AN ASSESSMENT OF FARMERS' WILLINGNESS TO PAY FOR THE PROTECTION OF NYABARONGO RIVER SYSTEM, RWANDA

MSc. THESIS

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURAL AND APPLIED ECONOMICS

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DEDICATION

This thesis is dedicated to my Mother Seraphine M. KAYOMBYA whose love has always inspired my life, my brother Eric MUNYESHURI, my sister Triphine HIRWA and my aunt Claire M. NYIRANEZA for their love and everyday encouragements.

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ABSTRACT

Nyabarongo River system is an ecosystem that provides goods and services to the Rwandese communities; this river serves as a tributary of the Nile River, an international resource. However, its integrity has been compromised due to increasing pressure for expansion of agricultural land.

Against the aforementioned background, the present study was undertaken to assess farmers' maximum Willingness To Pay (WTP) for protection of Nyabarongo River system. Further, the study assessed the potential influence of different factors on the WTP estimates. A sample of 359 households from four Districts in the catchment area was randomly selected and interviewed through household survey questionnaires. The Contingent Valuation Method (CVM) was applied to estimate the amount of money farmers are willing to pay while the influence of different factors was assessed using the Ordinary Least Squares regression method.

Results showed that the mean household's maximum WTP for the protection of Nyabarongo River system was 486.4 Rwandan francs (Rwf) per household per month over the proposed five years (USD$1 = 607 Rwf). The main factors that were found to have significant statistical influence on the WTP are household income, education of the household head, respondent's perception of the current quality of water in Nyabarongo River, access to tap water, household size, extension contacts, initial bid amount and knowledge of individual responsibility in wetland protection. Based on these findings, it may be concluded that riparian communities attach considerable economic value to the river system. In order to achieve sustainable management of the wetland, there is need to increase awareness through radios, trainings, extension services and there is a possibility of raising funds from these communities for continued wetland protection.

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LIST OF ABBREVIATIONS

AERC: African Economic Research Consortium

AHP: Analytical Hierarchy Process

ATP: Affordability to pay

CBA: Cost-Benefit Analysis

CE: Choice Experiments method

CVM: Contingent Valuation Method

DUV: Direct Use Values

EESD: Environmental Education for Sustainable Development

FONERWA: National Fund for Environment and Climate Change in Rwanda

GoR: Government of Rwanda

IUV: Indirect Use Values

MINELA: Ministry of Environment and Lands, Rwanda

MINITERE: Ministry of Lands, Resettlement, and Environment, Rwanda

NBCBN: Nile Basin Capacity Building Network

NEYP: National Environment Youth Project, Rwanda

NISR: National Institute of Statistics in Rwanda

NOAA: National Oceanic and Atmospheric Administration

NUV: Non-Use Values

OLS: Ordinary Least Squares

REMA: Rwanda Environment Management Authority

RUM: Random Utility Model

TCM: Travel Cost Method

TEV: Total Economic Value

UNDP: United Nations Development Program

VIF: Variance Inflation Factor

WTA: Willingness to Accept Compensation

WTP: Willingness to Pay

CHAPTER ONE: INTRODUCTION

1.1 Background information

Wetlands in Rwanda, like elsewhere in the world, are ecosystems that perform important ecological functions that support sustainable water resource management. They are the most agriculturally productive ecosystems; but in a very densely populated country like Rwanda, their soils can be exposed to diverse uses, resulting in degradation (Twarabamenye *et al.*, 2007).

The abundance of water resources in Rwanda is reflected by the existence of a network of wetlands in various parts of the country. Wetlands and aquatic lands are generally represented by lakes, rivers and marshes (MINITERE, 2005). An inventory of wetlands in Rwanda done in 2008 identified 860 marshlands, covering a total surface of 278,536 ha, which corresponds to 10.6 percent of the country's surface; 101 lakes covering 149,487 ha and 861 rivers totalling 6,462 km in length and representing 5.71 percent of country's surface. One of these marshlands is the Nyabarongo River wetland, which is a protected area and part of Rwanda's longest river and a tributary of the Nile covering 142.62 km^2. It originates from Nyungwe forest in the southwest of the country and merges with Ruvubu River in south-east to form Akagera River, which flows to Lake Victoria.

Two of the biggest development challenges facing Rwanda today are reducing poverty, especially among rural households, and protecting the ecosystems, which provide essential services that support activities, such as subsistence agriculture. Smallholder farmers own the land on catchment areas of Nyabarongo River and other adjacent wetlands. These farmers critically depend upon local ecosystems for survival through agriculture and are directly affected by changes in availability of ecosystem goods and services (REMA, 2009).

These wetlands make an important contribution to the livelihood of rural households who face food insecurity, poverty and vulnerability. In particular, the conversion of wetlands to agricultural production has increased rapidly over the last two decades due to acute scarcity of agricultural land (REMA, 2008). The Rwandan government supports this wetland development with the aim to boost agricultural production, to revitalize the rural economy and reduce poverty (REMA, 2009).

The challenge now is to utilize natural resources in a sustainable manner in order to develop the economy, while at the same time conserving the environment to avoid the adverse impacts of pollution, soil erosion, deforestation and general degradation. To avoid this continuing environmental degradation, the Organic Law (Number 04/2005 of 08/04/2005) determining the modalities of protection, conservation and promotion of environment in Rwanda was enacted in 2005. With respect to wetlands, streams, lakes and rivers, a clear definition of specific measures to be taken for their protection and conservation has been developed. These include a distance of 10 meters from the river banks that is not allowed to be used for agricultural and pastoral activities and 20 meters for building activities (GoR, 2005). In order to implement this law, the government has committed itself to the rehabilitation of degraded ecosystems and similarly national organizations in the management of natural resources are effectively utilizing environmental management tools to protect, conserve and promote environment (UNDP, 2009).

1.2 Problem statement

Nyabarongo River wetland is of great importance, as a tributary of River Nile and for biodiversity conservation, especially birds, with many species listed as endangered (REMA, 2009). However, this wetland is threatened by human activities such as agricultural

production, sand mining, pollution from sewage and industrial effluents, and land degradation.

Most of these activities are driven by pressures on land associated with poverty and lack of alternatives; including lack of motivation/incentives for the population to preserve environment (MINITERE, 2003). Consequently, in Nyabarongo River system and associated wetlands, ecosystem integrity has been compromised, riverbanks have been eroded and the resulting siltation has caused nutrient loading in water bodies (NEYP, 2008). During the rainy seasons, the river's overflow destroys all crops in the valley (MINITERE, 2003).

Measures proposed by the government to conserve Nyabarongo River wetland include leaving the first riparian 2 metres with natural vegetation, 4 metres with reeds (pennisetum), 4 metres with agro forestry and a demarcation line of bamboo. These are to be implemented in 17 districts in the catchment area. The implementation of these measures requires the removal of crops that have been cultivated in those 10 metres and constitutes a loss of a source of income for the owners of the land. This constitutes a development paradox on one hand since agricultural crops are removed but on the other hand there are more income generating activities created; these include the employment from National Environment Youth Project (NEYP) to protect riverbanks (implementation of the law on environmental protection) and maintenance of tree nurseries. In addition, farmers are allowed to own agro-forestry trees, reeds and bamboo on their land in the wetland. They are also gaining in terms of knowledge and formation of cooperatives, from where they are trained on environmental protection and on different income generating activities that can be done while protecting the environment (NEYP, 2008).

Moreover, the major concern for government and other development practitioners is that in all the districts in the catchment area, farmers do not respect the law that stipulates conservation of 10 meters of riparian area of Nyabarongo River (REMA, 2011).

Even though the Organic Law is currently being implemented, there is no empirical insight on farmers' willingness to engage in the protection of Nyabarongo River. In order to address this knowledge gap, the present study sought to put an economic value in Rwf on the wetland in order to contribute to expected positive outcomes of conservation of Nyabarongo River and its riparian area.

1.3 Purpose and objectives of the study

The purpose of this study was to assess farmers' willingness to pay for the protection of Nyabarongo River system.

The specific objectives of this study were:

- ✓ To describe farmers attitude towards environmental protection
- ✓ To evaluate the amount of money farmers are willing to pay for the protection of Nyabarongo River system
- ✓ To assess factors influencing the amount of money farmers are willing to pay for the protection of Nyabarongo River system

1.4 Hypothesis of the study

The following hypotheses were tested:

- ➢ Farmers are not willing to pay a positive amount of money for the protection of Nyabarongo River system.

- Farmers' personal characteristics (income and education) have higher positive statistical influence on WTP than institutional and infrastructure factors such as distance to the nearest input-output market and distance from residence to wetland.

1.5. Justification of the study

Nyabarongo River basin has most of Rwanda's wetlands and marshes, covering 67 percent of national territory. This resource is beneficial to all countries in the Nile Basin and its protection and conservation has great international significance. The estimation of the amount of money farmers are willing to pay seeks to provide information on the economic value to justify its protection. This is in accordance with Ramsar convention that promotes the sustainable use of wetlands for benefits of human kind in a way, which does not destroy natural properties of the ecosystems (Edward, 1997).

Environmental stewardship is driven by personal attitudes and thus it is important to understand motivations of farmers. Farmers might be viewing the services they get from Nyabarongo River system at individual or household level instead of viewing it at broader spatial and temporal scales because it is an environmental good benefiting many people in different countries. The estimation of WTP sought to reveal local households' attitudes towards environmental conservation, as they are *de facto* owners of this important resource. Studying the factors likely to influence the respondents' WTP for the protection of Nyabarongo River wetland is crucial since it helps to know the reasons why such amount of money was stated. In Nyabarongo River wetland, farmers are owners of land in the wetland and are the ones responsible of the implementation of the law N°04/2005 that seeks to protect the river shores.

Further, this study aims to inform policy makers on development of appropriate incentives and policies to encourage population to conserve Nyabarongo River system. Moreover, this

study sought to provide information that would help in identifying the preferred level of environmental conservation services and designing appropriate policies for a sustainable use and management of the Nyabarongo River system.

CHAPTER TWO: LITERATURE REVIEW

2.1 Theoretical background of economic valuation of environment

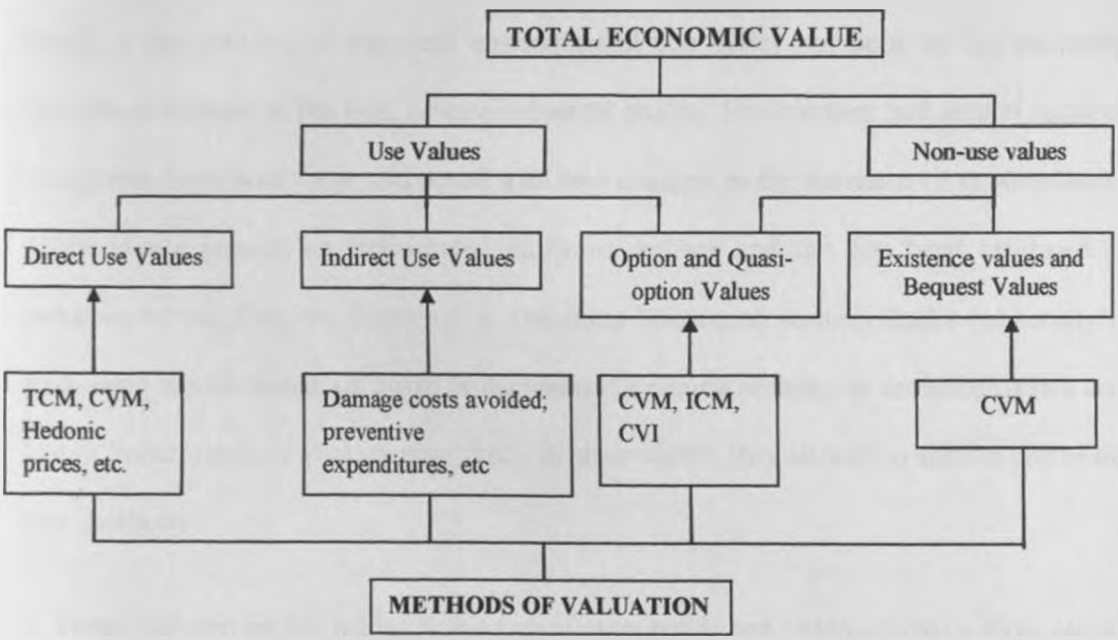
It is often imagined by many people that environmental goods and services have no economic value since they cannot be either bought or sold in the market. However, an array of literature has dwelt on this issue, confirming that it is possible to establish the economic value of environment. An economic value is a measure of the monetary amount an individual is willing to forego in other goods and services in order to obtain some good, service or state of the world. This is a measure of welfare expressed as willingness to pay. Thus, the lost value from the degraded environment is the maximum amount individuals are willing to pay to have a state where that same area is free of pollution (Douglas *et al.*, 1998).

From the literature, valuation is not considered as an end in itself, but rather a conceptual and methodological framework for organizing information as a guide for decision-making. It is one tool in the much larger politics of decision making; it is wielded together with financial instruments and institutional arrangements to allow individuals to capture the value of ecosystem assets (Jean-Michel, 2011).

The basic strategy for environmental valuation is the co-modification of the services that the natural environment provides; it serves to assess individual and group priorities and trade-offs in the case of unpriced scarce commodities. The most commonly used approach is based on the concept of Total Economic Value (TEV). In this approach, an impact on environmental resources is broken down into different categories of values. The idea behind this is that the resource or service comprises of various attributes, some of which are tangible and readily measured, and others are considered less tangible and difficult to quantify. These values are namely the direct use value (DUV), the indirect use value (IUV) and the non-use value (NUV).

The TEV of the good or service is given by the summation of the three categories of values. The DUV are derived from goods, which can be extracted, consumed or directly enjoyed; the IUV are non-extractive use values and they are derived from services that environmental resource provides, while the NUV are benefits or welfare gains/losses that arise from environmental changes independently of any direct or indirect use of the environment. The NUV are divided into option and existence values; the option values being the value derived from maintaining the option to use a good or service at some point in the future and the existence values representing the intrinsic values of the good or service. The existence values are also divided into pure existence value and bequest value (Alain, 2003). These values are represented in the theoretical framework presented in Figure 1.

Figure 1: Theoretical framework for economic valuation of environment



Source: Adapted from Edward et al., (1997)

Indirect use values (IUV) derive from supporting or protecting economic activities that have directly measurable values. This contribution is unmarketed and often goes unrewarded

financially because it is indirectly connected to economic activities. IUV are difficult to quantify and generally ignored in wetland management decisions.

Non use values (NUV) of wetlands are intrinsic values which are extremely difficult to measure. They involve subjective valuations by individuals unrelated to either their own or others' use, whether current or future (Edward *et al.*, 1997, 2003 and Alain, 2003). For the case of Nyabarongo River wetland, its functions in addition to constituting rare ecosystem include water reservoir, water source, flood control, swamp dam, biodiversity maintenance and mitigation of climate change. Its use values include agricultural production, fisheries, water supply to town and cities, timber and non-timber products, tourism and scientific and hydrological interests. Its non-use values include the conservation of biodiversity, flood control and conservation of protected species (REMA, 2009).

Much of the concern of empirical environmental economics has been on the economic benefits of changes in the level of environmental quality. Environment and natural resource economists have been more concerned with how changes in the provision of environmental public goods impacts on individuals' utility or welfare and this has been estimated in monetary terms. They are interested in estimating how much an individual's (or society's) well-being would change (increase or decrease) if a natural resource or resource service was lost or better managed (quality improved). In other words, they attempt to answer one of the two questions:

- How much are people willing to give up of other goods and services to have some natural resource or resource service?
- How much better off would people be if a policy or management action was implemented and the amount or quality of a resource or resource service was improved?

The current study attempted to answer the latter question as it seeks to investigate: "How much money (in Rwandan francs) farmers are willing to give up in other goods and services to have an improvement in the quality of Nyabarongo River system."

Environmental valuation applies the welfare economics concepts of producer and consumer surplus to solve issues involving natural resources and the state of the environment. It is the application of welfare economics when the differences in circumstances relate to the uses or states of natural resources or the quality of the environment (Douglas *et al.*, 1998).

To evaluate the welfare change in monetary terms due to a change in environmental quality, with the purpose of maintaining a constant level of utility before and after the change, two measures are used; namely the compensating variation and the equivalent variation. The compensating variation is the money income adjustment (welfare change) necessary to keep an individual at his initial level of utility throughout the change of provision. When the change is an improvement, WTP to secure the change measures the compensating variation. The equivalent variation is the money income adjustment (welfare change) necessary to maintain an individual at his final level of utility throughout the provision change. If the change is an improvement, WTA measures the equivalent variation (Nyborg, 1996).

For a proposed change in provision of the environmental public good which increases utility, the compensating variation is the money income adjustment (welfare change) necessary to keep an individual at his initial level of utility throughout the change of provision. It tells us the maximum money income the individual would be willing to give up (WTP) to ensure that the change occurs. Considering the change in quality of an environmental good from q_0 to q_1, the compensating variation can be written as $U_0(Y_0 - WTP, q_1) = U_0(Y_0, q_0)$ where U_0 is an initial state of well-being (utility) that an individual achieves with a money income Y_0 and a level of environmental quality q_0. An improvement in environmental quality q_1 would

increase the individual's well-being to a higher state U_1. The equivalent variation or willingness to accept compensation is the measure that tells us the minimum money income the individual would be willing to accept in compensation to forgo the change or improvement in environmental quality. Considering a change in environmental quality from q_0 to q_1, the equivalent variation can be written as $EV = e(p_0, U_1) - \omega$ where e represents the expenditure function, p_0 price at the initial state and ω represents wealth (Hanemann, 1991 and Cook, 2011).

In economics, the concept of WTP is defined as the maximum amount of money a person would be willing to pay, sacrifice or exchange in order to receive a good or to avoid something undesired such as pollution. It is the amount of payment which, combined with the presence of the good, gives the person the same level of utility as would occur if there were no payments and no acquisition of the good and it is expressed in currency (Charles, 2000).

To improve or maintain environmental quality, different measures and procedures can be used including laws, taxes, charges, tradable pollution permits, etc. depending on the nature of the environmental degradation or pollution to be managed or the legal and administrative framework of the country. The appropriate measure between the WTP and WTA compensation is related to the property rights of the individual on the environmental good/ service being valued. The WTP assumes no consolidated rights on the environmental improvement while the WTA compensation measure assumes the individual deserves some rights on the environmental improvement (Nyborg, 1996 and EDIEN, 2002). Moreover, the Organic Law being in place, farmers in Nyabarongo River wetland do not have consolidated rights over the river quality improvement as it is a public good and they have no other option than to follow the requirements in the law.

Another problem mentioned in the literature with elicitation of WTA compensation is that individuals attempt to extract the maximum obtainable rather than the minimum necessary to be compensated (EDIEN, 2002). In order to avoid the potential pitfalls of WTA, the current study uses the WTP measure for the farmers' welfare change due to the improvement of the quality of Nyabarongo River system. The use of WTP is also appropriate for this study because, although farmers are owners of the land on the shores of Nyabarongo River, the river is still a public good and its quality improvement benefits to many countries as it is a tributary of the Nile. The WTP measure is also recommended by the National Oceanic and Atmospheric Administration (NOAA) as a conservative choice (Arrow *et al.*, 1993), and in addition to this, it was used to avoid the over statement of estimates that could arise from the WTA compensation measure.

2.2 Review of literature on empirical economic valuation of environment

2.2.1 General literature on economic valuation of environment

The problem of economic valuation of environment is how to estimate lost values due to different environment and natural resource damages, or gained/added values due to improvement in environmental quality; this is because there are no direct market transactions that can be observed to provide information on which estimates can be based. Many studies have valued ecosystem and environmental resources using different methods. For example, Costanza *et al.*, (1997) estimated the economic value of the world's ecosystem services and natural capital by estimating values of ecosystem services per unit area by biome and then multiplying by the total area of each biome; these were then summed over all services and biomes. The study found that ecosystem services provide an important portion of the total contribution to human welfare on this planet (between $16 trillion and $33 trillion per year),

but the technique used has been criticized as being overambitious and as a drastic overstatement (Richard *et al.*, 2001).

The most common quantitative evaluation methods used are divided into revealed and stated preferences techniques. The revealed preference techniques also known as surrogate market techniques make use of individuals' behaviour in actual or simulated markets to infer the value of an environmental good or service. These include the market price method, damage cost avoided approach, replacement cost method, travel cost method, hedonic pricing method and the productivity method. The stated preference methods seek to measure individuals' value for environmental goods directly, by asking them to state their preferences for the environment. They are mainly used to determine non-use values of the environment such as existence values and bequest values which do not turn up in any related market though they can be used to measure use values. Among the stated preferences techniques include the contingent valuation method (CVM) and the Choice Experiments (CE). The CE approaches include conjoint analysis and choice modelling. Further, the conjoint analysis is divided into contingent ranking, contingent rating and paired comparison. Each of these methods is used according to the specific environmental good or service that is being valued, but the revealed preferences methods are not capable of capturing the non- use values.

In conjoint rating, respondents are requested to rate their preferences for several alternatives while in conjoint ranking, they are required to rank all the alternatives from least preferred to most preferred. A weakness of both methods is that they do not provide the respondent with an opportunity to reject the good; the only way of allowing opposition is by registering a low rating or ranking. The choice modelling is more versatile than the other stated preference methods. It can be used to value multiple sites or multiple use alternatives.

Unlike conjoint analysis, choice modelling can be used to provide conditional or absolute measures of WTP, provided a "choose neither" option is included in the alternatives. The main disadvantage of choice modelling is that complex survey designs are required. The number of choice sets can be large, which tends to lengthen interview times.

The general idea behind the choice experiment method is to identify what characteristics of a wetland individuals think are important, then estimate individual's marginal WTP for those different attributes of the wetland. This is done by creating a hypothetical market situation and eliciting individuals' preferences by asking them to make choices between different bundles of environmental goods, which are described in terms of their attributes or characteristics, and the levels that these take; one of these attributes is usually the price.

This method is particularly suitable for estimating marginal rates of substitution between different attributes of for example a wetland. It is important to note that different attributes that increase or decrease the utility derived from a wetland area are contextual; they depend on the community of respondents itself (Hanley *et al.*, 1998 and Carlsson *et al.*, 2003).

The CVM is often the most widely used to estimate both the use and non-use values of the wetlands (Alain, 2003 and John, 2005). The CVM attempts to measure the value of a good/service holistically, i.e. valuing the good in its entirety. Here, researchers ask hypothetical questions to elicit the amount the respondents are willing to pay for the improvement in the quality of service or commodity they are receiving. Alternatively they ask the amount the respondents are willing to accept to forego the existing service that they are enjoying currently (Jubin *et al.*, 2006). The choice of the method depends on the context of experiment and on trade-off between advantages and disadvantages of the two methods.

Some of the advantages of the CVM over the revealed preference techniques include the fact that the CVM gives immediately a monetary assessment of respondents' preferences with an advantage of being capable of shedding light on the monetary valuation of non-use values. Hanley *et al.* (1998) show several advantages of the CE method over the CVM. These include the ability to estimate the characteristic values for environmental goods. In the context of recreational estimations, the CE is superior to CVM in terms of modelling substitution possibilities. The CE also possesses advantages over revealed preference approaches in term of avoiding co-linearity between attributes and being able to estimate non-use values. These two methods provide similar preference patterns in case of recreation site choices. A critique of the CE is that it relies on representation of choice situation using attributes than describing a specific target change as does the CVM.

Carlsson *et al.* (2001) also discuss some issues due to the use of CE and mentioned that the CE is much more demanding for respondents to answer. The paper argues that preferences may be unstable throughout the experiment, that the incentive properties might be unclear and that the designing of experiments is a difficult and complex task. Foster *et al.* (2003) recommend the use of CE for evaluation of a single isolated change or of a policy that is part of a larger set of change/policies and Stephens (2010) recommends the use of CE in cases where the valuation of one or more attributes of a good or service are of a particular interest.

The CVM has also an advantage of valuing environmental change even if it has not yet occurred which makes it useful as advisory tool for policy decision-making (Paulo, 2009). These valuation methods are represented in Figure 1 of Section 2.1. The CVM has been used to elicit economic values of ecosystem services from individuals through the use of carefully designed and administered sample surveys (Cameron *et al.*, 1989; Hanemann *et al.*, 1991 and Hanemann, 1994). However, the CVM has been a subject of great controversy; its detractors

argue that respondents normally give answers that are inconsistent with the tenets of rational choice because they do not understand what they are asked to value and thus, the stated values reflect more than that which they are asked to value. To produce information useful in natural resource damage assessment, NOAA provides guidelines that any CV study should adhere to (Arrow *et al.*, 1993). From there, many studies have been done to improve the administration of CVM surveys particularly in developing countries (Whittington, 1995 and 2010).

2.2.2 Review of literature on economic valuation of wetlands

From the literature, the most important question is about why people destroy wetlands that are an essential element of their ecosystems? And the simple answer is that they do not value wetland goods and services in economic and monetary terms. Edward *et al.* (1997) suggest that the main reason is the failure to account adequately for their non-market environmental values in development decisions.

The main objective of valuation of wetlands is to indicate the overall economic efficiency of the various competing uses of wetland resources. It is also concerned ultimately with the allocation of wetland resources to improve human welfare. Economic valuation of wetlands is an important tool for environmental managers and decision makers to justify public spending on conservation activities and wetland management (Alain, 2003).

Wetlands provide tremendous economic benefits; these include water supply, fisheries, among others. Use values of wetlands involve commercial and non-commercial activities that can be important at domestic and international markets. Values of marketed products of wetlands are easier to measure than the value of non-commercial direct uses. This is one of

the reasons why policy makers fail to consider these non-marketed uses of wetlands in development decisions.

Some of the ecological services, biological resources and amenity values provided by wetlands have qualities of public good and would be impossible to market those services even if it was desired. Such situations make it extremely difficult to collect payments for the services and this is what makes wetlands services to be undervalued. Wetlands may also be undervalued because of the property rights governing their access and use. If valuation is done based only on simple observation of current use rates without taking into consideration the institutional context, it will result in undervaluation of the resource (Edward *et al.*, 1997).

The most widely used technique, in the stated preferences techniques, is the contingent valuation method (CVM) as well as the choice experiment (CE) method. Studies have been done to value wetlands all over the world with site-specific interest. These studies have used different techniques that capture specific values. For example, Hammack *et al.* (1974) estimates the WTP of recreational hunters for the prairie wetlands in North America, using the CVM, to derive the underlying value of the wetlands as "duck factories". Barbier *et al.* (1993) use partial valuation approach to assess the economic importance of Hadejia-Nguru wetlands and the opportunity cost of losing them, by estimation of key direct use values to local population. Hanley *et al.* (1991) conduct a partial valuation of alternative uses of peat bog in Northern Scotland's Flow country; and Sale *et al.* (2009) estimate the economic value of recreational services provided by Kowie and Kromme estuaries.

The above studies were done to estimate either direct or indirect use of the wetlands only. However, other studies have also been done to capture the total economic value of wetlands. A study by Wattage *et al.* (2008) estimates the total economic value of wetland conservation in Sri Lanka, and then uses the Analytical Hierarchy Process (AHP) to separate the total

economic value into use and non-use values. Wattage *et al.* (2008) prove that AHP is a highly applicable and useful approach to separate use and non-use values from the estimated WTP for conservation of wetland.

From the literature, many studies have been done to assess the merits of retaining wetland areas versus permitting them to be converted to alternative uses or simply to degrade from lack of investment in management. Using the CVM, Bateman *et al.* (1993) estimate the WTP for the protection of the wetland from saline flooding of the Norfolk Broads of Southern England. Hanley *et al.* (1991) also use a CVM to assess regional residents' WTP for conserving the peat bog in Northern Scotland's Flow country and Narin *et al.* (2008) estimate the WTP of the local communities for the wellbeing of the Micro Prespa Lake, Albania and its wetlands. Beaumais *et al*, (2007) examine the conservation of Seine wetlands in France versus their conversion in industrial area. The study found that more benefits would be realized in converting the wetlands into industrial area but concluded that residents were willing to conserve the wetlands due to non-use values. These studies justify the need of estimating the global economic value of the wetlands to decide among many conflicting and competing uses of the wetlands. These studies also highlighted the possibility of using the CVM as a tool to value wetland benefits that might be difficult to quantify using other techniques.

Edward *et al.* (1997) highlight that valuation is not an end in itself but needs to be directed towards policy issues ranging from simply raising awareness of the importance of wetlands to choices among alternatives to meet some stated policy goals, with protecting wetlands representing just one option. In some cases, it may be worthwhile to deplete or degrade wetland resources, for example Beaumais *et al.* (2007) who found that it would be more beneficial to convert the Seine wetlands in France into industrial area rather than conserving

them; but in others it may be necessary to hold on to the wetland. Economic valuation provides tools to assist policy makers with difficult decisions involved.

Different elicitation methods can be used for elicitation of WTP or WTA compensation values. From the literature, the estimates of economic values of wetlands are sensitive to question format in elicitation method used and this is observed in results where estimates from the dichotomous- choice format are higher than results from the open-ended format. James *et al.* (2001) estimate the value to residents of protecting Kuantu wetland in Taiwan using the CVM. Comparing the results from the double-bounded dichotomous choice format and a single open-ended question, they concluded that open-ended measures are substantially smaller than the results from the dichotomous choice measures.

The economic valuation of watersheds and wetlands also requires a careful design of the technique to be used to avoid biased results that can lead to misleading conclusions. Janet *et al.* (2007) estimate the domestic water users' WTP for a watershed management in Teguegarao City in Philippines; the results show that more than a half of the respondents were willing to pay at the highest price level. This was because the initial bid amount was set very low and could lead to biased conclusions.

According to Richard *et al.* (2001), even if some general trends are emerging, the prediction of a wetland's value based on previous studies remains highly uncertain and part of the problem lies in the lack of uniformity across studies of valuation of wetlands; which justifies the need for site- specific valuation studies.

2.2.3 Literature review on factors likely to influence the WTP

The literature on economic valuation contains many studies which have been done to determine factors influencing the WTP. Each of these studies has hypothesized different

factors to influence the WTP for wetland conservation but the level of significance of those factors depends on the type of values of the wetland being measured. For example, a study by Wattage *et al.* (2008) found that among hypothesized factors, only the 'bid value' and 'the expectation of future use' variables were significant. Wattage *et al. (2008)* found that the 'bid value' negatively influenced the WTP, and this was also the case for a study by Janet *et al.* (2007).

The level of significance of these factors may also depend on the characteristics of respondents and the wetland being valued. Wattage *et al.* (2008) found that the household income was not significant in explaining the WTP, because of wide variations of income among survey participants; while other studies like Prasher *et al.* (2006), Thang *et al.* (2007) and Janet *et al.* (2007) found the household income to positively influence the WTP for wetland conservation. The distance from residence to the wetland was also found to be significant in explaining the WTP; the closer the residence of the respondent, the higher the WTP (Prasher *et al.*, 2006 and Thang *et al.*, 2007). Other factors that were found to positively influence the WTP are the educational level, age and the knowledge about the wetland (Prasher *et al.*, 2006 and Thang *et al.*, 2007).

Each of these studies includes different factors to check for relative importance in explaining the WTP from a priori knowledge about the wetland being valued or the type of value being measured. This is the case for a study by Douglas, (2003) who included a variable on 'health effect concern from water quality' when estimating the economic value boaters put on Chesapeake Bay in Maryland. A study by Prasher *et al.* (2006) also included the 'number of visits to the wetland', the 'time' and 'costs spent for recreation' as explanatory variables of the WTP because the study was conducted with a purpose of estimating the recreational value against the conservation and restoration purposes.

CHAPTER THREE: METHODOLOGY

3.1 Description of the study area

Nyabarongo River basin is within the Rwandan Nile catchment that occupies 67 percent of Rwandan territory and drains most of the country's waters into Nile through Akagera River. The major Nyabarongo River tributaries are Akanyaru River from the South and Mukungwa River from North in the volcanoes. Nyabarongo River catchment area covers 17 districts from all the provinces of the country and Kigali city. These districts are Nyaruguru, Huye, Gisagara, Nyamagabe, Nyanza, Ruhango, Muhanga and Kamonyi districts from the Southern Province; Musanze, Gakenke, Rulindo, Gicumbi and Burera districts from the Northern Province; Gasabo, Nyarugenge and Kicukiro districts from Kigali City and Bugesera from the Eastern Province. Nyabarongo River has a catchment area of 8,900 sq.km and altitude varies between 3,000m upstream and 1,350m downstream with an average altitude of 2,176m (NEYP, 2008). Map 1 in Appendix 6 is a map of Rwanda which shows Nyabarongo River.

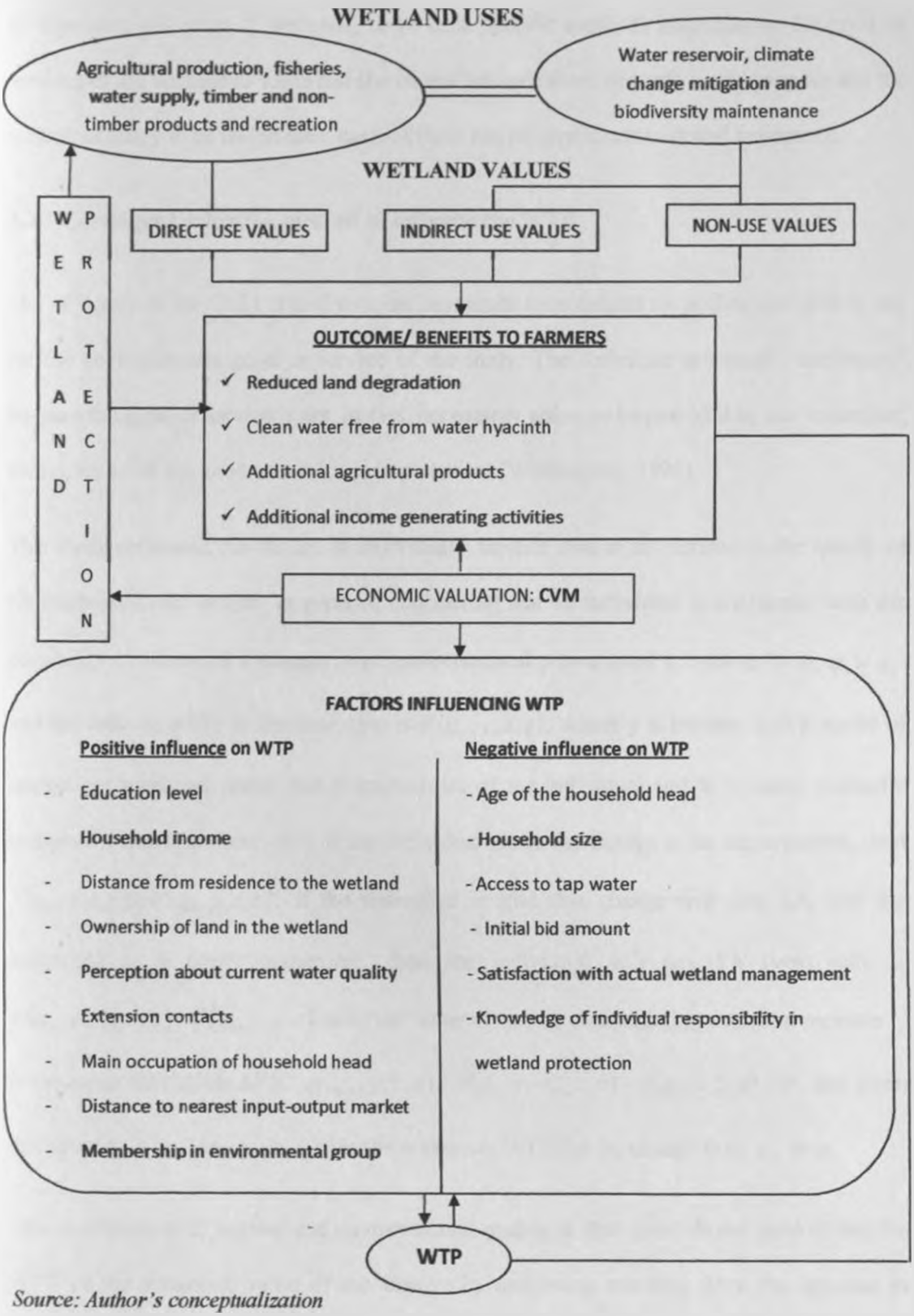
The current study covered 4 districts selected from all the provinces in the catchment area and Kigali City. These districts are Kicukiro, Kamonyi, Bugesera and Rulindo districts. The total number of households from those districts amounts to 214,645 households. Each district constitutes a cluster according to provinces of origin: Kicukiro district from Kigali City, Bugesera district from Eastern Province which is the only district in Nyabarongo River catchment area in Eastern Province and covers Nyabarongo River downstream. Kamonyi district is in Southern Province and covers Nyabarongo River upstream. In Northern Province, the study considered Rulindo district. In addition to covering the important parts of the catchment area, these districts show important human activities along the river shores with both implementation and non-implementation of the government measures to protect river shores.

3.2 Conceptual framework

From the definition, the WTP is the amount of money people are willing to forego to get an improvement in wetland quality. An individual's WTP is influenced by various factors, including those linked to individual's own social and economic characteristics and others linked to the wetland. But that WTP is measured through the benefits the individual gets from the wetland because if the utility was not affected, there will not be any interest in the good/service therefore resulting in zero WTP. The wetland itself has values and functions which provide many goods and services. The economic valuation of the wetland using the CVM provides information on factors influencing the WTP and the economic value of the wetland. This information is used by policy makers to enhance wetland protection and conservation, which improves the quality of the functions, and values of the wetland, as reflected in benefits users get from it. Figure 2 indicates the systems related feedback and the economic or ecological linkage.

From the literature and a prior knowledge on the wetland and the population of interest, the variables household income, educational level and main occupation of the household head, ownership of land in the wetland, extension contacts, membership in a group of environmental interest, distance to the nearest input-output market, distance from residence to the wetland and perception of current water quality in wetland are expected to positively influence the magnitude of WTP. The variables initial bid amount, household size, age of household head, access to tap water, satisfaction with actual wetland management and knowledge of individual responsibility in wetland protection are expected to negatively influence the WTP.

Figure 2: Conceptual framework for economic valuation of Nyabarongo River wetland



Source: Author's conceptualization

3.3 Methods and procedure

In economic valuation of wetlands, there exist specific methods according to the good or services of the wetland to value and the choice between them depends on the purpose and the context of study to be undertaken; each of these has its own constraints and limitations.

3.3.1 Contingent valuation method to estimate the WTP

The objective of the CVM is to determine how much respondents are willing and able to pay for the environmental good or service of the study. The technique is termed "contingent" because the good or service is not, in fact, necessarily going to be provided by the researcher; the provision of the good or service is hypothetical (Whittington, 1998).

This study estimated the change in individuals' welfare due to an increase in the quality of Nyabarongo River system. In general, considering that an individual is confronted with the possibility of obtaining a change in an environmental public good q from q_0 to q_1, $q_1 \succ q_0$, and the indirect utility in the base case is $V(q_0, y, z, \varepsilon)$, where y is income, z is a vector of market commodities, prices and characteristics of the individual and ε is some stochastic component that is unobservable. If the individual views the change as an improvement, then $V(q_1, y, z, \varepsilon) \geq V(q_0, y, z, \varepsilon)$; if the individual is told this change will cost \$A, and the individual is a utility maximizer, then the individual will pay \$A (yes) only if $V(q_1, y - A, z, \varepsilon) \geq V(q_0, y, z, \varepsilon)$ and "no" otherwise. The compensating variation measure C is the value that solves $\Delta V(C, q_1, q_0, y, z, \varepsilon) = V(q_1, y - C, z, \varepsilon) - V(q_0, y, z, \varepsilon) = 0$; and given this solution, $C = C(q_1, q_0, y, z, \varepsilon)$ is the maximum WTP for the change from q_0 to q_1.

This combination of income and environmental quality at this point allows us to define the WTP as the economic value of the change in well-being resulting from the increase in

environmental quality (Cook, 2011). The economic theory suggests that a person's WTP for a good is bounded from above by income. If the individual is indifferent to the good or sees it as an improvement, then WTP is bounded from below by 0, or taking the two bounds together, $0 \leq C(q_1, q_0, y, z, \varepsilon) \leq y$ (Joseph, 2001).

The theoretical construction of WTP for quality improvement shows that the WTP is a function of pre-policy and post-policy quality levels, among other variables. This requires the contingent valuation method to carefully describe both quality levels and ask for respondent WTP for the change in environmental quality with as crucial assumption that the respondent values the quality change that the survey requires him/her to value (Whitehead, 2006). The hypothetical market must be highly structured in order to ensure that respondents are confronted with a well-defined situation (Wattage, 2002). To avoid heterogeneity in quality perceptions by respondents, the current study described clearly the quality before and after change in the wetland quality, that is before and after adoption of the law N°04/2005, to respondents.

3.3.1.1 Willingness to pay elicitation format

When deploying the CVM, the researcher constructs a scenario or hypothetical market involving an improvement or decline in environmental quality. The scenario is then posed to a random sample of the population to estimate their willingness to pay for the improvement or their willingness to accept (WTA) monetary compensation for the decline in environmental quality. The choice of which approach to use between the WTP and WTA depends only on how questions are framed (ethics and property rights as described in Section 2.1).

There are several ways in which the question about the respondent's WTP can be posed among which there are open-ended and closed-ended formats. With an open-ended format,

respondents are asked to state their maximum WTP, while with a closed-ended format, respondents answer whether or not their WTP is equal to or higher than a certain proposed bid (Fredrik *et al.*, 2005).

There are criticisms of the open-ended format, in particular relating to the incentive compatibility and that it does not resemble an actual purchase decision: people do not state their maximum WTP for a good when they go to purchase it. The general tendency is that open-ended format results in lower WTP than the closed-ended, but experimental results show that the hypothetical bias, due to asking a hypothetical question (not confronting the respondent with a real situation), is not higher or even lower for the open-ended format compared to the closed-ended format. But many open-ended CV formats tend to produce an unacceptably large number of non-responses or protest zero responses to the WTP questions (Wattage, 2002 and Fredrik *et al.*, 2005).

Other alternative elicitation methods are the bidding game, payment card, discrete choice, modified dichotomous approach and discrete choice with follow-up approaches. The most widely used is the iterative bidding game where subjects are offered a controlled sequence of opportunities to give information about their valuation of a good or service. The enumerator ask subjects if they are willing to pay x (starting bid) for an improvement in a public good and then in a follow-up question, asks the subject to state a maximum willingness to pay.

The iterative bidding game is a series of dichotomous choice questions starting with an initial low bid, that nearly all respondents who have a positive WTP would be considered to be willing to pay for the good or service in question (Willis, 2002). The enumerator iteratively changes the stated amount of money to be paid or received until the highest amount the respondent is willing to pay or the lowest amount the respondent is willing to accept is precisely identified. This process is likely to capture the highest price respondents are willing

to pay and is best adapted to personal interview surveys (Wattage, 2002). The bidding game has also been proved to work well in developing countries; it provides relatively better results since it gives a 'market-like' situation to respondents in which they could research their preferences (Venkatalacham, 2004).

The iteration process provides the respondent with more time to consider the value of the public good to him; bid amounts increase monotonously in small regular amounts, with more opportunities to reject the bid amount, compared with doubling or halving the bid amount under a double-bound dichotomous choice format.

The disadvantages of the iterative bidding game are the additional time required to complete the questionnaire and possible biases that could be introduced by the dichotomous choice questions being repeated until rejection of a bid is obtained. The main bias likely to occur is the anchoring or starting point bias where the initial bid offered to respondents influences their final WTP value for the good. People tend to believe that the starting bid is the norm, what other people might reasonably pay and therefore what is expected of them (Willis, 2002).

The current study used the iterative bidding game elicitation format and the initial bid was calculated based on the price of land in Nyabarongo River wetland and based on information from the focus group discussions. From the survey responses, the mean and median WTP for an environmental improvement were then calculated.

3.3.1.2 Biases in Contingent Valuation Method

Although the CVM is extremely flexible and can be used to value any environmental asset, it can encounter biases, including strategic bias where the respondent, believing that his/her answer will be used to affect government policy, can intentionally overstate or understate his/her WTP to achieve the desired policy results. People may recognise two different

incentives to distort their responses; perceiving that they will not actually have to pay and that their responses may influence the supply of that good or bad, they may respond in ways that are more indicative of what they would like to see done than how they would behave in an actual market. On the other hand, if people believe (correctly or incorrectly) that their responses will influence actual fees, they may be more concerned about keeping their fees low than revealing their true values to the enumerator (Bishop *et al.*, 1979).

Other biases include design bias, hypothetical bias, starting point, vehicle, question order bias, operational bias, interview and compliance biases. The hypothetical bias is the most common and occurs where the hypothetical WTP deviates from the real WTP. It emanates from the design and presentation of the hypothetical market of the good being valued. It occurs when respondents state that they will pay for a good when in real life they will not, or they will actually pay less when placed in a comparable purchase decision (Karen *et al.*, 2008 and Sabah *et al.*, 2011). Neoclassical theory suggests the survey should overestimate true WTP while actual contributions should underestimate true WTP (Carson *et al.*, 2011).

To remove the hypothetical bias, Karen *et al.* (2008) suggest the follow-up certainty question where the hypothetical yes responses be divided into "probably sure" and "definitely sure" responses and only 'yes responses' which respondents were 'definitely sure', be treated as 'yes responses' and the 'yes responses' where the respondents were 'probably sure' of, be treated as 'no responses'. The explanation to this is that the 'definitely yes' response closely resembles the response necessary to make a purchase in real market situations. The current study adopted the "definitely sure", "sure" and "not sure" follow-up certainty question to overcome the hypothetical bias.

The interview bias occurs due to the way the interviewers conduct themselves; this can influence responses. This bias is removed by carefully checking answers from each

interviewer in analysis; if an interviewer has consistently higher or lower valuation responses, it raises doubts about the reliability of these answers, which can be eventually discarded. The compliance bias occurs when respondents try to guess the correct answer or tries to answer in a way that they think will please the enumerator. This bias can be avoided by carefully training enumerators in order to exactly follow the exact wording of the question (Wedgwood *et al.*, 2003). For the current study, the survey was carefully designed and enumerators carefully conducted in-person interviews after a two-days training and pre-test.

3.3.1.3 Focus group discussion

The focus group discussions were used to learn more specific and sensitive information on the wetland; they ranged in size of 7 to 14 participants and were conducted by the researcher and a team of enumerators. Groups were composed initially of at least one member of a cooperative involved in the protection of Nyabarongo River wetland and non-members, male and female. The researcher was the moderator but for the role of facilitator, one participant was chosen to guide the others and another one chosen to write the discussions. A checklist of discussion questions was used. The main focus was to understand much about how local beneficiaries use, perceive, understand and refer to the wetland; which provided access to a larger body of knowledge of general community information. The information from the focus group discussion was used to refine the valuation scenario for the survey.

3.3.1.4 Pre-testing of survey instruments

A pre-test was done to evaluate the effectiveness of the questionnaire and focus group checklist. The feedback from both the pre-test and the focus group discussion were used to revise the questionnaire and make the hypothetical market as real as possible. The study used the following hypothetical scenario to elicit the WTP for the improvement in wetland quality: "*Assume that there is an environmental law specifying the measures to be taken for the*

protection of Nyabarongo River wetland. According to this law, households will contribute a certain amount of money every month to support the protection and conservation of Nyabarongo River wetland through the National Fund for Environment and Climate Change in Rwanda (FONERWA) in REMA. This will lead to an improvement of water quality without water hyacinth and favourable for biodiversity conservation, transport and tourism. On the river shores, the natural vegetation will constitute a good habitat for reproduction of fish and increase its productivity. Agro forestry trees, reeds and bamboos on river shores will constitute another source of food and income for the local household owners. If your household is requested to voluntary contribute a certain amount of money through FONERWA for the protection of Nyabarongo River wetland, would you be willing to pay 1,000 Rwf every month over five years for the protection of the wetland?" Then, the bidding process generated the maximum WTP of each surveyed household.

The current study, after the pre-test survey, used as payment vehicle a voluntary contribution through the National Fund for Environment and Climate Change in Rwanda (FONERWA). The use of the iterative bidding method was expected to reduce the occurrence of the strategic bias and the relatively big sample of 359 respondents was expected to minimise the bias that could be caused by the bid design (Kanninen, 1993).

3.3.2 Empirical model to assess factors influencing the WTP

The relative importance of factors likely to influence the WTP was assessed by estimation of a model that allows inclusion of respondents' socio- economic factors as independent variables into the WTP function. The current study used the Ordinary Least Squares (OLS) regression model to analyze the relative importance of these factors. The decision to use OLS was arrived at after comparing its estimates with the censored Tobit method.

Specification of the OLS regression model

In different applications where the dependent variable is zero for a substantial part of the population (the WTP variable for this study), the alternative to Ordinary Least Squares (OLS) for this case is the Tobit model. The use of OLS in the case of censored data sets makes the estimates biased and inefficient, thus violating the basic tenets of Best Linear Unbiased Estimator (BLUE) conditions. OLS estimates become biased and inefficient depending on the number of zeros in relation to the number of observations in the data sets. The greater the number of zeros in relation to the number of observations, the greater the instability of the OLS estimates and vice versa. In cases where the number of zeros is low, the difference between OLS estimates and Tobit estimates is usually found to be marginal (Tobin, 1958; Cynthia *et al.*, 1986 and Clevo *et al.*, 2002).

Tobin (1958) found that if only the value of the variable was to be explained and if there was no concentration of observations at the limiting value, multiple regression would be an appropriate statistical technique for estimation. This was also confirmed by Cynthia *et al.* (1986) who explained that the choice between the OLS and the Tobit analysis should depend on assumptions concerning the nature of the data and the major research objectives. A study by Clevo *et al.* (2002), after estimating the Tobit and OLS models with datasets where the number of zeros was increased exponentially to see their effects on the final estimates, found that there were no noticeable differences in estimates from OLS and Tobit models until the zeros were more than 25% of the total number of observations. This study concluded that the number of zeros in the dependent variable has to be significantly large for differences in estimates between OLS and Tobit analysis to emerge.

The present study used the OLS regression model after comparing the estimates with the censored Tobit estimates and because the number of zeros in the dependent variable is less

than 25% (21.7%) of the total number of observations. The standard OLS regression model is written as:

$$Y = \alpha + \beta X + \varepsilon_i \qquad i = 1,2,\ldots, N \quad (1)$$

Where α is the intercept; Y a vector of maximum WTP values; X a vector of independent variables; β a vector of coefficients to be estimated and ε is a vector of stochastic disturbances assumed to be normally distributed with E(ε)=0 (Gujarati, 2007).

To help attain the best specified model, it was important to control for all relevant factors that might influence a respondent's maximum WTP for the protection of Nyabarongo River system. Broadly, this means that the model had to include households' characteristics (socio-economic and demographic) as well as respondents' perceptions of the current status of water in the river. This yields the following regression equation for maximum WTP:

$$MaxWTP = \alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_{14} x_{14} + \beta_{15} x_{15} + \varepsilon_i \quad (2)$$

Where X_1 up to X_{15} represent the hypothesized independent variables in Table 3.3.2

Table 3.3.2 Description of hypothesized independent variables

VARIABLE	DESCRIPTION	Expected sign
Dependent variable		
Max WTP	Amount of money household would pay for the protection of Nyabarongo River system	
Independent variables		
Distance from residence to the wetland	1= Reside in less than 100 metres; 0= Reside in more than 100 metres	+
Perception on current water quality	1= Poor quality 0= Good quality	+
Age	Age of the household head in years	-
Education level of the household head	Highest education level attained by household head 0= Primary education and below 1= Secondary education and above	+
Main occupation of household head	1= On-farm activities 0= Off-farm activities	+
Household size	The number of members in the family	-
Household income	The amount of money (Rwf) earned per month 0= Less than 10,000 Rwf/ month ; 1= 10,000Rwf/month and above	+
Ownership of land in the wetland	1= If the household owns land in the wetland 0= Household does not own land in the wetland	+
Membership in a group of environmental interest	1= if the household head or a member of the household is a member 0= Not a member of environmental group	+
Access to tap water	1= if the household has access to tap water 0= No access to tap water	-
Extension contacts	Number of visits received by household on agriculture and environment per month	+
Initial bid amount	1= if the household said yes to the initial amount 0= household said no to the initial amount	-
Knowledge of individual responsibility in wetland protection	0= No responsibility known 1= Responsibilities known	+
Satisfaction with actual wetland management	1= Satisfied 0= Not satisfied	-
Distance to the nearest input-output market	1= less than 500 metres 0= more than 500 metres	+

Source: survey data, 2012

From the literature, the independent variables household income, education level of the household head, distance from residence to the wetland, membership in a group of environmental interest and respondent's perception or knowledge about the wetland have been found to positively influence the magnitude of WTP. Those who are more educated and wealthier and those who live near the wetland have higher WTP. Those who have knowledge about the wetland and members of environmental groups are more aware and concerned about environmental protection, thus have higher WTP; which is the reason why these variables were hypothesized to positively influence the magnitude of WTP for the protection of Nyabarongo River system (Prasher *et al.*, 2006; Janet *et al.*, 2007 and Thang *et al.*, 2007).

The independent variables household size and initial bid amount were hypothesized to negatively influence the magnitude of WTP according to information from literature. A household with a big number of members is likely to face more expenses than a household with a small number of members because of the budget constraint. From economic theory, considering a real market situation, when a bid of a good increases, the demand of that good decreases. Considering that CVM presents market-like situation to the respondent, the initial bid amount is hypothesized to negatively influence the magnitude of WTP (Janet *et al.*, 2007 and Wattage *et al.*, 2008).

From prior knowledge on Nyabarongo River wetland, the variables extension contacts, ownership of land in the wetland, main occupation of household head and distance to the nearest input-output market are hypothesized to positively influence the magnitude of WTP. According to NISR (2012), about 72% of working individuals above the age of 16 have their main job in agriculture and in rural areas, agriculture provides main jobs to 78% of the working population. Considering these statistics, it was hypothesized that as many rural households depend on agriculture, they would be more willing to pay to protect the wetland,

provider of many support services to agriculture and those who own land in the wetland are more concerned about its quality improvement to improve productivity.

According to NISR (2012) also, it was found that half of all rural households require an hour or longer to reach the nearest food market. If households live near an input-output market, they are likely to be concerned with wetland quality improvement to get more money from their increased produce from agriculture. Extension services constitute a way of educating communities on different issues and wetland protection is one of them. NISR (2012) report mentions that around 97% of households received some sort of environmental information and the main means of information include meetings and radio. Increasing extensions contacts with rural households is likely to increase their awareness about wetland protection, thus a positive influence on the magnitude of WTP.

From prior information on the wetland, variables like access to tap water, age of the household head, satisfaction with actual wetland management and knowledge of individual responsibility in wetland protection are hypothesized to have a negative influence on the magnitude of WTP. This is because the implementation of government measures to protect wetland and rivers started in 2005, which could be a reason that older heads of household could be less aware of environmental protection, thus less willing to pay. Wetland protection awareness is also linked to knowledge of an individual responsibility in wetland protection. Therefore, if people do not know government measures in place, they cannot know their own responsibility as individuals. If they are satisfied with actual wetland management, it can be assumed that they would not need more improvement in wetland quality.

Finally, in Rwanda, around 72% of rural households have access to improved drinking water sources and only 12% of rural households use surface water (rivers and lakes) as drinking water (NISR, 2012). It means that households with access to tap water depend less on

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Nyabarongo River for different needs in water for different house uses and this is hypothesized to have a negative influence on household's WTP.

The model for the current study is thus:

$$MaxWTP = \alpha - \beta_1 Hhage + \beta_2 Educ + \beta_3 Hhinc + \beta_4 Dist + \beta_5 Ownl - \beta_6 Inbamt - \beta_7 Hhsize + \beta_8 Percwq - \beta_9 Tapw + \beta_{10} Mberenv + \beta_{11} Extcon + \beta_{12} Occup - \beta_{13} Indivres - \beta_{14} Satsmgt + \beta_{15} Distmkt + \varepsilon_i \quad (3)$$

After estimation of this model, the predicted mean monthly maximum amount of money farmers are willing to pay was calculated for each District in the sample.

3.4 Research design, data needs and sources

The research design of this study is quantitative and a survey was conducted using a semi-structured questionnaire. This questionnaire included an introductory section, a detailed description of the Nyabarongo River system as the good being valued, a clear description of the institutional setting in which the good will be provided and paid for, a method by which the survey elicits the respondent's preferences with respect to the good, a follow-up question and collection of the respondent's characteristics.

Data used for this study were primary data from focus group discussions and the survey. This includes collected information on the amount of money farmers are willing to pay and on factors likely to influence the WTP. Secondary data collected by the study included the price of land in the wetland to be able to determine the initial bid amount and the number of riparian households with other data that were needed all along the study. The survey used in-person interviews through a semi-structured questionnaire which was administered to a sample of 359 farmers from 4 riparian districts namely Kamonyi, Rulindo, Bugesera and Kicukiro. Secondary data were obtained from district officers in charge of agriculture and environment, heads of cooperatives involved in the protection of Nyabarongo River wetland,

the National Environmental Youth Project (NEYP) under Rwanda Environment Management Authority and the focal point persons of NEYP in the sample selected districts.

3.5 Sampling and data collection procedure

A multi-stage sampling procedure was used. The population of interest comprised all farmers in Nyabarongo River catchment area within the 17 districts in the area. In the first stage, 4 districts were purposively selected from the 17 according to their geographical location in the catchment and the part of the river that passes in those districts. Those districts were also chosen because of the important human activities that are observed on river shores and on the level of implementation of the national environmental protection law.

In the second stage, to avoid taking a sample from sectors that are very far away from the wetland, only riparian sectors from these 4 districts were considered and these were 6 sectors. For the same reason, in the third stage, only riparian cells (coordination interface between Sector and Village) from those 6 sectors were selected and these constituted a sampling frame of 8 cells. Then from those cells, the probability proportionate to size sampling was used to select a sample of 359 respondents from 7,283 households. The sample size of 359 was determined after due consideration of the available funds and the field requirements including the number of enumerators that could be hired to complete the survey in the required time of the research. The largest sample size the study could afford was 359 households. As shown in Table 3.5, the highest number of respondents is from Kicukiro District (108) which has the highest number of households, followed by Bugesera District (96) and Kamonyi District (78); the lowest number was from Rulindo District (77). The difference in ratios of surveyed households in different cells is explained by the fact that those cells have different total number of households, and as the sample size was predetermined, each cell contributed according to its total number of households. It is important to note that these samples were

not analysed separately, since the NOAA guidelines require a large sample size for CVM studies.

Table 3.5 Distribution of households by district

District	Cell	Sampling frame	Sample size	% of sampling frame
Kicukiro	Mbabe	1000	48	13.4
	Rusheshe	1189	60	16.7
Rulindo	Rutonde	787	38	10.6
	Kijabagwe	806	39	10.9
Kamonyi	Cubi	717	37	10.3
	Kirwa	826	41	11.4
Bugesera	Rugunga	990	49	13.6
	Rurenge	968	47	13.1
Total		**7,283**	**359**	

Source: survey data, 2012

3.6 Data analysis

Data collected from the survey on the amount of money farmers are willing to pay for the protection of Nyabarongo River system and factors likely to influence the WTP was analysed using econometric tools. Descriptive statistics, such as mean and percentage were generated using statistical packages. Descriptive analysis was done using SPSS, Excel and Minitab tools. To assess the relative importance of major variables hypothesized to influence the WTP of farmers, the Ordinary Least Squares method was employed using STATA.

CHAPTER FOUR: RESULTS AND DISCUSSION

This chapter provides a discussion of the socio-economic characteristics of the sample respondents. It also includes information on farmers' attitudes towards the protection of Nyabarongo River system, the estimations of the mean maximum WTP and factors that influence the WTP.

4.1 Socio-economic profile of farmers in Nyabarongo River catchment area

Table 4.1 summarizes the socio-economic characteristics of the respondents. The overall mean age of the head of the household was 42 years while it was 36 years for the spouse for the married respondent. The relatively high mean ages can be explained by the age structure of Rwandan population where 54.7% of the total population is between 15 and 64 years with life expectancy at birth of 58.44 years for the total population (CIA, 2012). About 50.7% of the respondents were male, and majority of the respondents (68.8%) were married, with other 31.2% being single, widowed, divorced or separated. According to CIA (2012), about 70.4% of the total population in Rwanda of age 15 years and above can read and write. From this study, data on level of education showed that 88.6 % had attained primary education and below and 11.4 % had completed secondary and above education.

More than a half of households (61%) earn less than 10,000 Rwf per month, while 39% earn 10,000Rwf and more per month. This relative high number of population earning less than 10,000 Rwf per month is not surprising since, according to the Rwanda National Institute of Statistics (NISR, 2012), about 44.9 percent of the Rwandan population was identified as poor and households in rural area which mainly rely on farm wages have the highest levels of poverty (51.5%).

Table 4.1.1 Households' socio-economic characteristics

Characteristics	Proportion	%
Age of the head of household (years)		
Mean	42	N/A
Standard deviation	13.661	N/A
Minimum	18	N/A
Maximum	95	N/A
Age of the spouse (years)		
Mean	36	N/A
Standard deviation	10.03	N/A
Minimum	18	N/A
Maximum	70	N/A
Gender of the household head		
Female	178	49.3
Male	181	50.7
Marital status of the household head		
Married	247	68.8
Non married	112	31.2
Education level of the household head		
Primary and below	318	88.6
Secondary and above	41	12.4
Main occupation of the household head		
On-farm activities	321	89.5
Other activities	24	10.5
Size of the household		
Mean	4.78	N/A
Standard deviation	2.071	N/A
Minimum	1	N/A
Maximum	18	N/A
Household income (Rwf/month)		
[<10,000]	219	61
[≥10,000]	140	39

Source: Survey data, 2012

The survey data on the main occupation of the household head showed that the majority (89.5%) live off on-farm activities while only 10.5 % depend on off-farm activities. According to NISR (2012) report, around 72% of working individuals are engaged in agriculture, which could explain the high number of respondents in this category. Off-farm activities in the study area are mainly transport on water and fishing. The mean average size of the household was of 4.7 with a minimum of 1 person to a maximum of 18 persons in one household in Bugesera District.

Differences in means and proportions of District samples

Calculations of differences in means and in proportions of the samples from 4 Districts were done by comparing pairs of Districts on the basis of two null hypotheses for both the means and proportions. For the difference in proportions, the null hypothesis was that a mean of one sub-sample is greater or equal to the other mean from another sub-sample, and this was estimated for important variables across the sampled Districts.

Table 4.1.2 Differences in proportions of district samples

Variables		Kicukiro n=108	Bugesera n=96	Kamonyi n=78	Rulindo n=77
Gender of household head	Female	56[a]	46[b]	36[c]	39[d]
Marital status of household head	Not married	32[a]	21[b]	30[c]	29[d]
	Married	76[a]	75[d]	48[b]	48[c]
Education level of household head	Primary and below	97[a]	86[b]	64[c]	71[d]
	Secondary and above	11[a]	10[b]	14[c]	6[d]
Main occupation of household head	On-farm activities	92[a]	94[d]	68[b]	67[c]
	Off-farm activities	16[a]	2[b]	10[c]	10[d]
Household income	<10,000 Rwf/month	62[a]	57[b]	53[c]	47[d]
	>=10,000 Rwf/month	46[a]	39[b]	25[c]	24[d]
Distance to the wetland	In less than 100metres	61[a]	38[a]	15[b]	33[c]
Employment in conservation activities		17[a]	31[b]	24[c]	20[d]
Membership in environmental group		11[a]	20[b]	14[c]	12[d]
Ownership of land in the wetland		41[a]	51[d]	21[b]	24[c]
Initial bid amount		23[a]	25[d]	12[b]	16[c]
Access to tap water		98[d]	68[a]	42[b]	67[c]
Perception of current water quality	Poor	93[a]	78[b]	65[d]	54[c]
	Not poor	15[a]	18[b]	13[c]	23[d]

Note: Exponents means differences in proportion following this order "a>b>c>d"
Source: Survey data, 2012

For example, considering the variable household income, the results showed that, at the significance level of 5%, the District sample proportion from Kicukiro District is greater than the proportions of the other Districts. Considering the variable distance from residence to the wetland, the results showed that the proportion from Bugesera District is greater than the proportions from the other Districts.

Table 4.1.3 Differences in means of district samples

Variables	Kicukiro n=108 Mean	Bugesera n=96 Mean	Kamonyi n=78 Mean	Rulindo n=77 Mean
Age of the head of household (years)	39^a	43^b	45^d	41^c
Household size (number of members)	4.69^a	5.1^c	4.88^d	4.39^b

Note: exponents show the difference in means in this order "a>b>c>d"
Source: Survey data, 2012

Considering the variable household size, the results in Table 4.1.3 show that the District sample mean from Kicukiro District is greater than Rulindo, Bugesera and Kamonyi Districts means respectively. This is a proof that those samples from Districts are representative of the population and that characteristics of households in the catchment area differ District by District.

4.2 Farmers' attitudes towards the protection of Nyabarongo River system

Farmers' attitudes towards the protection of Nyabarongo River system are summarized in Table 4.2. About 72.7 % of households expressed that Nyabarongo River system is important to their households; about 21.4% of households said that it is very important while 5% and 0.8% of the households said the river system is less important and not important at all to their households respectively. These households were also asked to express their interest in the wetland by saying at what level they perceived that the current status of Nyabarongo River system is worth discussion. About 61% of households reported that Nyabarongo River system is a serious issue worth discussion while 25.1% and 6.4% said that the current status of the wetland is a critical and very serious issue worth discussion respectively. In addition, 4.7% and 2.8% of households perceive that the current status of the wetland is less serious and not important issue worth discussion respectively. The explanation to these last percentages can be found in the fact that they either live far from the wetland hence do not have a lot of information on it or they do not directly benefit from it and so they do not give much interest to the wetland.

The protection of Nyabarongo River wetland is required by a specific Organic Law. Households were asked if they knew the existence of that Organic Law and what they knew about it. They were also asked if they knew the government measures in place for the protection of rivers and their knowledge were classified according to whether they knew the exact measures in place or have heard some aspects of these measures. Knowing this Organic Law and those measures is key to explaining their role in protecting the river system, which could be a reason to why a household would be willing to pay for protecting the river system or not. Most of the households (63.8%) said that they knew the Organic Law N° 04/2005 while 57.4% said that they knew the government measures in place for the protection of rivers.

The general aspects of the Organic Law and measures of protection of rivers and wetlands which were known by households include: the protection of animals in the river like crocodiles and hippopotamus, the tree cutting restrictions and the cultivation of reeds on river shores to protect soils on the shores and clean the water. These are summarized in Table 4.2.

The households' knowledge about who is responsible for the protection of the rivers including Nyabarongo River is among factors that can explain their attitudes towards its protection. About 42.9% of households (42.9%) believe that the responsibility of protecting and conserving rivers and wetlands is for all the stakeholders while 30.4% of households put this responsibility to the whole community. In addition, 25.1% of them consider that it is the government's responsibility and only 1.7% of respondents give that responsibility to private interest groups (represented by 'others' in Table 4.2).

Table 4.2 Households' attitudes towards the protection of Nyabarongo River system

Attitudes	%
Importance of Nyabarongo River system to the respondent	
Very important	21.4
Important	72.7
Less important	5
Not important at all	0.8
Perception of current status of the wetland as worth discussion	
Critical	6.4
Very serious	25.1
Serious	61
Less serious	4.7
Not important	2.8
Knowledge of the Organic Law N°04/2005	63.8
Knowledge of government measures for the protection of rivers	57.4
Knowledge about the general responsibility in protecting rivers	
Government	25.1
Community	30.4
Collaboration among all stakeholders	42.9
Others	1.7
Knowledge about own responsibilities in protecting rivers	
No role	5.8
Follow government measures, encourage others and report illegal	85.3
Resources contribution toward implementation of necessary activities	8.9
Overall satisfaction with the actual wetland management	
Satisfied	41.3
Unsatisfied	58.7

Source: Survey data, 2012

Farmers can be more concerned with the protection of rivers and wetlands if they know what their responsibility entails in that task. About 5.8% of households think that they have no role in the protection and conservation of rivers and wetlands and 94.2% of households said that if government measures are in place, their role will be to follow those measures, encourage others to do the same, report illegal activities and also to contribute with resources towards the implementation of necessary activities to protect rivers and wetlands. These results prove that with government measures in place, a considerable number of households (94.2%) are ready to contribute in different ways to protect Nyabarongo River wetland and its resources.

The implementation of these measures mostly benefits those people who are members of youth cooperatives in charge of the protection of Nyabarongo River wetland as it is a source of employment. The importance of protecting the river system is also most understood by

those members of cooperatives; others are either not informed about what is going on in the wetland since they do not use directly resources from the wetland while others are indifferent because they have had negative impacts from the implementation of these measures namely: loss of agricultural land, loss of crops on the 10 riparian metres thus loss of a source of income.

During the time of the study, in different parts of Nyabarongo River system catchment area, wetland management plans were place. Some of them are widely used than others and the authorities are the ones in charge of encouraging the population to participate in the protection of the river and the associated wetland. Households were asked at what level they were satisfied with the current wetland management and 58.7% of them said they are not satisfied with the current wetland management while 41.3% said they are satisfied with the current wetland management. By the time of the study, measures to protect the wetland were implemented in some parts of the catchment area and this is the reason why to some respondents, were not satisfied by the wetland management.

4.3 Farmers' uses and benefits from Nyabarongo River wetland goods and services

Nyabarongo River wetland provides many environmental goods and services to the riparian communities and activities done to protect Nyabarongo River include the removal of water hyacinth, which is later used as fertilizer and in manufacturing baskets, shoes and home decorations. The identification of goods and services which are mostly used by the surrounding communities can explain in part households' benefits derived from the protection of the wetland.

According to the survey, the main direct benefits from the wetland include: agricultural production (51.8%), fisheries (44.8), water (45.4%) and transport (45.7%). The most important indirect benefits include the fact that the wetland is water (49.3%) as well as

protected species (42.3%) reservoir. Some of the goods and services from the wetland that households are not aware of include trees for timber (63.5%) mostly because it is illegal to cut them; medicinal plants (50.7%); scientific interest as a field of research (59.1%) and sand mining (60.4%) which is not allowed by the authorities (Table 4.3).

Table 4.3 Direct and Indirect benefits from Nyabarongo River wetland to households

Importance / Benefits	Not aware (%)	Very unimportant (%)	Not important (%)	Neutral (%)	Important (%)	Very important (%)
Direct benefits						
Agricultural production	1.9	3.6	1.9	1.9	38.7	**51.8**
Fisheries	10.6	3.6	14.8	8.9	**44.8**	17.3
Trees for timber	**63.5**	12.0	16.4	4.2	3.3	0.6
Fuel wood	**47.4**	10.3	21.7	5.3	13.1	2.2
Herbal/medicinal plant	**50.7**	9.5	7.2	6.7	21.2	4.7
Reeds	8.4	1.4	17.8	3.9	**39**	29.5
Water	6.7	4.7	7	3.6	**45.4**	32.6
Tourism	**39**	7.2	16.2	9.7	25.9	1.9
Scientific interest	**59.1**	5.6	20.6	8.6	4.5	1.7
Transport	5.3	1.7	2.8	2.2	**45.7**	42.3
Sand mining	**60.4**	13.4	16.7	2.8	6.1	0.6
Indirect benefits						
Water reservoir	7.2	1.1	9.5	5	**49.3**	27.9
Water source	37	1.4	10.9	4.2	**38.2**	8.4
Biodiversity reservoir	13.6	3.6	15.9	19.8	**37.9**	9.2
Protected species	11.1	8.1	7	19.8	**42.3**	11.7
Mitigation of climate change	**46.8**	5.8	2.5	12	30.1	2.8
Flood control	29.0	1.4	13.1	8.4	18.9	**29.2**

Source: Survey data, 2012

4.4 Perceived main causes of the degradation of Nyabarongo River system

The degradation of Nyabarongo River system is the main reason of government establishment of current measures for its protection. In order to participate in these activities of protection and conservation of the river and the associated wetland, one has to know that there are threats to that river system like overfishing and cultivation on river shores. The surrounding communities have different ideas and perceptions about the causes of degradation of the wetland. Table 4.4 summarizes the main known reasons of degradation of

the wetland from households. Among the 359 households, 88.3% are aware that the river and the associated wetland can degrade/deplete because of different activities that are done in and near the wetland. The main causes identified by these households are erosion (61.8%), natural disaster (55.2%) and cultivation on river shores (49%).

Table 4.4 Perceived main causes of degradation of Nyabarongo River system

Causes of degradation	%	Causes of degradation	%
Natural disasters (climate change, etc.)	55.2	Housing development	19.3
Cultivation on river shores	49	Sand mining	5.4
Erosion	61.8	Irrigation	5.7
Waste disposal in the wetland	23.2	Overfishing	11.3
Industrial effluents	17.6		

Source: survey data, 2012

The less known causes of degradation of Nyabarongo River wetland are sand mining (5.4%) followed by irrigation (5.7%) and overfishing (11.3%).

4.5 Farmers' willingness to pay for the protection of Nyabarongo River system

To elicit the maximum WTP, after entering data from the survey, the next step was to identify the protest bids. Before the valuation question, respondents were asked if they are willing to pay any amount of money at all. Among the 359 households, 75.2% (270 households) agreed that they are willing to contribute a certain amount of money for the protection of Nyabarongo River system.

4.5.1 Identification of protest bids

Nyabarongo River system is a public good; eliciting the WTP for its protection assumes that this WTP is non-negative; no individual is made worse off by the proposed change. Individuals, who refuse the proposed change, exhibit a zero WTP. Some zero bids reflect the true preferences, zero being the reservation price of individuals who are indifferent to the proposed change (Strazzera *et al.*, 2003). However, some zero bids are protest bids, which

refer to situations where respondents indicate that their WTP is zero, not because they have no value for the environmental good or service in question, but because they object to some aspects of the way the hypothetical market of the good is presented. There are other protest bids with a positive amount of money, which are considered as outliers because they are large when compared to the respondent's income. The presence of outliers may indicate the presence of strategic behaviour, where respondents failed to consider their budget constraint with due care while answering the valuation question (David *et al.*, 2002).

In developing CV hypothetical markets, a lot of concern is put on the scenario, mode of payment and survey instrument. Normally, those concerns are addressed in pre-testing survey instruments; from there, the hypothetical scenario is modified to minimise the potential non-responses and outliers, with the use of follow-up debriefing questions to identify protest bids.

A lot of literature exist on how to treat these protest bids in contingent valuation analyses: NOAA guidelines suggest that to minimize non-responses, the reduction of the final sample by elimination of protest zeros, unrealistic high values and other problematic responses may lead to effective final total response rates so low as to imply that the survey population consists of interested and specially instructed quasi-experts. Halstead *et al.* (1991) believe that the practice of eliminating protest bids may not introduce unacceptable bias under conditions of either a high overall survey response rate or low protest rate (or both), but David *et al.* (2002) suggest that this can be done by ensuring that the reduced sample does not differ significantly in its characteristics from unadjusted sample. If characteristics of the adjusted sample changed, weighting procedures should be used to compensate for unrepresentativeness of the reduced sample.

Strazzera *et al.* (2003) propose that protest bids can be treated through the adoption of mixture, or spike models and Meyerhoff *et al.* (2005) support the incorporation of protest

beliefs into the analysis as true zeros, although it might bias the economic value downwards, but it can be taken as an attitude towards the behaviour of paying money for a public good. The current study, after identification of protest bids by the use of follow-up debriefing questions, deleted the protest bids from the sample, based on the high overall survey response rate and the fact that they constituted a very small number with the reduced sample not affected in its characteristics.

Among 89 households who said their contribution for the protection of Nyabarongo River system is Rwf 0, based on the responses they gave to the follow-up questions, 6 were identified to be protest bids, therefore deleted from the sample. The remaining sample is then 353 households. Table 4.5.1 summarizes the percentages of those households with 0 WTP showing the protest bids according to the answers given to follow-up questions.

Table 4.5.1 Summary of frequencies of important reasons for expressed WTP

Reasons for WTP	Yes (%)
Maximum WTP Valid N= 270	
Better quality of goods and services from the wetland	**81.5**
Wetland production of different environmental goods & services	**61.1**
Future generations to enjoy goods and services from the wetland	**30**
REMA will do a good job of administering funds from contributions	**19.3**
0 WTP Valid N=89	
Not supposed to pay for protection of the wetland	**13.5**
Satisfied with current status of the wetland	**10.1**
Cannot afford to pay	**56.1**
Choice of spending money in other ways	**4.5**
Not able to determine the amount to spend on the protection of the wetland	**1.1**
This is not a priority	**12.3**
Spending should be on all wetlands	**0**
The government should be the only one in charge of protecting the wetland	**5.6**
Need of more information time to answer this question	**1.1**
Contribution in kind (labour)	**8.9**

Source: survey data, 2012

The main reasons that were considered for protest bids are that the government is the only one in charge of protecting Nyabarongo River system and other wetlands; that the respondent

needs more time/information to answer the valuation question and that spending should be on all wetlands not only Nyabarongo River wetland (David *et al.*, 2002).

In addition to the protest bids, the survey found households that were willing to contribute in kind (labour), rather than money contribution. The current study's payment vehicle did not account for this contribution in kind; these zeros are not true zeros, therefore, they were also removed from the final observations as the initial sample size is big, it may not disturb the composition of the sample; this left the study with 345 households.

4.5.2 Follow-up certainty questions

From the literature, it has been noted that if respondents are given a chance to express their uncertainty, they frequently express a degree of uncertainty since they may be inherently uncertain about the nature of their own preferences or the circumstances surrounding the choice they are being asked to make (Balcombe *et al.*, 2009).

The primary concern affecting the CVM is that quite often, respondents have no previous experience with providing valuation responses to unfamiliar goods and the hypothetical markets. A lot of other reasons can be related to the uncertainty of respondents, including the uncertainty about the public good or policy valued, from the questionnaire used or simply respondents may be unable to make a trade-off between the good or services provided and their money. Assuming that respondents can estimate accurately (in %) their level of certainty and can interpret the certainty scale equivalently, past studies used different models to account for those "yes" answers with low levels of certainty to "no". These models include the Symmetric Uncertainty Models, Weighted Likelihood Function Model, etc. (Lyssenko *et al.*, 2009).

This is the hypothetical bias and to reduce its occurrence, the follow-up certainty questions were asked to respondents after the valuation question. These questions were to remind the respondents to think twice about the answer they have given as if they were given an

opportunity to pay. Most quantitative studies generally found that recording uncertain "yes" responses to "no" yield estimates of WTP that are a good approximation of actual payments. If this recording is combined with cheap talk, it is believed that it can reduce the hypothetical bias but these techniques may not work in all situations and should be used with caution as long as the reasons behind the hypothetical bias are not well known (Cummings *et al.*, 1999; Murphy *et al.*, 2004 and Whittington, 2010).

The current study used a qualitative scale to ask the respondent how certain s/he is of his/her response to the CV question (definitely sure, sure and not sure). In addition to this, a short cheap talk was included in the questionnaire before the valuation question. This cheap talk is as follow: *"Before expressing a certain amount of money, please ask yourself: "Am I willing to pay this amount of money for the protection of Nyabarongo River system every month? Or would I rather not pay this amount and remain in the current state of the wetland, which may eventually deteriorate?" Please, do not agree that you are willing to pay a certain amount if you cannot afford it on a regular basis (monthly), 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 truly willingness to pay, so please, provide the sincere response, thank you".*

Table 4.5.2 shows the frequencies of answers to the follow-up certainty questions of respondents who expressed an amount of money other than 0.

Table 4.5.2 Follow-up certainty questions

Level of certainty (N=270)	Frequency	%
Definitely sure	83	30.7
Sure	153	56.7
Not sure	34	12.6

Source: survey data, 2012

The majority of households (56.7%) said that they are sure of their answers to the valuation question while 30.7% said they are definitely sure about their expressed maximum WTP for

the protection of Nyabarongo River system. Only 12.6% of the households are not sure, this means that if they were in real market, they would be willing to give up the amount of money they expressed. Among this 12.6% are also spouses who expressed their own max WTP but added that they cannot be sure without the approval of their husbands. This spouse's maximum WTP could also become a zero in case the husband does not agree that the money she expressed can be given up for the protection of Nyabarongo River system.

To adjust for uncertainty, the current study recorded the 'yes' respondents to 'no' if the respondents was not sure. This calibration for certainty reduced the percentages of households which, if placed in real market situations, are surely willing to contribute to the protection of Nyabarongo River system from 75.2% to 67.1% from the sample of 353 households.

4.5.3 Estimation of mean WTP

Among 75.2% of households who agreed that they are willing to contribute a positive amount of money, only 28.2% were willing to pay the initial bid amount (Rwf 1,000) and more. A few respondents (8 out of the 83 who had zero WTP) said they would like to contribute in kind. However, the present study did not put into monetary terms that contribution in kind and considered these as zeros. From this sample, the mean maximum WTP was estimated and it is presented in Table 4.5.3.

Table 4.5.3 Summary of households' maximum WTP per month

Max WTP (Rwf) / household/ month	Valid N	Min	Max	Mean	Std. dev.
	353	0	5000	486.4	630.813

Source: survey data, 2012

The minimum amount of money that farmers are willing to pay is 0 Rwf per household per month and the maximum amount of money recorded is 5,000 Rwf per household per month. The mean WTP is Rwf 486.4 (US$0.80) per household per month over the 5 suggested years.

According to NISR report of 2012, rural households spend 42% of the total purchases on food while in urban areas; about 36% is for food items purchases. The current study covered 4 Districts from 3 provinces and Kigali city; statistics on household consumption patterns show that food purchases covered 34%, 52%, 46% and 42% for Kigali City, Southern, Northern and Eastern provinces respectively. Considering the level of income in rural areas which exclusively comes from agriculture, the expressed mean WTP is low relative to the initial bid amount but reasonable given rural poor household income.

4.6 Factors influencing farmers' WTP for the protection of Nyabarongo River system

The households' maximum WTP from the iterative bidding elicitation method is a continuous dependent variable that accepts zero values. The relative importance of factors that are likely to influence the WTP was assessed using an OLS regression model that allows the inclusion of respondents' socio-economic characteristics into the WTP function. This includes household income, age, main occupation and education level of the household head, and household size among others. Based on the current study, from a sample of 353 households, only 75 said their maximum WTP is 0; these constituted 21.2% of the total number of observations. This percentage being less than 25% allowed the use OLS regression model to estimate the relative influence of hypothesized explanatory variables on the maximum WTP.

The description of the explanatory variables that were hypothesized to influence the maximum WTP is listed in Table 3.3.2 and discussed in Section 3.3.2 with their expected relationship with the dependent variable. Before running the econometric model, the independent variables were tested for the presence of multicollinearity and heteroskedasticity as shown in Appendices 3 and 4. For multicollinearity, a linear correlation coefficient (r) which measures the direction of a linear relationship between two variables was used. The closer the coefficient is to +1 and -1, the greater is the strength of the relationship between the

variables. A value of r between 1 and 0.5 (-1 and -0.5) is defined as strong relationship; 0.5 to 0.3 (-0.5 to -0.3) defines a moderate relationship, 0.3 to 0.1 (-0.3 to -0.1) defines a weak relationship and -0.1 to 0.1 proves none or very weak relationship (Amit, 2009).

Considering the above cited intervals, the correlation matrix shows that none of the explanatory variables is strongly collinear with the others. To quantify the severity of multicollinearity, the Variance Inflation Factor (VIF) was used to measure how much the variance of the estimated regression coefficient is increased because of collinearity. A common rule of thumb is that if VIF (β_i)>5, then multicollinearity is high (Greene, 2002). As shown in Appendix 3B, the choice of variables to be included in the final model was also based on the VIF which were not showing multicollinearity.

Variables were also tested for heteroskedasticity, but although the test proved the existence of heteroskedasticity, data were corrected using the White's heteroskedasticity-corrected standard errors, also known as robust standard errors (Gujarati, 2007). Explanatory variables are both of a qualitative and quantitative nature. Qualitative variables are represented by dummy variables where 1 indicated their presence and 0 otherwise (Table 3.3.2).

The level of significance of each variable was tested using the null hypothesis that these explanatory variables have no effect on the maximum WTP. The decision to reject or not the null hypothesis was based on p-values; these being the lowest significance level at which a null hypothesis can be rejected (Gujarati, 2007). The levels of significance were of 1%, 5% and 10%. If at 1% level, p-value<0.01, it indicates that the variable is highly significant. At 5% level of significance, if 0.01<p-value<0.05, the variable is significant and at 10% level, a p-value between 0.05 and 0.1 indicates that the variable is weakly significant. Table 4.6.1 summarises descriptive statistics of variables used in OLS model.

According to Table 4.6.1, the mean of each explanatory variable indicates its frequency in households' data. For example, considering the variable "access to tap water', the mean is 0.77; which means that 77 percent of households covered by this study have access to tap water. This is in accordance with CIA statistics (CIA, 2012) which indicates that 65% of the total population in Rwanda have access to improved drinking water sources while 35% of the total population have access to unimproved drinking water sources. Taking another variable "main occupation of the household head", its mean is 0.90 percent; this means that 90% of household heads covered by this study live of on-farm activities.

Table 4.6.1 Descriptive statistics of explanatory variables

Variable	Min	Max	Mean	Std. dev.
Distance from residence to the wetland	0	1	0.30	0.458
Age of household head	18	95	41.58	13.618
Education level of household head	0	1	0.12	0.321
Household size	1	18	4.77	2.078
Household income	0	1	0.39	0.489
Perception on current water quality	0	1	0.76	0.428
Membership in environmental group	0	1	0.07	0.262
Access to tap water	0	1	0.77	0.423
Extension contacts	0	5	0.23	0.483
Main occupation of household head	0	1	0.90	0.307
Knowledge of individual responsibility in wetland protection	0	1	0.94	0.232
Satisfaction with actual wetland management	0	1	0.35	0.478
Ownership of land in the wetland	0	1	0.29	0.455
Distance to the nearest input-output market	0	1	0.11	0.314
Initial bid amount	0	1	0.22	0.412

Source: survey data, 2012

Table 4.6.2 shows OLS model estimates for the factors influencing the WTP for the protection of Nyabarongo River system. Coefficient estimates of the independent variables

help to identify those factors, which influence statistically the maximum WTP. The coefficient of determination R^2 is a summary that tells the researcher how well the sample regression line fits the data (Gujarati, 2007). The higher the R^2, the better the fit of the model to the data. The R^2 of the OLS model was found to be 0.61, which means that about 61% of the variation in the maximum WTP in the sample can be explained by independent variables (Table 4.6.2).

Table 4.6.2 Factors influencing WTP for the protection of Nyabarongo River system

OLS Regression model estimates				
Dependent variable: Max WTP				
	With Initial bid amount		**Without Initial bid amount**	
Variables	**Coeff.**	**P-value**	**Coeff**	**P-value**
Constant	521.38	0.001	841.97	0.000
Distance from residence to the wetland	40.79	0.428	248.41	**0.000*****
Age of household head	-1.83	0.292	-3.79	**0.097***
Education level of household head	334.51	**0.000*****	323.73	**0.001*****
Household size	-26.62	**0.016****	-53.64	**0.000*****
Household income	159.64	**0.001*****	354.65	**0.000*****
Perception of water quality in the river	125.74	**0.019****	182.07	**0.010****
Membership in environmental group	-168.64	**0.065***	-218.56	**0.069***
Access to tap water	-126.74	**0.015****	-126.19	**0.065***
Extension contacts	120.50	**0.015****	175.27	**0.007****
Main occupation of household head	81.99	0.255	106.85	0.260
Knowledge of individual responsibility in wetland protection	-265.17	**0.005****	-401.65	**0.001*****
Satisfaction with actual wetland management	-10.95	0.811	-46.30	0.443
Ownership of land in the wetland	67.97	0.172	135.82	**0.038***
Distance to the nearest input-output market	9.94	0.888	21.38	0.818
Initial bid amount	934.23	**0.000*****		
Number of obs.	353		**Number of obs.**	353
F(15, 337)	35.32		**F(14, 338)**	11.56
Prob.>F	0.0000		**Prob.>F**	0.0000
R-squared	**0.6112**		**R-squared**	**0.3238**
Root MSE	402		**Root MSE**	529.36

Note: *, ** and *** implies statistically significant at 10%, 5% and 1% respectively
Source: survey data, 2012

From the OLS regression analysis, the estimated WTP model is written as follow:

$$MaxWTP = 521.38 - 1.83Hhage + 334.51Educ + 159.64Hhinc + 40.79Dist + 67.97Ownld + 934.23Initamt - 26.62Hhsiz + 125.74Percwq - 126.74Tapw - 168.64Mbrenv + 120.50Extcon + 81.99Occup - 265.17Indvresp - 10.95Satismgt + 9.94Distnkt$$

If the mean values obtained from the sample data are substituted into the above estimated OLS model; the predicted mean WTP value for the protection of Nyabarongo River System becomes Rwf 486.4 per month (US$ 0.80) which is estimated to be Rwf 5,836.8 (US$ 9.61) per household per year over five years.

According to OLS results in Table 4.6.3, the variables household income, education level of household head and the initial bid amount are significant at 1% level. The variables household size, extension contacts, access to tap water, perception of current water quality and knowledge of individual responsibility in wetland protection are significant at 5%. In addition to this, the variable membership in a group of environmental interest is significant at 10%.

The variable household income is positively influencing the magnitude of WTP. If the household income was to be increased by 1 unit, the magnitude of WTP would be increased by 159.64. . Thus, relatively wealthy households are more willing to pay for the protection of Nyabarongo River than the poor households; this is consistent with expectations because from literature, wealthier households were more willing to pay for environmental protection. Population in the catchment area depend on agriculture as it has the largest share of income in poor households. With an increase in income, households are more aware of the benefits got from the wetland as production increases and thus are more willing to pay to get an improvement in quality of the wetland.

The variable educational level was found to be significant in explaining the magnitude of the maximum WTP at 5% level. The coefficient of education level variable has a positive sign

and thus positively influences the magnitude of WTP. It means that if the household head was to be given one more year of schooling, the household's WTP would be increased by about 334.45 times, holding other variables constant. From literature, these findings are consistent with expectations and explained by the fact that around 70.4% of the total population of age 15 and over can read and write, which means that they are more aware of environmental protection.

The factor perception of the current water quality has a coefficient with a positive sign; which means that it is positively influencing the magnitude of WTP. If the level of perception of current water quality of a household was to be increased by one more unit, the magnitude of the WTP would be increased by 125.74. This is consistent with expectations and it means that if household heads perceive that the current water quality in Nyabarongo River is poor, they will be more willing to pay for its improvement through protection and conservation of the primary source – river ecosystem.

The factor extension contacts positively influence the magnitude of WTP because of its coefficient with a positive sign; this implies that if extension contacts received by households from extension agents were to be increased by one more visit per month, households' WTP would be increased by 120.50 Rwf if other variables were held constant. This was consistent with expectations considering that extensions services are a kind of education to local communities and educated people are more aware of wetland conservation, thus more willing to pay for the protection of Nyabarongo River wetland.

The variable access to tap water had a negative coefficient, which means that it is negatively influencing the magnitude of WTP. It implies that if the access to tap water by households was to be increased by one unit, the magnitude of WTP would be decreased by 126.74. The plausible explanation is that households, which have easy access to tap water, are less willing

to pay for the protection of Nyabarongo River system. They do not depend directly on Nyabarongo River for water needs as they have another source of potable water. This is consistent with expectations because from a priori information, riparian households who have access to tap water only depend on the river for other uses like agriculture, tourism and fisheries.

The variable household size was also found to negatively influence the magnitude of WTP If the size of household was to be increased by one more person, the magnitude of the WTP would decrease by 26.62; which implies that as the household size increases, the household is less willing to pay for the protection of Nyabarongo River system because of the budget constraint. As the number of members of a household increases, there is an increase in expenses; which is likely to reduce the amount of money those households would be willing to give up in order to obtain an improvement in Nyabarongo River wetland quality.

The explanatory variable knowledge about individual responsibility in wetland protection was also found to negatively influence the magnitude of WTP at 5%. If the household head knows own responsibilities in protecting the wetland, s/he is less willing to pay for the protection of Nyabarongo River wetland. Increasing the knowledge of individual responsibilities in wetland protection by one unit would decrease the magnitude of WTP by 265.17. This was expected from a priori information and the explanation is that people who has information about the importance of protecting wetlands and are aware of government measures in place and their role in implementing these; they are probably already contributing in kind in protecting Nyabarongo River wetland. This means that they are not ready to add money or they cannot afford to contribute in kind and in money.

The factor membership in a group of environmental interest was found to negatively influence the magnitude of WTP at 10% level of significance. From OLS results, if one more

member of a household was to become a member of such group, the household's WTP would decrease by 168.74. This is not in accordance with expectations and the most probable explanation can be linked with the factor knowledge of individual responsibility in protecting the wetland. Groups of environmental interest are the ones in charge of implementing government measures for protecting wetlands; members value their contribution in kind, which lowers their contribution in money and thus less willing to give up another amount of money for the protection of the wetland.

The results also show that the magnitude of maximum WTP expressed by households in this study was highly influenced by the initial bid amount. It means that if the initial bid amount was to be increased by one more unit (1,000Rwf), the household's maximum WTP is likely to be increased of 933.55 Rwf and it was not consistent with expectations as the initial bid was hypothesized to negatively influence the magnitude of WTP. The inclusion of the initial bid amount variable in the regression model changed both the significance of variables as well as their coefficients; this shows that this variable has a lot of influence in explaining the magnitude of maximum WTP. The plausible explanation can be that respondents thought that the initial bid presented to them conveys some information on the economic value of the wetland, or the expected or reasonable bid and thus based their valuation on that value, which suggests the presence of the starting point bias.

From the variables that were hypothesized to influence the magnitude of maximum WTP, the variables age and main occupation of the household head, distance from residence to the wetland, ownership of land in the wetland, distance to the nearest input-output market and satisfaction with actual wetland management were not statistically significant at 1%, 5% and 10% level and thus they have no effect on the magnitude of money farmers are willing to pay for the protection of Nyabarongo River system.

The joint hypothesis was used to test the joint significance of these hypothesized variables; the null hypothesis tested was that all slope coefficients were simultaneously equal to zero against the alternative that not all slope coefficients were simultaneously equal to zero. At 5% level of significance, the study failed to reject the null hypothesis and concluded that not all slope coefficients were simultaneously equal to zero; i.e. some of them matter in explaining the variations in the maximum WTP.

Those variables which are significant are household income, household size, education level of the household head, initial bid amount, access to the tap water, extension contacts, perception of the current quality of water in Nyabarongo River, knowledge of individual responsibility in wetland protection and membership in a group of environmental interest; they significantly influence the magnitude of money farmers are willing to pay for the protection of Nyabarongo River system.

Mitchel *et al.*, (1989) noted that the reliability of a CV study that fails to pass the 15% level of R squared is questionable. The current CV is a reliable one, although the significance of the initial bid amount shows the presence of the starting point bias, which is inherent in all the WTP OLS models. The present CV estimates without the initial bid amount variable is still reliable as the model's R squared without it is 32.3%.

4.7 Estimation of the compensating variation at district level

A compensating variation measure offers practical policy insights on how an average respondent with certain characteristics would respond to policy interventions, and the requisite incentive systems that would enhance participation in a development initiative by stakeholder groups from different socio-economic profiles, given existing institutional arrangements.

The current study, considering the key characteristics of the respondents (household income, household size, education level, main occupation and distance from residence to the wetland), which are statistically different across the Districts (see Table 4.1.2 and 4.1.3), estimated the compensating variation for an average individual from each District. Initially, the WTP is a function of different explanatory variables (Section 4.6.1). Taking into consideration the aforementioned key characteristics of respondents, the compensating variation was estimated as follows: $CV_i = WTP + \alpha_1 MEduc + \alpha_2 MHhInc + \alpha_3 MDist + \alpha_4 MOccup + \alpha_5 Mhhsiz$

Where the α_i represent the coefficient estimates from the OLS regression and the M_i the mean of those explanatory variables at the District level. The WTP used is the mean maximum WTP of each District. In Kamonyi District, the compensating variation for an average household was found to be 481.96 Rwf/month; in Bugesera District, the compensating variation for an average household was found to be 715.29 Rwf/ month; 560.6 Rwf/month and 503.76 Rwf/month for Kicukiro and Rulindo Districts respectively. The relative differences in compensating variations across those Districts are explained by the differences in means of the chosen characteristics of the respondents. This is the proof that the economic value given to the wetland differs according to the specific characteristic of the respondents as well as the characteristics of the wetland in different parts of the catchment area. It is also a proof that there is need for policy makers to develop policies and plans which target population in a specific area, taking into consideration their socio-economic profiles and wetland characteristics in that region.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

Nyabarongo River system contributes significantly to the livelihood of the communities in the catchment area through the provision of goods and services vital to their livelihood. It is also a source of income and employment for the local residents working in agriculture, fishing, basketry, water transport and other activities in the wetland.

In its current status, the goods and services it delivers vary from water supply, support for agriculture, source of fish for commercial and domestic consumption purposes, water transport role, source of materials for mats, source of income and fertilizers from water hyacinth, trapping of incoming wastes and other sediments, flood regulation, climate change mitigation and water supply as a tributary of Nile River. It is important to note that these services and goods are not only beneficial to households and local communities around the wetland but also to the national and international communities, for example for climate change mitigation and water supply as it is a tributary of Nile River.

The primary objective of this contingent valuation study was to estimate the amount of money farmers are willing to pay for the protection of Nyabarongo River system. The mean WTP was found to be 486.4 Rwf per household per month over the 5 suggested years. This is a proof against the first null hypothesis where it was stated that farmers are not willing to pay a positive amount of money for the protection of Nyabarongo River system. This null hypothesis was rejected in favour of the alternative that farmers are willing to pay for the protection of Nyabarongo River system.

Another objective was to assess factors that are likely to influence the maximum WTP. Among the hypothesized 15 explanatory variables, only 9 of them were found to be statistically significant in explaining the maximum WTP at different significance levels (1, 5

and 10 per cent). Those variables are household income and size, education level of household head, perception of current water quality, access to tap water, initial bid amount, extension contacts, knowledge of individual responsibility in wetland protection and membership in environmental groups. These variables met a priori expectations in terms of direction of influence except for initial bid amount, knowledge of individual responsibility in wetland protection and membership in environmental groups.

This study has shown that the internal valuation of Nyabarongo River and its associated wetland by riparian communities is considerable; therefore, the study came up with some policy implications in the following section.

5.2. Policy implications

The study came up with the following policy implications:

As proven by the results, an increase in extension contacts would increase the households' valuation of the wetland. Villages (basic administrative level), in the catchment area should organize a special communal work once a month to focus on activities of protecting and conserving Nyabarongo River wetland. Extension agents could use that opportunity to raise the awareness of the population on measures in place for protection of wetlands, what is their role and what are the benefits they will get from protecting the river and associated wetland. This, in addition to the positive influence of the extension contacts, can be linked with the fact that the more educated people value more the protection of the river system; therefore, this can constitute another way of educating them on environmental protection.

This study found that knowledge on individual responsibility in wetland protection influenced negatively the magnitude of WTP because of the low level of awareness of communities in the catchment area. In order to raise this awareness, there is need of creating specific emissions especially on local radios in different Districts, as it is the main source of

information in rural areas. These emissions could focus on the need to protect wetlands and on income generating opportunities rising from activities of protection and conservation of wetlands.

There is also a need of intensive training of cooperatives in charge of wetland protection on other income generating activities like manufacturing of different house decoration materials from water hyacinth in Nyabarongo River; then on how to get information on available markets for their products. This would raise their income and increase the number of income earners in households with a big number of members. An increase in household income would raise the magnitude of WTP as per the results of this study.

This study found a positive amount of money that farmers would be willing to give up to obtain an improvement in quality of Nyabarongo River system. 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.

5.3 Suggestion for further studies

This study assessed the amount of money farmers are willing to pay for the protection of Nyabarongo River system using the CVM. From literature, it was proven that the CE methods have more advantages over the CVM in terms of valuing different attributes of environmental goods. This could be an interesting field of study for future studies to put an economic value on different attributes of Nyabarongo River system; this could also overcome the starting point bias that was encountered in this study.

Another improvement on the present study concerns the consideration of a careful design of the payment vehicle that should capture the respondents' contribution in kind in order to reduce the number of non-responses.

Rwanda has a big number of marshlands (860) of either national or international importance (for example Rugezi-Bulera-Ruhondo, Kamiranzovu wetlands, etc). They also offer an interesting field of research as, although general trends could be observed across studies, it is still impossible to estimate an economic value of a wetland based on previous studies. Therefore, there is still need for site-specific studies. This is in order to provide information to policy makers when deciding among alternative uses of these wetlands.

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APPENDIX 1: A CONTINGENT VALUATION SURVEY QUESTIONNAIRE

Interviewer's name .....

Date of interview.....

INTRODUCTION TO THE RESPONDENT

Hello, my name is .....and I am part of research team assisting in an on-going research by NIRERE Sylvie in partial fulfilment of her MSc degree at the University of Nairobi. We are conducting a survey about the farmers' willingness to pay for the protection of Nyabarongo River system and we have been granted permission to talk to people by REMA and the Sector Authority. Most of the questions are related to your attitudes and opinions and when answering, please remember that there are no correct or wrong answers. I particularly would like to discuss with the head of the household alone or his/her spouse and I can assure you that your identity and answers will remain confidential and only be used for academic purposes and; therefore, we are looking forward your honest opinion.

SECTION A: EXISTING NYABARONGO RIVER SYSTEM CONDITIONS

Part 1: Farmer and site identification

a. Respondent's name.....

b. District/Sector/Cell/Village.....

Part 2: Farmers' attitudes towards the protection of Nyabarongo River system

a. What do you think the protection of Nyabarongo River system is to you?

1. Very important
2. Important
3. Less important
4. Not important at all

b. To what extent do you perceive the current status of Nyabarongo River wetland is an issue worth discussion?

1. Critical
2. Very serious
3. Serious
4. Less serious
5. Not important

c. Do you think Nyabarongo River system can deplete/deteriorate?

1. Yes 2. No

3. If yes, in your opinion, what are the causes of degradation/ depletion of Nyabarongo River system?

1. Natural disaster (climate change, long rains…)
2. Cultivation on the river shores
3. Erosion (cultivation on hills around)
4. Waste disposal in the wetland
5. Industrial effluent
6. Housing development
7. Sand mining
8. Irrigation
9. Over fishing
10. Other (*specify*) ……

Part 3: Management and conservation of Nyabarongo River system

a. How far do you live from Nyabarongo River wetland?

1. In less than 100 metres near the wetland
2. More than 100 metres from the wetland

b. Please indicate which benefits you are aware of, which are from Nyabarongo River wetland and are of importance to your household. ***Use the following score***.

1 = Very unimportant 3 = Neutral 5 = Very important

2 = Not important 4 = Important

DIRECT BENEFITS	Aware 1=Yes, 2=No	1	2	3	4	5
Agricultural production						
Fisheries						
Trees for timber						
Fuel wood						
Herbal/medicinal plant						
Reeds						
Water						
Tourism						
Scientific interest						
Transport						
Sand mining						
INDIRECT BENEFITS	**Aware Yes =1,No =2**	**1**	**2**	**3**	**4**	**5**
Water reservoir						
Water source						
Biodiversity reservoir						
Protected species (e.g. hippopotamus)						
Mitigation of climate change						
Flood control						

c. Have you heard of the Organic Law number 04/2005?

1. Yes 2. No

3. If yes, what aspects of the Organic Law 04/2005 are you aware of? (*Specify*) .....

d. Have you heard of the measures from the Organic Law 04/2005 for the protection of rivers?

1. Yes 2. No

3. If yes, briefly explain the measures you know up to 5 (measures): .....

e. Who do you think is responsible for the protection of the wetlands?

1. Government 2. Community

3. Collaboration among all stakeholders 4. Others (*specify*) .....

f. As an individual, what is your role in the protection of Nyabarongo River system?

1. No role
2. Follow the government measures only
3. Follow government measures and encourage others to do the same
4. Follow government measures and report illegal activities.
5. Resources contribution towards implementation of necessary activities
6. Other (*specify*) .....

g. In relation to quality, how would you rank the current status of water in Nyabarongo River?

1. Good 2. Satisfactory 3. Poor

h. In relation to productivity of soil, how would you rank the current status of soil in the wetland?

1. Good 2. Satisfactory 3. Poor

i. Are you satisfied with the quality of water in the wetland?

1. Yes 2. No

j. Are you satisfied with productivity of the soil in the wetland?

1. Yes 2. No

SECTION B: WILLINGNESS TO PAY QUESTIONS

In the next section of the questionnaire, I would like to ask you how much it is worth to you in Rwandan francs, the protection of Nyabarongo River system. The following scenario describes the status of Nyabarongo River wetland without any protection or management plan in place, then the best world status with protection and conservation measures in place with associated benefits.

Background information

Nyabarongo River wetland is of international importance; it is among the protected areas and a source of living for riparian communities. It covers 67 percent of the country and is a

tributary of Nile River. It provides different benefits to the population; for example soils for agriculture, fish for eating, trees for timber, fuel wood, reeds, recreation and scientific activities. The current wetland quality has been deteriorating continuously due to different human activities that have destroyed river shores, causing erosion which carry away agriculture land and destroying biodiversity habitat. The government, through the Organic Law number 04/2005, has established protection measures to protect river shores and wetlands in general; this will require the removal of agricultural crops in the 10 riparian metres and specific crops to be put on those 10 metres.

VALUATION SCENARIO

Assume that there exist no environmental law, thus no government measures regarding the protection of the wetland and there are no organization in charge of this protection and conservation. If no action is taken, the river's quality is expected to deteriorate in the next few years. This deterioration include loss of soil productivity, increased risks of floods which destroy crops in the wetland; low productivity of fish and a remarkable increase in water hyacinth leading to the loss of the wetland scenic beauty, thus no tourism and transport on the river.

To get an improvement in the river's quality, the environmental law specifying the measures to be taken for the protection of Nyabarongo River wetland has to be implemented. This will lead to the improvement of water quality without water hyacinth and favourable for transport activities, biodiversity conservation and tourism. On the river shores, the natural vegetation will constitute a good habitat for reproduction of fish and increase its productivity. Agro forestry trees, reeds and bamboos on river shores will constitute another source of food and income for the owners.

WILLINGNESS TO PAY QUESTIONS

Assume that the Rwanda Environment Management Authority (REMA) wants households in Nyabarongo River catchment area to contribute monthly a certain amount of money through the National Fund for Environment and Climate Change in Rwanda (FONERWA) for the protection of this wetland. This money will be paid at Sector level through the office in charge of environment; it will help to achieve above mentioned improvements and the payments will be over 5 years to ensure that the wetland have recovered from previous degradation and that protection measures are implemented all over the catchment area.

Before expressing a certain amount of money, please ask yourself: "Am I willing to pay this amount of money for the protection of Nyabarongo River system every month? Or would I rather not pay this amount and remain in the current state of the wetland, which may eventually deteriorate?" Please, do not agree that you are willing to pay a certain amount if you cannot afford it on a regular basis (monthly), 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 truly willingness to pay, so please, provide the sincere response, thank you.

a. Are you willing to pay any amount of money for the protection of Nyabarongo River system?

   1. Yes 2. No (***If no, go directly to question h***)

b. Would you be willing to pay 1,000 Rwf every month for the protection of Nyabarongo River system?

   1. Yes 2. No

c. If yes, suppose the amount is increased to 1,250Rwf, would you be willing to pay this amount? (***If yes, continue increasing 1500, 1750, 2000, 2250, etc. up to where you get no***)

d. If no, suppose the amount was reduced to 750Rwf, would you be willing to pay this amount? (***If no, continue reducing 500, 250 up to where you get yes***)

e. Are you sure you are not willing to pay .....Rwf (***Increase the respondent's maximum amount by 100 Rwf***)

   1. Yes 2. No

f. How sure are you of your answer to the previous question?

   1. Definitely sure 2. Sure 3. Not sure

g. Please indicate the reasons why you would contribute to the protection of Nyabarongo River wetland (***you can circle more than one choice***) :

   1. I want better quality of goods and services I get from the wetland

2. I want the wetland to continue producing different environmental goods like biodiversity conservation, tourism, flood control, etc.
3. I want the future generations to enjoy the goods and services from the wetland
4. I believe that REMA will do a good job in administering the funds for environment protection
5. Other (*specify*) .....

Answer the following question (h) only if 0 amount of money was recorded to question (b)

h. What are the reasons behind your zero response to question (b): (***you can circle more than one choice)***

1. My household is not supposed to pay for the protection of the wetland
2. My household is satisfied with the current status of the wetland
3. My household cannot afford to pay for the protection of the wetland
4. My household would choose to spend money in other ways
5. I/we are unable to determine the amount to spend on the protection of the wetland
6. I/we think this is not a priority
7. Spending should be on all wetlands not only this one
8. The government should be the only one in charge of the protection of the wetland
9. I need more information/time to answer that question
10. I want to contribute in kind (labour)
11. Others (*specify*) .....

i. So far, has the administrative body done enough for ensuring that measures for protecting Nyabarongo River wetland are implemented?

1. A lot of attention
2. Some attention to the problem
3. Not too much attention
4. No attention at all

j. What is your overall satisfaction with the way Nyabarongo River system is managed?

1. Satisfied 2. Unsatisfied

k. Do you think the implementation of measures for protecting the river has improved your livelihood?

1. Not applicable 3. Important

2. Not important 4. Very important

3. If yes to 3 and 4, what are those improvements in your livelihood? .....

l. Are there any negative impacts on your livelihood from the implementation of these measures?

1. Yes 2. No

3. If yes, what are those impacts? .....

SECTION C: HOUSEHOLD SOCIO - ECONOMIC CHARACTERISTICS

Part 1: Household characteristics

a. Gender: 1. Female 2. Male

b. How old is the household head? .....

c. What is your marital status?

1. Married 2. Not married

d. How old is the spouse (***where applicable***)? .....

e. What is the highest education level you have completed? (in years)

1. Primary and below 2. Secondary and above

f. What is your main occupation?

1. On-farm activities 2. Off-farm activities

g. How many people normally live in your household? .....

h. This question is of great importance in determining people's preferences in the protection of Nyabarongo River system. Could you please tell me into which range your household income falls?

1. Less than 10,000 Rwf per month

2. 10,000 and more per month

Part 2: Land use in Nyabarongo River wetland

a. Do you own land near the wetland?

1. Yes 2. No

b. Do you have agricultural land somewhere else than near the wetland?

1. Yes 2. No

c. What is your total land holding size? .....ha

d. What is the land size under cultivation? .....ha

e. What are the crops types grown near the wetland on your land? .....

Part 3: Wetland benefits and degradation impacts

a. Are you or any person of the household a member of a group of environmental interest?

1. Yes 2. No

Answer this question (b) only if you got no to question (a) above

b. Have you or any person of the household been employed in conservation activities?

1. Yes 2. No

c. Do you have access to tap water?

1. Yes 2. No

3. If yes, how long does it take to go to that water source from your residence? .....

d. Do you have access to electricity? 1. Yes 2. No

e. How far do you live from the nearest market?

1. Less than 500 metres
2. More than 500 metres

f. How far do you live from the nearest tarmac road?

1. Less than 500 metres
2. More than 500 metres

g. How many visits do you receive per month of the officer in charge of environment? .....

Thank you very much for your time and effort. I really appreciate your input.

APPENDIX 2 VARIABLE CORRELATION MATRIX

	Dist	Indvres	Percw	Satsmgt	Hhhage	Educ	Occup	HHsiz	Hhinc	Ownl	Mbre	Tapw	Distm	Extc	Init
Dist	1.00														
Indvre	-0.05	1.00													
Percw	0.21	0.01	1.00												
Satsm	0.06	0.05	0.03	1.00											
Hhhag	-0.17	-0.006	-0.19	-0.04	1.00										
Educ	-0.01	-0.06	0.000	0.0005	-0.14	1.00									
Occup	0.10	0.03	0.01	0.05	0.11	-0.02	1.00								
Hhsize	-0.05	-0.08	0.10	0.01	0.06	0.12	-0.04	1.00							
Hhinc	0.16	-0.10	0.13	0.10	-0.22	0.15	-0.06	0.22	1.00						
Ownld	0.15	-0.0008	0.14	-0.001	-0.11	0.04	0.06	0.04	0.12	1.00					
Mbre	0.10	-0.07	0.12	0.08	-0.20	0.06	0.09	-0.04	0.10	0.19	1.00				
Tapw	0.05	-0.02	0.02	0.06	-0.04	0.03	-0.08	0.07	0.12	-0.007	-0.07	1.00			
Distm	-0.09	-0.02	-0.02	-0.10	0.14	0.04	-0.02	0.03	-0.007	-0.13	0.03	-0.03	1.00		
Extco	0.10	-0.007	0.18	0.01	-0.17	0.17	0.01	-0.03	0.13	0.10	0.34	-0.07	0.05	1.00	
Initbd	0.34	-0.10	0.15	-0.009	-0.19	0.02	0.02	-0.09	0.30	0.15	0.08	0.03	-0.03	0.15	1.00

APPENDIX 3 VARIANCE INFLATION FACTORS

VARIABLE	VIF	1/VIF
Initial bid amount	1.29	0.772
Household income	1.29	0.772
Membership in environmental group	1.24	0.808
Age of household head	1.23	0.812
Extension contacts	1.23	0.813
Distance from residence to the wetland	1.22	0.820
Household size	1.15	0.870
Perception of current water quality	1.14	0.878
Ownership of land in the wetland	1.11	0.899
Education level	1.09	0.915
Distance to the nearest input-output market	1.07	0.931
Main occupation	1.06	0.940
Satisfaction with actual wetland management	1.05	0.953
Access to tap water	1.05	0.955
Knowledge of individual responsibility in wetland protection	1.04	0.957
Mean VIF	**1.15**	

APPENDIX 4: WHITE'S TEST FOR HETEROSKEDASTICITY

White's test for Ho: homoskedasticity

against Ha: unrestricted heteroskedasticity

chi2(122) = 276.24

Prob > chi2 = 0.0000

Cameron & Trivedi's decomposition of IM-test

Source	chi2	df	p
Heteroskedasticity	276.24	122	0.0000
Skewness	59.79	15	0.0000
Kurtosis	3.02	1	0.0823
Total	339.05	138	0.0000

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APPENDIX 5: RWANDA MAP SHOWING NYABARONGO RIVER

Source: NBCBN, 2007