ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

VALUATION OF WATERSHED AND FISHERIES OF LAKE TANA: APPLICATION OF CHOICE EXPERIMENT

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FACULTY OF BUSINESS AND ECONOMICS

DEPARTMENT OF ECONOMICS

JUNE, 2009

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A Thesis Submitted to the School of Graduate Studies of Addis Ababa University in Partial Fulfillment of the Requirements for the Degree of Master of Science in Economics under Resource and Environmental Economics Stream

JUNE, 2009

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ACKNOWLEDGMENT

Thanks to God for all! First, I would like to give my gratitude to Dr. Alemu Mekonnen for showing me the directions, helping me in any difficulties, and giving me constructive suggestions. I can say I was so lucky being advised by him. Thank you Dr. Alemu. I would also like to thank Prof. Fredrik Carlsson and Dr. Girma Tesfahun for their help in the experimental design.

Next I want to thank the Environmental Economics Policy Forum for Ethiopia at the Ethiopian Development Research Institute (EEPFE/EDRI) for the financial support it gave me to undertake this research. It was so difficult to complete the research had it not been such financial support. Also I want to appreciate ECA (Economic Commission for Africa) for allowing me to use the library.

Finally, I would like to thank those individuals who helped me in any circumstances in the research work. Special thanks go to my wife Yetmwork Adamu, my brother Mezgebu Yitayal, and Yeshitla Hailu who helped me morally and financially.

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Abstract

In this thesis, the technique of choice experiment was applied for valuation of Lake Tana's fishery and watershed. Two attributes – fishing control and lake side plantation were identified as relevant attributes that must be included in the choice experiment. A monetary attribute – payment for fishing permit was also included.

The fishermen actively participating in fishing on Lake Tana were taken as respondents. Multinomial and random parameter logit models were used for estimation. All the attributes included were significant factors in affecting the probability of choosing an alternative scenario. Fishermen were more concerned about fishing control i.e. they give higher value to fishing control than lake side plantation. This was implied by their marginal willingness to pay for the attributes. The marginal willingness to pay for fishing control was 15 birr per month while for lake side plantation it was 50 cents per month. Some socioeconomic variables were included in the modeling. Monthly household income, years of education, and family size were found to be significant at the standard levels of significance.

Moreover, an economic welfare measure was calculated for two scenarios. The results suggest that fishermen are willing to pay 57 birr per month for a moderate scenario improvement and 93 birr per month for aggressive scenario improvement in those attributes.

Key words: Choice experiment, Economic welfare measure, Fishing control, Lake side plantation, Marginal willingness to pay, Payment for fishing permit, Valuation.

CHAPTER ONE

1. INTRODUCTION

1.1 Background

Ethiopia which is known as the water tower of East Africa is endowed with so many water bodies. These water bodies cover about 0.7% of the total area. The country has about 10 lakes (most of which are confined in the Great Rift Valley) and large rivers (such as Blue Nile, Tekezie, Awash, Barro, Genalle and so on).

The largest lake, Lake Tana found in North West highlands of Amhara Region has a surface area that ranges between 3150 to 3500 km^2 (depending on seasonal variation) (Berhanu et al., 2001). It is estimated that the lake extends about 84 kms (North – South) and 66 kms (East – West). It accounts about 50% of the total inland fresh water in Ethiopia and is the major source of the Blue Nile River.

This lake is home of various islands with monasteries or churches. These monasteries are historic in the Ethiopian Orthodox Church and are major tourist attraction areas. Lake Tana and its surrounding wetlands provide a lot of benefits for the dwellers in and around it. It is home of various fauna and flora (habitat of endemic fish species), provides transportation for tourists and freight, and increases quality of life for the residents in and around it (especially residents of Bahir Dar Town). Moreover, it is an important source of livelihood for the fishermen especially for the marginalized Woito ethnic groups. The wetland around the lake supports the livelihood of inhabitants in providing water supply, agricultural activities (farming, cattle raring and fishing), offering fuelwood and other socioeconomic services.

The Lake has a potential fish yield estimate of 15000 metric tones per year on average. But it is only bout 1500 metric tones of fish that is actually caught per year (only 10% of the potential yield estimate) (Lake Tana fishery resource development project, 1997). There are socioeconomic factors that contribute to this poor performance of the fishery industry in the lake.

Poor market organization and access, long distance from the capital city, low level of technologies used in fishing, lack of improved transportation and preservation facilities, lack of access to credit and technical support for the fishermen, know how of the fishermen, and poor fish eating habit of the society are some of the factors that could be mentioned for the low level of exploitation (Sewmehon et al., 2007).

Despite this low level of exploitation, there is a threat in the decline of abundance and even extinction of some endemic species (especially that of the endemic large Barbus species). de Graaf has pointed out that recently a sharp decline of the Barbus species has occurred due to unregulated over fishing of the spawning grounds. "Recruitment over fishing might occur due to severe and unregulated over fishing of spawning aggregations, resulting in a dramatic decrease of recruits. In Lake Tana, recruitment over fishing potentially threatens the survival of the unique Barbus species flock. Recent results show sharp declines in abundance, up to 75% in number and biomass, of different Barbus species." (de Graaf, 2003 p.210) Moreover, he has emphasized that the future of Lake Tana's Barbus species and its fisheries might follow the same path of collapse of other African cyprinid fisheries unless protective measures are taken soon.

Lake Tana which is considered to be quite small in species 'flocks' and shallow as compared to other African lakes is an old lake. It is estimated that it was formed

approximately 2 million years ago at the Pliocene-Pleistocene transition by the blocking of the Blue Nile through volcanic eruption. The Barbs species is considered to evolve during this formation of the lake. "Because of complete isolation of the Lake Tana from other fresh water systems, evolution could go its own way, resulting in the unique biodiversity of the Lake Tana barbs." (Nagelkerke, 1997 p.286)

According to de Graaf, although there is an overwhelming abundance of Cyprinid fishes throughout the world, the Barbus species of Lake Tana form the only remaining intact species flock of large Cyprinid fishes. This is because of the disappearance of a similar species in Lake Lanao in the Philippines due to anthropogenic activities (de Graaf, 2003).

As to Nagelkerke (1997), there was no sign of over fishing in the lake, but fishermen take the largest catches at or near the spawning grounds in the river mouths that flow into the lake. Mostly, they caught the mature Barbus during the spawning season and thus could seriously disturb the reproductive process and result in dramatic reduction in the number of recruitment. For instance, it was indicated that 90% of all the Barbus caught were mature about to spawn (at the river mouths of Gumara and Rib rivers during September 1994) (Nagelkerke, 1997).

Furthermore, loss of the surrounding wetland and plant coverage due to agricultural expansion, greater silt inflow into the lake, experiences in using inappropriate equipments (small mesh size gill nets) and methods (using poison substances like 'Birbira'), selective fish catch pressure in response to the societies' preference, and so on are the major causes that could lead to decline in and even extinction of endemic fish species as well as collapse of biodiversity.

There are five large rivers (Gilgel Abay, Gumara, Rib, Megech, and Gelda) that inflow to the Lake carrying a great deal of silt and sediment. It is estimated that about 1430 km^2 of land is seasonally flooded (Ayalew et al., 2007). This siltation and sedimentation problem along with shallowness of the Lake (which is 8m on average and 14m maximum depth) could indicate that the volume of the lake might reduce in the near future.

Expanded commercial gill net fisheries at the river mouths along with the watershed degradation will cause severe biodiversity loss of the Lake unless the resource is managed and regulated effectively. Because of such a fear of biodiversity collapse and sustainability of the lake, researchers have given great emphasis on fishery regulation and watershed management in and around the Lake.

It is from this point of view, that this study is designed to investigate the valuation of the lake's watershed management and fishery regulations. For implementation of fishery regulations and investments on sustainable utilization of the lake's resources, the preferences of the society (especially of the fishermen) must be taken into consideration. This could be achieved by identifying the relevant attributes and asking respondents about their preferences for the different levels of the attributes. The appropriate technique that could be used in this regard is choice experiment.

1.2 Statement of the Problem

Lake Tana which lies at an altitude of about 1800m above sea level contributes 50% of the fresh water in the country. The lake provides several benefits for the residents around it in particular and for the country in general. It is a habitat of 20 endemic fish species which could contribute for food self-sufficiency programs as a cheap source of protein if the

fishery industry is managed efficiently and used in a sustainable manner. Now-a-days, it has been reported that Lake Tana and its adjacent wetland supports the livelihood of more than 500,000 people directly or indirectly (Vijverberg et al., 2007). Moreover, it is also reported that about 1685[1] part or full time fishermen are participating in fishing activities in the lake.

But, as has been pointed out earlier, Lake Tana's fishery resources, in general, could not be considered to be overexploited compared to its potential. Paradoxically, however, the abundance of Lake Tana's endemic species (Barbus) is declining at an alarming rate in a short period of time. Wudneh (1998) notes that the lake's fishery is below the estimated maximum sustainable yield and, thus, could be increased by five to six times. But, de Graaf's (2003) study on the abundance and decrease in number of recruits of the Barbus species has indicated that there is a sharp stock decline of this species. de Graaf has argued that though fishing efforts have been increased due to the introduction of motorized boats, the decline of the Barbus species is not due to mere introduction of these boats. The most likely explanation for the decline in abundance of Barbus species, according to him, is fishing targeting of these boats at the spawning grounds of this species.

As to de Graaf (2003), the vast majority of fishing activity from 1991 to1993 was concentrated in Bahir Dar gulf (about 71%) and each species groups, namely, Nile Tilapia, African catfish and Barbus contribute roughly one third of the total catch. But, in 2001, 41% of the effort was allocated to the North-Eastern shores of the Lake. He has indicated

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1 Interview with the head of the fishery department at Amhara Regional state Agricultural and Rural Development Bureau

that both catch per unit effort and contribution of Nile Tilapia to the total catch had doubled. This increase in Tilapia's contribution was not only due to specific targeting of commercial gill net fishery on this species but also a three fold decline in the abundance of Barbus species (de Graaf, 2003).

The major cause mentioned for the decline in abundance of this endemic species is the expansion of fishing pressures on major river mouths that inflow to the Lake especially during the spawning periods. This expansion comes as a result of the introduction of motorized gill net fishery in 1986 (when the Lake Tana Fishery Resource Development Project (LTFRDP) was established). Before 1986 Lake Tana's fishery was dominated by a predominantly subsistence reed boat fishery operated by the Woito ethnic groups. The introduction of modern fishing gear and motorized boats by LTFRDP has created new opportunities for the fishermen to extend their fishing efforts from the shore to deeper offshore waters. More importantly, fishery efforts expand to distant river mouths (where the mature Barbus migrates in its spawning seasons). As such, the fish catch in the Lake was increased from 393 metric tones in 1994 to 1470 metric tones in 1997 (LTFRDP, 1997).

Even though the calculated maximum sustainable yield of fish catch in the Lake was yet higher, abundance of the Barbus species declines in a short period of time. This decline of the species is most probably caused by over fishing of mature Barbus that migrates to the river mouths during the rainy season (August to September) (de Graaf, 2003).

The biological behavior of fish in the Lake in particular and the lake ecosystem in general is studied by biologists. It is argued that watershed degradation and hence siltation and sedimentation problems along with pressure of fishing in spawning grounds at the river

mouths are the major threats for the sustainable utilization of the lake and the fishery resource.

In addition to this, the wetland vegetation cover (papyrus) is degraded for various reasons. Agricultural activities especially in the North and Eastern part (Denbia and Fogera plains) of the Lake are expanded. The natural papyrus around the Lake is deforested to make traditional boats, for fuel and other household services.

Wetlands are areas where the land is covered by shallow water but the water has not necessarily been at the surface (Wood, 2001). It is important to know that the sustainability of the underground and surface water is influenced by the conservation and wise use of wetlands. They have an advantage of keeping the balance of the ecosystem, improving water quality and sustaining the fishery resource. As such, great emphasis has to be given for the conservation of wetlands.

For the conservation of wetlands surrounding the Lake and for the regulation of the fishery resource, the participation of the society especially those of the fishermen is required to a great extent. To accomplish this and to know the users' preferences it is necessary to identify the attributes that could be provided in the lake. Since the lake is an open access resource, there is a need to use valuation techniques and the preferred method in this regard is choice experiment.

However, to the best of the researcher's knowledge, no valuation of use and non-use values of the Lake Tana has been conducted previously. But, a similar study has been conducted on the valuation of water quality improvement of Lake Awasa using choice experiment method. Nevertheless, since there are differences in geographical location, socioeconomic situations of the society and the fishermen, and endemic fish species of the Lakes; it creates

a motivation to conduct valuation of Lake Tana's watershed management and fishery regulations.

1.3 Research Objectives

The general objective of the study is to understand the preferences of individuals (users) for the different attributes of Lake Tana using choice experiment method. It focuses on estimating the marginal willingness to pay of the individuals in improvements for the different attributes of the Lake and its surrounding wetland cover. The specific objectives are:

- To estimate marginal willingness to pay of an individual fisherman and the welfare implications of improvements in some attributes of the Lake and its surroundings
- To identify socioeconomic factors that affect the utility of individuals for improvements of the Lake's attributes

1.4 Significance of the Study

Scholars in research have a saying 'An ant brings its single grain of sand to an anthill.' As has been said earlier, valuation of Lake Tana and its surrounding environment especially focusing on the attributes using choice experiment has not yet been experienced. As such, this research work could be used as a starting point in having further studies related to valuation.

The study could also provide valuable information for policy makers and concerned parties for fishery regulation and sustainability of the Lake ecosystem by determining marginal

willingness to pay of households and by identifying socioeconomic factors that affect individuals' participation in improving the Lake's attributes.

1.5 Limitations of the Study

In this study, only two environmental attributes – fishing control and lake side plantation, and one socioeconomic attribute – payment for fishing permit are included in the valuation process using choice experiment method. A better result could be expected if more attributes are included. However, to reduce complexities and thus the difficulty for the respondents, only two attributes (other than the payment) are included in the choice experiment.

In addition to this, the study is designed to take a sample of fishermen that are members of fishermen associations at two sites (one in Bahir Dar town and one in Gorgora) and a small number of non members at Enfranz (a small town in Northern Gondar). If more non-member fishermen were included (had it not been difficult to contact the fishermen) better estimation and identification of socioeconomic factors could be obtained.

CHAPTER TWO

2. REVIEW OF RELATED LITERATURE

2.1 Theoretical Literature Review and Background

2.1-1 Lake Tana Fishery Industry and Biodiversity

Lake Tana contains about 27 species of fish, 20 of which are considered to be endemic (Vijverberg et al., 2007). Among these endemic species, the Barbus species is highly vulnerable to over fishing due to its distinct breeding behavior (Nekelkerke, 1997 and de Graaf, 2003).

de Graaf (2003) suggested that the expansion of modern fisheries and their targeting in river mouths during the spawning seasons has led to the collapse of several Barbus and Labeo fisheries in Africa. In particular, he noted that in Lake Victoria, intense over fishing of Barbus altianalis and Labeo victorianus has reduced populations of cyprinids that were once abundant (de Graaf, 2003).

As has been explained by Nagelkerke, knowing the units of fish stock (for different populations and species) is essential for improved fishery management and regulations. "Unbalanced exploitation of fish stocks will lead to cascading effects in the ecosystem, especially if different fish stocks play different ecological roles. Shifts in fish composition or more dramatic deleterious influences could be the result, endangering the biodiversity of the system, which could lead to decreased and less stable productivity of the resources." (Nagelkerke, 1997 p.15)

More importantly, it has been stated that the Barbus species are essential for sustainable biodiversity of Lake Tana and for cheap source of protein. "The Barbus specie flock is a

unique source of freshwater biodiversity in Ethiopia. Lake Tana's barbs are worth conserving for future generations, not only for their scientific potential, but more importantly as a cheap source of protein for the local people. An impoverishment of Lake Tana's biodiversity might result in lower production and reduced resilience against environmental fluctuations." (de Graaf, 2003 p.192)

Nevertheless, when the Lake Tana Fisheries Resource Development Project (LTFRDP) started operation in 1986, four commercially interesting species were recognized in the Lake and commercial gill net fishery expanded to the deep and distant fish grounds. These species consist Oreochromis niloticus (Tilapia or 'Keresso'), Clarias gariepinus (Catfish or 'Ambaza), and the cyprinids- Varicorhinus beso ('Besso') and Barbus intermedius ('Nech Assa'). Out of these species, Barbus intermedius is considered to represent 60% of the commercial catch (Nagelkerke, 1997)

As a consequence of the introduction of motorized boats and the commercial gill net fishery in 1986, fishing efforts increased and expanded to the North Eastern part of the Lake at the river mouths. Above 50% of the annual Barbus yield is estimated to be caught during its peak spawning season (usually August to September). Moreover, the majority (about 85%) of this species landed by the commercial gill net fishery were considered to be mature. The dramatic decline in abundance of the Barbus species is, thus, due to recruitment over fishing as a result of poorly regulated high fishing efforts. This is practiced especially by the commercial gill net fishery on spawning aggregations of adult Barbus during its annual breeding migration to the river mouths and surrounding floodplains. de Graaf has pointed out that only effort control and regulations that could limit the gill net fishery in spawning

seasons and/or areas could be an effective measure that will prevent a total collapse of the Barbus stocks (which has occurred in other cyprinids of African Lakes) (de Graaf, 2003)

The other important problem in Lake Tana is the degradation of the wetlands and watershed. Eshete (2003) has pointed out that the Lake's ecosystem and the water resources as a whole are in danger due to deforestation, erosion, sedimentation, water level reduction, erratic rainfall, flooding of the wetlands, competing uses of water resources, increased pollution and pressure of the growing population. He stated that erosion of Lake Tana is affecting the stability and resilience of the system and is endangering sustainability of the Lake and the surrounding wetland resources. He has recommended that to deal with the threat of fishery resources (i.e. extinction of unique large Barbus species) and biodiversity, fisheries regulations i.e. restricting fishing near river mouths and upstream on spawning ground during the breeding period is urgently required (Eshete, 2003)

It is also indicated that a tree-based rural development strategy has to be promoted for curtailing the wetland degradation and lake basin protection. Tree based technology and practices would include agro-forestry for soil and water conservation, village and farm woodlots, windbreaks and boundary trees, swamp reclamation through high density tree/shrub planting, bamboo reed and palm tree growing (Amare, 2003)

2.1-2 Economic Approach in Valuation of Environmental Goods and Services

Environment provides goods and services or resources which are important in day to day life (and for the future) of individuals and the society as a whole. Fresh water bodies, for example, could offer scenic panoramas and radiant sunset. Fish and other edible creatures in these water bodies provide a rich nutritious source of food. Moreover, the beaches (or

water shores) are excellent recreational areas for relaxation, physical exercises, and enjoying bird watching. These are the direct use values of the water bodies that individuals enjoy. But, there are values that are not directly tied to individual uses like climate regulation, physical protection, stewardship for future generation, and so on by these water bodies.

As such, we could have the following equation for total economic value from environmental goods:

Total Economic Value = Direct Use Value + Indirect Use Value + Non-Use Values + Intrinsic Value

Direct use values: Goods and services directly consumed by users. The direct use values are the benefits derived from products (outputs and inputs in production processes), recreation, fish, agriculture, fuel wood, transport, wildlife harvesting, peat/energy, vegetable oils, dyes, fruits, waste assimilation, research and education etc. They are comprised of the values that people derive from directly utilizing an associated good or service, for instance, a watershed's drinking water or its irrigation capacity (Goldberg, 2007; Lambert, 2002).

Indirect use values: Indirect use values are the indirect benefits derived from the environmental goods and services and from preservation of ecological systems. These may include functions like biological support (in relation to other species and habitats), physical protection (flood control and storm protection provided by wetland conservation), climate regulations, nutrient retention, groundwater recharge and global life support in general (Lambert, 2002).

Non-use values: These are less direct, less tangible benefits to society. These values refer to the values of the benefits generated by environmental goods and services that are unrelated to the value of their current or planned use. Non-use (passive) values include option and existence values.

Option values are potential future uses of the resources. They reflect the fact that some potentially active user may not participate and is uncertain for future participation but the resource has value to him/her since he/she could derive utility from the option (Cameron and Englin, 1997). They arise from uncertainty about the future demand or supply for environmental goods and services.

Existence values reflect the fact that individuals have no intention of using the resource themselves but derive utility from its mere continuation of existence, perhaps for others or future generations to use it actively (ibid). They consist of bequest, stewardship and benevolence motives. The satisfaction gained through the ability to endow or transfer a natural resource for future generations are bequest values. The stewardship motive is derived from altruistic sense of responsibility in sustainable utilization of the environmental resources, i.e. in preserving the environment or reducing damages on the environment. The benevolence motive is reflected in the desire to conserve environmental resources for potential uses by others (Lambert, 2002; Birol et al., 2005).

Intrinsic value: This is a value attached to the belief that all organisms have a worth of their own regardless of their usefulness to human beings. That is living organisms are valuable in their existence regardless of monetary value placed on them by the society.

2.1-2-1 Reasons for environmental valuation

Most of the environmental goods and services have no market and hence prices that reflect their value. In the case of goods and services that are not traded in a market, an economic value of the goods and services obviously cannot be directly obtained from the market.

Moreover, environmental goods and services are often public goods. As a result, although consumers value these public goods, none of them could have an incentive to pay for their conservation and even utilization. In addition to this, these goods and services may encounter externalities, i.e. uncompensated side effects from human activities. Market mechanisms are unable to regulate consumption, production and distribution of such goods. There is therefore a need to value environmental goods for successful management and address market failure (Goldberg, 2007)

To determine the cost-benefit analysis of public projects on the environment, the methods of valuation of non-marketed goods becomes crucial. Valuation methods (especially those of non-market valuation methods) have been used in many different areas, ranging from health and environmental applications to transport and public infrastructure projects. Nevertheless, if one needs to compare different projects by using cost benefit analysis, the change in the quality or quantity of the non-market goods should be expressed in monetary terms. This indicates that we need to have valuation methods for such goods and services (Alpizar et al., 2001)

Bennett and Blamey (2001) explained that the development of environmental valuation techniques is associated with society's growing interest in environmental issues and in the environmental aspects of products and goods traded in markets. Over the recent decades,

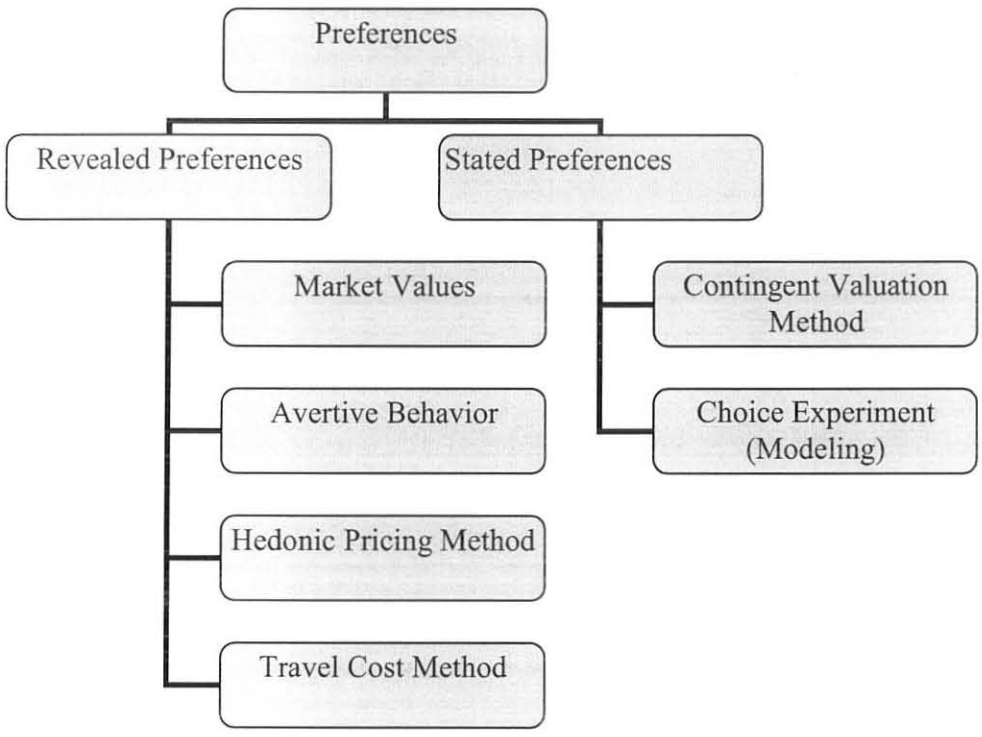
the demand for monetary estimates of environmental changes has grown and valuation techniques have become tools for policy and decision making processes in this regard.

As noted by Bennett and Blamey (2001) decision makers have also sought the quantification (in dollar terms) of their choice effects on the environment. As such, more and more companies are providing annual reports not only on their financial performance but also on their environmental performance.

2.1-2-2 Non Market Valuation Techniques

A number of valuation methods have been developed by environmental economists. The following diagram could demonstrate the techniques of valuation and their category according to Garrod and Willis (1999).

Fig. 2.1 Environmental Valuation Methods



Source: Garrod and Willis (1999)

As depicted in the diagram, there are four methods that are based on revealed preference approach, and two methods in the stated preference approach. However, there are other methods under stated preference approach such as conjoint analysis and contingent ranking methods.

Revealed preference approach is applied whenever an environmental good or service (or a product that uses environmental goods as an input) has a market through which the buyers could reveal their willingness to pay. In revealed preference approach, the value of a non-market good could be inferred by studying the actual behavior of consumers on a closely related market. The beauty of this approach is its advantage of being based on the actual choices made by individuals. Its main drawback is the impossibility of measuring the non-use values (existence values, option values, and bequest values) of environmental goods (Alpizar et al., 2001).

The stated preference approach enables to estimate the value of environmental goods and services which are not traded in the market or when they are not closely related to any market goods and services. In such situations, people cannot 'reveal' their willingness to pay for these goods and services. Furthermore, it may not be always possible to impute people's willingness to pay by their action or expressed intent to avoid losing those environmental goods and services or replacing them if they are lost. In such a case, stated preference approach assesses the value of non market goods from individuals stated behavior in a hypothetical market setting (Alpizar et al., 2001). Stated preference approach is performed by asking individuals, explicitly, how much they are willing to pay or accept for a change in environmental goods and services (Garrod and Willis, 1999).

The basic idea behind stated preference approaches for non market environmental valuation is to quantify a person's willingness to bear a financial impost to achieve some potential environmental improvement or to avoid some potential environmental harm (Bennett and Blamey, 2001)

Non- market valuation techniques have been used in many different areas, ranging from health and environmental applications to transport and public infrastructure projects. It is difficult to find an economic value of a good in cases where the good is not traded in a market. As has been mentioned earlier, markets may fail to exist for some goods either because the values of these goods might not be perceived yet (option values), or because they are public goods. As has been outlined, if it is required to compare different programs by using cost benefit analysis, to analyze the impact of changes in the quality or quantity of the non-market environmental goods and services, estimation of the use and non use values of such goods should be expressed in monetary terms using the valuation techniques

Hanley et al. (1998) explained that over the years, the research on valuation of non-market goods has focused on the two branches: revealed preference methods and stated preference methods.

I) Revealed Preference Approach for Non Market Valuation

The two most applicable methods under the revealed preference approach are the hedonic pricing method and the travel cost method (Hanley et al., 1998).

A. Hedonic Pricing Method

This method takes consideration of a good as a bundle of characteristics as Lancaster has suggested (Lancaster, 1966 and Hendler, 1975). It is assumed that consumers or buyers will

attach value to the characteristics of the good and will be willing to pay for them. Hedonic Pricing method is commonly applied to variations in housing prices that may reflect the value of local environmental attributes (Garrod and Willis, 1999). For example, a comparison of the housing prices in two streets, which were similar except for the level of air pollution, could be made using this method.

It is known that marketed products are mostly tied with environmental goods and services. Thus, environmental goods and services tied to the product could be among the characteristics of the product. As such, when the buyer of the (marketed) product buys this product, he/she also buys the environmental good or service and hence pays for it. This has an implication that the decline in quantity or quality in the environmental goods and services will lower the price of the product. As the Hedonic Pricing Method uses this fact, it is most suitable to assess the value of local environmental attributes.

This method, therefore, could be used to estimate economic benefits and damages associated with environmental quality such as air and water pollution, noise, and environmental amenities as aesthetic views, closeness to recreational sites etc. These attributes will have direct effects on house rents and land prices in a given region. The value of these environmental goods, thus, could be estimated from the change in the house rents or land prices.

Limitations of hedonic pricing method include:

- Applicable only when the environmental goods and services are tied to the marketed goods.
- Demands a rich data base and reliable estimation method

- Is susceptible to the choice of model specification used to estimate at hand.

B. Travel Cost Method

This method is based on the assumption that the costs that individuals incur to visit a certain recreational site reflects the payment for the access or improvement of an environmental good or service. Willingness to pay of the people could be estimated from the number of trips that people make at different costs.

The method is more applicable for the estimation of economic values of recreational sites. It is less controversial, less expensive and reliable method in estimation processes.

Limitations of the method include:

- Difficulty in assigning monetary value to time costs of visitors to a site.
- Inappropriate for estimating the use value of characteristics of a recreational site especially when visits serve many purposes of a particular visitor.

II) Stated/ Expressed Preference Approach for Non Market Valuations

The two most familiar methods in this approach for valuation of non-marketed environmental goods and services are contingent valuation method (CVM) and choice experiment (choice modeling).

A. Contingent Valuation Method (CVM)

CVM is the most widely used method of valuation around the world in cost benefit analysis and environmental impact assessments (Hanemann, 1994 and Alpizar et al., 2001). The idea of CVM survey was first proposed in theory by Ciriacy-Wantrup (1947) (Hanemann, 1994 and Verbic, 2007) for eliciting value of non marketed goods. The first practical

application of CVM was applied by Davis in 1961 on the recreational value of the Maine Woods (Verbic, 2007).

The main concept of CVM is to elicit individuals' responses in terms of their preferences by specifying a hypothetical market situation. Proposed changes in the environmental goods and services are described by a number of different scenario developments and individuals are asked directly to elicit their willingness to pay. The term 'contingent' valuation is because of the specific feature of the method as it is based on asking people to state their willingness to pay, contingent on a specified hypothetical scenario setting (Garrod and Willis, 1999). For instance, individuals could be asked to give their maximum willingness to pay to visit a certain recreational area, contingent up on a fee being introduced or for the access of the recreational area created.

Contingent valuation plays an important role in the valuation of environmental goods which could not be valued using revealed preference methods-in cases when the good is not closely related to marketed goods. Travel cost and hedonic price methods cannot estimate non use values, since there is, by definition, no related market good for non-use values. Thus, for example, contingent valuation is required to value public goods such as wilderness and landscape preservation; biodiversity; the existence value of national book collections such as the Library of Congress or the British Library; the value of preserving historical artifacts, monuments, and the character of old towns and villages. (Garrod and Willis, 1999)

Possible Biases in CVM

CVM is the most widely used method of valuation for non market goods which is relatively easy and straightforward to apply. However, it remains to be a questioned method for various potential biases (Bennett and Blamey, 2001). Some of the biases are:

- Hypothetical bias: - This is a bias because of hypothetical scenario. Most often, individuals tend to overstate their willingness to pay for private and public goods in hypothetical markets. One possible explanation for hypothetical bias in CVM is yea-saying (the tendency to agree with questions in the scenario regardless of their contents) (Blamey et al., 1999).
- Biases due to 'warm-glow' effect: - This may be evoked in the scenario or due to political bias that may dampen actual responses of individuals
- 'Embedding effect' biases: - If people are first asked their willingness to pay for one part of an environmental asset and then asked to value the whole asset, the amounts stated might be similar.
- Strategic bias: - Biased answers might be provided in order to influence a particular outcome.
- Information bias: - This may occur when respondents are asked to elicit their willingness to pay in which they didn't have enough information.

B. Choice experiment method

The interest to take consideration of environmental valuation in public projects has raised the demand for non-market environmental valuation techniques. With this regard, the interest for stated preference methods has been increasing for their capability to yield

estimates of full array of use and non use environmental benefits and costs (Bennett and Blamey, 2001). The most widely used method in stated preference approaches is CVM. However, due to the criticisms in CVM (especially for the potential strategic biases), other methods have been developed – one of which is choice experiment (ibid). Alpizar et al. (2001) suggested that, in addition to the well known contingent valuation method, choice experiment (CE) is a very important tool for valuing non-market environmental goods which could be used in cost benefit analysis and litigations related to damage assessments (Alpizar et al., 2001)

As to Birol et al. (2005), CE is the most appropriate method in the range of non market valuation techniques – for the valuation of the benefits generated from the multiple characteristics and functions of environmental goods.

Choice experiments are classified under the family of stated preference methods which are consistent with random utility theory in economics and psychology (Louviere, 2001). They were originally used in the fields of transport and marketing (Adamowicz et al., 1998b, Alpizar et al., 2001 and Hanley et al., 1998). It is only recently that they are used in the fields of health and environmental economics to value non market goods. Hanley et al. noted that the term 'choice experiment' seems to have been first introduced by Louviere and Woodworth (1983) (Hanley et al., 1998). Furthermore, it has been thought that the first application of choice experiment was done by Adamowicz (1994) to non market valuation i.e. to the valuation of Highwood and Little Bow Rivers in Alberta, Canada (Birol et al., 2005 and Hanley et al., 1998). Since then, the interest of using choice experiments has been increasing.

The technique of choice experiment is based on Lancaster's characteristic theory of value (Lancaster, 1966) and random utility theory (McFadden, 1974, List et al., 2006, Birol et al., 2005 and Hanley et al., 1998). Choice experiment is a structured method of data generation which needs designing choice sets that help to infer the factors influencing choice.

In choice experiment, respondents are offered a hypothetical market setting in which the attributes (and their levels) of environmental goods is presented as an alternative. Monetary values (prices) are included as one of the attributes. Individuals are, then, asked to choose their most preferred alternative from several alternatives in a given choice set. Respondents will be provided a sequence of choice sets to take the alternatives (Hanley et al., 1998 and Bennett and Blamey, 2001). When individuals make a choice from the provided alternatives, implicitly it is implied that they are making trade offs between the attribute levels.

Choice experiments could provide a large amount of information. This is because the method enables to value a non market good by separately evaluating individuals' preferences for the attributes (or characteristics) of the good to be valued. This information could be used in determining the preferred design of an environmental good (Alpizar et al., 2001).

According to Alpizar et al. (2001) the reasons for increased interest in using CE are:

- Possibility of reducing some potential biases in CVM
- Elicitation of more information from respondents as compared to CVM
- Possibility of testing internal consistency in choosing alternatives (due to sequence of choices provided)

- Possibility of avoiding the difficulty in attaching direct monetary values (in CVM) to an environmental good which is not highly experienced by the respondents

The literature suggests that respondents may overstate their true preferences in hypothetical exercises. List et al. (2006) indicate that, under the CE method two distinct types of hypothetical bias can be expected to emerge. First, a hypothetical bias might occur in the purchase decision. Second, even if hypothetical bias might not be present in the purchase decision, i.e., even if agents in the hypothetical scenario are equally likely to purchase the good as agents in the actual scenario, it might be present in the estimates of the marginal values of the attributes.

However, some evidence has been found that the choice-based approach performs better in both private and public goods; and hypothetical and real values are similar. "In all cases, hypothetical choices in a cheap talk treatment are statistically indistinguishable from actual responses. This evidence suggests that the choice experimental approach might provide a valuable avenue to credibly estimate use and passive use values of non-market goods and services." (List et al., 2006, p. 24)

Moreover, one important aspect in choice experiment is the difficulty for the respondents to make strategic response. When individuals are faced with consequential survey, they would have an incentive to misrepresent their true preferences. Consequential survey is a survey in which respondents could perceive as something that may potentially influence agency decisions or one in which they care about its out come. If there are such incentives, the preference profiles constructed could hardly reflect the true preferences, rather they reflect strategic behaviors. If this is so, choice experiments become flawed and welfare estimates will be unrealistic (ibid).

However, it is suggested that behaving strategically is more difficult in choice experiments (as compared to CVM). Respondents in CVM survey need to consider one single change in a project involving a certain payment. But, a typical choice experiment always consists of more than two alternatives described by at least three to four attributes. Attribute selection is assumed to be considering that attributes are significant determinants of choice behavior of respondents (in changing their utility levels). Thus, it will become more difficult for individuals to respond strategically in choice experiments (Bennett and Blamey, 2001 and Alpizar et al., 2001)

Choice experiment is among the attribute based techniques of valuation[2] (Bennett and Blamey, 2001; Girma, 2006). In contrast to other attribute based techniques, choice experiments are based on sound, well tested, and long standing behavioral theories. The empirical applications of choice experiments follow directly from random utility theory and allow tests of assumptions under random utility theory (Hanley et al., 1998, Bennett and Blamey, 2001 and Adamowicz et al., 1998).

The technique of CE is different from that of contingent ranking. In CE respondents are asked to choose their most preferred alternative in a given choice set and no ranking is

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2 Along with choice experiment, it is worth mentioning the term conjoint analysis which is some what broader in coverage than CE since it includes ranking exercises. Though there are some common characteristics, conjoint analysis methods differ widely from choice experiments in task characteristics especially in the nature of observed responses and statistical models used to analyze preferences (Bennett and Blamey, 2001).

According to Bennett and Blamey (2001), conjoint analysis methods are most often based on statistical and mathematical considerations which are not behavioral theories. This is illustrated better in marketing where techniques and methods tend to dominate academic and commercial practices though they lack behavioral or theoretical support. In addition, a technique of contingent ranking is indicated as one of the attribute based techniques. Conjoint analysis is described to be different from choice experiment and contingent ranking techniques. "Conjoint analysis also includes methods from marketing which look similar statistically to CE or contingent ranking, which lack the random utility basis of CE and contingent ranking." (Hanley et al., 1998)

required. But, in contingent ranking respondents are asked to rank their choices in the alternatives (Hanley et al., 1998 and Adamowicz et al., 1998).

CE is a technique based on the notion that attributes of an environmental good can be used to understand the general trade offs which an individual is willing to take. But, CVM focuses on a specific change in an environmental good. CE is, thus, better in contrast to CVM to understand the general trade offs between attributes individuals are willing to take. Moreover, CE is advantageous over the methods in revealed preference approach in terms of avoiding co-linearity between attributes and enabling the estimation of non-use values. Marginal values of attributes that may be difficult to identify using revealed preference data (due to co-linearity problems or lack of sufficient variation) could be obtained using CE method (List et al., 2006). CE is also preferable compared to contingent ranking since ranking of alternatives is a more difficult task for respondents than pair-wise comparisons (Bennett and Blamey, 2001 and Hanley et al., 1998).

There are, however, potential problems in using CE method. The first is the complex nature of the experimental design (from the possible combinations of attribute levels). The other is difficulty of selection of appropriate attributes and levels (Hanley et al., 1998).

2.2 Empirical Literature Review

Choice experiment is a relatively recently developed method of valuation in the family of stated preference methods. However, its application has become frequent in environmental valuation. Different studies have applied choice experiment in the fields of marketing, transport, health, and environment. Reviewing all those literatures applying choice

experiment is not an easy task. Here, an empirical review is presented on studies applying choice experiment in the valuation of environmental goods and services.

Birol et al. (2005) used choice experiment to estimate the non-use values of wetlands. The case study was Cheimaditida wetland, which contains one of the remaining freshwater lakes in Greece. The wetland is located 40 km South East of Florina in North West Greece with a total area of about 168 km^2 which is rich in flora, fauna, and habitat of biodiversity.

Choice experiment was designed to value the wetland management scenarios. The following four wetland management attributes were identified: biodiversity, open water surface area, research and educational extraction, and retraining of local farmers and fishers. In addition to these, a monetary attribute was included.

For biodiversity attribute, the management levels were low (deterioration from current levels) and high (a 10% increase in population and size of habitats). The attribute- open water surface area has the levels - low (decrease from the current level of 20%) and high (increase to 60%). Similarly, research and educational extraction has the levels - low (deterioration from the current level of extraction) and high (improve the level of extraction by providing better facilities). Each of the remaining two attributes has four numerical-value levels.

Only 32 pair-wise comparisons of wetland management scenario alternatives were used out of 128 possibilities for the choice experiments. These 32 pair-wise alternatives were, then, randomly divided into four versions (each with 8 choice sets). The total sample size was 407 respondents in 10 cities.

From the basic conditional logit model, it is reported that all of the wetland management attributes were significant factors in the choice of wetland management scenarios. More over, it is implied that any single attribute increases the probability of management scenario selection. Taking the monetary attribute i.e. 'payment' as a reference (normalizing) variable, the biodiversity attribute was the most important wetland management attribute. The relative importance of the rest of the attributes studied (in decreasing order of importance) is: open water surface area, research and educational extraction, and retraining of locals.

Choice modeling was applied for estimating wetland biodiversity values in Vetnam's Mekong River delta (Do and Bennett, 2007). The case study was Tram Chim National park in the Mekong River Delta (MRD) which is a 9000 ha wetland in Tam Nong district, Dong Thap province, Vietnam. This wetland provides habitats for 127 plant species and is the first wetland national park registered to be a Ramsar wetland site.

Five attributes and four levels for each attribute were determined from focus group studies. The five attributes were: area of healthy vegetation (the area having healthy melaleuca forest and grassland without any invasive mimosa pigra), number of Sarus cranes (the most endangered bird species), number of fish species, the number of households affected, and the cost option (or payment).

The levels of attributes were determined in consultation with wetland experts, and criteria were used to select the payment vehicle. Each attribute has four numerical-value levels (including the status quo level).

Three sub samples of respondents were administered in the study. The first sub sample was drawn from the populations of the Mekong River Delta that were not directly affected by

the changes in the management of Tram Chim wetland. The second sub sample was drawn from the urban residents adjacent to the MRD. The third sub sample was drawn from those who live far from MRD. In general, the total expected sample size indicated for the choice experiment exercise was 900.

Two models were estimated for each location (sub sample) across three options (status quo and two other options). The first model involves only the attributes and an alternative specific constant (ASC). This model was constructed to show the importance of the attributes in explaining respondents' choices across the options (in a choice set). The second model was constructed by interacting the socioeconomic and attitudinal characteristics with the ASC and selected attributes. The attribute 'cost' was interacted with 'age', 'gender', 'income', and 'education'.

Results of the multinomial logit and random parameter logit models suggested that respondents preferred more healthy vegetation, more birds, fewer farmers, and less cost. The number of fish species was an insignificant variable for the respondents. Moreover, both models were said to produce similar results in terms of magnitude of coefficients, signs and significance levels, except for 'education' interacting with the 'cost' variable.

From the MNL model, respondents were on average willing to pay 920 VND for a one per cent increase in healthy vegetation and 900 VND for an additional ten Sarus cranes; but, they required to be compensated with 870 VND for every ten local households made worse-off.

A case study of the wetland protection on the Macquarie Marshes in Central Western New South Wales, Australia was another study that used choice experiment (Bennett et al., 2001). It was reported that there was competition for water use with the irrigation industry

of the Macquarie River valley. As such, allocating more water to the wetlands would create non-use environmental values which could cause costs in forgone irrigation production. To meet the information requirement in weighing up the costs and benefits, and to assist reassessment of water allocation between irrigation and wetland, non-market valuation with choice modeling was applied.

The Macquarie Marsh with an area of about 5000 km^2 was once the largest wetland in New South Wales. It was listed as a wetland of international importance under the Ramsar Convention. The wetland was said to provide habitat for water birds and helps to act as a filter that improves water quality.

It is explained that a dam on the Macquarie River was opened in 1967 and a large area of irrigated agriculture was developed. Because of the extensive use of water for the irrigation, less water could reach the Macquarie Marshes. As a result, the area of the Marshes had fallen (from 5000 km^2 to 1200 km^2), frequency of water bird breeding declined, and number of protected bird species has fallen (from 34 to 12).

Five attributes were identified based on focus group discussion. The five attributes with their levels were: water rates ($0, $20, $50, $150), irrigation related employment (4400 jobs, 4350 jobs, 4250 jobs), wetland area (1000 km^2, 1250 km^2, 1650 km^2, 2000 km^2), frequency of water bird breeding (every 4 yrs, every 3 yrs, every 2 yrs, every yr), and presence of endangered and protected species (12 species, 15 species, 20 species, 25 species). Socioeconomic characteristics were also included in the questionnaire.

Three broad options: to continue the current situation, to increase water for the wetland, and/or to increase water for irrigation were provided for a respondent, in a given choice set. A respondent was provided with six choice sets and 318 usable questions were collected.

Two different multinomial logit models were estimated. The first was a basic model which includes attributes in explaining respondents' choices across four different options (continue with current situation, increase water to wetlands – in two options, and less water to the wetlands). The second model incorporates socioeconomic and attitudinal variables.

Using the first model, four utility functions were derived based on the four options. All the attribute coefficients in the choice sets and the overall model were significant at the 1% level of significance. The results indicated positive non-use values for environmental and social outcomes from wetland protection. The willingness to pay for changes in the attributes and the marginal rates of substitution between attributes of interest were reported.

Choice experiment was applied by Carlsson et al. (2003) to develop a wetland area in Staffanstorp, Southern Sweden. The study was motivated by the fact that the municipality of Staffanstorp plans to develop a wetland area as a means to increase the retention of nutrients, since more than 90% of the original wetlands have been eradicated due to expansion of cities, roads, and agriculture.

The attributes and questionnaire were developed in cooperation with researchers specialized on wetlands and focus group discussions. Three of the seven attributes that were identified along with their levels were: total cost (SEK 200, 400, 700, 850), surrounding vegetation (forest, meadow), biodiversity (low, medium, high). The other four attributes - fish, fenced waterline, crayfish, and walking facilities have two levels- Yes and/or No.

Sixty choice sets were created which were, then, blocked into 15 versions each containing four choice sets. A sample of 1200 randomly selected individuals (those 18 to 75 years living in Staffanstorp) was administered through mail survey. Only 468 individuals were

available for analysis from 580 (48%) individuals who returned the questionnaire. The questionnaire includes questions regarding the respondents' socioeconomic status.

Two models, the random parameter logit model and the standard conditional logit model were used and estimated. Except the 'Surrounding Vegetation', all attributes were significant for the two models. But, the mean coefficient for 'Crayfish' was implied insignificant in the random parameter logit model. The 'Surrounding Vegetation' attribute has a negative but insignificant WTP. The WTP for 'fenced waterline' and 'crayfish', was also negative suggesting that these attributes decrease the average utility that could be derived from a wetland area.

Adamowicz et al. (1998a) used both CE and CV approaches to measure the passive use values for a woodland caribou management program in Alberta, Canada. The woodland caribou in West Central Alberta are said to be characterized by considerable (forest, oil and gas) industrial and recreational areas. It is indicated that the woodland caribou were listed as "threatened" and programs were facilitated to maintain and enhance caribou habitat.

Five attributes were constructed through consultations with the biologists. The attributes were: mountain caribou population (number of caribou), wilderness area (in hectares), recreation restriction, forest industry employment, and change in provincial income taxes (annual change). Each of the five attributes has four levels – the current situation, one level below the current situation, and two levels above the current situation. Attitudinal and demographic questions were also included in the questionnaire.

A sample of 900 individuals selected through random digit dialing telephone contacts were taken as a sample and 447 respondents completed the CE task.

Linear and quadratic form utility functions were estimated for the CE, CV, and combined CE and CV models. From the linear functional form of CE model, the coefficients for caribou population and wilderness area were found positive while the coefficient on tax was negative, as expected. The quadratic form of the CE model out performed the linear model. Utility for caribou population and wilderness area was said to increase at decreasing rates in the quadratic model. The employment attribute was found insignificant in both functional forms.

A study that used choice modeling in tropical rainforest preservation was conducted by Rolfe et al. (2000). This was an application of choice experiment to the estimation of non use values that Australians might hold for the preservation of rainforest in Vanuatu.

Focus group discussions were used for assessing the Australians awareness of rainforest preservation. Afterwards, seven attributes were identified appropriate to the Vanuatu in rainforest preservations. The attributes include: Location (Vanuatu, Far North Queensland, Queensland/NSW boarder, Papua New Guinea, South America, Thailand, Indonesia), Area (100 ha, 1000 ha, 10000 ha), Rarity (Not rare, Fairly rare, Extremely rare), Visits (No visits, Moderate visits, Easy visits), Local people (Worse off from protection, No change, Better off from protection), Special features (No special features, Special plants and animals, Special landscape as well as plants and animals), and price ($ 5, $ 10, $ 20, $ 50).

An individual respondent had to answer 16 choice sets. 105 sample respondents in Brisbane, Australia completed the survey which could, thus, give a total of 1680 observations.

A basic MNL model was estimated and all attributes were found statistically significant at conventional levels of significance. Moreover, MNL model results incorporating

socioeconomic variables as interactions with the ASC were reported and different explanations were given. The study concluded that Australians hold substantial non use values in other countries than in Australia for rainforest preservation.

Choice experiment was applied by Carlsson et al. (2005) to examine Ethiopian farmers' preference for agricultural extension packages. The paper aims at analyzing the extent that farmers prefer agricultural packages to alternative local public goods.

A scenario that could describe the attributes and the choice task was prepared and read to the respondents. The extension package includes improved seeds (maize or teff) and modern agricultural inputs. The extension package was further described by two additional attributes: amount of money to be paid back (with four levels) and insurance scheme (in which farmers will not be forced to pay back money in case of a crop failure). The public good is either health station or protected spring.

Sixteen choice sets were constructed which were then divided into two versions (each with 8 choice sets), i.e., a respondent has to complete 8 pair-wise choices. A total of 1520 randomly selected households were interviewed from two Zones in Amhara regional state: East Gojjam and South Wollo. The head of the household and the spouse were asked choice experiment questions.

From the random effects probit model, the large majority of respondents were found to opt for the public good. Among the two public goods, health station was preferred to protected spring. The other result found was that when insurance was combined with extension package, a significant increase in choice of extension package was observed.

CHAPTER THREE

3. METHODOLOGY

3.1 The Study Area – Location and Features of Lake Tana

Lake Tana is found in North West highlands of Ethiopia, Amhara National Regional State. The Lake lies between latitude of 10°58' – 12°47' N and between longitude of 36°45' – 38°14' E, at an altitude of 1830 m above sea level (Ayalew et al., 2007). The surface area of the Lake is estimated to be between 3150 km^2 and 3500 km^2, depending on seasonal variations. Lake Tana is a shallow lake with average depth of 8 m and a maximum of 14 m.

The Lake is the major source of Blue Nile and the mean annual outflow is estimated to be about 4 km^3 per year (Berhanu et al., 2001). Five major rivers that carry a heavy load of silt and sediment feed the Lake. The Northern and Eastern shores of the lake are said to be dominated by Montmorillonite rich clay soils where most inflowing rivers originate and flood to the Lake (during the rainy season). Berhanu et al. (2001) noted that sediments of alluvial soils are loaded to the Lake from incoming rivers that flow passing areas of extensive agriculture. Moreover, annual soil loss in the lake catchment area ranges from 31 to 50 tons per hectare (Ayalew et al., 2007). In addition, fertilizers and pesticides used in agricultural activities (around the Lake) that are loaded to the Lake by heavy run-off are becoming dangerous for fish habitat and water quality reduction. All in all, it is said that Lake Tana is characterized by low nutrient and high silt concentrations.

3.2 Theoretical Framework of the Methodology

Maximization of utility subject to a budget constraint is the basis for microeconomic models of consumer behavior. The basic idea behind the choice experiment model formulation is the Lancastrian approach of consumer behavior (Lancaster, 1966) and the random utility theory (McFadden 1974, List et al., 2006, Birol et al., 2005 and Hanley et al., 1998).

According to Lancaster's approach, individuals are considered to derive utility from the properties or characteristics of the goods rather than directly from the goods themselves. This was said to be a 'break-away' from the traditional approach that goods are direct objects of utility. He elaborated that "utility or preference orderings are assumed to rank collections of characteristics and only rank collections of goods indirectly through the characteristics that they possess" (Lancaster, 1966 p.133). That is the utility that a consumer derives doesn't come from the good per se, rather it comes from the characteristics the good possesses.

Choice experiment is a technique in which individuals are asked to choose between options of the environmental goods hypothetically constructed from the different attributes (or characteristics) along with their levels. As such, the analysis of valuation of a good using choice experiment is said to be modeled based on the characteristics theory of value combined with random utility theory (Hanley et al., 1998).

In choice experiments (and based on the characteristics theory), an individual is expected to make two decisions in making a choice: choosing which good to consume and how much of the chosen good to be consumed, i.e. there is a discrete v_s continuous choice. Hence, when there are price changes of goods, individuals could make a discrete switch from one

bundle of goods to another bundle of goods that could give them the most cost – efficient combination of characteristics/attributes (Alpizar et al., 2001).

Accordingly, in the application of choice experiments to value non-marketed environmental goods, a specific continuous dimension is assumed as part of the frame work in such a way that discrete choices take place. But in CVM surveys, the same specific continuous dimension is assumed with the objective of obtaining the value of a certain hypothesized environmental project that includes a give continuous decision.

3.3 Econometric Model Specification

Most often stated behavior surveys are said to be found inconsistent with a deterministic model of utility functions of consumers. Those inconsistencies are assumed to arise from observational difficulties of consumers' behavior. Unobservable components, individualistic characteristics, attributes that are not included in the alternatives of the choice experiments, measurement errors, and heterogeneity of individuals' preferences are among the observational difficulties.

In order to incorporate the effects of observational difficulties in utility functions, random utility theory (McFadden, 1974) could be applied. The random utility approach enables to link the deterministic component with the random component.

For the specification of utility function, the most commonly used assumption is that the error term which represents the random component be entered as an additive term. This could enable to simplify the computations of results and estimations of welfare changes (Alpizar et al., 2001 and Hanley et al., 1998).

If utility function of a representative individual is assumed to depend on a vector of environmental attributes and socioeconomic factors, it could be formulated as: (Birol et al., 2005, Alpizar et al., 2001, Bennett and Blamey, 2001)

$$U_{in} = V(Z_{in}, S_n) \quad \text{---------- (1)}$$

However, this utility function could not be estimated for certain, due to the observational difficulties. Hence, U_{in} should be the representation of the unobservable (latent) utility from a given option i of individual n; Z_{in} is a vector of environmental attributes for an option i and individual n; and S_n is a vector of socioeconomic factors of individual n.

Incorporating the error term representing the random component as an additive term, the unobservable utility function could be explained by the deterministic (observable) portion and a random portion as follows: (ibid)

$$U_{in} = V(Z_{in}, S_n) + \varepsilon_{in} \quad \text{---------- (2)}$$

Where $V(Z_{in}, S_n)$ represents the deterministic (observable) component and ε_{in} represents the random component of the latent utility associated with alternative i and individual n.

As it is impossible to understand and predict preferences of individuals perfectly because of the random component in the latent utility function, we need to have an expression in the form of probability of choice. That is the presence of the random component permits to make probabilistic statements about consumers' behavior. Thus, the probability of an individual choosing option i to j in a given choice set is formulated as: (Birol et al., 2005, Bennett and Blamey, 2001)

$$P(i/C_n) = P\left\{(V_{in}+\varepsilon_{in})>(V_{jn}+\varepsilon_{jn})\right\} \text{ for } i \neq j \,\&\, j \in C \text{ ------- (3)}$$

where j is any option to the individual in a given choice set and C_i is choice set provided to the individual.

In using multinomial logit (MNL) for estimating choice probabilities, it is assumed that the random variable ε_{in} is identically independently distributed with an extreme value type I (Gumbel) (IID) and choices are consistent with the independence of irrelevant alternatives (IIA) (Cameron and Trivedi, 2005, Green, 2003, and Alpizar et al., 2001). The probability of choosing option i could be given by: (Cameron and Trivedi, 2005, Green, 2003, and Alpizar et al., 2001, Birol et al., 2005)

$$P(i) = \frac{\exp^{\mu V_i}}{\sum \exp^{\mu V_j}}, \; j \in C \text{ ---------- (4)}$$

μ is a scale parameter in which the true parameters are confounded with in it. It is not possible to identify this parameter from the data (Alpizar et al., 2001). The scale parameter, thus, has an impact of restrictions in interpretation of estimated coefficients. Coefficient interpretation in MNL model is relative to the reference or base category group. In MNL model, the scale parameter has an inverse relation with the variance of the error term given by $\delta^2 = \frac{\Pi^2}{6\mu^2}$ (Adamowicz et al., 1998 and Alpizar et al., 2001).

The main drawback in MNL model is the one that arises from the relation between probabilities. The ratio of any two probabilities is assumed to be independent of the

probability of any other outcome. This is known to result from the IIA. The IIA says that the odds ratio of option i being chosen over option j is independent of the availability of options other than i and j. The IIA assumption is said to follow from the initial assumption that disturbances are independent and homoscedastic (Cameron and Trivedi, 2005 and Green, 2003)

The random parameter logit model provides a simple way to generalize the multinomial logit model – to permit the utilities of each alternative to be correlated (Cameron and Trivedi, 2005). Thus, it does not require the IIA assumption.

The random utility function in the random parameter logit model will take the following form (Birol et al., 2005):

$$U_{in} = V_{in} + \varepsilon_{in} \equiv Z_i(\beta + \eta_n) + \varepsilon_{in} \quad \text{-------- (5)}$$

where respondent n receives utility U choosing alternative i from a choice set C. Utility is decomposed into a non-random component (V) and a stochastic term (ε); and the indirect utility is assumed to be a function of the choice attributes Z with parameters β (and socio economic characteristics, if included in the model), which due to preference heterogeneity may vary across respondents by a random component η_n.

Thus, the probability of choosing alternative i in each of the choice sets will have the following form (ibid)

$$P_{in} = \frac{e^{Z_{in}(\beta + \eta_n)}}{\sum e^{Z_{jn}(\beta + \eta_n)}} \quad \text{---------- (6)}$$

As noted by Birol et al. (2005), since the random parameter logit model does not require the IIA assumption, the stochastic part of utility may be correlated among alternatives and across the sequence of choices via the common influence of η_n. Moreover, it is indicated that in terms of overall fit and welfare estimates, random parameter logit model is superior to conditional logit model.

The estimated deterministic (indirect) utility function generally will have a form of:

$$V_{ij} = ASC + \sum \beta_k Z_k + \sum \beta_m S_m \quad \text{---------- (7)}$$

ASC is the alternative specific constant that captures effect of any attribute (not included in the choice specific attributes) on utility; k is the number of environmental attributes and m is the number of socioeconomic factors. Note that socioeconomic factors are constant across choice occasions for any individual and can only enter as interaction terms with the environmental attributes.

The marginal value of a change in an attribute could be given by the ratio of the coefficients of the attribute in question and that of the payment attribute, other things being the same. This is referred to as the part–worth or implicit price or marginal willingness to pay of the attribute. It represents the marginal rate of substitution between the payment attribute and the attribute in question.

$$MWTP = \frac{-\beta_{attribute}}{\beta_{payment\ attribute}} \quad \text{---------- (8)}$$

In general, for a linear utility function, the marginal rate of substitution between two attributes is simply the ratio of their coefficients (Bennett and Blamey, 2001, Alpizar et al., 2001, Birol et al. 2005).

Moreover, the welfare changes from quality or quantity change of an environmental good (attributes) could be given by the measure of consumer surplus as: (Bennett and Blamey, 2001, Alpizar et al., 2001, Birol et al., 2005).

$$CS = \frac{-(V_0 - V_1)}{\beta_{payment\ attribute}} \quad \text{---------- (9)}$$

Where V_0 represents the indirect utility at the status quo and V_1 represents the indirect utility associated with environmental changes in various scenarios.

CHAPTER FOUR

4. DATA COLLECTION AND SURVEY DESIGN

4.1 Data and Its Source

The data used in this paper is primary data. It was obtained from the fishermen through face to face interview. Currently about 1685 fishermen participate in fishing activities in Lake Tana[3].

Some of the fishermen are under associations. One association is found at Bahir Dar town named number 1 fishermen association and the other at Gorgora named Gorgora fishermen association. The one at Bahir Dar town is well organized and has 116 members. The association at Gorgora is not well organized and has about 40 members. Respondents were taken from these associations. To have respondents from the non-members of associations a sample of fishermen were interviewed at Bahir Dar town and Enfranz (a small town in North Gondar Zone). Three individuals were employed and trained to interview the respondents. Two of them were students at Bahir Dar University and the other was at Enfranz.

4.2 Design Issues

Four major tasks are expected to be done to undertake the choice experiment survey design. These are definition of attributes and their levels, experimental design, questionnaire development, and sampling.

[3] Interview with head of the fishery department at Amhara Regional State Agriculture and Rural Development Bureau)

4.2-1 Definition of attributes and levels

The first step in undertaking choice experiment survey design is to identify the attributes and attribute levels to be included in the survey. Before deciding those attributes to be included in the survey, the importance of the attributes in choice decisions has to be recognized (Alpizar et al., 2001). Moreover, the attributes identified should be consistent with policy instruments that are expected as outcomes from the alternatives provided and hence, they should be relevant to the policy making process (Bennett and Blamey, 2001). In addition to this, the attributes used must have meaning to the people who will answer the questions. If attributes are irrelevant to the respondents, the possibility of getting valid responses being received will reduce and response rate may diminish (ibid.). The issue of customization, i.e. making choice alternatives more realistic by relating them to actual levels is important to have better understanding by the respondents. Accordingly, it is better to include an alternative that describes today's situation – status quo as one of the alternatives in a choice set (Alpizar et al., 2001). One of the attributes required to be included in the choice experiment scenario is the monetary attribute. This attribute has to be included to measure welfare changes in the scenario (ibid.).

After attributes are identified and defined, the levels of each attribute have to be determined. The levels could be expressed qualitatively or quantitatively. Quantitative expression of levels has a distinct advantage in terms of modeling and valuation potentials afforded (Bennett and Blamey, 2001).

As to Nagelkerke (1997) and de Graaf (2003), the endemic fish species (Barbus) is in need of protection as its abundance is declining at alarming rate. de Graaf has suggested that fishing pressures focused at the spawning grounds and spawning seasons of the Barbus

species should be controlled and prohibited. He has proposed four options as measures to be taken to protect the endangered species.

From such perspective, fishing control at the river mouths during the spawning seasons of the Barbus species was taken as one attribute and two of the four proposed options have been selected as levels of the "fishing control" attribute in this paper. The levels were fishing control every other week during July to September and/or fishing control for the three months (from July to September).

The second attribute identified was lake side plantation at flood plains around the lake and at around the river mouths. According to Berhanu et al. (2001) and Eshete (2003), the plantation cover around the lake is being degraded from time to time. Agricultural activities around the Lake are expanded and the wetland is, thus, being lost. People cut the papyrus found at the shores of the Lake for making traditional boats, for fuel, for ceremonial purposes and for other household uses. On account of this, lake side plantation was taken as one of the attributes with two levels: plantation of local, environmental friendly, plants with 10 meters width and/or 50 meters width from the shores of the Lake.

The description of attributes and their levels is presented in the following table.

Table 4.1 Definition of attributes and their levels

Attribute	**Definition**	**Levels**
Fishing Control	This involves prohibition of fishing efforts at the river mouths during the spawning periods of the Barbus species.	_**Status quo** (No measure) _**Moderate:** Prohibition of fishing efforts **only every other week** during July to September at the

		river mouths _**Aggressive:** Complete prohibition of fishing efforts at the river mouths **from July to September**.
Lake Side Plantation	Local trees such as 'Dokma', 'Sholla', and 'Chveha' as well as Papyrus, Reed & Grass families, which are known to be environmental friendly, will be planted around the river mouths and flood plains. Equal proportions of the mentioned plant types will be planted.	_**Status quo:** No measures will be taken _**Moderate:** Plantation will be established with **10 meters wide** land areas from shores of the Lake. _**Aggressive:** Plantation will be established with **50 meters wide** land areas from the shores of the Lake.
Payment for Fishing Permit	This is an equal monthly payment that all fishermen will be required to be registered for legal participation in fishing activities.	**Status quo: No payment** **10 Birr** **25 Birr** **40 Birr**

4.2-2 Experimental design

The next step in choice experiment design is the experimental design. It concerns on the issue of how to construct the choice sets efficiently. The attribute levels are combined to form the alternatives and combination of alternatives could form a choice set. The standard and most commonly used experimental design is the so called orthogonal design where the

variations of the attributes in the alternatives are uncorrelated in all choice sets (Alpizar et al., 2001).

As noted by Alpizar et al. (2001), two steps are involved in developing an experimental design. The first step is obtaining optimal combinations of attributes and their levels and the second step involves combining the alternatives into choice sets. A full factorial is a starting point to be used which enables to identify all possible combinations of the attribute and levels. However, when there are many attributes and levels, a full factorial design may lead to very large combinations which could not be tractable. In such cases, there is a need to choose a subset of possible combinations to be included in a choice set.

In this study we use three attributes: fishing control, lake side plantation, and payment for fishing permit. The two attributes – fishing control and lake side plantation have two levels each while the third attribute has three levels. From the two attributes with two levels and one attribute with three levels, twelve possible combinations could be formed ($2^2*3^1=12$). From the twelve possible combinations, six optimal choice sets were created using SAS in orthogonal design method using the OPTEX procedure. Thus, a respondent has to complete six consecutive choice sets with three alternatives (options) – two with different combinations of attribute levels and one the status quo. One of the choice sets provided to respondents was the following:

Table 4.2 sample of a choice set

Attribute	Option 1	Option 2	Option 3
Fishing Control	July to September	Every other week	No change
Lake Side Plantation	50 meter	50 meter	No change
Payment for F. Permit	10 Birr	10 Birr	0 Birr
Choose one, please!			

4.2-3 Questionnaire development

The next step in choice experiment design is questionnaire development. It involves preparation of general questions and choice experiment questions that will be provided to the respondents. It has been suggested that respondents have to first be introduced to the issue under investigation, with the purpose and objective of the exercises, and how they were selected. To encourage participation, the importance of the information being gathered has to be explained (Bennett and Blamey, 2001). These issues were explained in the first page of the questionnaire and read to the respondents.

The questionnaire in this paper was classified in to three parts. First, questions to get the general information about the Lake and its resources were provided for the respondents. The questions focus on investigating fishermen's attitude and their observations with regard to the Lake and its resources.

The second part of the questionnaire consists of the choice experiment questions. Six choice sets, with three options (alternatives) each – two options with different level

combinations and the third status quo option were provided to the respondents. A respondent has to complete the six consecutive choice sets.

An important issue in questionnaire development is task complexity. It is determined by factors such as number of choice sets provided, number of alternatives in each choice set, and number of attributes in the alternative. Task complexity is said to affect choice decision. Alpizar et al. (2001) explained that when more than 4 to 5 attributes are included in a choice set, a severe detriment to the quality of the data will result due to task complexity. Respondents may give answers carelessly or may use some simplified lexicographic decision rule in case when they face task complexity.

As to Bennett and Blamey (2001), there is trade-off between the cognitive ability of the respondents and the number of variations in the attribute levels that is required to support an empirical model of the impact of attributes on choices made.

Like other valuation methods such as CVM, scenario description is needed for the application of choice experiment. A scenario description was prepared to the respondents before going to the choice experiment exercises. The description was about the general features of the Lake Tana fishery and its watershed, about the attributes and their levels, and about the payment vehicle. In addition to this, pictures that could explain the attribute levels in an option/alternative were prepared. Then the choice sets are presented to them and they were showed pictures which could elaborate the alternatives in a given choice set. Preparing visual aids has a crucial role in demonstrating differences in attribute levels and between alternatives (Bennett and Blamey, 2001).

After the choice experiment questions, a follow up question was presented to the respondents. It was designed to know how the respondents were acting in making their

choices. A follow up question has to come immediately after the choice experiment questions according to Bennett and Blamey (2001). Follow up questions should be targeted at picking up any response aberrations such as:

- Payment vehicle protests where for example, a respondent may always choose the status quo option because of an objection to the payment.
- Lexicographic preferences where a respondent may choose the alternative with highest level of one attribute or always appear to choose on the basis of a single characteristic of the task.
- Perfect embedding where a respondent may agree to pay in order to experience the 'warm glow' of supporting a good cause rather than a reflection of his/her genuine preferences.

The last section in the questionnaire was questions on socioeconomic characteristics. Questions seeking socioeconomic data (age, martial status, level of education, family size, monthly household income, and monthly household expenditure) were presented to the respondents.

4.2-4 Sampling

The sample respondents were taken from the fishermen who are participating in fishing activities in Lake Tana. It was intended to take all the fishermen who are members of number one fishermen association in Bahir Dar. The members of this association came from different districts in two zones – West Gojam and South Gondar. From the 116 fishermen, 105 were interviewed. 17 respondents were taken from Gorgora fishermen association. In addition to these, fishermen who are not members of any association were

interviewed at Enfranz and at Bahir Dar towns. Accordingly, a total of 44 non– member fishermen were taken at these towns. Thus a total of 166 fishermen were included in the sample.

Except the 105 fishermen taken from number one fishermen association, it could be said that the fishermen were selected randomly. The fishermen at Enfranz were interviewed when they go the town to sell their catch while those at Bahir Dar and Gogora were interviewed when they landed their catch.

CHAPTER FIVE

5. ESTIMATION AND DATA ANALYSIS

5.1 Definition of Variables

The definition of attribute and socioeconomic variables used in the model estimation is presented in the following table.

Table 5.1 Definition of variables

Variable	Definition
asc [4]	Alternative specific constant =1 for the alternatives with changes in the attributes and 0 for the status quo.
fishcrl	Fishing control at river mouths = 1 for fishing control every other week during July to September and 2 for fishing control from July to September.
lspltn	Lake side plantation at the flood plains and river mouths with 10 meters or 50 meters width from the lake shores and these values are coded directly.
payfp	Payment for fishing permit. It is a payment that the fishermen will be required in order to participate in fishing activities.

[4] According to Bennett and Blamey (2001), modeling constants known as 'alternative specific constant' (ASC) have to be included in the data. If there are three alternatives in the choice set, two of the alternatives have to be associated with an ASC, and a new 'attribute' has to be created for two of the alternatives. Thus, ASC has to take the value of 1 for the two alternatives of change in attributes and 0 for the status quo alternative. The role of ASC is to explain the variations in choices that cannot be explained by the attributes and socioeconomic characteristics.

	The values are 10 birr, 25 birr, and 40 birr for changed alternatives
age	Age of the respondents in years
durtn	Years spent by the respondent in fishing
famsize	Family size of the respondent
martalst	Martial status of the respondent
	= 1 for those who are married and 0 for divorced and single respondents.
yredu	Respondent's year of education
moninc	Monthly household income
monexp	Monthly household expenditure

5.2 Descriptive Statistics

The data collected was first coded and entered in spread sheet (excel format). The data from the choice experiment were coded according to the levels of the attributes. The status quo levels were coded as 0 for each of the attributes. For the attribute –fishing control, the moderate level (control every other week during July to September) was coded as 1 while the aggressive level (fishing control from July to September) was coded as 2. For the attributes – lake side plantation and payment for fishing permit, their values are entered directly.

From the descriptive statistics, the minimum year of experience in fishing activity is 1 year and the maximum is 41 years. More than 80% of the respondents have 18 years of

experience. The sample in this study includes those who have started fishing since 1968 and 50% of them have started fishing before 1998.

The responses show that 85% of the fishermen have a job in addition to fishing. Most of them participated in farming and cattle raring activities in addition to fishing. On average, a fisherman goes to fishing for 2 days per week and spends about 7 hours per day on average. The minimum amount of catch per day is 8 kilograms and the maximum amount is 70 kilograms. The average catch is 31 kilograms per day. All the fishermen surveyed have said that their catch incorporates 3 of the species: Tilapia, Barbus, and Catfish. Only half of the fishermen reported that they sometimes caught beso species. The most preferred species that fishermen prefer to exert more catching effort on is Tilapia followed by Catfish. The Barbus species takes the third place in preferences. More than 90% of the fishermen said more Barbus could be caught during July to September. In addition, about 86% of the respondents indicated that the appropriate place to get more Barbus catch is the river mouths. Most of the fishermen know the reason why they could get more Barbus catch during the rainy season. 86% of them have explained that the rainy season is the breeding season when the mature Barbus migrate to the river mouths for spawning.

About 94% of the fishermen agreed that degradation of the lake side plantation is a problem and most of them claimed that the farmers are responsible for such degradation. As well, 99% of the fishermen have observed that the Barbus species has been declining from time to time. Most of the fishermen perceived that high fishing efforts during the spawning period of the Barbus species is one of the causes for the decline in the stock.

The fishermen have suggested that there should be fishing control during the spawning periods of the fish; use of poisonous materials ('birbra') has to be stopped; and the gillnet

mesh size has to be regulated in order to solve the fish stock decline of the Lake. 98% of the fishermen have indicated that they could agree if fishing control during the spawning periods is introduced. As well, all of the respondents indicated their agreement if lake side plantation could be taken as a measure in solving the degradation problems around the lake. More than 86% of the fishermen agreed to contribute for the implementation of the two measures proposed.

Table 5.2 Descriptive statistics of attributes and socioeconomic variables

Variable	Mean	Std. Dev.	Min	Max
Fishcrl	1	.8166332	0	2
Lspltn	20	21.60608	0	50
Payfp	16.66667	15.45862	0	40
Yrstart	1998.0241	7.7775	1968	2008
Durtn	10.90361	7.714704	1	41
Kiloday	30.5241	12.00387	8	70
Incwek	220.1506	102.0631	35	500
Age	38.8012	11.72991	18	68
Martalst	0.89759	0.303234	0	1
Yredu	3.518072	2.543365	0	10
Famsize	4.939759	2.005446	1	10
Moninc	1217.892	355.2038	400	2300
Monexp	987.1084	264.2641	350	1800

* The number of observations is 2988 for 166 respondents with 6 choice sets and counting the 3 options.

The age of respondents was between 18 and 68 years while the average age was 39 years. 90% of the respondents were married. About 31% of the fishermen are above grade five while almost 20% of them are uneducated. The average family size is five, the minimum being one and the maximum ten. The average monthly income is 1218 birr and the average monthly income from fish sale is about 800 birr. Moreover, the average monthly income and average monthly expenditure are not much different – the average monthly expenditure is about 990 birr.

Analysis of results from follow up questions

About 82% of the respondents have answered the follow up questions presented after the choice experiment exercises. From those respondents, more than 60% replied that they have made their choice in such way that the aggressive options could be achieved. About 32% of them have made their choices with the cheapest payments. The rest have replied that though the proposed measures are appropriate, they did not have the ability to pay. The results are presented in the following table.

Table 5.3 Results from the follow up questions

Follow up questions	% of response
1. Just I want the aggressive options to be implemented	62.50
2. I exclusively chose the cheapest alternative whatever	32.35
3. The proposed measures were good but I didn't have the ability to pay and thus chose the status quo	5.15
4. I thought the fishermen did not have to pay and thus chose the status quo	_

5. I found the Fishing Control attribute as a preferred measure and thus made choices in accordance to its implementation _

6. I found the Lake Side Plantation attribute as preferred measure and thus made choices in accordance to its implementation _

5.3 The Deterministic Utility Model specification

Two different models were specified for the analysis of the choice experiment. The first model was a basic model that could show the importance of the attributes in explaining respondents' choices across three different options in a choice set: a status quo and two alternatives with changes in attributes. The second model is an extended model which includes the socioeconomic characteristics interacting with the alternative specific constant (ASC). The socioeconomic variables age, family size, year of education, and monthly household income were interacted with the ASC.

The basic model

The choice experiment modeling was specified with the assumption that the observable utility function would follow a strictly additive form. The model was specified in such a way that the probability of selecting a particular alternative was a function of attributes of that scenario and of the alternative specific constant.

The indirect utility from the proposed environmental improvement would take the following form:

$$V_i = \beta + \beta_{payfp} * payfp + \beta_{fishcrl} * fishcrl + \beta_{lspltn} * lspltn \text{ ---------- (10)}$$

V_i is the indirect utility for three alternatives; β refers to the alternative specific constant and β_{payfp}, $\beta_{fishcrl}$, and β_{lspltn} are the coefficients associated with the attributes payment for fishing permit, fishing control, and lake side plantation respectively. More specifically

$$V_1 = ASC_1 + \beta_{payfp} * payfp + \beta_{fishcrl} * fishcrl + \beta_{lspltn} * lspltn$$

$$V_2 = ASC_2 + \beta_{payfp} * payfp + \beta_{fishcrl} * fishcrl + \beta_{lspltn} * lspltn$$

$$V_3 = \beta_{payfp} * payfp + \beta_{fishcrl} * fishcrl + \beta_{lspltn} * lspltn \text{ ---------- (11)}$$

V_1 and V_2 represents the indirect utilities derived from environmental improvements in the lake i.e. scenarios with options 1 and 2. V_3 represents the indirect utility in the status quo option. It has to be recognized that it is difficult to make any interpretation of the coefficients. This is because the coefficients are confounded by a scale parameter i.e. they are dependent on the variance of the error involved in the estimation process. But it is possible to compare the sign and difference in magnitudes of the coefficients (Bennett and Blamey, 2001). Moreover, ASC_1 and ASC_2 are considered to be equivalent[5].

The extended model

In the basic model, homogeneity of preferences of individuals was assumed. However, preferences might in fact be heterogeneous. Thus, to have unbiased estimates of individual preferences, we need to account for such heterogeneity (Birol et al., 2005).

[5] When the alternatives in choice sets are presented in generic form, ASCs could be considered as equivalent (Bennett and Blamey, 2001; Carlsson et al., 2003).

One way of accounting for preference heterogeneity is using socioeconomic characteristics of respondents as interaction terms. Interaction of the socioeconomic characteristics with the alternative specific constant is the most commonly used solution to deal with the heterogeneity problem as well as possible violation of the IIA assumption (Bennett and Blamey, 2001, Birol et al., 2005, Alpizar et al., 2001).

However, due to a possible multicollinearity problem, all the possible interactions between the socioeconomic characteristics and the attributes should not be included (Birol et al., 2005). Moreover, it has to be recognized that the socioeconomic variables could not be introduced alone into the model. Since the respondent characteristics do not vary across alternatives, Hessian singularities could arise (Bennett and Blamey, 2001).

In this paper, the socioeconomic variables age, family size, year of education, and monthly household income are interacted with the ASC term. The indirect utility function in this case takes the following form.

$$V_i = ASC + \beta_{payfp} * payfp + \beta_{fishcrl} * fishcrl + \beta_{lspltn} * lspltn + \gamma_1 (ASC * age) + \gamma_2 (ASC * famsize) + \gamma_3 (ASC * yredu) + \gamma_4 (ASC * moninc) \quad \text{---- (12)}$$

where i=1, 2, 3 for the three scenario options; ASC=0 for the status quo and 1 for options 1 and 2.

Having these additive forms of the indirect utility specification, the multinomial logit and random parameter logit models could be estimated using equations (4) and (6).

5.4 Estimation and Discussion of Results

From 996 observations elicited from 166 respondents (each respondent was provided with 6 choice sets), the multinomial logit model with linear specifications in attributes was estimated using LIMDEP 8.0 NLOGIT 3.0 for the basic and extended models. In addition to this, the random parameter logit model was estimated to address unobserved preference heterogeneity and possible violation of the IIA assumption. The estimates of the multinomial logit model are presented in the following tables.

Table 5.4 Results of the multinomial logit model (basic model)

Variable	Coefficient	Standard error	P [|Z|>z]
ASC	1.96066	0.21328	0.0000
PAYFP	-0.53247E-01	0.53056E-02	0.0000 ***
FISHCR	0.78353	0.98611E-01	0.0000 ***
LSPLTN	0.28104E-01	0.44264E-02	0.0000 ***
Log-likelihood		-837.4248	
R-sqrd		0.07784	
Number of observation		996	

*** significant at 1% level

- The number of observations in this case is 996 for 166 respondents with 6 choice sets

All the coefficients are significant at the 1% level and the signs of attributes except the fishing control are as expected. The sign of fishing control may be expected to be negative, since fishing control affects income of the fishermen. However, it was observed at the time of interview that respondents are more concerned for fishing control. They have explained

that unless fishing control is exercised in the three months (the spawning periods), desirable results could not be achieved for solving the Barbus fish stock decline. If this is considered the sign of this attribute is as expected. It suggests that perhaps the fishermen want to have a more sustainable environment instead of maximizing their income in the very short run. The two attributes – fishing control and lake side plantation have positive signs implying that the probability of choosing an alternative scenario with changes in attribute improvements will increase as the levels of these attributes increase[6], ceteris paribus. The sign of the payment coefficient indicates that the effect on utility of choosing a choice set with a higher payment is negative. In other words, scenario improvements with 'cheaper' alternatives are preferred to 'expensive' alternatives. Moreover, all the attributes are significant determinants in the choice of the Lake's resource improvement. That is, ceteris paribus, any single attribute increases the probability of choosing a scenario of environmental improvement.

The coefficient magnitude of fishing control attribute is greater than that of the lake side plantation which indicates that the fishermen give relatively greater emphasis to fishing control than lake side plantation. As could be expected, the fishermen are more concerned about the Lake's fish stock sustainability and thus attach greater value to fishing control. As mentioned earlier, fishermen have suggested that fishing control during the spawning periods should be one of the measures to solve the problem of Barbus species stock decline.

[6] The probability of choosing an alternative increases as the levels of desirable attributes in that alternative rise or the levels of undesirable attributes fall relative to the levels of the attributes in other alternatives (Bennett and Blamey, 2001).

Table 5.5 Results of Multinomial logit (extended model)

Variable	Coefficient	Standard Error	P [|Z|>z]
ASC	-1.64999	0.78381	0.0353
PAYFP	-0.53858E-01	0.53338E-02	0.0000 ***
FISHCR	0.79453	0.99223E-01	0.0000 ***
LSPLTN	0.28683E-01	0.44527E-02	0.0000 ***
AGE	0.30589E-01	0.21807E-01	0.1607
MONINC	0.31122E-02	0.65357E-03	0.0000 ***
FAMSIZ	-0.31117	0.12256	0.0111 **
YREDU	0.19483	0.73677E-01	0.0082 ***
Log-likelihood		-837.4248	
R-sqrd		0.10200	
Number of observations		996	

*** significant at 1% level; ** significant at 5% level

We do not find differences between the basic model and the extended model with regard to the attributes in their sign and magnitudes. The coefficients of interactions of ASC with monthly income and year of education are significant at 1% level, while the interaction between ASC and family size is significant at 5% level. Thus, these socioeconomic characteristics are significant determinants in the choice of alternative scenario of improvements. As could be expected, the coefficient of family size is negative implying that as the family size increases the probability of choosing an alternative scenario with changes in the lake environment decreases, ceteris paribus. On the other hand, as years of education increases, the probability of choosing improved scenario options increases,

ceteris paribus. A similar argument holds for monthly household income. Age is not a significant factor in affecting the probability of choosing an alternative.

The overall explanatory power of a model could be assessed using the McFadden's (pseudo) R^2 (Birol et al., 2005). However, in both models, the reported pseudo R^2 statistic is small compared to the standard. Pseudo R^2 statistic values between 0.2 and 0.4 are said to be adequate (Birol et al., 2005; Bennett and Blamey, 2001). But, the extended model has relatively better explanatory power than the basic model.

Hausman's test was used to test whether the IIA assumption holds in the multinomial logit model we estimated. According to Alpizar et al. (2001), there are two problems with the MNL specification: (i) the alternatives are independent and (ii) there is a limitation in modeling variation in taste among respondents. As to Alpizar et al., the first problem arises because of the IID assumption (constant variance), which in turn could result in the independence of irrelevant alternatives (IIA) property. The IIA property states that the ratio of choice probabilities between two alternatives in a choice set is unaffected by other alternative changes in that choice set. Accordingly, the MNL should not be used if this assumption is violated. The result of this test is reported in table 5.6

The second problem arises due to observed and/or unobserved heterogeneity i.e. when there is taste variation among respondents. Observed heterogeneity can be incorporated into the model by allowing for interaction between socioeconomic characteristics and attributes of the alternatives or alternative specific constant terms (Alpizar et al., 2001).

The random parameter logit model can be used as an alternative method of estimation in order to account for preference heterogeneity. Birol et al. (2005) suggested that though the interaction of socioeconomic characteristics with the ASC or with different attributes could

help to recognize conditional heterogeneity, it could not detect unobserved heterogeneity. Unobserved heterogeneity in preferences across respondents can be accounted for by using a random parameter logit model, which does not require the IIA assumption. The results of the random parameter logit model are reported in table 5.7

Table 5.6 Hausman test for IIA

Variable	Coefficient	Standard Error	P [|Z|>z]
PAYFP	0.29817E-01	0.12428E-01	0.0164
FISHCRL	1.13238	0.23558	0.0000
LSPLTN	0.25395E-02	0.68587E-02	0.7112
*ChiSqrd [3] = 73.3064, Pr(C>c) = .000000			
PAYFP	-0.45755E-01	0.14857E-01	0.0021
FISHCRL	2.11778	0.29888	0.0000
LSPLTN	-0.6348E-02	0.11212E-01	0.5713
**ChiSqrd [3] = 36.7018, Pr(C>c) = .000000			

*when the excluded choice is option 1
**when the excluded choice is option 2

As shown in table 5.6, the null hypothesis about the IIA assumption could not be rejected at 99% confidence interval. That is the IIA assumption is not violated and thus the multinomial model could be used.

Table 5.7 Results of the random parameter logit model

Variable	Coefficient	Standard Error	P [|Z|>z]
ASC	1.96061	0.21335	0.0000
PAYFP	-0.53249E-01	0.53066E-02	0.0000 ***
FISHCR	0.78370	0.98626E-01	0.0000 ***
LSPLTN	0.28089E-01	0.44302E-02	0.0000 ***
Log likelihood function		-772.2324	
Chi squared (5)		643.9708	
Prob [ChiSqd > value]		0.00000	
R-sqrd		0.29426	
Number of observations		996	

As explained earlier, the random parameter logit model can address the problem of violation of the IIA assumption. Though there is no violation of the IIA assumption, the random parameter logit model is estimated in order to account for unobservable preference heterogeneity across respondents.

No difference is exhibited in magnitude and sign of the coefficients of the attributes. All attributes are significant as in the multinomial logit model. However, as compared to the previous models, the explanatory power of the random parameter logit model is better. The pseudo R^2 in this case is 0.29 which could be considered adequate.

5.5 Marginal Willingness to Pay

The parameters estimated in a MNL or parametric logit model can be used to estimate the rate at which respondents are willing to trade-off one attribute for the other. When the attribute being sacrificed is a monetary one, the trade-off estimated is known as 'part worth' or 'implicit price' or marginal willingness to pay for the attribute in question (Bennett and Blamey et al., 2001). It implies the amount of money respondents are willing to pay for an improvement in the environmental attribute.

Marginal willingness to pay has a significant role or implication for policy. Comparison of the implicit prices of different attributes provides some understanding of the relative importance of attributes. Policy makers, thus, will be better placed to design resource use alternatives. Attributes with relatively higher implicit prices will be favored. Marginal willingness to pay for the two attributes is estimated using equation (8)[7].

Using the coefficients of the attributes from the results of the random parameter logit model (which has a better goodness of fit), the following values of MWTP was found for the attributes – fishing control and lake side plantation.

Table 5.8 Marginal willingness to pay for the attributes

Attribute	Coefficient	Standard Error	P [|Z|>z]
Fish control	14.7176	1.7464	0.0000
L.side plantation	0.5275	0.5629E-01	0.0000

[7] Since the coefficients are confounded by the scale parameter, they are dependent on the variance of the error involved in the estimation process. The extent of the variance of the statistical error, thus, will have an impact on the absolute magnitude of the coefficients. Therefore, it is only through the division of the coefficients that will cancel the scale parameter (and eliminate the confounding effect of the error variance) (Bennett and Blamey, 2001)

Other things held constant, respondents are willing to pay about 15 birr per month for an increase in the level of fishing control. That is fishermen are willing to pay this amount for a change in fishing control from the status quo level. As well, the fishermen are willing to pay about 50 cents per month for an increase in the level of lake side plantation from the status quo level, ceteris paribus.

As explained before, fishermen consider fishing control more than lake side plantation as a desirable measure in alleviating Barbus species stock decline and hence attached greater value to this attribute. It has to be recognized that fishing control is intended to be exercised during the spawning periods of the Barbus species (July to September) at the river mouths. Since fishing will not be controlled at other parts of the lake, income of the fishermen might not be affected severely. Thus, the fishermen might have given greater value to fishing control expecting future fish stock enhancement. As noted earlier, fishermen claimed that the farmers are responsible for the lake side degradation. Perhaps, this could be one explanation for their low level of willingness to pay for lake side plantation i.e. they might expect the farmers to pay for the improvement of this attribute.

More over, note that the models were estimated by disaggregating the data in to two: for those who are members of number one fishermen association and for the rest of respondents. Based on these estimations, fishing control was insignificant for respondents who are not members of the association while it was positive and significant (at 1% level) for those who are members. The marginal willingness to pay for this attribute becomes even higher for fishermen who are members of the association. The most likely explanation for this could, perhaps, be the different situations for fishing activities of these respondents. Those fishermen who are members are operating with motorized boats and hence extend

their catch to distant river mouths and thus, might know that their fishing pressure at these sites could influence the breeding process of the Barbus species. Recognizing the Barbus stock decline situation as such, they are willing to pay for fishing control expecting future stock enhancements. But, those fishermen who are not members of number one fishermen association mostly use the traditional boats and could only fish around the shores of the lake and hence, might not recognize the Barbus stock decline situation.

5.6 Estimation of Welfare Measures

Another main purpose of a choice experiment is its ability to generate estimates of the values of different alternative scenarios from one application (Bennet and Blamey, 2001; Alpizar et al., 2001). That is from one set of the choice data; the values of different alternative scenarios can be estimated.

Economic welfare measurement involves an investigation of the difference between the utilities of the individual that could be achieved under the status quo and changed scenario alternatives. Welfare measures can be estimated using the parameter estimates and values (levels) of the attributes. First, the values of the attributes in the status quo alternative are substituted into the indirect utility function. Next, the values of the attributes in changed situation of scenarios are substituted into the indirect utility equation. The value of the alternative with a changed situation is, then, subtracted from the value in the status quo alternative and then divided by the coefficient of the monetary attribute (Bennett and Blamey, 2001).

In this paper, two alternative scenarios are proposed for the improvements in attributes – the moderate and aggressive scenarios. In the moderate improvement scenario, fishing will

be controlled every other week during July to September and the lake side will be planted with 10 meters width from the shores of the lake. In the aggressive scenario, fishing will be controlled from July to September and the lake side will be planted with 50 meters width from the shores of the lake. Using equation (9), the following results could be obtained.

Table 5.9 Estimates of economic surplus

Alternative improvement scenario	WTP for the scenario
Moderate scenario	57 birr
Aggressive scenario	93 birr

This measure indicates the amount that respondents are willing to pay in order to experience an improvement in their utility (which results from the status quo to the changed alternative scenarios). As such, the respondents are willing to pay 57 birr to have a moderate improvement in the attributes from the status quo and 93 birr to have an aggressive improvement from the status quo. A large difference in magnitude for the two scenarios is due to difference in levels of the attributes. The level of fishing control in the aggressive scenario improvement is taken to be twice the moderate one. The level of lake side plantation in the aggressive scenario improvement is five times larger than the moderate.

CHAPTER SIX

6. CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Lake Tana is the largest lake in the country that can contribute about 50% of the fishery resource. The lake is said to have a great potential in its fishery resource. It is estimated that on average fifteen thousand metric tons of fish could be caught annually.

However, the Barbus species stock is declining from time to time suggesting that there must be regulations of fishing activities in the lake. Fishing practices during the spawning seasons and spawning places of this species are the major problems for the stock decline of this species. Moreover, plantation cover around the lake has been declining at alarming rate (especially in the Northern and Eastern parts of the lake). Agricultural activities are expanded rapidly around the shores of the lake in these areas.

Studies have been undertaken with regard to the biological aspects of the lake. The fish species composition, evolutions of the lake and its fish, and exploitation status of the lake have been studied previously by different researchers. But, the socioeconomic aspects of the lake, especially valuation of the lake and its fishery resource have not been undertaken to the best knowledge of the researcher. If information is required for better understanding and policy making in the utilization of the lake's resource, valuation has to be undertaken.

In this paper, the method of choice experiment was applied to value the Lake Tana fishery and watershed resources. Two environmental attributes – fishing control and lake side plantation were identified from the literature. In addition, a monetary attribute – payment for fishing permit was included in the choice experiment.

Multinomial and random parameter logit models were used for estimation. Marginal willingness to pay for the attributes was estimated. The results indicated that fishing control was highly valued as compared to lake side plantation. Ceteris paribus, respondents were willing to pay 15 birr per month for fishing control while they are willing to pay only 50 cents per month for lake side plantation. Furthermore, the socioeconomic variables age, monthly household income, family size, and years of education were included in the modeling. We find that monthly household income, years of education, and family size were significant determinants in affecting respondents' utility from changed situations in attributes. Monthly household income and years of education have positive impact while family size has negative impact on the probability of choosing an alternative scenario with improvements in attributes.

Respondents have suggested that in order to alleviate the problem of decline in the fish stock, at least three measures have to be taken soon. These are: use of poisonous materials (like 'birbra') has to be prohibited; the gillnet mesh size has to be regulated i.e. use of small size mesh has to be protected; and fishing control during the breeding season (and at breeding areas) has to be exercised.

6.2 Policy Recommendations

Lake Tana could contribute a lot in the food self-sufficiency program and in creating job opportunities had the resource been properly used and regulated. For sustainable utilization of the fishery resource, sound management system should be implemented.

Ethiopia's fisheries legislation has been approved and various activities were planned to disseminate the wealth of knowledge on Lake Tana's fisheries (de Graaf, 2003). However,

pronounced measures have not been taken till now on the management of the lake's fishery. It is necessary to have communication and cooperation with the fishermen in implementing the legislations and solving the problems.

The situation of the unique Barbus species is the most critical of the three most known species that are caught by the fishermen. To alleviate the threat of decline of the stock (even extinction) of Lake Tana's endemic Barbus species, protective measures have to be taken immediately. Effort control and regulation that could limit the gillnet fishery in spawning seasons and/or areas around the river mouths will prevent the possibility of a total disappearance of the Barbus species.

The results of this study suggest that fishermen are willing to pay for the improvements in the Lake Fishery and watershed management. They attached significant positive values for the fishing control attribute. This implies that fishing control could be easily exercised. Moreover, there is an opportunity to participate extension service agents and 'kebele' administrative staff, where necessary, in implementing this measure for sustainable utilization of the resource. As such, decisive policy measures could be designed and implemented for solving the problems.

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Appendix I: Questionnaire

Addis Ababa University

Department of Economics

A Choice Experiment Survey Questionnaire for Valuation of Lake Tana Watershed and Fishery Management

Name of Interviewer _____

Date _____

Code of Respondent _____

Interview Started at _____

Interview Ended at _____

Good Morning/Afternoon! Thank You in advance for giving time for the interview. I am _____, an interviewer for this survey designed by Fitalew A. who is studying at Addis Ababa University. Currently, he is conducting a survey which focuses on valuation of Lake Tana watershed and fishery management. The research is designed in partial fulfillment for the MSc. award in Economics. You are requested to give information on your perception and observation in the fishery activities and to indicate your preferred choice for the options that will be provided. The information you provide could help to have a common understanding about the problems in utilization of the Lake and its fishery resource. More over, it will enable to design an appropriate policy for the sustainable utilization of the Lake and its resources. Whatever information you provide will be kept strictly confidential.

Questionnaire

Part I: - Questionnaire for General Information

Q1. When did you start fishing? _____ E.C. How long did you stay in this activity? _____years

Q2. Have you additional occupations out of fishing? _____

1. Yes 2. No

Q3. If you have additional occupation(s), which of the following is/are? _____

1. **Farming**
2. **Cattle raring**
3. **Trading**
4. **Government employee**
5. **Others (Specify) _____.**

Q4. How many days per week are you going to fishing on average? _____ days How many hours do you spend per day on average? _____ hrs

Q5. How much of fish could you catch per day, on average?

In kilograms _____ In number _____

Q6. What types of fish are you catching? More than one choice is possible. _____

1. **Tilapia ('Kereso')**
2. **Barbus ('Nech assa')**
3. **Catfish ('Ambaza')**
4. **'Besso'**
5. **Others (Mention them) _____**

Q7. What type of fish species did you prefer to fish more? Please order!

1. **Tilapia ('Kereso') _____**
2. **Barbus ('Nech assa') _____**
3. **Catfish ('Ambaza') _____**
4. **'Besso' _____**
5. **Others _____**

Q8. What is the reason(s) for your order of preference? _____

1. **Higher demand from the consumers**
2. **Easy abundance**
3. **Other reasons (specify) _____**

Q9. What kind of fish species could you catch <u>more</u> in your efforts? _____

1. **Tilapia ('Kereso')**
2. **Barbus ('Nech assa')**
3. **Catfish ('Ambaza')**
4. **'Besso'**
5. **Others (specify)**

Q10. At what parts of the Lake or areas could you have more catches? Choose one!

_____

1. **Around/At the river mouths**
2. **At the Lake shores**
3. **In the open water**

Q11. In what seasons could you have chances of getting more fish? _____

1. **From July to September**
2. **From October to December**
3. **From January to March**
4. **From April to June**

Q12. In what seasons could you have chances of getting more Barbus ('Nech assa')?

_____

1. **From July to September**
2. **From October to December**
3. **From January to March**

4. From April to June

Q13. At what places could you get the largest catch of the Barbus ('Nech assa') during the chosen season? _____

1. Around/At the river mouths
2. At the Lake shores
3. At the open water

Q14. Did you know the reason(s) why you could fish more Barbus ('Nech assa') during those seasons and places you choose? _____

1. The Season is the spawning period for Barbus
2. The places are spawning grounds for Barbus
3. I don't know the reason
4. Other reasons (Mention) _____

Q15. How much could you earn from sale of caught fish on average?

Per week _____Birr

Q16. What factors do you think affect the Lake's biodiversity and its fishery resource? _____

1. Silt and sediment deposits
2. Water flooding to the Lake
3. Over fishing of endemic fish species
4. Waste matters
5. Other factors (mention) _____

Q17. It ahs been indicated by researchers that the Lake side plantations and wetland cover have been degraded. Do you agree with them? _____

1. Yes 2. No

Q18. If you answered 'Yes' for question 17, whom do you think are the major agents that create the problems? _____

1. **Fishermen**
2. **Farmers**
3. **Both Fishermen and Farmers**
4. **Other people**

Q19. In addition to the degradation problem, the stock of the Lake's endemic fish species (particularly the Barbus species) is said to decline from time to time. Do you agree with? _____

1. Yes **2. No**

Q20. If you answered "Yes" for Q19, what do you think the major factors for the stock decline of this species are? _____

1. **Water flooding and hence deposition of silt and sediment**
2. **Over fishing of the said species**
3. **Deforestation of the watershed plantation**
4. **All of them are the factors**
5. **Other factors (specify) _____**

Q21. In general, what do you perceive about the situation of the Lake side vegetation cover? _____

1. **No change is observed**
2. **Vegetation cover is declining**
3. **I didn't have any idea**

Q22. What is your perception about the fish stock availability? _____

1. **No change in availability**
2. **Fish stock decline is observed**

3. I didn't have any perception

Q23. Have you got a chance of participation in a workshop or training concerning environmental protection and conservation? _____

1. Yes 2. No

Q24. What suggestions do you have in solving the problems of stock decline of the Barbus species? _____

_____

Q25. It has been intended to take a measure to control fishing activities at the river mouths (particularly during the spawning season of the Barbus species). Will you agree? _____

1. Yes 2. No

Q26. More over, plantation of local trees like 'Dokma' 'sholla', and 'Chveha'; and papyrus, reed and grass, on the lake side as well as flood plains has been planned as a measure in reducing flooding (and hence sedimentation) problem. Will you agree with this plan? _____

1. Yes 2. No

Q27. The implementation of these proposed measures, however, requires the contribution of a payment from you. Do you have the willingness and ability to the contributions? _____

1. Yes 2. No

Q28. The association that you are a member of is: _____

1. St. Michael (No 1) Fishermen Association
2. Gorgora Fishermen Association
3. I am not a member of any

Part II: - Choice Experiment Questions

Scenario Description

You are randomly selected among the fishermen participated in fishing activities in Lake Tana to be the respondents in this survey. Here is a short description about the proposed programs (measures) to solve the problems in sustainable utilization of the Lake and its fishery resources. You are kindly requested to attend for the description attentively. This will help you to understand the choice sets that will be provided.

Lake Tana is a shallow lake with an average of 8 m and a maximum of 14 m depth. It is the source of the Blue Nile River. Five major & more than 40 seasonal small rivers flow in to the Lake. Those rivers flooding the surrounding land areas carry a heavy load of silt & sediment and deposit it in to the Lake. It has been indicated, for instance, that in the Northern part of the Lake about 5 km of the water body was displaced with silt & sediment deposits. The land areas around the Lake, particularly the Eastern and Northern parts of the Lake, are extensively used for agriculture and hence deforested. Agricultural activities – farming and cattle raring are expanding from time to time. The vegetation cover around the Lake shores and the wetland areas are degraded for the mentioned activities. Consequently, the fish habitats and the water quality are seriously affected.

Further more, among the endemic fish species of the Lake, the Barbus species are known to migrate in to the river mouths and upstream during their spawning periods. This happens particularly in the rainy season. Greater pressure of over fishing of the Barbus species is practiced during this season at the river mouths where the matured barbs are excessively caught. Loss of breeding grounds (due to deforestation and sedimentation) along with over fishing of the matured barbs results in the decline of recruitments and fear of extinction of this species. Note that, in addition to the nutritional values, the endemic species have significant roles in the sustainability of the Lake biodiversity. Hence, the decline (and thereof extinction) of such species will lead to the collapse of biodiversity of the Lake.

The local government has an intention to take measures that could mitigate those problems and reassure the sustainability of the Lake and its fishery resource. In order to accomplish this, various development options are proposed. The proposed options are:

1. Fishing control: - this is designed to solve the problem of Barbus stock decline. Fishing efforts focused at the river mouths and upstream **during the spawning periods of the Barbus species** (i.e. in the rainy season) will be prohibited. The alternatives are prohibition of fishing efforts only **every other week during July to September** or complete prohibition of fishing effort **during July to September**.

2. Lake side plantation: - this involves plantation of environmental friendly local trees 'Dokma', 'Sholla', and 'Chveha'; and papyrus, reed and grass families with equal proportions of each plant type. Plantation activities will be exercised on **flood plains** around the Lake and at **river mouths.** The mentioned land areas will be planted with those types of plants from the shores of the lake in your permitted areas for fishing. The **alternative widths** of plantation cover are **10 meters or 50 meters** from the shores of the Lake.

These programs will have two alternative versions as described: the aggressive and the moderate. In the aggressive version of the programs, the plantation cover will have 50 meters width from the shore of the Lake and fishing efforts will be prohibited during July to September at river mouths. In the moderate version, plantation cover will have 10 meters width from the shores of the Lake and fishing efforts will be prohibited in only every other week during July to September at river mouths.

However, it has to be known that the implementation of these programs costs money. The responsible authority will set appropriate mechanisms for implementation of the programs. There will be fishery management regulations in such a way that a payment is required to be legally participated in fishing activities. All the fishermen will be registered for fishing permit and will be licensed as long as they obey the rules and regulations set by the authority. For such circumstances, all the fishermen will be asked to pay an equal specific amount of money, on a monthly basis. The raised fund will help to finance the costs of

implementation of the proposed programs. Those fishermen not registered for legal participation will be punished if they are found in the activity.

N.B.: - It must be recognized that this survey is not part of the project. The study is designed to know the major problems in the sustainability of the Lake and its fishery resource. It aims at knowing the preferences of the fishermen for the different options in the fishery and watershed management activities. It focuses on having common understanding in solving the major problems in the Lake's resource utilization.

For the questions that follow, no 'Wrong' or 'Correct' answers are expected. What is required is the priority that you place for the different options provided. You will be asked to choose your preferred option. Please! Be careful in considering the attributes – Fishing Control, Lake Side Plantation, and Payment for Fish Permit along with their respective levels.

If you have any difficulty in understanding the options, don't hesitate to ask for further clarifications. In case you change your mind, feel free to go back and change your previous choice(s).

- **To the Interviewer: Now, Please show the Cards and explain what they represent. Don't forget that you have to help them in clarifying any doubt they may face in choice tasks.**

Which of the following options do you prefer **most**?

Choice Set 1

Attribute	Option 1	Option 2	Option 3
Fishing Control	Every other week	Every other week	No change
Lake Side Plantation	10 meter	10 meter	No change
Payment for F. Permit	40 Birr	25 Birr	0 Birr
Choose one, please!			

Choice Set 2

Attribute	Option 1	Option 2	Option 3
Fishing Control	July to September	Every other week	No change
Lake Side Plantation	50 meter	50 meter	No change
Payment for F. Permit	10 Birr	10 Birr	0 Birr
Choose one, please!			

Choice Set 3

Attribute	Option 1	Option 2	Option 3
Fishing Control	July to September	Every other week	No change
Lake Side Plantation	10 meter	50 meter	No change
Payment for F. Permit	25 Birr	40 Birr	0 Birr
Choose one, please!			

Choice Set 4

Attribute	Option 1	Option 2	Option 3
Fishing Control	July to September	Every other week	No change
Lake Side Plantation	50 meter	50 meter	No change
Payment for F. Permit	25 Birr	25 Birr	0 Birr
Choose one, please!			

Choice Set 5

Attribute	Option 1	Option 2	Option 3
Fishing Control	July to September	July to September	No change
Lake Side Plantation	50 meter	10 meter	No change
Payment for F. Permit	40 Birr	10 Birr	0 Birr
Choose one, please!			

Choice Set 6

Attribute	Option 1	Option 2	Option 3
Fishing Control	Every other week	July to September	No change
Lake Side Plantation	10 meter	10 meter	No change
Payment for F. Permit	10 Birr	40 Birr	0 Birr
Choose one, please!			

Follow up Questions

Which one of the following explanations could best describe the reason for your choices of the options?

1. **Just I want the aggressive options to be implemented**
2. **I exclusively choose the cheapest alternative whatever**
3. **The proposed measures were good but I didn't have the ability to pay and thus choose the status quo**
4. **I thought the fishermen have not to pay and thus choose the status quo**
5. **I found the Fishing Control attribute as preferred measure and thus make choices in accordance for its implementation**
6. **I found the Lake Side Plantation attribute as preferred measure and thus make choices in accordance for its implementation**

Part III: - Socioeconomic characteristics

- ***To the interviewer*: - Fill the table appropriately by asking the respondents**

Age	Martial Status 1. Married 2. Divorced 3. Single	Years of Education	Family Size	Average monthly household income		Average monthly household expenditure	
				Fishing	Others	Fishing activities	Other HH expenditures

Thank You, for All!

Declaration

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any other university, and that all source of materials used for the thesis have been duly acknowledged.

The examiners' comments have been dully incorporated.

Declared by:

Name: Fitalew Agimass

Signature: [signature]

Date: July 1, 2009

Confirmed by Advisor:

Name: Alemu Mekonnen

Signature: [signature]

Date: July 1, 2009

Place and date of submission: Addis Ababa, 2009