VALUATION OF SELECTED WETLAND RESOURCES AND THEIR CONTRIBUTION TO HOUSEHOLD INCOME IN LOWER NYANDO RIVER BASIN, KISUMU COUNTY, KENYA

BY

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DECLARATION

Declaration by the candidate

This thesis is my original work and has not been presented to any other examination body. No part of this research can be reproduced without my consent and/ or that of University of Eldoret and Victoria Institute of Research and Environmental Development (VIRED).

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DEDICATION

I dedicate this study to my parents, my brothers and my family, wife Josephine Chebet, and beloved daughter Charlotte Elizabeth Atieno and to all scholars who would like to explore more in the world of Environmental conservation with special interest to environmental economics.

ABSTRACT

Wetlands such as the Nyando wetlands provide communities with a range of inter-related environmental functions and socio-economic benefits, which support a variety of livelihood strategies. Because of the range of wetland use options at the community levels, there are often competing demands placed upon wetlands. Extensive exploitation of the wetlands has led to a decline in its quality and ability of the wetland to perform environmental functions. The objective of this study was therefore to determine the economic value of selected wetland resources and how these resources translate to domestic income. The study used a combination of data collection methods, namely, questionnaire survey, focus group discussion, key informant interviews and field observations. Households were randomly selected in four study transects in the Nyando wetland. The incomes from the respective resource uses were averaged to obtain mean incomes. The mean incomes were further analysed to detect variances and significances by calculation of t-values and F vales (ANOVA). The data was then represented in tables, graphs and charts. Results of the study showed that the Nyando wetland provides a variety of resources and are heavily utilized directly by the communities living around the wetland. The mean annual incomes per household from farming activities ranged from Kshs. 33,148 for maize to Kshs. 53,050 from kale production. The value of papyrus, fishing and sand harvesting were Kshs. 111,240, Kshs. 126,511 and Kshs. 66, 805 respectively. Grazing was estimated at a mean of Kshs. 129,575 per household livestock while cumulative income from multiple wetland resource use was estimated at Kshs. 636,582.73. The t-test values are greater than 0.05 proving that the incomes are highly significant while the F-tests prove that the variances of these incomes are not significant but closely related. The preferred and sustainable resource use trade-off is farming since it generates the highest mean income to majority of the resource users. However, the valuation in this research is only useful if the people are made aware of the high significant incomes they obtain thus need to conserve the wetland.

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LIST OF ACRONYMS AND ABBREVIATIONS

CVM – Contingent Valuation Method

ES – Ecosystem Service

IOC – Indirect Opportunity Cost

IS – Indirect Substitute

IUV – Indirect Use Value

OV – Option Value

MDG – Millennium Development Goals

TCM – Travel Cost Method

TEV – Total Economic Value

OPERATIONAL DEFINITION OF KEY TERMS

Wetland: a geographical area with characteristics of both dry land and bodies of water. Under Ramser convention, wetlands are defined as;

"Areas of marsh, fen, peat-land 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."

Farming: Farming or Agriculture refers to the art, science, and industry of managing the growth of plants and animals for human use. In a broad sense agriculture includes cultivation of soil, growing and harvesting crops, breeding and raising livestock, dairying and forestry.

Papyrus: Also referred to as paper reed, common in name for a plant of sedge family. The plant grows about 1 to 3 m (about 3 to 10ft) high and has a woody, aromatic, creeping rhizome. The leaves are long and sharp-keeled, and the upright flowering stems are naked, soft and triangular in shape. The lower part of the stem is as thick as a human arm, and at the top is a compound umbel of numerous drooping spikelets, with a whorl of eight leaves.

Glut period: Also used as peak period. This is the season of plenty and excess supply of a resource. It is the time when a particular resource is highly available and usually leads to a state where the supply is in the excess of demand.

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CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter gives a background of the study, statement of the problem, purpose of the study, research questions, problem justification, limitation and scope of the study. This chapter also explains the theoretical framework of the study.

1.1 Background to the study

Wetlands are among the Earth's most productive ecosystems. The features of the system may be grouped into components, functions and attributes (Gerard, 2004). The components of the system are the biotic and non-biotic features which include the soil, water, plants and animals. The interactions between the components express themselves as functions, including nutrient cycling and exchange of water between the surface and the groundwater and the surface and the atmosphere (Mureithi &Keynon, 2002).

Wetlands have been described both as "*the kidneys of the landscape*", because of the functions they can perform in the hydrological and chemical cycles, and as "*biological supermarkets"* because of the extensive food webs and rich biodiversity they support (Mitsch & Gosselink, 1993).

Wetlands cover 0.6% of the Earth's surface and provide ecosystem services such as recreational amenities, flood control, storm buffering, biodiversity, climate regulation and socio-cultural values (Murtough, 2002). Wetlands also encourage biodiversity by contributing to primary productivity and providing habitat for a wide range of dependent species.

Wetlands store water providing protection to the surrounding areas from effects of storms and subsequent floods (Gerard, 2004). As flood water flows out over a floodplain in the wetland, the water is temporarily stored; this reduces the peak river level and delays the time of the peak, which can be a benefit to riparian dwellers downstream.

In wetlands, the surface of the water, water table, is usually at, above, or just below the land surface for enough time to restrict the growth of plants to those that are adapted to wet conditions and promote the development of soils characteristic of a wet environment. (Douglas, 2009). With the formed soil characteristic, wetlands prevent flooding by holding water much like a sponge. By doing so, wetlands help Keep River levels normal and filter and purify the surface water. Wetlands accept water during storms and whenever water levels are high. When water levels are low, wetlands slowly release water. (Redmond, 2008).

By benefiting in this way, people are making indirect use of the wetland. These functions and services in the wetland occur naturally and freely therefore at no cost to man. However, to continue benefiting and receiving these services, there is the cost of conservation and proper management of the wetlands. Alternatively, these functions can be obtained by construction of dams, sea walls and water treatment plants. The cost of setting up such projects is much higher than when the services are obtained naturally from the wetland. Moreover, the quality of the service from the wetland is much higher than in the artificial settings.

Wetlands also provide resources that can be used directly such as papyrus and fish. These goods and services supported by the wetland are crucial in the supporting the survival of human beings. Wetlands are good areas for food, shelter, and fish breeding

grounds in addition to clean water. As scientific understanding of wetlands has increased, more subtle goods and services have become apparent.

People use wetland soils for agriculture, catch wetland fish for food, hunt wild animals from the wetland, cut wetland trees for timber and fuel wood and wetland vegetation to make mats and to thatch roofs. Direct use may also take the form of recreation, such as bird watching or sailing.

Papyrus obtained from the wetland can be used to make ropes, mats, trays, baskets and paper. The rhizomes of the plant can as well be used as firewood. The wetland is also home to Sitatunga antelope, hippopotamus, water animals and other forms of wildlife such as birds and water fowl. This makes the wetland a good hunting ground for these special species of animals.

Wetland vegetation provides the ideal conditions to support the breeding and feeding of the wildlife. The hunting can be done as a sporting activity as well as a source of food. Goods and services directly derived from wetlands are usually of great value to the riparian community. The cultivation of crops and livestock rearing are possible since wetlands provide conducive conditions where aquatic plants can grow abundantly and these form good grazing grounds for domesticated livestock. Wetlands are ever moist and at times filled with flood waters that frequently leave the land fertile. This makes the area suitable for crop cultivation more so those crops that are adapted to the anaerobic conditions in wetlands such as rice.

As happening in Nyando, Wetlands can also be drained to provide more land for settlement, agriculture and further investments. However, permanent draining of the wetland would deny the residents and the community at large the ecosystem services provided by the wetland. This is due to the fact that regaining the wetland after the

change of use is literally impossible unless left to be re-flooded again over sometime. This was actually a key point of concern in this research.

In conclusion, the usefulness of a wetland varies in relation to the level of ecosystem service it can provide and support. This brings in the need for valuation of these goods and services in order to make a proper decision on the best way to sustainably use these resources.

1.2 Problem Statement

Most communities perceive wetlands as sources of direct benefits (crop production, fishing, craft materials, sand, clay and water harvesting) but fail to appreciate the ecological functions and other life support non-tangible benefits like filtering of polluted water, reduction of river flooding and siltation.

Wetlands such as the Nyando wetlands provide valuable functions and services to the riparian communities. Some of these functions include flood control, effective filtering and cleaning water pollution. The wetlands also offer crucial services such as provision of papyrus reeds, fishing grounds and sand harvesting points. Therefore, destruction of such ecosystems would result into lots of losses.

To replace wetland ecosystem services, enormous amounts of money may have to be spent on water purification plants and remediation measures, constructing dams, levees and other artificial flood controls (MA, 2003). To avoid such eventualities, valuation of the functions and services of the wetlands is necessary.

Comprehensive valuation of wetland resources in Nyando has not been done hence the continued occurrence of exploitation and eventual degradation of the ecosystem (Swallow et al, 2005). It is in this line of thought that the researcher undertakes to carry out valuation of the Nyando wetlands. This value would greatly aid the riparian community in identification of possible ways to use sustainably the resources derived

from the wetland. It is therefore necessary to conduct valuation of the wetland resources, to determine how the loss of the wetland would impact on the livelihood of residents and users of the wetland and the community at large. The information obtained from this research will aid stake holders and decision makers in planning for wetland management of the Nyando wetland and other wetlands in the country.

1.3 Objectives

1.3.1 General objective

To assess the economic value of selected wetland resources and how these resources translate to domestic income per capita;

1.3.2 Specific Objectives

1. To determine the economic values of papyrus, fish, sand, and farming services provided by Nyando wetlands;
2. To evaluate the trade-offs in product use alternatives in Nyando wetlands;
3. To assess the economic costs of conversion and degradation of Nyando wetlands;

1.3.3 Research Questions

1. What are the economic values of papyrus, fish, sand, and farming services provided by Nyando wetlands?
2. What are the economic values of trade off options in Nyando wetland?
3. What are the economic costs of conversion and degradation of Nyando wetlands' products?

1.3.4 Hypothesis

1. $H_{o:}$ The income values obtained from exploitation of the selected wetland resources (papyrus, sand, fishing, and farming) is not significant.

2. H_o: The are no possible options of resource use trade-off in the Nyando wetland

3. H_o: The conversion and degradation of Nyando wetland has no economic significance

1.4 Justification

Wetlands are vital ecosystems that provide livelihoods for the millions of people who live in and around them. The Millennium Development Goals (MDGs) called for different sectors to join forces to secure wetland environments in the context of sustainable development and improving human wellbeing. However, Nyando wetlands and more wetlands in the country are under pressure from human activities. For this reason, there is therefore need to have a balance between functions and exploitation of the wetland ecosystem.

By providing a means for measuring and comparing the various benefits of wetlands, economic valuation can be a powerful tool to aid and improve wise use and management of global wetland resources. Economic valuation is the attempt to assign quantitative values to the goods and services provided by environmental resources, whether or not market prices are available to assist us. The economic value of any good or service is generally measured in terms of what one is willing to pay for the commodity, less what it costs to supply it. Where an environmental resource simply exists and provides us with products and services at no cost, then it is our *willingness to pay* alone which describes the value of the resource in providing such commodities, whether or not we actually make any payment.

Loss of environmental resources is an economic problem because important values are lost, some perhaps irreversibly, when these resources are degraded or lost. Each choice or option for the environmental resource; to leave it in its natural state, allow it to degrade or convert it to another use; has implications in terms of values gained and lost. The decision as to what use to pursue for a given environmental resource, and ultimately whether current rates of resource loss are ‘excessive’, can only be made if

these gains and losses are properly analysed and valued. This requires that *all the values* that are gained and lost under each resource use option are carefully considered.

Valuation is used in assisting wetland management decisions and is generally used to indicate the overall *economic efficiency* of the various competing uses of wetland resources. That is, the underlying assumption is that wetland resources should be allocated to those uses that yield an overall net gain to society, as measured through valuation in terms of the economic benefits of each use less its costs.

1.5 Scope and limitations of the Study

The survey was carried out in Nyando Wetland. The area of concern is the direct use of the wetland resources. Special attention was given to selected consumptive products obtained from the wetland, namely, papyrus, fish, sand, and farming activities in valuing the importance of the wetland.

The study was limited to master of philosophy degree with the field study lasting only six (6) months. Because of the time spent in the field, it was not possible to analyse seasonal variations in the area under study. The finances available for the study only allowed partial valuation hence the selection of products from the wetland for valuation.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter looks at the literature review which is of relevance to this study- wetland resource use and wetland resource valuation.

2.1. Valuation of Wetland Resources

Economic valuation is an attempt to assign quantitative and monetary values to goods and services provided by environmental resources or systems (Lambert, 2003). Valuation is done using economic tools which might include market prices. In the absence of market prices valuation is done by the willingness to pay for the good or service. This is irrespective of whether we actually make any payment or not. Environmental resources are often considered as public/common goods and services thus are mostly not paid for. It is this situation that necessitates the use of willingness to pay in estimation of the said goods and services. The goods and services in this case include flood control services, disaster mitigation services, and erosion aversion services (Babier, 1997). Theoretically, the economic value of any good or service is measured in terms of what we are willing to pay for the commodity less what it costs to supply it.

The total economic value (TEV) of wetlands refers to the total amount of resources that individuals would be willing to put aside for every additional supply or use of wetland services (Barbier et al, 2003). The TEV can be sub-divided into various classes i.e. the use values and the non-use values (Lambert, 2003). The use values are further divided into direct use values and indirect use values. The direct use values are derived from fish, agriculture, fuel wood recreation, and transport, wildlife harvesting (hunting), vegetable oils and various forms of fruits. Direct uses of wetlands could involve both

commercial and non-commercial activities, with some of the latter activities often being important for the subsistence needs of local populations in developing countries or for sport and recreation in developed countries (MA, 2003).

Use values are grouped according to whether they are *direct* or *indirect*. Direct uses of wetlands could involve both commercial and non-commercial activities (De Groot, 2003). Commercial uses may be important for both domestic and international markets. In general, the value of marketed products (and services) of wetlands is easier to measure than the value of non-commercial and subsistence direct uses (MA, 2003). As noted above, this is one reason why policy makers often fail to consider these non-marketed subsistence and informal uses of wetlands in many development decisions (De Groot, 2003)

The Indirect Use Value (IUV) are the indirect benefits derived from the wetlands functions like nutrient retention, flood control, storm protection, groundwater recharge, external ecosystem support, micro-climatic stabilization, and shoreline stabilization (Turner et al., 2003). Individuals can also derive benefits by ensuring that the wetland resources are available for future use in a valuation referred to as option value (OV).

The Non-Use value of wetlands is the satisfaction derived with the knowledge that an environmental resource is well conserved and maintained. In such a context, the resources include cultural heritage, religious functional sites, and bequest values. This is usually the value most sought for by environmentalists who are in support of natural intrinsic value of nature (Turner et al., 2003).

The concept of *total economic value* (TEV) provides a framework with an increasing consensus that it is the most appropriate one to use in the determination of the value of environmental goods and services (De Groot, 2003).

In contrast, various *regulatory ecological functions* of wetlands may have important indirect use values. Their values derive from supporting or protecting economic activities that have directly measurable values. The indirect use value of an environmental function is related to the change in the value of production or consumption of the activity or property that it is protecting or supporting. However, as this contribution is un-marketed, it goes financially unrewarded and is only indirectly connected to economic activities (Turner et al., 2003). These indirect use values are difficult to quantify and are generally ignored in wetland management decisions (Barbier et al, 1997).

For example, the storm protection and shoreline stabilization functions of a wetland may have indirect use value through reducing property damages, yet often coastal or riverine wetland systems are drained in order to build more waterfront property (De Groot, 2006).

Mangrove systems are known to be breeding grounds and nurseries for shrimp and fish that are essential for coastal and marine fisheries, yet these important habitats are currently being converted rapidly in many regions for aquaculture, particularly shrimp ponds (Harper et al., 2008). Natural floodplains may recharge groundwater used for dry-land agriculture, grazing livestock and domestic or even industrial use, yet many of these floodplains are threatened by dams and other barrages diverting water for upstream irrigation and water supply (Wood et al., 2007).

A special category of value is *option value*, which arises because an individual may be uncertain about his or her future demand for a resource and/or its availability in the

wetland in the future (Turner et al., 2003). In most cases, the preferred approach for incorporating option values into the analysis is through determining the difference between *ex ante* and *ex post* valuation. If an individual is uncertain about the future value of a wetland, but believes it may be high or that current exploitation and conversion may be irreversible, then there may be *quasi-option value* derived from delaying the development activities (Turner et al., 2003). Quasi-option value is simply the expected value of the information derived from delaying exploitation and conversion of the wetland today. Many economists believe that quasi-option value is not a separate component of benefit but involves the analyst in properly accounting for the implications of gaining additional information (De Groot, 2003).

In contrast, however, there are individuals who do not currently make use of wetlands but nevertheless wish to see them preserved 'in their own right'. Such an 'intrinsic' value is often referred to as *existence value* (Turner et al., 2003). It is a form of non-use value that is extremely difficult to measure, as existence values involve subjective valuations by individuals unrelated to either their own or others' use, whether current or future. An important subset of non-use or preservation values is *bequest value*, which results from individuals placing a high value on the conservation of tropical wetlands for future generations to use (MA, 2003). Bequest values may be particularly high among the local populations currently using a wetland, in that they would like to see the wetland and their way of life that has evolved in conjunction with it passed on to their heirs and future generations in general. While there are few studies of non-use values associated with wetlands, campaigns by European and North American environmental groups to raise funds to support tropical wetlands conservation hint at the magnitudes involved (Turner et al., 2003).

2.2. Benefits of valuation

One of the benefits of economic valuation of environmental resources is its usefulness in resource allocation and budgeting as well as decision making to the government and the stake holders. Public finance expenditure requires public support and sanctions by the relevant authorities. (Barbier et al, 1997). Therefore, wetland valuation assists in the estimation of ecosystem benefits to people and allows financial experts to carry out a Cost-Benefit analysis of the activities which might be in favour of environmental investment. Cost-Benefit analysis compares the benefits and costs to society of policies, programmes, or actions to protect or restore an ecosystem. It is therefore an important tool for environmental managers and decision makers to justify public spending on conservation activities and wetland management (Barbier et al, 1997).

Another benefit of economic valuation is that people become aware of the values of environmental resources and ecosystems such as wetlands. Valuation therefore gives objective evidence to skeptical managers and the public of the monetary and non-monetary benefits of wetlands (Emerton, 1997). They are thus likely to support environmental conservation efforts by the environmentalists. In this way, people are aided to improve their living conditions by using and selling wetland goods and services sustainably as well as consciously since the individuals are aware of the environmental resource gains and losses (Emerton, 1997).

Other than economic valuation, there are many ways to define and measure values. Other valuation forms include religious, social, cultural, and ecological. These forms of valuation are equally useful and important even though it is only economic valuation that is most relevant to most countries when decision makers have to make difficult choices about allocation of scarce government resources (Brown and Henry, 1989).

Conflicts may arise in the process of economic valuation due to the fact that it often depends on human preferences which are usually very diverse as the people themselves. It depends on what people perceive as the gains and losses that the wetlands have on their wellbeing (Barbier et al, 1997).

2.3 Methods of Economic Valuation

If there is apparently no marketed substitute or alternative, then other methods of valuing a non-marketed wetland resource may have to be employed (Brown and Henry, 1989). One method is the *indirect opportunity cost (IOC)* approach, where the time spent collecting or harvesting is valued in terms of foregone rural wages – the opportunity cost of labour based on other employment (Brown and Henry, 1989).

Another method is the *indirect substitute (IS)* approach, where the opportunity cost of using a substitute for the wetland resource is employed as its value measure (Barbier et al, 1997). For example, the opportunity cost of using dung that is normally applied as fertiliser or as a substitute for fuel wood could be used to value the fuel wood, or the costs of obtaining water from outside the wetlands could be costed as a substitute for using the wetland as a source. The actual expenditures on directly-used wetland services (e.g., recreation/tourism, water transport) may not reflect individuals' willingness to pay for them since they may be non-marketed and therefore un-priced inputs (Brown and Henry, 1989). If this is the case, alternative methods of valuation may be required. For water transport, the value can be expressed in terms of the *cost of alternative/substitute means* of transport. For recreation/tourism, the *travel cost method (TCM)* may be applied, where the value of visiting wetland areas is derived from the cost of travel, including recognition of the opportunity costs of travel time.

More often, the *contingent valuation method (CVM)* has been used to value recreation involving temperate wetlands. Contingent valuation is a survey technique using direct questioning of individuals while they are on-site or by mail to generate estimates of individuals' willingness to pay for something they value – in this case it would be improved recreation opportunities or simply maintaining existing recreation opportunities (Brown and Henry, 1989). Alternatively, individuals might be asked how much compensation they would require if they no longer had access to the wetland for recreation (Brown and Henry, 1989).

The values of wetland environmental functions arise indirectly through their support or protection of economic activity and property. Where economic production is being supported, the value of these functions can be measured in terms of the *value of changes in productivity* attributed to these functions operating normally (Emerton, 1997). Where economic activity or property is being protected, the values can be expressed in terms of *preventive expenditures* that would be required if the functions were degraded or irrevocably disrupted, the *damage costs avoided* where these functions continue to function normally, the *costs of alternatives/substitutes* to replace these functions, or the relocation costs required if these functions were lost.

2.4 Trade-offs across Space, Time, and Ecosystem Services

Ecosystem service (ES) trade-offs arise from management choices made by humans, which can change the type, magnitude, and relative mix of services provided by ecosystems. Trade-offs occurs when the provision of one ES is reduced as a consequence of increased use of another ES. In some cases, a trade-off may be an explicit choice; but in others, trade-offs arise without premeditation or even awareness that they are taking place. Trade-offs in ES can be classified along three axes: spatial scale, temporal scale, and reversibility. Spatial scale refers to whether the effects of the

trade-off are felt locally or at a distant location. Temporal scale refers to whether the effects take place relatively rapidly or slowly. Reversibility expresses the likelihood that the perturbed ES may return to its original state if the perturbation ceases (Rodriguez et al, 2006).

2.4.1. ES Trade-offs in Space

Environmental economists use "externality" to refer to the effects of an ES management decision that are borne by others than those benefiting from the targeted ES (Tietenberg 1996). For example, the diversion of water from a river to provide drinking water for a town, or irrigation water to an agricultural area, will leave people downstream without water to meet their own needs. The use of water upstream imposes an externality on those living lower down the watershed.

Spatial trade- off are among those most commonly observed in human societies (Rodríguez et al. 2005). They are frequently linked to the use of a provisioning service, which is traded-off against another ES, e.g., when decisions about increasing agricultural production by increasing fertilizer use have broad-scale effects on water quality.

2.4.2. ES Trade-offs in Time

Management decisions often focus on the immediate provision of an ES, at the expense of this same ES or other services in the future. Such decisions are prevalent in democratic societies, where the term of elected officials is short enough that the ecological impacts of their decisions will probably be confronted by others than themselves (i.e., the consequences of poor decisions become externalities that are borne by future politicians) (Anderies et al. 2001, Greiner and Cacho 2001, Briggs and Taws 2003).

Temporal externalities are not just a political problem, however; many natural processes, such as those that create soil or alter soil fertility and groundwater levels, occur at such slow rates that several generations may pass before significant effects are perceived by humans. In each case, the principal characteristic of an ES trade-off in time is that the short-term needs of society drive decisions about ES management, purposely or inadvertently ignoring the future consequences of these actions (Anderies et al. 2001, Greiner and Cacho 2001, Briggs and Taws 2003).

2.4.3. Trade-offs across ES

Trade-offs does not only occur across space and time, and have different degrees of reversibility, but usually result in more than one ES traded-off for the ES being enhanced. For example, the management of a forest for tree production (a provisioning service) may also affect water quality downstream (a regulating service) or decrease the value of the land for recreation (a cultural service) (e.g., Rose and Chapman 2003, Maass et al. 2005, van Jaarsveld et al. 2005).

Across all four Millennium Ecosystem Assessment scenarios and selected case study examples, trade-off decisions show a preference for provisioning, regulating, or cultural services (Foley et al. 2005, Pereira et al. 2005, Rodríguez et al. 2005, van Jaarsveld et al. 2005). Supporting services are more likely to be "taken for granted." Cultural ES are almost entirely un-quantified in scenario modeling; therefore, the calculated model results do not fully capture losses of these services that occur in the scenarios. The quantitative scenario models primarily capture the services that are perceived by society as more important—provisioning and regulating ecosystem services—and thus do not fully capture tradeoffs of cultural and supporting services.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.0 Overview

This chapter looks at the study area, research design, population and sample size, sampling technique, and data collection instruments and data analysis.

3.1 The Nyando river Basin

3.1.1 Location

The Nyando River runs a total length of 170 km and drains a total catchment area of 3618 Km^2 (Swallow, et al, 2005). River Nyando drains into the Winam gulf of Lake Victoria and contributes a lot of sediment, nitrogen and phosphorus to the lake (Walsh, et al, 2004). The Nyando river watershed is characterized by a physically heterogeneous environment; whereby the altitude within the watershed ranges from 1,300 meters to nearly 3,000 meters above sea level, and the annual precipitation ranges from 1,100mm to nearly 1,800mm (Swallow, et al, 2005). The flood zone lies in the lowlands of the Lake Victoria drainage basin, and forms part of the lake shore lowlands and lies within the Nyanza rift valley in what is known as the Kano Plains. Most of these flood plains lie between 1120 m and 1150 m.

3.1.2 Climatic Conditions

Climatically, the Nyando catchment can be divided into two major regions by temperature and rainfall characteristics. There are two rainy seasons in the area of study. The first rainy season is the most pronounced and is experienced throughout the watershed from March to May. The second rainy season differs slightly depending on the location in the study area. The highland source region receives an annual average of about 1835 mm; the mean annual maximum temperature is 27°C, the mean annual minimum temperature about 9°C. The lowland region forming the flood plain receives a

mean annual rainfall of about 1000 mm with great variability, the mean annual maximum temperature being about 30 °C and a mean annual minimum of about18°C (District Survey Data, 2005).

The differences in climatic conditions between the lowland surrounding Lake Victoria and highlands beyond are mainly a consequence of the topographic differences. The lowlands lie in the rain shadow of the highlands on the eastern shoulder of the rift valley. By the time the winds descend the rift valley scarp they are relatively dry. Most of the flood waters of the Nyando River originate in the highlands.

3.1.3. Geology and Soils

The soils are generally medium to heavy clays which have a low infiltration capacity. The general drainage pattern of this area is controlled by the level of Lake Victoria in the west, which stands at approximately 1,138 meters above sea level, and the peak of the Tinderet Volcano at 2,930 m above sea level in the north-eastern portion of the basin (District Survey report, 2005). The Nandi and Mau escarpments are separated by a range of averagely 1,300m high. Numerous streams cut deeply through poorly sorted beds of coarse gravel, sands and sandy clays at the base of the scarps into the Kano plain. Steep hydrological gradients occur in this area with long slopes in excess of 20 degree inclination (Denga, 1990). Soils in the Kano plain are primarily derived from Holocene sedimentary deposits. Luvisol, Vertisol, Planosol, Cambisol and Solonetz types are common, often in saline or sodic phases (District report, 2005). Upland soils are derived from a wide variety of parent materials including phonolites, quartzites, nephelinites, granitoid gneisses and intrusives such as dolorites, monzonites and granidiorites which are representative of a large part of the Kenyan portion of the Victoria Lake Basin. Predominant soil types include Ferrasols, Nitisols, Cambisols and

Acricsols. The main activity here is arable agriculture with irrigation schemes for rice. Maize, and sorghum also make up the area's main crops (CBS, 2003)

3.1.4 Economic Activities and Land Use

The land tenure system in the Nyando basin is quite complex and this therefore creates many problems for watershed management. There is heavy overuse of private land leading to high rates of erosion in the lower part of the basin while on the upper part of the basin high erosion is linked 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 used commonly, but are located on private land (Beigut, 2004). The Luo flood-prone lakeshore area is used mainly for subsistence production of maize, beans and sorghum, combined with commercial production of sugar cane and irrigated rice. Land use between long-settled areas and resettlement areas are clearly different. Smallholder farmers and the National Irrigation Board own the downstream irrigated areas (Swallow et al, 2005). This eventually affects the income generated by the community members from farming in the wetland.

Deforestation and cultivation of riparian areas are associated with the privatization of riverine areas, together with ineffective enforcement of rules on the use of these 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 (Swallow et al, 2005). The Kalenjin upper part of the basin is comprised of gazetted forests, commercial tea plantations and small-scale agriculture plots on steep hillsides that were degazetted as forests over the last 40 years (Beigut, 2004). Mid-altitude areas are a mixture of smallholder farms (with maize, beans and some coffee, bananas, sweet potatoes and dairy) and large-scale commercial farms (mostly sugar cane).

The incidence of consumption poverty is high, ranging from an average of 58 percent in Kericho District, to 63 percent in Nandi District and 66 percent in Nyando District (Central Bureau of Statistics, 2003). At the administrative location level, the locations of Nyando District include both those with the lowest poverty rate in the sugar belt of Muhoroni Division (36 percent) and those with the highest poverty rate in Upper Nyakach Division (80 percent) for the entire basin (Central Bureau of Statistics, 2003).

A wide range of statutory property rights are applied in Nyando to control the land and water. Land-use and property rights vary across the basin according to both customary law and statutory entitlements. The land tenure systems evident include the private tenure that is applicable on the former crown land namely large agricultural leaseholds (former white-owned farms), subdivided agricultural leaseholds, and non-agricultural leaseholds. The other form of private tenure on trust land refers to freehold land in adjudication areas, freehold land in settlement schemes, non-agricultural leaseholds, and group ranches (Swallow et al, 2005).

There are other five types of public land in the Nyando basin. In both government land and trust land areas, some land is not alienated to any specific user. This type of public land is very vulnerable and subject to abuse because it is often an open access land. In addition, many very important areas for catchment management have been formally designated as private property. These areas include spring heads and the catchment areas immediately around them, riparian areas, some wetlands, and water harvesting structures (Swallow et al, 2005).

3.1.5. Socio-Economic importance

Agriculture is the key livelihood activity, employing 60% of the total population and supplying over 52% of household earnings (District Survey Report, 2005). Cropping

patterns are dominated by production of subsistence crops such as maize, cassava, sorghum and sweet potatoes whereas major cash crops are rice, sugarcane, cotton and coffee. Sugarcane ranks as the most important cash crop. Nevertheless, the output from the sector has been low due to poor use of modern agricultural technology, lack of proper storage, erratic and unreliable rainfall, lack of credit facilities, high costs of seed and other inputs, and poor road network.

Livestock production is practiced in the district, with Zebu Cattle being the main breed reared in the district. Small stock such as goats, sheep and poultry are also kept. The total stock of cattle, sheep and goats in the district was estimated at 388,000 animals in 2005. Some members of the Luo community practice fishing along river Nyando, Sondu and in Lake Victoria. Poor breeds, low productivity and inadequate control of livestock diseases, as well as lack of water for animal use and poor fishing methods are the most important constraints experienced in the sector.

The overall poverty incidence in the district is approximately 61% (CBS, 2003). Poverty is less prevalent in the rural areas at 61% as compared to urban areas where it stands at 72%. Nyando, Upper Nyakach and Miwani divisions have the highest counts of poor people. Poor agricultural technology, lack of proper storage, poor and inaccessible roads, frequent floods that disrupt economic activities, problems with the sugar, rice, cotton and fish industries, lack of title deeds, poor water and sanitation systems, the impact of HIV/AIDS (with 29.4% infection rate), low accessibility to health services, and gender disparity are some of the main factors perpetuating poverty in the district. Lack of alternative income generating opportunities has also culminated in high rates of unemployment (11%) (CBS, 2003).

The Nyando basin supports an estimated population of 750, 000 people who mainly belong to two major language groups: the Luo, who settled in the lower and middle watershed, and the Kalenjin, who live in upstream areas (KNBS, 2009). These areas are administratively divided and governed as Nyando District in Nyanza Province and Nandi and Kericho districts in Rift Valley Province respectively. Resettlement of the large farms in the "white highlands" has led to the coexistence of distinct clusters of Kalenjin and people from other ethnic groups (Swallow et al, 2005).

According to Kenya government statistics, over 70% of the population living around the Nyando River wetlands live below poverty level (<US$ 1.00), making them to over-exploit and degrade this fragile ecosystem. Further, the divergent communities, local institutions and stakeholders (governmental or otherwise) that surround the Nyando River Basin have varied perceptions on the symbiotic relationships between wetlands ecosystems and their daily activities.

The population of the River Nyando Wetlands is 166, 359 (2009 census). This is a significant rise from 139,185 people in the 1999 census. The labour force comprises nearly 50% of the population while the ratio of males to females is 100:104 (G.o.K Census 2009). The youth compose 21% of the population.

The settlement patterns in the wetland and the surrounding areas are mainly determined by the potential of the areas; Upper Nyakach division has the highest population density with nearly 368 persons per km^2, while Muhoroni is the least populous is with about 190 individuals per km^2. Muhoroni division is a high potential sugar-belt region, and is also the largest division in the district, covering an area of 334.8 km^2. The average density of the district is 284.6 people per km^2 with an annual growth rate of 3.4% (G.o.K, 2002).

3.2 Conceptual Framework

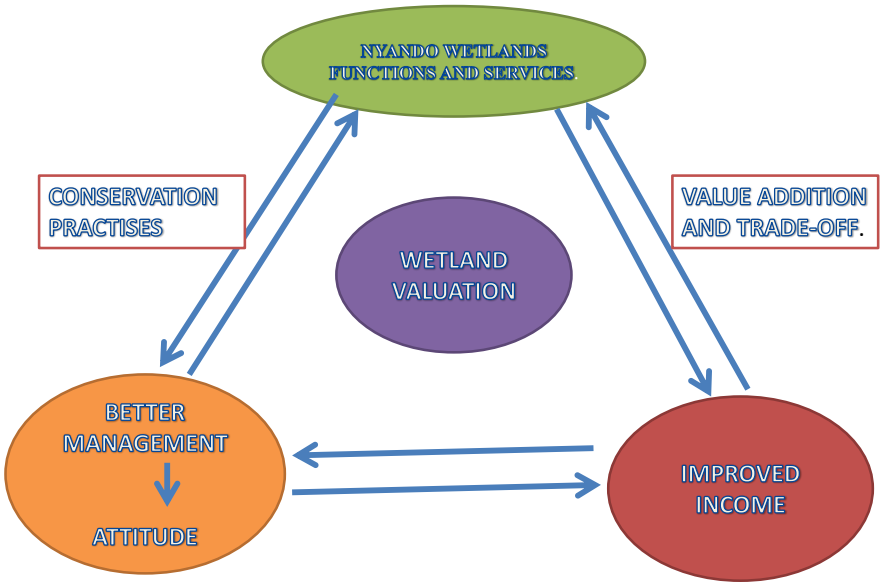


Figure 1: Conceptual Frame-work

(Source; Author, 2014)

Economic valuation is central to the determination of the worthiness of any natural resource. In this conceptual framework, wetland valuation is central to the determination of the worth of Nyando wetland. Valuation of the Nyando wetland would enable community members know how much they actually currently obtain from the wetland. A detailed valuation would give all the possible values that can be obtained from the wetland if well utilized. Therefore, the provision for resource use trade-off becomes key in the sustainable use of the Nyando wetland.

To continue having the income from the wetland, the resource users would have no choice but to embrace better management practices, positive attitude towards the wetland and the directed conservation efforts. Ramsar's *Principles and guidelines for wetland restoration* (Resolution VIII.16) recognize that the costs of restoring wetlands and their ecosystem services are often far higher than the costs of maintaining the eco-logical character of the intact wetland. The frame-work therefore provides that it is

possible to continue having the wetland functions and services intact without destroying the wetland only to reverse the damage later but having valuation done comprehensively as early as now.

3.3 Data collection sources and methods

The data used in this research was obtained from various sources namely primary and secondary data sources.

Primary data was collected through participatory approaches such as direct observations, interviewing people, conducting focus group discussions, Key informant interviews and filling in questionnaires. It is data collected for the first time (Kothari, 2004).

In the collection of secondary data, resource materials and books containing information related to the area of study were read and relevant information adopted to suit the research report. Such materials included books, journals, magazines and newspapers. Such data have already passed through various statistical processes and analysis.

3.4 Techniques of data collection

3.4.1 Observation

In this method of data collection, information was sought by way of the researcher's own direct view or sight without asking a response from the respondent. This method was used owing to the need to identify the resources obtained from the wetland and the methods employed in harvesting them. This involved the use of observation guide, recording sheets and field notes.

3.4.2 Questionnaires

A questionnaire is a set of written questions printed in a definite order on a form or set of forms (Kothari, 2004). Structured questionnaires were used in this study. This was useful in collecting the participants' views and information about the wetland. Questions on the willingness to pay for the goods and services in the wetland formed part of the questionnaire. The questionnaires were developed to translate the research objectives into a set of questions which helped in filling information gaps identified during the study.

3.4.3 Key Informant Interviews

An interview is a conversation between two people (the interviewer and the interviewee) where questions are asked by the interviewer to obtain information from the interviewee. This helped the researcher confirm some of the observed features and characteristics in the field of study. The participants were encouraged to relate their experiences, to describe whatever events seem significant to them, to provide their own definitions and attitudes as they see it with little direction from the researcher (Chava, 2005).

3.4.4 Focus group discussions

A focus group is a form of qualitative research in which a group of people are asked about their perceptions, opinions, beliefs and attitudes towards a given area or point of concern. Questions were asked in an interactive group setting where participants were free to talk with other group members hence the name discussion.

This method was cost effective for eliciting views and opinions of prospective clients, customers and end-users. In agriculture, focus groups have been used to obtain insights into target audience perceptions, needs, problems, beliefs, and reasons for certain practices.

3.4.5 Photography

A photograph (often shortened to photo) is an image created by light falling on a light-sensitive surface, usually photographic film. Most photographs are created using a camera, which uses a lens to focus the scene's visible wavelengths of light into a reproduction of what the human eye would see.

This method of data recording and collection was of great importance in keeping records and evidence of observed activities within and around the wetland.

3.5. Economic Valuation Method

3.5.1. Contingent Valuation

This method of economic valuation is commonly used where no market prices or no close replacements or substitutes are available. The method infers the value that people place on wetland goods and services by asking them their willingness to pay for them under the hypothetical scenario that they would be available for purchase. Alternatively, the individuals would be asked to give the values they would accept for compensation in case of the loss of the wetland (Brown and Henry 1989).

In this research, questions used during the oral interviews included;

i. How much would it cost you to feed your family if not producing any crops from the wetland farms?
ii. How much would you be willing to pay to continue using the wetland as a grazing point for your livestock?

This method was suitable for this research as it provided the best alternative to obtaining the values of direct use of the wetland resource uses.

3.6 Population & sampling technique

3.6.1. Target, accessible and sample population

Population is the entire set of relevant units of analysis, (Nachmias, 2005). A population is the aggregate of all cases that conform to some designated set of specification. Population refers to the total items about which information is derived. Thus in this study the population comprised the residents of Nyando wetland and users of Nyando wetland products. In addition, there were inclusion of stakeholders and government officers associated to Nyando wetland.

A sample is any subset of units from a population, that is, a combination of units that have been selected to represent the whole (population) (Nachmias, 2005). This is due to the fact that not all the individuals in the target population are likely to be present during the data collection period. This may make scheduling meetings time much more difficult.

The study site was purposefully selected since it was part of an on-going project. The sites were selected as a result of existing influence from river and lake. The influence of river and lake is crucial since a wetland cannot exist without the presence of water. Jimo-middle and Kakola Ombaka are all under the influence of river Nyando while Ogenya and West Kabodho are under the influence of Lake Victoria.

3.6.2. Sampling techniques

In this study the researcher made use of probability sampling technique, that is, stratified sampling method, simple random sampling and purposive sampling. A pilot study was conducted to aid in determining a more appropriate and efficient stratification plan. This was carried by taking small samples of equal size from each of the proposed sub-location and then examining the variances within and among the possible

stratifications. Under stratified sampling the population was divided into four sub-locations herein referred to as transects within the study area namely; Jimo-middle, Kakola Ombaka, Ogenya, and West-Kabodho. Then participants were selected from each sub-location to constitute a sample. Since each stratum was more homogeneous than the total population, the study was able to get more precise estimates for each stratum and by estimating more accurately each of the component parts, a better estimate of the whole was achieved. Thus stratified sampling was used as it was more reliable.

The sample size was derived from the ratio of house-hold to the entire population from the area. This calculation was done for each transect and then the entire area under study. The sum in each case gave an equal figure for the total sample size for the entire area under study. Taking a sample size to be n households, Z as the specified level of confidence (at 95% confidence, Z= 1.96) and Standard deviation assumed as 6 then the sample size was obtained using the formula;

$$n = \frac{Z\,\mathbf{s}}{Nm - Sm}$$

Where n - Sample size

Z – Level of significance

S – Standard deviation

N m – Population mean

S m – Sample Mean

n = (1.96 *6) / 14.965

= 176

The use of probability sampling in this study helped in generalization of this study's findings as the data collected was free from subjective bias. However this method of sampling technique may not have been 100% accurate as it may have led to the exclusion of some significant participants who may be willing to give the right information needed while picking on those who may not be ready to give the accurate information. In order to eliminate such errors or omissions of important participants, a pilot study of the participants was carried out in order to give an understanding of the participants before administering interviews, questionnaire or even carrying out the actual observation.

3.7 Data Analysis

Data analysis is a process of inspecting, cleaning, transforming, and modeling data with the goal of highlighting useful information, suggesting conclusions, and supporting decision making. The data collected in this study was grouped, tabulated, sorted out and classified.

Secondly, the data was presented using frequency distribution tables, charts, and graphs. This was after a careful scrutiny of the data in the filled-in questionnaires, observation guides and interview schedules. The data was then coded by assigning numerical values to answers so that responses could be put into a limited number of categories. Through coding, several responses were reduced to a small number of classes which contain the critical information required for analysis.

Using SPSS, the mean incomes were obtained and tested using t-test analysis. The calculated t-value was then compared to the tabulated t-value. In this way, it was possible to determine whether to reject or accept the null hypothesis (Kothari, 2004). If

the calculated value of t is greater than the tabulated value, it is concluded that the difference in sample means is significant (Kothari, 2004)

The t-test value was calculated based on the formula;

$$t = \frac{\bar{X}_1 - \bar{X}_2}{s_{X_1X_2} \cdot \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

Where;

$$s_{X_1X_2} = \sqrt{\frac{(n_1 - 1)s_{X_1}^2 + (n_2 - 1)s_{X_2}^2}{n_1 + n_2 - 2}}.$$

$s_{X_1X_2}$ is an estimator of the common standard deviation of the two samples:

n = number of participants; 1 = group one; 2 = group two;

$n - 1$ is the number of degrees of freedom for either group;

$n_1 + n_2 - 2$ is the total number of degrees of freedom, which is used in significance testing (Kothari, 2004).

The various mean incomes were further compared by an analysis of their variances (ANOVA). The calculated F value was compared to the tabulated F- value to determine whether to reject or accept the null hypothesis.

Table 3.1: ANOVA test analysis table

Source of variance	**Sum of squares (SS)**	**Degrees of freedom (d. f)**	**Mean Square (MS)**	**Variance Ratio of F**
Between Samples	SSC	V1= c-1	MSC = SSC/ (c-1)	MSC/MSE
Within Samples	SSE	V2= n-c	MSE = SSE/ (n-c)	
Total	SST	n-1		

(Source; Gupta 2003)

Where; SST= Total Sum of Squares of Variations

SSC= Sum of Squares between samples (Columns)

SSE= Sum of Squares within samples (Rows)

MSC= Mean Sum of Squares between samples

MSE= Mean Sum of Squares within samples.

If the calculated value of F is greater than the table value, it is concluded that the difference in sample means is significant (Gupta, 2003)

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION, INTERPRETATION AND DISCUSSIONS

4.0. Overview

This chapter presents the findings of the study. The results of the study are presented on the basis of the research objectives.

4.1. House-Hold Characteristics

The total number of households sampled was 176. Out of these, 43% were male while 57% were female. 49% were aged 40years and below while 51% ages of the respondents were over 40years old. The analysis of past information compared to present occurrences was to ensure comparison analysis of wetland changes in resources and productivity over a given period of time. The average house-hold size was 6 members. Table 4.1 shows details of the house-hold characteristics of the Nyando wetland respondents during the field study.

Table 4.1: House-Hold Characteristics of Respondents in Nyando Wetlands, Kenya (values in %)

		Transect 1 (Ogenya)	Transect 2 (Kakola Ombaka)	Transect 3 (Jimo Middle)	Transect 4 (West Kabotho)	Total %
Gender	Male	44	44	43	41	43
	Female	56	56	57	59	57
	Total	100	100	100	100	100
Age	<20 yrs	0	2	0	2	1
	21-30 yrs	24	21	16	25	22
	31-40 yrs	21	16	31	36	26
	41-50 yrs	22	14	14	7	14
	51-60 yrs	12	26	14	16	17
	> 60 yrs	21	21	25	14	20
	Total	100	100	100	100	100
House-Hold size	1 to 3	11	5	14	9	10
	4 to 6	42	37	43	43	41
	7 to 9	34	37	25	32	32
	10 to 12	11	19	16	16	15
	13 to 14	2	2	2	0	2
	Total	100	100	100	100	100

(Source: Survey Data, 2012)

4.2 Education

Education is very important in shaping and influencing community production and conservation strategies (Beigut, 2004). Education influences the economic activity carried out by an individual since highly educated individuals are likely to make more informed choices and be conscious of their use of the available resources (Swallow, 2005). Educated individuals are also more likely to accept and adopt changes towards improving production, value addition and income as well as conserving the environment. In addition, educated individuals are more likely to seek alternative sources of income and livelihood thus reducing pressure on the wetland resources. Out of the sampled individuals, 84% had undertaken up to up to upper primary education while the remaining 16% have attained secondary education and beyond. Only 1% of the respondents have university education and an equal percentage have post-secondary education training. Another 1% has middle level college training. From the foregoing

facts, it is evident that the education levels are low and this is largely due to the fact that the net income from the economic activities is not sufficient to support further education after primary education. That is why only 13% of the respondents have attained secondary education and the figure drops further as the scales in education rise.

Gender wise, more female, 50% than male 27% of the respondents have more of the primary education. On the contrary, more male than female are able to proceed to secondary education and beyond, 12 against 6%. This is attributed to the fact that under little resources, most of the house-holds have to make a choice between furthering the education of the boy-child or the girl child. In this context, cultural beliefs dictate that the boy child is educated as the girl is married off. Tables 4.2 and 4.3 illustrate the statistical figures. With over 80% of the population having secondary education and below, the reliance on wetland cannot be over-emphasized. The continued use and reliance on the wetland, however, needs to be sustainable (MA, 2003). This clearly calls for the need to value the resources utilized and the income generated by these households from the wetland. The income generated is majorly dependent on the wetland and therefore likely to lead to wetland degradation if not controlled for sustainability. However, these conservation efforts face a major challenge as the resource users have little or no alternative sources of income.

Table 4.2: An analysis of Education levels of the respondents against ages in percentages

Age in Years.	Education Levels							
	None	Lower Primary (1-3)	Upper Primary (4-8)	Secondary (Forms 1-4)	Post-Secondary Training	Middle Level Colleges	University	Total %
<20 yrs.	0	0	1	1	0	0	0	**2**
21-30 yrs.	0	1	16	3	0	1	1	**22**
31-40 yrs.	1	1	21	3	1	0	0	**27**
41-50 yrs.	1	2	9	2	0	0	0	**14**
51-60 yrs.	2	4	7	3	0	0	0	**16**
> 60 yrs.	3	6	9	1	0	0	0	**19**
Total %	**7**	**14**	**63**	**13**	**1**	**1**	**1**	**100**

(Source: Survey Data, 2012)

With few of the female going beyond secondary education, the girls are involved in household chores or assists in the family income generation through wetland resource use. Most of the girls are later married off and become house wives reinforcing their reliance on wetland for their house-hold income generation. This explains the higher number of females involved in wetland related activities compared to their male counterparts- 55% female compared to 45% male. The consequence of such low levels of education is that the residents keep relying on the wetland resources as a major source of livelihood and income to sustain their families. Table 4.13 gives the breakdown on education levels based on gender differences.

Tables 4.3: An analysis of Education levels of the respondents against gender in percentages

Gender	Education levels							
	None	**Lower Primary (1-3)**	**Upper Primary (4-8)**	**Secondary (Forms 1-4)**	**Post-Secondary Training**	**Middle-Level Colleges**	**University**	**Total**
Male	1	5	27	9	1	1	1	45
Female	5	8	36	6	0	0	0	55
Total	6	13	63	15	**1**	1	1	100.00

(Source: Survey Data, 2012)

At 95% confidence, education is positively related to the occupation of the residents of Nyando wetland. This means that the higher the education level, the more the chances of one securing a better job. In the context of resource use, the better the level of education, the higher the chances that the individual will reside away from the wetland or will be more conversant with the need to conserve the wetland and so will implement relevant practices that would ensure the wetland is conserved. This is illustrated by a t-test of the means in the number of individuals taking part in the wetland resource use form the four transects. The test gives a positive t-value of 10.078 which means that the two variables have a causal- effect i.e. an improvement in the education levels is likely to create a better occupation and not entirely dependent on the wetland. There is equally a close relationship between gender and occupation. From the fore stated facts that males are more highly educated than females, the t-test thus gives a negative t-value (-1.344) in the test of gender verses occupation. This confirms the relationship as causal but inverse. This value is confirmed by the negative mean score in the paired test of gender and occupation. The Nyando wetland resources are greatly exploited by the female who are also less educated compared to their male counter parts. (Swallow et al,. 2005). The males being slightly better educated have less of their occupations based in the wetland resources (District Survey Data, 2005). Table 4.4 gives this illustration of the t-test analysis.

Table 4.4: Paired t-test showing relationship between Gender, Education and Occupation 95% Confidence Interval of the Difference

Resources	**Mean**	**T**	**d. f**	**Sig. (2-tailed)**
Education& Occupation	1.223	10.078	174	0.000
Gender & Occupation	-0.149	-1.344	174	0.181

(Source; survey data, 2012)

In the Nyando wetland, the study revealed that farming was the most preferred economic activity and is carried out by 73% of the respondets despite differences in education levels. This is explained by the fact that frequent floods in the area lead to spillage of fertile alluvial soils by the river waters (District Survey Data, 2005). The alluvial soils brought by the flooding waters ensures that farming (crop production) in the area is easily carried out without much expenditure on inputs such as fertilizers and water for irrigation. It is in this line of reason that the area has attracted so many immigrants. Wetland had an immigration level at 18% of the respondents (Researchers' survey, 2012). Farming activities form a major attraction into the wetland (Swallow, et al, 2015). Having been married by residents of the wetland, 17.0% of the respondents moved into the wetland to settle with their spouses. Table 4.5 gives an insight in to the economic activities in the wetland in relation to the education levels of the respondents.

Table 4.5: Education Levels and Occupation in Nyando Wetlands, Nyanza Province, Kenya (Values in % of The Total Respondents)

Household main economic activity	None	Lower Primary (Class 1-3)	Upper Primary (Class 4-8)	Secondary	Post-Secondary Training	Middle-Level Colleges	University	Total
Farming	5	10	48	8	0	1	1	73
Fishing	0	1	2	2	0	0	0	5
Business	1	2	8	2	0	0	0	13
Salaried Employment	0	0	0	1	0	0	0	1
House-Wife	0	0	2	0	0	0	0	2
Casual Employment	0	0	1	0	1	0	0	2
None-Response	1	0	2	1	0	0	0	4
Total	7	13	63	14	1	1	1	100

(Source: Survey Data, 2012)

To supplement income from farming, most of the respondents are also engaged in other economic activities such as fishing, sand harvesting, papyrus harvesting and weaving, small scale business, and casual labor. In fact, wetland resource users were by default multiple resource users (Researcher's Survey, 2012) since they were involved in at least two economic activities within the wetland. These secondary income sources were important to the farmers' households since they acted as farmers' safety nets incase of crop failure; they also helped in the reduction of over dependence and over exploitation of the wetland resources leading to some level of conservation of the resources. In this

way, the resource users are able to meet their personal demand for the resources hence reduction in the demand for same from other exploiters. A reduced demand for a commodity forces the suppliers to equaly reduce the prices or supply of the item in mention. Eventually, the supply and exploitation of the resources from the wetland gets controlled.

It is also true that the activities carried out in the wetlands are done in accordance with the prevailing seasons i.e. during floods; farmers have their produce destroyed and thus reduction in source of food and income. It is also during the flooding period that access to papyrus is hindered hence the resource users heavily depend on lake fishing as well as fish brought close by the flooding water (District Survey, 2005). When the flooding waters reduce, the farm lands are left fertile with alluvial soils making crop farming very lucrative (District Survey Data, 2005). In addition, the papyrus harvesting areas are left open thus increasing their access, harvest and supply. Moreover, soon after floods, wetland fishing becomes very common as mud-fish and related species become highly available. During the dry season and low rain season, the residents are mostly attracted to sand harvesting. The sand is deposited during the heavy rains more-so in the upstream and easily accessed when the water levels go down within the wetland. The sand, though harvested in the wetland, is not a direct product of the wetland but from the upstream (District Survey Data, 2005).

4.3 Economic values of selected services in the Wetland.

4.3.1 Farming

Practised by 70% of the respondents, farming is carried out both as a source of income and also for subsistence purposes. Farming is done during the dry seasons i.e. after the flood waters have gone down (Distric Survey, 2005). This is supplemented by the rainy seasons during the short and long rainy season of March to May and September to

November respectively (District Survey, 2005). The flood waters leave the area wet and fertile after deposition of the alluvial soils from the up-stream and this makes farming very lucrative to the residents. There is a wide variety of crops grown in the wetland due to the fertile and moist soils found in the area. The most commonly cultivated crops in the area are beans, cowpeas, kales, maize, rice, sugarcane, tomatoes.

Crop production is usually done twice a year i.e. the rainy seasons based on the existing two rainy seasons in the area. However, being close to the lake, the region receives heavy convectional rainfall especially in the long rain season and this has led to the occurrence of floods in many years. The occurrence of floods is a big challenge to the success of crop cultivation since the farms get covered with water and crops destroyed. In addition, the flood water and river load deposited in the areas covered by the flood water leads to displacement of residents hence loss of properties and in some cases lives. During the dry seasons, water shortages also affect the successful practise of crop cultivation.

Crops such as rice heavily depend on flooded field and these are successfully cultivated close to the lake by use of irrigation (Swallow, 2005). However, the occurrence of floods still causes damage even to the rice fields.

Other than domestic uses, most of the products are sold in markets outside the wetland area. Therefore, the wetland acts as a granary to the majority of the neighbouring areas (District Survey, 2005). In fact this has been a major contributing factor to the number of people moving into the wetland and eventually settling there. This has created alot of pressure on the existing land and resources.

The value of the wetland to the farmer is relative to the crops being produced by the farmer. It is important to note that the research revealed that most of the farmers are

taking part in the production of more than one crop and therefore the value to the farmer would be a combination of income generated from each of the crops produced in the season. The market prices/values of the products also change with seasons. Majority of the farmers in the study area practice both subsistence and commercial farming. The major economic crops bringing high returns included sugarcane, rice, and maize. Majority of the farmers practice mixed cropping in which different crops were usually intercropped. For instance maize and beans were typically inter-cropped. Mixed cropping is believed to be important for soil erosion control especially when ground cover crops are included in the intercropping system. The major combination of crops reported by the respondents' were kales and tomatoes, maize and beans. The former combination is relatively common since such fields are easy to irrigate and manage during chemical application to do away with the pests. On the other hand, the maize beans combination is common since the two crops benefit from each other symbiotically. Beans have rhizobium bacteria which is useful in nitrogen fixation. The fixed nitrogen is used up by the maize during growth. Maize grows up to shelter the beans from intense heating hence reduced evapo-transpiration thus reduced wilting (Swallow, 2005). Resultantly, the two crops help each other towards productivity. The soil is improved in the process of the growth and development of the two plants thereby enabling a better yield. In-terms of income obtained a mix of tomatoes and kales would yield Kshs. 31,100.85 per acre per farmer per season. Assuming two harvests per year this would yield Kshs. 62,201.70 per year for every farmer. The table 4.6 shows some of crops most commonly grown, the area under production for each crop and the mean incomes in a season of production per farmer per crop.

Table 4.6: Crop valuation in mean income for every farmer in a season

Crop produced.	Average Area Under Production (Ha).	Average Income per season (Ksh.) per Acre.
Tomatoes	2.0	13,417.24
Maize	4.0	16,574.39
Kales	2.5	17,683.61
Rice	4.0	20,000.00
Cowpeas and Beans	2.5	18,000.00

(Source: Survey Data, 2012)

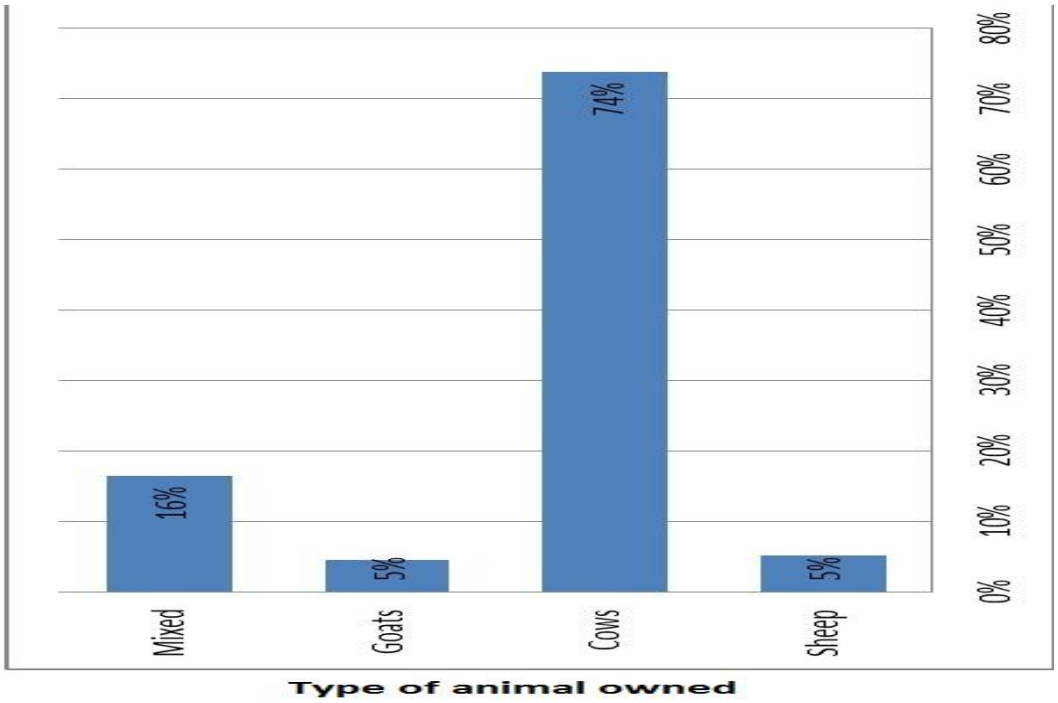
The relevance of farming and other activities to the livelihoods of the Nyando Wetland resource users is that even if the output from the farms are not sold and thus money earned, the produce will be consumed and therefore an expenditure averted. Consequently, in evaluating the value of income generated from these products, the price/value is two-fold i.e. earnings or savings to the family.

4.3.2 Grazing

The other form of farming in the wetland is the use of the wetland to graze and provide pasture for the domesticated animals/livestock. Of the total number of respondents, all acknowledged using the wetland to graze their livestock at one time or another.

The type of livestock grazed in the wetlands differs with the season and type of animal. The small stocks of animals such as sheep and goats are mostly grazed during the dry season especially when the flood waters have receded. The sheep do not go deep into the wet sections of the wetlands for fear of water and mud. In addition, sheep as opposed to goats are browsers (Swallow, 2005). This leaves the goat going into waters for the growing macro-phytes as a major food to the animal. On the other hand, the

large stocks are fed into the wetland as long as the water levels can allow them to graze i.e. they can sustain wet conditions but not flooded conditions for grazing. This makes the wetland a major source of fodder for the sustenance of the livestock. The chart below, graph 4.1 shows the percentage of farmers keeping animals within the area of study and the animal type under domestication.



Graph 4.1: Percentage residents and animal type owned in the wetland

(Source: Survey Data, 2012)

To estimate the value of the wetland to these farmers, they provided values they would be willing to pay in order to maintain their livestock if not using the free pasture provided by the wetland. The mode of payment by the respondents were commonly in the form of labour services to ensure conservation of the wetland. The conversion of these labour services into monetary terms enabled the researcher estimate their value of grazing in the wetland. From the respondents' valuation, 30% would be willing to pay an average of Kshs. 15,000.00 per month to keep using the wetland for all the livestock they have. Each household had a herd of livestock averaged at five (5) animals in

number. This depicts the high value the residents have put towards the use of the wetland resources. To come up with this, the respondents majorly had in mind the alternative activities for the wetland such as farming and settlement. Table 4.7 provides their willingness and ability to pay according to the transects in the area of study.

Table 4.7: Transects and respondents willingness to pay for grazing

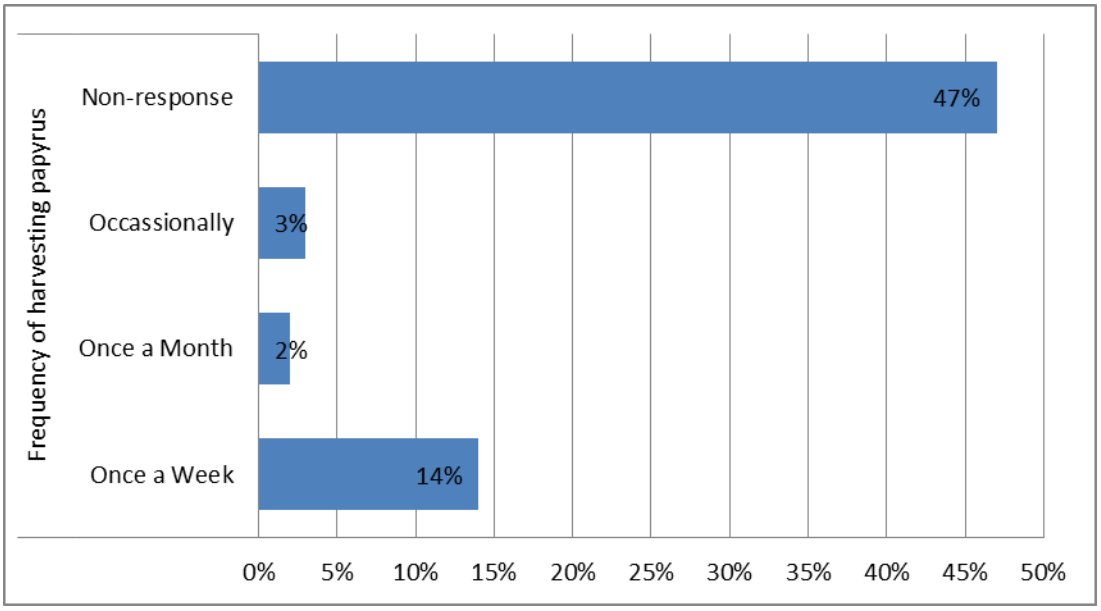
Sub-location (Transect)	Percentage of total respondents	Willingness to pay per annum per cow (Kshs)
Ogenya	16.00	36,500.00
K. Ombaka	14.00	29,200.00
J. middle	15.00	32,850.00
W. Kabodho	15.00	31,025.00
Non-response	40.00	-
Total	100.00	**129,575.00**

(Source; survey data, 2012)

4.3.3 Papyrus

From the data collected, papyrus is harvested almost throughout the year with exceptions of the flooding periods. The results show that papyrus is collected for various uses such as mat making (wall and table mats), door making, baskets, rafts, roofing, broom, ropes, firewood, seats/chairs, tables, picture frames, fish traps *"Osadhi",* bird cages, chicken cages *"Osera",* and granaries. To make these items, different stages and parts of papyrus is harvested. The papyrus umbel (head) is used in making brooms, mature papyrus is used to make doors, baskets, rafts and for roofing. The papyrus rhizomes (roots) are dried and used as firewood. The soft parts and seeds from papyrus are used in making mattresses and pillows. The soft inner part of the papyrus is chewed by livestock grazers to dull their appetite in the field. A high number of respondents, 53% confirmed to generating their income through papyrus. The papyrus harvesters had different levels and frequencies of harvesting the product from the wetland. The activity was carried out by 34% at least two to four days a week while 14% carry out the activity once a week. 2% does so once a month as 3% is occasional

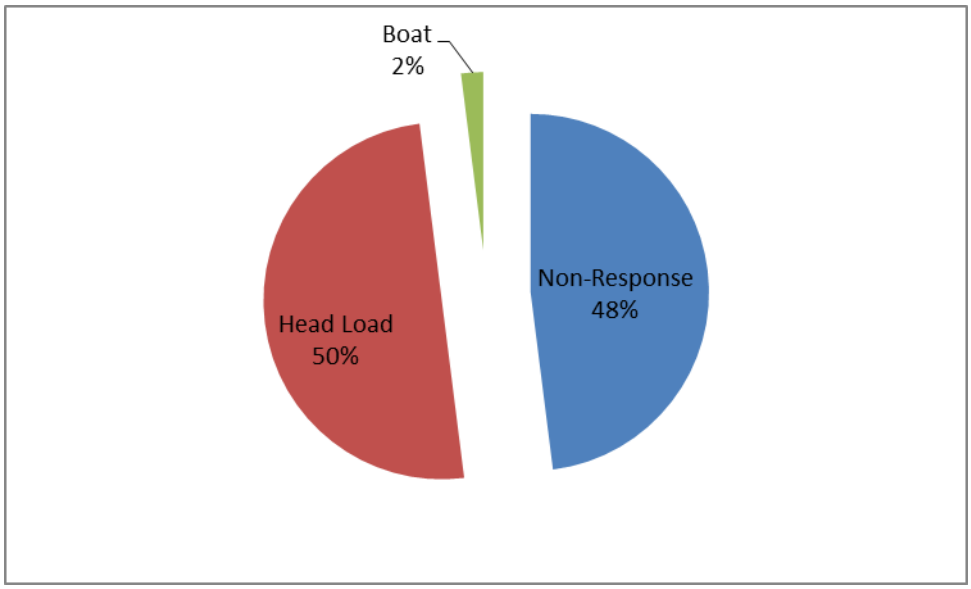
harvesters of the papyrus. Graph 4.2 illustrates the papyrus harvesting frequency in percentage of the respondents.



Graph 4.2: Papyrus harvesting frequency by the respondents

(Source: Survey Data, 2012)

Head-loads/ bundles is the common measure for papyrus since 50% of the respondents measure and transport their papyrus in head-loads, 2% of the respondents, transport their papyrus using boats as 48% are not directly involved in papyrus related activities. (Graph 4.3 shows a break-down of papyrus transportation mode by the respondents).

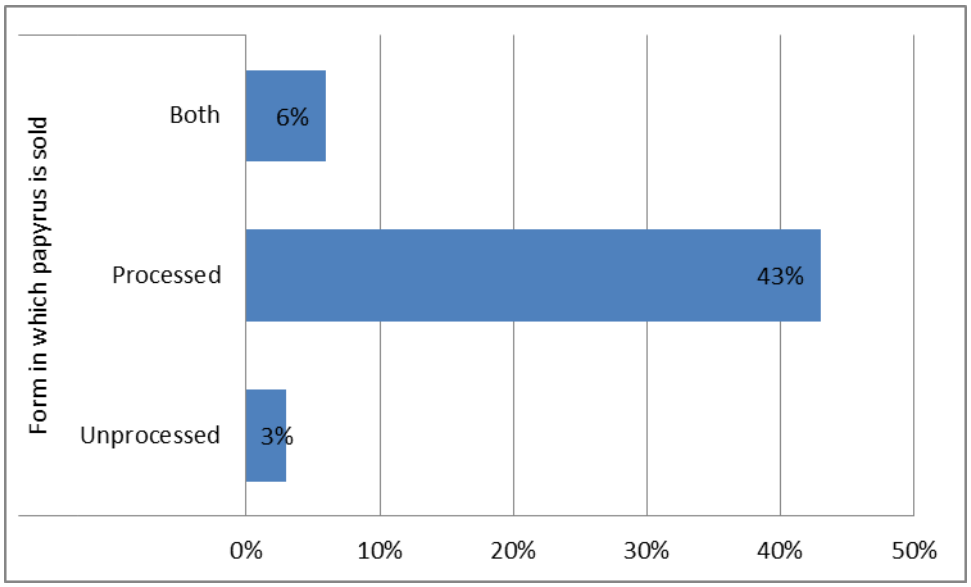


Graph 4.3: Unit of Measuring and Transporting Papyrus

(Source: Survey Data, 2012)

After harvest and transportation of the papyrus, the users of the resource sell their produce in different forms i.e. processed, unprocessed and both processed and unprocessed. 43% of the respondents sell their papyrus in a processed state. By so doing, the main parts of the wetland resource are actually retained within the area as only finished products are carried away. The soils and main parts that come along with papyrus harvesting are thus not lost from the wetland. The processing of the papyrus involves manufacture of mats, seats, brooms and many more. Only 3% sell their papyrus un-processed. In Nyando, culture is a determining factor in the access to the wetland papyrus making the trade in the papyrus as a wetland resource an exclusive affair. The sick people are not allowed access into the papyrus harvesting places and these are the people who make up majority who buy the resource un-processed and go on to process and sell the products. The others in this excluded group are pregnant women and those incapacitated by various ailments or simply physically challenged. Others who also do not make it to the harvesting points yet are users of the resource are

those who are water-phobic. Consequently, culture plays a great role in the control of papyrus exploitation. By creating such classes in the papyrus harvest, cultural practises ensure that the resource is conserved since the numbers accessing the resource is limited (District Survey, 2005). In addition, such differences by the resource users in the access of papyrus create the forced of demand and supply for papyrus and related products. By so doing, the people accessing the resource will always have some demand for their items all year round. The remaining 6% sell papyrus in both processed and un-processed. The target group for the unprocessed sales remain the same. Graph 4.4 shows the percentage respondents taking part in the resource trade and in which form they commonly sell their resource.



Graph 4.4: Form in which papyrus is sold by percentage respondents.
(Source: Survey Data, 2012)

The retail price of a single head-load of papyrus is Kshs. 50.00 in the months of October to March. The value then doubles to Kshs. 100.00 from April to September. The changes in price are due to factors such as increase in demand at a time when there is reduction in supply. The supply reduces when the wetland is flooded especially in the

rainy season even-though it is at this time that the plant is plenty in existence due to high regeneration rate. The supply is low at this time since access to the papyrus is hindered by overflowing water that comes along with soil and fertile alluvial deposits from the highlands (Swallow, et al, 2005). Therefore, the supply goes down during the flooding period causing a rise in price. Soon after the rains and flood water have gone down and the flood waters recede, the access to the regenerated papyrus is easy and thus the supply is higher than the demand.

However, it is worth noting that the prices of items such as brooms, seats and wall-mats are relatively stable in both the peak and off-peak periods.locally, these items are not generally in high demand. In fact, it would be right to state that their demand is constant throughout the year within the area. The brooms do not need alot of material and skill and therefore can be made by anyone thus the need to buy is relatively low. Moreover, the papyrus parts used in making the brooms are relatively cheap and easy to acquire. This accounts for the constant price of the broom. On the other hand, seats and wall-mats are mostly sold to tourists and visitors. The seats and wall mats are made and sold on demand. In addition, the items require specialised skill right from the harvesting of papyrus to the stitching of the pieces together. This makes the number of people making such items few and rare until the demand comes up. The market to such skilled people is obtained by reference from their fellow traders. A few residents also purchase these items but their usefulness has been given little focus by the residents. It is due to this low demand of such items that makes their prices stable all-year round. The income generated by the individuals is significant to the house-hold income with 29% generating between Kshs 200.00 to Kshs 300.00 per day from the direct sale of papyrus and mats while 32% obtain between Kshs 50.00 and Kshs 450.00 per day from the same trade. It is worth noting that this discrepancy in income is a result of differences in

papyrus resource harvesting. These differences come in the form of skills, location and time as well as frequency. The level to which the individuals wholly depend on the resource as a source of livelihood is also a factor in the amount of income generated by an individual. On average, the average returns per day are Kshs. 309.00 per day for papyrus harvesters. This translates to an average of Kshs. 2,163.00 per week, Kshs. 8,652.00 per month and Kshs. 103,824 per annum. In this analysis, papyrus and mats have been considered since they are the most common and dominant form in which the resource is traded. Table 4.8 shows the papyrus products and their respective prices during peak and off-peak seasons as plates 4.1 and 4.2 show some of the papyrus products i.e. brooms and a granary respectively.

Table 4.8: Market price of papyrus and related products

Papyrus/Product	**Unit of Sale**	**Price (Kshs) @item.**	
		Peak Season	**Off-Peak Season**
Mats	Small *"Nyangile"*	50.00	100.00
	Medium	60.00	120.00
	Large	80.00	150.00
Broom		10.00	10.00
Papyrus	Head-load	50.00	100.00
Seats		600.00	600.00
Wall-mat		200.00	200.00

(Source: Survey Data, 2012)

Plates 4.1 and 4.2: Some products from papyrus. Brooms and a Granary respectively **(**Source: Aurther, 2012)

4.3.4 Fish

Fishing is an economic activity which is very common in the wetland of Nyando. In all the four-transects, fishing was an important economic and income generating activity. Of the respondents 20% directly depend on fishing for their up-keep.

The frequency with which fishing is done by these individuals depends on the type of fishing and the seasons prevailing. The most common type of fishing is the lake fishing where the fishermen use boats into Lake Victoria to trap and harvest various species of fish. This type of fishing is common and carried out daily by the residents who depend on this activity for their livelihoods. On the other hand, wetland fishing is also carried out and mainly targets the harvest of mud fish species (District Survey, 2005). This kind of fishing is common during the wet seasons. In the dry seasons, fishermen are forced to move deep into the lake for good catch. During floods, this type of fishing is literally impossible to carry out and thus the fishermen remain dependant on lake fishing.

There are a number of landing beaches along the lake from which the harvested fish is collected and sold by the fishermen (Researcher's Survey, 2012). Most of these landing points are controlled and managed by respective "Beach Management Units- BMU"

This provides employment opportunities and income to riparian community members as well as the officials of the BMUs.

In some areas, fish farming through fish ponds have been introduced through the Economic Stimulus Programme. This is slowly picking up and coming in handy to reduce pressure on the lake for fish. This provides an alternative economic activity and source of income to the residents and at the same time going along way in reinforcing the wetland conservation efforts.

Fishing is not a continuous process since it does not take place during flooding periods and during the extremely dry periods when the area experiences water shortages i.e. November to March. The species of fish harvested are varied and the prices also vary with season and variety. Tilapia is the most demanded type of fish but it is not highly abundant in supply therefore the price is relatively high even though the price changes with seasons.

Nile perch is highly valued due to its big size and multiple functions such as fillets, ornaments making, and fertiliser manufacture (District Survey, 2005). For this reason, the price is relatively high i.e. between Kshs. 250.00 in the peak season and Kshs. 350.00 in the off-peak season. The price of *dagaa and adel (Barbus ssp)* is relatively stable throughout the year because of its stability in supply and demand. The quantity available is usually availed by lake fishing which is carried out all-year round. Table 4.9 shows the variety of fish and their respective prices during peak and off peak periods.

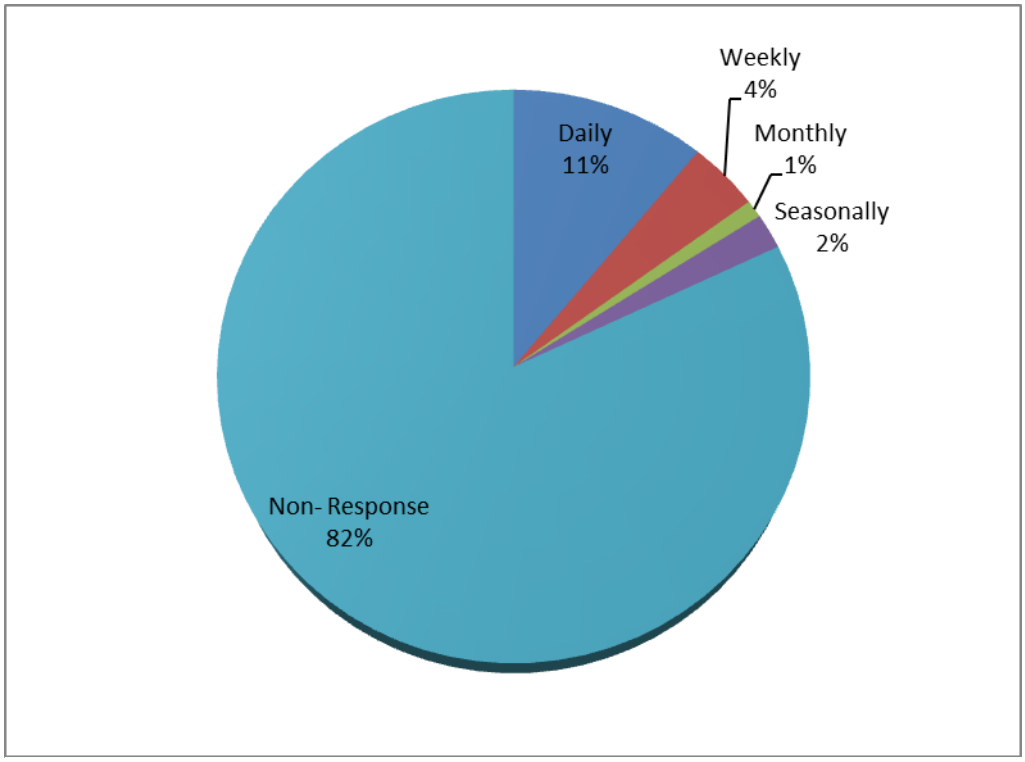
Table 4.9: Fish Varieties and their Respective Market Values/Prices

Fish Variety	**Unit of Sale**	**Price (Kshs)**	
		Peak	**Off-Peak**
Lung-fish and Cat- fish	Small	30.00	50.00
	Medium	70.00	100.00
	Large	100.00	150.00
Okoko, Sire, and *Nyawino*	Small Basin	200.00	500.00
	Medium Basin	500.00	700.00
Tilapia	Small	50.00	70.00
	Medium	100.00	120.00
	Large	150.00	200.00
Nile-perch *(Mbuta)*	1Kg	250.00	350.00
Mumi	Medium	50.00	100.00
Adel, Ondhedhe, Mandhe	13kg basin/ *Nyaum-pusi/ Toto*	700.00	700.00
Fulu and *Dagaa (Omena)*	13kg Basin	1,000.00	1,000.00

(Source, survey data, 2012)

The fish glut period occurs when flood waters are plenty and lake fishing brings good catch of fish (Researcher's Survey, 2012). The shortage period for fish occurs when water levels are low and the fishes' breeding grounds are shallow due to wetland destruction and little water available. From the sampled population, 11% of the respondents catch fish daily since they treat this as their main source of income and livelihood. 4% take part in the trade once a week as 1% does so once a month. The respondents who take part in fishing activities weekly, monthly and occasionally do not consider it basic to their survival and provision of livelihood needs. They use such occasions to supplement their income or diet. Graph 4.5 shows fish harvesting frequency in percentage by the respondents. Photos 4.3 and 4.4 show some of the fish

varieties available and fishermen preparing to get into the lake to carry out fishing respectively.



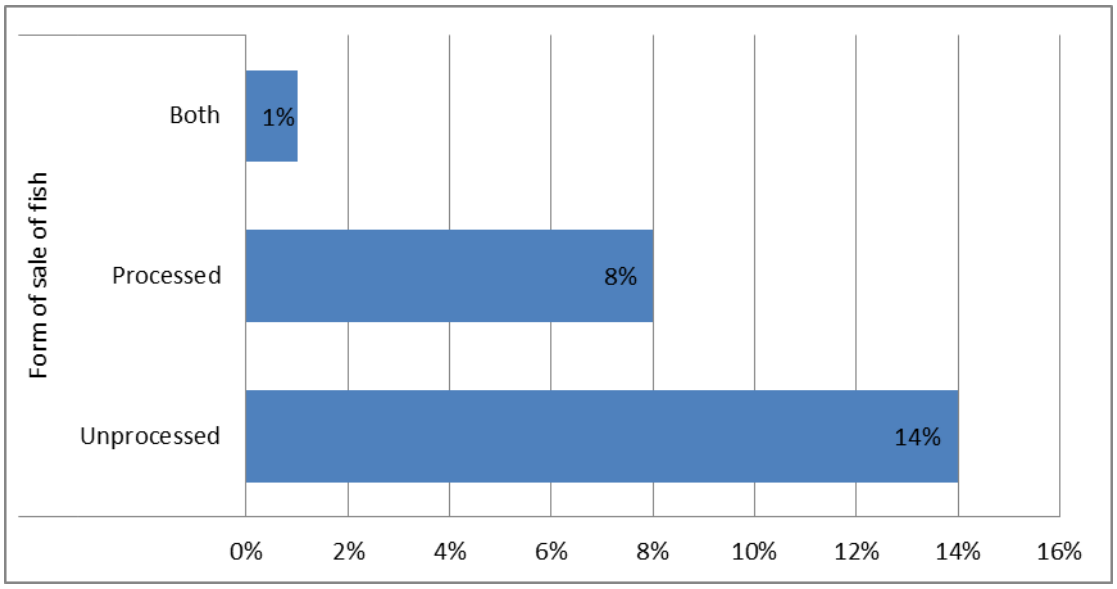
Graph 4.5: Fish harvesting frequency

(Source: Survey Data, 2012)

Plates 4.3 and 4.4: Cat Fish and fishermen getting into water for overnight lake fishing. (Source; Aurther, 2012)

The fish types once caught are sold in different states such as fresh fish and as processed. High amount of fish is sold in their fresh state since 14% of the respondents sell their catch as fresh (un-processed) while 8% sell theirs having processed. The

various forms of fish processing include frying as well as preservation practises like salting and smoking. Only 1% sell their fishes either processed or un-processed. The graph below, 4.6 gives in percentages the respondents type of fish sales.



Graph 4.6: Form of sale of fish by percentage respondents

(Source; survey data, 2012)

For those who fishing is the main economic activity and carry out the activity daily, income is significant. 13.8% of the respondents get between Kshs. 250.00 and Kshs. 3,000.00 per day. On average, each of the fishermen gets about Kshs. 351.42 per day from the sale of fish and related products. This gives a total of Kshs. 2,459.94 per week per person and Kshs. 9,839.76 per month. Annually, this figure comes up to Kshs. 118,077.12 per month.

The months of April to June as well as August to October experiences alot of rainfall and these periods are associated with alot of fishing activities (District Survey, 2005). The quantity and variety of species of fish caught in these periods is quite high. However, when the water volume exceeds the threshold into flooding, the fishing points become inaccessible thereby hindering fishing.

Fishermen contribute to wetland degradation through burning to clear grass and papyrus within the wetland. During the dry seasons, they burn the vegetation to create fishing spots (Researcher's Survey, 2012). For sustainability however, there is need to reinforce and offer alot of support to the beach management units to ensure continuous controlled fishing. This is achievable by having proper legislations and implementation of the set rules and regulations. Fish pond construction would also help in the reduction of pressure on the fishing grounds within and around the wetland. This would go a long way in reinforcing the conservation efforts.

4.3.5 Sand harvesting

Sand is not a direct wetland product but the product is deposited in the wetland and it is at this point that the commodity is harvested. There are two common forms of sand harvesting in the wetland. Riverine sand harvesting is done along the river beds and is common along Awach in the Nyando and is carried out when the water levels are low. Therefore this does not happen throughout the year as water levels keep fluctuating with the rainy seasons. The second form of sand harvesting occurs almost throughout the year except when the rains are heavy thus causing floods or blocking the passage routes to the lorries ferrying the sand to access the area. This is the harvesting of sand in areas where sand was buried during the flooding period. This kind of sand harvesting (from the agricultural fields) is a source of income but degrades the environment and reduces land available for farming (District Survey, 2005). This leads to additional pressure on the land within the wetland.

Sand harvesting is not a common activity in all the four transects but carried out in two transects namely Kusa and Wasare. Those involved account for 6% of the respondents who consider this activity as their major income earner. Sand is majorly harvested and parked in heaps of tonnes and eventually sold in Lorries. Most of

the Lorries come from outside the wetland thus a clear indicator that the highest demand for sand is not from within.

Sand harvesting is peak when the water levels are low in the river Nyando and other small rivers in the study area. Sand is carried and deposited in the river bed by flood water from up-stream. Heavy rains up-stream increases the water depth in the Nyando River and hence sand cannot be harvested during the period. The market price/value for sand also varies with seasons i.e. wet and dry periods. The Lorries that collect the sand from the wetland come from outside the area and this is courtesy of sand trade agents. To pay for their services, the agents demand a minimum of Kshs. 100.00 per tonne sold by the sand harvester. The sand harvesters also pay the municipal council cess of Kshs. 100.00. The individuals also account for the land on which they harvest the sand and the route through which the lorries use in transporting their products (sand) at the rate of Kshs. 100.00 per day in each of the two items. They also pay the loaders Kshs. 100.00 per tonne loaded into any lorry. This adds up to a total of Kshs. 500.00 in expenses per tonne sold. The price of sand therefore includes all these deductions by the agents and municipal council officials. Eventually, the net income earned by the individuals in this economic activity averages to Kshs. 185.57 per day per head. This totals to Kshs 1,298.99 a week, Kshs. 5,195.96 and 62,351.52 per annum. Table 4.10 gives the selling price for the various quantities of sand and the expenses for every tonne of sand sold.

Table 4.10: Unit price of sand as per market conditions and associated expenses per tonne sold

Unit of Sale	**Gross Price (Kshs)**		**Expenses for every tonne of sand sold (Kshs)**	
	Glut Season	**Off-Peak Season.**		
			Municipal council cess	100.00
5-tonne lorry	600.00	800.00	Harvesting land	100.00
7-tonne lorry	1,000.00	1,200.00	Route of transit	100.00
14-tonne lorry	1,400.00	1,800.00	Loaders	100.00
28-tonne lorry	2,500.00	3,500.00	Agents	100.00
			Total	**500.00**

(Source: Survey Data, 2012)

Sand harvesting especially the riverine increases the flow of water in the river into the wetland. The presence of water in the wetland facilitates other activities such as farming especially along river Awach and Nyando rivers. However, the activity has implications to the wetland management and conservation efforts. The sand harvesting causes soil degradation especially the type done over land. Once the land is set aside for the activity, it is no longer usable for crop farming and thus contributing greatly to decrease in production of crops as evidenced in Nyalunya location. This is a major cause of food insecurity in the riparian area. The areas used in sand harvesting are later left as open dredges/cuts creating an eye-sore over the land surface. These derelict cuts form

breeding grounds for mosquitoes and other water-borne diseases. These dredges are also dangerous for the livestock kept by the farmers in the wetland and even to the human beings who use such areas in the course of their operation in the wetland. To get additional lands for sand harvesting, at times, people have had to relocate. There have also been cases where during sand harvesting skulls have are excavated from graves in the old homesteads within the area (Researcher's Survey, 2012).

4.4 Economic Trade-offs and alternative product uses.

Ecosystem service (ES) trade-offs arise from management choices made by humans, which can change the type, magnitude, and relative mix of services provided by ecosystems (Rodriguez, et al, 2005). Trade-offs occurs when the provision of one ES is reduced as a consequence of increased use of another ES. This calls for decision making and choice of the best alternative activity as concerns the level of income obtained from the activity and environmental protection as well as conservation (Foley, et al, 2005)

In the Nyando wetlands, the respondents were majorly of the opinion that farming is the main economic activity and also the best alternative option to the successful livelihood and sustainability of the Nyando wetland. 72% of the respondents were of the idea that they would keep crop farming since it is the most productive and requires less input to obtain high yields. The respondents were confident that integrating crop farming with agro-forestry would be of great benefit both to the wetland and the riparian community at large. The high preference to crop farming is due to the fact that wetland is usually filled with water during floods and that the flood waters leave deposits of fertile alluvial soils from the upper sections of the streams flowing within the area. Farming is also lucrative since water is easily available from the lake and that the wetland is usually constantly filled with water for long periods of the year. This reduces the expenses that

would be incurred to irrigate the farms. It would therefore be more productive to educate the farmers to take in latest farming ideas and technologies such as mechanization, use of green houses to not only increase quality and quantity but also speed of productivity (Researcher's Survey, 2012)

Other alternative activities that can be traded-off as per the respondents were grazing with 5% response. The grazing would mean leaving part of the land fallow for a long period of time. This fallow land would form a great space and area for research and educational activities. However, this had low support due to the fact that a high number of the respondents reported low education levels and thus had reservations on this for fear of displacement from their "generational land". The other reason why grazing has a low score as an alternative activity is due to the fact that sales of livestock are not frequent and this is also restricted to availability of high breed livestock which is not a common occurrence in the Nyando wetland. Fish farming at 6% also had a low preference since the respondents were of the opinion that lake fishing is sufficient for their local needs. However, with increased awareness, such an activity would be very lucrative and of great benefit to the wetland resources as there would be reduced pressure on the resources under focus. Mechanization such as construction of fishing industries and fish preservation mechanisms in the area would increase such potentials since the income from the activity would greatly rise. Table 4.11 illustrates the respondents' preferred alternative activities in each of the sub-locations (transects) covered during the study.

A comprehensive trade off option decision needs complete resource valuation (Chapman, et al, 2003). However, in the prevailing available information in this research, farming would go as the most viable alternative since diverse varieties of crops can be produced and improved agricultural practices can be incorporated. This

would provide for the immediate needs of the resource users yet also conserve the wetland for future generations. The respondents are already positive to agro-forestry. In each case, the principal characteristic of an ES trade-off in time is that the short-term needs of society drive decisions about ES management, purposely or inadvertently ignoring the future consequences of these actions (Anderies et al. 2001, Greiner and Cacho 2001, Briggs and Taws 2003).

Table 4.11: Preferences in alternative activities by percentage respondents and sub-location

Sub-Location	**Crop Cultivation And Agro-Forestry**	**Eco-tourism and Recreation**	**Bee Keeping**	**Fish Farming**	**Grazing and Research Centre**	**Total**
Jimo Middle	16	3	2	2	2	**25**
Kakola Ombaka	18	2	1	2	2	**25**
Ogenya	20	3	2	1	0	**26**
West Kabodho	18	2	2	1	1	**24**
Total	**72**	**10**	**7**	**6**	**5**	**100**

(Source; Surveydata, 2012)

To identify with more certainty possible product use alternatives, it is necessary to establish the level of significance of the incomes obtained from the various product uses in the Nyando wetlands. The income significance established was based on the economic values obtained from the first objective above. In this way, it was possible to establish which activity has a better chance of creating more income at less cost or creating maximum social benefit to the users of the wetland resources.

As stated earlier, the wetland resource users are multiple resource users. Therefore, revenue obtained from a single resource might have an impact across the entire region as much as the same would be true to more than one resource under study. Putting the mean incomes to a t-test result, the means of income obtained by the resource users' of

papyrus and fishermen show a close interrelationship. The variances in the mean incomes obtained from the use of papyrus and fish harvesting show significance in their differences as the value in the "Sig. (2-tailed)" column is less than 0.05. The calculated t-value of -2.780 is greater than the table value, 1.797 therefore the null hypothesis is rejected as a further proof that the incomes are significantly different and the differences in income from one individual to another could be a result of resource use and not just from sampling error. On the other hand, the differences in the mean incomes from the use of papyrus and sand harvesting do not show significance in differences as the value in the "Sig. (2-tailed)" column is greater than 0.05. The t- value of the mean income is negative, means that increases in the income of one commodity/resource say papyrus would lead to a decrease in the income of the other say fish. Interpreted in economic resource utilisation, an increase in the income obtained from exploitation of one resource would mean a decrease in the exploitation of the other. An increase in income can be obtained without increasing resource exploitation but by having value addition. It's therefore right to say that with value addition in one of the resources, income would increase in that line of resource use and resultantly the exploitation of the other resource would decrease. Consequently, these multiple resource users are likely to concentrate (give more time and effort) on one activity that is more productive as far as income is concerned at the expense of the less productive activity. This explains the negative causal effect of the two resource uses. The same is true for the comparison of papyrus and sand. Table 4.12 shows the results of this t-test analysis.

Table 4.12: Paired t-test analysis showing the relationship between Papyrus, Fish and Sand at 95% Confidence Interval of the Difference

	Mean	t	d. f	Sig. (2-tailed)
Papyrus &Fish	-2379.167	-2.780	11	.018
Papyrus &Sand	-1419.125	-2.147	7	.069

(Source: Survey Data, 2012)

Further, An analysis of variances (ANOVA) of mean income show that the mean incomes from the resource use are related. This proves that the values were obtained from the same group and that the resource use in the wetland has great significance in the lives of the residnents. Table 4.13 below gives the details of the ANOVA test results. The income obtained from papyrus, rice, beans, sand, and maize have significance values calculated tending to zero. This is a statistical proof of the significance of the incomes obtained from the economic use of the wetalnd resources. The incomes also vary from one individual to another. However, this variance is not so significant in the economic value of all the products except papyrus. This is proven statistically since all the calculated F values with an exception of papyrus are less than the tabulated F values. The mean income obtained from papyrus being significantly different from the resource users is an indication of how diverse the resource is used or processed by the different people who harvest or process the raw material in the wetland. The diverse uses of papyrus provides different ways through which the single resource is useful to various users. In this way, the income generated from the resource has great variance from one individual to another based on the point of view and interest.

Table 4.13: ANOVA analysis of the incomes generated from the resource use in the wetland at 95% Confidence Interval of the Difference

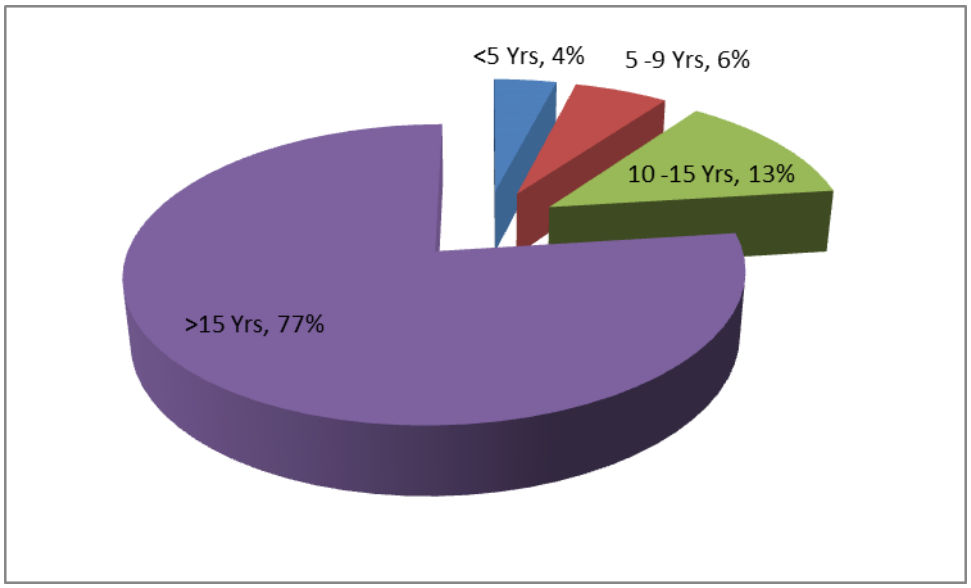
		d. f	**F**	**Sig.**
Papyrus Value	Between Groups	4	19.215	.000
	Within Groups	81		
	Total	85		
Fish value	Between Groups	2	.322	.728
	Within Groups	24		
	Total	26		
Sand value	Between Groups	3	.748	.557
	Within Groups	7		
	Total	10		
Maize value	Between Groups	6	.819	.557
	Within Groups	125		
	Total	131		
Tomato value	Between Groups	5	.333	.888
	Within Groups	23		
	Total	28		
Kales value	Between Groups	4	.077	.989
	Within Groups	56		
	Total	60		
Cowpeas value	Between Groups	3	.217	.883
	Within Groups	26		
	Total	29		
Rice value	Between Groups	3	1.508	.238
	Within Groups	24		
	Total	27		
Beans value	Between Groups	4	1.150	.352
	Within Groups	30		
	Total	34		
Sugarcane value	Between Groups	2	.408	.670
	Within Groups	24		
	Total	26		
Farm value	Between Groups	4	.416	.796
	Within Groups	56		
	Total	60		

(Source: Survey Data, 2012)

4.5 Changes in productivity

There have been changes in the wetland which have been noted by respondents some of which have been in the area for since birth. Out of the sampled respondents, 77% had stayed in the wetland for over fifteen years, 13% have been in the area for between 10 and 15years. Only 10% of the respondents have been in the area for less than 10years. Graph 4.7 has the percentage period of stay of the respondents in the wetland. This duration of stay was important for the study as the respondents were able to state some changes on selected parameters which had happened within the area for at least the period they had been around. It was useful to assess such occurrences from their own experiences and perspective.

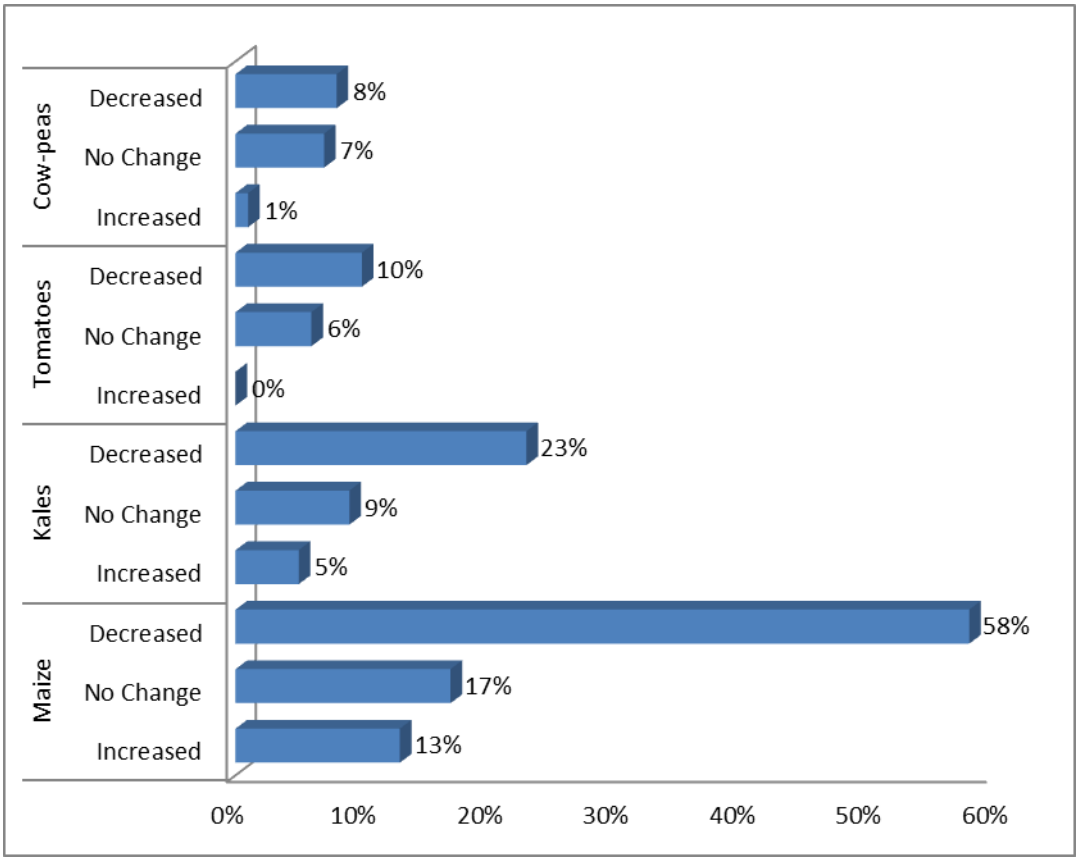
Graph 4.7: Period of time spent in the wetland



(Source: Survey Data, 2012)

Majority, 58% of the respondents agree that maize production has decreased in the last ten years while 23% affirm a reduction in the output from kales in the last ten years. 10% and 8% have recorded a decrease in the production of tomatoes and cowpeas

respectiely in the last ten years. Graph 4.8 shows the percentage responses on crop production changes in the laast ten years.



Graph 4.8: Crop- Production trend in the last ten years in the wetland

(Source; survey data, 2012)

Taking an estimation in the last ten years during the study, 38% of the respondents believe that a change in production is a result of weather changes. An increase in rainfall has led to increased production to some of the respondents (4%) while 33% attribute a decrease in productivity to un-predictable rainfall, flooding in the area after heavy rains and much more aspects associated to weather changes such as temperature increase. According to 19% of the respondents, a rise in temperature has been attributed to an increase in pests and diseases within the area and this has also significantly contributed to decrease in production quality. This occurence is reinforced by mis-use of pesticides which are used to control the pests and diseases. Only 1.0% of the

respondents believe that the use of pests and diseases has ensured sustained increased production quality and quantity. Another 4% attribute the increase in productivity to fertility in the land as a result of deposition of fertile alluvial soils after the flood waters have receded. This has also made crop farming much cheaper than with the use of fertilisers. Pressure on land in the the wetland has made 4% of the respondents to consider opening up of additional land. To them this has contributed an increase in production. 20% of the respondents consider floods responsible for the negative trend. 6% of the respondents thought poor seeds and infertile soils were a reason for the drop in production. Another 6% associated a reduction in quality and quantity of production to wetland destroying activities such as burning and sand harvesting. The sand harvesting carried out over land leaves the affected area derelict and less fertile. Population pressure and wetland destruction was a reason to 8.0% of the respondents for the decreasing quantity in production. Table 4.14 has the breakdown showing these percentages and resons for change in productivity.

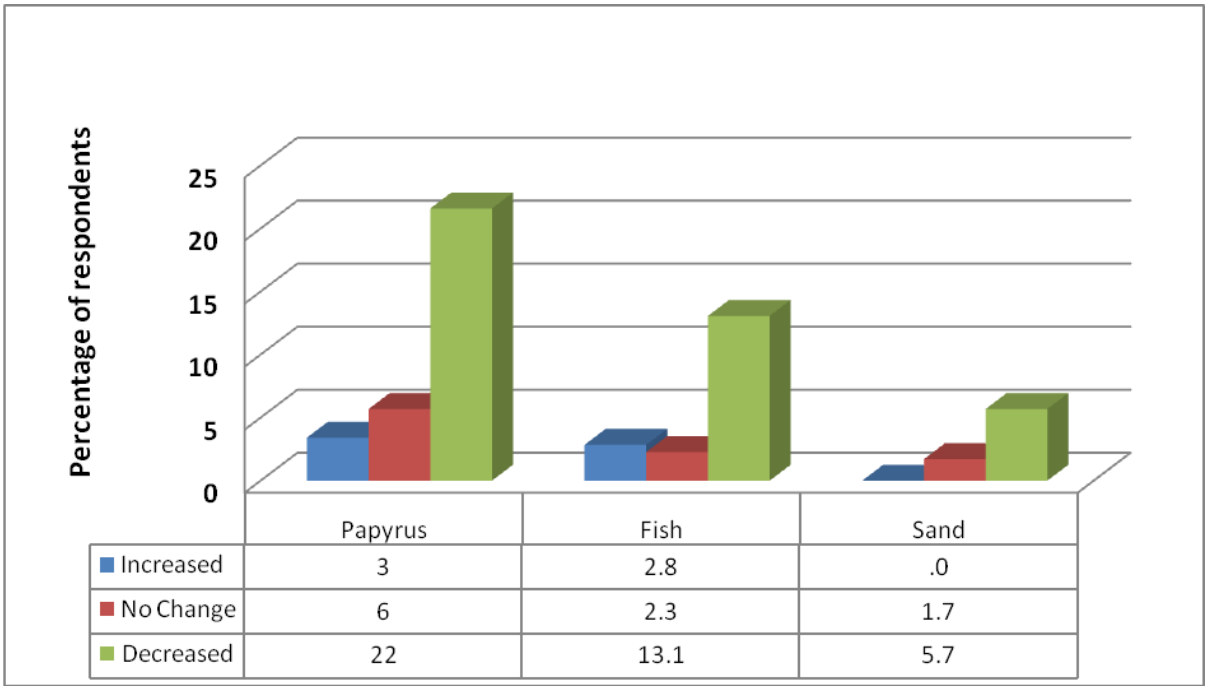
Table 4.14: Reasons for change in production according to the respondents in percentage

Reason for change in output	Kales	Maize	Tomatoes	Total
Weather Changes (Adequate Rainfall, temperature changes, and unpredictable rainfall patterns).	7	29	2	38
Chemicals	1	-	-	1
Opening up new land	1	2	1	4
Floods	6	12	2	20
Pests and Diseases (Misuse of pesticides).	10	3	5	18
Soil Fertility	1	3	-	4
Human-Wildlife conflict	1	-	-	1
Wetland Destruction (Burning and sand harvesting)	1	5	1	7
Poor/Bad Seeds	-	1	-	1
Poor/ Infertile Soils- Repeated cropping of maize.	-	5	-	5
Population Increase	-	1	-	1
Total	**28**	**61**	**11**	**100**

(Source; survey data, 2012)

The decline in productivity is not only on the crops being produced, but also in papyrus, sand harvesiting and fishing. The respondents revealed their fears on the sustainability of the wetland to their livelihood. The graph below, 4.9 depicts that majority of the users of these products strongly feel and believe that the quantities harvested have been on the decline in the last couple of years. 22% of the resopondents confirm a reduction in quantity of papyrus harvested as 13% agree that fish quantity and quality as well as variety of species available have been on the decline in the last ten years. For sand harvesting, only 5% of the respondents report a decline in the quantity of sand obtained in the wetland.

Graph 4.9: Trend in Quantity Harvested in the Last Ten Years



	Papyrus	Fish	Sand
Increased	3	2.8	.0
No Change	6	2.3	1.7
Decreased	22	13.1	5.7

(Source; survey data, 2012)

To the respondents,weather changes such as adequate rainfall is responsible for the increasing production of the resources under study according to 1% of the respondents. 21% of the respondents believe that weather changes have affected out put negatively. Such changes include occurences of drought through temperature increase, unpredictable rainfall patterns and excessive rinfalls leading to floods. Floods and heavy rains lead to scarcity acording to 7% of the respondents. 22% of the respondents attribute a decrease in productivity to population pressure leading to increase in demand for the products. Erosion is a major contributing factor to 2% of the respondents sice this occurrence washes away fertile soils that are the major source of other resources such as papyrus and food for the fish. 8% attribute the decrease to wetland degrading activities such as burning of papyrus by the fishermen and sand harvesting. The fishermen are believed to clear wetland fishing points by burning papyrus for access to mud-fish breeding places. Fishing nets used illegaly cause shortage of fish according to 3% of the respondents. Other causes for production changes include existence of water

hyacinth 1%, low-water levels 2% and grazing at 1% of the respondents. Table 4.15 gives an analysis of these responses on the causes of productivity changes.

Table 4.15: Reasons for change in Quantities of papyrus, sand and fish according to the respondents in percentage

Reason	Papyrus	Fishing	Sand Harvesting	Total (%)
Weather changes (adequate rainfall, rise in temperature, drought and unpredictable rainfall)	11	7	3	21
Wetland destruction (Burning and sand Harvesting)	8	-	-	8
Low Demand	3	-	-	3
Population Pressure	16	6	-	22
Grazing	1	-	-	1
Low Water Level	1	1	-	2
Un-lawful Nets	-	3	-	3
Pests and Diseases	-	1	-	1
Water Hyacinth	-	1	-	1
Soil Erosion	-	-	2	2
None-response	-	-	-	**36**
Total	**40**	**19**	**5**	**100.00**

(Source; survey data, 2012)

4.6. Income and Possible Loss

The economic cost of conversion and/or degradation of the Nyando wetland would be equivalent to the amount of money that would be used to repair the damage caused in the wetland from a given loss. The value can also be obtained by estimating the value likely to be lost from the usual income obtained by the residents of the wetland or the resource users of the wetland resources. Having said earlier that wetland resource users are multiple resource users, it is therefore right to conclude that the true value of income of an individual household would be a combination of incomes from the various resource uses.

From a resident fully dependent on ccrop cultivation only, using the five crops of tomatoes, maize, kales, rice, sugar-cane, beans and cowpeas, such a farmer is able to generate a total of Kshs. 85, 675.24 in every harvest season. However, this only true on the season and year when all these crops are harvested at the same time. Keeping the same conditions constant, the same farmer woul generate a total of Kshs. 202,451.33 annually. Table, 4.16 provides the possible income per crop harvested and possible cummulative in case the farmer has more than one crop produced within the wetland.

Table 4.16: Avearge Income generated from farming activities by households

Crop produced	**Average Income @ Season (Ksh.)**	**Harvests @year**	**Total income in a year.**	**Cumulative Total annual income (Kshs)**
Tomatoes	13,417.24	3	40,251.72	40,251.72
Maize	16,574.39	2	33,148.78	73,400.50
Kales	17,683.61	3	53,050.83	126,451.33
Rice	20,000.00	2	40,000.00	166,451.33
Cowpeas and Beans	18,000.00	2	36,000.00	**202,451.33**
Total	**85,675.24**		**202,451.33**	

(Source: Survey Data, 2012)

From the income obtained in each of these crops, it is possible to estimate income generarted by some of the farmers who have mixed crops in their farms. Combination of maize and beans and cowpeas would generate an income of Kshs. 34,574.39 per acre per farmer per annum. A mix of kales and tomatoes would provide an income of Kshs. 46,651.27 per farmer per acre per annum. Table 4.17 gives an insight into the possible crop combinations and possible income generated from the crops per annum per acre per farmer and their respective cummulative income combinations.

Table 4.17: Income generated from farming activities considering possible crop combinations

Crop produced	Average Income @ Season (Ksh.)	Harvests @year	Total income in a year.	Cumulative Total annual income (Kshs)
Tomatoes and kales	15,550.43	3	46,651.27	46,651.27
Maize and beans/cowpeas	17,287.20	2	34,574.39	81,225.66
Rice	20,000.00	2	40,000.00	121,225.66
Total	**52,837.63**		121,225.66	

(Source: Survey Data, 2012)

In addition, the wetland resource users have been discussed as multiple resource users and therefore take part in the use of more than a single resource in a year. Therefore, putting the three (papyrus, sand, and fish) resources under study into consideration, such individuals would generate an average income of Kshs 309.00 daily from the sale of papyrus and its related products, Kshs 185.57 from the sale of sand and Kshs 351.42 from the sale of fish. This translates to a monthly income of Kshs **25,379.70** and an annual income of Kshs **304,556.40** from the three products per annum. Putting this total to that generated from crop farming, the individual would ammase a total of Kshs **507,007.73** per annum from collective multiple use of the wetland resources under study.

Moreover, the same farmer would save a total of Kshs**. 129,575.00** per year per animal by using the wetland pasture freely rather than purchase animal feeds. The table below, 4.18 shows the income from a combination of all the activities and products under study within the wetland and possible combinations since the wetland resource users are by default multiple resources users. These activities include papyrus harvesting, fishing, crop farming, grazing and sand harvesting.

Table 4.18: Total average income from various activities and possible cummulative income combinations

Wetland product	**Average daily income (Kshs)**	**Average monthly income (Kshs)**	**Average annual income (Kshs)**	**Cummulative income (Kshs)**
Papyrus	309.00	9,270.00	111,240.00	111,240.00
Fish	351.42	10,542.60	126,511.20	237,751.20
Sand	185.57	5,567.10	66,805.20	**304,556.40**
Total	**845.99**	**25,379.70**	**304,556.40**	
Tomatoes	-	-	40,251.72	344,808.12
Maize	-	-	33,148.78	377,956.90
Kales	-	-	53,050.83	431,007.73
Rice	-	-	40,000.00	471,007.73
Cowpeas and Beans	-	-	36,000.00	507,007.73
Grazing (Averted cost)	-	-	129,575.00	**636,582.73**

(Source; survey data, 2012)

CHAPTER FIVE

SUMMARY OF FINDIMGS, CONCLUSION AND RECOMMENDATIONS

5.0 Overview

This chapter presents the summary of the key findings, conclusion and recommendations based on the data collected during the survey on the valuation of the impact of selected wetland products to house-hold income in Nyando wetlands, Western Kenya.

5.1 Summary of the Findings

From the t-tests and F-tests carried out, the study revealed that Nyando wetland is of great significant value and importance to the socio-economic activities within the community. This is proven statistically since the values in the "sig. 2-tailed column" are tending to zero. The t-value is greater than 0.05 hence at 95% confidence the incomes are proven to be greatly significant. The incomes obtained from the use of the selected wetland resources are also not significantly different as the calculated F-values are less than the tabulated F-values. Nyando wetland ecosystems therefore support a number of human activities and thus significant amount of income is obtained by the resource users. The high and significant levels of income are made possible by multiple uses of the resources in the wetland. The income can be improved further through specialization in resource use as guided by the trade-off alternatives as well as value addition of the products under use.

The research established farming as a major economic activity in the wetland as it is carried out by 70% of the respondents. Papyrus harvesting, fishing and sand harvesting are other direct uses of the Nyando wetland. Both papyrus and fish are sold in raw or processed forms.

A low education level by majority of the resource users is a major output from this research. The result is continued reliance on the wetland which is now experiencing a decreasing level of income obtained from the resource use over the recent years.

5.2 Conclusion

This research provides the values of various economic activities carried out in the Nyando wetland namely fishing, papyrus harvesting, crop farming, grazing and sand harvesting. From the survey data obtained by the researcher, a Nyando wetland resource user strictly dependent on papyrus alone would earn an average annual income of Kshs. 111,240. A resource user dependent on fishing alone would earn an average annual income of Kshs. 126,511.20 while that resource user dependent on sand harvesting alone would earn an annual income of Kshs. 66,805.20. The three resource uses would cumulatively generate an annual income of Kshs. 304,556.40. In addition, farming would give an additional average annual income of Kshs. 332,026.33 to a farmer having multiple crops such as maize, kales, tomatoes, rice, cowpeas and beans valued at one acre each. The figures obtained herein, may be of great relevance in comparisons and decision making in use and allocation of resources within the wetland. These mean incomes from the t-test carried out have proven statistically significant to the resource users and the F-test carried out proved that the variances within and between groups are not significant.

From the trade-off options, there is need to have a balance between clearing of land to create room for farming and papyrus harvesting. This is because these two activities have been proven in the research to have an effect on the efficiency of the wetland to carry out its natural functions such as flood control. Moreover, clearing of land for papyrus harvesting has a negative effect on fishing as a resource from the wetland since the fish breeding grounds are destroyed.

5.3 Recommendations

- ✓ The values obtained from this work are comprehensive average income values of Nyando wetland resource use of papyrus, sand harvesting, fishing and selected farming products. It is therefore my take that additional research be done to determine the value of more wetland resources.
- ✓ Further research should be carried out on the possible resource use trade-off to come up with the best sustainable alternative.
- ✓ Community sensitization would go a long way in ensuring better use and management of the Nyando wetland. This is easily achievable by improving the education standards of the residents as well as involving them in decision making.

REFERENCES

Akanga, J., Downing, T. E., Konijn, N. T., Mungai, D. N., Muturi, H. R. & Peter, H. L. (1987) The Effects of Climatic Variation on Agriculture in Central and Eastern Kenya

Ashley C (2000). Applying Livelihood Approaches in Natural Resource Management Initiatives: Experiences in Namibia and Kenya. Overseas Dev. Institute working paper 134. London.

Barbier, Acrerman and Knowler, in Economic Valuation of Wetlands: A Guide for Policy makers and planners, Ramsar Convention Bureau publication, 1997.

Buigutt, K.S.A. 2004. The Mandate of the National Environmental Management Authority and Implementation of the Environmental Management and Co-Ordination Act (1999). *In* D. Mungai, B. Swallow, J. Mburu, L. Onyango and A. Njui, eds. *Proceedings of a Workshop on Reversing Environmental and Agricultural Decline in the Nyando River Basin.* Nairobi, ICRAF, NEMA, the Water Quality Component of the Lake Victoria Environment Management Programme (LVEMP), and the Ministry of Agriculture and Rural Development.

CBS (2003). Geographical Dimensions of Well-Being in Kenya. Who and Where are the poor? From Districts to Locations. Volume 1. Figures in parentheses in the table are the poverty gaps, expressed as a percentage of those living below the poverty line Central Bureau of Statistics (2003). *Poverty in Kenya.* Nairobi, Central Bureau of Statistics and International Livestock Research Institute.

Costanza, R., R. d'Arge, R. deGroot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S . Naeem, R. V. O'Neill, J. Paruelo, R. G. Raskin, P. Sutton, and M. v. d. Belt. 1997. The value of the world's ecosystem services and natural capital. Nature 387:253-260.

B. Swallow, N. Okono, M. Achouri and L. Tennyson, eds. *Preparing for the next generation of watershed management programmes and projects. Proceedings of the African Workshop.* Nairobi, 8 to 10 October 2003. Watershed Management and

Sustainable Mountain Development Working Paper No. 8. Rome, FAO, FORC Department

Denga, F. G. O. (1990) The flood hazard in the lower reaches of the Sondu/Miriu River. Unpublished Dissertation

Downing, T. E., Gitu, T. W. & Kamau, C. M. (eds) (1989) *Coping with Drought in Kenya: National and Local Strategies*

De Groot, R.S. (1992). Functions of nature: evaluation of nature in environmental planning, management and decision-making. WoltersNoordhoff BV, Groningen, the Netherlands.345 pp

De Groot, R.S., Wilson, M., &Boumans, R. (2002).A typology for the description, classification and valuation of ecosystem functions, goods and services (pp. 393-408). In The Dynamics and Value of Ecosystem Services: Integrating Economic and Ecological Perspectives. Ecological Economics 41 (3): 367-567

De Groot,R.S., van der Perk, J.P., Chiesura, A.& van Vliet, A.J.H. (2003). Importance and threat as determining factors for criticality of natural capital. Ecological Economics 44 (2-3): 187-204.

Edward B Barbier, Mike Acreman and Duncan Knowler (1997): Economic valuation of wetlands: A guide for policy makers and planners; Ramsar Convention Bureau, Gland, Switzerland

Food Security District Profile (2002): Nyando District, Nyanza Province.

Ghabo, A. A. (2007) Wetlands Characterization; Use by Local Communities and Role in Supporting Biodiversity in the Semiarid Ijara District, Kenya. Terra Nuova East Africa.Wetlands in drylands

Harper D, Zalewski M and Pacini N Eds. Ecohydrology: Processes, Models and Case Studies, An approach to the sustainable management of water resources. Cromwell Press, Trowbridge, UK, 2008.

Karl TR, Riebsame WE. The impact of decadal fluctuations in mean precipitation and temperature on runoff: a sensitivity study over the United States. Climatic Change, 1989, 15:423-447.

MA, 2003, Ecosystems and human Well-Being: A framework for Assessment. Island Press, Washington DC.

Mitsch, W.J., J.G. Gosselink, C.J. Anderson, and L. Zhang.(2009) "Wetland Ecosystems". John Wiley & Sons, Inc., New York, 295 pp

Muriithi, S. and Kenyon, W. (2002), "Conservation of biodiversity in the Arabuko Sokoke Forest, Kenya", *Biodiversity and Conservation*.

Murtough, G., Aretino, B. and Matysek, A. (2002), Creating Markets for Ecosystem Services, Productivity Commission Staff Research Paper, AusInfo, Canberra.

Nachmias D. and Chava F. N. Research methods in the Social Sciences 2nd ed. Replica Press Pvt. Ltd India (2005) p.12-64

Nyakaana Jockey Baker (2008):African Journal of Environmental Science and Technology, Vol. 2 (10) (pages 326 to 335); Sustainable wetland resource utilization of Sango Bay through ecotourism development

UNESCO-IHE Global Partnership for Water Education and Research: UNESCO-IHE Partnership Research Fund (UPaRF) (2010):Call for Proposals for Small Size Research Projects (UPaRF Category III)

Republic of Kenya, District data survey reports of 2002- 2010. District by district report and analysis. Nyando district report, ibid.

Rodríguez, J. P., T. D. Beard, Jr., E. M. Bennett, G. S. Cumming, S. Cork, J. Agard, A. P. Dobson, and G. D. Peterson. 2006. Trade-offs across space, time, and ecosystem services. *Ecology and Society* **11**(1): 28.

UNDP (2004a), "The Millennium Goals for Development and Biodiversity" available from http://www.undp.org/biodiversity/mdgandbiodiversity.html. Site used on 23rd July 2012

Walsh, M., Shepherd, K. & Verchot, L. 2004. Identification of sediment sources and sinks in the Nyando River Basin. *In* D. Mungai, B. Swallow, J. Mburu, L. Onyango and A. Njui, eds. *Proceedings of a Workshop on Reversing Environmental and Agricultural Decline in the Nyando River Basin.* Nairobi, ICRAF, NEMA, the Water Quality Component of the Lake Lake Victoria Environment Management Programme (LVEMP), and the Ministry of Agriculture and Rural Development

Wilcox, Douglas A. "Wetland." Microsoft® Encarta® 2009

Wood P J, Hannah D M and Sadler J P. Hydroecology and Ecohydrology, Past, Present and Future. John Wiley & Sons, 2007.

WWF (2004), "The Economic Values of the World's Wetlands", report prepared with support from the Swiss Agency for the Environment, Forests and Landscape (SAEFL), Gland/Amsterdam.

Zavaleta, E.S. (2000), "The economic value of controlling an invasive shrub", *Ambio*, 29(8):462-467.

Zedler, J. B., and S. Kercher. 2005. Wetland resources: Status, ecosystem services, degradation, and restorability. Annual Review of Environment and Resources 30:39-74. Annual Reviews, Palo Alto, CA.

APPENDICES

Appendix 1: Plan of work and Time frame

Phase/activity	**Time(month)**	**Dates**
Development of proposal • Literature search • Topic consultations with the supervisors • Drawing the research outline • Actual proposal text writing	2	May 2011 –June 2011
Piloting • Developing the instruments • Administering the instruments for pilot • Testing the instruments and research questions • Restating the research questions	2	July 2011-August 2011
Data collection • Going to the field to collect data • Recording the collected data	3	October 2012-December 2012
Data organization, analysis and interpretation • Grouping the data collected • Coding the data • Testing the data using analysis instruments • Relating the answers given to the expected	2	January 2013-February 2013
Report writing /editing/submission • Developing the final text • Making the corrections • Consultation with the supervisor	3	March 2013 - May 2013

Appendix 2: Budget

N o.	**Item**	**Description**	**Estimated Amount (Kshs)**
1.	Personnel	6 field assistants @ 500 per day for 21 days(in intervals) Training of the6 field assistants	63,000 20,000
2.	Printing materials	Papers, binding cost, writing materials, drinks for focused group discussions etc.	35,000
3.	Recording machine	CD's, flash discs, digital camera, lap top	43,500
4.	Transport	Fare	10,000
5.	Accommodations	Food and housing , @800 per day for 1 month	24,000
6.	Services	Photocopy, secretarial	6,500
7.	Miscellaneous	Internet/cyber, modem.	11,500
Total			**213,500**

Appendix 3: Focus Group Discussion Guide

Topic: VALUATION OF SELECTED WETLAND RESOURCES AND THEIR CONTRIBUTION TO HOUSEHOLD INCOME IN LOWER NYANDO RIVER BASIN, KISUMU COUNTY, KENYA

1. Are there people who migrated to the area? Yes/No
2. What are the reasons for migration?
3. Do people own land in the wetland? Yes/No
4. How did they acquire land (they own)?
5. What are the activities practiced in the wetland?
6. How much do you obtain from the activities you carry out in the wetland?
7. What is the common unit of measurement of income for these activities?
8. What is the economic/monetary value of the above unit of measurement?

Crop Cultivation

9. Which crops are grown in the wetland?
10. How often are these crops grown/ harvested?
11. Apart from crops grown, what are other activities practiced and when are they gaining their vitality?
12. How do you rate the trend in income/ productivity I the last 10years?
13. What impact do the crops grown have in the wetland?
14. What impact does the over-utilization of the resources have on the wetland?
15. In case of negative impact in 14 above, what do you suggest as solutions?
16. Apart from the activities/ crops grown in the area, are there alternative activities engaged in by the communities?
17. If yes, in 16 above, on what season do they carry out the alternative activity? Mention the alternative activity.
18. Of what impact would the alternative activity (ies) be to the wetland?
19. On average, what is your expenditure on the following items in the area?

20. How much would it cost you to feed you family if not producing crops from the wetland farms?
21. How much would you be willing to pay to continue using the wetland as a grazing point for your livestock?

Appendix 4: Key Informant Interview Guide

Topic: VALUATION OF SELECTED WETLAND RESOURCES AND THEIR CONTRIBUTION TO HOUSEHOLD INCOME IN LOWER NYANDO RIVER BASIN, KISUMU COUNTY, KENYA

1. Do people own land in the wetland? Yes/ No
   If Yes in 1 above, how did they acquire the land/
2. What are the activities practiced in the wetland?
3. How much do you obtain from the activities you carry out in the wetland?

Crop cultivation

4. Which crops are grown in the wetland?
5. How often are these crops grown/ harvested?

Crop	When grown/ Harvested in the wetland

6. Apart from crops grown, what are other activities practiced and when are they gaining their vitality?

Activity/ Resource use	Vi

7. Of what impact would/ are the alternative activities to the wetland?

Alternative activity	Impact on the wetland

8. What impact do farming/ crops grown have in the wetland?
9. What impact do the over utilization of the resources have on the wetland?
10. In case of negative impact in 8 and 9 above, what do you suggest as solutions?
11. On average, what is your expenditure on the following items in the area?

Item	Expenditure
Food	
School fees	
Health	
Farming	
Investment	
Leisure	
Savings	
Others (specify)	

12. How would food security be attained in the wetland?
13. From the wetland activities, how do you rate the trend in income in the last 10yrs?
14. How much would it cost you to feed your family if not producing any crops from the wetland farms?
15. How much would you be willing to pay to continue using the wetland as a grazing point for your livestock?