstated. Thus, valuation of such commodities would help policy makers by providing some guidelines in decision making over projects associated with the environment.

This paper tries to apply one of the methods used in the valuation of environmental commodities in the elicitation of the willingness to pay of fishermen of Lake Chamo to water quality improvement, i.e., the Contingent valuation Method (CVM)

Chamo is one of the rift valley lakes in the southern part of Ethiopia. It is mainly used for fishing, keeping the balance of climate, recreation by foreigners as well as citizens of the country. But the major purpose of the lake that has got attention so far is fishing. Chamo is one of the three lakes (Abaya, Ziway, and Chamo) that serve as the major sources to catch fish in the country.

Fish farming is a complement to agriculture, particularly to crop production because income from crop fluctuates greatly depending on the prevailing rain condition. This is the main problem that the agricultural sector of most developing countries faces. Thus, integrating fish farming with other agricultural activities provides the chance of income diversification for farmers and reduces the risk associated with the failure of crop production.

In addition to this, fish are an important source of high quality food, especially for the poor, whose diet suffers from lack of sufficient nutrients. Furthermore, particularly for developing

countries like Ethiopia, where a large number of unemployed labor force exists; fish farming could be an important source of employment. To show the importance of fish farming, Sterner (2003) argued that:

“The economic benefit of fish cannot be undermined and even its commercial value by-far outstrips the value of any other wild game that human beings hunt.”

Since fish live in water, their growth as well as their stock greatly depends on the quality of the water body. This is due to the fact that every living thing in the world needs the environment in which it lives to be safe and convenient. Just like the environment affects physical and mental growth of human beings, the quality of water is a decisive factor in affecting the stock and growth of fish; and thus it directly affects fish farming and the income derived from it. Therefore, the quality of water is of great significance and it should be valued and included in policy analysis.

## **1.2.Statement of the problem**

The value of a good or service will be determined by the market where buyers and sellers play their part. But environmental goods are exceptional to this because they cannot be traded and thus the market doesn't price them. This is the main challenge to policy makers who are dealing with the cost-benefit analysis of projects involving environmental benefits and costs. To take account of these values of environmental benefits and costs, economists developed various methods of non-market valuation, one of which is the contingent valuation method (CVM).

This study will use contingent valuation method to examine the value that the fishermen put on improvement of the quality of water and maintaining the depth of the lake. Fishing is a water dependent business. The benefits obtained from this business greatly depend on the environment on which the fish population lives, i.e., water. Thus any action directed towards maintaining the stock of fish and/or increasing the stock from time to time, must address the problems associated with the water in which the fish live.

Ethiopia has an extensive body of inland waters comprising eight principal lakes and numerous rivers and reservoirs, which makes the country known as the water tower of Africa. These water bodies host enormous wealth of fish resources. Chamo, Abaya and Ziway are the main lakes from which more than half of the total fish catch in the country comes. But the interest of this study is lake Chamo, and it tries to analyze how much the fishermen are concerned about the quality and quantity of water and how much they are willing to pay for maintenance of the depth of the lake and a one step quality improvement (i.e. to put the quality of water one step upward from the level that they perceive)

Lake Chamo like any other lake is home for many aquatic animals, fish being one of these. In addition to this, the lake is also used for recreational purposes. To our knowledge there is no study that tried to estimate the value of such uses of the lake. Thus, this study tries to fill that gap. But the concern of this study is only the value of the improvement to fishermen. The study tries to elicit the willingness to pay of the fishermen for maintaining the depth of the lake and a one step quality improvement.

Currently, there are more than 125 registered fishermen out of which 9 are females. But, at the beginning the business was started with only 32 members and they obtained license for the first time in 1976 and they started the business with a total initial capital of Birr 64. As can be seen from Table 1.1, over a period of over two decades the number of registered fishermen increased from 1976 to 1999, but in subsequent years it was decreasing. The main reason for this is the increasing number of unlicensed fishermen on the lake. Until 2003 females were not participating in fishing, but 9 females started being involved in the business at that time.

**Table 1.1 The Number of Fishermen of Lake Chamo**

Year	Male	Female	Total
1976	32	-	32
1998	192	-	192
1999	169	-	169
2001	163	-	163
2003	116	9	125

Source: Unpublished documents of fishermen association, Arbaminch.

The main problem with these fishermen is that most of the fishing equipments are traditional and backward, which leads to low quality and quantity of fish catch. In addition to this, the quality of the lake is deteriorating from time to time and its depth is also decreasing, which reduces the stock of fish. The fishermen have direct contact with water from which they catch fish. They use fishing as a business to earn their livelihood. For this business to be worthwhile, the lake has to be conducive for fish, otherwise the stock will decline and at some point of time it may become extinct. Thus improving the quality of water and maintaining its depth can be one of the possible mechanisms to maintain the existing stock and/or increase the stock of fish in the lake. But as it is common for most environmental (public) goods, this improvement could not be traded, as explained earlier, and thus valued rarely. Therefore, this study tries to value the improvement by creating a hypothetical market for the good to elicit the WTP of fishermen.

### **1.3.The objective of the study**

The general objective of the study is to analyze how much the fishermen of Lake Chamo are willing to pay for a one step quality improvement maintaining the existing depth, and to identify factors that affect the willingness to pay of these people.

The specific objectives are to:

- Estimate willingness to pay of fishermen for a one step quality improvement while maintaining the existing depth of the lake

- explore factors that motivate fishermen of the lake to safeguard the quality of the lake and to explain determinants of willingness to pay of fishermen of the lake for water quality improvement.
- identify the vehicle of payment that may be used by policy makers so that popular support could be obtained
- explain the direction of the influence of legality on willingness to pay of the fishermen of the lake.

#### **1.4. Significance of the study**

As far as the knowledge of the researcher is concerned, this is the first study on the area of valuing the economic value of an improvement to Lake Chamo. Thus, the study will help policy makers as a base for relevant information and it is hoped to provide a basis for cost-benefit analysis of projects concerned with values of the lake.

#### **1.5. Limitations of the study**

Since environmental goods are hardly marketed, it is difficult, if not impossible, to know their value. Thus this study used a hypothetically created market to value an improvement to the lake. Thus care should be exercised in interpreting and using the results of this study because there might be differences between responses to real and hypothetical improvements. Furthermore, since a number of the questions are subjective, about which the researcher cannot easily guesstimate, the inaccuracy of data may impair the quality of the study.

## II. REVIEW OF RELATED LITERATURE

### 2.1. Conceptual framework

An individual is assumed to maximize his/her utility derived from conventional market goods,  $X$ , and an environmental good,  $Q$ ; subject to his/her budget constraint.

Formally, this can be stated as:

$$\text{Max } U(X, Q_j) \text{-----2.1}$$

s.t  $PX=M$  , where  $M$  = budget constraint

$P$  = price of  $X$

$Q_j$  = the amount of environmental good in state  $j$

$X$  = vector of marketed goods

The key point here is that the individual's consumption of  $Q$  is fixed exogenously, while he/she can freely vary his/her consumption of the  $X$ 's. The individual's utility is assumed to be continuous, non-decreasing in its arguments and strictly quasi-concave in  $X$ .

First order conditions of the above maximization problem of the individual yield a set of ordinary demand functions,  $X = h(P, Q, m)$ , where  $i = 1, 2, \dots, n$ , and by substituting for  $X$  in  $U(X, Q_j)$  the indirect utility function can be given as:

$$V = V(P, Q, m) \text{-----2.3}$$

But the problem is that the utility function that the individual wants to maximize is not observable by the researcher.

Now suppose that the environmental quality improves from  $Q_0$  to  $Q_1$ , where  $Q_1 > Q_0$ ; while prices and income remain constant at  $p$  and  $m$ . Following this improvement, the individual's utility changes from  $U^0 = V(p, Q_0, m)$  to  $U^1 = V(P, Q_1, m)$ , where  $U^1 > U^0$  because we assumed that utility is non-decreasing in  $Q$ .

The compensating variation associated with this environmental quality improvement is the amount of money ( $y$ ) that must be deducted from the income of the individual to keep his/her utility constant, and it satisfies:

$$V(P, Q_0, m) = V(P, Q_1, m-y) \text{-----2.4 ;}$$

If the individual is willing to pay this amount ( $y$ ), then it could be considered as his/her WTP for the improvement. But since there is a random component in the preference of the individual, the researcher may not know the wtp of the individual certainly. Thus what the researcher can do at most is making probability statements about the responses of respondents, and this probability may depend on various factors such as income, education level, age, etc of the respondent. Formally,

Probability of the response =  $f(\text{income, education level, age, etc})$

## 2.2. Economic value of environmental Goods

In the case of market goods the price is determined by the demand and supply forces. From buyers' side what matters is not only willingness but ability to pay should also be considered. Buyers would buy the product if they were willing and able to pay the price determined by the market. However, in the case of environmental products (for which markets rarely exist) it is difficult, if not impossible, to assign a price. Thus a main interest of environmental economists is to put such lacking prices on environmental (ecological) goods (Hoevenagle et al., 1993) and CVM is found to be one of the standard approaches for valuing non-marketed goods (resources) (Hanemann et al., 1991)

Environmental resources provide both direct and indirect services to society. These services range from basic life support to the filtration of pollution; however, they remain unpriced by the market because they are rarely bought and sold in the market, and therefore never enter into private markets. Generally, the market undervalues environmental services because the market does not consider the indirect benefits that accrue to the non-owner of the resource i.e. in the case of environmental resources it is rarely possible to exclude others from enjoying benefits or suffering costs (Hanley et al., 1997). Due to this market prices do not send the correct signal about the true economic value of such resources.

In response to market failure (i.e. the markets inability to assign correct prices to environmental resources), policy makers started to consider possible ways of determining the

economic value of such resources. Non-market valuation uses the explicit and implicit trade-offs between development and conservation to assess the value of the unpriced environmental resources.

Assuming that individuals are rational decision makers, they are able to value environmental changes despite the absence of market for their services. If a change occurs in the services of the environment such that the individual believes he/she is better off in some way, then he/she would be willing to pay some amount of money to secure this improvement, and this amount reflects his/her economic valuation of improved environmental services (Freeman, 1993; Hanley et al, 1997; Sterner 2003). On the other hand, if the change makes the individual worse off, he/she might be willing to accept compensation to let this deterioration. Economic value includes both use and non-use value. Use value implies the economic value of current use and it includes direct use value, indirect use value and option value. Non-use value is more problematic and controversial. It includes bequest value and existence value of a resource, given that the individual has no plans ever to use it.

Unlike market goods, it is possible to use environmental goods passively i.e. it is possible to get utility without physically using the resource. According to Freeman (1993), it is Krutilla who first argued for existence value and who tried to show that people obtain utility indirectly without using the resource, and have positive willingness to pay (WTP). If such passive use values were marginalized, pure public goods would have little or no measured economic value. When we say pure public goods it is to mean those goods for which it is impossible to exclude people from enjoying the good. Furthermore, enjoyment by one person does not degrade another person's enjoyment of the good. (Freeman, 1993; Kopp, 1992).

For Kopp, non-use values are a well-defined concept, fitting into neo-classical welfare economics. Non-use values are nothing more than the value individuals place on a particular pure public good; and hence, in theory they should be included in any CBA of policies and projects. For others like Blamey et al. (1995), however, responses to CV questions concerning existence value are dominated by citizen judgments concerning desirable social goods rather

than by consumer preference and hence it may be inappropriate to include non-use values in CBA.

There are different views concerning the inclusion of passive use (existence) value. Some authors argue that passive use values are irrelevant to decision making (Blamey et al, 1995) but others say that passive use values can be reliably measured, and should be taken into account. Failure to include such values is clearly inconsistent with economic theory if the objective is to maximize public welfare; otherwise pure public goods would be under supplied (Carson, 2000; Kopp, 1992).

Traditional economic techniques cannot be used to assess the value of pure public goods. This is because in the case of public goods, all people exercise the same level of the good. To solve this problem, economists developed several methods of non-market valuation.

### **2.3. Methods of non-market valuation**

As cited in Freeman (1993), Mitchell and Carson (1989) classified the methods of valuing the environment based on the characteristics of the methods. The first characteristic deals with the data sources, i.e. whether the data come from observations of people acting in real world or whether they come from peoples' responses to hypothetical questions. The second characteristic deals with the mechanism of generating monetary values, i.e., whether the method yields monetary values directly or they must be inferred through some indirect methods. Using these methodological characterizations as a basis, methods of estimating environmental values are classified into four categories such as: direct observed, indirect observed, indirect hypothetical and direct hypothetical. The following section explains these methods.

#### **2.3.1 Direct observed methods**

The source of data for these methods is what one observes. They use competitive market and simulated markets to learn about individual values. Since the choices are made on the basis of prices, the data reveal monetary values directly;

### 2.3.2 Indirect observed methods

These methods are based on actual behavior, reflecting utility maximization and involve a kind of detective work. Suppose the individual is given a fixed quantity of a good at a given price on take-it-or-leave-it basis. In this case the choice of the individual reveals only whether the value of the offered good to the individual was greater or less than the given price. The problem with environmental goods is that they do not have offered price but their quantity does affect the choices of people about the quantities of market goods thus the value of environmental service will be inferred from the relationship between market goods and the environmental service, which is based on assumption of complementarity or substitutability between them (Freeman, 1993).

### 2.3.3. Indirect hypothetical methods

To generate data, these methods involve asking people hypothetical questions rather than getting data from observations of real world choices. While dealing with these hypothetical methods one can use non-market valuation methods developed by environmental economists. The questions asked using indirect hypothetical methods could involve asking the respondent whether he/she is willing to pay a certain amount of money for a given improvement in environmental quality.

### 2.3.4 Direct hypothetical methods

In this case, people are directly asked to place values on environmental services. Simply, creating hypothetical markets can do this. For example, respondents could be asked the following question type: how much of the environmental services would you purchase at \$X price or what value would you pay if the quality of the environmental service changes from the status quo in positive direction? What makes this method different from indirect hypothetical method is that in this case values are directly obtained from the response of the respondents but in the case of indirect hypothetical methods, values are inferred from the yes or no responses of the respondents.

## **2.4. Contingent valuation**

It is a survey based method of valuing environmental goods and services which are non-marketable and are not bought and sold in the market place. The method is designed to include both passive-use and direct use values in economic analysis which is one of the advantages of the method. Since actual sales information is rarely available for environmental goods and services, it is not a simple task to place monetary value on those goods. However, economists came up with several techniques to value non-market amenities, consistent with the valuation of marketed goods. Some of the techniques are based upon either observed behavior or stated preferences. CVM is related to the latter approach.

In CV surveys, to come up with the estimate of the value of environmental amenity, respondents are asked to state their preferences concerning the changes in environmental quality. Economic values could be derived from choices observed either in an actual market or in the hypothetical market created in the survey (Carson, 2000)

The CV method values environmental goods simply by asking respondents what they at most are willing to pay for an environmental improvement or what they at least are willing to accept in the case of environmental deterioration. These are necessary questions to establish hypothetical markets for environmental goods. But for these markets to be meaningful, realistic and plausible, the ecological good under investigation has to be properly described. The method of payment needs also be clearly defined (Hanemann, 1984; Cummings et al., 1986)

### **2.4.1. Stages of CVM Surveys**

Any CVM study can have five stages (Hanley et al., 1997).

In the first stage a hypothetical market for the environmental good in question should be established. In this stage respondents might be told about the concerned body responsible for improving (maintaining) the quality of the resource, what this improvement would consist of and its effects. In addition to this it should be explained that the operation could only go ahead if extra funds are generated, and it is here that a reason for payment of services could be set up.

How funds will be raised needs to be described, i.e. the bid vehicle (property taxes, income tax, utility bills, entry fees etc) must be described here. Moreover, in this stage the provision rule need also be explained. The questionnaire should be designed to handle all these areas and it should describe whether all consumers will pay fee if the change goes ahead and how this fee will be set. A well-designed questionnaire could have the following section (Whitehead, 2000)

- an introductory section
- behavioral section
- valuation section
- demographic section.

The main objective of CVM surveys is to obtain the value of non-market goods, i.e., the maximum WTP and/or minimum WTA compensation. The maximum willingness to pay (WTP) of respondents can be derived by using open-ended question, closed-ended questions, payment card or bidding game.

Open-ended questions do not constrain the respondent's answers where as closed ended questions constrain answers by specifying the response categories. The benefit of open-ended questions is that, one ends up with a point estimate of the response, in which case it is possible to use the ordinary least squares (OLS) to analyze the data without diving in the ocean of complexity. The main disadvantage of these types of questions is that they are relatively difficult for respondents to answer especially where respondents have no prior experience of trading with the commodity in question, as is common in the case of environmental goods.

On the other hand, closed ended questions give a yes/no response, an ordinal scale response, which makes them more difficult to analyze empirically. However, the advantage of these types of questions is that they are much easier for respondents to answer, and this helps the researcher by reducing the protest zero responses. This is due to the fact that the more time a single question takes to answer, fewer questions will be answered and no-response rate will be high (Whitehead, 2000). The closed ended format single bounded or double bounded dichotomous choice. in the case of single bounded format the respondent is asked whether he/she is willing to pay a given bid and no other question. in the case of double bounded format, however, the

respondent would be asked two questions, where the second question is contingent on the response to the first question. i.e., if the respondent says 'yes' for the first question he/she will be asked for some amount higher than the first, and if the individual says 'no' for the first question he/she will be asked for some amount lower than the first bid. The main advantage of double bounded format over single bounded questions is increasing the statistical efficiency of CV surveys. This format increases efficiency in three ways. Firstly, there will be clear bound in WTP response in the case of 'yes'-'no' or 'no'- 'yes' responses. secondly, even when there is no clear bound on the response ( the case of 'no'-'no' or 'yes'-'yes' response) for the two questions, it is possible to constrain the distribution of WTP. Finally, the number responses may be increased.

The second stage is obtaining bids. It is in this stage that the survey will be administered and it can be done either by face-to-face (in -person) interviewing, telephone interviews or mail surveys.

In choosing among these survey modes, cost, time and the amount of assistance available must be considered. Mail surveys are relatively the least expensive mode of survey (Hanley et al., 1997; Whitehead, 2000; Blamey et al., 1995). In mail surveys it is possible to provide visual aids such as maps, bar charts, photos etc and they also allow some privacy to respondents. Furthermore, this mode of survey provides plenty of time when considering the amount of money that the respondents would give up so that they would be indifferent between having an improvement and maintaining status quo. Due to the mentioned and other advantages mail surveys are frequently used (Hanley et al., 1997).

However, mail surveys are blamed for the existence of potential non-response bias and for low response rate. Moreover, mail surveys require several months to conduct properly. If there are follow up questions that depend on the answer to the preceding WTP questions, respondents would hardly be trusted because it is possible for them to peak ahead.

Telephone interviews are probably the least preferred methods since conveying information about the good over the telephone may be difficult. The main reason for this is that it allows limited attention time span. In telephone surveys, it is also not possible to include visual aids. In the case of in-person surveys it is possible to offer detailed questions and as a result genuine response, to some extent, will be obtained because respondents will get chance to ask things which are not clear.

The problem with in-person interview is that the researcher is required to hire professionals, which makes it costly. It also requires the researcher to bear the travel and time cost of enumerators. Furthermore, it also suffers from the problem of interviewer bias.

In general, to choose from the survey modes the National Oceanic and Atmospheric Administration (NOAA) favored in-person interviews (Hanley et al., 1997; Freeman, 1993). But according to Whitehead (2000), to use in-person interviews the researcher must have plenty of interviewer help and/or sufficient budget. It is also advisable to use this mode if the researcher is in hurry. On the other hand, for Carson (2000) a combination of telephone-mail-telephone surveys hold promise in terms of substantially reducing administration costs while maintaining many of the advantages of in-person surveys (Carson, 2000)

The third stage of the CVM study is estimating average WTP. In the case of bidding game, open ended or payment card approaches, the calculation of mean WTP is straight forward (Hanley et al., 1997). However, in the case of dichotomous choice (DC) method (which uses the random utility theory) the calculation of average WTP is more complex.

The fourth stage is estimating bid curves. While a bid used for open-ended CVM formats can be estimated from WTP responses directly by taking WTP as a dependent variable, it can be obtained from logit functions that predict the probability of 'yes' response to a particular offer price for closed ended questions.

The last stage is aggregating the data. In this stage the sample mean bid will be converted to population mean. This can be done through different ways, one of which is multiplying the number of respondents in the population by the sample mean.

## 2.4.2 Drawbacks of CVM

### ❖ Bias

Possible sources of such biases are

- starting point in bidding games
- the choices of bid vehicle
- the hypothetical nature of the market

The bias could take the form of strategic bias, starting point bias, mental account bias etc. The presence of untruthful responses leads to the argument that CV responses should be calibrated to potentially correct for either an upward or downward bias. (Cameron, 1992; Adamowicz et al., 1994)

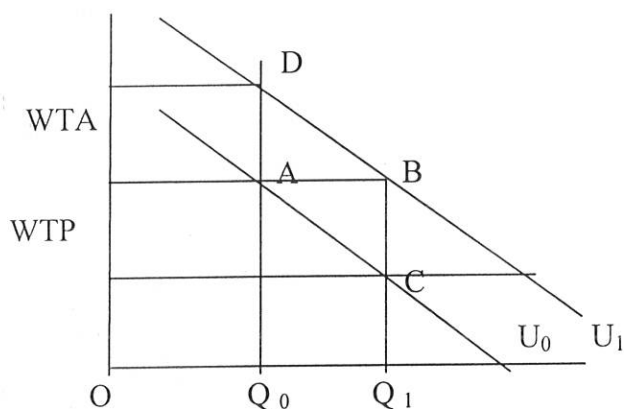
### ❖ Warm glow effect

This implies that people some times contribute to the improvement in the quality of the environment simply because they get moral satisfaction by making contribution. They offer the amount of money that makes them feel good about their attitude towards the environment. Their contribution does not depend on the level of the improvement.

### ❖ Divergence between WTP and WTA

The divergence between WTP and WTA can range from zero to infinity depending on the degree of substitution between an environmental good and other market and non-market goods. The fewer the available substitutes, the greater the divergence will be since there will be fewer possibilities to make up for the loss (Hanley et al., 1997). To explain this concept, suppose environmental service, and some market goods  $X_i$  are perfect substitutes, which lead to linear indifference curves.

Fig. 2.1. WTP and WTA given perfect substitutability

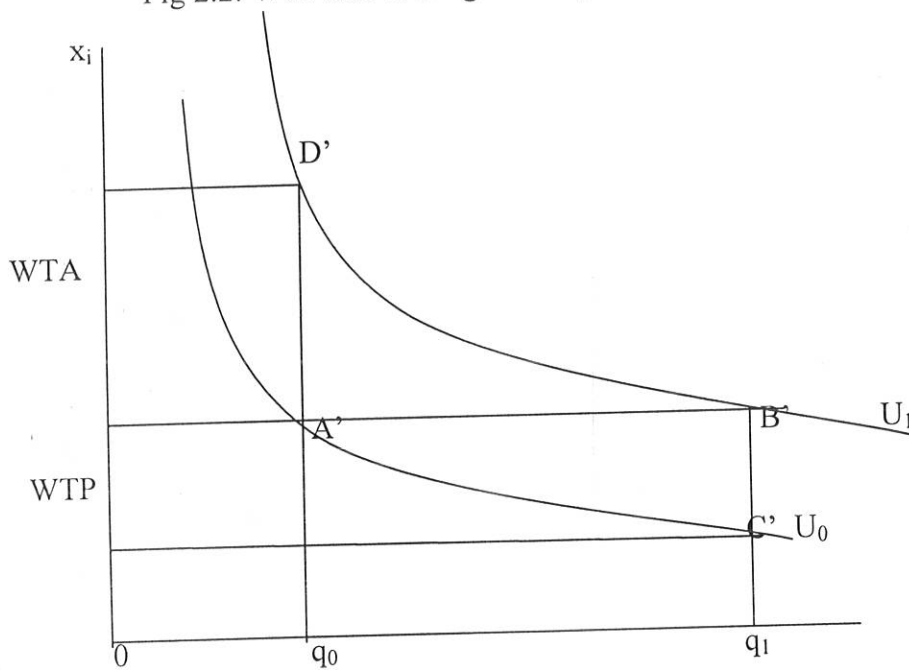


Source: Shogren et al., 1994.

WTA is the quantity of the market good ( $X_i$ ) necessary to compensate the individual to forgo a change in  $Q$  from  $Q_0$  to  $Q_1$  in figure 2.1. This is the amount  $AD$  that puts the individual on the higher indifference curve but maintains the original  $Q_0$  consumption level—an equivalent surplus measure. The WTP measure, on the other hand, is the quantity of the market good that one can take from an individual after the change to  $Q_1$  leaving him/her as well off as before—a compensating surplus measure given by  $BC$ , i.e.,  $BC$  amount of  $X_i$  should be taken away from the individual so that he/she remains on the original level of utility. Thus perfect substitutability implies that  $BC$  equals  $AD$  and both should equal the average market price of the good, which could be the value of non-market good.

Now suppose that markets are incomplete and environmental services and market goods are imperfect substitutes. In this case WTA will exceed WTP (Hanley et al., 1997). Figure 2.2 shows this.

Fig 2.2. WTP and WTA given Imperfect Substitutability



Source: Shogren et al., 1994

The individual's willingness to pay to secure the new level of environmental quality  $Q_1$ , keeping him at his original utility level,  $U_0$ , is  $B'C'$ , in figure 2.2 above. whereas the compensation required to reach the new level of utility,  $U_1$ , while remaining at his/her original level of environmental service, is  $A'D'$ , which are WTP and WTA respectively.

For some people like Knetsh (1991), the existence of a large difference between WTP and WTA measures is the manifestation of the problem, which sometimes is referred to as an endowment effect, but according to Hanemann (1991), the large difference between the two measures may arise in consumption choices where substitution possibilities are limited. Hanley et al. (1997) also shared the latter argument. If the discrepancy, between WTP and WTA reflects real economic preferences, WTA will be an appropriate measure for use in cost benefit analyses involving preservation or developing of existing underdeveloped areas. But Carson (2000) argued that whether WTP or WTA is the correct measure depends on the property right to the good. If the consumer does not have legal right to the good, the correct measure is WTP.

Generally, the discrepancy between WTP and WTA measures puts the reliability of the CVM study under question mark because it raises the question of which measure to use in the study.

❖ Information effects

Since information is crucial in making preferences among choices, changing the information set that people hold will change their valuation of environmental goods (Hanley et al., 1997). In making responses to the CVM surveys, individuals go through two stages. First they consider the proposed change, their income and the availability of substitutes and complements for the good in question. Then, individuals decide whether to honestly reveal their true WTP as their stated WTP to the survey conductor or not. (Hoehn and Randall, 1987)

The true WTP may be affected by new information about the characteristics of the good (whether they are substitutes/complements) and relative expenditures. To test the importance of information about the characteristics of the good, Hoevenagle et al. (1993) conducted a survey and found that a large difference in the description of the ecological good matters and has a significant effect on WTP. However, they found that the effect of small difference in description is negligible. More explicitly, according to Hanley and Munro (1994), increases in information can produce big increases in estimates of WTP.

The difference in information also makes the aggregation of bids (the final stage in CVM) difficult because the information set of sample respondents may be different.

❖ The transferability of benefit estimates.

In CVM it is hardly possible to generalize results from one study site to other cases. For CVM estimates of WTP for certain quality improvement of environment in one place to be transferred to that of a similar improvement of another good (but both goods should be similar, for example two rivers) other things must be equal. However, such other things are not equal and thus a straightforward transfer of benefits is not possible.

### 2.4.3. Validity of CVM study

There are two common procedures of testing the validity of the CVM study. The first one is test- retest procedure which involves conducting a CVM survey for a particular change in environmental quality on a certain sample, and then repeating the same CVM survey on a different sample from the same population some time latter. Results from these two samples will then be compared for statistically significant differences, where insignificant differences are the manifestation that the CVM provides reliable estimates of WTP (Loomis, 1989)

The second procedure is convergent validity checks. This procedure compares CVM estimates for a particular environmental good with estimates gained from other valuation methods. If a CVM survey provides a similar result to hedonic pricing or travel cost method, then it can be said that the study is reliable. It is reasonable to take the convergence of any two methods on a value of a given good as a desirable sign (Hanley et al., 1997; Carson, 2000).

To increase the reliability of a CVM study it is advised to increase the use of focus groups, the use of debriefing questions to see how well CVM respondents have understood the survey, and why they gave that particular answer recorded and others (Cummings et al., 1986).

In assessing the quality of a CV study, the first consideration is the survey instrument. A good CV study should have what is known as 'face validity'. The good and the scenario under which it would be provided should be described clearly and the trade off that the respondent is required to make should be plausible. The respondent should be given enough information to make informed decision but not be overwhelmed with it.

According to Carson (2000), a good CV survey contains:

- an introduction section
- a detailed description of the good be offered.
- the institutional setting in which the good will be provided.
- the manner in which the good will be provided.

- the method by which the survey elicits the respondents preferences with respect to the good
- debriefing questions
- question regarding respondents characteristics.

The panel convened by National Oceanic and Atmospheric Administration (NOAA) in January 1993, concluded that CV studies can produce estimates reliable enough to be the starting point for a judicial or administrative determination of natural resource damages (Carson, 2000; Hanley et al., 1993).

## **2.5. Welfare change and its measures**

A given change in environmental quality is supposed to affect the welfare of an individual through various channels. It can affect his/her welfare through the price of goods and services he/she purchases in the market. It may also affect through the price of factors of production supplied by this individual. Furthermore, it can also affect through changes in the non-marketed goods (Freeman, 1993).

This change in the environment could cause a gain or loss of welfare to the individual. Thus, the amount of gain or loss of welfare should be measured, if not it should be approximated, and be included in cost benefit analysis. To deal with this, various possible measures of welfare change have been developed.

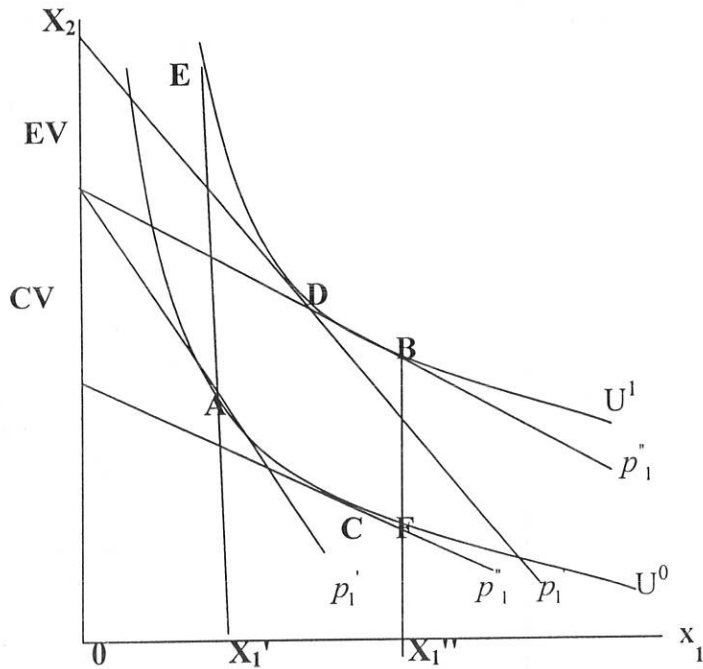
### **2.5.1 Alternative measures of welfare change**

**2.5.1.1 Ordinary consumer surplus:** If we maximize the utility function, we get ordinary demand functions conditional on prices and income. Then, the area under these demand curves, but above the horizontal price line gives this measure of welfare change (Varian, 1992; Freeman, 1993).

**2.5.1.2. Compensating Variation (CV):** Assuming one of the channels through which environmental change affects the welfare of the individual, (i.e, through the change in the price of marketed goods) it is possible to explain this measure of welfare change. Suppose the

aforementioned change in environmental quality causes the price of marketed good  $x_1$  to fall from  $p_1'$  to  $p_1''$ .

**Fig. 2.3 The compensating variation and the equivalent variation measures of welfare change.**



• Adapted from Freeman (1993)

Following this change in price, the individual will move from equilibrium point A to equilibrium point B in figure 2.3. Then, CV is defined as the compensating payment necessary to make the individual indifferent between the original situation and the new price set, i.e., CV is the amount deducted from the income of the individual so that he/she would be as well off at point C as at point A with the original prices and income. Thus, CV measures the maximum amount that the individual would be willing to pay so that the potential for the welfare gain from the new price set is exhausted (Lankford, 1988; Freeman, 1993, Varian, 1992). This implies that CV is the amount of money income taken away from the individual so that he/she

remains on the initial utility level  $U^0$ , at point C as shown in figure 2.3. In terms of indirect utility function, CV can be given as the solution to:

$$V(p_1^1, m) = V(p_1^0, m - CV) = U^0 \text{-----2.5}$$

In terms of expenditure function;

$CV = e(p_1^1, p_2, u^0) - e(p_1^0, p_2, u^0)$  i.e., CV is the difference between the expenditure required to sustain the initial utility level  $U^0$ , at the price levels;  $p_1^1$  and  $p_1^0$ .

$$CV = \int_{p_1^0}^{p_1^1} \partial e(p_1, U^0) / \partial p_1 dp_1 = \int_{p_1^0}^{p_1^1} h(p_1, U^0) dp_1 \text{-----2.6}$$

**2.5.1.3 Equivalent Variation (EV):** It measures the income equivalence of the change in the price of  $x^1$  that would enable the individual to achieve the new level of utility,  $u^1$  in figure 2.3, given the original prices. The individual will attain  $u^1$  at point D. In other words, EV is the minimum amount of money that should be given to the individual so that he/she would be induced to voluntarily give up the opportunity to purchase at the new price set.

Thus, it can be given as the solution to equation (2.7) below.

$$V(p_1^1, m + EV) = V(p_1^0, m) = u^1 \text{--- (2.7)}$$

To express EV in terms of expenditure function, one can write it as:

$EV = e(p_1^1, p_2, u^1) - e(p_1^0, p_2, u^1)$ , i.e, it is the difference between the expenditure levels required to achieve the final and initial utilities given the initial set of prices. EV can also be expressed as the difference between the expenditure functions at the initial and final price sets given final utility level (Hanley et al., 1997; Whittington et al., 1991)

$$EV = \int_{p_1^0}^{p_1^1} \partial e(p_1, U^1) / \partial p_1 dp_1 = \int_{p_1^0}^{p_1^1} h(p_1, U^1) dp_1 \text{-----2.8}$$

EV can also take another form, i.e., it can be the maximum amount of money that the individual would be willing to pay to avoid the change in prices. This is the case when prices increase (Freeman, 1993).

Both EV and CV measures are the area to the left of the Hicks-compensated demand curve but the main difference is that the Hicks-compensated demand curve in the case of CV passes through the initial position while that associated with EV passes through final position.

The common characteristics that CV and EV measures share is that both allow the individual to adjust the quantity consumed of one or more goods in response to changes in relative prices and income levels, which is not the case for compensating surplus and equivalent surplus (Lankford, 1988).

Even though EV and CV look similar here, to explain the difference between the two measures Freeman (1993) argued that: “The EV is the monetary equivalent of a price change. It can be interpreted as an index of utility in the sense that it imputes the same monetary value to all changes from an initial position that result in the same final utility level. But, the CV cannot be interpreted as an index of utility. Rather, it measures the offsetting income change necessary to “prevent” a utility change.” (Freeman, 1993, pp.57)

However, there are cases where EV and CV measures of welfare change are the same, i.e., in the case where the income elasticity of the good whose price has changed is zero (in which case income difference does not matter and has no effect on the purchase of the good (Varian, 1992, Freeman, 1993, Carson, 2000).

Generally, both EV and CV can be defined either as WTP or WAC depending on the direction of price change and the presumptions behind CV and EV concerning the implied property right. Freeman (1993) summarized this as:

Welfare measure	Price increase	Price decrease
EV-implied property right in the change	WTP to avoid	WTA to forgo
CV-implied property right in the status quo	WTA to accept	WTP to obtain

❖ Adapted from Freeman (1993) pp.58.

**2.5.1.4. Compensating surplus (CS):** CS measures the amount of money required to maintain pre-change level of utility  $U^0$  in figure 2.3 above, with the post change imposed quantities, prices and income (Lankford, 1988).

Assume an individual has the usual utility function that increases in its arguments, twice differentiable and quasi-concave and is given as  $U(x_1, x_2)$ . Also suppose that there is a change from  $\{x_1^1, p_1^1, p_2^1, m^1\}$  to  $\{x_1^{11}, p_1^{11}, p_2^{11}, m^{11}\}$ , where  $p_1$  is the price of  $x_1$ ,  $p_2$  is the price of  $x_2$  and  $m$  is income of the individual.

Then, CS would be the solution to:

$$V(x_1^1, p_2^1, m_1 - p_1 x_1^1) = V(x_1^{11}, p_2^{11}, m^{11} - p_1^{11} x_1^{11} - CS) = U^0 \text{ --- (2.9)}$$

Explicitly,

$$CS = \{(m^{11} - p_1^{11} x_1^{11}) - (m^1 - p_1^1 x_1^1)\} - \{e(x_1^{11}, p_2^{11}, u^0) - e(x_1^1, p_2^1, u^0)\} \text{ --- (2.10)}$$

Note, however, that to make graphical explanation simple, it is assumed that the only change that has happened is a change in  $p_1$  (price of  $x_1$ )

In simple terms CS is the compensating payment that makes the individual indifferent as to the original situation and the opportunity to purchase the new quantity  $x_1$  of the good whose price has changed (Freeman, 1993, Lankford, 1988, Hanley et al., 1997). It is given by the vertical distance between the two indifference curves at the final quantity  $x_1^{11}$ , which is given by BF in figure 2.3. CS is closely related to CV and the major difference between the two measures is that in the case of the former measure the individual does not have a freedom to adjust his/her purchases of one or more of the good(s).

**2.5.1.5. Equivalent surplus (ES):** It is the other appropriate measure associated with imposed quantity and it measures the amount of money paid to or by the individual so that the new level of utility  $u^1$  is attained given the pre-change levels of  $x_1$  (whose quantity is imposed), prices and income were maintained. In other words, ES measures the change in the income required to make the individual as well off as the change in prices, given the old prices and consumption level of  $x_1$  (Whittington et al., 1991, Lankford, 1988). This implies that ES is the amount of money that should be given to the individual (in place of prices and income change) so that

he/she can attain the post-change utility level with the initial consumption of  $x_1$ . It is given by AE in figure 2.3 above.

Mathematically, ES is given as the solution to:

$$U^1 = V(x_1^{11}, p_2^{11}, m^{11} - p_1^{11}x_1^{11}) = V(x_1^1, p_2^1, m^1 - p_1^1x_1^1 + ES) \quad (2.11)$$

Explicitly,

$$ES = \{ (m^{11} - p_1^{11}x_1^{11}) - (m^1 - p_1^1x_1^1) \} - \{ e(x_1^{11}, p_2^{11}, u^1) - e(x_1^1, p_2^1, u^1) \} \quad (2.12)$$

The explicit equations (2.11) and (2.12) of CS and ES show that ES is the difference between actual payments and willingness to pay of the individual, given the final utility as the base level of satisfaction, and CS is the difference between actual payments and willingness to pay of the individual, given the original utility as the base level of satisfaction. The only difference between CS and ES in this case is the base level of satisfaction, i.e., one uses  $U^1$  and the other uses  $U^0$  as the base level of satisfaction.

## 2.6. Empirical evidence

Lipton (2003), who conducted contingent valuation survey on boat owners of Maryland, found that if the individual ranks the quality of water lower and if he or she is more concerned about health effects of water quality, then the more would be his/her willingness to pay for the quality improvement. To arrive at this conclusion the data were collected from a sample of 2,510 registered boaters out of 220,800. To elicit the willingness to pay of the boat owners, he used open-ended question format and the payment was to one step improvement in quality of water. The tobit model was used to estimate the econometric model in his study.

Viscusi et al. (2004), using the iterative choice approach to value water quality improvements for nationally representative sample of over 1000 respondents, found that willingness to pay for a one percentage point improvement in water quality increases with family income, age and education.

Abou-Ali and Carlsson (2004) conducted a survey on the welfare effects of improved water quality in Egypt. They administered the survey to about 750 households and found

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that households in Cairo have a positive willingness to pay to reduce health risks related to water quality, and they concluded that there is significant heterogeneity among the households both in terms of observed characteristics (such as level of education, whether they had contracted diarrhea in the year before the study or not) and unobserved characteristics. To allow for the latter case, they used a random parameter logit model. In their study estimated WTP was lower than the costs required to achieve the improvement programs. They attributed this mainly to limitations in understanding of respondents about health problems and their sources.

Hanley et al. (2004), in their study that values the benefits of Coastal water quality improvements in Scotland, showed that there was an imperfect match between perceived water quality and biological monitoring results. In addition to this they argued that respondents were not very confident at rating water quality at other beaches, which results in many “protest zero” responses and “don’t know” responses. To estimate the welfare benefits of the improvement, they combined both real behavior and contingent behavior; and they found that the better the water quality is perceived to be, the more trips are made. Furthermore, if water quality is improved such that people can go swimming where previously they chose not to will increase the number of trips to be made to the beach.

In their methodological approach they combined real and contingent behavior using a Random Effect Negative Binomial Panel Data Approach. According to them the benefits of combining stated preference and revealed preferences include checking convergent validity, producing more efficient sampling and others.

Yaping (2003) applied CV and Travel Cost Method (TCM) to estimate the value of improved water quality for recreation in East Lake, Wuhan, of China and found that income and education are individually significant determinants of WTP of respondents. The necessary information for the estimation of WTP had been elicited using open-ended questions. It is showed in the study that the relationship between WTP and distances presents an irregular pattern and WTP responses of respondents with their judgment on quality, income and education show a well-fitted liner relationship. To increase the reliability of the income data,

which is rarely genuine, this study adjusted the real income of the respondents for the possible differences in the residential house.

This study showed that CV values are higher than those from TCM, and the main reason for this according to the study is that CV values take the existence value of the lake in to consideration, which is not the case for TCM. The study used random sampling technique and selected 600 respondents from users group (visitors). Furthermore the study confirmed that the medians are lower than the arithmetic means, indicating that more visitors are willing to pay lower than the average.

Hausen and Van Kooten (2001), using CVM to estimate the benefits of improving water quality in the Abbotsford Aquifer, British Colombia, found that the average WTP was \$63.86 per year. In addition to this their study showed that respondents who own agricultural land are willing to pay more than those owning no agricultural land. The main reason they attributed for this is that those who own agricultural land may see them selves as contributing to nitrogen nitrate pollution. They use random sampling technique to select sample respondents, and ordinary least squares (OLS) as econometric technique to show the relationship between WTP and relevant variables.

### III DATA SOURCES AND METHODOLOGY

#### 3.1 Data sources

In this study one of the standard methods of measuring values of non-marketed goods in general and environmental goods in particular, i.e., the CVM, has been used. As it is common in studies that use CVM, this study also used primary data sources. To generate the necessary information in eliciting the WTP of respondents, a questionnaire was developed and onsite interview was held. The questionnaire had the following three parts: personal information, attitudinal questions, and willingness to pay<sup>1</sup>. In the willingness to pay part double bounded dichotomous choice questions were used, in which case the respondent was asked whether he/she is willing to pay a given amount (bid)- if the individual accepts the offer he/she will be asked for some higher amount and if he/she refuses the first bid he/she will be given a lower bid.

The questions used in this study, thus, are closed-ended and the main reason to use these questions is that the closed-ended questions lead to more reliable and less biased responses than other methods (for example, open-ended). The reason is that people are more accustomed to deciding whether to buy or not when take-it-or-leave-it price is fixed than to determining the highest price they would be willing to pay.

#### 3.2. Sample and survey design

The study used random sampling method from the list of registered fishermen of Lake Chamo and convenience was used to select from the population of unregistered (illegal) fishermen of the lake and in total 150 sample respondents were selected.

The survey was administered using face-to-face (in-person) interview. Interviewers were supervised by the researcher and they were trained carefully before they started interviewing the respondents.

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<sup>1</sup> The willingness part of the questionnaire is given in appendix 3

Before the main survey, pre-testing of the questionnaire was done and some minor restructuring and rearrangements were made to the questionnaire. In addition to that the pilot survey also enabled us to determine the starting points (bids) used in the main survey.

### **3.3. Methods of analysis**

To analyze the data collected, tables and charts were used. In addition descriptive statistics such as mean, median, standard deviation etc were also used.

Furthermore, we used simple probit and bivariate probit models to discuss the relationship between responses to the closed-ended questions on willingness to pay of respondents and different factors expected to influence it.

## IV. DISCUSSION AND ANALYSIS

### 4.1 Introduction

This chapter mainly deals with the analysis of data obtained from the survey and it analyzes the attitudes of fishermen of Lake Chamo towards the problems pertaining to the lake and their willingness to pay for an improvement in the quality of the lake and maintaining the current depth of the lake.

By definition economic value of an amenity is people's willingness to pay (in any form) in order to obtain the amenity, i.e., it is the maximum amount of money that fully – informed people would be willing to pay in aggregate to obtain the amenity. One of the possible ways to obtain aggregate values from sample estimates is by multiplying sample averages by total population.

### 4.2 Descriptive statistics

A summary of data is given in table 4.1. On average, respondents have 5 years of formal education and are 26.1 years old.

The average family size for the sample respondents is 2. This low family size may be due to the fact that most of the fishermen of the lake are single (unmarried). Our survey result shows that more than 60% of the respondents are single (table 4.1)

**Table 4.1. Summary and description of variables**

Variable	Mean
Education (Number of years completed)	5
-No education (1 if no education, 0 otherwise)	0.16
- Primary (1 if primary school, 0 otherwise)	0.60
- High (1 if high school, 0 otherwise)	0.24
Age (in years)	26.31
Family size	2
Married (1 if yes)	0.386
Sex of fisherman ( 1 if male, 0 otherwise)	0.90
Good (1, if the respondent ranks the existing quality of the lake as good 0, otherwise )	0.26
Very good ( 1, if the respondent ranks the existing quality of the lake as very good or excellent 0, otherwise)	0.12
Chamo (1, if lake Chamo is the only lake from which the respondent catches fish 0, otherwise)	0.88
Bid	23
Member( 1, if the respondent is member to fishermen association 0, other wise)	0.48
income per month	471.63 Birr

Source: Own Survey, 2005

According to the survey results, about 90% of the fishermen of the lake are males. These results are consistent with the documents of Arbaminch Fishermen Association, which shows that about 93.18% of registered fishermen are males.

It is evident from the survey result that the average monthly income of sample respondents is 471.63 Birr per month (Table 4.1). The income figures have been adjusted to include incomes from all sources as reported by the respondents.

**Table 4.2. Water quality ranking of fishermen of Lake Chamo**

Water quality	Number of respondents) (% of total)	WTP		Reasons for zero WTP	
		Zero (% of total)	Positive (% of total)	Low income (% of all zero response)	Other reasons
Bad	45 (30%)	2 (1.33%)	43 (28.67)	2 (29%)	-
Fair	47 (32%)	-	47 (32%)	-	-
Good	39 (26%)	5 (3.33%)	34 (22.67%)	4 (57%)	1 (14%)
Very good	12 (8%)	-	12 (8%)	-	-
Excellent	6 (4%)	-	6 (4%)	-	-

Source: Own Survey, 2005

The survey result shows that there is quality problem in the lake. As Table 4.2 reveals the proportion of respondents who rated the quality of the lake as bad and fair is more than that of respondents who rated it as good, very good and excellent. Most of the respondents (62%) rated the quality of water as bad and fair. It is only 38% of respondents who rated the quality as good, very good and excellent. Paradoxically, but not surprisingly, there are respondents who rated the quality of the lake as excellent and had positive willingness to pay. On the other hand, there are respondents who rated the lake's quality as bad and had zero willingness to pay. The explanation for a positive WTP for someone who has already rated the water quality as excellent might be the difference between quality and other considerations (depth), i.e., the respondent might have considered quality and other problems as different aspects of the

problem as mentioned in the questionnaire (particularly in the willingness to pay part), and his/her positive willingness to pay might be for other improvements than quality, i.e., maintaining current depth.

The reason for the latter case may be the fact that individuals who perceive water quality as bad may have less confidence in any program that attempts to resolve the problem and improves the quality of the lake to a higher level and thus they may refuse to pay anything. The other reason could be due to low income, i.e., despite the poor quality of the lake they may not have sufficient income to pay for the improvement programs. From Table 4.2 it is also clear that 4.67% of the respondents have zero WTP for the improvement program. For more than 85% of those whose WTP is zero the reason is low income or inability to pay.

**Table 4.3 Other sources of income to fishermen than fishing**

Source	Number of respondents (% of total)
Farming	30 (20%)
Commerce	24 (16%)
No other source	96 (63.67%)

Source: Own Survey, 2005

Based on the survey responses, for most of the fishermen of the lake fishing is the a major source of income. In particular more than 62% of the sample respondents are generating major share of their income from fishing (Table 4 .3). This implies that fishing is a main source of employment that supports the labor force of the surrounding villages and is a means to generate income. On the other hand the major source of fish for these people is Lake Chamo, which is the only source of fish for about 88% of sample respondents (Table 4.1). Thus, making an

improvement to the lake in a way that increases the stock of fish in the lake will help the fishermen of the lake in particular and the community in general by increasing the level of income and hence their standard of living.

Moreover, Lake Chamo provides other services to the fishermen of the lake. About 43% of the fishermen use the lake for drinking and washing purposes.

**Table 4.4 Other purposes of the lake to fishermen than fishing**

Purpose	Proportion of respondents
Recreation	0.28
Boating	0.11
Drinking and washing	0.43
Others	0.16
No response	0.02

Source: Own Survey, 2005

The other purpose of the lake is for recreation and boating; more than 39% of the respondents benefit from this activity (Table 4.4). In addition to fishermen of the lake there are others who use the lake for recreation purpose. But the willingness to pay of these people is not included in this study as the main interest of this study is to elicit the WTP of fishermen alone.

It is a known fact that every action directed towards improving the existing state of the lake costs money and one way of financing the expenses is by collecting money from the public. One of the most frequently used methods of collecting money is taxation. But as shown in Table 4.5, it is revealed that a majority of sample respondents at least do not like new taxes. About 63% of the sample respondents are in favor of voluntary contributions.

**Table 4.5 Attitude of fishermen towards  
different payment vehicles**

Payment vehicle	Number of Respondents (% of total)
Additional taxes	30 (20%)
Voluntary contribution	94 (62.67%)
Additional or registration fee	24 (16%)
No response	2 (1.33%)

Source: Own Survey, 2005

Furthermore, as shown in Table 4.7, 41% of the respondents believe that polluters of the lake should pay for the improvement program. According to them, concerned body should move away farmers who farm the surrounding agricultural land, who are the principal polluters of the lake. A majority of the respondents (70%), charged farmers of the village to be held responsible for the damage (Table 4.6). Farmers who own the near-by agricultural land damage the lake in three ways. The first is by clearing the hedge plant around the lake to get more agricultural land. Due to this sediment brought by flood will directly join the lake. In addition to this as they plough the nearby land, it becomes very sensitive to flood and erosion, which adds to the pollution of the lake and affects the depth of the lake.

**Table 4.6 Major problem creator to the lake**

Agent	Number of Respondents (% of total)
Farmers	105 (70%)
Factories	6 (4%)
Others	39 (26%)

Source: Own Survey, 2005

Secondly, they cut grass from the lake to feed their livestock, which subjects small fish to danger (for example they may be taken away by birds) as the grass in the lake serves as a shelter to small fish. Furthermore, the grass is a source of food for fish<sup>2</sup>. Finally, these farmers use fertilizers, pesticide, herbicide and other chemicals that pollute the lake. This could be a possible reason why some respondents are reluctant to pay for the proposed improvement in the quality of the lake. In other words they may not like to pay the cost that polluters ought to pay.

**Table 4.7 Measures that should be taken to safeguard the quality of the lake and to maintain the existing depth of the lake**

Measures	Number of Respondents (% of total)
Punishing polluters	62 (41.33%)
Improving the administration of the lake	31 (20.67%)
Awareness creation	57 (38%)
No response	-

Source: Own Survey, 2005

<sup>2</sup> The source for this information is personal communication with the heads of Arbaminch fishermen association

The other possible reason for the respondents to be reluctant to pay additional taxes may be their belief about the importance of the improvement of the administration of the lake, i.e., respondents may believe that improved administration could solve the problems without requiring additional taxes. About 21% of respondents suggested improving the administration of the lake as one of the possible measures to solve the problems pertaining to the lake. They also addressed awareness creation among the public as one of the possible ways that help the improvement effort. About 38% of respondents considered awareness creation as one of the measures that should be taken to encourage people to safeguard the quality of the lake (Table 4.7).

According to the survey result 41% of the respondents said that the quality problem of the lake seriously affected the benefits they obtain from the lake. For 27% of the respondents the impact of the problem is moderate. The remaining 18% and 14% rated the impact as very serious and simple respectively (table4.9)

**Table 4.9 The impact of the quality problem of the lake on the benefits obtained from the lake**

Impact	Percentage of respondents
Very serious	18
Serious	41
Moderate	27
Simple	14

Source: Own Survey, 2005

The survey result revealed that 40% of the respondents do not know the impact of their personal activity on the quality of the lake and it is only about 25% of the respondents who

think their personal activity could affect the quality of the lake. About 35% of the respondents said that their personal activity does not affect the quality of the lake (Table 4.10).

**Table 4.10 The perception of respondents about the impact of their personal activity on the quality of the lake**

Perception of the respondent	Percentage of respondents
Free of adverse impact	0.35
Adversely affects	0.25
I don't know	0.4

Source: - Own Survey, 2005

### 4.3. Bivariate analysis

Correlation coefficients between the variables considered in this study are reported in Appendix 1. The results show that there is a positive and significant correlation between willingness to pay of the respondent and income of the household. The WTP response is also significantly and positively correlated with education level of the respondent and the dummy variable Chamo<sup>3</sup>. This response, however, is negatively and significantly correlated with the age, perception of the respondents about the existing quality of the lake and sex of the respondent. The negative correlation coefficients between WTP response and perception of the respondents about the existing quality suggest that fishermen who perceive the current quality of the lake as bad are more likely to accept the given bid than those who perceive the existing quality as good, i.e., as the perception of the respondents goes up wards, for example from bad to fair, they would tend to say no to the offered bid. The correlation between WTP responses and the rest of the variables considered in this study was found to be insignificant.

<sup>3</sup> Chamo is a dummy variable that assumes 1 if lake Chamo is the only lake for the respondent to catch fish and 0 other wise.

#### 4.4. Model Specification

This study, following Hanemann (1984), utilizes the random utility model with a linear utility function. The random utility model starts with utility function; where by indirect utility of an individual contains deterministic and stochastic components.

$$V_{ij} = V_j(Q_j, m_i, z_i, \varepsilon_{ij}) \quad (4.1)$$

Where,  $Q_j$  = the state of the lake

$m_i$  = income of the individual

$z_i$  = socio-economic characteristics of the individual 'i'

$\varepsilon_{ij}$  = a component of preferences known to the individual respondent but not observed by the researcher.

Notice that there are two states, i.e the state that occurs when the CV scenario is implemented (which is given by  $j = 1$ ) and the status quo (the existing) state ( $j = 0$ ). Thus, the indirect utilities after and before the program are given as:

$$V_{i1} = V_1(Q_1, m_i - t_i, z_i, \varepsilon_{i1}) \text{ and}$$

$$V_{i0} = V_0(Q_0, m_i, z_i, \varepsilon_{i0}) \text{ respectively.}$$

Now suppose that the representative fisherman is asked whether he would pay an amount  $t_i$  for the program that improves the quality of water in the lake and maintains the current depth of the lake. Then, economic theory tells us that the individual would pay  $t_i$ , if the utility with the program is greater than the utility without it, taking other variables into consideration. This implies that:

$$V_1(Q_1, m_i - t_i, z_i, \varepsilon_{i1}) > V_0(Q_0, m_i, z_i, \varepsilon_{i0}) \quad (4.2)$$

The challenge that the researcher encounters here is that he does not know the random part of preferences; therefore, he can only make probability statements about 'yes' and 'no' responses to the given bid. In other words, the true willingness to pay (WTP) of the respondent is unobservable and what the researcher observes is a discrete indicator variable,  $Y_i$ , which equals 1 if the individual accepts the offer and 0 otherwise, and the researcher can only make probability statements about this.

$$Y_i = \begin{cases} 1 & \text{if } t_i \text{ is accepted} \\ 0 & \text{otherwise} \end{cases} ;$$

This implies that  $Y_i = 1$  if the individual accepts the offer, i.e., if the individual thinks that he is better off with the program than without it and equation (4.2) holds.

Thus,

$$\Pr(\text{yes}_i) = \Pr(Y_i=1) = \Pr [V_1(Q_1, m_i - t_i, z_i, \varepsilon_{i1}) > V_0(Q_0, m_i, z_i, \varepsilon_{i0})] \quad (4.3)$$

Since this is too general to estimate, decision over the functional form of utility should be made at this point. In addition to this decision over the distribution of random (stochastic) term should also be made.

So, by specifying the utility function as additively separable in deterministic and random components and by assuming linear functional form (which is the simplest and most commonly used), the preference function can be written as:

$$V_i(Q_1, m_i, z_i, \varepsilon_{ij}) = V_i(Q_0, m_i, z_i) + \varepsilon_{ij} \quad (4.4).$$

From equation (4.4) the deterministic component of utility function can be expressed in linear form as:

$$V_i(Q_j, m_i, z_i) = \alpha_j z_i + \beta_j m_i \quad (4.5)$$

Note here that  $\alpha_j$  stands for a vector of parameters and  $z_i$  stands for different variables, excluding income, related to individual 'i' that affect his utility

$$\alpha_j z_i = \sum \alpha_{jk} z_{ik}$$

If the offer  $t_i$  is accepted and the program is implemented the deterministic utility would be:

$$V_{1i}(m_i - t_i) = \alpha_1 z_i + \beta_1 (m_i - t_i) \quad (4.6)$$

In the same way, the initial (status quo) deterministic utility would be:

$$V_{0i}(m_i) = \alpha_0 z_i + \beta_0 m_i \quad (4.7)$$

The change in the deterministic utility is given by the difference between equations (4.6) and (4.7)

$$V_{1i}(\cdot) - V_{0i}(\cdot) = (\alpha_1 z_i - \alpha_0 z_i) + \beta_1 (m_i - t_i) - \beta_0 m_i$$

$$\Delta V = (\alpha_1 - \alpha_0) z_i + \beta_1 m_i - \beta_1 t_i - \beta_0 m_i$$

By assuming that the marginal utility of income is constant between the initial and final state (i.e.,  $\beta_1 = \beta_0 = \beta$ ), the change in utility ( $\Delta V$ ) is given by

$$\Delta V = \alpha z_i - \beta t_i \quad (4.8),$$

where  $\alpha = \alpha_1 - \alpha_0$

From equations (4.3) and (4.4)

$$\begin{aligned} \Pr(Y_i=1) &= \Pr \{V_1(Q_1, m_i, z_i) + \varepsilon_{i1} > V_0(Q_0, m_i, z_i) + \varepsilon_{i0}\} \\ &= \Pr \{V_1(.) - V_0(.) + \varepsilon_{i1} - \varepsilon_{i0} > 0\} \\ &= \Pr(\Delta V + \eta_i > 0) \text{ ---- (4.9), where } \eta_i = \varepsilon_{i1} - \varepsilon_{i0} \end{aligned}$$

To reduce computational efforts, multiply both sides of inequality in the parenthesis of equation (4.9) by  $-1$ .

$$\begin{aligned} \Pr(Y_i=1) &= \Pr(-\Delta V - \eta_i < 0) \\ &= \Pr \{ -(\alpha z_i - \beta t_i) < \eta_i \} \\ &= 1 - \Pr(-(\alpha z_i - \beta t_i) > \eta_i) \end{aligned}$$

Assuming the distribution of  $\eta_i$  to be symmetric

$$\begin{aligned} \Pr(Y_i=1) &= 1 - \Pr(-(\alpha z_i - \beta t_i) > \eta_i) = \Pr(\eta_i < \alpha z_i - \beta t_i) \\ &= \Pr(\eta_i < \alpha z_i - \beta t_i) \text{ ---- (4.10)} \end{aligned}$$

Assuming the distribution of  $\eta_i$  to be normal, i.e.,  $\eta_i \sim N(0, \sigma^2)$ , it can be transformed to standard normal distribution (with mean zero and variance one) by dividing the inequality in the parenthesis in (4.10) by  $\sigma$

$$\begin{aligned} \Pr(\eta_i/\sigma < \alpha/\sigma(z_i) - \beta/\sigma(t_i)) \\ \Pr(\theta < \alpha/\sigma(z_i) - \beta/\sigma(t_i)) \text{ ---- 4.11} \end{aligned}$$

where,  $\theta = \eta_i/\sigma$

Therefore, the probability that a unit normal variable ( $\theta$ ) is less than  $(\alpha/\sigma(z_i) - \beta/\sigma(t_i))$  can be written as

$$\Phi(\alpha/\sigma(z_i) - \beta/\sigma(t_i)) \text{ --- (4.12)}$$

where  $\Phi(.)$  is the cumulative standard normal

To estimate the parameters from (4.12), we use maximum likelihood method, which maximizes the joint probability of the responses of all individuals in the sample, i.e., the likelihood function. Thus, the likelihood function is given as:

$$L_i = [\Phi\{\alpha/\sigma(z_i) - \beta/\sigma(t_i)\}]^{I_i} [1 - \Phi\{\alpha/\sigma(z_i) - \beta/\sigma(t_i)\}]^{1-I_i}$$

where  $I_i = 1$ , if respondent  $i$  answers yes

Taking logarithm of the likelihood function, we get:

$$\ln L = \sum \left\{ I_i \ln [\Phi(\alpha/\sigma (z_i) - \beta/\alpha (t_i))] + (1-I_i) \ln [1-\Phi (\alpha/\sigma (z_i)-\beta/\sigma(t_i))] \right\} \dots (4.14)$$

Maximizing (4.14) with respect to parameters, we get parameter estimates of simple probit model. But to obtain the parameter estimates of bivariate probit model, which takes the follow up question into consideration in double- bounded dichotomous choice, we need to drive the likelihood function of the model. Assume individual ‘i’ is asked whether he is willing to pay ‘ $t_k$ ’ amount for a given improvement in environmental good or not, where  $k = 1$  if ‘t’ is the first bid and  $k = 2$  if it is the second bid. Thus the four possible responses of individual ‘i’ and the ranges within which his/her true WTP can lay are:

- (1)  $t_1 \leq WTP < t_2$  if the individual’s response is ‘yes’ for  $t_1$  (first bid) and ‘no’ for  $t_2$  (second bid)
- (2)  $t_1 > WTP \geq t_2$ , if the individual’s response is ‘no’ for  $t_1$  and ‘yes’ for  $t_2$
- (3)  $WTP > t_2$  if his/her response is ‘yes’ for both  $t_1$  and  $t_2$
- (4)  $WTP < t_1$  his/her response is ‘no’ for both  $t_1$  and  $t_2$ .

Thus, the probability of observing one of the possible two-bid responses can be given as:

$$\Pr(\text{yes, no}) = \Pr(WTP_{i1} > t_1, WTP_{i2} < t_2) \dots \dots 4.15$$

However the  $i^{\text{th}}$  individual’s WTP in double –bounded data can be given as

$$WTP_{ik} = \mu_k + \varepsilon_{ik} \dots \dots 4.16$$

where  $WTP_{ik}$  represents the  $i^{\text{th}}$  respondent’s willingness to pay, and  $\mu_1$  and  $\mu_2$  are the means for the first and second answers. This implies,

$$\Pr(\text{yes, no}) = \Pr(\mu_1 + \varepsilon_{i1} > t_1, \mu_2 + \varepsilon_{i2} < t_2)$$

By constructing the other three response sequences analogously, the  $i^{\text{th}}$  likelihood function becomes

$$Li(\mu/t) = \left[ \Pr(\mu_1 + \varepsilon_{i1} > t_1, \mu_2 + \varepsilon_{i2} < t_2)^{YN} \right] \left[ \Pr(\mu_1 + \varepsilon_{i1} > t_1, \mu_2 + \varepsilon_{i2} > t_2)^{YY} \right] \\ \left[ \Pr(\mu_1 + \varepsilon_{i1} < t_1, \mu_2 + \varepsilon_{i2} < t_2)^{NN} \right] \left[ \Pr(\mu_1 + \varepsilon_{i1} < t_1, \mu_2 + \varepsilon_{i2} > t_2)^{NY} \right]$$

where YY = 1 for a yes-yes response, 0 otherwise, NY= 1 for a no-yes response, 0 otherwise, NN = 1 for a no-no response, 0 otherwise and NY = 1 for a no-yes response, 0 otherwise.

Suppose the error terms ( $\epsilon_{ik}$ 's) are normally distributed with means 0 and respective variances of  $\sigma^2_1$  and  $\sigma^2_2$ .

Thus,  $WTP_{i1}$  and  $WTP_{i2}$  will have a bivariate normal distribution with means  $\mu_1$  and  $\mu_2$ , and variances  $\sigma^2_1$  and  $\sigma^2_2$  and correlation coefficient  $\rho$ .

By computing individual probabilities from equation 4:17, we get

$$\begin{aligned} \Pr(\text{yes, no}) &= \Pr(\mu_1 + \epsilon_{i1} > t_1, \mu_2 + \epsilon_{i2} < t_2) \\ &= \Pr(\epsilon_{i1} \geq t_1 - \mu_1, \epsilon_{i2} < t_2 - \mu_2) \text{-----4.18} \end{aligned}$$

Assuming the distribution of  $\epsilon_{ik}$  to be symmetric and transforming the normal distribution of  $\epsilon_{ik}$  to standard normal distribution by dividing equation 4.18 by respective standard deviation ( $\sigma_k$ ):

$$\Pr(\text{yes, no}) = \Phi_{\epsilon_1 \epsilon_2} \left[ \frac{-(t_1 - \mu_1)}{\sigma_1}, \frac{(t_2 - \mu_2)}{\sigma_2}, -\rho \right]$$

In the same way,

$$\Pr(\text{yes, yes}) = \Phi_{\epsilon_1 \epsilon_2} \left[ \frac{-(t_1 - \mu_1)}{\sigma_1}, \frac{-(t_2 - \mu_2)}{\sigma_2}, \rho \right]$$

$$\Pr(\text{no, no}) = \Phi_{\epsilon_1 \epsilon_2} \left[ \frac{(t_1 - \mu_1)}{\sigma_1}, \frac{(t_2 - \mu_2)}{\sigma_2}, \rho \right]$$

$$\Pr(\text{no, yes}) = \Phi_{\epsilon_1 \epsilon_2} \left[ \frac{(t_1 - \mu_1)}{\sigma_1}, \frac{-(t_2 - \mu_2)}{\sigma_2}, -\rho \right]$$

Let  $y_{i1} = 1$  if the response to the first question is yes, and 0 otherwise and  $y_{i2} = 1$  if the response to the second question is yes, and 0 otherwise. Then equation 4.17 can be rewritten as

$$L_i(N/t) = \Phi \left[ d_{i1} \frac{(t_1 - \mu_1)}{\sigma_1}, d_{i2} \frac{(t_2 - \mu_2)}{\sigma_2}, d_{i1} d_{i2} \rho \right] \text{-----4.19}$$

where  $d_{i1} = -2y_{i1} + 1$  and  $d_{i2} = -2y_{i2} + 1$

Beyond estimating the parameters, the interest in such models is to calculate willingness to pay (WTP). WTP is the amount of money that makes the individual indifferent between the initial and the final state.

$$\alpha_1 z_i + \beta_1 (m_i - t_i) + \epsilon_{i1} = \alpha_0 z_i + \beta m_i + \epsilon_{i0}$$

$$\alpha_1 z_i + \beta (m_i - WTP_i) + \epsilon_{i1} = \alpha_0 z_i + \beta m_i + \epsilon_{i0} \quad ;$$

$$(\alpha_1 - \alpha_0) z_i - \beta WTP_i + \varepsilon_{i1} - \varepsilon_{i0} = 0$$

$$\alpha z_i - \beta WTP_i + \eta_i = 0, \quad \text{where } \eta_i = \varepsilon_{i1} - \varepsilon_{i0} \text{ and } \alpha = \alpha_1 - \alpha_0$$

$$WTP_i = \sigma/\beta (z_i) + \eta_i/\beta \text{ --- (4.20)}$$

Taking expected value of both sides of (4.20) and assuming  $E(\eta_i) = 0$ , we get

$$E(WTP_i) = \sigma/\beta E(z_i)$$

$$= \alpha/\beta(\bar{z}), \quad \text{where } \bar{z} \text{ is mean value of } z_i \text{ (exogenous variables).}$$

#### 4.5 Regression Result

In this study a probit model is estimated and a summary of the regression results is given in table 4.11a. The explanatory variables in the regression model are dummy variables for education level attained by the respondent; dummy variables associated with the perception of the respondent about the current quality of the lake; a dummy variable for whether the respondent is a licensed fisherman or not, a dummy variable for whether the respondent has other alternative water bodies for fishing or not; age, bid and family size. The description of these variables is given in table 4.1.

It is evident from the regression results given in table 4.11a<sup>4</sup> that all the signs of the coefficients are consistent with a priori expectation and they make intuitive sense. For example, it is more likely that more educated people are more willing to pay for the improvement effort; i.e. the probability of saying 'yes' for a given bid is positively related with education and if the respondent has primary education the probability will increase by 0.15 and if the respondent has high school education the probability will increase by 0.12. On the other hand, the probability of saying 'yes' declines as the amount of money to be paid for the program increases and it decreases by 0.006 for every 1 birr increase in the offered bid. However, it increases by 0.0002 for every 1 birr increase in the income of the household.

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<sup>4</sup> The regression results are corrected for possible existence of heteroscedasticity. In addition to this the problem of multicollinearity may not be severe because the pair wise correlation coefficients between explanatory variables are not in excess of 0.8. See appendix 1.

The probability is expected to decline as the perception of respondents about existing water quality moves from poor to excellent. The survey shows that as the perception of the respondent changes from fair (which is the base group in the estimation) to good, the probability will decrease by 0.02 and it will decline by 0.03 if the respondent ranks the existing quality of the lake as very good or excellent. This implies that the better the respondent feels about the existing water quality, the more would be the marginal decline in the probability of a 'yes' response.

Even though a priori expectation about the direction of gender effects is not made, results here show that the probability of a 'yes' answer decreases if the respondent is male i.e., females are more likely to pay for the improvement program. The probability of saying yes will decline by 0.22 if the respondent is male. In the same way, a priori expectation about the influence of legality on the willingness to pay response was not made, but the variable was included because a difference is anticipated between the two groups. As can be seen from the regression result, it is evident that the probability increases if the respondent is not licensed (illegal) and it will decline by 0.07 if the respondent is legal. The reason may be due to the payment vehicle proposed in the CV scenario, i.e., since the legal fishermen have already been paying taxes, they may be reluctant to pay additional taxes.

The probability of a 'yes' response is expected to decline with age because younger people are often said to be more concerned about the environment than older people. The probability decreases by 0.12 for every one year increase in age of the respondent. As expected, regression results show that the probability of accepting a given bid increases if the respondent does not have an alternative water body for fishing and it increases by 0.41 if Lake Chamo is the only lake for the respondent to catch fish. It is clear from this table that coefficients of dummy variables for high school, membership to the association, ranking of existing quality of the lake (very good) and sex are insignificant.

The full model test of significance is done on the basis of likelihood ratio. The result in table 4.11a shows that the null hypothesis that all the parameter estimates except the constant term

are equal to zero is rejected at 5% significance level, i.e., the variables included in the model jointly explain the WTP of the respondents significantly.

Table 4.11a Marginal effects of variables

Number of obs = 150			
Wald chi2(11) = 50.48			
Pseudo R2 = 0.3702			
Robust			
wtp	dF/dx	Std. Err.	Z
primaryschool*	.149	.076	1.96**
highschool*	.121	.225	0.54
age	-.007	.003	2.34**
income	.0002	.00007	4.29***
bid	-.006	.0024	-2.32**
member*	-.067	.036	1.89*
good*	-.022	.011	-2.02**
verygoodg*	-.039	.122	-0.33
Chamo*	.271	.032	2.08**
sex*	-.221	.099	-1.52
Family size	-.028	.045	-0.61

(\*) dF/dx is for discrete change of dummy variable from 0 to 1  
z and  $P > |z|$  are the test of the underlying coefficient being 0

\*\*\*.... Significant at 1% significance level

\*\* ... significant at 5%

\*.... Significant at 10%

Table 4.11b. Bivariate probit estimates

Number of obs = 150			
Wald chi2(2) = 18.04			
	Coef.	Std. Err.	z
<b>y1</b>			
Bid1	-.126	.034	-3.73
cons	.422	.177	2.93
<b>y2</b>			
Bid2	-.183	.072	-2.53
cons	.327	.186	1.76
athrho	.918	.218	4.2
rho	.523	.048	
Likelihood ratio test of rho=0: chi2(1) = 46.2214			

We used the bivariate probit model, here, simply to see whether the follow up question in double bounded-dichotomous choice improves statistical efficiency or not. In Table 4.11b, the first two rows are for the initial bid and the second two rows are for the second bid; which is contingent on the response for the initial bid. The 'rho' result shows that there is positive but non-perfect correlation between the two responses, i.e., the random components in the first and second responses are positively correlated. This implies that the joint estimation of the two responses (responses to the first and second bids) will increase the statistical efficiency of the CV survey, which is consistent with the result of Hanemann et al., 1991.

The mean willingness to pay is calculated from estimated parameters and average value of the variables included in the model. The average willingness to pay is 4.63 birr per month. This average willingness to pay can be used to estimate the total value for the population in a straightforward way, i.e., it is possible to extrapolate this result to the population multiplying it with the number of total fishermen of the lake. In this study, however, this has not been done because most of the fishermen are illegal and unregistered, and hence their total number is not known. Thus, what is computed here is the total economic (social) value of an improvement to

the registered fishermen of the lake alone, and it is found to be 578.75 birr per month. Nonetheless, the obtained WTP per household may be biased. The reason may be due to the fact that to achieve accurate results respondents should have an extended discussion with enumerators. But this was not done since most of the fishermen were illegal and most of them were not willing to spend much of their time discussing about the issue. Thus the absence of such discussion may impart a bias.

In addition to this the WTP figure may also be biased because most of the respondents, as given in table 4.4, at least do not like new (additional) taxes. Therefore, in this study payment vehicle bias (where respondents provide biased responses because of payment vehicle) is suspected. In this case the WTP estimates would be biased downward because the payment vehicle proposed in the CV scenario was putting new taxes. Thus, WTP responses could have been increased if other payment vehicles were used. We must note, however, that the use of additional taxes was based on the expectation that it is more realistic. Moreover, the use of other ways of payment such as voluntary contributions would also be expected to lead to problems as it may not reflect the true preference of the respondent.

## V. CONCLUSIONS AND POLICY IMPLICATIONS

### 5.1. Conclusion

Water quality is a public good that serves to produce different products and services, one of which is fishing. Thus it affects the fishing activity and the fishermen would benefit most if it were to improve. The improvements, however, would cost money and needs the participation of fishermen and others in the improvement programs. But the participation of others is well beyond the scope of this study and the attempt made here is to elicit the willingness to pay of fishermen of the lake alone.

In this study we used the contingent valuation method to elicit the willingness to pay of fishermen of Lake Chamo. We used the double-bounded dichotomous choice value elicitation format in which case respondents are asked a yes or no question for a given bid and depending on the response to the first bid, respondents are asked the second bid, i.e., if the first response is 'yes' the second bid would be greater than the first bid and if the response for the first bid is 'no' the second bid would be lower than the first. These payments are for the improvement to Lake Chamo. The proposed improvement in this study has two aspects: one step quality improvement and maintaining the existing depth of the lake.

To maintain the exiting depth of the lake, this study proposed stopping the sediment brought by flood from surrounding agricultural lands from joining the lake by; for example, using something that filters (separates) sediments from pure water. The quality improvement is based on the perception of fishermen about the existing (current) quality of the lake and it is one-step improvement from how they ranked the quality

In general, it was found in the study that the poorer the fisherman feels current water quality is the higher is the probability that the individual will accept the given bid. In addition to this, the probability of a 'yes' for the offered bid increases if the respondent is illegal. This is perhaps because the legal ones are already paying taxes and they may be reluctant to pay additional taxes.

Furthermore, a majority of the respondents are against additional taxes and they suggested voluntary actions to be used so that people may be encouraged to participate in the improvement program and popular support could be obtained. In addition they advocated the 'polluter pays' principle and most of them blamed farmers of surrounding villages as major polluters.

In this study it is found that education level attained by fishermen of the lake affects their willingness to pay for the improvement to the lake and it is revealed that respondents with higher education level are more willing to accept the offered bid. Moreover, the probability of 'yes' for a given bid increases if lake Chamo is the only lake for the respondents to catch fish as compared to respondents for whom there are substitutes (other opportunities). This probability also increases with the income of respondents. On the other hand, the probability of a 'yes' response for the offered bid declines with the increase in the bid.

The average willingness to pay of respondents is about 4.63 birr per month. This figure, however, is expected to be biased downward because the payment vehicle proposed in the CV scenario has not been accepted by most of the respondents.

## **5.2 Policy implications**

- Since most of the sample respondents are against new taxes, it demands policy makers to pay attention to the vehicle of payment if the money were to be actually collected. Policy makers should either use other payment vehicles or give intensive training and convince people about additional taxes and their implications where other mechanisms of collecting money become impractical.
- Near by farmers are blamed to be the main polluters of the lake. Thus, the concerned body should consider the case of these farmers and if possible they should be moved away.

- Training and awareness creation among the public should be given priority because most of the respondents are not well aware of the impact of their personal activity on the quality of the lake and of the significance of their personal action for improvement to the lake.

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### Pair wise correlation coefficients

	wtp	Primary school	High school	age	income	bid	member	good	Very good	Chamo	sex	Family size
wtp	1.00											
Primary school	0.14* 0.07	1.00										
High school	0.30* 0.03	0.88* 0.00	1.00									
age	-0.08 0.55	0.35 0.07	0.10 0.47	1.00								
income	0.16* 0.00	0.24 0.08	0.09* 0.00	0.10 0.46	1.00							
bid	-0.07* 0.00	-0.54 0.30	0.06 0.64	-0.17 0.22	0.43 0.00	1.00						
member	-0.40* 0.00	0.22 0.11	0.06 0.08	0.29 0.03	-0.03 0.83	-0.02 0.88	1.00					
good	-0.79* 0.00	0.28* 0.04	0.40* 0.00	0.06 0.68	0.01 0.93	0.21 0.12	0.32 0.02	1.00				
Very good	-0.09 0.51	0.52 0.38	0.07 0.95	0.20 0.14	0.18 0.18	0.23 0.08	-0.07 0.61	0.22 0.12	1.00			
chamo	0.45* 0.00	0.00 0.99	0.02 0.86	-0.16 0.25	-0.09 0.49	-0.07 0.43	-0.62 0.10	-0.31* 0.02	-0.09 0.53	1.00		
sex	-0.15 0.28	-0.13 0.33	-0.13 0.36	0.00 1.00	-0.04* 0.00	-0.31 0.43	0.21 0.12	0.18 0.20	0.09 0.50	-0.27* 0.05	1.00	
Family size	-0.01* 0.00	-0.25* 0.05	-0.56 0.00	0.34 0.57	0.04* 0.01	-0.09 0.28	0.13 0.09	-0.34 0.05	-0.07 0.41	0.05 0.18	.06 0.76	1.00

\* significant at 95% significance level.

## Appendix 2

Table 4.12 Regression results

Probit estimates		Number of obs = 150	
		Wald chi2(11) = 50.48	
		Pseudo R2 = 0.3702	
Robust			
wtp	Coef.	Std. Err.	z
Primary school	.4587022	.2339634	1.96**
highschool	.3502488	.6450186	0.54
age	-.120271	.0512577	2.34**
income	.00663	.001547	4.29***
bid	-.0169344	.0072924	-2.32**
member	-.1969557	.1040265	-1.89*
good	-.4647377	.2305102	2.02**
Very good	.1124671	0.343	-0.33
chamo	.4101581	.200464	2.05**
sex	-.8426768	.555015	-1.52
Family size	-.0808606	.1331273	-0.61
cons	3.5585287	1.213975	2.93***

\*\*\*.... Significant at 1% significance level

\*\* ... significant at 5%

\*.... Significant at 10%

### Appendix 3 Questionnaire

#### Willingness to Pay Section

A certain program has been prepared to maintain the size and the depth of the lake where it now is. In addition to this the program will also improve the quality of the lake one step from how you perceive the existing quality of the lake.

However, all these plans of the program cost money. Therefore, large amount of fund has to be allocated to filter the water from the sediment brought by flood and let pure water join the lake. Finally, to improve the quality of the lake, some mechanisms will be established through which those who wash their cars on the tributary rivers (for example, Kulfo and other rivers) will be restricted and /or those rivers will be stopped from joining the lake. The awareness of farmers and others who pollute the lake will be raised through education so that the quality of the lake will be improved one step up wards.

Thus the high cost of the program makes it difficult to implement the program without people paying for it. The current taxes you pay are inadequate to meet the costs of the program. Due to this, if the program is required to go ahead, all of you must pay a sufficient amount of money. The fee will be collected through tax from all fishermen per month. Every angler would pay the same amount.

Do not forget that this is charged in addition to other taxes. If you pay money for this purpose, you cannot use the money for any other purpose. Hence;

1) Would you be willing to pay for the improvement?

1. Yes.... go to question no (3)

2. No.....go to question no (2) :

- 2) Why do not you pay any?
1. the quality of the water is all right
  2. no money to pay because of low income
  3. it is none of my business
  4. other (please specify) \_\_\_\_\_
- 3) Would you be willing to pay \_\_\_\_\_ birr per month?
1. Yes ..... go to question no (4)
  2. No ..... go to question (5)
- 4) Would you be willing to pay \_\_\_\_\_ birr per month?
- 1) Yes ..... go to question no (6)
  - 2) No ..... go to question (6)
- 5) Would you be willing to pay \_\_\_\_\_ birr per month?
- 1) Yes ..... go to question no (6)
  - 2) No ..... go to question (6)
- 6) What is the maximum amount that you would be willing to pay? \_\_\_\_\_
7. If inconsistency between your answers to question number 3 -5 and 6 is observed, what is your reason? \_\_\_\_\_

**Thank you for giving your time to fill the questionnaire!**

## DECLARATION

I, the undersigned, declare that this thesis is my original work, has never been presented for a degree in any other university and that all source of materials used for this thesis have been dully acknowledged.

**Declared by:**

*Tsegaye Tsegesse*  
Candidate

Signature *Tsegaye Tsegesse*

Date: June 29, 2005

**Confirmed by:**

Dr. Alemu Mekonnen  
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Signature *Alemu Mekonnen*

Date: June 29, 2005

Place and date of submission: Addis Ababa University, June 29, 2005