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Households' Willingness to pay for Water Hyacinth Control to Lake Tana, Ethiopia: An application of Contingent Valuation Method.

By

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Addis Ababa, Ethiopia

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A Thesis submitted to the Department of Economics Presented in Partial Fulfillment of the Requirement for the Degree of Master of Science in Economics (Resource and Environmental Economics).

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School of Graduate Studies

This is to certify that the thesis prepared by Tesfa Getnet, entitled: Households' Willingness to pay for Water Hyacinth Control to Lake Tana, Ethiopia: An application of Contingent Valuation Method and submitted in partial fulfillment of the requirements for the Degree of Master of Science in Economics (Resource and Environmental Economics) complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

CERTIFICATION

We, the undersigned, certify that we have read and here by recommend for acceptance by the Addis Ababa University, a thesis entitled **"Households' Willingness to pay for Water Hyacinth Control to Lake Tana, Ethiopia: An application of Contingent Valuation Method"** in partial fulfillment of the requirements for award of the degree of Master of Science in Economics (Resource and Environmental Economics) in Addis Ababa University.

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Abstract

Households' Willingness to pay for Water Hyacinth Control to Lake Tana, Ethiopia: An application of Contingent Valuation Method.

Currently, Water Hyacinth (WH) has become a growing problem in Lake Tana. Infestations of this weed have been, causing environmental, economic, and social problems to the riparian communities. This study uses a cross-sectional survey of 398 randomly selected households in Bahir Dar city, Ethiopia, to assess their willingness to pay (WTP) for Water Hyacinth Control to Lake Tana applining contingent valuation approach, and Considering hypothetical scenarios encircling different socio-economic variables. The Tobit regression model was used to analyze the socio-economic factors influencing urban households' WTP decisions for water hyacinth Control in Lake Tana. The results showed that household's were on average willing to pay the amount of 1011.436 ETB with a total contribution of 77,624,226.2 ETB for a one-time payment to clean water hyacinth from Lake Tana. Results reveal that residents' WTP for control of water hyacinth is significantly related to income, member of household's having job and awareness of water hyacinth, among other factors. The mean WTP that found can be a guide for municipal officials in setting a more appropriate fee that can finance cleaning up water hyacinth, where both regional and federal governments have co-operated.

Key Words: CVM, Household's, Tobit regression, Water hyacinth, WTP.

DECLARATION AND COPY RIGHT

I, Tesfa Getnet, declare that this Thesis is my own original work and that it has not been presented and will not be presented to any other university for a similar or any other degree award.

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Acronyms

ARARI	Amhara Regional Agricultural Research Institute
ARBA	Amhara Regional Bureau of Agriculture
ARBOEPLAU	Amhara Regional Bureau of Environmental Protection, Land, Administration, and Use
ARBT	Amhara Regional Bureau of Tourism
ARBW	Amhara regional Bureau of Water
ARCPA	Amhara Region Cooperative Promotion Agency
BDU	Bahir Dar University
CPUE	Catch per Unit of Effort
CV	Contingent valuation
CVM	Contingent valuation method
DC	Dichotomous choice
DCLT	Global Coalition for Lake Tana
DTURU	Debre Tabor University Research Unit
EEA	Europian Environmental Agency
EFCC	Environment Forest and Climate Change Commission
EFWPDANRS	Environment, forest and wildlife protection, and development of Amhara national regional state
ETB	Ethiopian Birr
FAO	Food and Agriculture Organisation
GERD	Grand Ethiopian Renaissance Dam
IAS	Invasive Aliens Species

IFAD	International Fund for Agricultural Development
IUCN	International Union for Conservation of Nature
MNL	Multinomial Logit
NGO	Non-governmental Organisation
NOAA	National Oceanic and Atmospheric Administration of US
OLS	Ordinary least square
OP	Open-ended
ORDA	Organization for Rehabilitation and Development in Amhara
PC	Payment card
RWHSC	Regional Water Hyacinth Steering Committee
SQ	Status quo
TEV	Total Economic Value
UN	United nation
UNEP	United Nations Environment Program
UOG	University of Gondar
USD	United State of Dollar
WH	Water Hyacinth
WTA	Willingness-to-Accept
WTP	Willingness-to-pay
ZWAARS	Zonal and Woreda administration of the Amhara Regional State

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Water hyacinth is an invasive aquatic plant that live, reproduce, and floating freely on the surface of fresh waters and can be anchored stolon in mud in the bottom of the water body and spread throughout vital freshwater bodies (Cilliers et. al, 2003). The size of the plant spans from an inch to a meter in height. Its rate of propagation under a certain environment is extremely rapid and it can spread out and cover large areas of water bodies causing a variety of problems and affect flora and fauna. Moreover, the plant has significant impact on water loss due to evapotranspiration (Patel, 2012). The weed also a major cause for biodiversity degradation and significant effects on reauction in resource availability (Chatterjee et.al.2015; Patel, 2012).

The native of the plant is Amazon Basin and spread to many parts of Latin America as an ornamental purpose due to its beauty. It is the most widespread and damaging aquatic weed in terms of its invasive potential, adverse impact on aquatic ecosystems and cost of controlling (Cilliers et. al, 2003). The plant is particularly suited to tropical and subtropical climate and has become a problem in several parts of Southern USA, Latin America, Eastern, Western and Southern Africa, South and South East Asia and Australia. It is spread throughout the world over the last 100 years but the actual course of its spread is poorly documented (Vila et. al, 2011, Cilliers et.al, 2003).

In Africa, water hyacinth was first reported in Egypt between 1879 and 1893 (Osienala, 1990). It is considered one of the most widely known weed in tropical West Africa (FAO, 2000). According to (UN, 1997) water hyacinth is an environmental disaster to the Central and Eastern region of Africa. The fast-spreading water hyacinth is introduced to some of the region's major inland waterways, threatening communities living on the shores of Tanzania, Uganda, and Kenya. The weed put pressure on world's biodiversity by altering ecosystem services and processes, that reduce the prevalence of native species, and decrease genetic biodiversity of the ecosystem (Rand et. al, 2010; Vila et. al, 2011 & Hejda et.al, 2009; Xu et al.2012).

The International Union for Conservation of Nature (IUCN) identfied WH as one of the 100 most aggressive and top 10 worst weed in the world (Téllez et al., 2008 & Shanab et al., 2010; Gichuki et al., 2012; Patel, 2012).In Africa WH is listed by law as a poisonous weed in several countries (Theuria, 2013), it is the most widespread and damaging aquatic plant. The economic impacts of the weed for seven African countries have been estimated between USD 20-50 million every year .For example in South Africa (1908), Zimbabwe (1937), Zaire (1957), Sudan (1957); Senegal (1964), Nigeria (1983) and Uganda (1987) (Osienala, 1990) and across African countries, the economic cost of water hyacinth is as much as USD100 million annually United Nations Environment Programm (UNEP, 2006).

In Ethiopia, around 35 invasive alien plant species exist including water hyacinth. Thus weed posing threat to economic, social and, the environmental livelihood of the riparian community and, ecosystem health of environment (Rezene et.al, 2014). They may completely change biological communities and ecosystem structure and processes in terms of food web structure and energy flow. Water hyacinth was first reported in South-Central Ethiopia in1965 in Koka Lake and the Awash River (Fessehaie, 2012). But it spread fast in the Country on a large scale in many water bodies including Awash River Basin (Koka Lake, Koka Dam), Abbay River Basin (Lake Tana, Blue Nile), Baro-Akobo River Basin (Sobate, Baro, Gillo and Pibor rivers) and Rift Valley Basin System (Lake Abaya, Lake Elltoke), creating serious problems for the use of the water as a resource (Rezene, 2005; Taye et al., 2009) and other parts of the Country include Gambela Region, the Blue Nile from just below Lake Tana into Sudan, and Lake Ellen near AlemTena (Adugnew et.al, 2017).

Organization for Rehabilitation and Development in Amhara (ORDA), Bahir Dar University (BDU), Amhara Regional Bureau of Environmental Protection, Administration and Use (BOEPLAU), Global Coalition for Lake Tana,Debre Tabor University Research Unit (DTURU) ,Environment Forest and Climate Change Commission(EFCC), Regional Water Hyacinth Steering Committee (RWHSC), Environment ,Forest and Wildlife Protection and Development of Amhara National Regional State(ANRSERWPD) Amhara Regional Bureau of Agriculture (BOA), Amhara Regional Bureau of Tourism (BOT), Amhara regional Bureau of Water (BOW), Amhara Regional Agricultural Research Institute (ARARI), Amhara Region Cooperative Promotion Agency (CPA), Zonal and Woreda administration of the Amhara Regional State, and

University of Gondar(UOG) aim to control this weed at local and national level(Wassie et al., 2014).

However, in the case of Lake Tana, its occurrence has been reported officially as one of the top ten ecologically dangerous and worst infestation since 2011 (Ayalew et al., 2012; Wassie et.al,2014). But, the exact source of water hyacinth infestation of Lake Tana is not well known. The first infestations were found near the mouth of the Megech River on the northern shores of the lake (Ayalew et al., 2012).

The coverage and the expansion of water hyacinth was 10 hectare in 2011 at the mouth of Megech River with the lake. In the same year, 2011 and 15 kebeles were immediately infested by the weed and covered 20,000 hectares Two years later, the estimated coverage of the weed doubled from 20,000 to 40,000 hectares (Wassie et.al, 2014). But weed covrage to the Lake is estimated around 50,000 hectares (Solomon, 2018) in the current perid (2011). But the coverage level of water hyacinth is differing in degree in different areas of the Lake. In Dembia Woreda is higher than Fogera, Libo kemkem, and Gondar Zuria Woredas. Dera Woreda has the least areal coverage of water hyacinth than other Woredas. For those Woreda agricultural activities, product of the farm crops and fish production (decreased and lost by 75 percent) is highly affcted the weed in recent year (Ayalew et al., 2012).

As aresult, the local communities are infected by snakes, hippos, and other dangerous insects like a leech. Especially, fishermen are facing different problems like hindrance to water navigation, water flow, recreational use of aquatic systems, and poses of mechanical damage to hydroelectric systems,blockage of canals and rivers, (Senayit et al., 2004; Taye et al., 2009).

A floating mat of water hyacinth is a precondition for reproduction (breeding) system for pests and vectors) of organisms that are harmful to human health (Minakawa et al., 2008, Chandra et al., 2006, Varshney et al., 2008, Borokini & Babalola, 2012). To day Water hyacinth is a serious problem to Lake Tana but, the federal government has not yet given due attention to the problem.

1.2 Statement of the Problem

Lake Tana has been registered as a biosphere reserves site as rich in biodiversity (Edward ,20130). The Lake is very important both internationally and nationally for its enormous water resource potential for hydropower generation and irrigational development (Wassie et.al, 2014). Currently the Lake supports approximately 123 million people in the Nile Basin (Yimenu, 2005) and the source of Blue Nile River that contributes 60 precept of the water (McCartney et al., 2010). The Lake also play important role in the Ethiopian economy with about USD1.1 million annual value of fish production and source of income for the riparian communities (Solomon, 2018).

Today LakeTana faces multiple problems that recognized officially one of the top ten ecologically dangerous and worst invasive weed (WH) infested it (Wassie et al 2014). The Amhara Bureau of Environmental Protection, Land Administration and Use (BOEPLAU, 2015) reported as the weed affected the Lake opration of 63.06 percent of the Lake volume reducetion, 25.87 percent pollution of the Lake and 5.02 percent of Lake Water quality and fish species were reduced due to its infestation.

The propagation rate of WH is due to the existence of stagnating water bodies and absence of natural enemies (Khatri et al, 2018). Essentially, colonization of WH is might be a shortage of dissolved oxygenas a result of less sunlight below the water surface which, may put at a risk to aquatic life, that creating both an ecological and economic cost burden (Richardson & Loomis, 2009). The mats of the weed totally blocked the transfer of oxygen from the air to the water bodies' and clogging hydropower generation activities (Villamagna & Murphy, 2010). The decomposing biomass to the bottom part of the water surface the decreased oxygen content and catalyze to release phosphorus from the sediment which in turn accelerates eutrophication and can lead to a subsequent increase in water hyacinth or algal blooms in the water body (EEA, 2012; Bicudo et al., 2007). This results in deteriorate water quality and increases treatment costs for drinking water and financial losses act as an obstacle to positive economic change or growth (Khatri et al., 2018; Patel, 2012, Mironga et al., 2011, Ndimele et al., 2011). The adverse

environmental and economic effects of the weed estimated at 120 billion USD (Pimentel et al., 2005; & Kettunen et al., 2009). Principally water hyacinth degrades ecology of the environment and finally causes to biodiversity loss and economic losses (Mirongaet al., 2014; Rai & Scarborough, 2013; Pimentel et. al, .2005; Ndimele et al., 2011; Patel, 2012; Villamagna & Murphy, 2010).

Despite the fact that free grazing of wetlands and recession of agricultural land that seems to degrade buffer zone,that leads to (1) rivers flow in to the lake are recipient of different sort of wastes such as heavy loads of soil sediment, drain pesticides, urban pollution, nutrients of fertilizer pollutant chemicals from agricultural land and (2) discharging of municipal solid waste without treatment, from Gondar city (100 percent) to Megech river and from Bahir Dar city (80 percent) to Abay and 20 percent to the Lake that aggravate and facilitates the speared or the expanstion of WH in Lake Tana (Wassie et.al, 2014). For the individual fisherman, the hyacinth mats reduced their catch by covering fishing grounds, increasing fishing catch time and causing loss of nets. Furthermore, the catch per unit of effort (CPUE) of Labeobarbus fish in lake had sharply declined to 6 kilograms/trip in (2010) compared with in (2001) 28 kilograms/trip and in (1991-1993) 63 kilogram/trip due to decomposition of the weed that caused massive algal blooms intern affected the taste and quality of the fish and fishermen were changed their landing site and unable to sell the fish product in the market which reduced their income (Edward, 2013).

In general, researchers argued the reduction in volume of the lake due to the infestation of water hyacinth. Unless the infestation is halted soon, it will affect the part of the lake which is the source of the Blue Nile endangering the Grand Ethiopian Renaissance Dam (GERD), built along the river (Solomon, 2018). Despite, the fact that ecosystems are placed under considerable stress, at some stage; economic thresholds may be reached. This would result in a drastic loss of resource value, causing high mitigation costs and highlighting the value of a functioning, resilient ecosystem (Charles, 2007).

However, households' willingness to participate and contribute in the effort to control water hyacinth is not known until it is assessed by research on household's willingness to pay to alleviate the problem. Households Willingness to pay depends on a number of demographic, socio-economic and environmental factors.

Studies on the willingness to pay for water hyacinth control in the world were only Charles, 2007, Khatri et al, 2018 & Otieno et al, 2019. These studies identified the factors that affect households' willingness to pay for water hyacinth control. For instance, factors that significantly affect households' willingness to pay are distance from the bank of the water body, recreational activities to the lake affected by water hyacinth, prior knowledge of the problem (Charles, 2007); Household expenditures, assistance received and occasional presence of a household member who has visited the lake (Khatri et al ,2018).

To best of my knowledge, studies on households' willingness to pay for the control of water hyacinth to Lake Tana and other parts of the region of our country are not yet to be conducted. Protecting the health of the lake is imperative to ensure a continuous flow of the ecosystem services the lake provides to the local communities, the country and millions of people in downstream Nile basin countries. Thus, conducting a study on water hyacinth control to Lake Tana is crucial in order to create a healthy Lake environment for the residents of the city and riparian community. Therefore, this study will address the following research questions.

I. What is the attitude of households' towards water hyacinth control action in Lake Tana?
II. What are the factors influencing willingness to pay of households' for water hyacinth control in Lake Tana?
III. How much money households' are willing to pay for water hyacinth control to Lake Tana?

1.3 Objective of the Study

The main objective of this study is to investigate the Household's willingness to pay for Water Hyacinth control in Lake Tana.

The specific objectives are to:

- ✓ Assess attitude of households for water hyacinth control in Lake Tana.
- ✓ Identify factors that affect households' willingness to pay for water hyacinth controlling.
- ✓ Estimate the amounts of money households are willing to pay for water hyacinth control to Lake Tana.

1.4 Significance of the Study

The study will extract information on the preference of households for water hyacinth control. Stakeholders, governmental and non-governmental organizations, whose target is aquatic environment protection to make appropriate decisions and can design appropriate policy to address the problem based on the preferences made by the respondents aiming at controlling the spread of water hyacinth in Lake Tana.it is important for the city administration of Bahir Dar city to have some benchmarks or clues to formulate lake Sanitation programs and also have significance for the surrounding community to make them be conscious enough to preserve resources and keep up their economic value This will reduce the negative impacts of existing infestations on the Biodiversity losses of the Lake.

1.5 Scope of the Study

The study is geographically delimited to Lake Tana. The study will restrict to urban households of Bahir Dar city due to the proximity of the City to the Lake.

1.6 Organization of the paper

In addition to introduction this paper contains five chapters. Chapter two is a review of literature. In the third chapter Methodology of the study that included models for estimation, sample sizes, target population, research design, and questionnaire development are explaining. In the fourth chapter, the descriptive analysis and results of the models are discussed in detail accompanied by conclusions and policy implications in the fifth chapter.

CHAPTER TWO

RELATED LITERATURE REVIEW

2. 1 Theoretical Literature

2.1.1 Evolution of Water Hyacinth

An ornamental property, (sometimes for feed) of the weed is the main reason for the worldwide distribution in generally (Ding et al., 2001). WH has invaded freshwater bodies of five continents over 50 countries. Especially its spread widely throughout South-East Asia, the Southern United States, Central, East and Western Africa and Central America (Lu et al, 2007; Gomez, 2007). Water bodies of tropical and sub-tropical were more exposed to WH infestation due to nutrient levels are often rich, agricultural runoff, deforestation and insufficient wastewater treatment (Kelly, 2009; Chikwenhere et al., 1999). People and common pasture or joint use of resource watersheds were the primary causes for the spread of the weed around the world (Center et al, 2002 and Cilliers et al, 2003& Lu et al, 2007). In general, both intentional (ornamental) and unintentional (rivers flowing from one country to another) interoductions of WH was have been occurred throughout Africa.

According to Center et al., 2005, & Gopal, 1987, and several schools of thought the native or the actual point of origin of WH were in South America includes in Argentina, Brazil, Paraguay, Uruguay, Bolivia, Ecuador, Colombia, Chile, Guyana, Surinam, and Venezuela. In North America, it is believed that it has been introduced in 1884 at the Cotton States exposition in New Orleans, Louisiana. It is frequently spread across the south-eastern part of the United States to Florida in 1895 and California in 1904. It is more prolific in the south-eastern region as well as being recorded in Hawaii.

WH infestation in Ethiopia has been manifested on a large scale in many water bodies of the country. The weed is believed to have been introduced by people for decorative purpose. It was officially reported in Ethiopia about 55 years ago in Koka Lake and the Awash River (Stroud, 1994). The introduction and rapid spread of this weed in the Awash River Basin(Koka Lake, KokaDam), Abbay River Basin(Lake Tana, Blue Nile), Baro-Akobo River Basin (Sobate, Baro,

GilloandPibor rivers) and Rift Valley Basins system (Lake Ellen, Lake Abaya, Lake Elltoke),Gambella area,and Lake Tana (Stroud, 1994;Rezene,2005; Taye et al., 2009). According to (Edward, 2013) the exact source of water hyacinth infestation to Lake Tana is not well known but some schools of thought postulate that the weed could have come to through importation of used fishing gears, second-hand agricultural inputs, and fishing boats from Sudan and other neighboring countries.

2.1.2 Ecology and Habitat of water hyacinth

WH occurrence is mostly in acidic and alkaline waterbodies. But maximum growth of the plant is determined by the nearness of neutral water bodies (Gopal, 1987; Levine 2000; & McNeely et al. 2001). Under the optimum circumstance, a hectare of WH plant could absorb an average daily nitrogen and phosphorus waste production of over 800 people. WH causes disturbances in aquatic systems water flow by retreading it by 40 percent to 95 percent in irrigation channels. It is widely documented as one of the primary causes for the loss of biodiversity and can have significant suppress effects on resource availability and aggravating the existence of non-indigenous invasive species in relative to abundance (Didham et al., 2005).

WH can be found not only in Ethiopia but all around the globe in a variety of different habitats. These include habitats from shallow ponds, possibly temporary, to large lakes and even fairly fast flowing rivers and canals (Gopal, 1987; Mironga et al., 2011& Eichhornia et al., 2011). It grows and spread rapidly in freshwater bodies and can withstand extremes of nutrient supply, PH level, temperature, and can even grow in toxic water. WH invasion is facilitated by water bodies that are enriched by agricultural, chemicals, sediments from catchment erosion, domestic effluents and plant nutrients. Where the plant is situated in shallow water bodies it does not have to contend with excessive wave action and varying depths of water (Eichhornia et al., 2011). The velocity or speed of water in river flow and change of climatic conditions also plays a key role in the plant habitat vary within a system and have been an effect on the ecology of the plant itself. Water hyacinth can be located in both natural water and aquatic systems.

However, it does not occur in aquatic systems when an average salinity greater than 15 percent of seawater (Jones, 2009). WH is able to absorb high levels of nutrients from the water, that influences the plant‘s growth in or near to a sewage outlet, compared to those plant‘s established

in a low nutrient habitat (Tacio, 2009; Varshney et al., 2008). The root system, as well as the above water structures of the plant, forms a habitat for organisms. The feathery root structure of WH provides suitable habitat and substrate for some specific plants (Varshney et al., 2008, Borokini & Babalola, 2012). In addition, a large variety of invertebrates are particularly associated with the roots hanging in the water as they provide habitat, and may possibly trap them from the water column. In some cases, a few organisms have been reported to be specifically associated with water hyacinth mats. Water hyacinth mats also provide a suitable habitat for germination and establishment of the seedlings of a number of emergent species (Gopal, 1987; Sotolu, 2013; Firehun, 2014).

2.1.3 The Impact of water hyacinth

WH infestation has large and widespread impacts, for millions of the ripariancommunities and resulting in high ecological, social, economic and environmental cost problems (Mailu, 2001; Perrings et al., 2002; & Pimentel et al., 2005). Most commonly documented effects of WH are that lower phytoplankton productivity and dissolved oxygen concentrations beneath mats and the physicochemical characteristics of the water, in general, are declines in temperature, Phvalue of water,biological oxygen demand(organicload),and nutrient levels (Mironga et al., 2011;Onyango, C.O., et al, 2018 & Opande et al., 2004; Frezina, 2013). WH is a growing threat that, causing losses in biodiversity, changes in ecosystems, and impacts to economic enterprises such as agriculture, fisheries, power production, and international trade (Opande et al., 2004). The costs of controlling for water hyacinth are not well understood or documented, but estimates indicate that the costs are quite high, in the range of millions to billions of dollars per year (VanWyk & van Wilgen, 2002; Cilliers 2003,& Jones 2001).

2.1.3.1 Ecological impact of Water Hyacinth

Depend upon the environment WH has an excellent ability to take up nutrients and other chemical compositions. It has mixed effects on zooplankton abundance and diversity (Levine, 2000). Zooplankton abundance tends to decrease in response to phytoplankton availability, but populations may increase in response to increased refuge from predators. Macro-invertebrate abundance and diversity generally increase in response to increased habitat heterogeneity and structural complexity provided by water hyacinth (Villamagna, &Murphy 2010).

WH mats degrade water quality by blocking photosynthesis, which greatly reduces oxygen levels in the water (Villamagna, 2010). The introduction of weed to the beach of the lake has caused significant ecological alterations in the surrounding ecosystem community, due to weed being functionally different from native species (TOFT et al, 2003). The existence of high WH coverage in water bodies that form large colonies and can clog waterways, which prevents the movement of boating, fishing, and other water activities. Mats of the weed block sunlight from reaching submerged plants below, and create stagnant water conditions that attract mosquitoes (McNeely et al. 2001). The ecological impacts of WH on water ecosystems vary significantly depending upon, the extent of the invasion, and the vulnerability of the ecosystem being invaded (Wilcove et al. 1998; Levine, 2000; McNeely et al. 2001 & Meyerson et al, 2005) and reduce the abundance of native species through alteration of ecosystem structure and processes (change food web structure and energy flow).

WH infestation affects the functioning of ecosystems by changing the availability of the existing resources and change soil processes (Liao et al, 2008), impacts on native species richness and underpin human well-being, including provisioning of food and fiber; regulating the spread of human diseases; and providing aesthetic,recreational,and tourism benefits (Pejchar et al,2009 &Kettunen et al ,2009).

2.1.3.2 Economic impact of water hyacinth

The economic impacts of WH broadly categories in to two: market impacts (changes in prices of goods and services), and non-markets impacts (changes in ecosystem services) market impacts imply reduced productivity of commodities sold within the marketplace such as in fisheries and aquaculture production, within the marketplace (Pimentel,2002). Robustness of the seeds of water hyacinth caused a physical interference with fishing obstruction of shipping routes and loss of water in irrigation system due to high evapotranspiration(Lovell et al, 2005) its impact are not restricted to the ecosystem but, it has significant economic and commercial losses to great lake fisheries.

According to (Firehun et al., 2014) WH reduced fish catches rate, Increase in transportation costs, difficulties in electricity generation, Difficulties in water supply and blockage of irrigation canals, Effects on tourism activities and government budget Percentage of overall responses.

The cost of aquatic weed is estimated around hundreds of thousands of dollars a year to tens of millions of dollars a year (Mailu, 2001). Government of Florida, spend millions of dollar millions of dollars in a year to WH control; finally getting the plant under "maintenance control" has greatly reduced that expenditure (Lovell et al, 2005). Comprehensive local estimates of economic impacts of water hyacinth in the affected areas of the Ethiopian water bodies have not been done yet, except for the Wonji-Shoa Sugar state which incurred about USD 100,000 in total from 2000 to 2013 for the control of this weed (Firehun et al., 2014). The weed also reduced fish catches, increase in transportation costs, difficulties in electricity generation and water extraction, reduction of tourists, blockage of irrigation canals (Mailu, 2001).

The high shading and oxygen depletion by the hyacinth mats reduced biodiversity and primary fish productivity, throughout the entire food chain. This reduces fish stocks by interfering with other plants on fish feed. According to (Onyango, C.O., et al,2018 & Opande et al., 2004) when WH infestation is present, access to fishing sites become difficult for riparian communities which rely solely on fishing as their main economic activity. Similarly, a study by Frezina (2013) also reported that WH can present many problems for the fishers. On the other hand, WH provides highly complex habitat structure by restricting the growth of other submersed macrophytes. This modification and habitat complexity at the surface of the water is likely to affect fishing. In the area of severe infestation, especially around the shore area fishing is therefore too much difficult. This results in blockage of fish landing sites and destruction of fishing gear (Opande et al., 2004). Hence, as much as WH is viewed; it has had a negative impact on fishing, as it causes difficulty in fishing (Waithaka, 2013; Otieno, 2014). It greatly affects fish catch rates in Lake Tana, because the mats block access to fishing grounds and clog eye of the net. As a result, fish production in the Lake especially in Eastern shore has been declined (Ayalew, 2012). According to (Erkie, 2017) the catch per unit of effort (CPUE) of Labeobarbus in 2010 had dropped to an alarming 6-kilogram/trip in comparison with 28 Kilogram/trip in 2001 and 63-kilogram /trip in 1991-1993 (63-kilogram/trip). Similarly, Aloo et al., 2013 reported that due to anthropogenic activities and the newly emerged WH affect landing site and income-generation from the sale of fish.

2.1.3.3 Environmental impact of water hyacinth

On earth, WH is listed as one of the most productive plants and the worst plant in the world (Epstein, 1998). The size of the plant (WH) multiplied in every 5 days and the mats of medium plants of WH contain 2 million plants per hectare that weigh around 270 tons to 4000 tons. The dens mates of the weed affect navigation, recreation, irrigation and power generation in order to cleared water hyacinth from hydropower schemes that consume significant time and money. Blockage of canals, dams, and rivers by WH mats can even cause dangerous flooding (Malik, 2007). On the other hand scarcity of water comes from evapotranspiration of due to hyacinth mats and that leads to decreased fish population (Mbula,2006; Mironga,2004) decline in diversity and abundance of aquatic life, and water quality, increased water loss, increased siltation, increased the potential for flooding Percentage of the overall response. In Zambia, the extensive proliferation of WH has threatened the important economic infrastructure such as Road Bridge, which accounts for about 80 percent of Zambia's international trade through Dam responsible for 60 percent of the country's hydropower requirements (Thomson et al., 2002).

The weed has also been reported to impact negatively on the health of the communities. It provides habitat for vectors of malaria and bilharzia, and it harbors poisonous snakes, the decline in water quality, water loss through evapotranspiration, siltation, increased the potential for flooding and a decline in the diversity of aquatic life (Mailu, 2001). It is suspected to transmit amoeba, dysentery, and typhoid and to cause severe skin rashes. Its roots turn water muddy and dirty, making the water supply unsuitable for drinking and for other domestic uses. This impact poses an additional burden on the limited health services and facilities available to poor rural communities.

2.1.3.4 Social impact of Water Hyacinth

The dense mats of WH in stagnant water bodies can serve as a breeding ground and habitat for vector organisms that carrying malaria, bilharziosis, flies, snails and other organisms associated with human illnesses, including, encephalitis, filariasis, and cholera (CABI, 2015). The weed also impedes the recreational use of rivers and lakes (Mujingni, 2012).

People working in infested areas of WH is a risk of catching water born disease especially schistosomiasis and also social impact including lack of clean water, migration of communities,

social conflict, and difficulty in accessing water accessibility. Change in density of WH has the potential to a negative effect depending on designated or beneficial uses of water body on ecological and human communities in areas where it is established. in Africa infested water bodies due to water hyacinth include Lake Malawi, the Zambezi River, Tano Lagoon, River Niger in West Africa, Incomati River in Mozambique, Kafue River in Zambia, Pangani River in Tanzania and Lake Naivasha in Kenya (Mailu, 2001).

"*Fishers, riparian communities, Institute of Biodiversity, National Agricultural Research Institute, and Water Resources, Ministry of Agriculture and Environmental Protection Authority were identified as the organizations and communities affected by this noxious weed. Similarly, other studies have indicated that the weed poses a great threat to agriculture, fisheries, transportation, hydro-electric power generation, health and the environment*" (Mailu, 2001 pp, 133).

As reported by the communities living around the affected water bodies, the impact of WH gets higher whenever there were mats. The most noticeable impacts include: restricting proper water flow, water loss through excessive evapotranspiration, interference with fishing, grazing and crop production activities (accessibility to land water hindered), the effect on power generation, increase siltation, flooding, increase the cost of production and effect on native plants (Wassie, 2014).

2.1.3.5 Potential Use of Water Hyacinth

Beyond the negative impacts of WH, it has many potential uses for assets of the environment (Tacio, 2009). For example in Serbia the weed used as wastewater treatments that have high potential in removing a vast range of pollutants from suspended metals, organic matter to heavy metals and pathogens. It also used to tends to eliminate all other living organisms in surrounding since they are the most notorious worldwide weeds that when we introduced into aquatic ecosystem it spreads very quickly and high reproduction potential. For , wastewater treatments WH also used for,profitable crop production such as papermaking products by small scale cottage industry and production of rope in the form of fiber from the steam of water hyacinth in Bangladesh ,Philippines(dried and used to make baskets and matting for domestic use) , Indonesia, and India,Charcoal ,sewage systems water purification either for drinking water,

aerobic bacteria to function production for organic fertilizer or composting to agricultural input (green manure) in Kenya ,good feed for fish and pigs in China(Tacio ,2009).

WH is a global threat to biological diversity and ecosystem functioning (Cilliers 2003, & Jones 2001). Management of most aquatic plant species depends on properly identifying the desirable or nuisance plant. For instance, if eradication of this notorious weed is not possible, then the feasibility of using this plant as an alternative energy resource i.e bio-ethanol and briquette can be considered (Tacio, 2009). As aquatic plants do not compete with land resources used in arable food crop cultivation and thus are an incentive factor when it comes to biofuels production. Natural aquatic plants population can be healthy for any aquatic ecosystems as they serve as fish feed, play an important role in nutrient cycling, purify the water, control unwanted algal growth and support fauna including birds, biodiversity conservation and sustainable use of natural resources so that water hyacinth could be viewed as an asset of multifarious benefits considering the revealed highlights rather than been labeled expensive nuisance (Sotolu, 2013).

Roughage of WH is an alternative to reduce the shortage of animal feed (Mujingni, 2012). The dry matter basis of water hyacinth contains 20 percent of protein contents which is good roughage for ruminants. In developing countries, small scale composting (i.e aerobic decomposition and biogas) from water hyacinth is main interest due to lack of infrastructure and capital (Stephen et al., 2005; Christie et al., 2004).

2.1.3.6 The Economics of Environmental Goods and Services

To determine the value or benefit of clearing alien invasive species (AIS) it is necessary to take into account the loss of environmental goods and services that would have been incurred if the invasion were to continue. For that, estimates are needed of the levels and rates of invasion and methods that accurately place economic values on environmental goods and services (Turner et al. 2003).

In order to conceptualize the idea that environmental goods and services have financial value, it is necessary to consider these goods and services to be associated with what the environment produces for current and future human consumption. Ecosystem functions are the structures that provide those goods and services at given quality levels. With functions such as water

purification, for example, the value associated with any given quantity of water will also depend on the quality of that water (Moran, 1994).

Turner et al. (2003) defined the two classes of environmental values. These are anthropocentric value and non-anthropocentric value. According to Him, the combination of the two gives an estimate of Total Economic Value. If we assessing the impact of invasive alien species in a good manner that leads to account Total Economic Value of biodiversity; however this assessment is not completely accepted by ecologists due to the weak links of the concept of goods and services with biodiversity (Turpie, 2004).

According to Turner et al., 2003, total economic value (TEV) includes both use values, options value (anthropocentric) and non-use values, which incorporate existence value and bequest value (anthropocentric and non-anthropocentric).

We have two classes of use values in resource which is direct use values that incorporate all actual uses (goods) and indirect use values that is ecosystem functions (services) .the values of environmental goods and services that not succeed in accomplished through current of future consumption such as existence value (specific aspects of environment) is classified in nonuse values (Pearce &Moran, 1994).

According to Humphries et al. (1995), ecosystem stability and survival are determined by the existence of nonuse values of environmental resources. The multi-dimensional and interconnected use of nature is in monetary terms. Towards the component parts of the ecosystem that ensure survival and its value has limited scientific knowledge (Turner, 2003).

Although it is not possible to assign a comprehensive value for any given level of biodiversity, the concept of Total Economic Value goes a long way not only towards valuing the aspects of an ecosystem that provide direct use value, but also to include an estimate of the value of the functioning of the ecosystem. Although there are a number of methods available that attempt to value non-use environmental goods and services, valuation of ecosystem functioning is an altogether more complicated exercise that would facilitate a more comprehensive estimate of the value of biodiversity.

2.1.3.7 Economics of Biodiversity

Today economists give more emphasis to conservation and protection of natural resources due to increasing recognition of negative impacts of human activities particularity through habitat destruction that focused on the concept of biological diversity, or biodiversity (Weikard, 2002; Simpson, 2002). We do not know the true number of species on earth, even to the nearest order of magnitude. But, Scientists estimated that the absolute number of species falls between 5 and 30 million, although some scientists have put forward even higher estimates, up to 50 million.

"The total variability of life on earth" which incorporates the interaction between different species to adapt the environment at different scales or more broadly as the total range and quantity of biological variability, including species numbers and population sizes, at all levels of existence from the genetic level to the species and community levels which is known as Biodiversity (Simpson, 2002; Heywood et al., 1995; Heal, 2004; Simpson, 2002; Fromm, 2000).

The capacity to define biodiversity at the accurate term is limited because the nature of the natural environment and the varying benefits that are received from it is more complex. So this largely accounts for the number of definitions of biodiversity, and conflicting views regarding biodiversity and its importance (Simpson, 2002; Weikard, 2002).

Human's beings are directly or indirectly depend on the environment or natural systems to produce a wide variety of ecosystem goods and services, ranging from direct use of certain species for food or medicines to ecosystem functions that provide water purification, nutrient retention or climate regulation to current or future consumption. To straggle the nature species also interacting each other that Threats to biodiversity which include habitat loss and fragmentation, the introduction of nonindigenous species(water hyacinth), over-harvesting, pollution, changes in geochemical cycles and climate change. The loss of biodiversity affects human welfare as well as being lamentable for its own sake. Sustaining biodiversity in the face of increasing human populations and increased human economic activity promises to be a major challenge. Therefore, the conservation of biodiversity is a major environmental issue, one that promises to remain at or near the top of the environmental agenda for the foreseeable future (Stephen et al., 2005).

The holding capacity of the given environment depends upon the various human activates. When the activity (human) exceeds than the environmental holding capacity, it results in environmental degradation, This decline will reduce the value generating capacity of biodiversity, in other words, environmental degradation represents a decline in the value of biodiversity (Christie et al., 2004).

2.1.3.8 Values of biodiversity

There are gaps in our knowledge, many of which will have to be led by joint endeavors between economists and ecologists. We certainly need to know more about how biodiversity contributes to society. Ecosystem services and natural capital provide a helpful paradigm here. The stock of natural capital, which consists of ecosystems and earth's basic biogeochemical cycles to which they contribute, provides services such as stabilization of the climate within a comfortable and agriculturally productive range (Heal, 2000). Beyond intrinsic value, biodiversity plays a great fundamental role as ecosystem services in the maintenance of natural ecological processes. Asutilitarianviewhuman being Spreading upon values of biodiversity-ecosystem products that nature can provide a variety of organisms at all levels, from genetic variants belonging to the same species through arrays of different species; as well as the variety of ecosystems, encompassing ecological communities in a given habitat and the physical conditions and variety of life forms occurring in nature, as a result of evolutionary history therefore, known as biodiversity or biological diversity. The values of biodiversity Emphasizes to Anthropocentric values (economic or utilitarian values of biodiversity), Aesthetic value (humans seeking contact with nature), Mitigation and compensation values (Conservation of biodiversity due to human activities impact on environment), Market valuation (benefits generated by biodiversity), Political value and Scientific value (CJR, 2008).

According to the Food and Agriculture Organization (FAO),"biodiversity encompasses the: variety and variability of plants, animals and micro-organisms, at the genetic, species and ecosystem level, that are necessary to sustain the key functions of the agro-ecosystem, including its structure and processes for, and in support of, food production and food security"PP 9 (Dasgupta, 2000*).*

This defines biodiversity partly in terms of its contribution to economic production. Biodiversity has economic value; it can be assumed that a loss can be associated with economic costs. However, to date, there has been no comprehensive valuation of biodiversity that has been developed, largely due to the limited level of understanding of biodiversity, and its value-generating functions.

2.1.4 Methods of Environmental Valuations

Environmental valuation is largely based on the assumption that individuals are willing to pay for environmental gains and, conversely, are willing to accept compensation for some environmental losses. The individual demonstrates preferences, which, in turn, place values on environmental resources. Environmental economists have developed a number of market and non-market-based techniques to value the environment.

According to Pearce and Turner (1994), environmental valuation can be broadly classified into two kinds of methods: Revealed preference and stated preferences. Revealed preference techniques rely on the analysis of market price (observable behavior). On the other hand, stated preference techniques are based on individuals 'responses to surveys and questionnaires relating to hypothetical situations.

As cited by Rolfe et al., 2004, there are two broad methods of environmental valuation techniques as far as ways of estimating the economic values attached to non-marketed good and bad services. These are known as revealed and stated preference methods. Revealed preference methods (approaches) identify the ways in which a non-marketed good influences actual markets for some other good, i.e. value is revealed through a complementary market and that rely on data obtained from actual behavior of consumers. But, stated preference approaches are based on constructed markets, i.e. they ask people what economic value they attach to those goods and services. In fact, the values of environmental resources valuation using stated or revealed preference techniques depend up the two characteristics of methods. The first characteristics are whether the data comes from observation of people acting in a real-world setting where people live with the consequence of their choice or comes from people's response to the hypothetical question of the form what would you do if...? Would you be willing to pay…? The second characteristics are whether the method yields a monetary value directly or whether monetary

values must be inferred through some indirect technique based on a model of individual behavior and choice. While stated preference data are collected through surveys, where people state what their choices would be in a hypothetical scenario. Contingent valuation, choice experiment, ranking, and rating are types of stated preference methods though the last two are more applicable in marketing and transportation. The validity and reliability of economic models are tested by examining the degree to which they can explain the actual behavior of individuals (Tietenberg & Lewis, 2012).

Stated Preference Methods as Valuation techniques used to measure individuals' values for environmental goods and services directly, by asking them to state their preferences or willingness for the environment. In other words, the economic value is revealed through a hypothetical market based on questionnaires. Unlike the Revealed Preference Methods, the stated preference method used mainly to determine non-use values of the environment such as existence value, altruistic value, and bequest value since these values do not turn up in any related markets (Zainudin et al, 2015).

Even though, stated preference methods have a unique role in social preferences and gauging public support related to invasive plant species control in non-marketed social value (benefit) of welfare analysis it was also controversial, with debates over their validity magnified by highly publicized cases such as damage assessments for the 1989 Exxon Valdez oil spill in the United States (Carson et al. 2003). Despite this controversy, the need for information on economic values in the absence of market choices leads to an unquestionable demand for stated preference value estimates. Stated preference techniques were first used widely during the 1980s and 1990s. Starting from a few dozen published papers and two key books (the literature expanded to at least 7,500 Stated preference studies in the published and gray literature by 2011 (Carson 2011; Kling et al. 2012).

2.1.4.1 Contingent Valuation Method

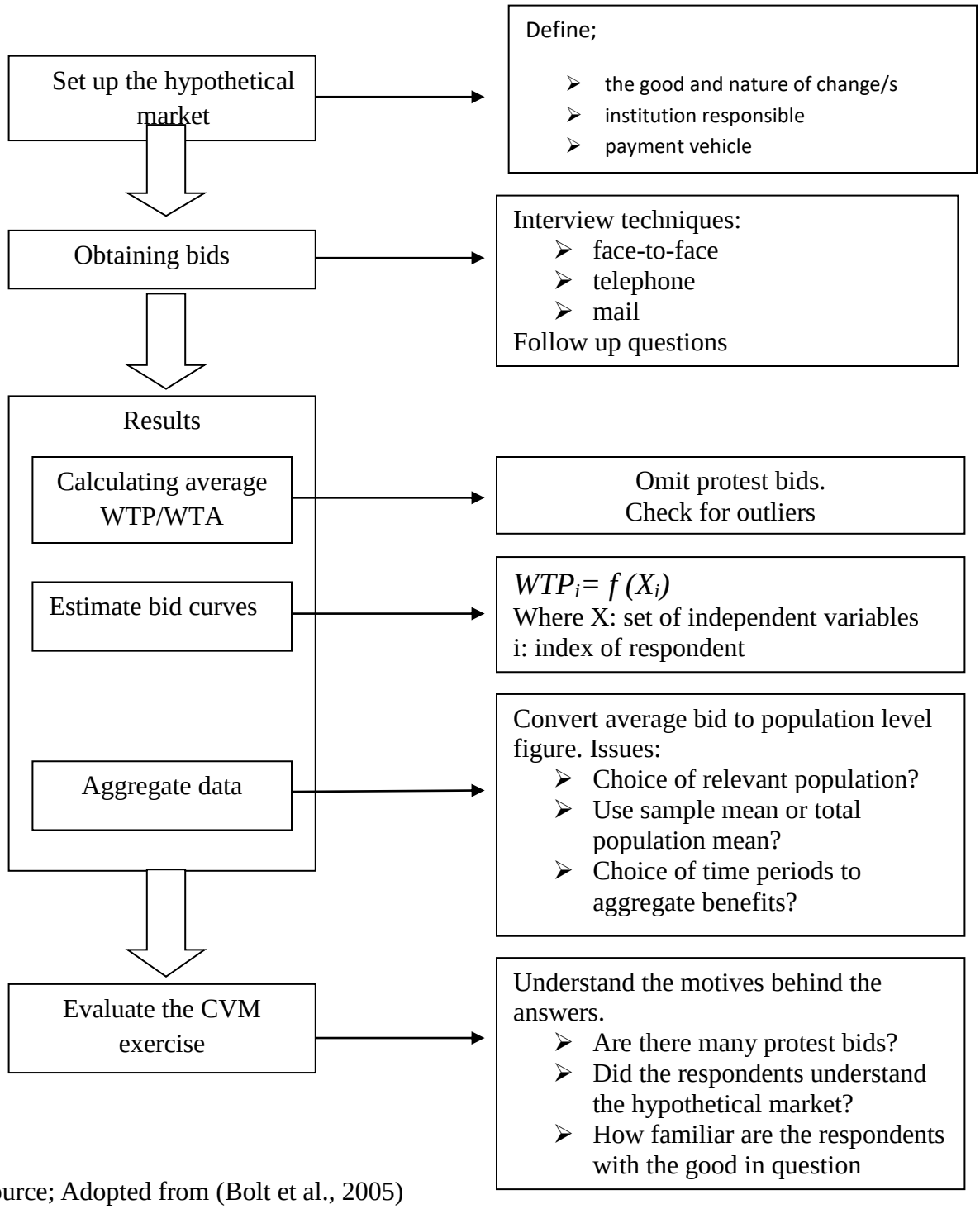
The CV aimed at eliciting their willingness-to-pay (WTP) in monetary value (birr). Respondents to contingent valuation surveys might also be asked what level of compensation they would be willing to accept (WTA) to take a loss, or for not getting an improvement in environmental quality or where people are asked directly how much money they would be willing to pay (or

willing to accept) to maintain the existence of (or be compensated for the loss of) some environmental feature such as biodiversity (Bolt et al., 2005).

CV questionnaires contain several well-defined elements including a description of the study site, details of the proposed changes (including a method of payment), an elicitation question and a series of socio-economic and attitudinal debrief questions. State-of-the-art applications of the contingent valuation generally utilize the 'referenda' format for the elicitation question respondents are asked whether they support a project given that they are required to pay a certain amount towards it, with the payment amounts being varied between respondents. This method involves asking a randomly chosen sample of people what they are WTP for a clearly defined change in the provision of a good or service, or to prevent a change. It can also be used to elicit what people are WTA to forgo a change or tolerate a change (Parajuli, 2016).

The CV has the advantage of being recognized by respondents as a standard public choice instrument (as it is similar to a referendum). However, despite its wide usage, the contingent valuation has several limitations. It is relatively costly to use, provides limited information about people's preferences and can be prone to various biases. Despite models are useful abstractions, the conclusions they provide are dependent on the formation of the model and changing the model may likely change the conclusions. Therefore, they should be analyzed with some skepticism (Tietenberg and Lewis, 2012).

Application of the CVMs should pass several stages. According to (Bolt et al., 2005) there are four steps to the application of the contingent valuation method. The first step is to set up a hypothetical market or hypothetical scenario for the environmental service in question. Then Bids can be elicited using survey techniques yet it can be done with step one simultaneously. After Bids is to elicit an individual’s MWTP in order to control water hyacinth or their maximum willingness to pay WTP to prevent deterioration in environmental quality occurring. The results of the analysis are undertaken in step three once bids WTP or WTA have been gathered, an average bid can be calculated. Average WTP or WTA can be used to have a quick assessment of the value resources has for a particular population. Finally, evaluating the CVM results are interpreted for policy analysis and decision support.Even though all steps are important, the third step analysis of the results requires much attention in contingent valuation technique. The stages are portrayed in the following figure which is adapted from (Bolt et al., 2005).



Source; Adopted from (Bolt et al., 2005)

Figure 2.1; Flow chart of designing a contingent valuation study.

2.1.4.2 Contingent valuation (CV) Scenario

A hypothetical market scenario was described to the respondents in order to help them to elicit their MWTP for WH control to Lake Tana.The secenario decribed as there no existing environmental law, thus no government measures regarding the protection of the Lake operation and there are no organization in charge of this protection and conservation. If no action is taken, the Lake quality and its function are expected to deteriorate due to WH in the next few years. This deterioration includes low productivity of fish, encroaching of the weed on farm and grazing land, hampering navigation, increasing human diseases in the Lake; reduce income of the riparian community and a remarkable increase in WH leading to the loss of Lake Aesthetics value and hence reduced tourism activity and transport service of the Lake.

To clean the lake from WH and improve its quality to its previous state, the environmental law specifying the measures to be taken for the control of WH has to be implemented. This will lead to the improvement of lake quality and make the lake favorable for transport activities, biodiversity conservation, good environmental lake operation, reduction in human disease, increase the income of the riparian community and increase tourism attraction.

2.1.4.3 Value elicitation formats

Formally, in the literature there are four types of elicitation techniques available: namely the bidding game, the payment card (PC) approach, as well as the open-ended (OE) and dichotomous choice (DC) approaches (single and double bounded choice formats (Carson &Groves, 2007; Carson, Groves & List, 2014; Vossler, Doyon & Rondeau, 2012; Vossler & Evans, 2009; Johnston et al. 2017).

For this study the researcher used the PC value elicitation format because this method has become popular since it applies or replicates real-life decision making for consumers (deciding whether or not to buy a good at a given price) better than the OE (deciding the maximum price one would pay for a good). In addition, PC offers visual support or attaching a price to goods that facilitate the construction of evaluation and avoids a high rate of non-response and overestimated values and containing different ranges of WTP values.

The PC elicitation format approach has advantages over other elicitation formats: First, respondents MWTP values can be determined directly from the original data; second, respondents in PC have confidence to state WTP values (Ready et al., 2001); third, WTP values estimated by a PC approach are more robust than those relying on a DC approach (Ready et al., 2001); fourth, there is no starting point bias affecting the PC approach (Mitchell & Carson, 1989). The study used a payment card valuation method to source information regarding households' WTP for the control of water hyacinth in Lake Tana. The use of PC format provides households' a chance to scan through all the WTP values and then settled on their suitable or highest WTP value. Data obtained from this format was less scattered thus minimum samples required to yield robust estimates. PC format does not also suffer from starting point bias unlike other valuation formats commonly used in literature today (Otieno et al, 2019). However, it has a weakness of giving a very low proportion of zero responses as compared to other formats even though it has the possibility of generating protest zero responses (Alberini, 2013).

Although the method reduces the biases associated with closed-ended and bidding formats (especially when starting with very low (or zero) values and ending with very high values or outliers), biases due to starting values, the range and the centering of bids may occur. Variants tackle starting-point bias by introducing randomness, like the randomized card sorting first used by Carthy et al. (1999). A payment card (PC) is really the only format that takes respondents' uncertainty directly into account through the WTP elicitation mechanism and has been improved since 1981 (Cook et al., 2012). Moreover, open-ended question format is used for pilot survey to design, PC because the dependent variable, or WTP, is not fully observed (it is censored at zero), and we use a standard Tobit model in the analysis of determinants of WTP.

2.1.4.4 Payment Vehicle

This study used a special trust fund which was a neutral payment vehicle to help in minimizing objections and protest responses by households. Based on this payment vehicle, Household's were going to make a one-time contribution to help in the management of water hyacinth infestation in Lake Tana. This special trust fund method was highly recommended due to its credibility and ability to improve the hypothetical scenario. It was thus, superior over other payment vehicles such as; fees, tax and amenity bills (Otieno et al, 2019).

2.3 Review of Empirical Literatures

In recent years, especially since 1940, the Contingent Valuation method has found expensive application in the valuation of environmental resources benefits. Until 1987 the application of this method was limited in developing countries due to illiteracy and lack of capital, but currently, it was improved or used (Whittington 1998). The above theoretical explanations of the method have been employed in many studies of valuing the environment in both developed and developing countries. Some of the CVM studies done in developing countries in general and in Ethiopia, in particular, are reviewed as follows.

A study by Khatri et al (2018) willingness to pay for water hyacinth control of visitors and local people to Phewa Lake in Nepal using stated preference contingent valuation method was employed to 13 sample points to capture heterogeneity. The main objective of their studies was to elicit the non-marketed social value (benefit) of controlling Water hyacinth to the lake and derives a relatively inelastic demand curve for preserving the environmental goods and services. They prepared three contingent valuation scenarios to the respondents by encircling different socioeconomic variable and introduced six impact categories to the valuation scenarios such as weed impact on scenic beauty of the lake Phewa, impact on aquatic life, impact on economic, impact on ecosystem health and recreational impact. They used a binary response logit model to identify determinants that affected the donations of visitors and the local people to control water hyacinth from the lake and to derive elasticity of the demand curve. The finding of their journal article showed that from the first scenario the mean willingness to pay to remove water hyacinth for one year was NPR 920.51. Similarly, the mean willingness to pay for the second scenario to minimum annual impact was NPR 717.38 and the final mean willingness to pay for the third scenario that keeps the impact at a low level in the lake for ten years was NPR 1848.17. Assistance and expenditure of the households were negative sings and significant at 5 percent level that determines willingness to pay of the respondent but a number of visitors were a positive sign and significant at 5 percent level that determines willingness to pay for removal of water hyacinth in Phewa Lake, Nepal.

Economic Analysis of Fisherfolks' Willingness to Pay for Improved Management of Water Hyacinth in Lake Victoria, Kenya was conducted by Otieno et al, (2019) using a contingent

valuation method with payment cared elicitation format for a one–time payment donation in the form of the neutral trust fund from 268 sampled fisherfolks. They used a binary response Tobit model in order to analyze the socio-economic determinants of individuals' (fisherfolks') WTP decisions for the improved water hyacinth management in Lake Victoria. The finding of the study showed that fisherfolks were on average willing to pay the amount of Kshs. 175.11 with a total contribution of Kshs. 42,500 monthly to improve water hyacinth management in Lake Victoria. Among used explanatory variables age, experience, income, perception of fisherfolks about water hyacinth infestation to the lake, fishing groups and gender of fisherfolks had a significant at (1 percent) level which has a strong influence on the fisherfolks' WTP decisions for improved management of water hyacinth.

Preez et al (2010) conducted research on willingness to pay for restoring indigenous vegetation in Underberg, KwaZulu-Natal, and South Arica using contingent valuation method from 260 samples. The results showed that respondents were on average willing to pay the amount of Kshs. 175.11 (USD1.75) with a total contribution of Kshs. 42,500 (USD 42.5) monthly to improve water hyacinth management in Lake Victoria. The variables age, experience, income, perception of fisherfolks about water hyacinth infestation, fishing groups and gender of fisherfolks had a significant influence on the fisherfolks' WTP decisions for improved management of water hyacinth in Lake Victoria. The Lake Victoria management authorities should take the opportunity to raise funds for improved management of water hyacinth in Lake Victoria.ple respondents. The purpose of the study was to estimate the household's willingness to pay for indigenous vegetation over the alien's vegetation and to measure a household's willingness to pay using the Tobit model. the mean of willingness to pay for restoring of indigenous vegetation was found to be R21.12 (R26.40 at 2008 price levels), R25, 344.00(R31, 680.00 at 2008 price levels) and R21.87 (R27.34 at 2008 price levels per hectare. the finding of this study showed that knowledge of the local working for water programs and income were important determinants of willingness to pay.

Rodriguez-Tapa et al (2017) also applied the contingent valuation method to household's perception of water quality and willingness to pay for clean water in Mexico City using censored econometric (Tobit) model. The average willingness to pay for better potable water quality is

US$3.1 or 4.7 percent of the bimonthly water bill per family. The finding of the study was that the high cost of bottled water significantly influences willingness to pay.

Marbuah(2016)applied an ordered logistic regression model to a willingness to pay for environmental quality and social capital influence in Sweden .the study found that individuals are fair will contribute to environmental protection and elements of social capital (stock of social and institutional trust, incentives) were significantly influence individual willingness to pay for the environment protection.

A study on assessing of willingness to pay for lake conservation on North Pond and west pond in Waterville, Maine was conducted by Sarkar in 2011. He employed a contingent valuation survey on 100 shoreline residents through a web-based interview with mail and applied a non-parametric test (Mann-Whitney U-Test and Two samples T-Test) for estimation of the mean willingness to pay for lake conservation. The study found that the mean willingness to pay from the two ponds (North and west pond) was USD 5,652 per year for water shade conservation program. Age, income, lake association membership and water quality perception were the most significant determinants of willingness to pay for lake conservation.

A Study by Do et al (2007) employed the choice modeling approach of Multinomial Logit (MNL) to estimate willingness to pay for wetland improvement in Vietnams Mekong River Delta. they employed MNL and RPL models using contingent valuation approach and they divided respondents into three subpopulations'; Cao Lanh, Ho Minh city, and Hanoi to 300 sample size personal interviews or face –to- face interviews were conducted. The finding of their articles showed that respondents in three locations have different marginal willingness' to pay for wetland attributes and the overall willingness to pay for the proposed wetland biodiversity conservation in the three sub-sample ranging from 2.5 USD per households in Hanoi to 0.9 USD in Ho Chi Minh city and zero in Cao Lanh. Age of the respondents (older), knowledge of the problem and geographical distance from the study site were positive factors which determines willingness to pay.

A study by Eugene et al.,(2015) preference and willingness to pay for close to home nature for outdoor recreation in Sweden, using the contingent valuation method. The data was originated from a mail survey that involves Swedish residents' with a random selection from the national

register. They used Tobit and ordinary least square (OLS) model for estimation and to account factors influence willingness to pay. The finding of the articles showed that approximately 50 percent of the respondents spend their leisure time by visiting nature (consumption from the recreation of nature) and/ or establishing to nature areas close to their home and the average frequency of visit to this area was 74 times annually. The mean willingness to pay of the respondents was approximately 7200 SEK (USD 1080) annually the respondents willing to pay for nature strongly influence by income , types of nature areas and distance to and time to spent at the recreational areas .again the finding of the study showed that those respondents live nature the recreational areas (nature)and live in rural areas were more willing to pay for nature which is an average of 9044 SEK (USD1357) per year for outdoor recreation than the urban respondents were willing to pay an average of 6425 SEK (USD 964) . The coefficients of the variables were relatively the same except age and gender that the coefficients associated with distance, time and income had positive and statistically significant effects that determine willingness to pay of the respondents that support the theory of demand and supply.

Willingness to pay as an economic instrument for coastal tourism management by Birdir et al (2013) in Mersin, Turkey using contingent valuation method from 432 respondents. A non-parametric one-way analysis of variance test with ANOVA was used to estimation of the model. The mean willingness to pay of the respondents was approximately €1.70 -2.30 can willingness to pay for the beaches as a fixed price per visit for maintenance and improvement of coastal tourism management. The finding of the study showed that local government should be ultimately focused on environmental policy, programs, and implementation. Using a discrete choice experiment method, Peng & Oleson, (2017), the study on beach recreationalists' willingness to pay and economic implications of coastal water quality problem in Hawaii. Conditional logit model was used for estimation. Individuals were willing to pay $11.43 per day to reduce the bacterial exceedance in the beaches from 11 to 5 per year the respondents also willing to pay USD15.33 to improve coral reef cover from 10 percent to 25 percent. To increase fish species in the coastal areas the individual willing to pay was from USD 2.47 to USD 7.14. The finding of the study showed that consumer surplus (recreationalists 'welfare) was increased from USD20 million to USD550 million and USD120 million due to environmental improvements in coastal water quality. The study estimated benefits of environmental improvement by taking management actions targeting each of the areas relevant to the

recreationalist government and other agency can effectively increase consumer surplus derived from improved coastal water quality.

The study by Wang &Jia (2012) on tourist's willingness to pay for biodiversity conservation and environment protection, DalaiLake protected areas implementation for the entrance fee and sustainable management in northern East China using contingent valuation method from 2000randomly selected respondents (tourist). Logit and Probit model was used for estimation and to establish the relationship between the variables and willingness to pay. The finding of the articles showed that majorities of the respondents (tourists) 73.6 percent were willing to pay. 26.4 percent of the respondents were unwilling to pay. Income level and awareness of being in protected areas were the most significant factors or predictors of the tourist willingness to pay which have positive sign and significant at 1 percent level but educational level and the institutional trust were also significant predictors' and having positive sign and significant at 5 percent levels the median willingness to pay was 71.08 RMB (USD10.72).

A study by Bhandari&Heshmati (2010) willingness to pay for biodiversity conservation in Sikkim, India using cross-sectional surveys from 375 domestic and foreign tourists through personal interviews (face-to-face) interviews in verities of sites. Logit and Tobit model was used for estimation .the finding of the study showed that higher socioeconomic status of tourist was positively related to willingness to pay, higher age brackets might constitute an improvement revenues generators of biodiversity conservation, higher education and income of the respond ants have positive significant to determine willingness to pay.

MacLeod et al, (2010) study on Economic valuation of the influence of invasive alien species on the economy of the Seychelles islands Using contingent valuation method to obtain a willingness to pay (WTP) estimate for a policy to protect important biodiversity from IAS. Tourists indicated a mean WTP of USD52–USD58 on top of their usual expenditures to fund conservation policy. At present approximately USD 0.25 million per year is spent on IAS control while the economic damage associated with 4 key IAS is approximately USD 21 million per year. Comparing the benefits from eradication with the costs involved gives a benefit-cost ratio greater than unity, indicating that the policy of eradicating IASis economically justified. However, there is a long way to go before the resources devoted to the problem will be in proportion to the risks.

Coopera et al, (2004) conducted the study on the structure of motivation for contingent values: a case study of lake water quality improvement. This study examines the role of such motives by using measures of attitude and motive strength to interpret willingness-to-pay (WTP) values for a set of nested environmental goods with potential use and non-use benefits. Social motivations possibly associated with the benefit of contributing to a public good rather than the benefits of the good itself are potentially relevant to the WTP decision but do not give rise to separable values. The strength of perceived personal responsibility for the provision of the good is significantly associated with WTP but also with the theoretically desirable property of enhanced scope sensitivity. WTP is not found to be associated with the extent to which the individual feels under some general moral obligation to contribute to ‘‘good causes’’. Motives arising from ethical concerns for the environment and altruism are also potentially relevant to WTP but are closely related to underlying motives associated with existence and personal use values, respectively. The associations among motives found here also suggest that investigations of any particular motive should be conducted in context.

Halkos &Matsiori (2012) conducted a study on the point of assessing the economic value of protecting the artificial Lakes, by using CVM. The study was employed a logistic model followed by a Tobit and they apply the two hurdle model for analysis. The WTP was derived from a face-to-face survey of 564 residents and recreational users of the Plastira’s lake, one of the most important constructed wetlands in Greece. The study found a higher WTP of individuals towards the lake’s functions and their desire to prevent possible diminutions of its total economic value and study show that the most important variable is pro-environmental behavior. They also found that respondents have different behavior for the lake’s economic value according to mainly to their origin (residents or recreational users). Demographic variables (like income, age, gender) together with the extracted factors have a strong impact on the decision of individuals to pay as well as on the specific amounts stated. In conclusion, an important finding of the study is the influence of the lake’s functions on people WTP for its protection.

Non-economic motives behind the willingness to pay for biodiversity conservation by Montes &Benayas in 2007 from 649 sample respondents. The annual mean willingness to pay ranged from €23.2 to €30.8 depending on the method applied in the estimation. The finding of the study

was geographical distance; age and knowledge of the respondents were the most important determinants of willingness to pay for biodiversity conservation.

In Ethiopian experience there is no studies have been conducted on households' WTP for water hyacinth control to Lake Tana and other recreational sites but two studies were conducted on Current Trend of Water Hyacinth Expansion and Its Consequence on the Fisheries around North- Eastern Part of Lake Tana (Erkie, 2017) and Water Hyacinth in the Rift Valley Water Bodies of Ethiopia: Its distribution, socioeconomic importance, and management (Firehun et al ,2014).those two studies were not account social ,environmental and economic impacts of water hyacinth on Lakes and fershwater bodies in Ethiopia and they could not used both environmental valuation methed and econometric model.

All the above contingent valuation method (CVM) studies also identified that the variables like monthly income, level of education, age brackets (group) ,geographical distance , knowledge to invasive alien's spices (Montes &Benayas ,2007) ,recreational activities to the lake affected by water hyacinth, prior knowledge of the problem (Law, 2007);Household expenditures, assistance received and occasional presence of a household member who has visited the lake, and household's expenditure or size (Khatri et al.,2018) are the main determinant for positive willingness to Pay. Besides, all the studies had concluded that the result from the CVM survey is theoretically and practically consistent and gives a reliable result. However, all the above studies failed to account the non-use value (bequste value or existence value) and /or the non-marketed social value (benefit) of environmental goods and services.

Following a review of variables included in previous studies, the independent variables for demographic characteristics in this study included: gender of household head (male or female), age of respondents, household income, and number of household member having a Job (generating income in fulltime or not), household size, Marital status (married or not), and education.

MWTP: is a dependent variable that indicates respondents' maximum willingness to pay for the control of water hyacinth. This variable is a continuous variable which takes the actual value that respondents willing to pay or willing to accept from the payment card proposed after a pilot survey.

WTP: is a willingness to pay that respondents will be asked to state their willingness to pay for WH control in Birr (open-ended question). In this case, the dependent variable MWTP takes a continuous value and the researcher employed a censored regression model, i.e., the Tobit model.

Age: age is a continuous variable. We measured the household head in a number of years is another determinant of households MWTP for WH control. So far, studies conducted on fisherfolk MWTP for the management of WH found positive effects (Otieno et al, 2019). Older people have long years of experience in the city and could observe the gradual contamination of the Lake by WH and may easily compare the impact and more informed about the problem of WH to the Lake. Besides, they may feel altruism and crave to pass a clean and safe environment for their children. Hence, it was expected to affect the dependent variable positively.

Number of Visit (NVST): numer of the visit is the number of times that household's member visits the lake and this is a continuous variable and we expected positively affect to MWTP. It is expected that a direct relationship between the number of trip and WTP. This means as a number of trip increases respondent will have an awareness about the problem and the benefit of the lakes and they will have positive MWTP. This is due to respondent give high value for the lake. Studies conducted on visitors' WTP for the control of water hyacinth reveal that the number of visits has a positive effect on WTP (Khatri et al, 2018).

Awareness of the respondents to Water Hyacinth (ARWH): This variable is a dummy variable (1 = aware; 0 = not aware). Awareness of respondent about the impacts of water hyacinth on the environment, human health and the economy has a significant effect on their WTP for weed control. Hence, households' awareness about the impacts of WH is expected to positively affect their WTP for its control in Lake Tana. Studies conducted on urban households' WTP for the control of water hyacinth in South Africa reveal that the WH awarness has a positive effect on MWTP (Charles, 2007).

Income (Y): This variable is before -tax income of respondent per month of the head of the household in Ethiopian Birr (as aproxiy of monthly food expenditure for the household). It is obvious that individuals underestimate their income level. Taking this into account, the data will carefully collect the information from individuals. Income is a continuous variable and we expect to have a positive effect on the dependent variable, WTP which shows individuals with higher

income pay more for the control of water hyacinth. So far, studies conducted on fisherfolk MWTP for the management of WH found as income of households' has positive effect on MWTP (Otieno et al, 2019).

Household size (HHS): This variable is related to the number of people in the family. On the one hand, larger household size is expected to spend more and have less money to contribute to water hyacinth control or protection. On the other hand, one, a family having many members may have many hands to work and bring income to the family; two, they need to have a clean and safe Lake to exist nearby their area or environment, since the probability of infestation of the weed is high and more importantly the cost of control to the family might be high. Consequently, the sign of the household size was difficult to be determined in advance.

Distance (DIST): This is a continuous variable. It is expected to be negative. This refers to the distance between the respondents' house and the lake. Respondents who live near the lake are expected to be more aware of water hyacinth. Thus, as the distance (i.e. measured in kilometer) of the lake from respondents' house decreases, the WTP of the respondent for control of the weed increases. Otieno et al, 2019, found that distance negatively affects WTP.

Education Level (EDUC): The level of education refers to the number of years a respondent spent in formal education. Households with a higher level of education have more exposure to the problem of the environment in general and are more cognizant of the solution to the problem so that they are expected to be activists to the improvement of the lake from water hyacinth. Thus, it was expected to have a positive sign in the model. Both (Khatri et al, 2018 & Otieno et al, 2019) found that education has positive effect on MWTP.

The Number of household Members who have a job (NHHMHJ): This is a continuous variable. That is expected to influence WTP positively. As the number of members of household working any place increase income of the household would be higher and support the lake protection plan also expected to be high.

Gender: It is a dummy variable that has a value of "0" for female respondents and "1" for male counterparts. Females have less participation in the economy especially in those sectors that may

bring substantial income to the family and may refrain from contributing to environmental improvement while males do. Hence, it was expected to be positive.

The value attached to the lake by respondents (VATL**):** This variable is once again categorical dummy variable which shows whether the respondent's value or use the resource, i.e, Lake Tana for the purpose of recreation, as a source of income, and the future generation, or existence value. We can say nothing about the sign or effect of this variable before the data was analyzed. But, not sure, those who use the lake for recreation and a future generation have high willingness to pay.

Marital status (MRS): This is a dummy variable taking 1 if the respondent is married; 0 otherwise. This variable is expected to have a positive sign since married people are more responsible than single because they are worried about the sustainability of lake resource for future generation than respondents who are single.

CHAPTER THREE

DATA AND METHODOLOGY

3.1. Description of the Study Area

Lake Tana is a natural lake situated in the North of Bahir Dar city. The lake maintains high water levels throughout the year. Since the rain water from the neighboring areas is drained into the lake, including several tributary streams such as Megech River. The geographical location of the Lake is 10°58`–12°47`N latitude and l36°45`-38°14`E longitude. It has a surface area of 3,200 square kilometers, the minimum depth is 8 meters and a maximum depth is 14 meters with fluctuations due to increased siltation levels. It is the largest freshwater body in the country, contributing about 50 percent of the water resource of the nation. The lake lies at higher altitude in the range of 1,840 meters above sea level compared to Lake Victoria at 1,134 meters above sea level and is considered the highest lake in Africa. Due to its altitude, it is characterized by cold waters with a mean temperature of 21.7°C. The Lake watershed consists of 347 Kebeles (the lowest administrative units) and 21 Woredas in four administrative Zones, International Fund for Agricultural Development (IFAD, 2007). The lake catchment covers an area of 16,500 square kilometer**.** The historical monasteries, in the Lake and lake water activities, are the main tourist attractions of Bahir Dar City. The lake outflow is used to generate electricity and irrigation infrastructure used by local people there are residential settlements and hotels near the South, South-West and East banks of the Lake.

Geographically, Bahir Dar city is found in the North-Western part of Ethiopia and the faster growing city and a global position of the city is located between 15°37’ N latitude and 37°25’ E longitude, and enjoys tropical type of climate with 19.6°C mean annual temperature and the average elevation of the city is estimated 1801 meter above sea level (UNEP, 2010). The city is strategically located Southern side of the lake in Western Gojjam province. The current population of the city is estimated to be 313,997 and the total number of households in the City is 63,916 (FFE 2010; Kassahun, 2018). Currently, the city is serving as a regional capital city of Amhara National Regional State (ANRS) in Ethiopia. It has become one of the major tourist destinations of the country with a variety of attractions in the nearby Lake Tana (Ethiopia’s

largest Lake) (FFE 2010). The decision to select Bahir Dar city for our study was informed by (i) its status as the most popular tourist destination in Ethiopia, (ii) its nearness to Lake Tana and (iii) its current infestation of water hyacinth to the Lake.

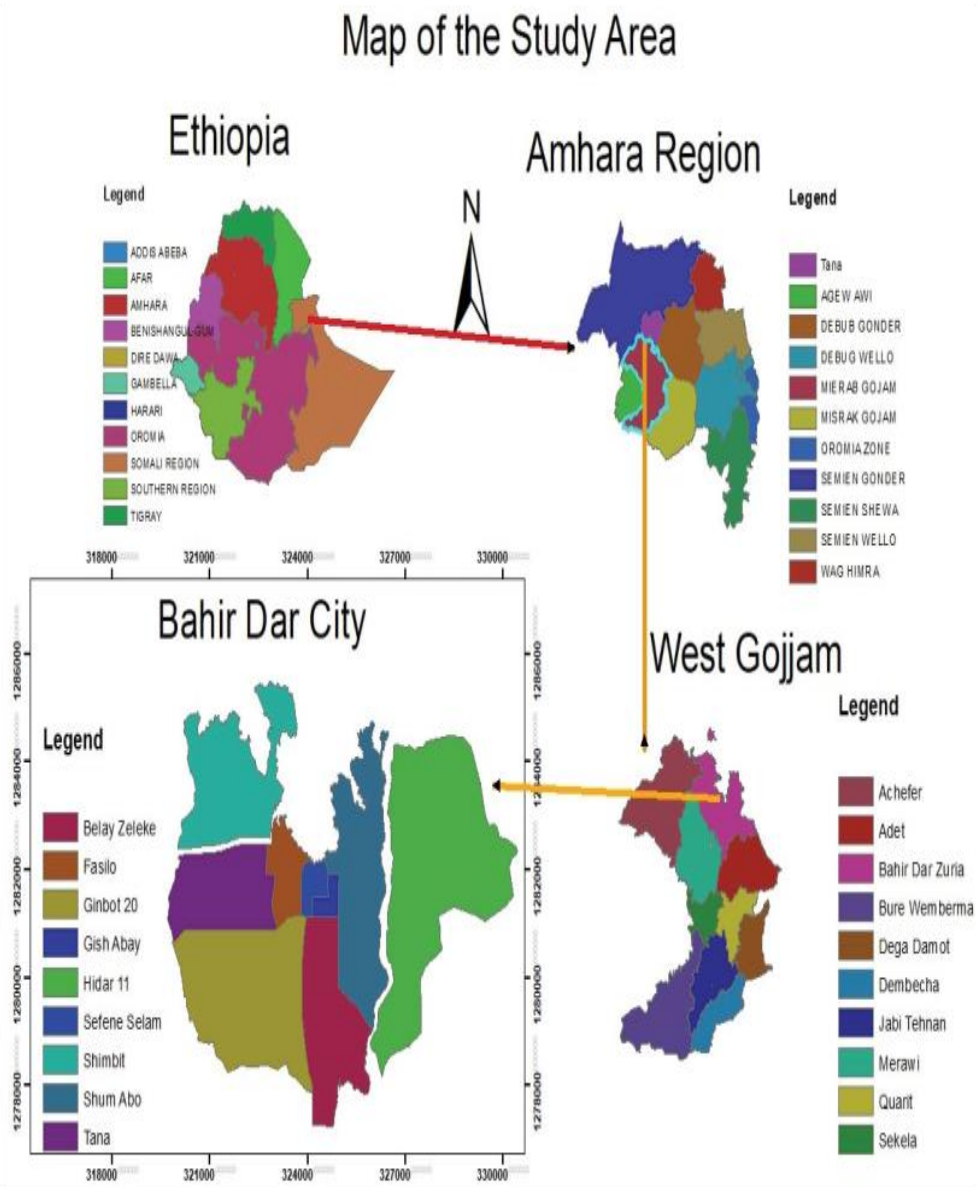


Figure 3.1: Map of the case study area, Source; Adopted from (Birara &Kassahun, 2018).

3.2 Research Design

Research design is a plan for conducting research which usually includes specification of the elements to be surveyed and the procedure to be used (Boadi, 2016). It helps to seek information, analyse the evidence of research and answer the initial questions as explicitly as possible. This study employed a cross sectional study design, where data collection was confined to a single time period for each household head.

This research design was preferred as it gave a room to compare more than one variable at the same time with little or no additional cost, such as socio-demographic factors and WTP in relation to the study context. Also, it is capable of using data from a large number of subjects unlike other types of research designs which are geographically bound. However, the shortfall of this design is that the changes in phenomena of the study area cannot be measured as it offers a snapshot of a single moment in time (Gray, 2009).

The researcher informed the respondents about the future possibility of total infestation of the Lake by WH and explained to the respondents that a technological intervention (mechanical removal of WH currently in Lake Tana) exists to get rid of such problem. Appropriate use of such technology can delay or control the invasion of the weed for a given time period from today to the future but the technology for clean-up is not over come the problem. This introductory section was created to inform the respondent to eliciting households'demand for WH control .To make the survey less time consuming and more attractive to the respondent, a pilot survey was done. But the major aim of the pilot survey was to collect direct open-ended 'information about how much respondents were willing to pay for hyacinth control.

The design of the survey followed recommendations from the National Oceanic and Atmospheric Administration (NOAA) Panel (Arrow et .al, 1993) and Mitchell & Carson (1989), and consisted of four sections. Questions in the survey first section asked about respondents' awareness of the current situation with WH in Lake Tana. Section two of the survey covered general environmental problems of WH to the Lake or valuation scenario. The third section of the survey asked respondents about their willingness to pay, and the fourth section asked about household's demography & socioeconomic characteristics.

Pretest with open-ended questions provides some information on the bounds of respondents' WTP (Hoyos & Mariel, 2010). As a result, 20 households were randomly selected for pretest before the actual survey was done. Based on the pretest, their minimum and maximum willingness to pay for WH control was 100 and 3,000 Ethiopian Birr (ETB) for a one-time donation. Depending on the result of the preliminary survey the general valuation question was formulated as follows; "The EFWDANRS and the Nile Basin authority(NBA) concerned with WH control or management to Lake Tana, then pick the maximum amount you are willing to pay towards the special trust fund to help full realization of the proposed project .But the households' were required to circle only one amount in the card at a time .The survey was administered from March 23 to April 27, 2019, for consecutive days, through a face-to-face interview by the researcher , and three enumerators (two second year MSc students from Addis Ababa) and one MSc student from Bahir Dar but he contrbuted or supported me for data collection only four days.

3.3 Sampling design

The choice of sampling technique (probability or non-probability) depends on the purpose of the study. So, the objective of this study is to estimate households' willingness to pay for water hyacinth control. For such quantitative research, the probability sampling technique is appropriate as compared to non- probability sampling technique because every sample household has an equal chance of being interviewed. Stratified sampling (strutum) was applied first from six selected Zones and group the households' based on their location to the Lake and secondly simple random sampling techniques were used to determine the number of households, in order to collect primary data from these samples to obtaina reasonable and reliable result.

The city is divided into 17 administrative Kebeles and after the 2007 reforms; these Kebeles are rearranged into 52 zones (smallest legal administrative units). The researcher grouped selected Zones in the city into three main groups i.e. Zones nearest to the Lake, middle Zone (i.e selected Zone between the neraset and outer Zone) and Outer Zone based on the distance of the respondent's house to the Lake in a kilometer, and geographical location of the respondent to make homogenous for primary data collection from sample units.

Table 3.1 shows the details about making stratum and proportional sample households' selection. About 0.62 percent of sampling units were selected from the total households in the selected Zones using a random sampling method with the help of the sample frame developed before. From all sample Zones selected randomly, 398 sample households was selected for the study.

Table 3.1 Sample Households determination across sample zones

The stratum of an area	Sample Zones	Total households	Sampled households	Percentage (%)
Nearest	A&B	15839	183	1.16
Middle	C& E	39381	131	0.33
Outer	B& D	8696	84	0.96
Total	6 zones	63,916	398	0.62

Source: Total population data as per the census of 2007

3.4 Data Type and Data Collection Methods

3.4.1 Data Type

The study used primary data collected directly from respondents through a cross-sectional survey. Both qualitative and quantitative data were collected for analysis. Qualitative data were used to investigate households'attitudes towards conservation the Lake whereas quantitative data were used to analyse factors influencing households' WTP and the MWTP value for water hyacinth control.

3.4.2 Data Collection Methods

In this study, the main instrument for the collection of household data was a questionnaire survey. The study used primary data obtained directly from a sampling frame of 63,916 households through structured questionnaire interview. The survey collected household demographic and socio-economic characteristics, household's attitudes towards Lake Conservation, households WTP and the factors influencing their MWTP.

The study employed contingent valuation method (CVM) to come up with precise analysis on a household decision whether or not to willing for water hyacinth control. The underlying principle idea to this method is that people have preferences for environmental goods and services and these preferences are hidden, but can be translated in monetary units. Continuous CVM was used to elicit the WTP values. During the interview, respondents were freely to answer the open-ended questions while indicating the maximum amount they are ready to pay (Song et al., 2012).

The CVM technique despite the advantages to measuring total economic values, however, have been criticised for having many biases including strategic bias, hypothetical, design bias, and operational bias (Padi et al., 2015). Respondents may not provide information on their true WTP to please the interviewer. Despite its drawbacks, CVM was used in this study because of its ability to capture use and non-use values, unlike other environmental methods such as hedonic pricing and travel cost methods which have a tendency to underestimate satisfaction by considering use values only.

The method was also preferred because of easy data collection and the results obtained are relatively easy to understand, interpret, and to use for policy intervention purposes.

3.5 Target population and Sample Selection

3.5.1 Target population

(Ishach and Abu-bakar, 2014), defined the target population as the group of elements that must be finite and can be counted to which the researcher wants to make inference. The fundamental units of the population are elements such as persons, households, housing units, parts of an organization/institution, etc.

This study targeted adults representing households aged 18 years and above to make a meaningful contribution to water hyacinth control in the study area. Bahir dar city has divided into 52 Zones (small adminestrative unit). This study, however, did not cover all the Kebles in the city because there needs finance and time .The study was therefore administered in 6 Zones of Bahir dar city.

3.5.2 Sampling Frame

A sampling frame as has been narrated by (Ishak and Abu-Bakar, 2014) is a listing of the population units from which a sample size is to be selected at any stage of sampling. The sampling frame of this study was 63,916 households obtained from 6 zones of Bahir dar city Council through a cencuse register where the sample size was drawn.

3.5.3 Sample size determination

Based on statistical principles, the survey sample size of households was sampled according to the stratified random sampling method (Dhokhikah et al., 2015). The nominated and interviewed households had various socio-economic levels and other characteristics including gender, age, household size, education background, marital status and household average monthly income. Sample size determination formula was used to calculate the sample size for the stratified random sampling technique while putting clear some of the assumptions (Israel, 2003).

A critical component of sample size formulas is needed for the estimation of variance in the primary variables of interest in the study. There are two ways of estimating population variances for sample size determinations, (1) use pilot study results and (2) use data from previous studies of the same or similar population. The sample size for the study take from Israel (2003) published tables with the sample size for a $\pm$5 percent degree of precision level and 95 percent confidence interval was taken. Hence

$$n = \frac{\mathrm{N}}{1 + N(e)^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

Where n= is the required sample size. N= is a number of large household size

e= is the desired level of precision.

Using the formula, the sample size for the study is 398. The Simple Random Sampling Technique used to select the 398 households out of the total household size of three hundred and ninety-eight (398) questionnaires was administered on the selected residents in the communities after stratification is done.

3.5.4 Sampling Procedures

Sampling refers to the selection of some part of an aggregate or totality on the basis of which a judgment or inference about aggregate or totality is made. In other words, it is the process of obtaining information about an entire population by examining only a part of it .A sample size is a definite plan determined before data is actually collected for obtaining a sample from a given population . From the onset, stratified sampling was adopted where the study area was stratum into 6 zones based on Locations of the head of the household in nearest, middle and outer to the Lake.

3.5.5 Sampling technique

The study was designed to obtain a representative sample of households in city. The list of households was first obtained from Bahir dar city Council through formal interview for the city council. A stratified random sampling method was used to select representative samples from every zone. Since, the study population was very large (63,916 households) having homogenous items for the universe, hence geographical location were regarded as strata, therefore, households representatives from each zone were randomly selected. A total sample of 398 households from 6 zones was obtained to ensure consistency of results from Tobit regressions analysis.

3.6 Data Analysis

3.6.1 Descriptive Statistics

To obtain descriptive statistics (percentages and frequencies, means and standard deviations) stata version 14.0 and excel programmes were used. Descriptive statistics were used to analyse data on selected socio-demographic factors, and households' attitudes towards positive actions in water hyacinth control.

3.6.2 Econometric Data Analysis

STATA version 14.0 programme was used to run the Tobit binary regressions models to obtain the relationships between the variables as indicated in the table 3.1 below. The Tobit output estimated the effects of factors influencing the MWTP value for water hyacinth control.

Table 3.2: Description, measurement and a priori expectation of the explanatory variables used in the Tobit model

Variables	Description	Measurement	Type	Expected sign
MWTP	Maximum willingness to pay	The actual amount in Birr	Continues	+
Age	Age of respondent in years	actual years	Continuous	––
Number of Visit	Number of times household member visit in lake	actual number per month	Continuous	+
Awareness of the respondents to Water Hyacinth	Respondents were aware of the problems associated with the invasion of water hyacinth	(1 = aware; (0 = not aware;	Dummy	+
Households Income	Monthly income of the head of the household in Ethiopian Birr as	The actual amount in Ethiopian Birr	Continuous	+
Household size	Number of persons living in a Household	actual number	Continuous	+ or −
Distance	respondents house farness from the lake	actual amount in kilometer	Continuous	––
The Educational level of the respondents	The household maximum level of educational attainment	the actual amount in a year	Continuous	+
Number of household Member having a job	members of household working in any place that generates income	Number of a person having a job within the household	Continuous	+

Gender of Household Head	Sex of the Household Head	1= male 0=female	Dummy	+/-
The value attached to the lake by respondents (users)	The respondents value or use the resource, i.e. LakeTanafor the purpose of recreation, source of income, for the future generation, or simply for existence value.	(1=if recreation purpose, 0 otherwise 2= if the source of income,0 otherwise 3=if for the future generation or existence purpose,0 otherwise)	Dummy	+/-
Marital status of the household	Relation status of the respondent i.e married or otherwise	1 = Married, 0= Otherwise	Dummy	+/-

Source: Author's own constructs

3.7 Econometric Model

The study used the contingent valuation method (CVM) Framework to analyze urban Households' preferences for the control of water hyacinth in Lake Tana. The CVM framework was preferred over payment card elicitation format approaches since it yielded the aggregate (non-use and use) value of the proposed socio-economic aspect of water hyacinth control (Ndambiri et al., 2015). Protecting natural resource such as lakes from the infestation of invasive species like water hyacinth involves non-market valuation techniques. Since the market value and the" WTP price" is used to estimate the economic benefits of Lake Tana. This study focuses on the price that households are willing to pay to maintain the natural resources (Herath & Kennedy, 2004; Wu et al., 2007).

Given the nature of the data (cross-sectional), and the dependent variable (MWTP) makes it appropriate to use Tobit econometrics Model or Censored regression approach to analyze households willingness to pay and identify factors that affect their maximum willingness to pay

for the control of water hyacinth. In CVM studies, Tobit econometrics model or censored econometrics model are used to analyze the determinants of WTP and the maximum amount of money that individuals (households) are willing to pay. Zero response data are inevitable in WTP surveys. Tobit Model is often assumed as the true distribution of willingness to pay to bid censored at zero and is better suited in case of data with many zeros than Ordinary least squares regression analysis which may result in biased and inconsistent parameter estimates (Greene, 2008; Wu et al., 2007).T obit model has an advantage over other discrete choice models such as linear probability model(LPM), probit, and logistics in that, it reveals both the probability of WTP and the maximum WTP of the respondent (Maddala, 2002). To elicit the maximum willingness to pay (MWTP) value, Tobit model (Otieno et al, 2019) and Logit model (Khatri et al, 2018) were used. To estimate the WTP in this study, the threshold decision-making theory was employed where respondents were asked to pick the maximum amount they are willing to donate to clean the weed and elicit a specific monetary value for 'willing' responses.

3.7.1 Models for Analysis

In analysing the relationship between the selected socio-economic factors in determining the household WTP for water hyacinth control to Lake Tana choice model were used. Some studies on household's WTP cited in this study employed either a Tobit model (for instance Otieno et al., 2019 on Fisherfolks' WTP) or logit model (example see Khatri et al, 2018) in estimating the factors influencing WTP for water hyacinth depending on whether a random component is normally or logarithmically distributed (Breidert et al., 2006).

3.7.2 The Tobit Model

An alternative method to ordinary least square (OLS), when the dependent variable response is less or equal to zero for a significant fraction of the observation is the so-called Tobit model (Tobin, 1958). Following (Bigerna, 2014 & Neha, 2013), the study adopted the Tobit model for situations where the dependent variable is observed for values above zero but is censored for zero values or less than zero. In this study, households WTP is not directly observed and thus may take some zero values as well as positive values for the rest of the population. Given the unique properties and broad application of the Tobit model, it is used in this study for the observed maximum households WTP values. This model is superior due to its inclusive property

that is, it uses all information including those from censoring, and the ability to provide consistent estimates for all the parameter under investigation unlike other competing models (Genz et al, 2014). Depending on the modified payment card survey, each selection represents the actual outcome of households' WTP. Respondents can select their minimum or maximum bids from the PC, as a result, the choice variable indicating the WTP is observed in actual amount. Standard Tobit model is consistent (Batte et al, 2007) to construct an exact WTP premium. The study employed a Tobit model to investigate the results of the open-ended question, surveyed in CVM questionnaire to model the actual household's WTP for water hyacinth control. In the probit and logit model the dependent variable ($MWTP_i^*$) is not observed, what we observe is the dummy variable. However, in Tobit model the dependent variable, or the WTP, is partially observed and the dependent variable ($MWTP_i^*$) assumes zero values for a substantial part of the sample. That is, $MWTP_i^*$ is observed if $MWTP_i^* > 0$ and is not observed if $MWTP_i^* \leq 0$. If $MWTP^*$ and x_i were observed for everyone in the population, there would be nothing new, and we could use standard regression methods (ordinary least squares (OLS)) (Maddala, 1992). However, in this study since we deal with maximum WTP for water hyacinth control which is partly observed, therefore, using OLS leads bias and hence, this study employed Tobit model. Censored regression (Tobit) models generally apply when the variable to be explained is partly continuous. According to Maddala (1992) the equation for Tobit model is specified as:

$MWTP_i^* = \alpha + \beta x_i + \varepsilon_i$ …….. (2)

$MWTP_i = MWTP_i^*$ if $MWTP_i^* > 0$

$MWTP_i = 0$ if $MWTP_i^* \leq 0$

Where $MWTP_i^*$= is latent or unobserved willingness to pay for water hyacinth control ; $MWTP_i$ is a household's actual maximum willingness to pay for water hyacinth control ; X' is a vector of theoretically important independent or explanatory variables; β is vector of the coefficients or parameter vector common to all households; α is the intercept; and ε_i is a disturbance term, which is assumed to be normally and independently distributed with zero mean and constant variance σ^2 and is independent of x_i (Verbeek, 2004) . In other words, NID (0,δ^2) and independent of xi. Some of the households interviewed did not have any WTP, whereas,

some of them had WTP for water hyacinth control. For those not undertaking WTP is zero. In Tobit model the WTP is a random variable and has probability distribution and it is possible to determine each observations probability.

$$P(MWTP_i) = 0 = P\varepsilon_i < \beta x_i = 1 - F\beta x_i \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.. (3)$$

$$P(MWTP_i) > 0 = 1 - P(MWTP_i) = 0 = F\beta x_i$$

Where p is probability distribution and $F(\beta x_i)$ is cumulative density function.

The conditional distribution $MWTP_i^* \mid x$~normal (Xβ , δ^2)

δ^2 = var ($MWTP_i^* \mid x$) is assumed not to depend on X, and ε_i is a mean zero, costant variance error term. Let $\alpha_1 < \alpha_2 \dots\dots\dots < \alpha_J$ denote known boundaries limits and define as

$MWTP_i^*$ = 0 if $MWTP_i^{*\,*} \leq \alpha_1$

$MWTP_i^*$ = 1 if $\alpha_1 < MWTP_i^{*\,*} \leq \alpha_2$ ……………………………………………………………..(4)

⋮ ⋮

$MWTP_i^* = J$ if $MWTP_i^{*\,*} > \alpha_J$

In an analysis of the CVM survey, all the data should be substituted into the standard Tobit model for analyses. .The Tobit or censored regression latent variables can be used to obtain the forecast value of actual WTP price. That is,$E(mwtp_i)$ (Maddala, 1983) is as follows;

$$E(mwtp_i) = P(mwtp_i > 0) * E(mwtp_i \mid mwtp_i > 0) + P(mwtp_i = 0) * E(mwtp_i \mid mwtp_i = 0 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (5)$$

$$E(mwtp_i = \Phi_i\,(\beta x_i + \frac{\sigma\varphi}{\Phi}) + (1 - \Phi_i) * 0 = \Phi_i\,(\beta' x_i * \sigma\varphi_i$$

Where $E(mwtp_i)$ represents the expected $Wtp_i{}^*$price of the i^{th} respondent. The standard Tobit model is used to forecast the average benefit of $Wtp_i{}^*$ price. The $Wtp_i{}^*$ price obtained from the forecast of each observation point is used to obtain the estimate of its average benefit.

Maximum likelihood method will be used for this study to estimate the Tobit model. The log-likelihood function of the Tobit model can be written as follows.

$$\log L_1(\beta, \sigma^2) = \sum_{i \in I_0} \log \mathrm{P}\{Wtp_i^* = 0\} + \sum_{i \in I_1} [\log f(Wtp_i^* \mid Wtp_i^* > 0) + \log \mathrm{P}\{Wtp_i^* > 0\}]$$

$$= \sum_{i \in I_0} \log \mathrm{P}\{Wtp_i^* = 0\} + \sum_{i \in I_1} \log f(Wtp_i^*) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Where $f(.)$ is a generic notation for the density function. The last equality follows from the definition of a conditional density. I_0 and I_1 are index sets $of\ Wtp_i^*$ for the censored regression model and defined as the sets of those indices corresponding to the zero and the positive observations respectively. Here, $I_0 = \{i = 1, 2, \ldots, N;\ y_i = 0\}$. The following function can be obtained using the appropriate expressions for the normal distribution. The maximum likelihood estimates can be obtained via maximizing the function with respect to β and σ^2 (Verbeek, 2004).

$$\log L_1(\beta, \sigma^2) = \sum_{i \in I_0} \log\left[1 - \Phi\left(\frac{x_i'\beta}{\sigma}\right)\right] + \sum_{i \in I_0} \log\left[\frac{1}{\sqrt{2\pi\sigma^2}}\, exp\left\{-\frac{1}{2}\frac{(Wtp_i^* - x_i'\beta)^2}{\sigma^2}\right\}\right] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Where $\Phi(.)$ is the standard normal cumulative distribution function (CDF)

The Tobit coefficients do not directly give the marginal effects of the explanatory variables on the dependent variable. But their signs show the direction of change in probability of WTP as the respective explanatory variables changes. Therefore, it is not reasonable to interpret in the same way as the one interprets coefficients in an uncensored linear model (Johnston & Dinardo, 1997).

Hence, we should estimate the marginal effect of the Tobit model. Following Long (1997), McDonald & Maffitt (1980) the following techniques could be used to identify the effects of explanatory variables on the probability of WTP and the amount of households'WTP (the whole and willing respondents only). The change in the probability of willingness to pay for water hyacinth control as explanatory variables X_i changes was estimated by

$$\frac{\partial F(Z)}{\partial Xi} = f\ Z\frac{\beta}{\delta} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \quad (8)$$

The marginal effect of an explanatory variable on the expected value of willingness to pay was estimated by

$$\frac{\partial E(mwtp_i)}{\partial X_i} = F\ Z\beta \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \quad (9)$$

Similarly, the change in the probability of willingness to pay with respect to a change in explanatory variable among willing respondents was estimated by:

$$\frac{\partial E(mwtp_i, mwtp_i^* > 0)}{\partial X_i} = \beta\ 1 - Z\frac{fZ}{FZ} - \frac{fZ^2}{FZ} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (10)$$

Where Z=$\frac{X\beta}{\delta}$, F (z) is the cumulative normal distribution of Z, f(z) is the value of the a derivative of the normal curve at a given point(that is, unit normal density), Z is the Z-score for the area under the normal curve, β is the vector of Tobit maximum likelihood estimates and is the standard error of the error term.

Here we assume that censored point is zero because WTP is always non-negative and equal to the difference in utility from the status quo hypothetical control scenario of water hyacinth or specific level of cleaning. CVM studies include an estimation of the WTP function that depends on income and other socio-economic characteristics of the respondents.

Therefore, our empirical specification of the Tobit model assuming that censoring point is zero will be for urban household's resident response for water hyacinth control is:

$$Wtp_i^* = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} x_{10} + \beta_{11} x_{11} + \varepsilon_j \quad \text{if } MWTP_i^* > 0$$

$$= 0 \text{ Otherwise (if } MWTP_i^* \leq 0 \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots .. (11)$$

CHAPTER FOUR

ANALYSIS OF THE SURVEYED DATA AND RESULTS

This chapter deals with the empirical findings and discusses the results obtained. The data from the contingent valuation survey is analyzed in two ways. The first part used descriptive analysis with the help of summary statistics. Besides, an overview of the households' attitude towards the existing situation of water hyacinth in the lake is discussed and we analyzed and discussed Tobit model result, factors that affect the maximum amount of money that households are willing to pay from the surveyed data econometrically.

4.1 Descriptive Analysis and econometrics result

4.1.1 Response Rate

This section is a summary of the number of household respondents who gave response for surveyed questionnaire in the study with respect to the designed sample size. Table 4.1 shows the response rates.

Table 4.1: Response rate

	Predicted the sample size	Percentage	Sample used for analysis	percentage
Total Response	398	100.0	390	98
Total	398	100.0	390	98

A total of 390(98 percent) of the response was obtained after administration of CVM surveyed questionnaire of 398 (100 percent) from the stipulated sample size, this shows that the response was good and thus fit for data validation.

4.1.2 Socio-Economic Characteristics of Respondents

The basic information on sampled households is displayed in Table 4.2. Under the contingent valuation survey questionnaire, respondents were interviewed about their socioeconomic conditions. As it is revealed in the following Tables among the 398 households interviewed 83 percent is a male who had a positive WTP for water hyacinth control compared to female respondents (17.08 percent). The average age of respondents is 48 and the minimum and maximum are 25 and 79 years old, respectively.

All of them were decision makers since the study mainly focused on the interviewers' decision-making ability rather an aged member of the family. The minimum and a maximum number of household size or family members are 1 and 9, respectively while the average is 4.76. The minimum and the maximum number of household's member or family having job per family within the household's is 1 and 3, respectively while the average is 1.17.

The mean educational attainment of respondents is 13.69 years. When the minimum education is zero (illiterate), the maximum educational achievement is 20 years (PhD. level). Most of the time people do not provide accurate information about their income. For this reason, respondents were presented different questions that are proxy to income for a number of workers in the household that generate income or family member having a within the family, and monthly income of the household before tax. Accordingly, based on the survey the average monthly income of the sample households was ETB 4873.5, with a minimum monthly income of ETB 1000 and a maximum of ETB 16,451. As the level of income and education increased, so did the percentage of willing responses for the control of Water hyacinth.

Table 4.2 Summary of Descriptive statistics of Variables Used in the Analysis

Variables	Mean	Ste.dv	Min	Max
Mwtp	1011.436	877.0138	0	3500
Age	48.11538	11.28434	25	79
Nvst	1.294872	0.8347987	0	3
Arwh	0.9589744	0.1986043	0	1
Y	4873.5	3178.206	1000	16451
Hhs	4.766667	1.83354	1	9
Dist	2.719	0.849422	0.5	3.75
Educ	13.697	2.87096	0	20
Nhhmhj	1.176923	0.4081191	1	3
Gender	0.8282051	0.3776866	0	1
Mrs	0.8923	0.3103896	0	1
$vatl_{-1}$	0.4846154	0.50040	0	1
$vatl_{-2}$	0.325641	0.4692158	0	1
$vatl_{-3}$	0.1794872	0.3842527	0	1

Source; survey result (2019)

Table 4.3 Socio-Economic Characteristics of respondents

Qualitative variables	Frequency	Precent (%)
Gender(female)	68	17.43
Bussiness practice /fising	59	15.12
No education	28	7.17
Elementary School completion	189	48.46
Secondary School completion	101	28.9
College Diploma	35	8.97
University level	17	4.35

Respondents were also asked if they practice business (fishing activity). 15 percent of them do base their lives mainly on the production and supply of fresh fish to the surrounding hotel and communities in the city. The proximity of the house of the respondent to the Lake Tana ranges from 50 meters immediate to the lake to 3.75 kilometers. The average distance for the respondents is 2.72 kilometer with a minimum distance of 0.5 kilometers and a maximum of 3.75 kilometers.

4.1.3 Households' Willingness to Pay for Water hyacinth control

In the questionnaire, households were asked whether they are willing to pay for water hyacinth control for Lake Tana. Consequently, among the sample household heads, about 96 percent are willing to pay if the donated money is correctly used for weed cleaning. This indicates that the implementation of the project is supported by about 96 percent of households from the entire sampled respondents in general. Only 4 percent of respondents were not agreed to pay for conservation of the lake. 8 respondents were unwilling to respond for interviews while another 8 respondents are willing to donate money but they are unable to pay due to low monthly income.

Table 4.4 Willingness to pay of sampled respondents

Willingness to pay	Frequency	Percent (%)
Number of respondents Willing to donate	374	96
Number of respondents unwilling to donate	16	4
Total	390	100

Source; Survey data, 2019

4.1.4 The reason for zero willingness to pay

In the survey, 16 respondents were not willing to donate money among the entire sample for the proposed water hyacinth control program and reveal zero WTP. From these 16 respondents, 2 respondents revealed that they did not have enough income to pay for the proposed project, and 5 respondents disagreed with the program and they said that the government should take the responsibility and pay money for water hyacinth control. Similarly, out of unwilling respondents, 9 stated that they are afraid that the collected money will not be used for the conservation of the lake.

4.1.5 Importance of giving value for the lake

There are different reasons to attached value for the lake. Not only lakes but also other natural resources are attached to a different value by different people such as intrinsic value, recreation purpose, and source of income, existence value, and reserved for the future generation. From these, recreation and source of income are use-value and the remaining one; intrinsic value, existence value and use of future generation are non-use-value. The respondents were asked to indicate the value they attach to the lake and why they value the lake. A summary of these responses is indicated in the following table 4.5.

Table 4.5: Summary of reasons for giving value for Lake from survey questionnarie

Reasons	Household response	Percent (%)
Recreational value	122	31.28
Future generation	75	19.23
Source of income	193	49.48
Total	390	100

Source: summary of survey data, 2019

The most important reasons for attaching value to Lake Tana by surveyed respondents were for the source of income and recreation value. This may be due to the fact that Lake Tana is used for dual purposes; since hotels are built near to the lake and the riparian communities were also live

around the lake the practice business activity to supply fish to the hotel and city community entered generating income.

4.1.6 Households' attitudes towards water hyacinth control

Households attitudes towards conservation of Lake Tana are summarized in Table 4.6 about 30.07 percent of households expressed that lake Tana is important to maintaining biodiversity of the environment,about 27.17 percent of households responde that it is very important to moderate temperature which is climate condition in the city change over time while 25.89 percent and 25.12 percent of the households said the Lake serve as fish production for riparian community that generates income and recreational purpose that people derive utility in leisure time from the lake respectively. Lake Tana is also important for transportation service 3.84 percent and existence value 4.87 percent this may be due to the fact that the Lake is used for dual purposes; these are for transportation purposes and historical place with its cultural importance so that respondents want to transfer heritages from generation to generation. They have a strong attitude towards water hyacinth control from the Lake since Lake Tana is the life of the urban residents as well as the riparian community.

Table 4.6 Households' attitudes towards water hyacinth control

Attitudes	Actual response	Percentage
Meaintaining biodiversity	51	30.07
Transportaion services	15	3.84
Fishing production	101	25.89
Recrational purpose	98	25.12
Eistance value for future genration	19	4.87
Moderating temprature	106	27.17
Total	390	100

Source: Survey data, 2019

4.1.7 Households' perception on who is responsible for water hyacinth control

Interviewees were asked about their opinion on who is more responsible for the conservation of the Lake Tana. Accordingly, more than 50 percent of respondents believe that the federal government and other countries should take the main responsibility to protect the Lake from an infestation of water hyacinth. Whereas 23.58 percent argue that those use the Lake directly should take the responsibility and 22.56 percent of households (respondent) put this responsibility to the whole community. In addition, 3.84 percent of the respondent considered that it is the Amhara regional government responsibility.

The researcher also asked or surveys the respondent's problems they are observing around the lake and within the lake. Here, 64.35 percent of the respondent believed that reduction of volume of the Lake is the major problem currently in Lake Tana due to water hyacinth infestation whereas 24.35 percent of the respondents stated that pollution of the Lake in the surrounding area and the part of the Lake. Similarly, in the lake, only 6.41 percent respondents identified water quantity reduction problem followed by reducing the number of fish and its species 2.26 percent respondents who mentioned unwise usage or improper utilization of lake water as a problem was 2.31 percent.

Table 4.7 Households' perception on who is responsible for water hyacinth control

Responsible body	Respondents	Percentage (%)	Rank
The Federal government	195	50	1
The direct user of the lake	92	23.58	2
All community (user & non-user)	88	22.56	3
The regional gov't	15	3.84	4
Total	390	100	
Problems			
Reduction volume of the lake	251	64.35	1
Pollution around the lake	95	24.35	2
Water quality reduction	25	6.41	3

Improper utilization of the lake	9	2.26	5
Endangerment of different species of fish from the lake	10	2.31	4
Total	390	100	

Source; Stata version 14.0

4.1.8 Estimated Willingness to Pay Value

Through the use of the continuous open-bounded question, the mean one-time donations or WTP in Bahir dar households'is estimated at 1011.436 ETB as presented in Table 4.8.

Table 4.8: Estimated Willingness to Pay Value

DescriptiveStatistic				
a number of obeservation	Minimum	maximum	mean	st.devation
390	0	3500	1011.436	877.014

4.2 Empirical Analysis and Post-estimation results

The econometric analysis helps in providing more insight about factors influncing of WTP, mainly socio-economic variables and resource characteristics that affect responses of households to CV survey questions. The WTP question is presented for both direct user and non-user of the lake during the served time. The general approach of this technique is to estimate a valuation function that relates the hypothesized factors influncing households' WTP response. The variables to be included in the models were mainly based on the degree of theoretical importance and their significant impact on WTP.

Data exploration is an important preliminary step before estimation is done. Accordingly, the correlation matrix generated using the data shows that multicollinearity is not a serious problem in our case since the value of variance inflation factor (vif) is 3.50 which is less than 10 (see appendix). For heteroscedasticity, the study used a couple of tests that come handy to establish the presence or absence of heteroscedasticity using the "symmetrically censored least square (SCLS) test"**.** In our case, we used the command "SCLS" that performs consistently after regression of the model. From the "SCLS" we got prob >chi2= 0.1268 which is greater than a significance level of 5 percent, therefore we fail to reject the null hypothesis (that variance of

residuals is constant) and therefore we infer that the residuals are homoscedastic i.e. heteroscedasticity is not a problem for the model. Testing normality of the error term for the surveyed data we used the SK & tobitcm STATA command to test the Tobit assumptions. From the two test statistics we gote the p-value of (0.08) significance at 5 percent levels and in the conditional movement test (tobitcm) value of 4.47 which is less than 10 percent, 5 percent & 1 percent significance level i.e the error term is normally distributed in both tests(see table 4.9). 'Linktest' for joint model specification as indicated in Table 4.8 was executed and it was found that the probability of 'hatsq' is 0.058 equivalents to 5.8 percent which is good for model specification error. Therefore, this indicates that the Tobit model used has integrity and is appropriate.

Table 4.9: Specification Test for Tobit Statistical model

```
. linktest, ll

Tobit regression                                Number of obs     =        390
                                                LR chi2(2)        =     252.34
                                                Prob > chi2       =     0.0000
Log likelihood = -2968.6772                     Pseudo R2         =     0.0408

------------------------------------------------------------------------------
        mwtp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _hat |   .7286949   .1519204     4.80   0.000     .4300047    1.027385
     _hatsq |   .0001133   .0000595     1.91   0.058    -3.63e-06    .0002302
      _cons |   114.9047   86.94309     1.32   0.187    -56.03378    285.8433
-------------+----------------------------------------------------------------
      /sigma |   649.1471   23.89307                      602.1711    696.1232
------------------------------------------------------------------------------
```

Table 4.10: Normality test for the error term

```
. sktest ei

                    Skewness/Kurtosis tests for Normality
                                                                ------ joint ------
    Variable |        Obs  Pr(Skewness)  Pr(Kurtosis) adj chi2(2)    Prob>chi2
-------------+-------------------------------------------------------------------
          ei |        390      0.0249        0.9787        5.04          0.0803


.  set seed 10000

. tobcm, pbs reps(100)

Conditional moment test against the null of normal errors

                    critical values
    CM         %10         %5          %1
    4.472    7.63403   11.029723 25.34673


. hausman scls tobit, equation(1:1)

                      b = consistent under Ho and Ha; obtained from scls
           B = inconsistent under Ha, efficient under Ho; obtained from tobit

    Test:  Ho:  difference in coefficients not systematic

                 chi2(12) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =      17.65
                Prob>chi2 =     0.1268
```

4.3 Econometric Results

This section summarises the estimation result of the Tobit regression model in equation (2) presented in chapter three on the factors influencing MWTP value for WH control. Sections 4.2.2 present the results on the factors influencing the MWTP value.

4.3.1 The Results of Tobit regression model

Table 4.11; Maximum Likelihood Estimates of the Tobit model

Explanatory variales	Coef	Std.Err.	T	P>|t|	[95% Conf.	Interval]
Age	-3.1344	3.41747	-0.92	0.36	-9.8541	3.58525
Nvst	31.8195	41.6899	0.76	0.446	-50.154	113.793
Y	0.03416	0.01362	2.51	0.013**	0.00737	0.06095
Hhs	49.0528	20.7849	2.36	0.019**	8.18397	89.9216
Dist	20.7419	41.5271	0.5	0.618	-60.912	102.396
Educ	93.6635	16.371	5.72	0.000***	61.4736	125.853
Nhhmhj	925.206	89.1752	10.38	0.000***	749.863	1100.55
1.arwh	451.841	179.634	2.52	0.012**	98.6303	805.052
1.gender	67.188	91.9828	0.73	0.466	-113.68	248.052
1.mrs	35.2937	112.604	0.31	0.754	-186.12	256.703
1.vatl$_{-1}$	240.898	237.001	1.02	0.31	-225.11	706.906
1.vatl$_{-2}$	228.999	238.054	0.96	0.337	-239.08	697.078
1.vatl$_{-3}$	153.823	247.533	0.62	0.535	-332.9	640.541
_cons	-2463.3	398.502	-6.18	0.000	-3246.9	-1679.8
/sigma /	652.92	24.0194	--	--	605.691	700.149

Number of obs = 390

LR chi2 (13) = 248.74

Prob > chi2 = 0.0000

Log likelihood = -2970. 4

Pseudo R2	=	0.0402

** Significant at 5 percent *** significant at 1 percent

Using continuous CVM, respondents were asked to give the maximum amount of money they are willing to pay for WH control. Since the dependent variable (MWTP) cannot be fully observed (it is censored at zero) and that an OLS (ordinary least squares) estimator cannot be applied, a Tobit model for the observed MWTP value was employed. The Tobit regression results of factors influencing MWTP value for water hyacinth cleaning showing the coefficients, standard errors, significance levels, and the constant together with the log-likelihood value, Chi-Square, Pseudo R-square and the overall significance of the model is presented in Table 4.8. In order to test for the goodness of fit, the Pseudo R-squared was used. The Tobit regression gave a Pseudo R-squared of 0.0402. The explanatory power of the model increases by 0.0402, suggesting that approximately 4 percent of the variation in MWTP value is explained by the explanatory variables. But, the pseudo R2 of 0.0402 is not surprising, given that the conventional measure of goodness of fit of it is not particularly meaningful in binary regressed models. The likelihood ratio chi-square of 248.74 degrees of feerdem (DF=13) with a p-value of 0.0000 means that the joint significance test of all variables in the model is significant at 1% level as $P<0.05$, implying that the variables correctly predict the model.

From the above Table 4.11, Tobit regression result we have 5 statistically significant , positive effect on MWTP and met the priory decision for the sign of the coefficients from 11 explanatory variables such as awareness of water hyacinth as a problem , the household's income ,household size ,educational level of households ,and number of household's member having job. Awareness of WH was positive and statistically significant at 5 percent which has a positive effect on the household's MWTP for its control. Since knowledge of the problem associated with the invasion of WH did have a positive effect on MWTP i.e households had more information about the problem they conveyed or concern for the environment that they live it.

Households' income (as proxiy of households' monthly food expenditure) was another significant variable at 5 percent and a positive relationship with the MWTP value. This showed that an increased head of household income resulted in an increase in the maximum amount of money a household head would be MWTP for control of WH. It was therefore evidenced that wealthy households were more MWTP for its control than the poor household's. This is consistent with expectation depend on theoretical literature weather household were more willing to pay for environmental protection. This is also an indication that people were making "real decisions". The study by Otieno et al, (2019), & Mironga, (2015) were found the same result. Household size also significantly and positively at 5 percent influences the household willingness to pay. Chuen-Khee & Othman (2002) pointed out that the more the number of people in the household, the more willing the household will appreciate a clean environment.

The number of household's member having job found to be significant (1 percent) and positive effect on MWTP as the income of the household member increase that they were live in any place and do anything was more willing to pay for clearing of the lake from water hyacinth.educational level was positive and statistically significant at 1 percent level, suggesting that highly educated household heads had a higher willingness to pay for WH control program. This is true because education is believed to increase individuals' ability to obtain, analyze and assimilate information that helps to make prudent decisions related to the management of their environment. In this instance, educated people will have a better understanding of the negative impacts of water hyacinth and working in infested areas of water hyacinth is the risk of catching water born disease and lack of clean water possibility. The variables number of visit to the lake, marital status, and value attached to the lake and gender were insignificant but, met the priory decision for the sign of the coefficients except for the variable age.

4.3.2 Factors influncing Households' MWTP value for water hyacinth control

Eleven explanatory variables were included in the Tobit model to predict its influence on households' MWTP for water hyacinth control. Table 4.12 shows the sign, magnitude, statistical tests, marginal effects and a significance level of each explanatory variable. Out of the 11 variables hypothesized to influence households' MWTP, 5 explanatory variables were found to be statistically significe at 1 and 5 percent levels. These variables are an educational level of

household's, awareness of WH as a problem, number of household's member having a job, households' income and household size. The other 6 explanatory variables have insignificant effect on the amount of MWTP for WH control but the significance one.

However, the interpretation of the Tobit regression model is not straightforward like that of linear model. That is, the marginal effects cannot be adequately explained from the estimated coefficients of the Tobit model (see Table 4.12 below). Therefore, to intereprate the results the researcher report three sets of marginal effects: i.e the effect on the probability of a positive MWTP, the effect on conditional MWTP, and the effect on unconditional MWTP.

To be more specific, household's monthly incomes (as a proxiy of households' monthly food expenditure) have a positive and significant association with the households MWTP for WH control. That is, when the income of the household increase by one Birr, it would increase the probability of willingness of a household to pay for WH control by about 0.00065 percent. Besides, when the income of the household increase by one birr their willingness to pay would increase, on average, by about 0.032 ETB for all observation and 0.0266 ETB for willing respondents',ceteris paribus. This shows that conservation of Lake from WH infestation is a normal economic good whose demand changes or increases in the direction of income change which confirms the economic theory which says that income and quantity demanded to a particular commodity are positively related for the case of normal goods.

Respondents with higher education levels were more likely to state positive MWTP, and on average, they actually stated higher conditional and unconditional MWTP than respondents with lower educational levels (illiterate one). This result suggests that investing in the education of people might help to control or restore lake resource in a degraded environment. The marginal effect of the result shows that the respondent being educated, the probability of willingness to pay for water hyacinth control increases by 1.8 percent. Also, as the years of education increases by one year, the amount of cash the household is willing to pay for WH control increase by 87.69ETB for the whole sample of the study, and 72.95 Birrs for the willing respondents, Ceteris paribus. The variables awareness of WH also has a positive and significant effect at 5 percent level which has a positive effect on the amount of households MWTP.

In terms of awareness to WH, a unit changes from 0 (not aware) to 1 (aware) the probability of being willing to pay increases by 13.5 percent. That is, the marginal effect result shows that a unit changes from 0 (not aware) to 1 (aware), the willingness to pay increased by 398.3 ETB and 311.5 ETB for the whole and willing respondents respectively, ceteris paribus.When respondents have better knowledge or information about the problems associated WH would be able to make a better valuation assessment.

The estimated coefficients household size and a number of the household member having a job was also found to be statistically significant with expected have positive value on the amount of MWTP. Indicating the probability of MWTP to support the control of WH project increases as the household size increase, holding, the influence of other factors, constant an increase household size by one member within the household, increased the probability of MWTP by about 0.938 percent. According to marginal effects, as the household size increases by one person within the household's, the expected MWTP value increased by 45.93 ETB for the entire population and 38.21 ETB for observations with positive MWTP respondents. This is because the households may feel secure of their right to use the Lake resource after control. Numbers of household's member having a job were another variable found to be a significant and positive effect on MWTP. Members of household work in any place that generates income increase by one Birr; it would increase the probability of willingness of a household to pay for water hyacinth control by about 17.7 percent. Besides, when the income of the household member within the household increase by one birr their willingness to pay would increase, on average, by about 866.20 ETB for all observation and 720.60 ETB for willing respondents',ceteris paribus.

Table 4.12: Results of Tobit regression model: Dependent variable: MWTP Value; 390 observations

				Marginal effects (dy/dx) 1, 2, & 3.		
Variables	Coef	std.err	t-value	prob(1)	truncated(2)	censored(3)
Age	-3.1344	3.41747	-0.92	-0.0006	-2.441	-2.935
Nvst	31.8195	41.6899	0.76	0.00609	24.78	29.79
Y	0.03416	0.01362	2.51 **	6.5E-06	0.0266	0.032
Hhs	49.0528	20.7849	2.36**	0.00938	38.21	45.93
Dist	20.7419	41.5271	0.50	0.00397	16.16	19.42
Educ	93.6635	16.371	5.72 ***	0.0179	72.95	87.69
Nhhmhj	925.206	89.1752	10.38***	0.177	720.6	866.2
1.arwh	451.841	179.634	2.52 **	0.135	311.5	398.3
1.gender	67.188	91.9828	0.73	0.0135	51.73	62.61
1.mrs	35.2937	112.604	0.31	0.00697	27.29	32.95
1.vatl$_{-1}$	240.898	237.001	1.02	0.046	187.8	225.4
1.vatl$_{-2}$	228.999	238.054	0.96	0.0401	181.8	215.9
1.vatl$_{-3}$	153.823	247.533	0.62	0.0262	122.2	145.3
/sigma /	652.92	24.0194				
N	390	390	390	390	390	390

(dy/dx) for discrete change of dummy variables from 0 to 1

.esttab coef prob, truncated, censored, p star(0.1 ** 0.05 *** 0.01) margin mtitles nostar b(% 9.5g)*

[1] *Marginal effects on the probability of being censored.*

[2] *Marginal effects on the truncated expected value (Observations with positive WtP)*

[3] *Marginal effects on the censored expected value (the total observations)*

Source; survey result (2019)

4.3.3 Estimating Aggregate Willingness to Pay

Hence, we can calculate total MWTP for a one-time donation by multiplying the mid WTP value by the total number of households in the city. In this study, the aggregate value of willingness to pay of the household from the total sample was estimated to77, 624,226.2 ETB using population figure. The true willingness-to-pay value (with protest responses eliminated from the sample in advance) was used as the average individual value of willingness-to-pay for aggregation purposes

The results can serve as a starting point for cost-benefit analysis of degraded lake resources rehabilitation related policies. These results, which are shown in Table 4.6, suggest that if a policy aiming at promoting rehabilitation of degraded lake resource and use requires charging a price within the above range, households would be willing to pay for it. The information obtained from the household maximum willingness to pay result can also be used to draw the demand curve and to make aggregation for the willingness to pay for recovering of degraded lake resource activities. The demand curve for willingness to pay for control of water hyacinth is derived to see the extent of cost recovery. The demand curve can be derived in terms of the total number of households and their associated mid-WTP.

Table 4.13: Total One-time MWTP Estimats for water hyacinth control

WTP (in ETB for a one-time donation) (A)	Frequency of sample distribution		MidWtp (D)	Total no. of households(E) **E= C*63,916**	Total WTP (in ETB) (F) **F= E*D**
	Number (B)	Percent (%) (C) , **B/100=C**			
0	16	4.10	0	0	0
100-250	71	18.21	176	11635.9896	2047934.17
251-350	37	9.49	301	6063.82533	1825211.42
351-450	31	7.95	401	5080.5026	2037281.54
451-600	32	8.21	526	5244.38961	2758548.93
601-800	21	5.38	701	3441.63052	2412582.99

801-950	13	3.33	876	2130.53312	1866347.01
951-1000	28	7.18	976	4588.84091	4478708.73
1001-1250	14	3.59	1126	2294.42078	2583517.8
1251-1400	9	2.31	1326	1474.98442	1955829.34
1401-1500	17	4.34	1451	2786.08182	4042604.72
1501-1600	5	1.28	1551	819.435717	1270944.8
1601-1750	6	1.54	1676	983.323372	1648049.97
1751-1850	8	2.05	1801	1311.0974	2361286.42
1851-1900	10	2.56	1876	1638.87207	3074524
1901-2000	19	4.87	1951	3113.85649	6075134.01
2001-2250	11	2.82	2126	1802.75909	3832665.83
2251-2500	15	3.85	2376	2458.30779	5840939.31
2501-2700	8	2.05	2601	1311.0974	3410164.34
2701-3000	13	3.33	2851	2130.53312	6074149.93
3001-3500	6	1.54	3250	983.323372	3195800.96
Total	390	100		63,919	77,624,226.2

Source: Own survey result

4.3.4 Aggregate Demand for Water Hyacinth control

The demand for WH control at different price level is shown graphically in figure 2 below. The demand curve is derived with a midpoint value of the maximum willingness to pay on the horizontal axis and a total number of willing urban households on the vertical axis.

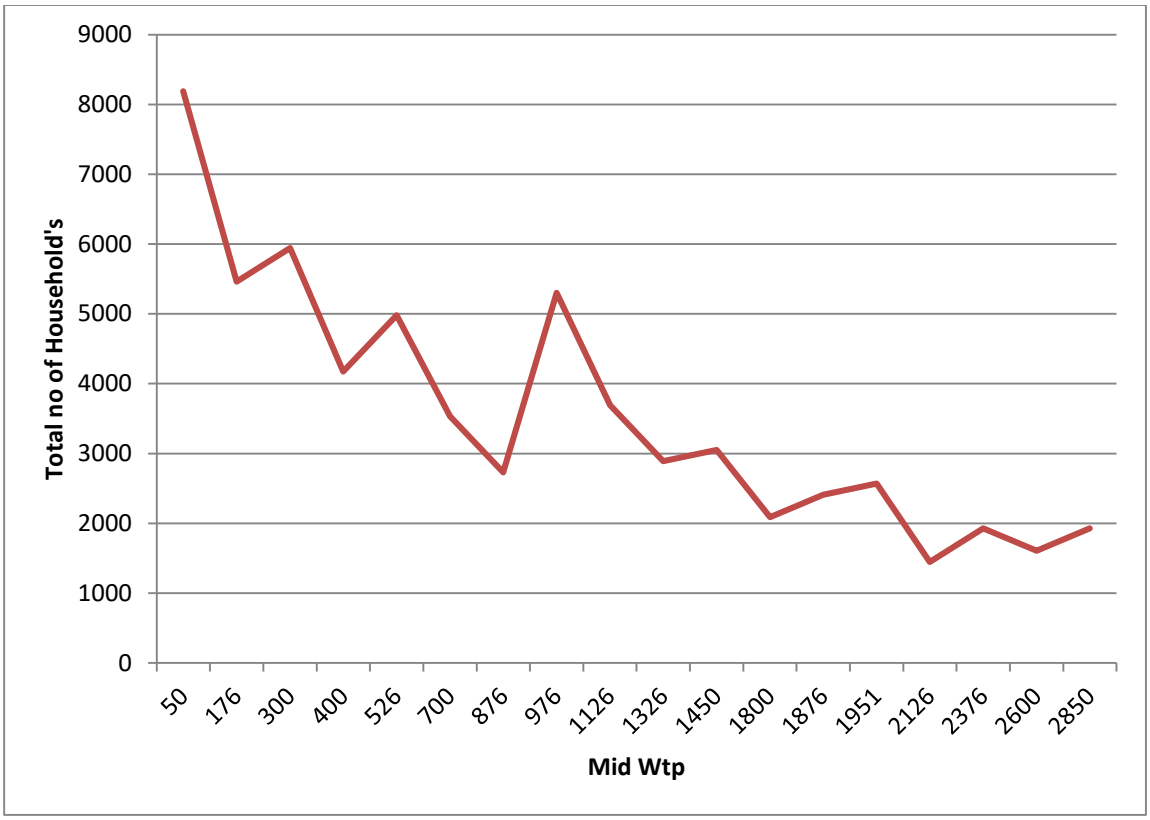


Figure 4.1 Aggregate Demand Curve for water hyacinth (WH) control

We note from the above figure, the demand curve is the zigzag line (slightly negative slope), indicating that demand for water hyacinth control project was decline as the bid amounts (prices in the proposed payment card) increases for control or recovery of degraded Lake resources, like most other economic goods, other things remaining the same. If Lake is considered as a free resource to the society, the consumers' surplus would be the total area under the demand curve. The area under the demand curve represents the gross value of consumers' surplus if they are not paying anything for the recovery of a lake infested by water hyacinth.

CHAPTER FIVE

CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Conclusions

The aim of this study is to assess urban households' of Bahir Dar city conservation of the Lake Tana and their willingness to pay (WTP) for WH control. We used a contingent valuation approach with a payment card elicitation format followed by open-ended questions. We administered our survey via in-person interviews with 398 sampled household heads and used 11 explanatory variables in the regression models based on the degree of theoretical importance and their impact on WTP. Tobit model were used to identify factors influencing households' WTP for WH control and to analyze the mean WTP of households.

From the study, it is apparent that the majority of the urban households were willing to pay for the cleaning of WH from the Lake with varying degrees of amount while some protested and some were outliers. On the estimation of willingness to pay (WTP), 96 percent (374) of the households were willing to pay with an average amount of 1011.436 ETB while 4 percent (16) of the households were not. The mean WTP for WH control for a one-time donation per household from the Tobit analysis (using payment cared elicitation format) is ETB 1011.436, with a total contribution of 77,624,226.2 ETB for a one-time donation. The other objective was to examine socio-economic factors influencing households' WTP decisions for WH control to Lake Tana. From the Tobit regression result, factors that positively affected WTP of the households' for WH control to the Lake include: household's income, awareness of WH and household size, were significant at 5 percent and number of household's member having job and educational level of household's, were also significant at 1% level that met the priory decision for the sign of the coefficients while gender of household head, value attached to the lake, number of visits, and marital status of the household aware met the priory decision for the sign of the coefficients except for the variable age and distance of household's home to the lake.

5.2 Policy Recommendations

- To bring a sustainable solution on the management (control) of WH, the national and/or the regional government(s) should co-operate with rural and urban households or communities this is because households reveal greater willingness to pay values for water hyacinth control as we found from contingent valuation survey.
- This study found that awareness (knowledge) on problems of WH to the Lake influenced positively the magnitude of WTP because of the high level of awareness of communities. In order to raise this awareness, there is a need for creating Co-operation among different Districts, for the conservation of wetlands and to built catchment areas.
- This study found a positive response from urban households would be willing to give up obtaining clan Lake fromWH. The authorities should consider this opportunity to raise funds for wetland protection, as the project in charge of protecting this wetland will be ending soon.
- The regional government should solved upper and pre-catchment problems and built Buffer zone or core zone line between the lake and farming land areas to enhance wetlands and reserve for catchment areas.

5.3 Research Limitations

Firstly, this study is mainly based on cross-sectional data. Such kind of data limits the analysis of the dynamics. For this reason, use of panel data for future research is recommended.

Secondly, this study was carried out from a sample of households depicted randomly from 6 zones of Bahir dar city in Amhara region, Ethiopia with out including rural households. Thus, the findings might be region-specific. Future studies could use samples of households from other regions in the country or from other national contexts of a similar set-up to test and extend the generalisations of the findings.

Thridly, The CVM technique employed for this study, however, suffers from one major drawback despite its ability to measure total economic values. The hypothetical nature of the questions used in CVM surveys may pose problems since respondents may have little incentive to provide information on their true MWTP.

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Appendex

Sample size determination $n = \frac{N}{1+N(e)^2} = \frac{63,916}{1+63,916(0.05)^2} = \frac{63,916}{160.79}$ =397.512283 ≈ 398

Tobit regression results

```
. tobit mwtp age nvst arwh y hhs dist educ nhhmhj gender mrs vatl1 vatl2 vatl3, ll

Tobit regression                                  Number of obs     =        390
                                                  LR chi2(13)       =     248.74
                                                  Prob > chi2       =     0.0000
Log likelihood = -2970.4751                       Pseudo R2         =     0.0402

------------------------------------------------------------------------------
        mwtp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         age |  -3.134445   3.417472    -0.92   0.360     -9.85414     3.58525
        nvst |   31.81945   41.68993     0.76   0.446    -50.15448    113.7934
        arwh |   451.8408   179.6342     2.52   0.012     98.63029    805.0514
           y |   .0341601   .0136231     2.51   0.013     .0073732     .060947
         hhs |    49.0528   20.78489     2.36   0.019     8.183965    89.92164
        dist |   20.74188   41.52705     0.50   0.618    -60.91178    102.3955
        educ |   93.66353     16.371     5.72   0.000     61.47362    125.8534
      nhhmhj |   925.2058   89.17524    10.38   0.000     749.8627    1100.549
      gender |   67.18795   91.98275     0.73   0.466    -113.6756    248.0515
         mrs |   35.29365   112.6035     0.31   0.754    -186.1159    256.7032
       vatl1 |   240.8979   237.0005     1.02   0.310    -225.1105    706.9063
       vatl2 |   228.9987   238.0538     0.96   0.337    -239.0808    697.0782
       vatl3 |   153.8227   247.5331     0.62   0.535    -332.8958    640.5413
       _cons |  -2463.327   398.5023    -6.18   0.000    -3246.892   -1679.761
-------------+----------------------------------------------------------------
      /sigma |   652.9197   24.01939                      605.6909    700.1485
------------------------------------------------------------------------------
    16  left-censored observations at mwtp <= 0
   374     uncensored observations
     0 right-censored observations
```

```
. linktest, ll

Tobit regression                                Number of obs     =        390
                                                LR chi2(2)        =     252.34
                                                Prob > chi2       =     0.0000
Log likelihood = -2968.6772                     Pseudo R2         =     0.0408

------------------------------------------------------------------------------
        mwtp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         hat |   .7286949   .1519204     4.80   0.000     .4300047    1.027385
       _hatsq |   .0001133   .0000595     1.91   0.058    -3.63e-06    .0002302
       _cons |   114.9047   86.94309     1.32   0.187    -56.03378    285.8433
-------------+----------------------------------------------------------------
       /sigma |   649.1471   23.89307                      602.1711    696.1232
------------------------------------------------------------------------------
        16  left-censored observations at mwtp <= 0
       374     uncensored observations
         0 right-censored observations

. vif
    Variable |       VIF       1/VIF
-------------+----------------------
     1.arwh |      1.10    0.909141
   1.gender |      1.08    0.922883
     1.mrs |      1.09    0.914349
     1.vat11 |     12.83    0.077964
     1.vat12 |     11.38    0.087873
     1.vat13 |      8.25    0.121241
         age |      1.34    0.745509
        nvst |      1.10    0.909738
           Y |      1.71    0.586386
         hhs |      1.31    0.762069
        dist |      1.13    0.885961
        educ |      1.99    0.501468
      nhhmhj |      1.21    0.829741
-------------+----------------------
    Mean VIF |      3.50
```

. corr
(obs=390)

	hhcode	mwtp	age	nvst	arwh	y	hhs
hhcode	1.0000						
mwtp	0.0011	1.0000					
age	0.0899	0.0197	1.0000				
nvst	0.2623	0.0902	-0.0573	1.0000			
arwh	0.1536	0.1902	0.0187	0.1972	1.0000		
y	0.0514	0.4271	0.1378	0.0373	0.1433	1.0000	
hhs	0.2324	0.1486	0.4292	0.0434	0.0584	0.1546	1.0000
dist	0.3849	-0.1444	-0.0360	0.0332	-0.0677	-0.1009	0.0299
educ	0.0046	0.5391	-0.0261	0.1560	0.2037	0.6140	0.1678
nhhmhj	0.0137	0.4112	0.0842	0.0259	0.0506	0.1705	0.1757
gender	0.0399	0.1131	0.0936	0.0815	0.0412	0.1494	0.1038
mrs	0.0248	0.1077	0.1927	-0.0392	-0.0287	0.1291	0.1937
vatl1	0.0285	-0.0489	0.0175	-0.1460	-0.0840	-0.0397	-0.0670
vatl2	0.0308	0.0734	0.0666	0.0737	0.0895	0.0695	0.0831
vatl3	-0.0734	-0.0061	-0.1124	0.0910	0.0294	-0.0566	-0.0280

	dist	educ	nhhmhj	gender	mrs	vatl1	vatl2
dist	1.0000						
educ	-0.1663	1.0000					
nhhmhj	-0.1848	0.2614	1.0000				
gender	-0.0529	0.2181	0.0307	1.0000			
mrs	-0.0288	0.1769	0.0391	0.0849	1.0000		
vatl1	0.1230	-0.1025	0.0147	0.0264	-0.0691	1.0000	
vatl2	-0.0500	0.0502	0.0120	-0.0242	0.0615	-0.6559	1.0000
vatl3	-0.0900	0.0559	-0.0118	-0.0316	0.0078	-0.4535	-0.3269

	vatl3
vatl3	1.0000

```
. eststo prob: mfx compute, predict(p(0,.))

Marginal effects after tobit
      y  = Pr(mwtp>0) (predict, p(0,.))
         =  .93623787
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-.0005997	.00066	-0.91	0.361	-.001886	.000687	48.1154
nvst	.0060876	.008	0.76	0.447	-.00959	.021765	1.29487
arwh*	.1345207	.07458	1.80	0.071	-.011661	.280702	.958974
y	6.54e-06	.00000	2.44	0.015	1.3e-06	.000012	4873.5
hhs	.0093846	.00407	2.30	0.021	.001398	.017371	4.76667
dist	.0039682	.00795	0.50	0.618	-.011622	.019559	2.72103
educ	.0179193	.00356	5.04	0.000	.010945	.024894	13.6974
nhhmhj	.1770064	.02368	7.48	0.000	.130602	.223411	1.17692
gender*	.0135326	.01951	0.69	0.488	-.024716	.051781	.828205
mrs*	.0069735	.02298	0.30	0.761	-.038058	.052005	.892308
vatl1*	.0460346	.04576	1.01	0.314	-.043654	.135723	.484615
vatl2*	.0401451	.03856	1.04	0.298	-.035428	.115718	.325641
vatl3*	.0262492	.03755	0.70	0.485	-.047352	.09985	.179487

(*) dy/dx is for discrete change of dummy variable from 0 to 1

```
. eststo truncated: mfx compute, predict(e(0,.))

Marginal effects after tobit
      y  = E(mwtp|mwtp>0) (predict, e(0,.))
         =  1082.1222
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-2.441336	2.66229	-0.92	0.359	-7.65932	2.77665	48.1154
nvst	24.78333	32.474	0.76	0.445	-38.8638	88.4304	1.29487
arwh*	311.4845	107.44	2.90	0.004	100.909	522.06	.958974
y	.0266064	.01063	2.50	0.012	.00577	.047443	4873.5
hhs	38.20593	16.213	2.36	0.018	6.42994	69.9819	4.76667
dist	16.1553	32.345	0.50	0.617	-47.2406	79.5512	2.72103
educ	72.95205	12.869	5.67	0.000	47.7299	98.1742	13.6974
nhhmhj	720.6184	71.85	10.03	0.000	579.795	861.442	1.17692
gender*	51.72688	69.992	0.74	0.460	-85.4544	188.908	.828205
mrs*	27.29127	86.436	0.32	0.752	-142.12	196.702	.892308
vatl1*	187.8147	184.86	1.02	0.310	-174.506	550.135	.484615
vatl2*	181.8205	192.42	0.94	0.345	-195.32	558.961	.325641
vatl3*	122.7507	202.11	0.61	0.544	-273.376	518.877	.179487

(*) dy/dx is for discrete change of dummy variable from 0 to 1

```
. eststo censored: mfx compute, predict(ystar(0,.))

Marginal effects after tobit
      y  = E(mwtp*|mwtp>0) (predict, ystar(0,.))
         =  1013.1237
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
age	-2.934586	3.19959	-0.92	0.359	-9.20567	3.3365	48.1154
nvst	29.79057	39.031	0.76	0.445	-46.7088	106.29	1.29487
arwh*	398.3227	145.69	2.73	0.006	112.778	683.867	.958974
y	.031982	.01276	2.51	0.012	.006977	.056987	4873.5
hhs	45.92509	19.462	2.36	0.018	7.77975	84.0704	4.76667
dist	19.41933	38.879	0.50	0.617	-56.782	95.6207	2.72103
educ	87.69134	15.343	5.72	0.000	57.6187	117.764	13.6974
nhhmhj	866.2127	83.931	10.32	0.000	701.712	1030.71	1.17692
gender*	62.60728	85.29	0.73	0.463	-104.558	229.773	.828205
mrs*	32.94741	104.8	0.31	0.753	-172.464	238.359	.892308
vatl1*	225.4493	221.48	1.02	0.309	-208.64	659.539	.484615
vatl2*	215.8553	225.63	0.96	0.339	-226.37	658.081	.325641
vatl3*	145.3208	235.74	0.62	0.538	-316.715	607.357	.179487

```
(*) dy/dx is for discrete change of dummy variable from 0 to 1

. esttab prob truncated censored, margin mtitles nostar cells(b) b(%9.7g) keep(model:) replace
```

	(1) prob b	(2) truncated b	(3) censored b
model			
age	-.0005997	-2.441336	-2.934586
nvst	.0060876	24.78333	29.79057
arwh (d)	.1345207	311.4845	398.3227
y	6.54e-06	.0266064	.031982
hhs	.0093846	38.20593	45.92509
dist	.0039682	16.1553	19.41933
educ	.0179193	72.95205	87.69134
nhhmhj	.1770064	720.6184	866.2127
gender (d)	.0135326	51.72688	62.60728
mrs (d)	.0069735	27.29127	32.94741
vatl1 (d)	.0460346	187.8147	225.4493
vatl2 (d)	.0401451	181.8205	215.8553
vatl3 (d)	.0262492	122.7507	145.3208
N	390	390	390

```
Marginal effects
```

Appendices

Appendix I: Questionnaire Used for the Survey

Addis Ababa University

Department of Economics

Survey Questionnaire

"Willingness to pay (WTP) for the benefits of water hyacinth control to Lake Tana for the residential area of Bahir Dar city households"

This survey is designed to gather information about how much you value the function of the lake. The purpose of this study is to know our willingness to pay for the control of water hyacinth to Lake Tana. This is purely academic research and has nothing to do with governmental or non- governmental organization. You are selected from that household within the city due to its location with regard to the lake. Therefore I kindly request you to give me a genuine answer to the following questions. Your genuine answer would help to bring a sustainable resource (lake) management through informed decision making. This survey will take about 15 minutes to complete. Thank you for taking part in the survey.

Tesfa Getnet
Addis Ababa University

Date of Interview	Date	Month	Year
			2011/2019
Code of Household Head			

Section One: Respondents' awareness of the current situation with Water Hyacinth in Lake Tana.

To take part in this survey it is important that you are at least 18 years old due to the fact that some of the survey questions are about income. Are you 18 years old?

1 □ Yes 2 □ No

(If yes, continue…….)

As you probably already know, there is a species of aquatic plant living on Lake Tana called water hyacinth (Local Name Emboch).

1.1 Have you noticed any water hyacinth on Lake Tana?

1 □ Yes 2 □ No

1.2 If yes, have you noticed an increase in the amount of water hyacinth in the Lake in the past year?

1 □ Yes 2 □ No

1.3 Do you think that the presence of water hyacinth is a problem?

1 □ Yes 2 □ No

1.4 If yes, why do you think water hyacinth is problematic?

_____

1.5 Can you think of any benefits that you would receive from the clearing of water hyacinth?

1 □ Yes 2 □ No

1.6 If yes to question number 1.5, please specify_____

1.7 Has water hyacinth imposed any cost on you or anyone else in your household?

1 □ Yes 2 □ No

1.8 If yes to question number 1.7, please specify_____

1.9 Do you or your household member visit the lake?

1 □ Yes 2 □ No

(If yes, continue…….)

1.10 About how often do you visit the lake per Month_____?

1.11 Do you think that the presence of water hyacinth in the lake affected your visit?

1 □ Yes 2 □ No

1.12 Do you watch any programs on TV that deal with water hyacinth problem?

1 □ Yes 2 □ No

1.13 How far is the Lake Tana from your house? _____ Kilometer

1.14 What about the total economic values of the Lake (i.e. biological and global life supports, Climate modulation, Recreational value (Tourist attraction), Fish production, etc.?

1 □ Very high 2 □ High 3 □ Medium 4 □ Low

1.15 What is the reason, why you give the value for the lake?

1 □ Recreation purpose 3 □ reserving for the future generation

2 □ Source of income

1.16 Which problem do you observed in the Lake most frequently? (You can tick more than one alternative)

1 □ Reduction in water quality

2 □ Pollution in surrounding area and a part of the lake

3 □ the water quantity of the lake reduces through time due to Water Hyacinth.

4 □ Endangerment of different species from the lake

5 □ improper utilization of the lake resource

6 □ Disposal of (Solid &Liquid) wastes to the Lake.

7 □ other (please state) _____

1.17 In your view who is more responsible body for the Control of Water Hyacinth from the lake?

1 □ The Amhara Regional government 4 □ All community (user and non-user)

2 □ The Federal Government 5 □ Recreational site owner and direct user

3 □ Visitors' 6 □ All

7 □ if other, specify_____

Section Two: the contingent Valuation Scenario

Assume that there exist no environmental law, thus no government measures regarding the Protection of the Lake operation and there are no organization in charge of this protection and Conservation. If no action is taken, the Lake quality and its function are expected to deteriorate

due to Water Hyacinth in the next few years. This deterioration includes low productivity of fish, encroaching of the weed on farm and grazing land, hampering navigation, increasing human diseases in the Lake; reduce income of the riparian community and a remarkable increase in water hyacinth leading to the loss of the scenic beauty of the lake and hence reduced tourism activity and transport service of the Lake.

To clean the lake from Water Hyacinth and improvement it's quality, to its current state the environmental law specifying the measures to be taken for the control of water hyacinth has to be implemented. This will lead to the improvement of lake quality, increasing volume of the Lake and make the lake favorable for transport activities, biodiversity conservation, good environmental lake operation, reduction in human disease, and increase the income of the riparian community, increase volume of the Lake and increase tourism attraction. On the Lake shores, the natural vegetation will constitute a good habitat for the reproduction of fish and increase its productivity.

Section Three; Willingness to pay questions for Water Hyacinth clearing

The next section of this survey is designed to measure the value to you of the benefit of the control of water hyacinth through your willingness to pay to support clearing of water hyacinth program for Lake Tana.

Some of the problems already experienced with Water Hyacinth that are preventable through Controls are as follows;

-Improve drinking water quality of the lake.

-Reduce human diseases in the Lake.

-Clean up the surrounding environment or operation of the Lake.

-Restoring flora and fauna species from the lake.

-Reduce Hyacinth impact on fish production.

-Reduce Social impact of Hyacinth.

-Restoring Ecology or ecosystem health of the lake.

-Increasing income of the riparian community.

-Increasing environmental quality or operation of the lake.

The Amhara National regional state of environment forest and wildlife protection and development (ANRSEFWPD) and the Nile Basin Authority (NBA) wants Bahir Dar household's to contribute or donate a certain amount of money for water hyacinth control program. This money will be paid through a neutral trust fund; it will help to achieve above-mentioned improvements and the donations or payments will be a one-time for the management or control of water hyacinth from the status quo level of the Lake to solve half of the problem. The implementation of the control program depends on the extent of the threat of water hyacinth that exists around and part of the Lake. Before expressing a certain amount of money, please ask yourself: "Am I willing to pay or donate this amount of money for the Control of Water Hyacinth? Or would I rather not pay or donate this amount and remain in the current state of the Lake, which may eventually deteriorate?" Please, do not agree that you are willing to pay a certain amount if you cannot afford it, or if you feel that there are more important things you can do with your money or if you are not sure that you are prepared to pay such amount of money. We are asking for your most true willingness to pay, so please, provide a genuine response that you are able to pay. Thank you.

1.18 Do you support the conservation or cleaning of water hyacinth from Lake Tana?

1. □Yes, 2. □ No 3.□ Don't know

1.19 Would you be willing to donate some money (even a very small amount) to a project for cleaning water hyacinth from Lake Tana?

1. □Yes, 2. □ No

1.20 If answered 'yes ' for question number '1.19' Why you are would like to contribute to the water hyacinth clearing project because (Please *cross your answer among the following options. You can cross several options.*)

.

□LakeTanaplaysanimportantroleinmaintainingbiodiversity (1)

□ I use the transport service the Lake offers (2)

□ I use the Lake for fishing (3)

□ I use the Lake for recreation (4)

□ I would go to Lake Tana for recreation/fishing if possible in the future (5)

□ I hope future generations can enjoy the existence of Lake Tana and the services it offers (6)

□ I hope some other people can enjoy the services offered by Lake Tana (7)

□ other reason _____ (8)

The Amhara regional government, done a number of things that are necessary for the municipality to spend money for the quality of the City, and some of them are regarded as more important than the preservation of our aquatic resource. By spending more on quality of education, providing health services, improving access to water and electric services, for example, less would be available for the control of water hyacinth and the invasive species would be allowed to spread further. From the payment card below, and taking in to account your monthly household spending, Income, and a one-time payment, please pick the maximum amount you are willing to donate towards the proposed project, to go from your present protection level, for half clearing of water hyacinth from the Lake.

Table

100 ETB	250 ETB	350 ETB	450 ETB	600 ETB	800 ETB	950 ETB
1,000 ETB	1,250 ETB	1,400 ETB	1,500 ETB	1,600 ETB	1,750 ETB	1,850 ETB
1,900 ETB	2,000 ETB	2,250 ETB	2,500 ETB	2,700 ETB	3,000 ETB	> *3,000* ETB

1.21 If your maximum amount of money that you are willing to donate the proposed project is not listed in the above payment cared, please specify the amount you willing to give? ……ETB

1.22 If you would not like to donate any money to the project, what is your reason *(Please cross your answer among the following options? You can make several options)*

- □ I am not able to pay
- □ It is government's responsibility
- □ Money should be collected from business around the Lake
- □ Money should be collected from big companies
- □ NGOs should be responsible for the conservation of the Lake
- □ It is none of my business
- □ I am afraid that the money will not be used for the conservation project

□ Other reason: _____

Section Four. Respondent Demography & socio-economic Characteristics

1. Gender? 1 □ Male 2 □ Female

2. Age: _____

3. What is your maximum level of educational attainment? _____

4. What is your job/profession? _____

5. How many members are there in your household including you? _____

6. What is your approximate monthly gross income (before tax)? (Please remember that your answers are anonymous.)_____ ETB

7. How much is your family's monthly food expenditure? _____

8. What is your Marital Status?

1. □ Married 2.□ Single 3. □Other, specify: _____

9. How many member of the family's are there having a job including you? _____

Thank you very much for your time & co-operation as well as a contribution to this survey.