SOCIAL PREFERENCES AND TRADE-OFFS IN WETLAND MANAGEMENT OPTIONS IN NYANDO RIVER BASIN

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other university. No part of this thesis may be reproduced without the prior permission of the author and/or University of Nairobi. All other sources of information cited herein have been duly acknowledged.

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ABSTRACT

The Nyando River basin provides important ecosystem goods and services on which the basin's community rely for livelihood. However, the basin has faced some of the most severe forms of unsustainable use, which has reduced its ability to provide the needs of a growing population. A number of specific interventions have been initiated to reverse the situation. However, most of these have pursued different resource use options without knowledge of the values that residents attach to the different wetland uses, and thus their preferences for different management options. Among the key hindrances to sustainable management of the basin is lack of knowledge of the economic values of the basin's different wetland uses. This study sought to elicit the values of the key wetland uses in the lower part of the basin, and the residents' relative preferences for alternative management interventions in the basin.

Four environmental attributes that reflect the variety of economic benefits of Nyando River basin (NRB) were identified. They are: flood risk reduction, agricultural yield improvement, employment creation and water quality improvement. A choice experiment (CE) was conducted to estimate the value of changes in each of these wetland functions. A household survey was conducted in March 2012, using a semi-structured questionnaire, with questions on perceptions on NRB degradation, the choice experiment, and socio-economic characteristics. STATA 11 was used to run a basic multinomial logit (MNL) model showing the importance of the attributes in explaining respondents' choices, and a second model explaining the importance of socioeconomic characteristics in the respondents' choice decisions.

Results show that the two greatest contributors to residents' welfare are agricultural yield improvement and employment creation, with annual MWTP values of KSH 5.57 billion and KSH 0.51 billion, respectively. The corresponding figure for reducing flooding risk is KSH 0.05 billion, while that of improving water quality is KSH 0.18 billion. The results also show that there are some heterogeneity in preferences as more educated respondents had a higher probability of choosing alternatives with reduced flooding risk, and elder respondents had a higher probability of choosing alternatives with improved agricultural yield. The results further reveal that a wetlands management option with improved agricultural yield and more employment opportunities attracted the highest MWTP (KSH 6.08 billion per year), while the one with improved agricultural yield and improved water quality had the least MWTP of KSH 5.62 billion per year.

It is concluded that even though the main concern of NRB residents is improvement of agricultural yield, they also derive substantial benefits from employment creation, flooding risk reduction and water quality improvement. As such wetland management programmes should be designed such that the strategies employed to improve agricultural yield also incorporate improvements in the other attributes. It is also concluded that heterogeneity in preferences should be considered in wetlands management in order to ensure social equity. In addition, the study has shown that the management option favoured most by the residents is that which improves agricultural yield and creates employment. Finally, it is demonstrated that choice experiment can be successfully applied to estimate non-market values of wetlands in Kenya. Important policy implications of the study include the need for harmonization of sectoral policies touching on wetlands, and recognition that poverty plays a central role in wetlands management. The information provided by this study can assist wetland managers and policy makers in formulating socially optimal policies and programmes for sustainable management of NRB with possible implications for similar wetland areas in Kenya and the rest of Africa.

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LIST OF ACRONYMS

ANOVA	Analysis of Variance
ASC	Alternative Specific Constant
asl	above sea level
CE	Choice Experiment
CM	Choice Modelling
CVM	Contingent Valuation Method
EMCA	Environmental Management and Conservation Act
ESRS	Exogenously Stratified Random Sampling
ha	Hectare
IIA	Independence from Irrelevant Alternatives
KNBS	Kenya National Bureau of Statistics
KWS	Kenya Wildlife Service
MEMR	Ministry of Environment and Mineral Resources
MNL	Multinomial Logit Model
MRS	Marginal Rate of Substitution
MWTP	Marginal Willingness to Pay
NEMA	National Environmental Management Authority
NRB	Nyando River Basin
RPM	Revealed Preference Method
RUT	Random Utility Theory
SPM	Stated Preference Method
SPSS	Statistical Program for Social Sciences
VIRED	Victoria Institute for Research on Environment and Development
WKIEMP	Western Kenyan Integrated Ecosystem Management Project
WTA	Willingness to Accept
WTP	Willingness to Pay

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CHAPTER ONE: INTRODUCTION

1.0 Background information

Humans have sought to manage and exploit wetlands and the important services that they provide from the beginning of recorded history. Modifications of the marshlands of Mesopotamia and the draining of the English fens to pave way for agriculture are some of the earliest attempts at wetlands management (McInnes, 2011). Down through the ages wetlands management have reflected the major societal and economic drivers of the times. Wetland conservation management began during the first decade of the twentieth century. During this time, wetlands began to be assigned a degree of protection from increasing threats imposed by pollution, drainage, and modification (McInnes, 2011).

A series of conferences, technical meetings and negotiations culminated in the Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Gardner & Davidson, 2011; Turner *et al*., 2000). The convention, commonly known as The Ramsar Convention (1971) came into effect in 1975. Parties to the convention have an obligation to better manage wetland ecosystems. This is to be done through embracing the principles of 'wise use'; by designating at least one internationally important site; and through international cooperation. By December 2010, the convention had 160 signatories with 1,913 sites covering an area of about 1.87 million km^2 (McInnes, 2011). Despite the concept of 'wise use', there has been lack of adequate understanding of wetland functions and ecosystem services until relatively recently. This has contributed to continued wetland loss, conflicts and other potentially negative impacts on wetlands (McInnes, 2011).

Since the 1970's, there has been a burgeoning recognition that wetlands provide many important services to human society, fish and wildlife (MA, 2005; EPA, 2001). In its preamble, The Ramsar Convention (1971) recognizes wetlands as resources of great economic, cultural, scientific and recreational value. The functions of wetlands have been discussed in detail in Schuyt & Brander (2004). According to these authors, wetlands are habitat for many birds, mammals, reptiles, amphibians, fish and invertebrate species. It is estimated that freshwater wetlands hold more than 40% of the entire world's species and 12% of all animal species. Moreover, some individual wetlands may be extremely important in supporting endemic species. Wetlands also have cultural and spiritual values for many local communities. For example, the Bukusu community of Kenya used to conduct circumcision ceremonies in sacred places in wetlands (Odote, 2010). Provision of food is another important function of wetlands. Rice which grows in many wetlands around the world is the staple food of 3 billion people, about half the world's population (Schuyt & Brander, 2004).

Wetlands are particularly important in Africa where many countries are faced with serious water shortages. In such contexts, wetlands are an important source of water and nutrients necessary for biological productivity and often sheer survival of the people. In many cases, wetlands are the exclusive source of natural resources upon which rural economies depend (Schuijt, 2002). In Kenya, wetlands are recognized as some of the most productive ecosystems. According to NEMA (2011) and Odote *et al.* (2008), they are sites of exceptional biodiversity and of enormous social and economic value. Many of the country's rural communities depend almost exclusively on wetlands for sustenance. The wetlands are their sources of materials for construction, food, medicine, handcrafts and furniture. This is in addition to being important fishing areas, grazing grounds and sources of water for domestic use and livestock watering (NEMA, 2011). Wetlands also contribute a large percentage of the country's domestic and foreign exchange earnings. However, wetlands in Kenya continue to be degraded and lost through unsustainable activities, conversion and overexploitation of their resources. This has been caused by lack of effective management mechanisms and proper appreciation of the wetlands true worth.

Kenya is a signatory to The Ramsar Convention and as such is obliged to ensure sustainable management and wise use of its wetlands. Furthermore, achievement of Vision 2030 (Kenya,2007), Kenya's development blueprint, is intricately linked to sustainable management of wetlands both as source of raw materials and as sink for waste products. The country has taken a number of steps to ensure sustainable management of its wetlands. Among these is the declaration of the wetlands management regulations (MEMR, 2009), under the Environmental Management and Co-ordination Act (EMCA). There are also on-going efforts to carry out a nationwide inventory and mapping of Kenyan wetlands in order to enhance their management

(NEMA, 2011). Besides, the government and other stakeholders have spearheaded development of several site-specific wetland management plans for nationally important wetlands (NEMA, 2011). Nyando River Basin (NRB) is one of the important wetland areas in Kenya and has been the site of a number of such management interventions.

Wetland management interventions are often designed to enhance provision of different wetland services or attributes. Thus, a number of possible management options can exist depending on the targeted wetland attribute(s) and the levels of improvements of such attributes. The best management option is that which achieves both wetland conservation and improved livelihood for the local people. Achieving the best wetland management option obviously requires a strong legal and institutional support. Apart from that, quantitative information on the values that residents attach to different attributes and to possible alternative management options is also critical. Information on the values and residents' preferences for the different wetland management attributes and management options is still largely missing in Kenya. This research used the NRB as a case study to shed light on the values and social preferences and trade-offs in wetland management options.

1.1 A general overview of Nyando River Basin (NRB)

The NRB covers an area of 3517 square kilometres (NEMA, 2011) spread across five counties: Kisumu, Kericho, Nandi, Uasin Gishu and Nakuru. It is a source of materials for construction, food, medicine, handcrafts and furniture. Besides, the basin is an important fishing area and source of water for domestic use and for livestock. It is also used as space for human settlement, farming and grazing and as a source of sand and soil for making bricks (Mbaria, 2006). The area provides a habitat for various bird species, a number of rare mammals and some endangered fish species. Reptiles such as the famous *omieri* python which is mythically associated with flooding are also found in the area. The basin also regulates ecological processes and provides cultural services such as recreation, aesthetic, inspirational, educational, sense of place and cultural heritage.

The basin has faced some of the most severe forms of unsustainable use, cutting down on its ability to supply the future needs of a big and growing population (Mbaria, 2006). According to Mungai *et al.* (2004), NRB contains some of the most severe problems of agricultural stagnation, environmental degradation and deepening poverty found anywhere in Kenya. Studies have reported a consistent pattern of deforestation and degradation over the last century. Key catchment areas like the Mau and Tinderet Forests are still being deforested. Increasing population has pushed agriculture into marginal areas. Aerial surveys have shown the removal of riparian vegetation, extended cultivation of the river bank and increasing establishment of homesteads closer to the river (Boye, 2010).

Deforestation has affected the role that the basin's wetlands play in filtering pollutants and preventing them from finding their way into Lake Victoria (Mbaria, 2006). Massive soil erosion in the river basin continues to contribute to sedimentation of Lake Victoria (Boye, 2010). To date, more than 120,000 ha within Nyando are believed to be affected by erosion that has washed away as much as a 1.5m layer of soil (Mbaria, 2006). Over the last 100 years, sedimentation at the mouth of the Nyando has increased by between three and four times (Mungai *et al*., 2004). As a result, the lake has been rapidly colonized by water hyacinth and fish and aquatic plant diversity has declined. In fact, the entire NRB's biodiversity is under serious threat. Land degradation also adversely affects soil fertility and water quality in the surrounding area (Boye, 2010). Flooding has been a perennial problem in the area. One of the causes of flooding is reported as washing away of soil cover after the indigenous forests were destroyed. The others are overgrazing and the fact that annual crops do not provide adequate cover.

The environmental degradation in the NRB is so bad that it has been considered by some (e.g. Mbaria (2006)) as the epitome of the environmental crisis of the wider Lake Victoria Basin. Chin Ong, a principal scientist and hydrologist at ICRAF summarised the crisis thus:

'Nowhere else is the environmental crisis as severe as in the 3517 km2 of the Nyando Basin, which is made up of three relatively small rivers—the Nyando, the Awach and the Sondu' (Mbaria, 2006).

The government and other organizations have initiated specific management and conservation interventions in the area. For example, Western Kenyan Integrated Ecosystem Management Project (WKIEMP) aims at improving water quality and livelihoods of the local communities (Boye, 2010). The TransVic project also runs a programme to provide extension agents, policy makers and researchers with information, methods, technologies and approaches for improving land productivity (Swallow *et al.,* 2003a). The Homa Lime/Nyando Valley Development Trust and Swedish Co-operative Centre (SCC)-VI are other notable organizations involved in the area. Both organisations target improved land management and by extension reducing erosion and flood risk (Maraga *et al.,* 2010). The Kenya Disaster Concern (KDC) and VIRED International, both funded by UNDP Kenya target conservation as well as awareness creation and participation (UNDP Kenya, 2010).

1.2 Problem statement

The NRB provides important ecosystem goods and services on which the basin's community rely for their livelihood. The basin has faced some of the most severe forms of unsustainable use. This has cut down on its ability to provide the current and future needs of a big and growing population. There is a clear challenge in attaining sustainable management of the river basin. This is caused by weak institutional arrangement, lack of knowledge of the economic values of the different wetland uses and conflicting interests among different stakeholders.

The government, donors and other research and development organizations have initiated specific management and conservation interventions in the area. Such specific interventions have pursued different resource use options without knowledge of the monetary values gained and lost under each option. There is no literature on valuation studies in the basin that reveals the monetary values of different wetland management attributes or management options. This has made it difficult to come up with conservation and management programmes that are both sustainable and socially desirable. This study, using the choice experiment (CE) technique, attempts to analyse the preferences and trade-offs in wetland management options among the residents of the lower part of NRB.

1.3 Research questions

The following are the main research questions of the study:

i. are the different NRB wetland attributes (flood risk reduction, agricultural yield improvement, employment creation and water quality improvement) valued the same by the residents?
ii. do socio-economic characteristics of NRB residents influence their relative preferences for the basin's different attributes?
iii. are different possible alternative wetland management options valued the same by NRB residents?

1.4 Research objectives

In order to answer the research questions, the study's main objectives are:

i. to elicit the marginal willingness to pay (MWTP) for improvements in each NRB management attribute
ii. to identify the socioeconomic determinants of the MWTP for different wetland management attributes
iii. to elicit the monetary values of possible alternative wetland management options in NRB

1.5 Research hypothesis

i. In evaluating the specific wetland attributes of NRB, the study intends to find out whether the residents are likely to prefer one attribute over the others. To this end, the study tests the null hypothesis that the attributes- flood risk, water quality, agricultural yield and employment are preferred equally by the residents:

H_{01}: Flood risk = Water quality = Agricultural yield = Employment = ¼,

against the alternative hypothesis that at least one attribute is preferred over the others:

H_{a1}: At least one of the proportions exceed ¼

ii. The study also investigates whether certain socioeconomic characteristics of NRB residents determine their preferences for alternative wetland management options:

H_{02}: Socio-economic characteristics of NRB residents have no significant influence over their choice of wetland management options

against the alternative hypothesis that:

H_{a2}: At least one of the socioeconomic characteristics of the residents is likely to influence significantly their choice decisions

iii. Using the different attributes, the study will generate three hypothetical management scenarios - Scenario A, Scenario B and Scenario C, varying in levels of the attributes. The null hypothesis that the residents attach equal values to the hypothetical management scenarios (options) will be tested:

H_{03}: Scenario A = Scenario B = Scenario C =1/3

against the alternate hypothesis that at least one scenario is preferred over the others:

$H_{a3:}$ At least one of the proportions exceed 1/3

1.6 Justification of the study

The degradation and loss of environmental resources is an economic problem because it means loss of important values, some perhaps irreversibly. Each choice or option for management of the environmental resource has implications in terms of values gained and lost. Deciding on which option to pursue therefore requires that all the values gained and lost under different options are carefully considered (Barbier *et al*., 1997). As Prato (2003) states, effective programs and policies to protect and restore ecosystems require evaluation and prioritization of management alternatives. The goal of wetlands management is to come up with programmes that maximize the societal welfare while conserving the resources. Thus, information on the residents' preferences and values of the wetland management attributes and possible options is also critical to such evaluation and prioritization.

People's preferences and values of wetland management attributes and alternatives are very important for policy decisions. According to Adamowicz (2008), policy makers need to understand people's preferences for environmental quality which is an increasingly important component of environmental economics. A part from aiding the design of socially optimal wetland management options, grasping residents' preferences also enables public participation in decision making. Apart from its global popularity, the requirement of public participation in wetlands management is clearly spelt out in the EMCA wetlands regulations (MEMR, 2009). This paper presents a research work to estimate and compare the values of improving different wetland management attributes associated with Nyando River Basin. The result is expected to contribute policy relevant information on the wetland values that are important to the residents. This is expected to be of interest to wetland managers and policy makers in guiding the design of wetland management programmes that are both sustainable and socially desirable.

1.7 Limitations of the study

One of the limitations of this study is time and financial constraints. The study was restricted to only the lower part of NRB. Moreover, it was fitted into the allotted time-frame by the University to complete a master's thesis. If not for financial and time constraints, the findings would have been more relevant if the study was conducted in the entire Nyando River Basin.

The other limitations relate to the choice experiment method (Pearce, 2006). First, there is the issue of cognitive difficulty associated with multiple complex choices between bundles with many attributes and levels. There is a limit as to how much information respondents can handle while making a decision. Increased complexity usually leads to increased random errors and irrational choices due to inherent learning and fatigue effects. Second, the total economic value of a wetland management option will be calculated by summing up the values of the component attributes. This assumes that the value of the whole is equal to the sum of the parts but this assumption raises two potential problems. There may be additional attributes of the good/programme that are not included in the design but that generate utility. Besides, the value of the whole may not be necessarily additive this way. Some evidence in transport research literature suggests that whole bundles of improvement are valued less than sum of component values.

Lastly, like with all other stated preference methods (SPMs), the study was limited by the choice of study design. Welfare estimates are sensitive to study design e.g. choice of attributes, levels used and the way choices are relayed to respondents. If these are not neutral they may impact on the values of estimates of consumers' surplus and marginal utilities (Pearce, 2006).

1.8 Organization of the Thesis

This thesis comprises five chapters. Following this introduction, Chapter 2 presents literature review including an overview of wetlands, wetlands management in Kenya and methodological review. Chapter 3 summarises the methodology used, including the analytical framework and the study design. In Chapter 4, samples descriptive are provided and the results of the choice experiment are presented and discussed. Chapter 5 summarises the main findings of the study and discusses some important policy implications of the results.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter presents literature review of the study. It starts by defining and giving an overview of wetlands. This is followed by a review of the wetlands management arrangements in Kenya including the legal and policy framework and the property rights regime in Kenya in relation to wetlands. The chapter is concluded with a methodological review including a review of economic valuation techniques and literature on relevant choice experiment studies.

2.1 Definition and overview of wetlands

Wetlands fall along a transitional zone between permanently wet and dry habitats. Their boundaries may expand or contract over time depending on periodic inundation by water. They range from permanently or intermittently wet land to shallow water and land-water margins. They are thus difficult to identify making it difficult to find a definition that is precise and an accurate reflection of their ecological parameters (Odote, 2008). The most universally accepted definition of wetlands is that given by the Ramsar Convention (1971, p.1). The convention defined wetlands as:

> *"areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres"*

Wetlands are characterized by distinctive hydrology, soils and plants (EPA, 2006) and cover a wide variety of habitats including rivers, lakes, coastal lagoons, mangroves, peatlands, and coral reefs (Lambert, 2003).

There are two broad categories of wetlands: natural wetlands and man-made (or artificial) wetlands. Man-made wetlands are usually designed for a specific purpose and seldom have the full range of wetland functions and values provided by natural wetlands. They include aquaculture ponds, farm ponds, irrigated agricultural land, salt pans, gravel pits, reservoirs, sewage farms and canals (Odote, 2008; Lambert, 2003). Natural wetlands are further classified into five. These are: (a) marine i.e. coastal wetlands including coastal lagoons, rocky shores and coral reefs, (b) estuaries including deltas, tidal marshes and mangrove swamps, (c) lacustrine i.e. wetlands associated with lakes, (d) riverine i.e. wetlands along rivers and streams and (e) palustrine (or marshy) which include marshes, swamps and bogs. Wetlands can also be classified only into two broad categories, being marine or coastal wetlands and inland wetlands (Odote, 2008).

Wetlands perform many varied roles in society through the interactions of their physical, biological and chemical components such as soils, water, plants and animals (Lambert, 2003). The functions of wetlands can be classified into four groups (Schuyt & Brander, 2004). Firstly, wetlands perform regulation functions by regulating ecological processes that contribute to a healthy environment. Examples are flood and flow control, recycling of nutrients, watershed protection and climate regulation. Secondly, they perform carrier functions by providing space for activities such as human settlement, cultivation, energy production and habitat for plants and animals. The third function of wetlands is the provision of direct use services such as food, water, raw materials for building and clothing. Lastly, wetlands provide information functions by providing scientific, aesthetic and spiritual information.

Wetlands have for a long time been regarded as wastelands (EPA, 2001) and evidence abounds of wetlands that continue to be treated as unproductive and unhealthy lands (Odote, 2008). Thus despite the understanding that wetlands are part of our natural capital and wealth creation potential (Costanza *et al*., 1997), they continue to be degraded and lost due to conversion. It is estimated that 50% of all wetlands in the world have been lost in the 20th century due to anthropogenic activities (Stuip *et al*., 2002). According to UNESCO-IHE (2006), conversion to intensive agricultural, industrial and residential uses is one of the major culprits of wetland loss. Wetlands are being drained due to excessive irrigation and polluted due to nutrient run-off from intensive agricultural production and industry. These are exacerbated by poverty, economic inequality, population growth, immigration and mass tourism (Birol *et al.,* 2008a).

Furthermore, wetlands have numerous different stakeholders whose interests don't always coincide and often result in conflicts (Schuyt & Brander, 2004). Although every wetland will have a different set of stakeholders, nine groups of stakeholders have been identified across wetlands. They comprise direct extensive users; direct intensive users; direct exploiters; agricultural producers; water abstractors; human settlements close to wetlands; indirect users; nature conservation and amenity groups; and non users. For a detailed description of the different wetland stakeholders, see for example, Turner *et al.,* (2000).

2.2 Wetlands Management in Kenya

Wetlands are defined by the Environmental Management and Conservation Act (EMCA) (Republic of Kenya, 1999) as areas permanently or seasonally flooded by water where plants and animals have become adapted. According to NEMA (2011), they include lakes, swamps, marshes, rivers and their riparian zones. The shoreline areas of Lake Victoria and the Indian Ocean up to a depth of six meters below low tide are also classified as wetlands. Wetlands cover between four and six percent of Kenya's total land area depending on water inundation during different seasons of the year (NEMA, 2011).

Wetlands are recognized as being among the most productive ecosystems in Kenya. Odote *et al*. (2008) terms them as sites of exceptional biodiversity and of enormous social and economic value. The country's wetlands have been traditionally utilized as sources of materials for construction, food, medicine, handcrafts and furniture. This is in addition to being important fishing areas, grazing grounds and sources of water for domestic use and livestock watering. Furthermore, a large percentage of Kenya's domestic and foreign exchange earnings are contributed by the wetlands. For example, Lake Nakuru is visited by over 300,000 visitors annually bringing in over US $ 24 million per annum. Lake Naivasha on the other hand supports a thriving horticultural industry with large-scale farms that employ over 30,000 people with net returns of US$63 million per year (NEMA, 2011). Despite recognition of their importance, wetlands in Kenya face a number of threats due to human population pressure and development activities. According to NEMA (2011), they have increasingly been targeted for conversion to agriculture and settlement over the past five decades.

Vision 2030 (Republic of Kenya, 2007) makes a strong case for sustainable management of wetlands. The vision, Kenya's overall development blueprint targets a growth rate of 10 per cent per annum. This growth will heavily rely on exploitation of environmental and natural resources including wetlands. Besides, anticipated growth in manufacturing will also lead to an increase in effluents discharged into the environment including wetlands. Not surprisingly, all the vision's initiatives to secure sustainable development and equity in access to a clean environment have a direct or indirect link with wetlands. For example, the conservation projects target forests (includes wetland forests), water towers, wildlife sanctuaries and marine ecosystems. Effective pollution and waste management will reduce effluent discharge and enhance land and air quality in wetlands. Flooding is a wetland phenomenon that can be addressed through the high risk disaster zones initiative contained in Vision 2030.

The vision's goal for the water and sanitation sector is "to ensure water and sanitation availability and access for all by the year 2030". It identifies environmental degradation as one of the issues to be addressed and identifies key projects to ensure achievement of the sector's goals. Again all these projects have direct implications on wetlands and wetland users. They include improved water resource information and management; improved water storage and harvesting; and irrigation and drainage. From the foregoing discussion, it can be concluded that sustainable management of wetlands is intricately linked to Kenya's achievement of Vision 2030.

2.2.1 Legal frameworks governing wetlands management in Kenya

Kenya lacks a conservation and management policy framework that deals exclusively with wetlands (although efforts are currently underway to develop one). However, the constitution and the laws governing land and the environment can be used to manage and conserve wetlands. For example, EMCA (Republic of Kenya, 1999) and several other sectoral laws have provisions that address certain aspects of wetlands management. Some of these laws are briefly discussed below.

- ***Environmental Management and Conservation Act of 1999 (EMCA, 1999)***

EMCA is the broad framework law that guides the management of the environment and natural resources in Kenya. Apart from being broadly relevant, the Act also has specific provisions for the conservation and management of wetlands. Section 42 of the Act provides for the protection of rivers, lakes and wetlands by prohibiting certain activities that are likely to degrade the resources. The section also empowers the Minister in charge to declare a wetland to be a protected area and impose necessary restrictions to protect them. The Minister may also under this section issue general and specific orders, regulations or standards for the management of wetlands (section 42(3) and section 147). Following this provision, the minister for Environment and mineral resources, made the EMCA Wetlands, river banks, lake shores and sea shore management regulations of 2009 (MEMR, 2009). The broad objective of the regulations is to provide for the conservation and sustainable use of wetlands to ensure they provide social, economic and ecological benefits to the society. To ensure this, the regulation provides a list of general principles to be observed in the management of wetlands. Among these are the principle of sustainable utilization and the principle of public participation in the management of wetlands. If implemented properly, the regulations provide a useful and detailed framework for the management of wetlands.

- ***The Water Act (Cap 372 Laws of Kenya)***

The word wetland is not expressly mentioned in the Water Act. However the word "swamp" as defined in the Act is very close in meaning to wetlands. The Water Act (Cap 372 Laws of Kenya, p.944) defines a swamp as:

> *"any shallow depression on which water collects either intermittently or permanently and where there is a small depth of' surface water or a shallow depth of ground water and a slight range of fluctuation either in the surface level of the water or of the ground water level so as to permit the growth of aquatic vegetation"*

Besides, one of the criteria for defining wetlands is the presence of water. The Water Act is therefore very relevant for wetlands management. It addresses a number of issues that affect wetlands. Among these are ownership, control and use of water resources as well as protection of water catchment areas. It also provides for management of wetlands by the requirement of a permit before draining a wetland. The Minister is also empowered by the Act to make regulations for better implementation of the Act. However, as pointed out by Odote (2008), there are two potential sources of conflict between the Act and EMCA. Firstly, section 42 of EMCA also empowers the minister in charge of environment to make regulations for the management of EMCA. Secondly, section 148 of EMCA states:

> *"Any written law, in force immediately before the coming into force of this Act, relating to the management of the environment shall have effect subject to modifications as may be necessary to give effect to this Act, and where the provisions of any such law conflict with any provisions of this Act, the provisions of this Act shall prevail."*

Since the Water Act came after EMCA, some people have argued that its provisions should prevail.

- ***Agriculture Act (Cap 318 Laws of Kenya)***

This Act is the legal framework governing the agriculture sector in general. It lays down standards for planned land development; preservation, utilization and development of agricultural land; and conservation of land and its fertility. The Act does not explicitly mention wetlands or river basin. It however empowers the minister in charge to intervene in the management of wetlands that fall under agricultural lands. For example, section 48(1) of the Act gives the Minister the powers to prevent the adverse effects of soil erosion on any land with the concurrence of the Central Agricultural Board.

- ***Physical planning Act (Act No. 6 of 1996)***

The stated purpose of the Act is to provide for the preparation and implementation of physical development plans and for connected purposes. Broadly speaking it seeks to integrate environmental concerns into the physical development plans. Section 29 of the Act gives local authorities powers to prohibit, control or approve physical development plans. The local authorities also have powers under the Act to preserve and maintain all land planned for open spaces, parks, urban forests, and green belts. Apart from the local authorities, the act also specifies the powers of the Director of physical Planning, the Commissioner of Lands and the Minister in approval and implementation of development plans. The Act can therefore be used by the local government and other authorities as a tool for the conservation and management of wetlands.

- ***Wildlife (Conservation and Management) Act (Cap 376 Laws of Kenya)***

The relevance of this Act to wetlands management is through the Kenya Wildlife service (KWS), whose establishment and operations the act regulates. KWS was designated by the government as the institutional focal point for the implementation of the Ramsar Convention. Among the duties of KWS are advising the government on the establishment of national parks, game reserves and protected wildlife sanctuaries. The Act also gives the minister powers to declare any area a protected area and thus can declare a wetland a protected area to improve their status and conservation. On-going efforts to revise both the Wildlife Act and Wildlife policy intends to place the role of managing wetlands under KWS. This furthers the confusion caused by institutional and structural overlaps in management of wetlands (Odote, 2008; Cap 376 Laws of Kenya).

Other sectoral laws with provisions touching on wetlands management include the Survey Act (CAP 299 of the Laws of Kenya), Public Health Act (CAP 242 of the laws of Kenya) and the Local Government Act (CAP 265 of the Laws of Kenya). In total, there are more than 77 sectoral pieces of legislation inscribed under various Acts all relevant to wetlands conservation and management (Republic of Kenya, 2008). However, the laws are not harmonious. Each of them considers the issue from a rather narrowly defined as opposed to a multi-sectoral and integrated perspective (Guthiga & Makathimo, 2010). The sectoral approach to conservation and development has failed to address the cross cutting environmental and conservation issues. Instead it has led to inter-sectoral inconsistencies leading to duplications, conflicts and further loss of Kenya's natural resources including wetlands (Republic of Kenya, 2008).

As a way forward, there is need for a wetlands policy to coordinate efforts to manage wetlands and elevate their status in the planning processes. Many attempts to develop a national wetlands policy culminated in a draft policy (Republic of Kenya, 2008) which is yet to be adopted. The draft policy goes a long way in providing a framework for conservation and wise use of wetlands. Among other objectives, it calls for increasing knowledge and awareness of wetlands and their values and reviewing the status of and identifying priorities for wetlands. A part from concluding the discussions on and adopting the policy, Kenya should also address a number of critical issues in the context of good wetlands management (Odote, 2008). First, there should be institutional co-ordination and strengthening of the legal structures and aligning them to the imperatives of EMCA. Secondly, the knowledge on, importance and utility of wetlands should be improved. Finally, there should be fundamental shifts in the way wetland resources are valued and in the way decisions are made about their access, utilization and management.

2.2.2 Property rights and wetlands management in Kenya

According to The constitution of Kenya (Republic of Kenya, 2010), there are three property regimes in Kenya i.e. public, community and private. Wetlands can occur in any of the three regimes. While a substantial portion of land in the country is either under communal tenure or under public ownership, most of the land in the country is under private tenure. The private tenure status has had far reaching implications for society in terms of productive use and sustainability as well as environmental management. This is because private ownership gives private owners sweeping user rights which are prone to abuse through unsustainable use (Sifuna, 2009). Thus wetlands falling under private land have suffered degradation as the owners exploit them often without regard to sustainability.

In NRB for example, a report by Swallow *et al.* (2003b) exemplifies how private ownership of land contributes to continued wetland degradation. According to the report, high rates of erosion in the lower part of NRB is associated with private uncultivated areas that are overused for grazing and wood collection. High rates of erosion in the upper part of the basin also appear to be associated with the private allocation and farming of steep hillsides. Gulley formation and low quality water in the mid-altitude areas are associated with springs that are commonly used, but located on private land. Deforestation and cultivation of riparian areas is associated with privatization of riverine areas, together with ineffective enforcement of rules on the use of those areas. Lack of public infrastructure for water management is partially associated with the lack of public or collective land on which to locate water storage structures.

Regardless of the property regime however, the state can regulate the manner in which land is used by application of either the powers of eminent domain or police power. Eminent domain refers to the power of the state to acquire private property without the owner's consent. The power is however limited by two restrictions. First, the property must be required for a public purpose and that purpose must be such as to justify hardship to be caused on the owner. Secondly the owner must be paid prompt and adequate compensation (Federal Reserve Bank of St. Louis, 2007). The power of eminent domain is anchored on section 40(3) of the constitution of Kenya (Republic of Kenya, 2010). The section states:

> *The State shall not deprive a person of property of any description, or of any interest in, or right over, property of any description, unless the deprivation—*
> *(a) results from an acquisition of land or an interest in land or a conversion of an interest in land, or title to land, in accordance with Chapter Five; or*
> *(b) is for a public purpose or in the public interest and is carried out in accordance with this Constitution and any Act of Parliament that—*
> > *(i) requires prompt payment in full, just compensation to the person; and*
> > *(ii) allows any person who has an interest in, or right over, that property a right of access to a court of law.*

Relying on the power of eminent domain therefore, the state can acquire land in a wetland and have the same protected and conserved.

Police power of the state refers to the power of the state and governmental authorities to regulate land use in the public interest. This function is anchored on the government's constitutional mandate to provide for the welfare of its people and on its responsibility as the custodian of the public interest (Sifuna, 2009). Police power is exercised in Kenya through the adoption of appropriate policies, laws and regulations. Some of these have been discussed under the legal frameworks governing wetlands management.

2.3 Methodological review

Central to all the causes of wetland loss has been information failures (Schuijt, 2002). Such information failures relate to: a) the failure by wetland stakeholders to understand the consequences of land use, water management, pollution and infrastructure on wetlands; b) the fact that many wetland functions do not have market prices. As such there is lack of recognition of the economic value of wetlands by decision-makers (Schuijt, 2002); and c) the lack of understanding of complexity and 'invisibility' of spatial relationships among groundwater, surface water and wetland vegetation. Solving such information failures can help to achieve the required consistency across various government policies (Turner *et. al*., 2000). Solution to the information failures lies in part in a combination of social and natural sciences to achieve sustainability in wetlands management. Turner *et al*. (2000) proposes an integrated wetland research model that combines economic valuation, integrated modelling, stakeholder analysis, and multi-criteria evaluation. This model aims to achieve a socially acceptable balance between nature conservation priorities, resource use, and the sharing of benefits (McInnes, 2011). The framework may provide important information about eco-hydrological consequences and the associated costs and benefits of land-use policies (Turner *et al*., 2000).

Economic valuation is important in such models to provide a means of comparing the economic costs and benefits related to environmental change (Schuijt, 2002). Costanza *et al*. (1997) contends that valuation is inseparable from the choices and decisions that humans have to make about ecological systems. In economics, the value of any good or service is generally measured in terms of what we are willing to pay for them, less the costs of supplying them. However, many environmental resources simply exist and provide us with products and services at no cost. For such resources, economic value is described only by our willingness to pay (WTP), whether or not any actual payment is made (Barbier *et al*., 1997).

2.3.1 Techniques of economic valuation

Most of the normal valuation techniques cannot be applied to environmental resources. This is because it is difficult to monetize the non-market environmental goods and services. Even more difficult is grappling with the nonmarket benefits associated with passive use or non-use values. A series of special techniques has been developed to value the benefits from environmental improvement or the damage due to environmental degradation. The techniques are classified as either revealed preference methods (RPMs) or stated preference methods (SPMs) (Tietenberg & Lewis, 2009).The RPMs infer the value of a non-market good by studying actual (revealed) behaviour on a closely related market. The travel cost method and the hedonic pricing method are the two most common RPMs (Alpizar *et al*., 2001).

SPMs assess the value of a non-market good by using individuals' stated behaviour in a hypothetical market using an appropriately designed questionnaire (Alpizar *et al*., 2001). The hypothetical market defines the good itself, the institutional context in which it would be provided, and the way it would be financed. A random sample of people is then directly asked to state their WTP or willingness to accept (WTA) compensation for a hypothetical change in the level of provision of the good (Tietenberg & Lewis, 2009). The assumption is that the respondents behave as though they were in a real market. The most familiar SPM is the contingent valuation method (CVM) which has existed for over thirty years (Louviere *et al*., 2003) and has been applied to value virtually every type of environmental impact (Pearce, 2006). See for example Carson *et al*. (1995) for a bibliography of CVM studies.

The CVM has gained a general acceptance by both practitioners and policy makers as a versatile and powerful methodology for valuation of non-market goods. However, it is also acknowledged that the method poses a number of problems. One of the problems is that a number of factors may systematically bias respondents' answers thus affecting the validity and reliability of WTP estimates (Pearce *et al.,* 2006; Birol & Koundouri, 2008). For example there may be a *yea-saying* bias in dichotomous choice contingent valuation studies and difficulty of stating a value in an open-ended contingent valuation (Birol & Koundouri, 2008). Other biases include strategic behaviour (such as free riding); embedding/scope problems (where the valuation is insensitive to the scope of the good); anchoring bias (where the valuation depends on the first bid presented; and, information bias (when the framing of the question unduly influences the answer) (Pearce *et al*., 2006).

In response to the problems of CVM, other varieties of SPMs such as choice modelling (CM) approaches have become popular in environmental valuation. Much interest in CM has arisen, specifically as an alternative to the use of CVM in passive use value cases. Both CVM and CM are based on random utility theory. They differ in the sense that CM is the explicit use of attributes and levels in an experimental design and the construction of response surfaces from these data (Adamowicz & Boxall, 2001). In CM, respondents are presented with various alternative descriptions of a good, differentiated by their attributes and levels, and are asked to rank the various alternatives, to rate them or to choose their most preferred. A price or cost is typically included as one of the attributes to enable estimation of WTP from people's rankings, ratings or choices. Like CVM, CM also measures all forms of value including non-use values (Pearce *et al*. 2006). There are four different CM techniques: choice experiments (CE), contingent ranking, contingent rating and paired comparisons. Stated preference methods are shown in Figure 2.1.

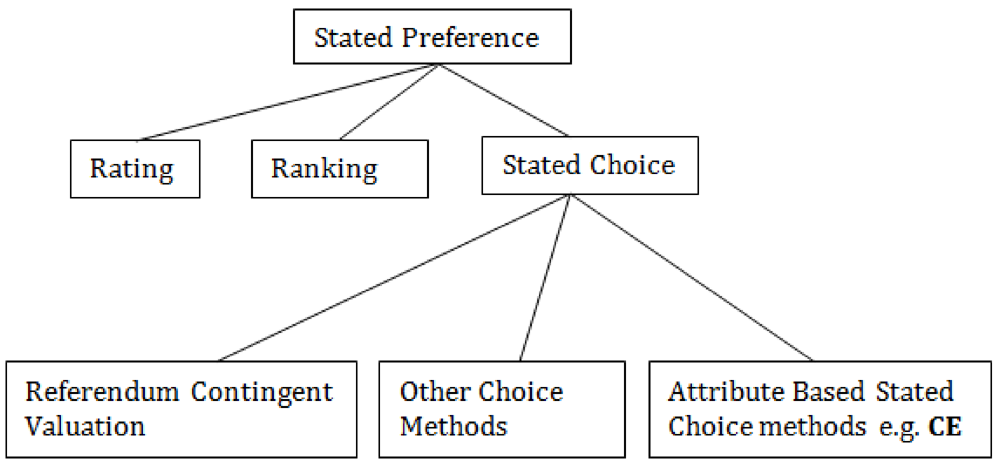

Figure 2.1 Stated preference methods (Source: Adamowicz *et al.,* 1998b)

The CE approach is based on the notion that any environmental good can be described in terms of its attributes, and the levels that these attributes take (with or without an intervention or policy change) (Birol & Kounduri, 2008). After identifying the attributes and their levels, experimental design theory is used to generate different profiles of the environmental good or service. Each profile contains varying levels of each attribute. A monetary cost or benefit attribute is typically included as one of the attributes. The profiles are then assembled in choice sets which are presented to the respondents. A baseline alternative, corresponding to the *status quo* or "do nothing" situation, is usually included in each choice set. This is important as it permits interpretation of results in standard (welfare) economic terms. The respondents are then asked to state their preferences on multiple occasions (Birol & Kounduri, 2008).

When individuals make their choice, they implicitly make trade-offs between the levels of the attributes in the different alternatives presented in a choice set (Alpizar *et al*., 2001). Inclusion of the monetary attribute and the random utility framework on which the CE is based allow for the estimation of welfare changes (Hanemann, 1984). The CE method was chosen in this study because of its ability to measure the value of the attributes that make up the environmental good. Environmental policies are generally concerned with changing the levels of attributes quantity or quality, rather than losing or gaining the environmental good as a whole. This makes the CE method preferable over CVM in informing the design of efficient and effective environmental policies (Birol & Koundouri, 2008).For a review of the other CM approaches, see for example Pearce *et al.* (2006) and Hanley *et al.* (2001).

2.3.2 Literature on choice experiment studies

A growing numbers of valuation studies on wetlands point to the increasing recognition of the importance of these ecosystems (Schuijt, 2002). Woodward and Wui (2001) conducted a meta-analysis covering 39 wetland valuation studies. The analysis found that the mean value per hectare per service of a wetland varied from \$1.21 per hectare for amenity value to as high as \$490 per hectare for bird watching (1990 dollars). The researchers however pointed out that prediction of a wetland's value based on previous studies is highly uncertain. They stressed the need for site-specific valuation efforts. Heimlich *et al.* (1998), Kazmierczak (2001) and Boyer and

Polasky (2004) provide extensive overviews of wetland valuation studies which also capture a broad variety of valuation techniques.

Although most studies have focused on wetlands in developed countries (Schuijt, 2002), a number of valuation studies of African wetlands also exist in literature. See for example Barbier *et al*. (1991), Schuijt (1999, cited in Schuijt, 2002) and Seyam *et al.* (2001). Emerton (1998) also provides an account of several valuation studies on wetlands across East Africa including Emerton *et al*. (1998). A number of wetland valuation studies have also been completed in Kenya. An overview of these studies including Abila (2005); and Navrud and Mungatana (1994) is given in Schuijt (2002).

The first application of the CE method in environmental management was done by Adamowicz *et al*. (1994). This was followed by growing interest in use and development of the method by both academics and practitioners (Birol & Kounduri, 2008; Alpizar *et al., 2001).* For application to valuing animal genetic resources, see Ouma *et al*. (2004), Scarpa *et al.* (2003) and Ruto *et al*. (2007). The method has also been applied to environmental issues. Boxall *et al.* (1996) did an empirical comparison of choice experiments and CVM in valuation of environmental quality changes arising from forest management practices on recreational moose hunting values. The study, done in west central Alberta showed a significant difference in the values obtained using the two methods. This was attributed to the fact that respondents ignored substitute recreation areas in the CVM question. The study thus showed that substitutes are very important in environmental valuation and that CE may be more appropriate than CVM in some cases. A similar conclusion was made in Adamowicz *et al.* (1998a). The study also employed the CE approach to measure passive use values and compared the results to those of a CVM exercise.

Rolfe *et al.* (2000) used CE to value rainforest conservation in Vanuatu. The study estimated the non-use values that Australians might hold for the preservation of rainforests in Vanuatu (Vanuatu is not very well known to Australians). The results showed that depending on the circumstances of the conservation proposal, Australians can hold substantial non-use values for rainforest preservation in other countries relative to preservation options in Australia. Among other things, this information can help in informing decisions that prioritise rainforest preservation. Naidoo & Adamowicz (2005) evaluated tourists' demand for elevated biodiversity levels relative to other protected areas attributes. As the biodiversity level (described by the number of bird species seen) increased, tourists demonstrated increased willingness to visit a protected area. The researchers used the results to evaluate a revenue-maximizing park management strategy and how revenues from nature-based tourism compare with those from local agricultural land-uses.

There are also increasing application of the CE method in wetlands management. Birol *et al.* (2008a) used the method to estimate the value of changes in several economic, social and ecological functions of the Cheimaditida wetland in Greece. The results also revealed that there is considerable preference heterogeneity across the public and that on average they derive positive and significant values from sustainable management of the wetland. Birol *et al.* (2008b) also used the method to inform river management in Poland. The study revealed that even though the main concern of the households is minimisation of flood risks, they also derive substantial benefits from recreational activities and biodiversity.

In Do and Bennett (2007), a choice experiment was used to estimate wetland biodiversity values in Vietnam's Mekong River Delta. The study estimated the value of the wetland improvement at USD 3.9 million. This value outweighed the cost of the proposed management plan of about USD 3.4 million. The study also showed that the values depended not only on wetland biodiversity improvement but also on the number of farmer households affected, age, sex, education, knowledge of and distance from the wetland. Another application of choice experiment to value wetland attributes was by Carlsson *et al.* (2003). The study was conducted in a wetland area in Staffanstorp, southern Sweden. It showed that biodiversity and walking facilities are the two greatest contributors to welfare, while a fenced waterline and introduction of crayfish decreased welfare.

CHAPTER THREE: RESEARCH METHODOLOGY

3.0 Introduction

This chapter details the methodology used in the study. It starts by discussing the analytical framework including the theoretical and empirical frameworks as well as the design of the choice experiment. This is followed by a description of the methods and study design including the study site, data, sampling and analysis.

3.1 Analytical framework

The conceptual, theoretical and empirical framework of the study as well as the design of the choice experiment is discussed below.

3.1.1 Conceptual framework

A schematic diagram of the conceptual framework is shown below (Figure 3.1).

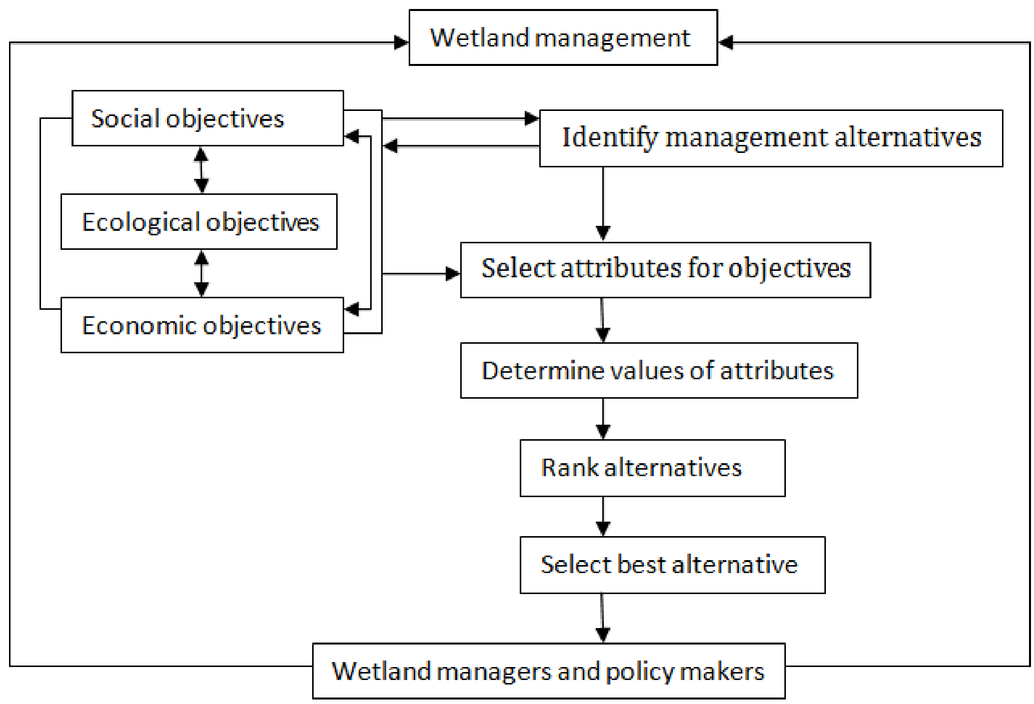

Figure 3.1 Schematic diagram of the conceptual framework (Source: Prato (2003); Bacalso (2007)

In this framework, wetlands management is undertaken in pursuit of three objectives: social, economic and ecological. The framework requires identifying wetland management alternatives and selecting attributes of the objectives. Each alternative consist of different levels of the selected attributes. The choice among alternatives reflects an individual's preference on how the wetland should be managed. This choice implies trade-offs in the levels of the attributes under each alternative. The trade-offs are used to calculate the Marginal Willingness to Pay (MWTP) for improvement in each attribute. The sum of the MWTPs of all the attributes under an alternative gives the value of that alternative. The best alternative is that with the highest value. Understanding these values will help the wetland managers and policy makers to develop wetland management programmes that are effective, sustainable and socially desirable**.**

3.1.2 Theoretical framework

The Choice Experiment (CE) method has a theoretical grounding in Lancaster's characteristics theory of value (Lancaster, 1966). Lancaster proposed that the good, per se, does not give utility to the consumer. Instead the good possesses characteristics and it is these characteristics that give rise to utility. This theory also posits that in general, a good will possesses more than one characteristic, and many characteristics will be shared by more than one good. Besides, goods in combination may possess characteristics different from those pertaining to the goods individually. The econometric basis of CEs is the random utility theory (RUT) (Luce, 1959; Mcfadden, 1973) while its basis for empirical analysis is limited dependent variable econometrics (Greene, 2003). According to this framework; the utility of a choice is comprised of a deterministic component and an error component. The error component is independent of the deterministic part and follows a predetermined distribution. This implies that predictions cannot be made with certainty. The choice made among alternatives will be a function of the probability that the utility associated with a particular option is higher than that associated with other alternatives (Luce, 1959).

In CEs, respondents are asked to choose 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 price. For example, consider a respondent's choice of wetland management option. As illustrated by Hanley *et al.* (1998), assume that utility depends on choices made from some set, C of alternative wetland management options. The representative individual is assumed to have a utility function of the form:

$$U_{in} = U\,(Z_{in}, S_{in}) \tag{3.1}$$

where, for any individual *n*, a given level of utility will be associated with any alternative wetland management option *i*. Alternative *i* will be chosen over some other option *j* iff $U_i > U_j$. Utility derived from any wetland management option is assumed to depend on the attributes, *Z*, of that option (Lancaster, 1966). These attributes may be viewed differently by different agents, whose socioeconomic characteristics *S* will also affect utility. However, a consumer may not choose what seems to the analyst to be the preferred alternative. To explain such variations in choice, a random element, ε is included as a component of the consumer's utility function. Equation 3.1 can then be re-written as:

$$U_{in} = V\,(Z_{in}, S_{in}) + \varepsilon\,(Z_{in}, S_{in}) \tag{3.2}$$

and the probability that individual *n* will choose option *i* over other options *j* is given by:

$$Prob\,(i|C) = Prob\{V_{in} + \varepsilon_{in} > V_{jn} + \varepsilon_{jn}, \text{all } j \in C\} \tag{3.3}$$

where C is the complete choice set. In order to estimate equation 3.3, assumptions must be made over the distributions of the error terms. The usual assumption made is that the errors are Gumbel-distributed and independently and identically distributed (McFadden 1973). Hence the probability of choosing *i* is given by:

$$\text{Prob}\,(i) = \frac{\exp \mu V_i}{\sum_{j \in C} \exp \mu V_j} \tag{3.4}$$

Here, μ is a scale parameter, which is usually assumed to be equal to 1 (implying constant error variance). As μ tends to infinity, the model becomes deterministic. An important implication (Hanley *et al.,* 2001) of this specification is that selections from the choice set must obey the Independence from Irrelevant Alternatives (IIA) property (Luce, 1959). IIA, also known as the Luce's choice axiom, states that relative probabilities of two options being selected are unaffected by the introduction or removal of other alternatives. Equation 3.4 is estimated by means of a probabilistic choice model. Probabilistic choice models are models used to represent the selection of one among a set of mutually exclusive and collectively exhaustive alternatives. The mathematical form of a probabilistic choice model is determined by the assumptions made regarding the error components of the utility function for each alternative (Koppelman & Bhat, 2006). The assumptions that the error components are Gumbel distributed and choices obey the IIA property lead to the multinomial logit (MNL) model (Hoffman & Duncan, 1998).

The assumption of independence is critical. As illustrated in Hoffman & Duncan (1998), any other assumption leads to substantial computational difficulties involving the computation of multivariate integrals. As a practical matter, the independence assumption is most likely to be problematic when the alternatives are similar to one another, so that unobserved factors affecting one alternative may well affect another alternative. If the IIA assumption is not supported, there are two general alternatives. One is the conditional probit model, which allows for multivariate normal correlated error terms. The other is the nested logit model in which the choice process is viewed as a set of nested choices. This approach retains the computational advantages of the logit form but selectively relaxes the independence assumption and thereby allows a variety of response patterns to a change in the characteristics of one alternative (Hoffman & Duncan, 1998).

3.1.3 Empirical framework

Each respondent's multinomial responses that were obtained from the choice sets were interpreted as the choice results from the respondents' utility maximization problem. In this study, each respondent was given 6 choice sets and asked to choose among 3 alternatives including the status quo. The choice results for alternative i of respondent n were either 'yes' or 'no'. The log-likelihood function can be written as:

$$\ln L = \sum_{n=1}^{N} \sum_{i=1}^{3} (y_{ni} \ln[P_n(i|C_n)] \quad (3.5)$$

where y_{ni} is a binary variable (1 when respondent n chooses alternative i among 3 alternatives and 0 otherwise) and N is the total number of respondents. The parameters of this log-likelihood function are estimated by maximum likelihood estimation.

The utility function of the model without covariates, with exception of the error term, ε_{in}, can be expressed as a linear function of an attribute vector, (Z_1, Z_2, Z_3, Z_4, Z_5) =(Flooding risk, Water quality, Agricultural yield, Employment, and Price).Two alternative-specific constants (ASCs), which represent dummies for the two non-status quo alternatives (A and B) were included. ASC captures the utility of an alternative that the attributes fail to capture (Adamowicz *et al*., 1994). The ASCs for alternatives A and B were constrained to be equal because (Carlsson *et al*., 2003) they were presented in a generic form. Therefore only one ASC (ASC_i) was used.

$$V_{ni} = ASC_i + \beta_1 Z_{1,ni} + \beta_2 Z_{2,ni} + \beta_3 Z_{3,ni} + \beta_4 Z_{4,ni} + \beta_5 Z_{5,ni} \quad (3.6)$$

where β's are the parameters to be estimated for each attribute that influences the respondent's utility. The parameter estimates obtained can be used to estimate the rate at which respondents are willing to trade-off one attribute for another. The trade-offs between the price and each attribute represent the 'part-worth' or an 'implicit price' or the 'marginal willingness to pay (MWTP)'. This value demonstrates the amount of money that an individual is willing to pay in order to receive more of the non-marketed environmental attribute:

$$MWTP = -(\beta_{non\ marketed\ attribute} / \beta_{price\ attribute}) \quad (3.7)$$

To calculate the MWTP from the status quo level of each attribute, it is assumed that all the other variables remain constant. By totally differentiating equation 3.6 and omitting n for brevity, the following MWTP estimates can be obtained.

$$MWTP_{Z_1} = -(\partial V/\partial Z_1)/(\partial V/\partial Z_5) = -\beta_1/\beta_5$$
$$MWTP_{Z_2} = -(\partial V/\partial Z_2)/(\partial V/\partial Z_5) = -\beta_2/\beta_5$$
$$MWTP_{Z_3} = -(\partial V/\partial Z_3)/(\partial V/\partial Z_5) = -\beta_3/\beta_5$$

$$MWTP_{Z_4} = -(\partial V/\partial Z_4)/(\partial V/\partial Z_5) = -\beta_4/\beta_5 \quad (3.7)$$

The principles applying to the determination of MWTP can also be applied to derive the marginal rates of substitution (MRS). MRS is the rate at which a consumer is willing to trade-off between any pairs of attributes in order to remain at the same indifference curve (Bennett & Blamey, 2001). By division of the β coefficients, the MRS across all the attributes can be estimated.

Preference heterogeneity and WTP variations among individuals can be explained by including some individual-specific variables (covariates) in the model. This is done by making the individual-specific variables to interact with the ASC terms in the utility function. In this study, age, education, household size, farm size and income were interacted with ASC. This can be formulated through the following utility function:

$$V_{ni} = ASC_i + \beta_1 Z_{1,ni} + \beta_2 Z_{2,ni} + \beta_3 Z_{3,ni} + \beta_4 Z_{4,ni} + \beta_5 Z_{5,ni} + \beta_6 ASC_i Age_n + \beta_7 ASC_i Education_n + \beta_8 ASC_i Household\ size_n + \beta_9 ASC_i Farm\ size_n + \beta_{10} ASC_i Income_n \quad (3.8)$$

where β_1 to $\beta_5$are the parameters to be estimated for each attribute that influences respondent' utilities while β_6 to β_{10} represents the parameters to be estimated for individual-specific variables multiplied by ASC.

3.2 Methods and Study Design

3.2.1 The study site

The Nyando River Basin (NRB) covers an area of 3517 square kilometres and is located in Western Kenya to the east of Lake Victoria. Centred on the equator at 35°1^{0}E, the basin borders Lake Victoria to the west, Tinderet hills to the east, Nandi escarpment to the north and Mau escarpment to the south (Maraga *et al*., 2010; Kung'u & Namirembe, 2012). It consists of an upper catchment, a mid-altitude area, and the Lake Victoria lowlands and floodplains region. The upper catchment covers part of Nandi and Kericho counties and a smaller part of Nakuru and Uasin Gishu counties. The mid-altitude area covers lower parts of Nandi and Kericho counties and Muhoroni division in Kisumu county. The lowland area stretches to Miwani, Nyando and Lower Nyakach Divisions in Kisumu county and is referred to as the Kano Plains. The basin has a population of about 1,100,000 (KNBS, 2009) and is primarily inhabited by two ethnic groups. The Luo occupy the lowlands and parts of the midlands while the Kalenjin occupy the highlands. A small number of a third ethnic group, the Ogiek, occupy parts of the forest margin at the upper most parts of the basin (Kung'u & Namirembe, 2012). There is extensive poverty in the basin. About 41% of the population in Kericho county, 47% in Nandi county and 48% in Nyando district live below the national poverty line (KNBS, 2009).

A digital elevation model of Nyando river basin is shown in Figure 3.2.The land in the basin slopes generally in the Northeast-Southwest direction. Altitude varies from about 1,100 metres above sea level (masl) at Lake Victoria shores to about 3,000masl in Londiani and Tinderet forest in the upper catchment (Kung'u & Namirembe, 2012). The main drain channel is river Nyando rising in the Mau escarpment. The river has a steep gradient in the upstream but the gradient gentles downstream. In the Kano plains, the river dissipates in a swamp area and finally discharges into the Nyakach Bay in the Winam Gulf of Lake Victoria (Maraga *et al*., 2010). The river has three major tributaries; Ainabngetuny, Kipchorian and Awach each forming a sub-catchment within NRB. The Ainabngetuny and Kipchorian sub-catchments cover the highest elevations of the basin. The Awach sub-catchment on the other hand is on the low-lying region of the basin where rainfall is low and temperatures are high (Onyango *et al*., 2005).

As described by Njogu (2000), NRB has a sub-humid climate with a mean annual temperature of 23°C. Its mean annual rainfall varies between 1000mm in the low lands and 2000mm in the highlands. The annual rainfall pattern is bi-modal with peaks during the long rains (March-May) and short rains (October-December). Altitude, proximity to the highlands and nearness to the lakeshore causes considerable spatial variations in rainfall. Consequently, areas around the plains and lake shore experience minimal rainfall while the highland areas have high rainfall.

The study focused on the lower part of NRB covering the three districts of Nyando, Nyakach and Muhoroni. The population of the three districts is estimated to be about

419,482 (KNBS, 2009) although (Mungai *et al.,* 2004) only 86% (362,206) fall within NRB. The population is mainly rural based although about 7% live in the urban village towns of Muhoroni, Chemelil and Ahero. Like the Kenyan country average, the population growth rate is high due to a combination of high fertility, declining mortality and a relatively young population (Njogu, 2000). The average density is 311 people per square kilometre (KNBS, 2009), although the distribution over the area is not uniform. The Luo ethnic group are the primary inhabitants of the region. The community is well known in Kenya for the strength of its customary authorities on individual land use. Clans and sub-clans are very important sources of social authority. Women have very little independent access to land under Luo customary law (Onyango, 2002 cited in Kung'u & Namirembe, 2012).

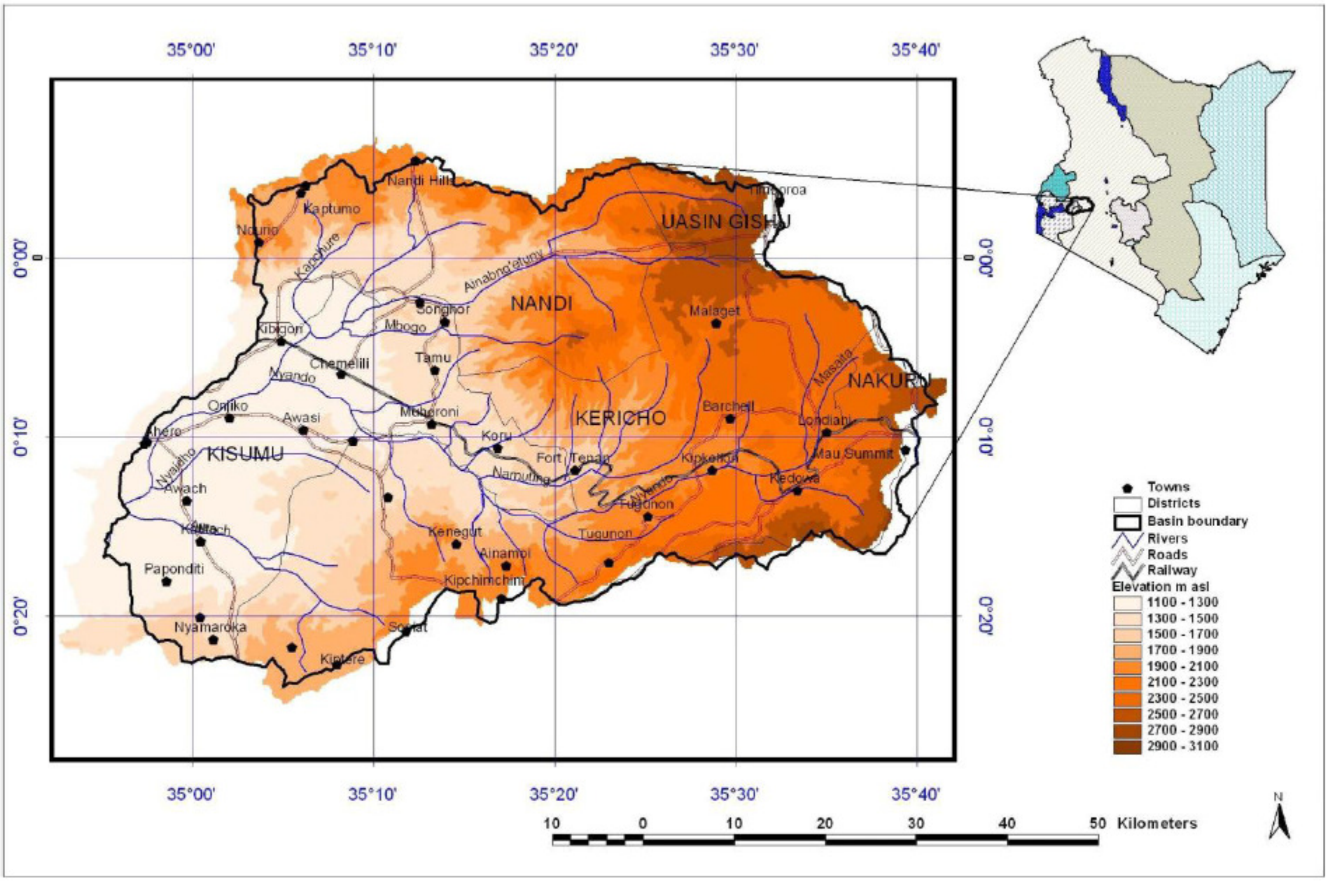

Figure 3.2 Digital elevation of Nyando River Basin (Source: Kung'u & Namirembe (2012)

Land use in the area is primarily subsistence farming of maize, sorghum, pulses and tuber crops, and commercial production of sugar cane and irrigated rice. Cotton is commonly grown in the plains especially in Nyakach District. Large areas of land are also left for livestock raring which is also a main agricultural activity in the area (Njogu, 2000). In terms of land tenure, the tenure systems in the country apply. As such, land in the area is either under community, private or government land (The Constitution of Kenya, 2010). While substantial portions of land in the area are under communal or public ownership, a large percentage is under private ownership.

3.2.2 Design of the choice experiment (CE)

The first step in CE design is to define the good or programme to be valued in terms of its attributes and their levels. In this study, the programme to be valued is the wetland management option or alternative. The choice of attributes is a very important task for a number of reasons. Firstly, the attributes should in one way or another be relevant for the policy making process. Secondly, the respondents must perceive the attributes as relevant. This implies that the respondents should consider the attributes important and their (attributes) variation across levels realistic. Perception of the attributes and/or levels as non-relevant might influence the responses negatively and the number of valid responses would decline (Bennett and Blamey, 2001).

The attributes that reflect the variety of economic benefits generated by NRB were initially identified from existing literature. The attributes used in the choice experiment were then selected through interviews with residents, wetland researchers and environmental managers involved in the area. In addition to the identified attributes, a monetary attribute was included to help (Birol *et al*., 2008a) in estimating welfare changes. The final attributes and their levels (Table 3.1) were decided with help of environmental economists from University of Nairobi.

The next step involved combining the attribute levels into alternatives and choice sets. This was done using orthogonal design in SPSS Conjoint software. The five attributes, four with 3 levels each and one with 4 levels would result in a full factorial with 324 (3^4x4) combinations. These are too many and it would be unrealistic to expect respondents to carry out such high number of choices. To manage this, fractional factorial design (Louviere *et al*., 2000) was used. Fractional designs involve the selection of a subset of complete factorials, so that particular effects of interest can be estimated. The assumption is that often, many interactions are not significant. The fractional factorial design resulted in 18 combinations. After reducing identical combinations and combinations that seemed unreasonable, 12 combinations remained. These 12 combinations were then randomly assigned to six blocks of two combinations each. A common base line or status quo option was added to each block such that a single respondent would be confronted with six choice sets each with three alternatives. Inclusion of the status quo alternative is instrumental in achieving welfare measures that are consistent with demand theory (Louviere *et al*., 2000).

Table 3.1 Attributes, their definitions and levels used in the CE

Attribute	**Definition**	**Levels**
Flooding risk	Percentage of study area at risk of flooding	**a. 50%**[a] b. 30% c. 10%
Agricultural yield	Percentage change in annual value of crop and livestock yield in the area.	**a. 0% (no change)**[a] b. 2 x present yield c. 3 x present yield
Employment	Percentage change in the number of employments for residents	**a. 0% No change**[a] b. 10% increase c. 20% increase
Water quality	Percentage of population with access to good quality water	**a. 36%**[a] b. 50%; c. 72%
Price	Number of days in a week that one is required to work if they choose a particular option	**a. 0 days**[a] b. 1 day c. 2 days d. 3 days

[a] Bold indicates the baseline or status quo level

3.2.3 Data type, sources and needs

Both primary and secondary data were used in the study. Secondary data was obtained from literature to generate information on the residents of the wetland, wetland uses and the level of degradation. Literature review also helped in the initial identification of the important attributes of the wetland. Primary data was obtained from sampled respondents among residents of NRB. The data included perceptions on NRB degradation, responses to the CE questions and social and economic characteristics.

3.2.4 Development and design of the questionnaire

The questionnaire consisted of three sections. The first section consisted of questions about general perception and observation of environmental status of NRB. This information was important for examining to what extent respondents were actually triggered to express their preferences. The second section constituted the choice experiment. In order make the choice sets clear to the respondents, a separate card with an explanation of the task and some ground rules for their answers was provided during the interview. For example, the card included detailed definitions of the attributes and their levels.

Section 2 also had some ‘debriefing questions’ which asked the motivations behind respondent’s choices and other comments. This was meant to pick up any response irregularities. Such irregularities may include:

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

The final section had questions seeking socio-economic data including age, sex, education status, occupation, income etc. These data are required as inputs in the modelling phase of the choice experiment and for checking how well the sample represents the population.

3.2.5 Sampling procedure and data collection

Exogenously stratified random sampling (ESRS) strategy was adopted to reflect relative proximity and different usage types of the wetland resources. Thus samples were drawn from Nyando, Muhoroni, Miwani and Lower Nyakach Divisions. The minimum sample size was calculated using the formula provided by Louviere *et al.* (2003) for calculating sample sizes in stated preference techniques. In order to estimate the true proportion within *a* per cent of the true value *p* with probability α or greater, then the required minimum sample size must satisfy the requirement that $Prob(| p_n - p | \geq ap) \geq \alpha$. Given this, the minimum sample size is given by the equation:

$$n \geq \frac{1-p}{rpa^2} \Phi^{-1} (\frac{1+\alpha}{2})$$

where Φ^{-1}(.) is the inverse cumulative normal distribution function. Note that *n* refers to the size of the sample and not the number of observations. Since each individual makes *r* succession of choices in a choice experiment, the number of observations is much larger. Secondly, the formula above is only valid for simple random sample and with independency between choices (Alpizar *et al.,* 2001). The minimum sample size was calculated as 265. The number was apportioned among the four study locations in proportion to the corresponding population. Thus Nyando had 91 respondents, Lower Nyakach 85, Muhoroni and Miwani had 94 respondents between them.

The survey was administered using face to face interviews with a semi-structured questionnaire. The interviewers used a language that each respondent was most comfortable with. During the interviews, interviewers described the NRB, its location, ecological importance and threats to its existence. They also defined each attribute to ensure uniformity in understanding. The respondents were reminded to consider their budget constraints and other environmental goods provided by NRB before making a choice.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.0 Introduction

This chapter presents and discusses the descriptive statistics of the respondents, results of the choice experiment (CE) and estimation of willingness to pay (WTP) for improvements in different wetland attributes. A household survey was conducted in the month of March 2012 in the areas of Nyando, Muhoroni, Lower Nyakach and Miwani. On average, each interview lasted about 30 minutes. A total of 270 questionnaire responses were gathered. Six of the questionnaires were excluded from the data set due to non-responses to various items. In particular, four of them had at least one section left completely unanswered while the other two answered less than two (out of six) choice sets. In all, 264 (97.8%) data sets were available for analyses. This comprised 88 questionnaires in Nyando, 51 in Muhoroni, 85 in Lower Nyakach and 40 in Miwani.

4.1 Descriptive Statistics

4.1.1 Household characteristics

A summary of some of the household characteristics is shown in Table 4.1.

Table 4.1 Household characteristics (n=264)

Variables	**Mean**	**Standard deviation**	**Minimum**	**Maximum**
Age (years)	38.98	12.77	18.00	73.00
Duration of residence (years)	27.88	16.23	1.00	73.00
Household size	5.99	2.89	1.00	14.00
Number of children	4.11	2.59	1.00	14.00
Education (years)	10.27	3.84	0.00	23.00

The average age of the respondents was 39 years. The youngest respondent was 18 years old while the oldest was 73 years old. The average respondent had lived in the area for 28 years. The average household consisted of six people out of which four were children below 18 years. The respondents' average number of years of formal education was 10 years. While the least educated respondent had no formal education at all, the most educated one had completed 23 years of formal education.

Respondents in Nyando and Lower Nyakach appeared slightly older than those from Miwani and Muhoroni (Table 4.2).The average respondents' age was 37.33 in Miwani, 37.51 in Muhoroni, 39.69 in Nyando and 39.91 in Lower Nyakach. ANOVA test (*F=0.688, p=0.560*) however, showed that the means across the divisions were not statistically different meaning that the respondents' ages were not influenced in any way by their divisions of residence.

Table 4.2 Age of respondents by division

Division	**Nyando (n=88)**	**Muhoroni (n=51)**	**Lower Nyakach (n=85)**	**Miwani (n=40)**
Mean	39.69	37.51	39.91	37.33
Standard deviation	13.39	12.77	11.81	13.46
Minimum	18.00	20.00	19.00	19.00
Maximum	73.00	68.00	68.00	67.00

There were more male (55%) than female (45%) respondents. This could have been partly because in cases where only one member could be interviewed, most of the families opted to be represented by the household heads, majority of who were male. In addition, male constituted more than half of the respondents in all the divisions except in Miwani (Figure 4.1).

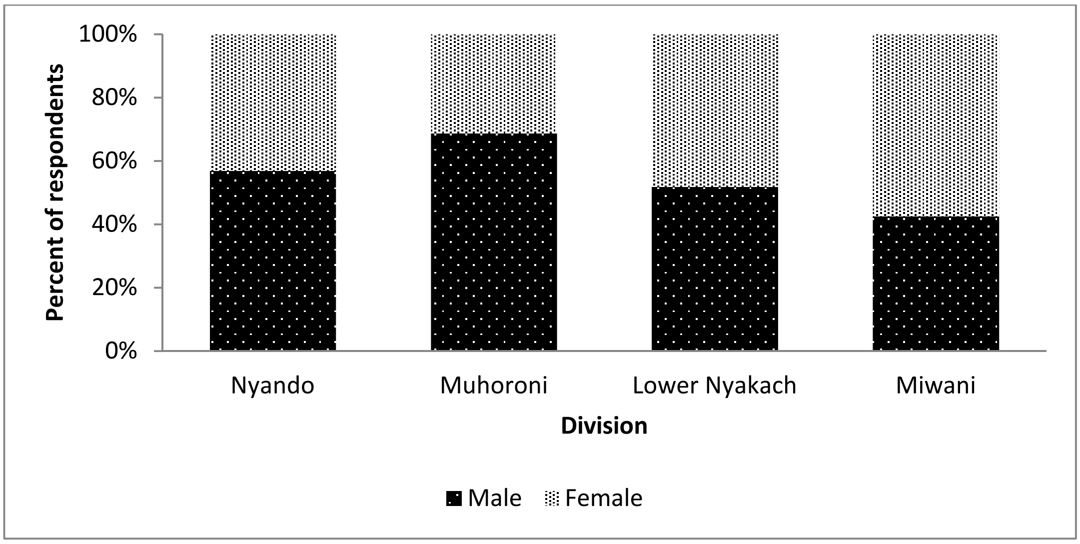

Figure 4.1 Distribution of respondents by gender across the divisions

Results on the marital status showed that 60% of the respondents were married, 19% single, 17% widowed while the rest were divorced, separated or never married. These overall percentages also reflected the observations within individual divisions as shown in Figure 4.2.

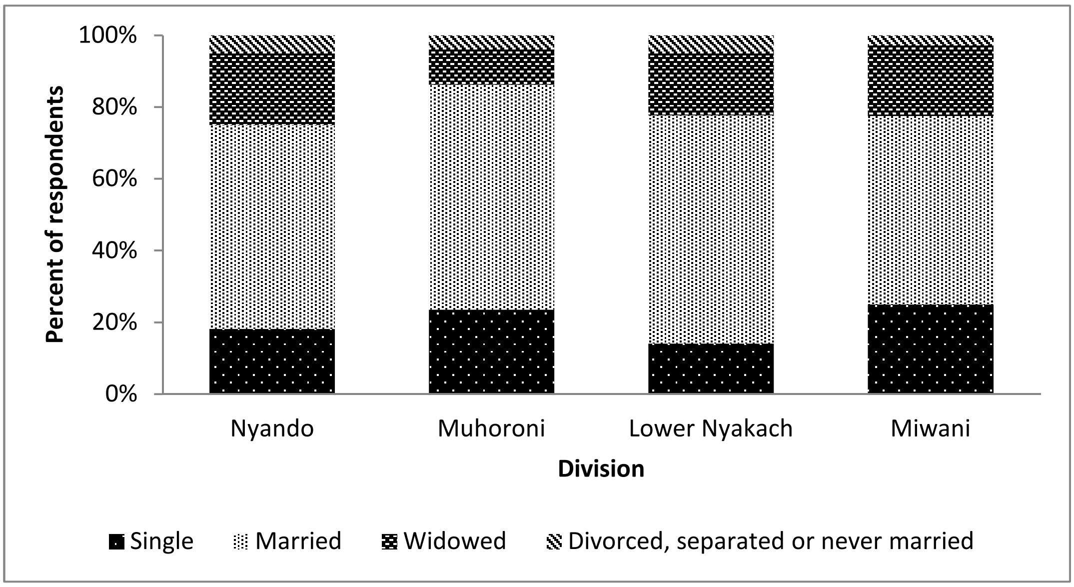

Figure 4.2 Distribution by marital status across the divisions

Large household sizes were common in the area. About 66% of the respondents were from households with more than 5 members while 24% were from households with more than 8 members. Only 34% came from households with four members or less.

High number of children could have contributed to the large household sizes. Most (49%) of the respondents were from households with between two and four children while 30% were from households with more than five children. The largest values recorded for both household size and number of children was 15. Figure 4.3 shows the distribution of respondents by household sizes and number of children.

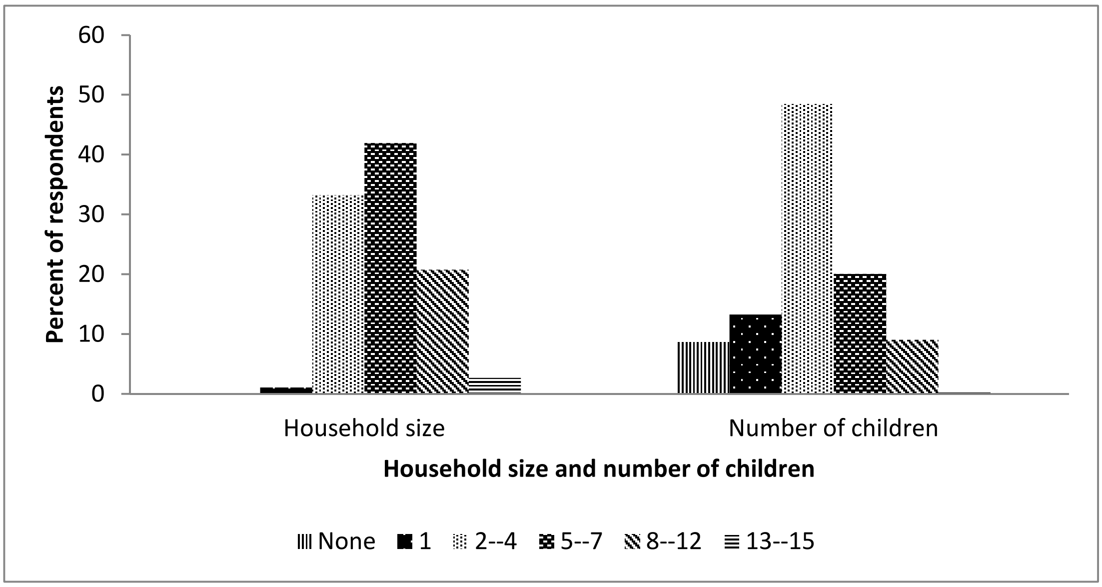

Figure 4.3 Distribution by household size and number of children

The average male had lived in the area longer (33years) than the average female (22years) (Table 4.3). A t-test (*t=5.932, p=0.000, crit t=1.969*) showed that the means for the number of years that one had lived in the area for males was statistically different from that of females. The difference could be attributed to the fact that most females move from other places to live with their husbands when they get married. Compared to other divisions, respondents from Muhoroni had lived in the area for the shortest time (20.31 years). This could be attributed to two reasons. Firstly, most land in Muhoroni was a settlement scheme and most of the residents migrated there at different times. Secondly, some of the respondents in Muhoroni were urban dwellers who moved recently from their homes elsewhere to work in Muhoroni town.

Table 4.3 Duration (years) of residence in the area by gender

Sex	**Male (n=146)**	**Female (n=118)**
Mean	32.82	21.78
Standard deviation	16.34	13.90
Minimum	1.00	1.00
Maximum	73.00	66.00

Source: Survey data, 2012

A summary of the respondents' distribution by the highest education level attained is shown in Figure 4.4. Nine respondents representing 3.4% had no formal education. About 34% had at least some level of primary school education while 37% had graduated or had at least some level of secondary school education. Twenty-three percent of the respondents had either graduated from the university or had at least some level of college education. Only 2.7% had postgraduate qualification.

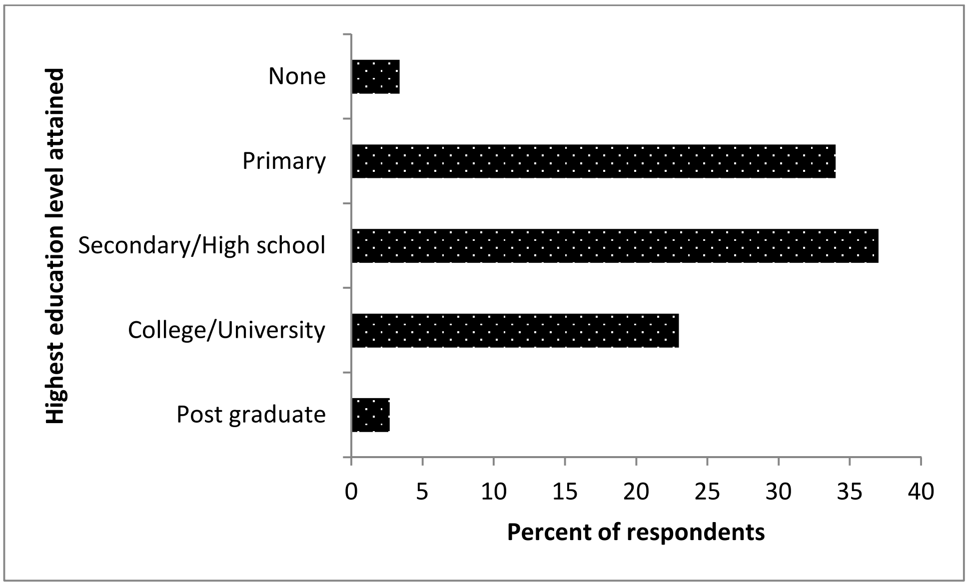

Figure 4.4 Distribution by the highest education level attained

The results also showed that male respondents were on average slightly better educated than their female counterparts (Table 4.4). This observation was supported by a t-test (*t=2.377, p=0.018, crit t=1.969*) which showed that the means for education level (years) for males was statistically different from that of females.

Table 4.4 Education level (years) by gender

Sex	Male (n=146)	Female (n=118)
Mean	10.77	9.66
Standard deviation	4.02	3.53
Minimum	0.00	0.00
Maximum	23.00	18.00

Source: Survey data, 2012

Across the divisions (Figure 4.5), respondents from Muhoroni and Miwani were slightly better educated than those from Nyando and Lower Nyakach. The average education level (years) was 11.02 in Muhoroni, 10.53 in Miwani, 10.32 in Nyando and 9.66 in Lower Nyakach.

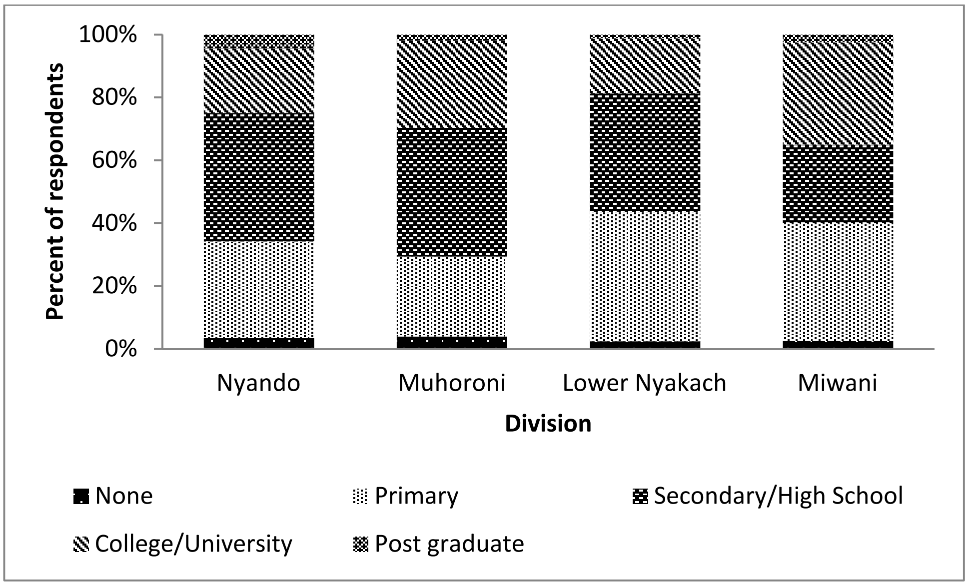

Figure 4.5 Education level (years) of respondents across the divisions

Majority (70%) of the respondents used fuel wood as the main source of energy for cooking. This was followed by charcoal which was used by about 20% of the respondents. The others used either kerosene (5%) or gas (5%). For lighting at night, kerosene was the main form of energy, used by over 80% of the respondents. The other reported forms of energy for lighting (Figure 4.6) were electricity (10%), solar (5%) and fuel wood (4%).

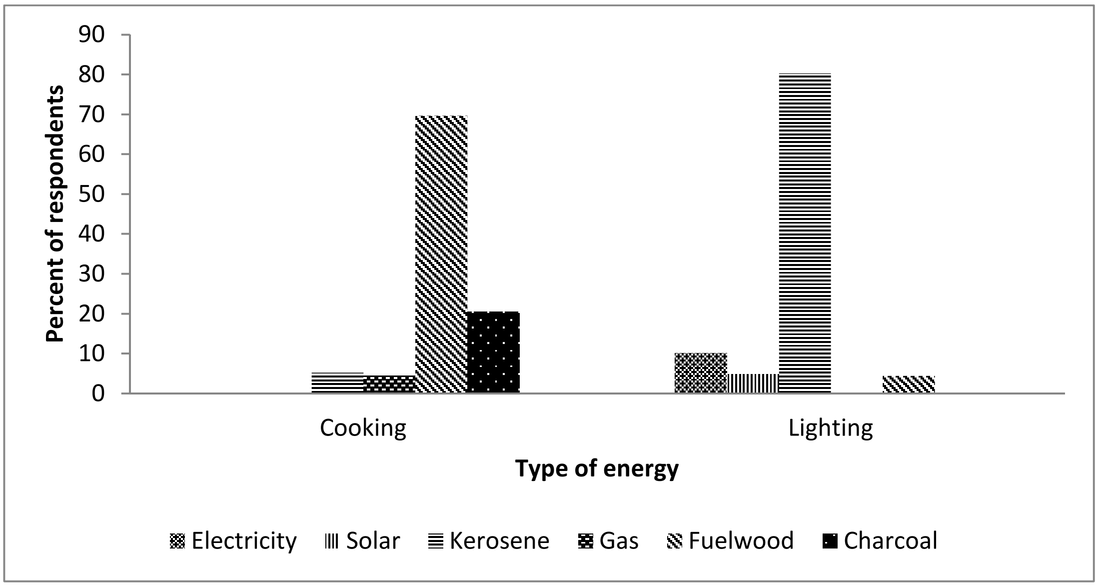

Figure 4.6 Distribution by source of energy for cooking and for lighting

4.1.2 Household Income and occupation

A summary of the respondents' monthly post tax household income is shown in Figure 4.7.

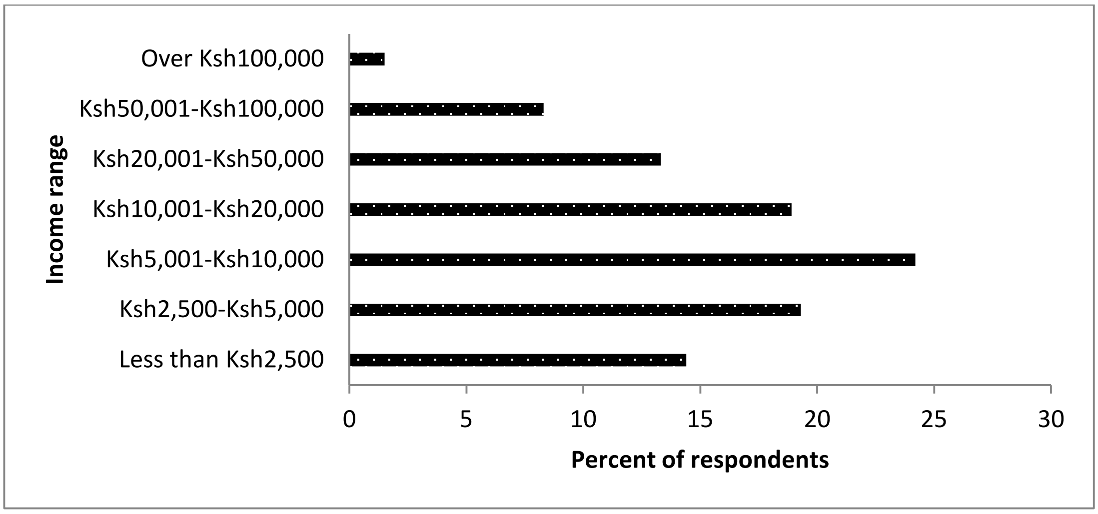

Figure 4.7 Respondents' post tax household income ranges

On average, the post-tax household income was Ksh20,145. The lowest income reported was Ksh150 while the highest was Ksh420,000. Slightly over half of the respondents (53%) reported household post tax incomes under Ksh9,500. Kenya's rural poverty line is Ksh1,562 (KOD, 2012) which translates to Ksh9,372 for a household of 6 members. The figure reported by the respondents is therefore close to the country's figure for population below poverty line (50%) and the study area's figure (48%).

Across the divisions (Figure 4.8), respondents from Nyando reported both the lowest (Ksh150) and the highest (Ksh420,000) post tax household incomes. The average household income was Ksh25,981 in Muhoroni, Ksh22,467 in Nyando, Ksh18,127 in Miwani and Ksh15,187 in Lower Nyakach. Although there was variation in the means of income across the four divisions, an ANOVA test (*F=1.057, p=0.368, F crit=2.640*) showed that the means were not statistically different. This means the divisions of residence had no influence on the household incomes.

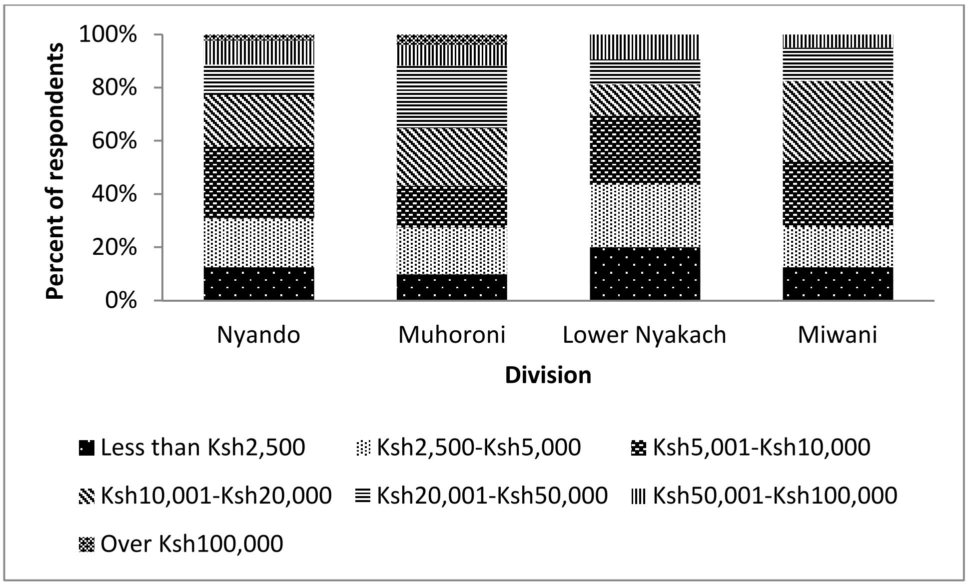

Figure 4.8 Distribution of post-tax household incomes by division

The distribution of respondents under different occupation status is shown in Figure 4.9. Most (41%) of the respondents were self-employed. Others were in formal employment (21%) or were casual labourers (19%) on other farms. The remaining were retired (2.7%), students (4.5%) or unemployed (12.1%). The self-employed respondents were mostly farmers although a few were involved in other off-farm businesses. At least 26% of the respondents were also involved in harvesting and trading in natural products. Most (61%) of these were from Lower Nyakach and were involved in harvesting of murram, sand and clay for making bricks.

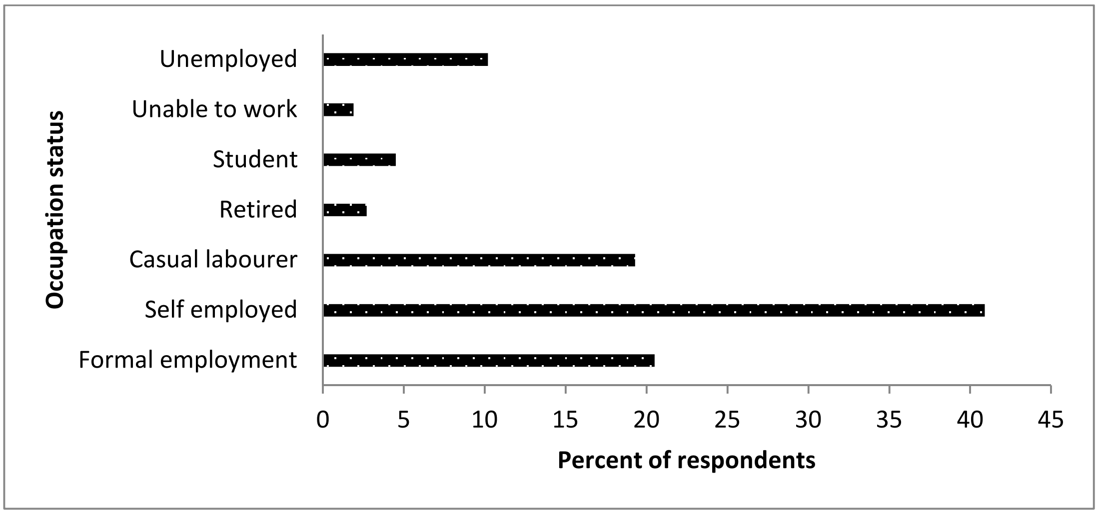

Figure 4.9 Distribution of respondents by occupation status

Self-employment constituted the biggest occupation in all the divisions although formal employment and casual labour also had significant shares (Fig 4.10).The highest rate of unemployment was in Muhoroni (20%) followed by Nyando (15%) and Lower Nyakach (9%). Miwani had the least unemployment rate at 2.5%.

4.1.3 Farm size and Farming

Overall, the average farm size was 2.25 acres. The smallest farm size was 0.1 acres and was reported in Muhoroni while the largest was 16.4 acres in Miwani. Average farm sizes were almost uniform across the four divisions although Miwani had slightly larger farms (Table 4.5). An ANOVA test (*F=0.283, p=0.838*) showed that there was no statistical difference in the means of farm size across the four divisions.

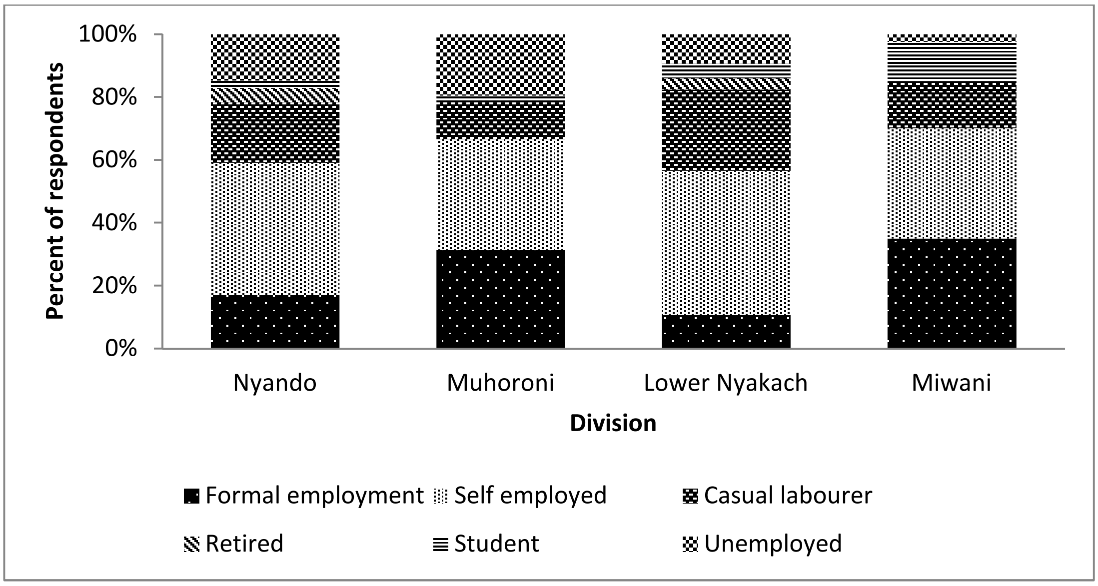

Figure 4.10 Occupation status by division

With exception of Muhoroni, most land in the area was privately owned. About 87% of the respondents had private ownership of at least some portion of the total land that they had access to. About 31% of the respondents, including some with private land also had access to land through communal tenure, rental or as squatters. In Muhoroni, only 47% (less than half) had private tenure over land. Most of the respondents lived in the area either as squatters or on rented land. This may be because most land in the area was a settlement scheme.

Table 4.5 Average and range of farm sizes by division

Location	**Nyando (n=88)**	**Muhoroni (n=51)**	**Lower Nyakach (n=85)**	**Miwani (n=40)**
Mean	2.16	2.23	2.23	2.56
Standard deviation	1.71	3.15	1.94	2.81
Minimum	0.25	0.10	0.13	0.25
Maximum	9.00	15.00	13.00	16.40

Source: Survey data, 2012

At least 90% of the respondents were involved in some kind of farming. Among these, about 54% did their farming purely for subsistence while 44% farmed for both subsistence and commercial purposes. Only three respondents representing 1.3% were purely commercial farmers. Almost 90% of the respondents kept at least some kind of livestock. Poultry was kept by the highest number (65%) of the respondents. About 60% of the respondents had cattle at an average of six herds per respondent. Goats were kept by 45% of the respondents also at an average of six while 42% percent kept sheep at an average of eight per respondent. The other notable livestock reported were donkeys with 11% of the respondents each having two donkeys on average. Figure 4.11 shows percentage of respondents by the type of livestock.

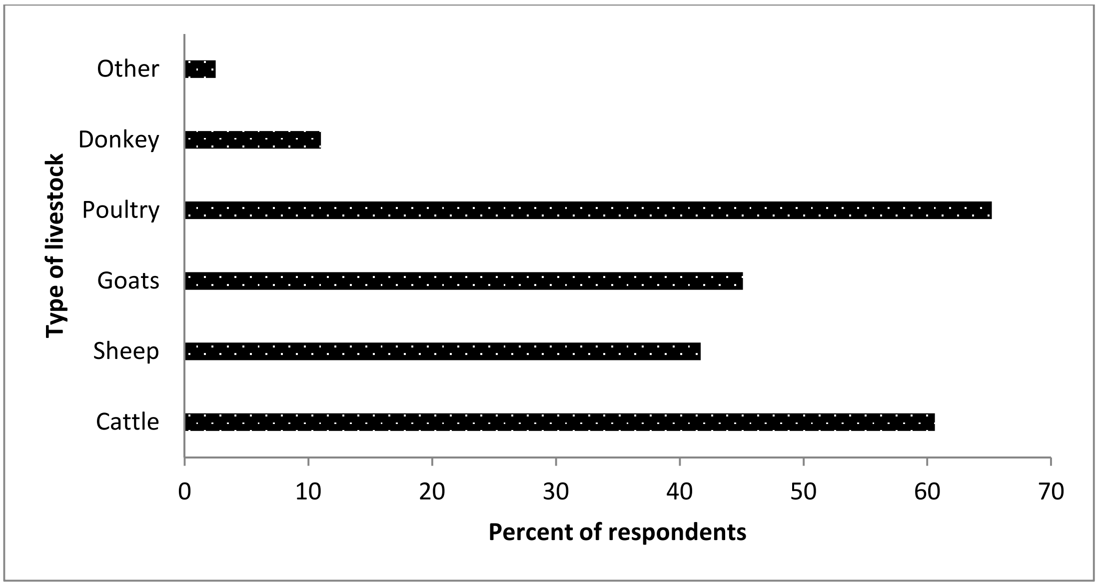

Figure 4.11 Percentage of respondents by type of livestock

Open range grazing was the most common means of feeding livestock. About 70% of the respondents who kept livestock also practiced open-range grazing. Only 14% grew or fetched animal fodder while 12% practiced zero grazing (Figure 4.12).

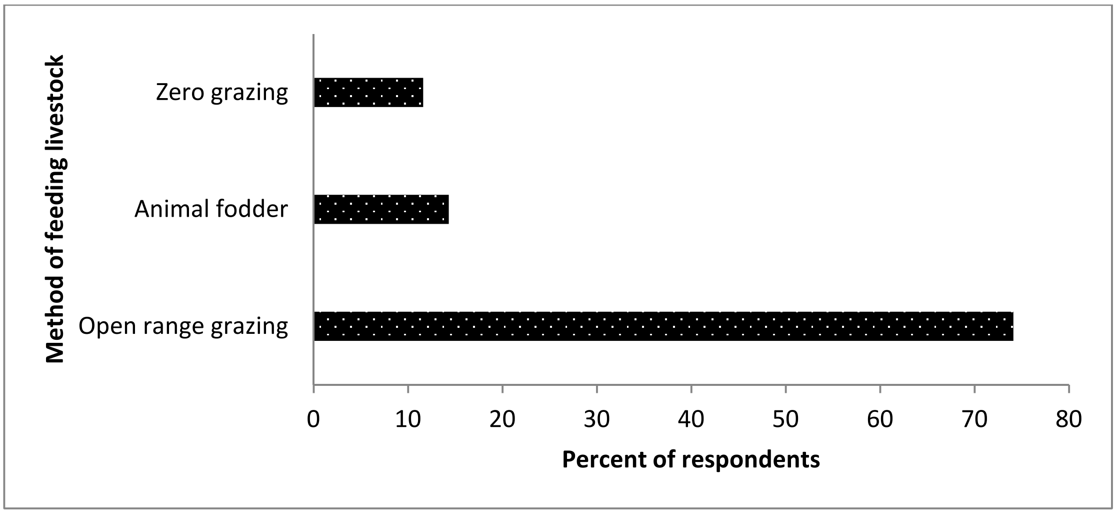

Figure 4.12 Percentage of respondent by methods of feeding livestock

Rice was the main cash crop grown by the respondents in Nyando and Miwani while sugarcane was common in Muhoroni. Some respondents from Lower Nyakach also grew cotton as a cash crop. Maize, beans and sorghum were grown by respondents across all the divisions mainly as subsistence crops. Division-wise distribution of rice, sugarcane and cotton farmers is shown in Figure 4.13.

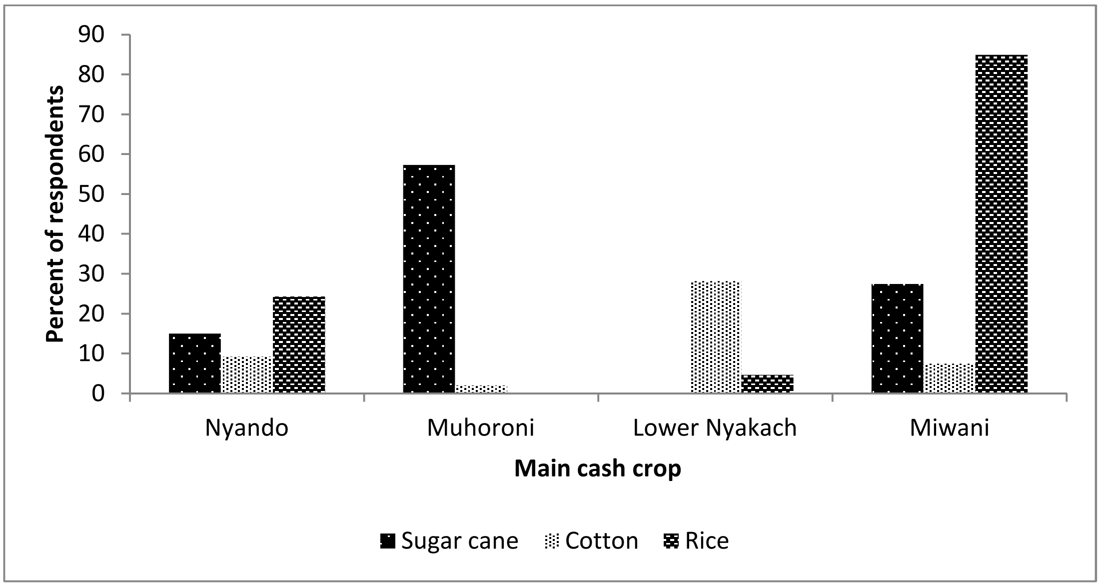

Figure 4.13 Distribution by main cash crop across the divisions

The respondents' average distances to the market was 5.6Km. Although some, particularly rice farmers said they sold their produce at the farm gate, others said they normally transported theirs to far flung markets. For example most sugarcane farmers said they normally transported their produce to one of the four sugar factories in the area or pay the factories for the transport costs. Horticulture and poultry farmers said they mostly sold their produce in Kisumu town. The longest distance to the market reported was 35Km. Overall, about 50% (half) of the respondents travelled less than 3Km to the market while 41% travelled between 3 and 10Km. The remaining 10% had to travel between 11 and 35Km to sell their produce (Figure 4.14).

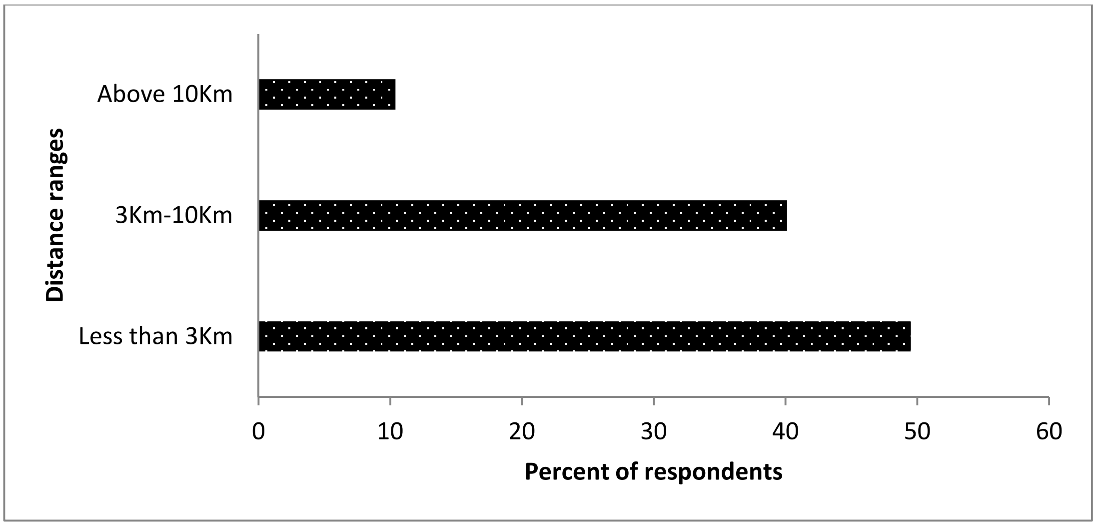

Figure 4.14 Distribution of respondents by distance to market

4.1.4 Perceptions and observations on Environment

Figure 4.15 shows the respondents perceptions on the environment. About 52% of the respondents rated Nyando River Basin as degraded and 19% as very degraded. Twenty-seven percent however felt it was good while 2% felt it was very good. In particular, majority (77%) of the respondents rated the quality of water in the area as between bad and satisfactory compared to 23% who rated it as either good or very good.

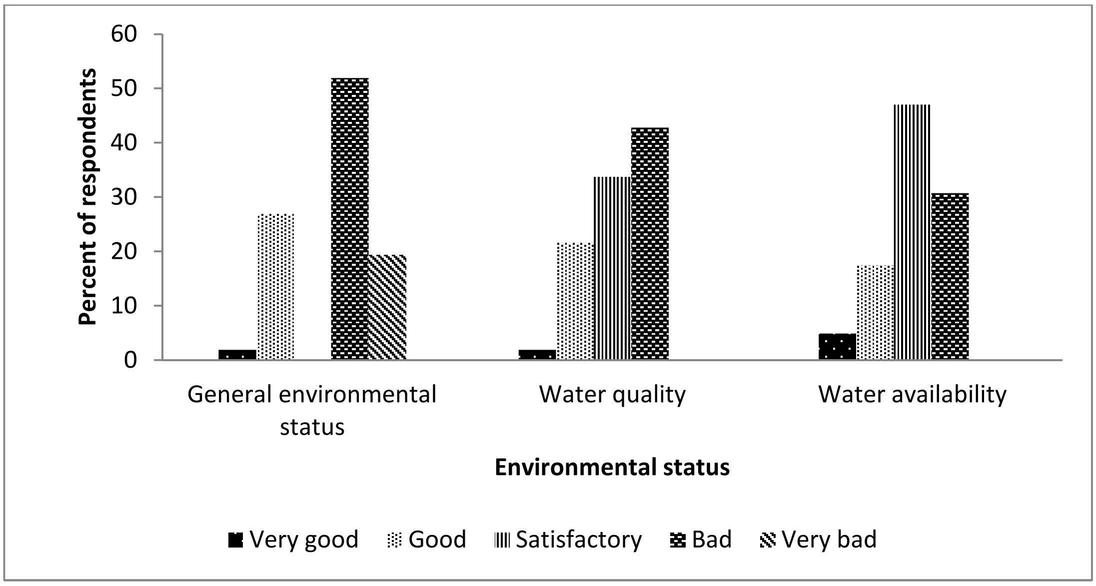

Figure 4.15 Respondents' perceptions on environment

Only 22% rated availability of water for domestic use as either good or very good. About 47% rated it as satisfactory while 31% thought it was bad. Information on the distribution of respondents by main source of water for domestic use is given in Figure 4.16.

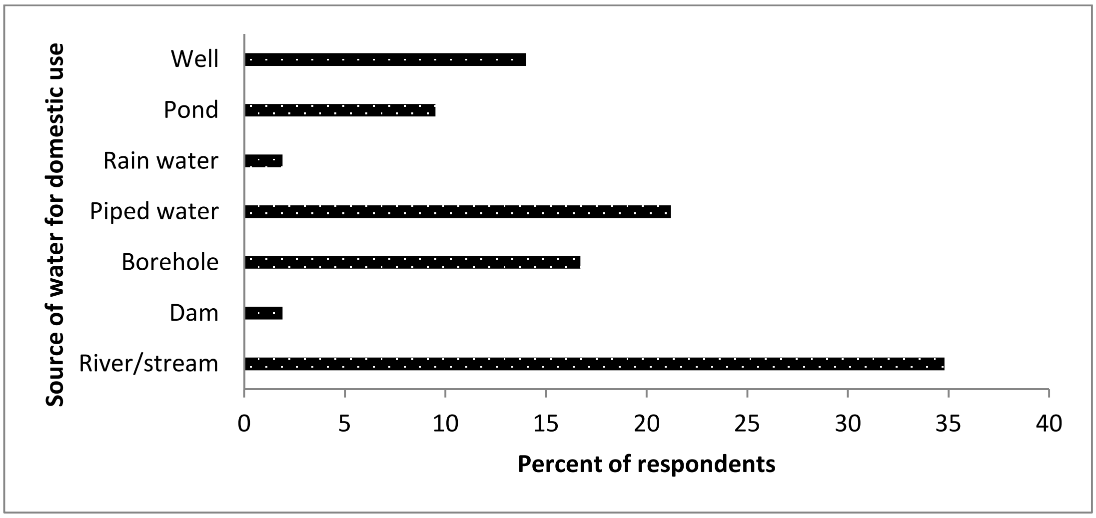

Figure 4.16 Distribution by main source of water for domestic use

Following KIHBS (2005), water is considered good quality if it is obtained from: piped water, borehole, and protected spring and protected well. Based on this, 52% of the respondents had access to good quality water while 48% did not. Rivers and streams were the most common source of water with 34% of the respondents reporting them as their main source. Across the divisions, Nyando led with 62% of respondents having access to good quality water. It was followed by Lower Nyakach (52%), Muhoroni (33%) while Miwani had the least (28%). About 21% of the respondents had access to piped water and they were mainly from Lower Nyakach, some parts of Nyando near Ahero town and in Muhoroni town. Figure 4.17 shows the distribution of respondents by the main sources of water across the divisions.

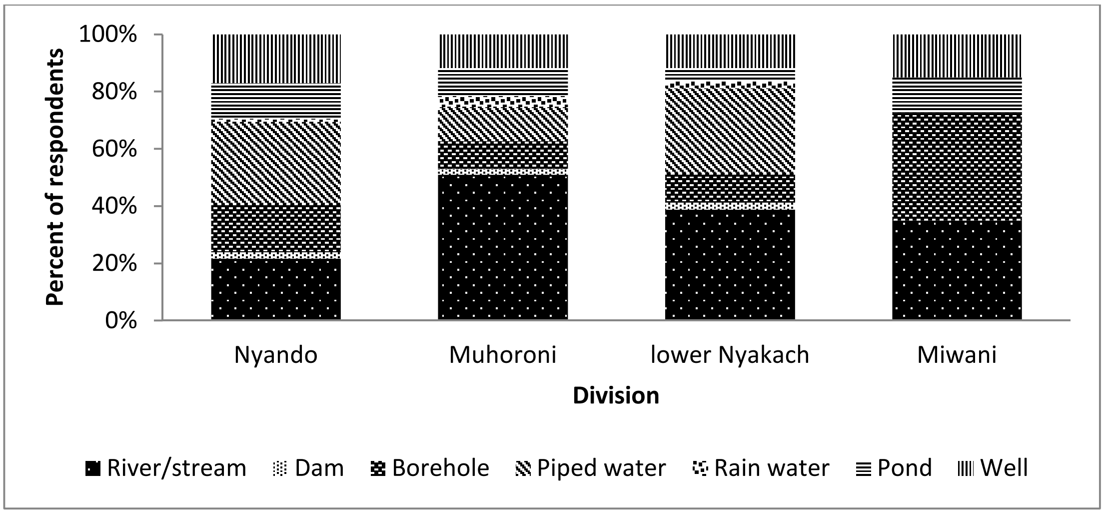

Figure 4.17 Distribution by main source of water across the divisions

Flooding was reported as a serious environmental problem in the area, affecting 58% of the respondents. Most (64%) of those affected by floods were from Nyando and Miwani and had been affected on average eight times in the last ten years. The floods affected them in several ways (Figure 4.18).Damage to crops was reported by most (90%) of the respondents followed by damage to property (81%). About 73% said it disrupted life e.g. by damaging roads and other infrastructure such as schools and hospitals or by rendering them unusable. Nearly 66% said the floods caused disease to members of their household while 48% said they lost their livestock to the floods. Loss of human life to the floods was reported by 15% of the respondents.

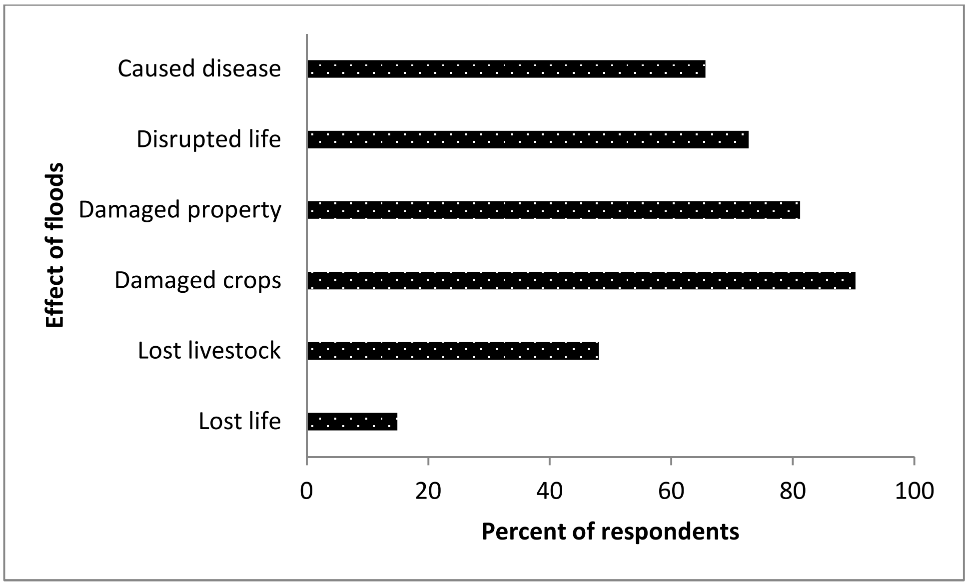

Figure 4.18 Distribution of respondents by effect of floods

4.2 Willingness to Pay (WTP)

4.2.1 Model Estimation

STATA 11 was used to run two Multinomial Logit (MNL) models of the choice data. The first model was a basic model showing the importance of the attributes in explaining respondents' choices across three different options in a choice set. The options were a status quo (no change) and two alternatives each involving some improvements. The second model included socio-economic characteristics (covariates) interacted with the attributes. In this case, each of the attributes was interacted with covariates of age, education, household size, farm size and income. Definitions of the variables used in the model are presented in Table 4.6.

Table 4.6 Definitions and sample statistics of the variables used in the model

Variables	Definitions	Mean	Std deviation
Age	Respondent's age	38.98	12.77
Education	Respondent's education level (years)	10.27	3.84
Household size	Respondent's family size	5.99	2.89
Farm size	Household's total farm size (acres)	2.25	2.29
Income	Household's monthly income (Ksh[a])	20,144.51	37,535.70

[a] At the time of the survey, USD 1 was approximately equal to Ksh 83

The estimation results of the MNL without covariates are presented in Table 4.7. The coefficients of all the attributes were highly significant suggesting that these attributes do influence individuals' choice of a wetland management option. Moreover, coefficients of the wetland attributes had the expected positive signs. A positive sign implies that as levels of these attributes increase from the status quo, the probability of choosing alternatives rather than the status quo increases. Likewise, the price attribute had the expected negative coefficient. This implies that the higher the price, the lower the probability of choosing the alternative. Using the Wald statistic, all estimated equations were statistically significantly different from zero at the 1% level.

Table 4.7 Estimation results of the MNL model without covariates

Variables[b]	**Coefficients**	**Std error**	**t-value**
Flooding risk	0.0045***	0.0096	0.4600
Water quality	0.0155***	0.0022	7.0700
Agricultural yield	0.4737***	0.0857	5.5300
Employment	0.0438***	0.0126	3.4700
Price	-3.08E-05 ***	0.0000	-5.5700
Number of iterations completed	5.0000		
Log-likelihood	-1058.898	Significance of chi-square = 0.0000	
Number of observations	4743.0000		

[b] The variables are defined in Table 3.1
*** Indicates statistical significance at 1% level

In addition, the estimation results of the model with covariates are presented in Table 4.8. Age, education (years), household size, farm size and income were interacted with the environmental attributes. All the attributes' coefficients were statistically significant at 5 percent level. Still the attributes had the expected signs. Therefore, with respect to the attributes both models generated similar results. It is particularly important to note that in this model the price attribute was still negative and significant at 5 per cent level. This confirms that residents of Nyando River Basin value and are prepared to pay for improvements in the basin's attributes. Furthermore, such improvements are valued higher as the cost of obtaining them decrease. However, apart from flooding education interaction and agriculture age interaction, all coefficients on socio-economic variables interacted with each attribute were not statistically significant.

Table 4.8 Estimation results of the MNL model with covariates

Attribute variables[b]	**Coefficients**	**Standard error**	**t-value**
Flooding risk	0.0045***	0.0096	0.4700
Water quality	0.0155***	0.0022	7.0600
Agricultural yield	0.4735***	0.0859	5.5100
Employment	0.0438***	0.0126	3.4600
Price	-2.99E-05***	0.0000	-4.5700
Agricultural yield*Age	0.0056*	0.0032	1.7500
Flooding risk*Age	-0.0004	0.0002	-1.4700
Flooding risk*Education	0.0018**	0.0009	2.0800
Flooding risk*Farm size	0.0004	0.0013	0.3100
Flooding risk*Income	0.0000	0.0000	0.2300
Flooding*Household size	-0.0006	0.0010	-0.6100
Water quality*Age	-0.0001	0.0001	-0.5500
Water quality*Education	0.0000	0.0004	0.0900
Water quality*Farm size	0.0002	0.0006	0.2900
Water quality*Hsehld size	0.0002	0.0005	0.4700
Water quality*Income	-0.0000	0.0000	-0.2100
Log-likelihood	-1054.5763	Significance of chi-square = 0.0000	
Number of observations	4572.0000		

[b] The variables are defined in Table 3.1
*** Indicates statistical significance at 1% level
** Indicates statistical significance at 5% level
* Indicates statistical significance at 10% level

Education interacted with flooding risk and agricultural yield interacted with age of respondent had statistically significant coefficients at 5% and 10%, respectively. This implies that education level modifies the effect of 'flooding risk' on the probability of choosing an alternative. Likewise, the respondent's age modifies the effect of 'agricultural yield' on their probability of choice. Furthermore, the two coefficients had positive signs. This shows that more educated respondents had a higher probability of choosing alternatives with reduced flooding risk. With regard to agricultural yield, elder respondents had a higher probability of choosing alternatives with improved agricultural yield.

4.2.2 MWTP estimates of each attribute

The marginal willingness to pay (MWTP) of each attribute was calculated by estimating the average marginal effects of improving each of the attributes. MWTPs reflect the rate at which respondents are willing to trade off price for changes in any of the other attributes. They were calculated as the ratio of the average marginal effects of the attribute of interest and that of the monetary attribute (Equation 3.7). The estimates were then multiplied with the study population to get the MWTP for each of the attributes (Table 4.9). From the results, the residents' MWTP for reduced flooding risk is KSH 0.05 billion (USD 0.64 million) while the MWTP for improving access to good quality water was KSH 0.18 billion (USD 2.20 million). With respect to agricultural yield, the estimated MWTP was KSH 5.57 billion (USD 67.06 million). Finally, the MWTP for increasing employment opportunities for the residents was KSH 0.51 billion (USD 6.20 million).

Table 4.9 estimated Marginal willingness to pay (MWTP) of each of the attributes.

Attribute	**MWTP**[a]
Flooding risk	0.05
Water quality	0.18
Agricultural yield	5.57
Employment	0.51

[a] The MWTP unit is Ksh 1 billion per year. At the time of the survey, USD 1 was approximately equal to Ksh 83.

4.2.3 Scenarios for NRB management

One of the major strengths of choice experiment is its ability to generate estimates of the values of many different alternatives from the one application (Alpizar *et al.*, 2001, Adamowicz et al, 1994). The estimated MWTP values can be used to calculate the values of an array of alternative ways of reallocating resources. In this study, three different wetland management scenarios (Table 4.10) were considered. If other attributes are held constant, the annual WTP for a wetland management option that improves agricultural yield and creates more employments is KSH 6.08 billion (USD 73.23 million). If there is improved agricultural yield and less flooding risk, the households are willing to pay KSH 5.62 billion (USD 67.71 million) annually. In addition, households' annual WTP for improved agricultural yield and better access to good quality water is KSH 5.75 billion (USD 69.26 million). Apart from these three, other scenarios can be constructed using the different attributes of NRB.

Table 4.10 Scenarios of NRB management

Attributes	**Base rate**	**Scenario 1**	**Scenario 2**	**Scenario 3**
Flooding risk	50% of land area[a]	No change	Reduced	No change
Water quality	36% of population[a]	No change	No change	More access
Agricultural yield	Status quo[a]	Improved yield	Improved yield	Improved yield
Employment	Status quo[a]	Increased	No change	No change
WTP (KSH 1 billion)		6.08	5.62	5.75

[a] Indicates the baseline or status quo level

CHAPTER FIVE: CONCLUSION AND POLICY IMPLICATIONS

5.0 Introduction

This chapter concludes the thesis by summarising the main findings of the study and giving recommendations. It also points out some policy implications of the results.

5.1 Conclusion and recommendation

This study was motivated by the need for quantitative information to help wetland managers and policy-makers design wetland management programmes that are both sustainable and socially desirable. In particular, it sought to analyse how residents of lower Nyando River Basin (NRB) value different environmental attributes associated with the river basin by employing a choice experiment approach. A choice experiment breaks respondents' preferences for an environmental good into components associated with the attributes that go to make up the good. It is thus possible to use choice experiment results to investigate the relative importance of attributes that make up an environmental good.

Choice experiment results can also be used to estimate the values associated with various combinations of attribute levels. Four different river basin management attributes were employed as indicators of NRB's environmental quality. These were; flood risk reduction, water quality improvement, agricultural yield increase and creation of more employments. The data was analysed using two specifications of the multinomial logit model (MNL). The first model concerned only the environmental attributes while the second one included some covariates interacted with the environmental attributes. The following conclusions can be drawn from the results:

- The average NRB resident values positively and significantly improvements in all the river basin management attributes used in the study (flood risk reduction, water quality improvement, increasing agricultural yield, and employment creation).
- Agricultural yield attribute generates the highest impact on the residents' utility, with an annual MWTP value of KSH 5.57 billion equivalent to USD 67.06 million. The corresponding figure for creating more employment opportunities is KSH 0.51 billion or USD 6.20 million. Reducing flooding risk

attracts an annual MWTP of KSH 0.05 billion (USD 0.64 million) while the MWTP for improving water quality is KESH 0.18 billion equivalent to USD 2.20 million.

- Even though the main concern of these residents is improvement of agricultural yield, they also derive substantial benefits from employment creation, flooding risk reduction and water quality improvement. Therefore, the wetland management strategies in this region should be designed in such a way that the precautions or interventions taken to improve agricultural yield also incorporate improvements in the other attributes. For example, more commercial rather than subsistence farming should be promoted to improve yield and create more employment. In addition, modern farming technologies such as improved seed varieties and livestock species, as well as on-farm value addition should be adopted in order to increase farm earnings.

- The significant valuation of flood risk reduction and water quality improvement necessitates precautions or interventions which reduce the devastating effects of floods and improves water quality. For example, construction of water channels and large dams would help to harness potential flood water for irrigation use. This will have a multiple effect of reducing floods, improving farm yields and minimizing contamination of other surface and ground water sources. Another example is to promote cultivation of crops that are both environmentally friendly and economically valuable. For example, Chaomao *et al.* (2006) shows that bamboo trees are superior to other trees and plants in withstanding strong winds and water surge, reducing soil erosion and screening debris that go to the water system. Bamboo also has enormous value as rapidly renewable source of timber for construction, ornaments and charcoal. Planting bamboo trees along river banks can therefore not only reduce flooding but also create employment, improve water quality and increase farm yield.

- There is at least some heterogeneity in preferences among the residents particularly for the agricultural yield and flood risk reduction attributes. Such heterogeneity should be taken into consideration to ensure social equity, as well as the stakeholder participation and consultation requirements of the EMCA wetlands regulations (MEMR, 2009).

- The residents place different values on alternative hypothesized improvements in the environmental quality of NRB. This can help in identifying and implementing management strategies that best fit the needs of the locals.
- Finally, the study has demonstrated that choice experiment can be successfully applied to estimate non-market values of wetlands in Kenya. This contributes not only to wetlands management in Kenya but also to other decision making processes involving natural resources in the whole region.

5.2 Policy implications

The following policy implications can be drawn from the study:

- Agricultural yield appears to be the strongest motivation of Nyando river basin residents in making their decisions. Correspondingly, wetland management programmes or policies that promote improvement of agricultural yield have a high probability of gaining the residents support. In a way, this makes a case for harmonization of sectoral policies touching on wetlands including those on water, land, wildlife and agriculture as suggested in the Draft Wetlands Policy (Republic of Kenya, 2008). Such harmonisation will position wetland conservation and human development as two interests which compliment rather than conflict each other.

- The employment attribute was the second strongest motivation for the respondents' decisions after agricultural yield. Most of the respondents were low income earners involved in small scale subsistence farming. It appears that their motivations for choice decisions are essentially the immediate and basic needs for their daily survival. This causes them to willingly trade-off flood risk reduction and water quality improvement, perhaps because they consider these attributes as of secondary value. This has clear policy implications. It shows that addressing the issue of poverty is critical to and should be a good starting point in improving management and conservation of wetlands. This study therefore suggests that wetland related policies should not treat wetlands as areas that should not be 'touched' but as areas that should be utilized sustainably to improve residents' livelihoods. Luckily, this requirement is captured by the Draft Sessional Paper on Wetlands (Republic of Kenya, 2008) and will hopefully be included in the final Kenya Wetlands Policy which is currently under development. Other measures such as improving physical infrastructure and access to education should also be encouraged to tackle poverty.

- Furthermore, during initial interviews with residents to identify NRB management attributes, most of the interviewees revealed a disregard for certain attributes one being more biodiversity. This fact, together with the low valuation of flood risk reduction and water quality improvement raises some fundamental questions regarding the use of stated preference methods. For example, what do people actually understand by "more birds, more fish, and more insects"or"good quality water"? And how does this understanding vary between respondents? This study suggests that if flood risk reduction, water quality improvement or biodiversity protection is to be a policy priority, public awareness campaigns should be conducted to educate residents on the value of these attributes.

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Appendix

Appendix 1: **HOUSEHOLD QUESTIONNAIRE**

Questionnaire Number [______________________]
Interviewer Name [_________ ____]
Interview date [M________________Day______________Year____________________]

Section 1: General perception and observation of Nyando river basin

101	What is your general perception of the current environmental status of Nyando River Basin?	Very good [ ] Good [ ] Degraded [ ] Very degraded [ ]
102	Rank environmental problems in Nyando river basin in order of their severity, listing the most severe first (1) and the least severe last (6).	[_____] Flooding [_____] Loss of biodiversity [_____] Lack of sufficient water [_____] Poor agricultural yield [_____] Unemployment [_____] Low water quality
103	What is the distance from your house to the nearest river/stream?	[______________________Km]
104	Where do you normally obtain water for domestic use?	River/stream [ ] Dam [ ] Borehole [ ] Piped water [ ] Rain water [ ] Pond [ ] Lake [ ] Spring [ ] Well [ ]
105	What is your general perception of the quality of water in Nyando river basin?	Very good [ ] Good [ ] Satisfactory [ ] Bad [ ]
106	What is your general perception of the availability of water in Nyando river basin?	Very good [ ] Good [ ] Satisfactory [ ] Bad [ ]
107	Has your household been affected by floods in the last 10 years?	Yes [ ] No [ ]
108	If Yes, how many times?	[__________________]
109	How did the floods affect your household?	Lost life [ ] Lost livestock [ ] Damaged crops [ ] Damaged property [ ] Disrupted life [ ] Caused disease [ ]

Section 2 Choice questions

In each of the following choice sets, assuming that the three wetland management options were the only choices you had, which one would you choose?

CHOICE SET 1

Management characteristics	**Management Option A**	**Management Option B**	**Neither option: status quo**
Percentage of land area at risk of flooding	30	30	50
Percentage of population with access to improved water quality	36	50	36
Change in the annual value of crop and livestock yield	2 x Present	No change	No change
Percentage change in the number of employments created	20	10	0
Number of days per week that you are required to work if you choose this option	3	2	0
I prefer (Please tick as appropriate)	Option A [ ]	Option B [ ]	Neither Option [ ]

CHOICE SET 2

Management characteristics	**Management Option A**	**Management Option B**	**Neither option: status quo**
Percentage of land area at risk of flooding	10	10	50
Percentage of population with access to improved water quality	50	36	36
Change in the annual value of crop and livestock yield	2 x present	2 x present	No change
Percentage change in the number of employments created	10	0	0
Number of days per week that you are required to work if you choose this option	1	2	0
I prefer(Please tick as appropriate)	Option A [ ]	Option B [ ]	Neither Option [ ]

CHOICE SET 3

Management characteristics	**Management Option A**	**Management Option B**	**Neither option: status quo**
Percentage of land area at risk of flooding	50	30	50
Percentage of population with access to improved water quality	36	50	36
Change in the annual value of crop and livestock yield	3 x present	3 x present	No change
Percentage change in the number of employments created	10	0	0
Number of days per week that you are required to work if you choose this option	1	2	0
I prefer (Please tick as appropriate)	Option A [ ]	Option B [ ]	Neither Option [ ]

CHOICE SET 4

Management characteristics	**Management Option A**	**Management Option B**	**Neither option: status quo**
Percentage of land area at risk of flooding	50	10	50
Percentage of population with access to improved water quality	50	72	36
Change in the annual value of crop and livestock yield	2 x present	3 x present	No change
Percentage change in the number of employments created	0	10	0
Number of days per week that you are required to work if you choose this option	3	3	0
I prefer (Please tick as appropriate)	Option A [ ]	Option B [ ]	Neither Option [ ]

CHOICE SET 5

Management characteristics	**Management Option A**	**Management Option B**	**Neither option: status quo**
Percentage of land area at risk of flooding	10	10	50
Percentage of population with access to improved water quality	50	72	36
Change in the annual value of crop and livestock yield	No change	No change	No change
Percentage change in the number of employments created	20	0	0
Number of days per week that you are required to work if you choose this option	1	3	0
I prefer (Please tick as appropriate)	Option A [ ]	Option B [ ]	Neither Option [ ]

CHOICE SET 6

Management characteristics	**Management Option A**	**Management Option B**	**Neither option: status quo**
Percentage of land area at risk of flooding	50	30	50
Percentage of population with access to improved water quality	72	72	36
Change in the annual value of crop and livestock yield	No action	3 x present yield	No change
Percentage change in the number of employments created	20	0	0
Number of days per week that you are required to work if you choose this option	2	1	0
I prefer (Please tick as appropriate)	Option A [ ]	Option B [ ]	Neither Option [ ]

Debriefing questions

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

(1) I find this attribute [____] is important and chose exclusively such attribute in the alternatives.

(2) I don't think the residents should have to contribute (work) towards environmental quality improvement and conservation of natural resources.

(3) I exclusively chose the cheapest alternative.

(4) I wish I could pay/contribute more for the aggressive management options (options that maximize most of the attributes), but I cannot afford it.

(6) I chose the aggressive management options.

Section 3 Demographic Information

Q.	Question/ Detail	Response/Observation code
301	Residential area	Division______________________________ Location______________________________ Village________________________________
302	How long have you lived in this area?	________________________________years
303	In what year were you born?	[____________________________]
304	What is your sex?	Male [ ] Female [ ]
305	What is your marital status?	Married [ ] Widowed [ ] Divorced [ ] Separated [ ] Never married [ ]
306	Up to what class have you gone to school? If currently enrolled please state your current grade	____________________________________
307	What is your occupation now?	Formal employment [ ] Self employment [ ] Casual labour [ ] Retired [ ] Student [ ] Unable to work [ ]
308	How many people normally live in your household?	1 [ ] 2-4 [ ] 5-7 [ ] 8-12 [ ] 13-15 [ ]

309	How many children (below 18) do you have?	None 1 2-4 5-7 8-12 13-15	[ ] [ ] [ ] [ ] [ ] [ ]
310	Does your household possess any livestock? Select None OR provide the number under the type of livestock you posses	None Cattle Sheep Goats Poultry Donkeys Other, Specify and provide number	[ ] [_____] [_____] [_____] [_____] [_____] ___________ [_____]
311	How do you normally feed your livestock?	Open range grazing Animal fodder Zero grazing	[ ] [ ] [ ]
312	What type of fuel does your household use most for cooking?	Fuel wood Charcoal Kerosene Gas Electricity Solar energy	[ ] [ ] [ ] [ ] [ ] [ ]
313	What type of fuel does your household use most for lighting?	Fuel wood Charcoal Kerosene Gas Electricity Solar energy	[ ] [ ] [ ] [ ] [ ] [ ]
314	What size of land do you have access to? Please provide the number of acres under the type of tenure system with which you own the land.	Owned (with title) Owned (no title) Communal tenure Rented Squatter (not owned)	[___________acres] [___________acres] [___________acres] [___________acres] [___________acres]
315	What do you mainly use your land for? You are free to select more than one answer	Subsistence farming Commercial farming Livestock raring Harvesting of natural products (e.g. sand, clay, sisal, bamboo, papyrus etc.) Other	[ ] [ ] [ ] [ ] [ ], Specify_____

316	What crops do you normally grow in your farm?	None [ ] Maize [ ] Beans [ ] Sorghum [ ] Millet [ ] Rice [ ] Sugarcane [ ] Coffee [ ] Tea [ ] Cotton [ ] Horticultural crops [ ] Other [ ], Specify_____
317	Do you have access to irrigation water?	Yes [ ] No [ ]
318	If yes, how much of your land in acres is normally under irrigation?	[_____________________acres]
319	Where do you normally sell your products?	_____________________________________
320	What is your average monthly (post tax) household income in Ksh? Provide the answer under the source of income	Farm [Ksh_________] Employment [Ksh_________] Business [Ksh_________] Other, Specify[________] [Ksh_________] Total [Ksh_________]

Appendix 2: INSTRUCTION TO INTERVIEWERS

INFORMED CONSENT (The following statement must be read to every respondent)
May I have a minute of your time? **Mr Duncan Okowa**, a graduate student of Environmental Policy at the University of Nairobi is conducting a study on the Stakeholders' preferences and values of different wetland uses and management options in Nyando river basin. In order to meet this objective, it is important to obtain information from the river basin's residents such as you. The information is being collected for academic purposes only and therefore there are no personal benefits or risks to your participation. It is also not necessary for you to give your name or address- the only identifier on the questionnaire will be a number. All the information collected will be treated with utmost confidentiality. The interview takes approximately twenty minutes. You may terminate the interview at any point if you do not wish to proceed. If you would like to know more about this study, please contact ……………………………at …………………………………………

Consent granted:
YES (proceed with interview)
NO (thank person and look for next respondent. You are required to keep this questionnaire whether the respondent agreed to participate or not).

Section 1: General perception and observation of Nyando river basin
(Guide the respondent to answer Section 1 of the questionnaire)

Section2 (Now read the choice scenario to the respondent. Make sure that they pay attention to your description)

You have been randomly selected together with a large number of people living in Nyando River Basin to participate in this survey. We are investigating individuals' preferences for various actions taken to change the quality of the river basin (in terms of **flood risk, water quality, agricultural yield and employment).**

Below, we describe four factors characterizing the quality of Nyando river basin. We ask you to consider these factors and the costs for carrying out various measures in the choice questions that follow.

Flood risk
The lower reaches of Nyando basin continue to experience floods every year during the long (April-June) and short (October-November) rainy seasons. Possible measures to address the issue include river bank protection and harnessing the flood waters for use.

Flood risk is expressed as percentage of land area in Kano plains at risk of flooding.
50% – today's level
30% (240 Km^2)
10% (80 Km^2)

Water quality

Access to potable water in Nyando river basin depends on the measures taken to control flooding, prevent pollution, protect springs, provide piped water etc.

Percentage of population with access to piped water, public taps, tube wells, protected dug wells, boreholes, protected springs and rain-harvested water.
36% today's level
50%
72%

Agricultural production

Agricultural production in Nyando river basin is affected by declining soil fertility, erratic and unreliable rainfall, frequent damage to crops and loss of livestock due to floods, loss of farmland due to land degradation, poor use of modern agricultural technology etc. A number of measures are being put in place to address these issues

Percentage change in the annual value of crop and livestock production in the area
0% (no change) today's level
2 x present (200% improvement)
3 x present (300% improvement)

Employment of locals

It is expected that the management interventions implemented in the area to address the various issues will create employment for a number of local people.

Percentage change in the number of residents employed due to the basin's management interventions
0% No change - present level
10% increase
20% increase

Cost

Assuming all permanent residents of Nyando river basin aged 18-65 are required to physically work on the basin's management and conservation projects. The levels of improvement (or deterioration) of each of the four attributes will depend on the number of days per week that each individual works in that particular year. It is assumed that enough residents support the initiative (if support is too low, no measures will be taken). Thus:

1 day implies working one day per week during that particular year
2 days implies working two days per week during that particular year
3 days implies working three days per week during that particular year

Please, carefully choose between the alternatives below understanding that these choices may be difficult. Also note that there are no ”correct” answers, but priorities have to be made. Consider flood risk, water quality, agricultural production, and employment. Assume that the levels of these four attributes are independent of each other. Please mark your preferred wetland management option. Feel free to go back and change your choice in a previous question.

(Now show the cards then present the respondent with the choice sets and explain the cards. Pay attention and help in case they have any doubt)

Section 3 Demographic Information

(Guide the respondent to answer Section 3 of the questionnaire)