IMPACTS OF RESOURCE USE CONFLICTS ON FOOD SECURITY IN NYANDO WETLANDS, KISUMU COUNTY, KENYA

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DECLARATION

Declaration by the Candidate

This Thesis is my original work and has not been submitted for any academic award in any institution; and shall not be reproduced in part or full, or in any format without prior written permission from the author and/or University of Eldoret.

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DEDICATION

This thesis is dedicated to my dear husband, Prof. Phillip Raburu, my loving children Jessica, Eugene, Steve and Joy for their immense support during the study period.

I also dedicate it to my late father, Mr. Hosea Oluoch who ensured that I got basic education and my late mother, Mrs. Anne Oluoch who really longed that I get higher education before she died.

ABSTRACT

Nyando Wetlands are a multi-use resource that provides the riparian community with a range of interrelated environmental functions and socio-economic benefits, which support a variety of livelihood strategies. This study set out to assess the impacts of resource use conflicts on food security in Nyando Wetlands, Kenya. The study evaluated the changes in wetland resources between 1982 and 2012, the types and causes of conflicts associated with wetland resource use, and to establish the relationship between resource use conflicts and food security among communities living in Nyando Wetlands. The study was carried out between February and April, 2012, and used various participatory techniques to collect data, including in-depth household interviews with 384 randomly selected wetland resource users. Key Informant Interviews (KII), Focused Group Discussions (FGD) and direct observations were used in extracting information on underlying relationships between changing wetland resources, conflicts and food security. Secondary data from published and unpublished materials was reviewed to complement primary data. The data was entered and analyzed using SPSS Version 20 and results tested at 5% level of significance using Descriptive Statistics, Nominal Logistic Regression, Cluster Analysis and Spearman Correlation. The indicators for wetland degradation were wetland resources like fish, vegetables, birds, animals, insects, and water. The results show that most of the resources used as food by the community such as fish (90%), vegetables (81%) and some animals (63%) which were abundant in the wetland had reduced between 1982 and 2012 by 20%, 8%, and 18% respectively due to anthropogenic activities. The same applies to wetland plants used as building materials, fuel wood, fencing, animal feed, medicinal purposes, making fish traps, ropes, furniture, mats and brooms. Three major types of conflicts were recorded. Human-human conflicts arose mainly due to land disputes (61%), human-wildlife conflicts arose mainly from crop destruction (79%) while conservation-resource utilization conflicts were attributed to overdependence on the wetland resources by the riparian community. Generally, as the conflicts increased, food production decreased. Floods, drought and human pressure leading to overdependence on the Nyando Wetlands resources were significantly ($p < 0.05$) the major cause of conflicts that led to reduced food production. It is recommended that a comprehensive wetland management plan be developed to ensure sustainable exploitation of wetland resources. The Nyando Wetlands community should also be empowered to embrace wise use principles (importance of maintaining a balance between wetland utilization and maintenance of ecosystem diversity) through education and awareness creation to minimize conflicts and enhance food security for improved community livelihood. Policies should also be put in place at the Kisumu County level to conserve Nyando Wetlands biodiversity which plays a major role in food security.

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LIST OF ABBREVIATIONS AND ACRONYMS

CBO	Community Based Organization
CBS	Central Bureau of Statistics
EMCR	Environmental Management and Coordination Regulations
FAO	Food and Agriculture Organization
FGD	Focused Group Discussions
GOK	Government of Kenya
KII	Key Informant Interviews
KNBS	Kenya National Bureau of Statistics
KWS	Kenya Wildlife Service
LDC	Least Developed Countries
MDG	Millennium Development Goals
MEA	Millennium Ecosystem Assessment
MT	Metric Tons
NEMA	National Environment Management Authority
NGO	Non-Governmental Organization
ROK	Republic of Kenya
SPSS	Statistical Package for Social Sciences
VIRED	Victoria Institute for Research on Environment & Development
WFP	World Food Programme
WRI	World Resources Institute
WRMA	Water Resources Management Authority

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Human populations continue to grow despite the decline in natural resources which forms the backbone of livelihoods of local communities. The global population is expected to peak at 9 billion by 2050 according to the United Nations Population Division (Population Reference Bureau, 2010). In an environment already constrained and/or changed by human activities, greater scarcity of energy, water and food vital to the maintenance of both the economic order and the preservation of human life in general is expected (Brock, 2012). At current population levels, demand for these key resources is already unsustainable. As the number of people on the planet and those of people living affluent lifestyles increases, with emerging impacts of climate change, greater competition over resources is highly probable thus further affecting individuals, communities and states.

Communities in sub-Saharan Africa are most vulnerable to resource scarcity; with low incomes and poverty already limiting access to resources that sustain life. Further depletion of resources will reduce opportunities for development and empowerment, both locally and nationally. Competition over natural resources will further increase tension resulting into violent conflicts between communities within national boundaries and countries (Abbott, 2008).

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 2006). The notion of food security has expanded in recent years from a relatively static focus on food availability to one that recognizes long-term concerns about access and resources. FAO (2008) outlines the four main components of food security as food availability, food accessibility, food utilization, and food system stability – which implies affordability. Hendrix (2011) reports that in the recent past, rising world food prices and the global economic downturn increased the ranks of the world's food insecure persons from 848 million to 925 million by September 2010, reversing decades of slow yet steady progress in reducing hunger (WFP and FAO, 2010).

Climate change is already, and will increasingly play a pivotal role in food security (Easterling *et al.*, 2007; FAO, 2010). Climate change will affect all the four dimensions of food security. It will likely alter the functioning and resilience of ecosystems such as wetlands and forests, which underpin the livelihoods of dry land inhabitants and which already provide important safety nets in times of need. In this respect, the achievement of the Millennium Development Goals (MDGs), particularly MDG-1 that focuses on eradication of extreme poverty and hunger and MDG-7 on ensuring environmental sustainability, may well be jeopardized by the impacts of climate change (Chapman *et al.* 2011, United Nations, 2012). Climate change will impact most strongly on those who are already food-insecure, subject to existing high levels of climate variability and stress, and unable to cope with, or adapt to, the additional stressors. Many countries in sub-Saharan Africa, notably the Least Developed Countries (LDCs), that are over-reliant on rain fed agriculture for food

production, have a large poor rural population engaged in subsistence farming, and poorly developed infrastructure. East Africa is one of the regions likely to suffer negative impacts of climate change on several crops such as maize and sorghum which are very important to large food-insecure populations (Lobell *et al.*, 2008).

Kenya is riddled with conflicts associated with instability, as was evident in the widespread violence in the wake of the two last national elections in 2002 and 2007 (Klopp and Kamungi, 2008). Much of the violence took place in rural areas, where conflicts and competing claims over natural resources appear closely entangled. Indeed, issues of land ownership, access and use are central to political, economic and cultural tensions which bring conflicts among Kenyan communities. Due to inappropriate land tenure systems, a large segments of the population continue to have difficulties not only in adapting to the modern agrarian economy, but also in coping with the increasingly fragile environment, land degradation and low agricultural output, leading to increasing entrenched poverty.

Kenya's vulnerability to conflict over natural resources was again highlighted in 2009, during the severe and prolonged drought that affected much of East Africa. Vast areas became parched and barren, wildlife numbers decreased and thousands of livestock died of thirst and starvation. This coincided with reports of rising armament among communities in the arid lands of northern Kenya and increasing outbreaks of violent, inter-community conflict (Conservation Development Centre, 2009).

Resource use conflicts have also been reported in the utilization and management of wetland resources in Kenya. Wetlands within the Lake Victoria basin have and

continue to be under pressure from conversion to other uses that include agriculture, settlement, potential for tourism amongst others due to changes in demographic trends and increasing need for more food security (Kairu, 2001; Odada *et al.*, 2009). For example, conflicts over the Yala Swamp resources which is Kenya's largest wetland, has escalated in the last decade as access of the local population has increasingly been restricted by the introduction of a leasing system. In 2003, Dominion Farms (K) Limited, a multinational company based in Oklahoma USA, entered into a 25 years lease agreement with the Government of Kenya through both the then Siaya and Bondo County Councils to develop 6,900 ha of the swamp under the Yala Swamp Integrated Development Project giving rise to conflicting issues including access to the swamp, wetland resource use and ownership rights by local population (Kinaro, 2008).

Nyando Wetlands are a multi-use resource that provides the surrounding community with a range of interrelated environmental functions and socio-economic benefits, which support a variety of livelihood strategies. The wetlands contribute directly to food security by providing products that people can utilize and/or sell to provide them with cash for purchasing food. The crop harvested from the wetland areas is always ready throughout the growing season when the supply of food from the upland fields and other regions is insufficient for many families and the "hungry season" is starting, hence the produce from the wetland areas plays a major role in supplementing their food security. Due to the ever increasing human population and effects of climatic change, pressure on Nyando Wetland has intensified as riparian communities desperately look for moist and fertile lands for crop growing, especially during dry season, leading to increased frequency of resource use conflicts in the area (Obiero *et*

al., 2012). The increased frequency of conflicts has further exacerbated the food insecurity situation in the region (Raburu *et al.,* 2012).

Despite the occurrence of resource use conflicts within the Nyando Wetland, the underlying causes/drivers and impacts of such conflicts on food production is not well understood. The objective of this study was therefore to provide a better understanding of wetland resource use conflicts and in particular their impacts on food production in the wetland areas. The study also identifies management issues and proposes a broad vision for the future that will help minimize conflicts and food insecurity in the area.

1.2 Statement of the Problem

Nyando Wetlands, one of the major deltaic wetlands on the shores of Lake Victoria provides goods and services that are critical to sustaining community welfare and livelihoods. Despite this, riparian communities surrounding the wetlands are categorized as the most food insecure with a high poverty index (CBS, 2003). Nyando District is a food deficit zone despite being considered 99% cultivatable (GOK, 2009). Although the region is endowed with abundant land and fisheries resources, the inhabitants of the study area continue to be among the poorest and most food insecure in Kenya, always meeting their food requirements by importing food from neighbouring Districts. For instance, the district produced 33,892 MT of cereals in 2005 as compared to its annual cereal demand of 51,465 MT (GOK, 2009). The Nyando Wetlands cultivation can be seen as a critical survival mechanism and a source of food security, especially for those people whose harvest from upland areas

was poor following recurrent droughts in other parts of the District (Swallow *et al.,* 2008).

Despite the important roles played by the Nyando Wetland in sustaining community livelihoods, they are now threatened by the already high and increasing population density of both humans and livestock, changing community lifestyles, pollution of surface water sources, unplanned human settlement and deforestation, limited access to clean water/sanitation and inappropriate and degrading fishing practices (Obiero *et al.*, 2012; Raburu *et al.*, 2012). In addition, the ever increasing human population and the effects of climate change has led to increased competition over land for crop cultivation, water and other wetland resources, especially during dry season, leading to destruction of wetland habitats and loss of biodiversity. The competition is fuelled by the 'tragedy of the commons' (Hardin, 1968) as wetlands are public trust resources and therefore not under the ownership of any individual. Consequently, a number of wetland resource use conflicts are highly likely thus compromising the already worse food security situation. There is therefore need to identify the causes and impacts of these conflicts to ensure sustainable food production, and promote the wise use of Nyando Wetland resources for posterity.

1.3 Justification of the Study

Conflicts between sustaining the livelihoods of the local communities' and national and international concerns for conservation of biodiversity and environment have increasingly received a significant amount of research and policy attention (Castro and Nielsen, 2003). Despite this, little attention has been paid to local conflicts over

the use and management of wetland-based natural resources such as soil, plants, trees and animals by small scale resource poor communities. Yet, these are probably the most common and widespread conflicts affecting natural resource management practices and livelihood options of the large number of small-scale farmers who constitute the bulk of rural population in Kenya. The activities of these rural populations who depend entirely on natural resources for their livelihoods are also the major culprits in the degradation of the environment. In Nyando River basin, there is currently very little information on the impacts of wetland resource use and the emerging conflicts among local communities and the overall impacts of these conflicts on food security in the region. This study therefore aimed at filling these gaps in knowledge by assessing the conflicts that arise due to resource utilization and their impacts on the overall food security in the Nyando Wetlands region. The findings are crucial for wetland resource management planning process which would guarantee a healthy environment and sustainable exploitation of wetland resources for increased food security among the riparian communities.

1.4 Objectives of the Study

1.4.1 Overall Objective

The overall objective of this study was to assess the impacts of resource use conflicts on food security in Nyando Wetlands, Kenya.

1.4.2 Specific Objectives

i) To determine the resources found in Nyando Wetlands and evaluate their changes as they are used by the local communities between 1982 and 2012.

ii) To determine the types and causes of resource use conflicts.

iii) To establish the relationships between the resource use conflicts and food security.

1.4.3 Research Questions

The study was guided by the following research questions:

i) What resources are found in Nyando Wetlands and what changes have occurred as they are used by local communities between 1982 and 2012?

ii) Which types of resource use conflicts have occurred in the wetlands and what are the causes of these conflicts?

iii) What relationships exist between the resource-use conflicts and food security?

1.5 Scope of the Study

The survey was conducted among communities living in the Nyando River mouth Wetlands in the lower catchment of Nyando River Basin which traverses three administrative Districts namely Kisumu East, Nyando and Nyakach in Kisumu County. The target populations were residents living closer to wetlands fringing the Lake Victoria. Data was collected using various participatory techniques, including

in-depth household interviews using semi-structured questionnaires administered to a representative sample of 384 randomly selected wetland resource users such as farmers, fishers, traders, herdsmen and craft makers.

Key Informant Interviews (KII) was limited to those involved in the management of wetland related resources such as land and water. Focused Group Discussion (FGD) groups were based on resource users of different gender, resource use and geographical location within the wetland study boundary. Direct observations were made throughout the study while traversing the study area and interacting with the communities and the environment. Although respondents were randomly selected, every attempt was made to get a balanced opinion of socio-economic issues in the study areas and how they affect wetland management, putting issues of resource use conflicts and food security into consideration.

1.6 Limitations of the Study

The study was limited to the assessment of resources and resource use conflicts in Nyando Wetland and its implications on food security among the Nyando Wetland communities. The main limitation was the reluctance of some respondents to answer questions associated with variables such as level of income, household monthly income, family size and marital details as well as incomplete responses. To solve this limitation, all the respondents were pre-briefed and given an assurance of individual anonymity and confidentiality. Results of the study are derived from data collected and analysed based on a representative sample of the wetland areas population.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview of Wetlands and their Resources

Globally, wetlands occupy about 6% of the earth's surface (Mitsch and Gosselink, 1993). The Ramsar Convention of 1971 defines wetlands as "*areas of marsh, fen, peat land or water whether artificial or natural, permanent or seasonal 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 6 meters"*. In Kenya, the Environmental Management and Coordination Regulations 2009, on Wetlands, Riverbanks, Lakeshores and Sea Shores Management which are largely based on the Ramsar Convention define wetlands as '*areas permanently or seasonally flooded by water where plants and animals have become adapted; and include swamps, areas of marsh, peat land, mountain bogs, banks of rivers, vegetation, areas of impeded drainage or brackish, salt or alkaline; including areas of marine water the depth of which at low tide does not exceed six metres*'.

The foregoing definitions of the Ramsar Convention and NEMA's Wetland Regulations are fairly extensive and include shallow lakes, ox-bow lakes, dams, river meanders and floodplains, lakeshores as well as marine and intertidal areas such as deltas, estuaries, mud flats, mangroves, salt marshes, sea grass beds and shallow reefs (MEMR, 2012). Consequently, wetlands provide many ecological and socio-economic goods and ecological services which support community and individual

livelihoods and environmental integrity important for biodiversity (de Groot *et al.,* 2002; MEA, 2005).

Wetlands represent one of the vital natural resources Kenya is endowed with. Kenya's wetlands occupy about 3% to 4%, which is approximately 14,000 km^2 of the land surface and fluctuates up to 6% in the rainy seasons. They provide ecological services including climate modification, water purification, waste water treatment, flood control and water storage and distribution in space and time (Kipkemboi *et al.,* 2007; van Dam *et al.,* 2011; Morrison *et al.,* 2012). Direct uses include water for domestic purposes, livestock watering, source of fish, medicinal plants and animals and various materials (Katua and M'mayi, 2001; Gichuki *et al.,* 2001; Ogutu *et al.,* 2003; Raburu *et al.,* 2012).

Lake Victoria wetlands constitute a vital life support system for about 12 million people who extract fresh water, fish, medicinal plants and building materials from these ecosystems (Kayombo and Jorgensen, 2006). Although the overall value of wetlands in Kenya has not been quantified, it is clear that they have vital attributes such as biological diversity, gene pool research materials, cultural values and aesthetic values.

A large body of literature exists on Nyando Wetlands resources, their uses and management for the last two decades (Katua and M'mayi, 2001; Gichuki *et al.,* 2001; Kipkemboi, 2006; Maithya *et al.,* 2011; Obiero *et al.,* 2012; Raburu *et al.,* 2012). A study by Obiero *et al.* (2012) noted that the extensive Nyando Wetlands are utilized by the community on both seasonal and long-term basis in their quest for livelihood

benefits. Consumptive use activities include farming, fishing, livestock rearing, and wetland biomass harvesting form the main livelihood activities. Results by Obiero *et al*. (2012) show that two activities, namely crop production (92%) and harvesting of wetland macrophytes (86%) obtained 'high importance' ranking scores. Five other activities such as livestock grazing (78%), fishing (72%), harvesting medicinal plants (61%), and human settlement (55%) were ranked as 'important'.

A recent investigation by Morrison *et al.* (2012) indicated that papyrus (*Cyperus papyrus*, L.) harvested from Nyando Wetlands is a highly valued source of natural capital, providing multiple benefits to impoverished riparian communities. Papyrus harvesting for craft making forms the backbone of most household economy and can also be preserved by farmers as dry season fodder for livestock (Kipkemboi, 2006). The vast majority (95%) use the plants' stems (in some cases this represents waste material discarded during commodity production, in others plants are harvested explicitly for use as fuel), but a large proportion (69%) also use the roots (being woodier and thus burning more efficiently) which greatly reduces the regenerative capacity of the plant (Morrison *et al.*, 2012). Phragmites *spp*. and papyrus have additional uses in house construction where they are used as rails to hold mud on the hut walls (Schuyt, 2005; Kipkemboi, 2006). Papyrus culms are also used to make ropes to tie these rails firmly on the poles as a substitute for nails. Clay soils from wetlands are mixed with cow dung and used to plaster rural huts. Wetlands are also popular grazing grounds during dry and wet seasons. According to Maithya *et al.* (2011), 60 to 80% of respondents in locations survey in his stud, pointed out that during the dry season grazing was done inside wetlands.

Against this background, it is worth noting that the importance of wetlands is often associated more with direct consumptive use values like crop cultivation, human settlement, and extraction of useful materials. The essential life support processes for example stabilization of the hydrological cycle and microclimates, protection of riverbanks, nutrient and toxin retention, and sewage treatment are the least recognized because of their indirect nature. Destruction of these ecosystems poses a serious environmental problem to the country. Due to their ecological significance and importance to the livelihoods of the local populations, Nyando Wetland needs to be conserved and sustainably managed.

The enormous socio-economic potential of Nyando Wetland has not been fully exploited, primarily because of limited knowledge on wetland ecosystems and little appreciation of their role in alleviating poverty and supporting sustainable development. Despite the existence of different studies on Nyando Wetlands resources, information on temporal changes in the availability and abundance of resources used as food by local communities over the last three decades is scanty. This study set out to close this knowledge gap by highlighting the changes and the possible consequences on food security in the region.

2.2.1 Types of Wetland Resource use Conflicts

Natural resource conflicts are disagreements and disputes over access to, and control and use of, natural resources (FAO, 1998). These conflicts often emerge because people have different uses for resources such as forests, water, pastures and land, or want to manage them in different ways. Wilmot and Hocker (2007) noted that a

conflict is an expressed struggle between at least two interdependent parties who perceive incompatible goals, scarce resources, and interference from others in achieving their goals. These parties may be individuals, small or large groups of individuals, organizations and even countries. In Kenya, as is the case in many countries, various groups, communities, developers, the government and other organizations have differing ideas of how to access and utilize environmental resources hence fuelling resource use conflicts (Muigua, 2009).

Conflicts can be categorized in terms of whether they occur at the micro–micro or micro–macro levels, for instance among community groups or between community groups and outside government, private or civil society organizations (Grimble and Wellard, 1997; Warner, 2000). Micro–micro conflicts can be further categorized as taking place either within the group directly involved in a particular resource management regime such as a forest user group or ecotourism association, or between this group and those not directly involved like between the user group and women entering the forest to collect fuel wood (Conroy *et al.,* 1998). These natural resources management (NRM) conflicts have been on the increase, and if ignored, can escalate and result into further degradation of natural resources, erosion of social and human capital and pose significant challenges to achieving sustainable rural livelihoods. In Kenya, several authors have reported the occurrence of different kinds of conflicts in natural resource use and management (Kinaro, 2008; Obiero *et al.,* 2012).

A recent study by Obiero *et al.* (2012) noted resource based conflicts in Nyando Wetland to be in three broad categories. These include: human-human conflicts; human-wildlife conflicts and utilization-conservation conflicts. The types and

dimensions of these conflicts are complex and range from intra-and supra-household gender relations, land disputes to antagonist, distrustful relationships and violent clashes amongst different wetland users, and between resource users, local communities, government and external institutions.

Human-human conflicts are fuelled by the excessive fragmentation of the very small agricultural land, and the high competition over the use of farmland (Ruhanga and Iyango, 2010). In addition, unpredictable climate changes coupled with unsustainable consumptive utilization activities such as increased pressure on agricultural land and over-exploitation of wetland vegetation have been the major source of increased frequency of conflicts in the study area (Raburu *et al.,* 2012).

Human-wildlife conflict (HWC) has emerged as one of the potential threats to conserving key wildlife species and a major challenge for wildlife managers to address (Obiero *et al.,* 2012). Crop and livestock degradation, human casualties due to attacks and property damage are among the major types of HWC. Increasing incidences of HWC mostly in the peripheral areas of unprotected wetland areas has resulted in increasingly negative attitudes among the local communities towards the conservation of these important wildlife resources (Hill *et al.,* 2002). Incidents of retaliatory killing of wildlife commonly observed in different parts of the country have further compelled managers to develop and implement cost effective and practical solutions to address this problem for example compensation for damaged crops.

Apart from human-human and human-wildlife conflicts arising from the use of wetland resources, other conflicts arise because some wetland uses are in conflict with environmental conservation priorities. In Kenya, there is inadequate and/or weak institutional coordination and links on environmental management in general and wetland conservation in particular (Muigua, 2009). Wetland use and management is dispersed in several government and non-governmental organizations with no strategies and programmes and operational coordinating mechanisms at most levels leading to conflicting policies (NEMA, 2011). As a result, interventions calculated to maximize benefits from wetlands to communities are not sustained and end up not causing the expected impact on the ground.

Few studies have been carried out to identify the different kinds of resource based conflicts in Nyando Wetland area and their possible impact on food security. Resource use conflicts normally compromise the integrity and sustainable utilization of wetland resources for community livelihood improvement. This issue needs to be investigated if any meaningful solutions and conflict resolution mechanisms are to be developed for the Nyando Wetland community to co-exist with these resources for posterity.

2.2.2 Causes of Wetland Resource use Conflicts

Conflicts over the use and management of natural resources are widespread yet the underlying reason why the conflict emerges is often more complex (Bennett *et al.*, 2001). There is a large body of literature that analyses the emergence of conflicts in natural resources, their potential impacts and management (Homer-Dixon, 1994;

Hendrickson *et al.*, 1998; Warner, 2000; Bennett *et al.*, 2001; UNEP, 2009). Warner (2000) identifies four issues that may explain the emergence of conflicts. These include a) demographic change due to sharp influx of new-comers perhaps driven by declining economic or ecological well-being in other sectors and b) natural resources competition as a result of increased dependence upon natural resources can heighten competition for space and resources. Others are c) developmental pressures such as government policy switches from livelihood protection to food production and d) structural injustices due to changes in legislation that deny or severely restrict access to a resource by dependent groups in society.

A recent report by UNEP (2009) provides a framework for understanding three main ways in which resource availability or access may change, and how this can lead to conflict between user groups (Figure 1). These pathways can be grouped into three categories. First, *when demand for natural resources exceeds supply*. Tensions may develop between competing user groups when the overall supply of key renewable resources can no longer support the needs of the local population. Where these tensions intersect with other issues, such as socio-economic, ethnic or religious cleavages, they can contribute to violent conflicts. Secondly, *the degradation of natural resources reduces supply*. The depletion or degradation of a specific resource can occur for a number of reasons, including overuse, pollution and violent conflict itself. For example, pollution from industrial activities, agricultural run-off and poor management of waste can impact on water quality, leading to health risks and diseases, which can act as a source of grievance. Decreases in the supply of resources can also place different user groups into direct competition and lead to conflict. Lastly, *access to natural resources is restricted or unequal.* When one user group

controls access to renewable resources to the detriment of others, natural resource-dependent communities are often marginalized. Violence can occur as these groups seek greater or more equitable access to key resources (UNEP, 2009).

Increasing attention has been paid to the linkages between climate change and conflict or insecurity in recent years. This is prompted by the concern that the environmental effects of climate change, especially the depletion of natural resources will create conditions that increase the risk of violent conflict (Conservation Development Centre, 2009). Nyando Wetlands, which are found in a largely semi-arid area, are particularly at risk. The problem is compounded by rapid urbanization, reducing soil fertility, increasing human population and their various activities which contribute to the decline of quality and quantity of wetlands due to pressure beyond the ecosystem's carrying capacity (Morrison *et al.*, 2012). Figure 1 highlights the causes of environmental scarcity and natural resource conflicts.

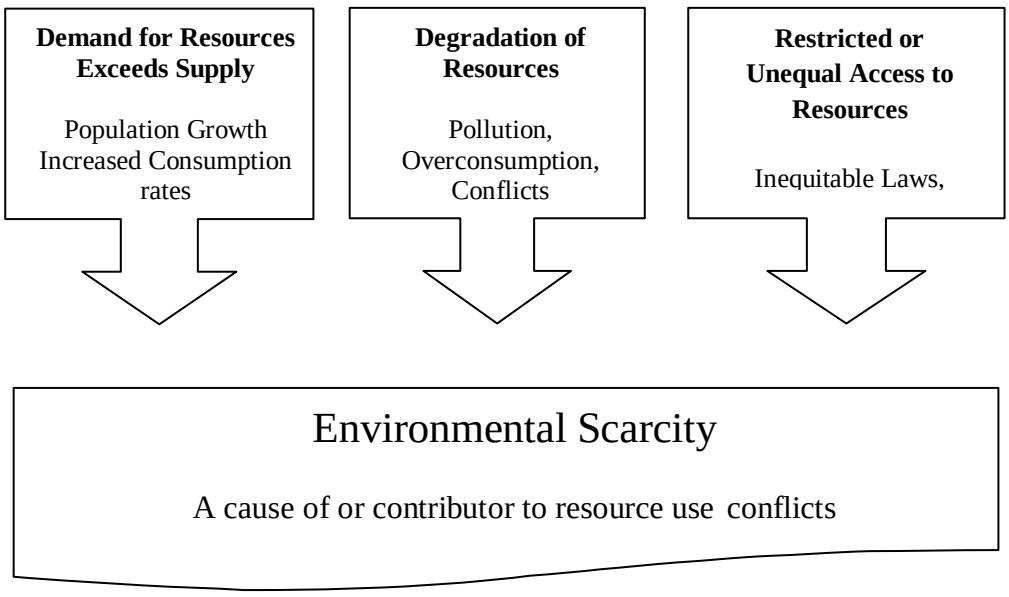

Figure 1: Causes of Environmental Scarcity and Natural Resource Conflicts (Source: (UNEP, 2009)

Most of Lake Victoria Basin lies in the lowlands and is therefore exposed to floods and relatively long periods of droughts. During floods, people tend to migrate from the affected areas to highland areas considered safe, while during droughts local community members search for grazing lands for their livestock in the higher areas and along river valleys. Frequent alterations in the river course and water levels leads to frequent human-human and human-wildlife conflicts in the wetlands. The migration of the river mouth between Nyakach and Kano affects communities bordering the wetlands leading to disputes on community boundaries. Apart from this, the destruction of papyrus swamps may displace wildlife such as the hippopotamus causing human-wildlife conflicts. Further, burning of wetland habitats may cause migration of birds into rice paddies in pursuit of new sanctuaries and feeding grounds, and this may lead to crop destruction, damage or loss.

Another potential contributing factor of resource use conflicts in Lake Victoria basin wetlands arises due to the ambiguous nature of land ownership and user-rights. This situation is likely to create uncertainties and in some cases room for irresponsible behaviour. Wetlands are a common property resource in Kenya and is therefore vulnerable to misuse (NEMA, 2012). However, land tenure and ownership in wetland areas is not clear, thus compromising the success of community based wetland management initiatives (Raburu *et al.*, 2012).

According to a socio-economic survey conducted during the Nyando Wetland Resource Utility Optimization Project, 65.3% of the respondents indicated that wetlands are owned by local communities while 34.7% showed that the wetlands are owned by the government. However, the nature of this ownership is not clear as some

parcels of land allocated to individuals within the wetland areas by the Ministry of Lands, fall under areas which should legally be protected. Some claims on parcels of land in the wetlands are sometimes also based on ancestral inheritance, and have been a source of continuous human-human conflicts. This is particularly so whenever the Lake water level recedes, thus exposing it to degradation forces (Obiero *et al.*, 2012). An analysis of the different types of conflicts and their drivers is therefore important in understanding their possible impacts on food security among Nyando Wetlands communities.

2.3 Relationship between Wetland Resource use Conflicts and Food Security

Wetland agriculture is important for poverty reduction and food security in many developing countries (Frenken and Mharapara, 2002). Although in the short-term the agricultural development of wetlands results in an increase in the provision of food, in the long term it often increases the input of pollutants, removes their natural filtering function, and reduces other ecosystem services (Terer *et al.*, 2005; McCartney *et al.*, 2010). Agriculture in and around wetlands can lead to conflict between farmers and other wetland users. The most frequent impact of the development of wetland agriculture is losses in subsistence agriculture, which are offset by gains in market-orientated agriculture which is often associated with intensive water use (McCartney *et al.*, 2010). Agricultural intensification in wetlands therefore often results in groups of people being reliant on subsistence agriculture losing out, with a negative feedback cycle occurring where productivity losses lead to further expansion and transformation of wetland areas (Wood and van Halsema, 2008). This in the long run affects productivity leading to shortfalls in food production.

Nyando Wetlands play a vital role in the lives of people by helping them achieve food security during the "hunger season" when upland crop production is minimal due to prolonged droughts in the region (Obiero *et al.,* 2012). The major cash crops grown in the wetlands are rice, cotton and sugarcane that provide an income that is used for purchasing food from local markets. A study by Swallow *et al.* (2008) revealed that the residents of the lower Nyando basin have become even more dependent on maize over the last 15 years, with accompanying drops in area covered by minor crops such as millet, cassava, pyrethrum, and potatoes. Occasioned by the ever increasing human population and unpredictable climatic variations, conflicts have occurred within the wetland as people scramble for pieces of terrestrialized land to grow rice, sugarcane and other horticultural crops. For instance, Raburu *et al.* (2012) reported that during the period between 1992 and 1995, Okana Wetland dried up completely as a result of severe drought, triggering a series of conflicts over land between Okana and the neighboring Sidho community. The conflict lasted almost one year, with conflict resolutions attempts by the government yielding very minimal results. Due to drought and reduced productivity, food insecurity set in as there was a drastic reduction in the production of indigenous food crops like sorghum and millet, and mass death of livestock (Raburu *et al.,* (2012).

Fisheries also play a critical role in the food security of the local people living around Nyando Wetland. The unique hydrological cycle of Lake Victoria influences the fisheries of the Lake, which together with its seasonally flooded wetlands, has a high diversity of fish species (Kiwango and Wolanski, 2008).

The recent lake water recession has had severe social and ecological consequences. It has resulted in social conflicts between different resource users as they compete for land exposed by receding water levels thus resulting in reduced fish food catches (Obiero *et al.*, 2012). As the lake level receded, breeding and nursery sites were exposed and left dry following the clearing of dominant macrophyte for crop cultivation. On the other hand, lake level recession also made livestock grazing areas smaller due to clearing of vegetation while the distance walked to livestock watering and grazing grounds become longer. Kipkemboi (2006) noted that most farmers sold their livestock due to lack of pasture to avoid the raging conflicts that occurred in the area during dry seasons. Despite the link between wetland resource use conflicts and food insecurity in the area, the relationship between the two variables is not yet well understood, therefore this study is timely.

2.4 Theoretical Framework

This study adopted the Game Theory as the theoretical framework. The Game Theory advanced by (Straffin (1993) is described as a way of understanding conflicts that arise in resource use and in developing appropriate measures. It describes the manner in which two or more decision makers strategize and make choices in a possible conflict situation. Therefore games exist and decision makers are called players. The complications involved in the game therefore increase with the number of players.

This theory helped in analyzing the role of the different players (the different stakeholders of the wetland) in the Nyando Wetland. The assumptions that accompany the theory is that each player can decide between two or more clear

choices, called strategic choices. Every decision a player makes leads to either a win, a loss, or a draw of the game and these moves will have a payoff associated with them. The rules of the game and the payoffs for each player are known to all participants in the game. They act rationally by strategizing and making choices that will bring an optimal solution to all the stakeholders to reduce the conflicts and use the wetland resources sustainably to enhance food production for food security in Nyando Wetland.

2.5 Conceptual Framework

This study adopted a conceptual framework to help in understanding the three main ways in which resource availability or access may change, and how this can lead to conflict between user groups based on what is documented by UNEP, (2009). Three components represent the main causes or drivers of environmental scarcity. These are demand for resources exceeds supply, degradation of natural resources and unequal or restricted access to resources. Their role in contributing to violent conflict can be aggravated by other influences over which local populations have very little control. These include climate change and other natural hazards, and socio-economic change, or a combination of the two factors (UNEP, 2009).

Lastly, all of the pathways described above are filtered through governance factors. While robust institutions, policies and processes can help reduce the vulnerability of populations to environmental scarcity and ensuing conflicts, weak governance has the opposite effect. Governance also plays a critical role in preventing tensions from arising between competing user groups and states. Indeed, the way that governance

factors address increasing environmental scarcity influences the range of livelihood response options available to different groups. Some will migrate or change their practices, while others will use short-term coping and survival strategies. In the worst case scenario, where resource scarcity compounds other factors such as socio-economic marginalization, ethnic rivalry or religious divisions, violent conflict can occur. Figure 2 illustrates how these various factors, combined with the drivers of environmental scarcity, can lead to conflict and ultimately food insecurity.

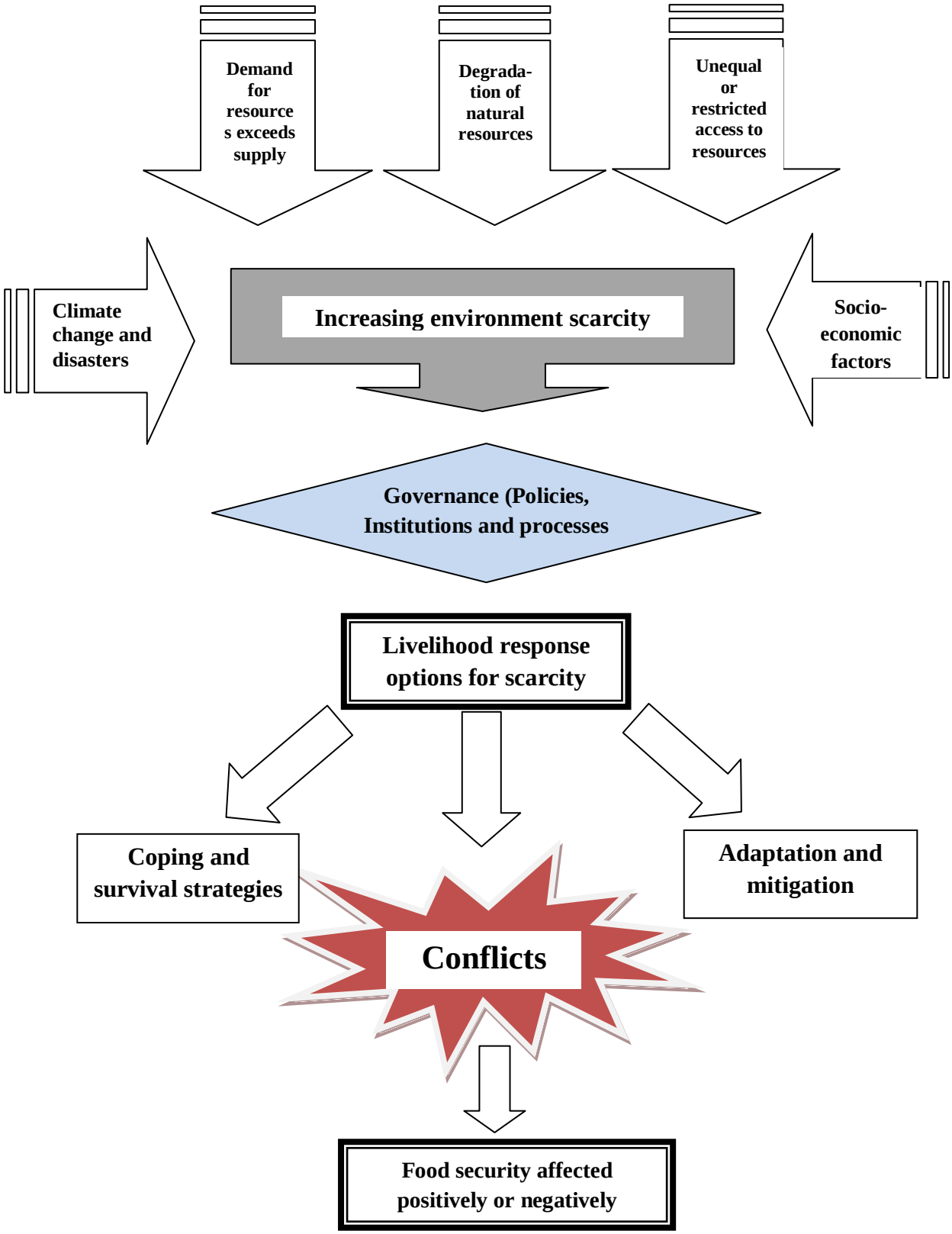

Figure 2: Links between Drivers of Environmental Scarcity, Governance, Livelihood Responses and the Potential for Conflict (UNEP, 2009)

2.6 Knowledge Gaps in the Literature Review

As indicated in preceding sections, Nyando Wetlands are a multi-use resource that provides the community with a range of interrelated environmental functions and socio-economic benefits, which support a variety of livelihood strategies. The enormous socio-economic potential of Nyando Wetlands has not however been fully exploited, primarily because of limited knowledge of wetland ecosystems and little appreciation of their role in alleviating poverty and supporting sustainable development. Furthermore, because of their ecological significance and importance to the livelihood of the local populations, there are often conflicting demands placed upon the wetlands with concomitant negative consequences. Conflicts over the use and management of Nyando Wetlands resources are widespread yet the formation and impact of such conflicts are often poorly understood. Despite the link between wetland resource use conflicts and food insecurity in the area, the relationship between the two variables is not yet well studied and thus poorly understood. As a result, there is need for investigation of this subject if any meaningful solutions and conflict resolution mechanisms are to be developed. This study therefore set out to bridge the information gaps which would ensure sustainable exploitation of the natural food resources for the community while at the same time minimizing conflicts affecting food security. Better planning, legislation, appropriate land use, effective weather monitoring, environmental management, financial safety nets and public education programmes are likely to benefit from the study findings to minimize resource conflicts and enhance food security in the region and beyond.

CHAPTER THREE

METHODOLOGY

3.1 Study Area

Nyando Wetlands are situated at the mouth of the Nyando River at Nyakach Bay, lying between longitudes 35°25' E and 35°45' E, and latitudes 0°05' N and 0°15' S and extending back onto the Kano/Nyakach floodplains (GOK, 1996). The wetlands which measures 15 km from West to East and some 6 km from North South and is found in Kisumu County traversing Nyando, Nyakach and Kisumu East Districts covering approximately 40 Km^2 (~4000 Hectares). The wetland derives its name from its occurrence at the mouth of the Nyando River and adjacent floodplains, and form part of the expansive and complex system of freshwater papyrus swamps renowned for their biodiversity and ecosystem goods and services (Kipkemboi, 2006).

Nyando River is 153 Km long and it originates in the highlands at an altitude of 1,700 metres above sea level and terminates at the lakeshore where the wetland is located at an elevation of 1,135 metres above sea level. There are also several smaller but important wetlands including the Nyamthoe/ Ambowo/ Okana/ Nyamware complex in Kisumu District and Osodo/ Sango Rota floodplain at the mouth of river Sondu – Miriu (Ogutu *et al.,* 2003). The upper parts of the river are characterized by agricultural activities primarily of maize, sugarcane and tea plantations. The lower parts include the extensive Kano plains (90,000 ha) and the delta where rice growing and livestock rearing are the dominant human activities (Terer *et al.,* 2005). The rice

paddy fields of West Kano irrigation scheme constitute a significant component of the wetland. Figure 3 shows the Map of Nyando Wetlands.

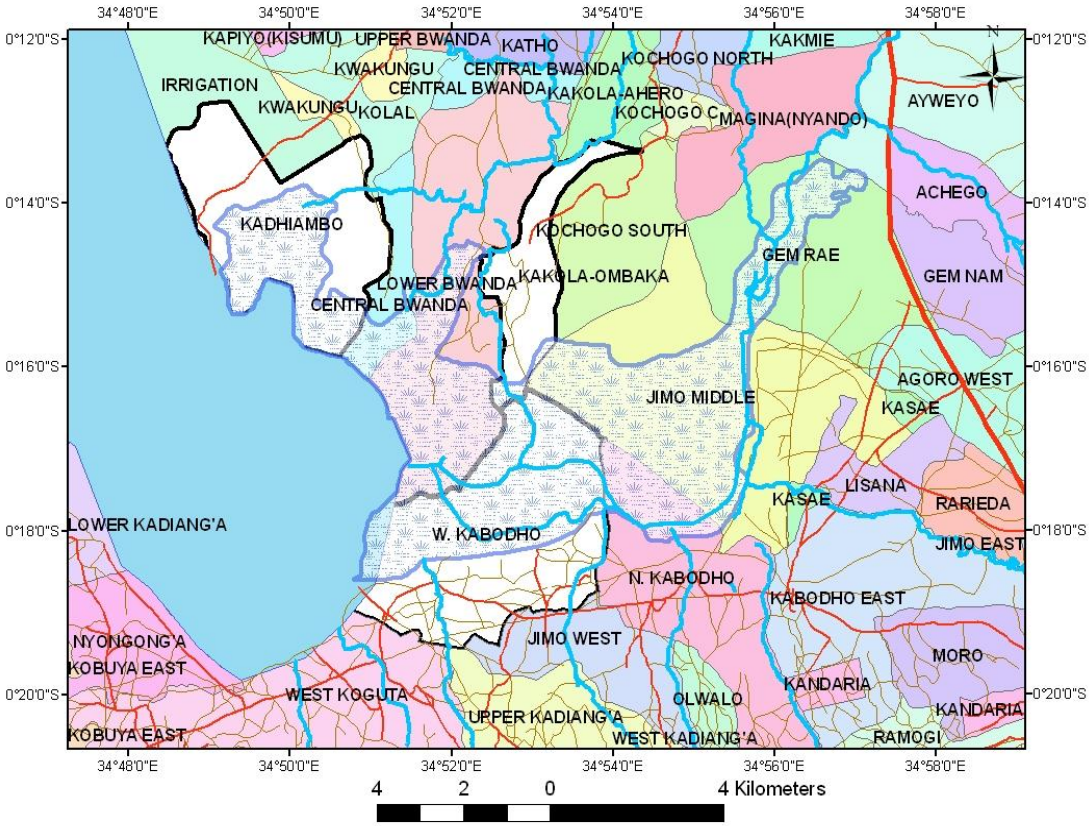

Figure 3: Locations in Kisumu East, Nyando and Nyakach Districts where Interviews were conducted during the Study Period.
(Source: Ecolive Project VIRED International, 2012)

3.1.1 Climate

Nyando wetlands are located in a low-lying region adjacent to Lake Victoria characterized with low rainfall (Jaetzold and Schmidt, 1982). The basin experiences a bimodal rainfall pattern with long rains in March-May and short rains in September-November (ROK, 2002). The mean annual rainfall ranges from about 1,100 to 1,600mm with a minimum and maximum mean monthly rainfall of 72mm and 243mm respectively. The amount of rainfall is greatly influenced by altitude and

relief features. The Kano Plains experience a sub-humid to semi-arid climate and receives rainfall in the range of 600-1100 mm per year (FAO, 1996). The presence of convective currents in the Lake Victoria region is responsible for most of the rain at the shorelines. The relative humidity in the middle and lower basin varies between 55% and 75% in the dry and rainy seasons, respectively, with peaks in May and July with the minimum occurring in January during the short dry season and October, during the long dry season (JICA, 1992).

3.1.2 Soils

The Nyando wetlands have a wide range of soils but is mainly dominated by vertisols, planosols and their associated complexes (ROK 2002). In the wetland, the soils are poorly drained, very deep, very dark grey to black, firm, cracking clay, with acidic humic top soil (humic gleysols) on seasonal wetlands, or in many places peaty (dystric histosols) on permanent swamps. Although the soils within the lower catchment of the two river basins are well drained, the area is always flooded during the long rains. This is due to the stagnation of the water by the small rivers between Nyando River and Nyakach escarpment (Jaetzold and Schmidt, 1982).

3.1.3 Economic Activities

Nyando Wetlands play an important role in the livelihood and subsistence economic activities of local communities through farming, fishing, trading activities, beekeeping, brick making, harvesting of macrophytes, mat making, sand/stone mining, pottery (GOK, 2009). The major economic activities are associated with the

primary industry sector; mainly subsistence and commercial agriculture. Specifically, residents of Nyando Wetland draw their livelihood mainly from agricultural activities, the majority being subsistence farmers who grow food crops such as maize, sorghum, finger millet, cassava, sweet potatoes, fruits, vegetables and keep livestock. The livestock kept include cattle, goats, sheep and poultry which serve as a source of income for farmers (GOK, 2009). Wetland vegetation, especially papyrus, grasses and water hyacinth provide materials for making mats, baskets, furniture and other marketable products (Katua and M'mayi, 2001). These economic activities contribute to poverty alleviation and job creation in the study area. The increased utilization of wetlands to supplement local economies has led to degradation of the wetlands. The main reason for this increased use is the increased demand for settlements, food and grazing lands (Ogutu *et al.,* 2003).

3.2 Research Design

This study employed the survey research design. A survey is a representative selection from the population of a particular type. An attempt was made to collect data from members of the population in order to determine the current status of that population with respect to one or more variables (Kothari, 2004). The main purpose of using survey design was to provide quantitative descriptions of whole or parts of the population as well as to allow for rapid data collection (Mugenda and Mugenda, 1999). Sampling and data collection centred on the households since households constitute the basic unit of shared economic food production and resource utilization.

3.3 Target Population

The survey was conducted in the lower parts of Nyando River Basin in three administrative Divisions namely Kadibo, Nyando and Lower Nyakach in Kisumu East, Nyando and Nyakach Districts respectively. The target populations were the residents living in areas riparian to the lakeshore wetlands, such as Singida, Nyangweso, Nyamware, and Oware in the targeted divisions. According to the Kenya Population and Housing Census Report of 2009, the three Districts have a total population of 152,554 persons (79,894 men; 72,690 females) occupying a total area of 461.4 km^2 with an average population density of 331 persons per km^2. A total of 32,859 households are found in the three divisions of Nyakach, Nyando and Kadibo (KNBS, 2010). This population was chosen based on the fact that they live within the environs of Nyando Wetland thus their livelihood directly depend on the wetland.

3.4 Sample Size

In sampling the wetland resource users, and in order to get a 95% confidence level and sampling error of 5%, a sample size of 384 respondents were interviewed as per Mugenda and Mugenda (1999) based on the formula as given below:

$$n = \frac{Z^2 (p).(q)}{d^2}$$

where,

n = the desired sample size

Z = the standard normal deviate at the required confidence level i.e. 1.96 for 95% level of confidence.

p = 0.5 (probability of ensuring the largest sample size)

q = 1 - p

d = the level of statistical significance set i.e. 0.05

Hence, the sample size

$n = \{1.96^2 * (0.5*0.5)\} \div 0.05^2 = 384$

1.96 is the expected standardized normal deviation (expected Z-score) for an infinitely large sample for a normal distribution. However, from the initial sample size of 384, a total of 233 questionnaires were found to be properly answered and so a total of 233 respondents were selected as the appropriate sample size to allow for unbiased representation of the wetland resource users.

3.5 Sampling Method

Simple random sampling technique was used to select households living along the Nyando Wetlands area to ensure an equal chance of the respondents of the representative sample by sampling every third household. Purposive sampling was also used to interview Key Informants and Focus Groups. Although respondents were randomly selected, every attempt was made to get a balanced opinion of the socio-economic issues in the study area and how they affect wetland management, putting issues of resource use conflicts and food security in consideration and interviewing a cross section of the community including the elderly and paying attention to gender of the respondents.

3.6 Data Collection Methods and Instruments

A preliminary study was undertaken to test the sample questionnaire and key informants interview schedule on a few community representatives to determine the quality and quantity of data collected. Feedback from the pilot study was used to adjust the questionnaires.

The study used both primary and secondary data sources. Field work was conducted to collect primary data between February and April 2012 using various participatory techniques, including in-depth household interviews using semi-structured questionnaires administered to 384 randomly selected wetland resource users such as farmers, fishers, traders, herdsmen, craft makers; Key Informants Interviews (KII) with community leaders, Provincial Administrators, Government Institutions including Ministry of Agriculture, Ministry of Fisheries Development, Kenya Wildlife Service, National Environmental Management Authority, Water Resources Management Authority, Community Based Organizations and Non-Governmental Organizations leaders; Eight Focus Group Discussions (FGD) and direct field observations. FGD were conducted at the community level mainly with people who depend largely on wetland resources. The researcher in collaboration with a survey team from VIRED-International, a local NGO, distributed the questionnaires to the local community members. Secondary data was collected through desk research from published and unpublished literature including government and NGO reports, District Development Plans, textbooks, Journals, Economic Surveys, Academic Theses and Dissertations and the Internet.

3.7 Data Analysis and Presentation

Data was entered and analyzed using SPSS Version 20 to give a summary of the coded data which in turn generated descriptive statistics composed of frequencies and mostly, with the socioeconomic and demographic characteristic, and the tables were generated for the variables. Minitab 14 was used to test the hypothesis of no significant change in wetland resource over time, and nominal logistic regression was used with the response information on change in the wetland resource; abundant (being the reference level), moderate and few, with log-likelihood and goodness of fit test; chi-square table, Pearson and deviance to test that the model was fit for the data. Statistica 10 software was used for the multivariate cluster analysis to generate dendrogram on the relationship of factors that had similar effect on food security, and lastly, Microsoft excel was used to generate bar-graphs with relative percentages and standard deviation bars for the range of the response measurements. The inferential statistics were analysed at 5% significance level.

CHAPTER FOUR

RESULTS

4.1 Socio-economic and Demographic Characteristics of Respondents

Household respondents interviewed were selected from Kisumu East, Nyakach and Nyando districts living around the edges of Nyando Wetland in Kadibo, Lower Nyakach and Nyando Divisions. There were six locations in Kadibo, three in Lower Nyakach and three in Nyando Division. Table 1 shows the number of households sampled in each sub-location, location, Division and District.

Table 1: Distribution of Respondents Sampled in the Study Area

District Name	**Division Name**	**Location Name**	**Number of Sub-locations**
Kisumu East	Kadibo	Kawino South Kanyagwal Kochieng West Kochieng East Bwanda Kawino North	35 26 16 8 15 11
Nyakach	Lower Nyakach	Rang'ul North Nyakach Nyalunya	37 25 10
Nyando	Nyando	Kakola Wawidhi Kochogo	24 20 6
Total			**233**

Results in Table 2 summarize the socio-economic and demographic characteristics of respondents. From the results, 70% of the sampled households were male-headed followed by 28% headed by females, while only 2% households were male-headed but economically run by females. Most of the respondents (55%) in the households were wives followed by husbands who represented 44% while 1% were children.. 44% of the respondents were aged 30–50 years, followed by those above 50 years at 34% and those between 18 – 29 years 21%. Only 1% of the respondents were below 18 years.

Over half of the respondents were females (54%) while 46% were males. Majority of the respondents were married (77%), followed by the widowed (21%) and the single (2%). Majority of the respondents had education up to primary school level (61%) followed by 22% who had secondary level education. Sixteen percent (16%) had no formal education at all, while only 1% had attained above secondary school level.

More than half of the respondents (51%) had lived in areas adjacent to the wetlands or stayed in their ancestral homes for more than 30 years. Out of this, 11% had lived in the wetlands for less than 25 years while 38% had lived for between 10 and 30 years. Average household sizes ranged from six and ten people 58% to less than five people (36%) while only 6% of the respondents had a household size of between eleven and fifteen people. The principal occupation of the respondents was farming (63%) followed by business involving trade in wetland products (13%), harvesting of wetland macrophytes for making handicrafts (10%) and fishing (6%). Other occupations are shown in Table 2. Most of the respondents (64%) experienced reduced income during the dry season, 36% reported experiencing reduced income

during the rainy season and only one respondent stated that his income is not associated with seasons.

Table 2: Socio-economic and Demographic Characteristics of Respondents

Characteristics of Households	**Respondent**	**Frequency**	**% Frequency**
Type of Household	Elderly supporting orphans	1	0%
	Female headed	66	28%
	Male headed	162	70%
	Male headed female run	4	2%
	Total	**233**	**100%**
Respondents position in the Household	Child	3	1%
	Husband	103	44%
	Wife	127	55%
	Total	**233**	**100%**
Age	Less than18 years	2	1%
	18-29 years	49	21%
	30-50 years	102	44%
	More than 50 years	80	34%
	Total	**233**	**100%**
Gender	Male	107	46%
	Female	126	54%
	Total	**233**	**100%**
Marital Status	Married	179	77%
	Single	5	2%
	Widowed	49	21%
	Total	**233**	**100%**
Level of Education	College	2	1%
	Non	37	16%
	Primary	142	61%
	Secondary	52	22%
	Total	**233**	**100%**
Period lived in Wetland	≤ 10 years	25	11%
	10-20 years	44	19%
	21-30 years	45	19%
	>30 years	119	51%
	Total	**233**	**100%**

Table 2 Cont: Socio-economic and Demographic Characteristics of Respondents

Characteristics of Households	Respondent	Frequency	% Frequency
Number in a Household	< 5	85	36%
	6-10	135	58%
	11-15	13	6%
	Total	**233**	**100%**
Primary Occupation	Business	31	13%
	Farmer	146	63%
	Fisherman	15	6%
	Formal employment	8	3%
	Harvesting wetland products	23	10%
	Housewife	6	3%
	Student	3	1%
	Unemployed	1	0%
	Total	**233**	**100%**
Experienced reduction in Income	Dry season	149	64%
	Rainy season	83	36%
	Not associated with season	1	0%
	Total	**233**	**100%**

Thirty two percent of the respondents earned between 1000-5000 Kshs. followed by 25% who earned between 500-1000 Kshs. and 21% earned less than 10000 Kshs. Among the respondents, farmers who earned the most from wetlands (63%) compared to businessmen (13%) and harvesters of wetland products (10%) among others.

Table 3: Occupation and Monthly Earnings of Respondents

Primary Occupation	Income Levels (Kshs)						
	100-500	500-1000	1000-5000	5000-10000	□ 10,000	Frequency	%
Business	2	5	14	0	10	31	**13%**
Farmer	7	37	49	23	30	146	**63%**
Fisherman	2	4	3	3	3	15	**6%**
Formal employment	0	5	1	2	0	8	**3%**
Harvesting wetland products	3	5	5	4	6	23	**10%**
Housewife	3	2	1	0	0	6	**3%**
Student	0	1	2	0	0	3	**1%**
Unemployed	0	0	0	0	1	1	**0%**
Total	**17**	**59**	**75**	**32**	**50**	**233**	**100%**
	7%	**25%**	**32%**	**14%**	**21%**	**100%**	

4.2 Nyando Wetlands Resources

Results showed that Nyando Wetlands ecosystem provides a variety of resources, goods and services to the local community. These include fishes, leafy vegetables, woody plants, and other fauna, all of which constitute the basic capital to meet the communities' food, fuel, water and other requirements.

4.2.1 Wetland Fishes

Several fish species are found within the wetland area fringing the Lake shores. About 18 different fish species were identified in the study area as shown in Table 4.

Table 4: Fish Species in Nyando Wetland as given by Respondents during the Study Period

TYPES OF FISH		
SCIENTIFIC NAME	**COMMON NAME**	**LOCAL NAME**
Alestes sadleri	Saddler's robber	Osoga
Barbus alternialis	Ripon fall barb	Fwani
Barbus spp.	Luambwa barb	Adel
Bagrus docmac	Silver cat fish	Seu
Clarias gariepinus	Cat fish	Mumi
Clarias werneri	Werner cat fish	Nyawino
Gnathonemus longibarbis	Longnose stonebasher	Suma
Haplochromis spp.	Haplochromines	Fulu
Labeo spp.	Victoria labeo	Ningu
Lates Niloticus	Nile perch	Mbuta
Mastercembelus frenatus	Long tail spiny eel	Okunga
Momyrus	Elephant fish	Ondhore
Oreochromis esculentus	Tilapia	Ngege
Proptopterus aethiopicus	Lung fish	Kamongo
Rastrineobola argentea	Sardines	Omena
Schilbe mystus	African butler catfish	Sire
Synodontis spp.	Victoria squeaker	Okoko
Protopterus	Mud fish	Ndhira

In evaluation of the fish resource, majority of the respondents (90%) indicated that the fish were more abundant in 1982 as compared to 2012 where 80% of the respondents believe that currently the fish available in Nyando Wetland are few with 20% of the respondents maintaining that they are moderate. From the findings, there is an indication of reduction of the number of fish species in the wetland over the last 30 years (Figure 4.).

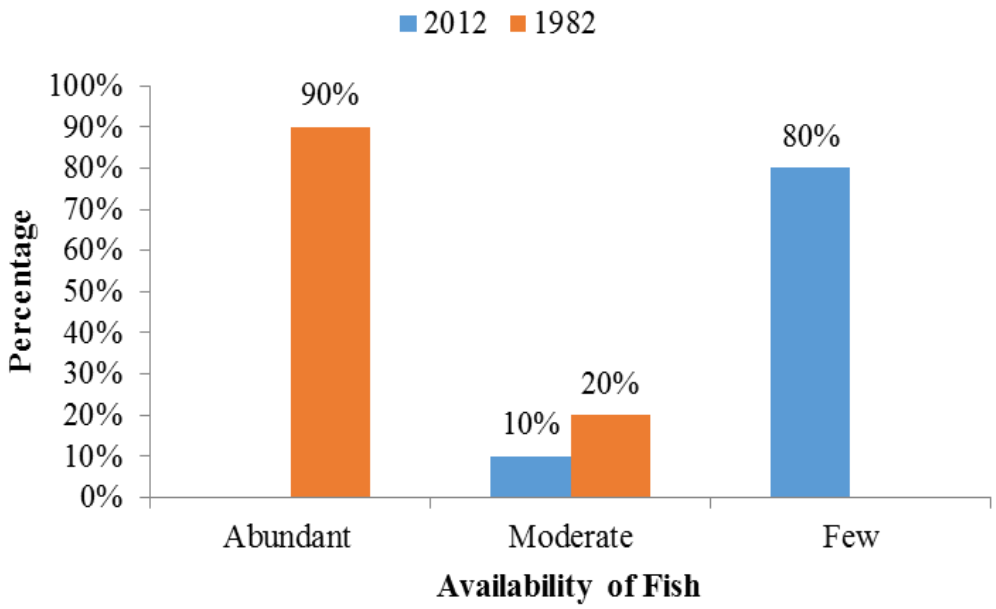

Figure 4: Respondents' Views on Fish Availability between 1982 and 2012

Fish species such as *Proptopterus aethiopicus* (Kamongo), *Clarias gariepinus* (Mumi), *Schilbe mystus* (Sire) and *Synodontis spp.* (Okoko) were the most abundant in 1982 while *Lates Niloticus* (Mbuta), *Tilapia Haplochromine* (Ngege) and *Rastrineobola argentea* (Omena) were relatively abundant followed by *Barbus spp.* (Adel), *Labeo spp.* (Ningu), *Clarias werneri* (Nyawino), *Mastercembelus frenatus* (Okunga) and *Momyrus* (Ondhore), as shown in Figure5. Despite this, most of the fish species are currently few for example *Gnathonemus longibabis* (Suma), *Labeo spp.* (Ningu) and *Tilapia Haplochromine* (Ngege) among others; (Figure 6).

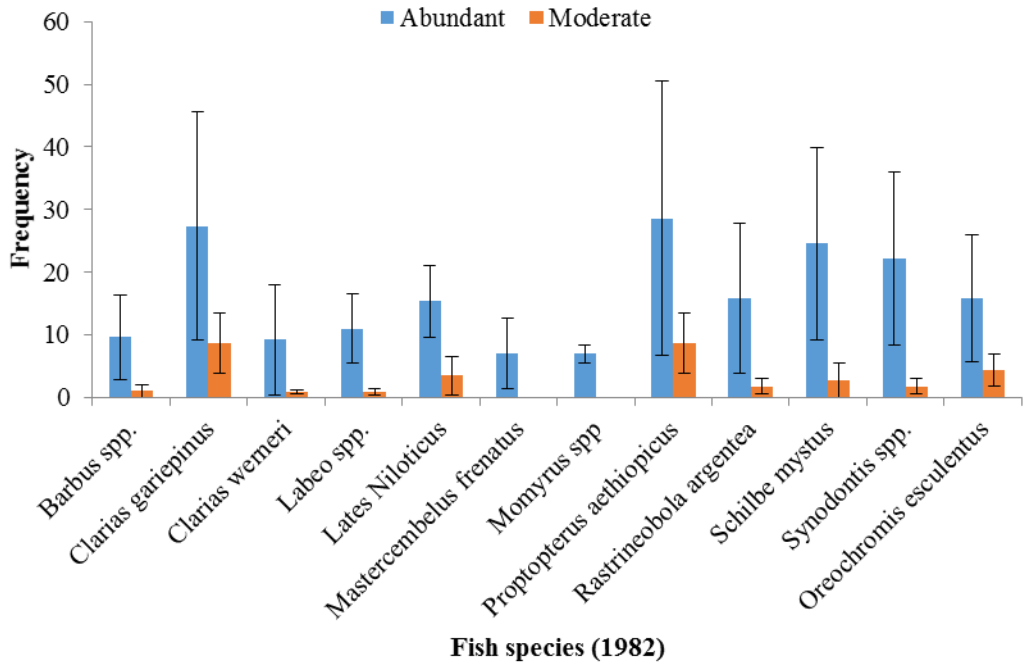

Figure 5: Community Perception on the Abundance of Fish in Nyando Wetlands in 1982

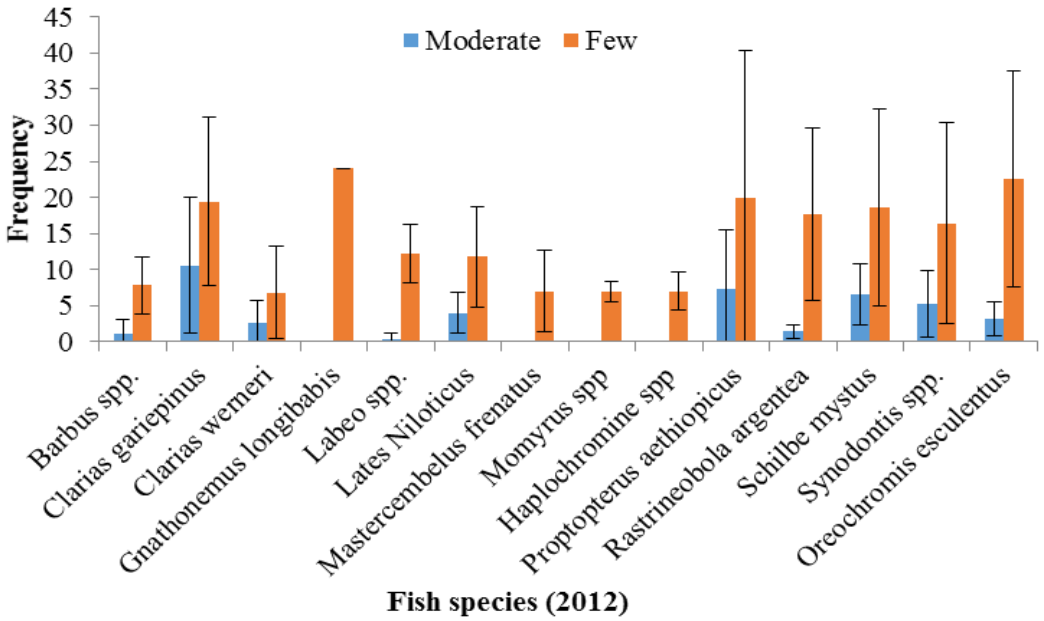

Figure 6: Community perception on fish availability currently (2012)

4.2.2 Wetland Vegetables

Nyando Wetland also had a great diversity of plants that were used as traditional vegetables. Table 5 gives the names of different types of vegetables which were used by the local community as food.

Table 5: Vegetables in Nyando Wetlands

TYPES OF VEGETABLES		
SCIENTIFIC NAME	**COMMON NAME**	**LOCAL NAME**
Achyranthes aspera	Devil's horsewhip	Akajo
Amaranthus hybridus	Amaranths	Machicha
Amaranthus spinosa	Careless weed	Ododo
Asystasia mysorensis	Violet asystasia	Atipa
Blepharis spp.	Creeping blepharis	Onduong'o
Brassica oleracea acephala	Kales	Sukuma
Brassica oleracea capitata	Cabbage	Ang'ina
Cleome gynandra	Spider plant	Dek
Commelina benghalensis	Day flower benghal	Odielo
Corchorus olitorious	Jute mallow	Apoth
Crambe abyssinica	Eurasian oil seed	Nyadegdani
Crotalaria brevidens	Slender leaf	Mitoo
Curcubita maxima	Pumpkin leaves	Susa
Hermannia uhligii	Dolls rose	Nyayuora
Lycopersicum esculentum	Tomatoes	Nyanya
Oxygonum sinuatum	Double thorn	Awayo
Senna occidentalis	Septicweed	Nyayado
Solanum vilosum	African nightshade	Osuga
Spinacia oleracea	Spinach	Sikumb Wasungu
Vigna unguiculata	Cowpeas	Boo

According to 81% of respondents, vegetables were abundant in Nyando Wetlands in 1982 as shown in Figure 7, 11% of respondents indicated the vegetables were moderate while 8% stated that the vegetables were few. The current status of vegetables and their availability in the Wetland has however reduced (Figure 6). Over half of the respondents (58%) reported that the vegetables found were currently few or moderate (21%) while 8% of the respondents indicated that the vegetables were abundant. Only 7% of respondents however, maintained that there was no change in the availability of vegetables while 6% alluded that these vegetables have been completely depleted.

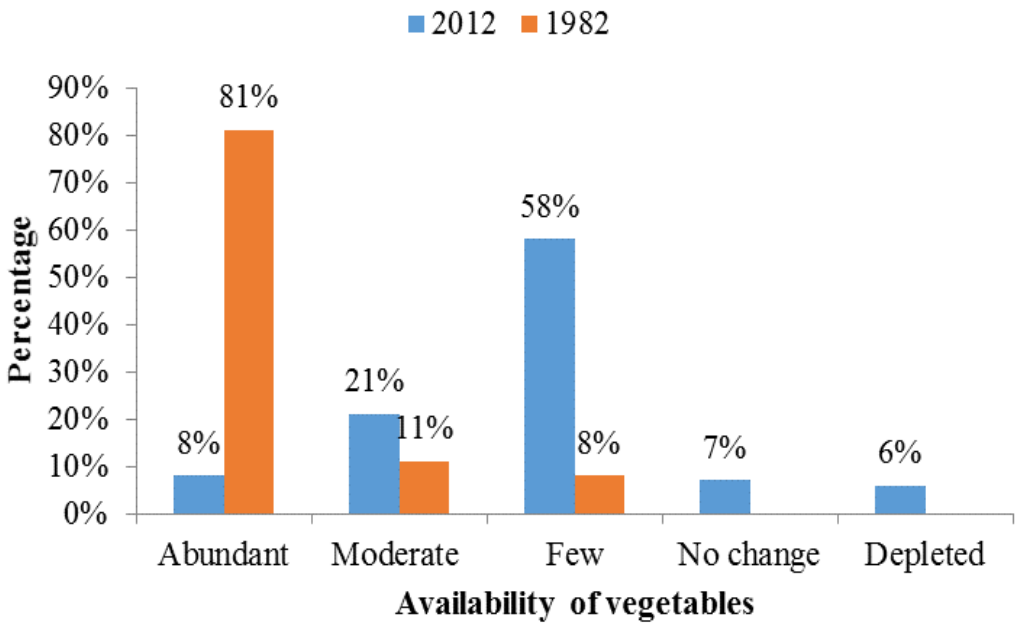

Figure 7: Community Views on availability of Vegetables between 1982 and 2012

Specific vegetables among them *Cleome gynandra* (Dek), *Solanum vilosum* (Osuga) and *Vigna unguiculata* (Boo) were the most abundant in 1982 followed by *Corchorus olitorious* (Apoth), *Amaranthus spinosa* (Ododo), *Crotalaria brevidens* (Mitoo), *Crambe abyssinica* (Nyadegdani), *Brassica oleracea acephala* (Sukuma), and

Asystasia mysorensis (Atipa). Other vegetables like *Hermania uhligii* (Nyayuora) and *Curcubita maxima* (Susa) were also relatively abundant as shown in Figure 8. However, currently wetland users have recorded a reduction in the availability of vegetables (Figure 9). Vegetables like *Cleome gynandra* (Dek), *Solanum vilosum* (Osuga), *Vigna unguiculata* (Boo) and *Crotalaria brevidens* (Mitoo) which were abundant 30 years ago are now scarce with respondents categorizing them as either moderate or completely depleted. Other vegetables which have reduced in availability include *Corchorus olitorious* (Apoth), *Asystasia mysorensis* (Atipa), *Amaranthus spinosa* (Ododo), *Crambe abyssinica* (Nyadegdani) and *Hermania uhligii* (Nyayuora).

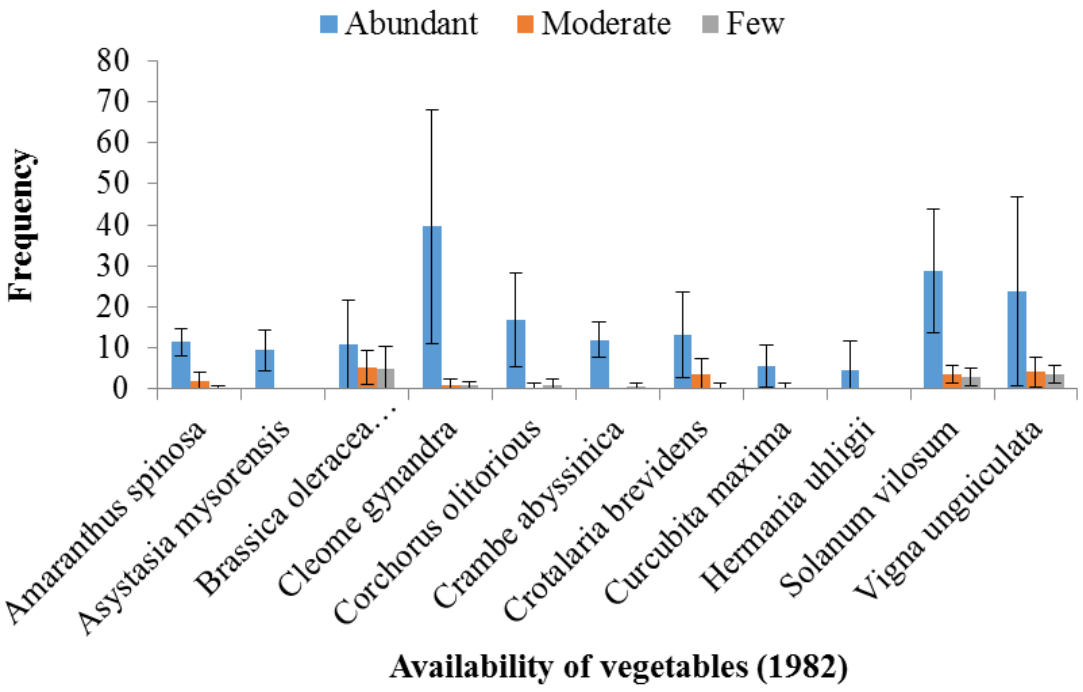

Figure 8: Respondents' Views on availability of Vegetables in Nyando Wetlands in 1982

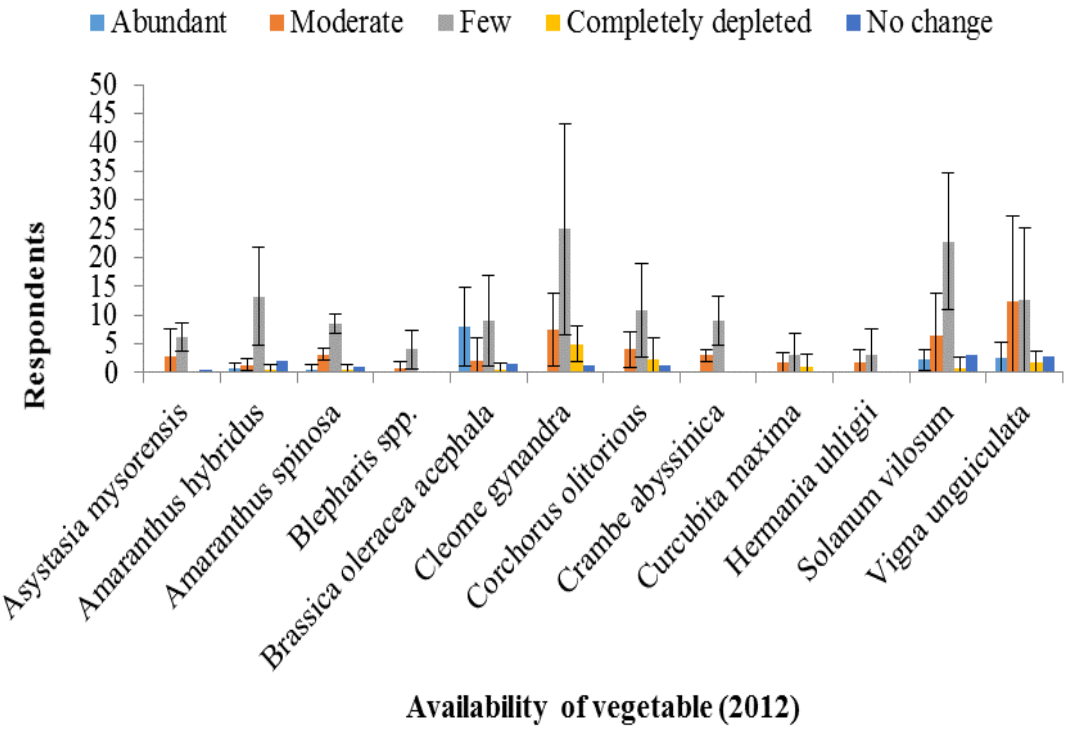

Figure 9: Community views on the Current (2012) status of Vegetables in Nyando Wetlands

4.2.3 Wetland Plants

About 42 plant species were found within the wetland area which the local community exploited for livelihood as shown in Table 6.

Table 6: Plants Available in Nyando Wetlands

TYPES OF PLANTS		
SCIENTIFIC NAME	**COMMON NAME**	**LOCAL NAME**
Acacia drepanolobium	Acacia thorn tree	Alii
Acacia seyal	Prickly acacia	Otiep
Aeschynomene laphroxylon	Balsa wood tree	Orindi
Albizia gummifera	Peacock flower	Ober

Azadirachta indica	Neem tree	Dwele
Blepharis spp.	Creeping blepharis	Onduong'o
Cassia siamea	Kassod tree	Oyieko
Cynodon dactylon	Wetland grass	Modhno
Cyperus papyrus	Papyrus	Togo
Cyperus rotundus	Nut grass	Oluga
Cyperus spp.	Sedges	Ang'ang'o
Eichhornia crassipes	Water hyacinth	Fod
Eucalyptus grandis	Blue tree	Ndege
Eucalyptus spp.	Blue gum tree	Kaladali
Euphorbia tirucali	Milk hedge	Ojuok
Ficus spp.	Fig tree	Ng'ou
Gossypium spp.	Cotton	Pamba
Indigofera spp.	Indigo	Sina mburi
Ipomea spp.	Morning glory	Selesele
Ipomoea aquitica	Water spinach	Ao rao
Jacaranda mimosifolia	Jacaranda tree	Jacaranda
Laggera alata	Winged stem laggera	Ounyu
Lutea spp.	Water-lily	Siala
Mimosa pigra	Sensitive plant	Osiri
Nymphae alba	Water-lily	Oyungu
Pennisetum purpureum	Nappier grass	Ogada
Phragmites spp.	Common reed	Odundu
Phyllanthus fischeri	Shrub	Olando
Phyllanthus sepialis	Carry me seed	Kagno
Pistia stratiotes	Water lettuce	Anyuongi
Polygonum spp.	Knot weed	Odielo
Pycreus nitidus	Sedges	See
Ricinus communis	Castor oil plant	Odagwa
Sacchrum officinalis	Sugarcane	Niang'
Sesbania sesban	Egyptian pea	Omburi
Sesbania spp.	Sesban	Asao
Solanum incanum	Thorn apple	Ochok
Sonchus oleraceus	Sow thistle	Achak
Thevetia peruviana	Yellow oleander	Chamama
Triumfetta tomentosa	Bur heed	Owich
Typha spp.	Bulrush	Odhong'
Vossia cuspidate	Hippo grass	Saka

From the responses, it was evident that plants were abundant in 1982 as reported by 82% of the respondents as compared to 2012 where respondents reported that they were few (53%). Some respondents however, stated that the plants were moderately available (23%) as shown in Figure 10.

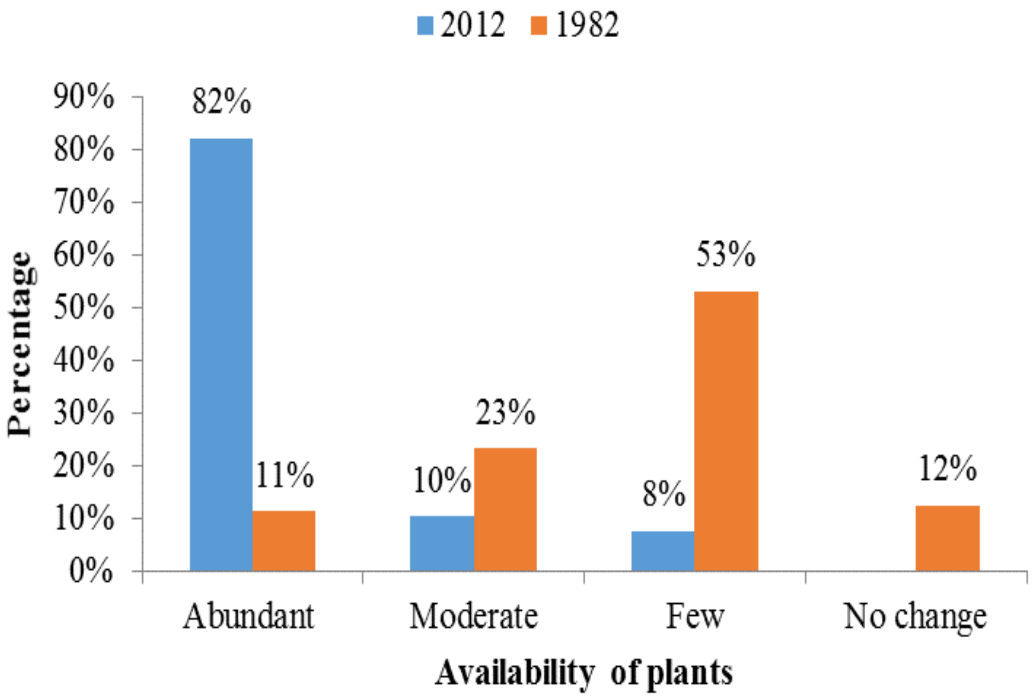

Figure 10: Community Views on Plant Availability between 1982 and 2012

Specific plants that were abundant in 1982 were *A. laphroxylon* (Orindi), *Cyperus papyrus* (Togo), *Phragmites spp.* (Odundu), *Pycreus nitidus* (See) *and Sesbania sesban* (Omburi) as shown in Figure 11. These plants have however, become moderate or few in recent years particularly since 2012 as shown in Figure 12.

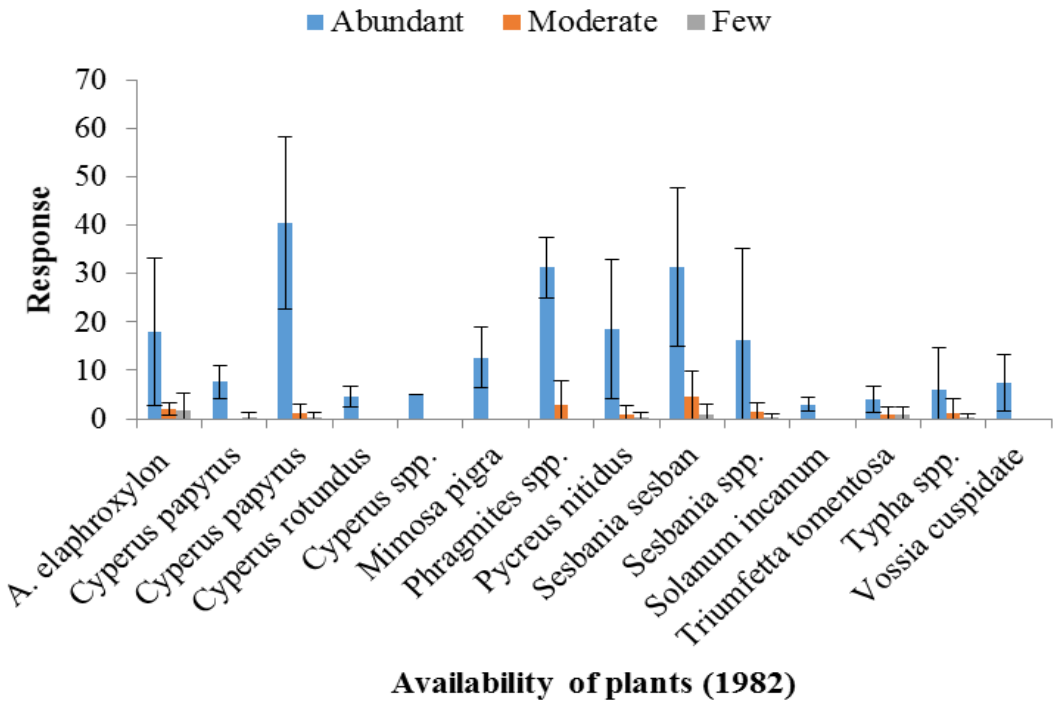

Figure 11: Respondents' Views on Availability of Plants in Nyando Wetlands in 1982

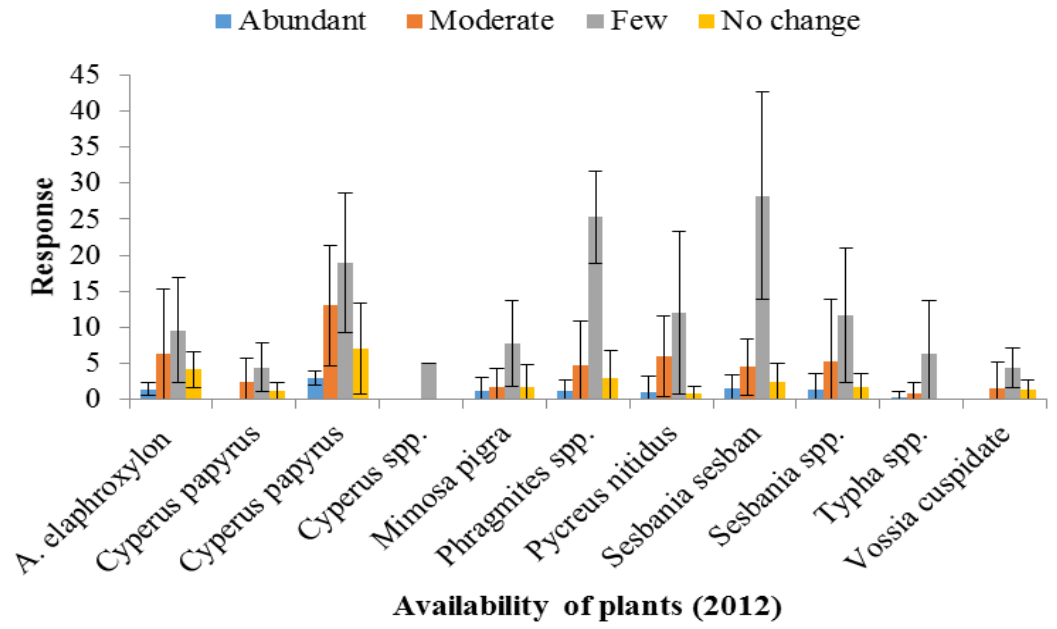

Figure 12: Community Views on the Current (2012) Status of Plants in Nyando Wetlands

4.2.4 Wetland Birds

Wetland birds appear to be one of the most abundant animal resources in Nyando Wetlands. During the study, a total of 37 bird species were recorded to exist in the wetland (Table 7).

Table 7: Community Perception on Birds Available in Nyando Wetlands

TYPES OF BIRDS		
SCIENTIFIC NAME	**COMMON NAME**	**LOCAL NAME**
-	Sacred ibis	Ng'ang'a
Agapornis fischeri	Fischer's lovebird	Ngili
Anas luzonica	Wild ducks	Atut nam
Apus caffer	White-rumped swift swallow	Opija
Aquila chrysaetos	Golden eagle	Otenga
Ardea cinerea	Grey heron	Manaha/nyamanaha
Ardeola ibis	Buff-backed heron/Cattle egret	Okok
Asio capensis	African marsh owl	Tula
Balearica regulorum	Crowned crane	Ongowang'
Bucorvus leadbeaeri	Ground hornbill	Arum tidi
Campethera abingoni	Golden-tailed woodpecker	Teltel
Centropus superciliosus	White browed coucal	Tutu
Cinnyris asiaticus	Sunbird	Nyinyodhi
Corvus albus	African pied crow	Agak
Dicrurus ludwigi	Square-tailed drongo	Ochol
Ephippiorhynchus senegalensis	Saddle-bill stork	Kwasi
Falco cuvieris	African hobby falcon	Olit/Olith
Gyps bengalensis	White-backed vulture	Achuth
Hagedashia hagedash	Hadada ibis	Ng'ang'a
Hedydipna collaris	Collared sunbird	Nyonyodhi
Himantopus himantopus	Black-winged stilt	Onyango saga
Ixobrychus minutus	Little bittern	Oseng'

Lagonosticta rubricate	African firefinch	Oyundi
Lanius Collaris	Shrike	Onjinyo/ochinjo
Macronyx ameliae	Rosy-breasted long claw	Nyakwadha/ Okwadha
Microcarbo africanus	Reed duiker/long-tailed cormorant	
Motacilla aguimp	African pied wagtail	Odiero
Numida meleagris	Guinea fowl	Awendo
Passer griseus	Grey-headed sparrow	Abang'chieth
Pelecanus rufescens	Pink-backed pelican	Adiel mbusi
Perdix perdix	Quail/partridge	Aluru
Ploceus castanops	Northern brown-throated weaver	Osogo
Podiceps ruficollis	Little grebe	Kulbidi
Pyconotus barabatus	Yellow vented bulbul	Ochongorio
Rutopictus francolinus	Grey-Breasted francolin	Aywer
Scopus umbretta	Hamerkop	Onyinjo
Streptopelia decipiens	Mourning dove	Akuru

Results show that birds were more abundant in 1982 as compared to 2012 as reported by 70% of respondents (Figure 13). Seventeen percent (17%) of the respondents however said that the birds were moderately available while 13% indicated that they were few. The status of Nyando Wetlands birds however shows that a great change has taken place since 1982 (Figure 14) and 2012 (Figure 15). According to 38% of the respondents, birds are currently few in the wetland (Figure 15). However, an equal number of respondents indicated that either birds were moderate (21%) or there was no change in their availability (21%), while 17% of the respondents reported that the birds were abundant with 3% observing that they were completely depleted.

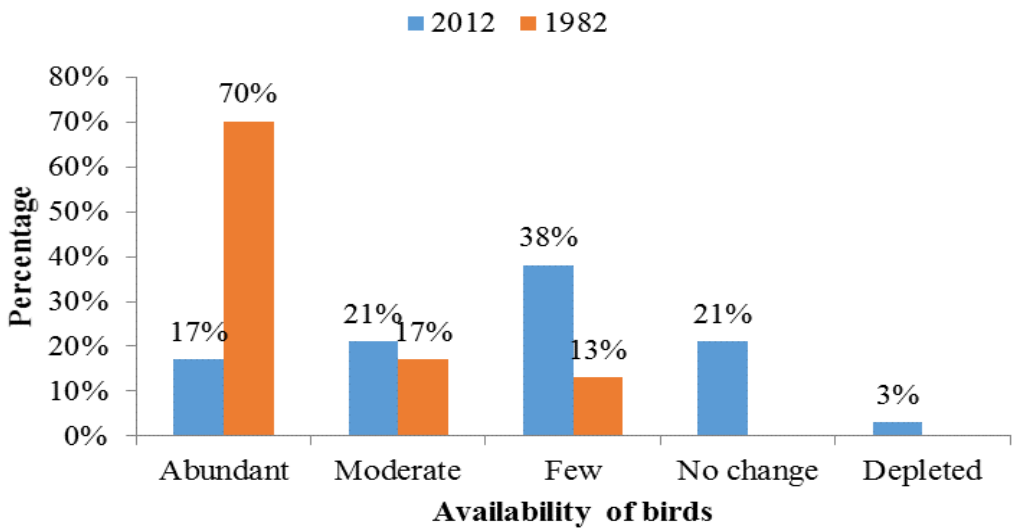

Figure 13: Community Perception on the Abundance of Birds in Nyando Wetlands between 1982 and 2012

According to the respondents, birds such as *Ardeola ibis* (Okok), *Ploceus castanops* (Osogo), *Streptopelia decipiens* (Akuru), *Hagedashia hagedash* (Ng'ang'a), *Aquila chrysaetos* (Otenga), *Pelecanus rufescens* (Adiel mbusi), *Balearica regulorum* (Ongowang') and *Scopus umbretta* (Onyinjo) were abundant in the wetland in 1982 while the rest like *Perdix perdix* (Aluru), *Lagonosticta rubricata* (Oyundi), *Anas luzonica* (Atut nam), *Ephippiorhynchus senegalensis* (Kwasi), *Ixobrychus minutus* (Oseng), *Campethera abingoni* (Teltel), *Motacilla aguimp* (Odiero) and *Gyps bengalensis* (Achuth) were considered moderate in numbers (Figure 14). The wetland has recorded a reduction in bird availability since 2012 (Figure 15). Birds like *Hagedashia hagedash* (Ng'ang'a), *Ardeola ibis* (Okok), *Perdix perdix* (Akuru), *Lagonosticta rubricata* (Oyundi) and *Balearica regulorum* (Ongowang') are currently few, and respondents categorized them as either moderate to completely depleted. Other birds which have reduced in availability are *Pelecanus rufescens* (Adiel mbusi), *Perdix perdix* (Aluru), *Scopus umbretta* (Onyinjo), *Ploceus castanops* (Osogo) and *Campethera abingoni* (Teltel).

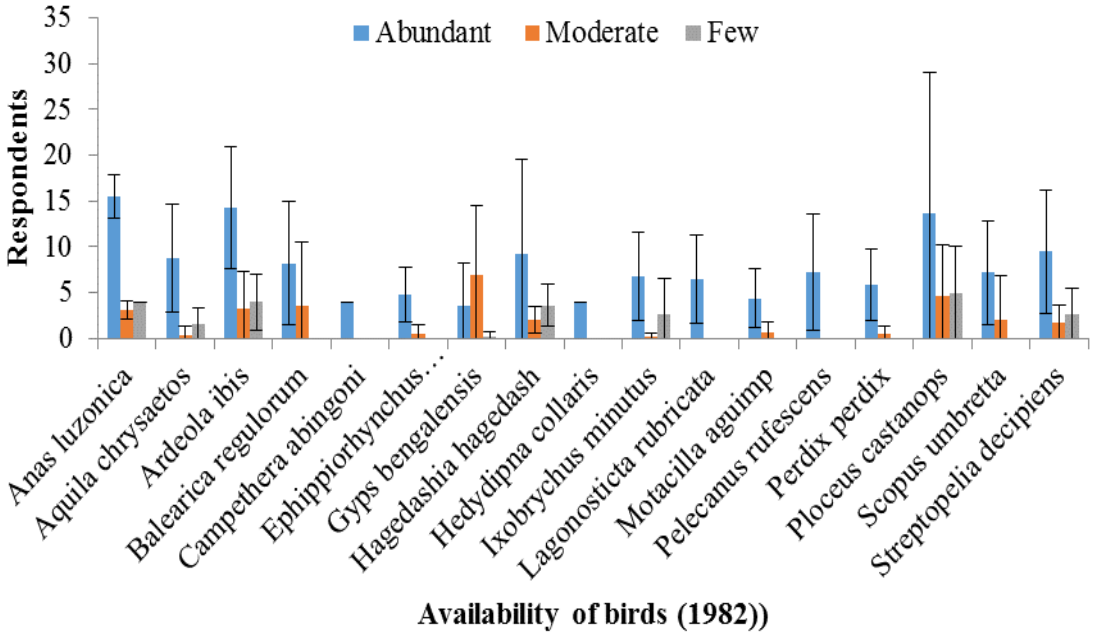

Figure 14: Community Views on the Availability of Birds in Nyando Wetlands in 1982

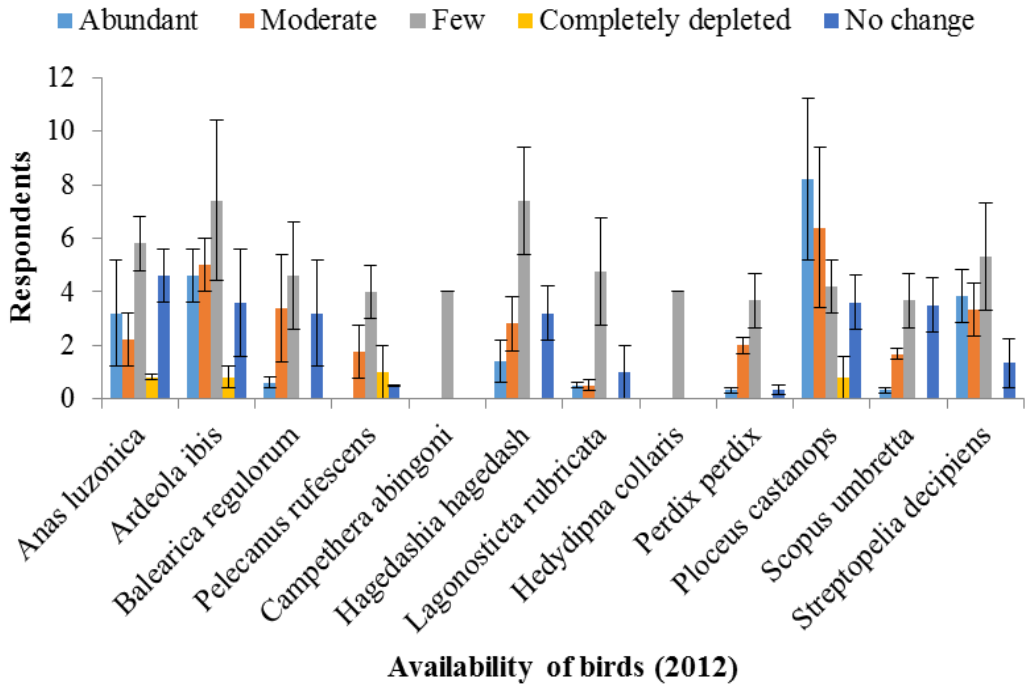

Figure 15: Community Responses on the Current (2012) Status of Birds Available in Nyando Wetlands

4.2.5 Wetland Animals

About 12 animal species were identified as residing in Nyando Wetlands as shown in Table 8. Other wildlife species reported included frogs, snakes and Nile monitor.

Table 8: Animal Availability as given by Respondents Interviewed in the Study Area

TYPES OF ANIMALS		
SCIENTIFIC NAME	**COMMON NAME**	**LOCAL NAME**
Candata	Salamander	Kalagwena
-	Antelope/Gazelle	Mwanda
Cercopithecus aethiops	Green monkey	Ong'er
Crocodiles niloticus	Crocodile	Nyang'
Genet	African wild cat	Ogwang'
Hippopotamus amphibious	Hippopotamus	Rao
Hystrix spp.	Crested porcupine	Chiewo
Lutra maculicollis	Spotted naked otter	Anduko
Phacochoerus aethiopicus	Warthog	Mbidhi
Poelagus marjorita	African rabbit	Apuoyo
Tragelaphus spekii	Sitatunga	Dwe
Xerus rutilus	Pallid ground squirrel	Aidha

Mammals and reptiles were also abundant in Nyando Wetlands in 1982 as reported by 63% of respondents, although 26% of the respondents contended that the animals were moderately available while 11% responded that they were few in number (Figure 16). These views contrasted with the responses on the current status and availability of animals in Nyando Wetlands. Most of the respondents (45%) alluded that the animals were few although observed that there was no change in the animals'

availability (21%), while only 18% of the respondents stated that the animals were abundant. Further 12% of the respondents observed that the animals were moderate while 4% indicated that they were completely depleted.

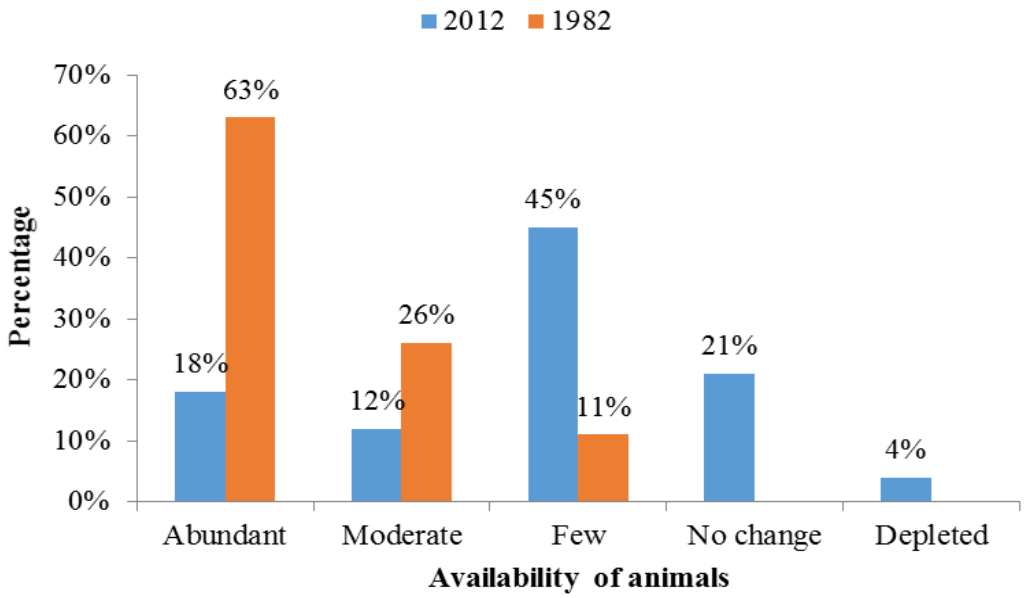

Figure 16: Mammals and Reptiles Available between 1982 and 2012 in Nyando Wetlands

Animals that were abundant in Nyando Wetland in 1982 were *Hippopotamus amphibious* (Rao) and *Poelagus marjorita* (Apuoyo). Other wildlife like *Tragelaphus spekii* (Dwe), *Varanus niloticus* (Ng'ech), Antelope (Mwanda) and *Cercopithecus aethiops* (Ong'er) were also relatively abundant (Figure17). However, the wetland has recorded a reduction in animals available in recent years (Figure 18). Animals like *Poelagus marjorita* (Apuoyo), *Tragelaphus spekii* (dwe), *Hippopotamus amphibious* (Rao), *Lutra maculicollis* (Anduko) and antelope (Mwanda) are currently very few. The other animals which have reduced in number are *Cercopithecus aethiops* (Ong'er), Frog (Ogwal), *Varanus niloticus* (Ng'ech) and *Crocodiles niloticus* (Nyang').

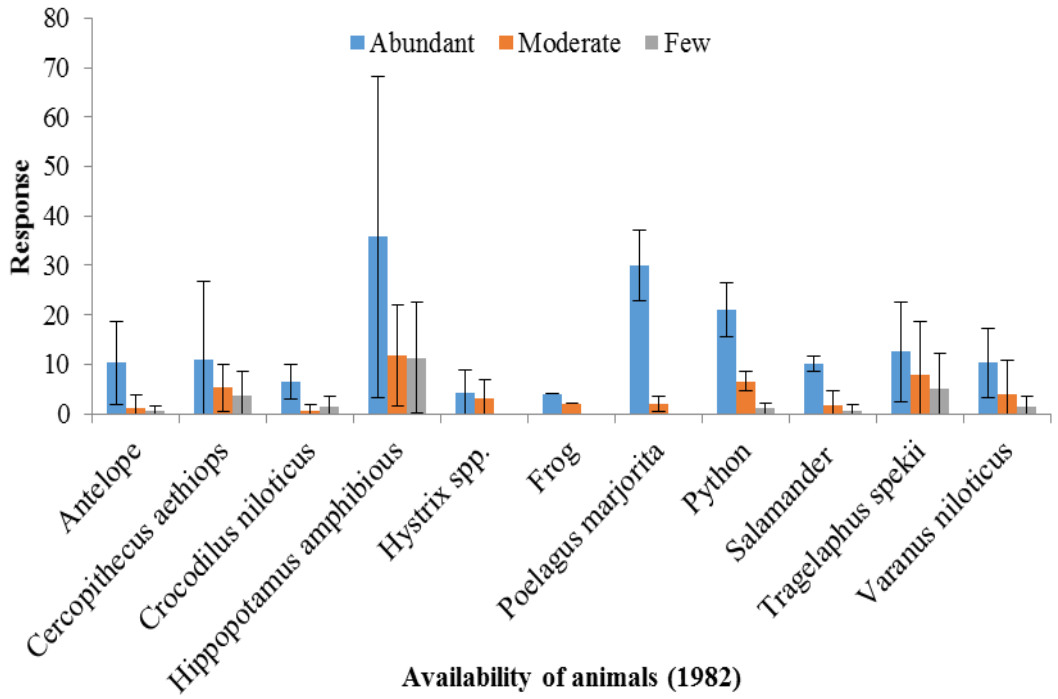

Figure 17: Animals Available in Nyando Wetlands in 1982

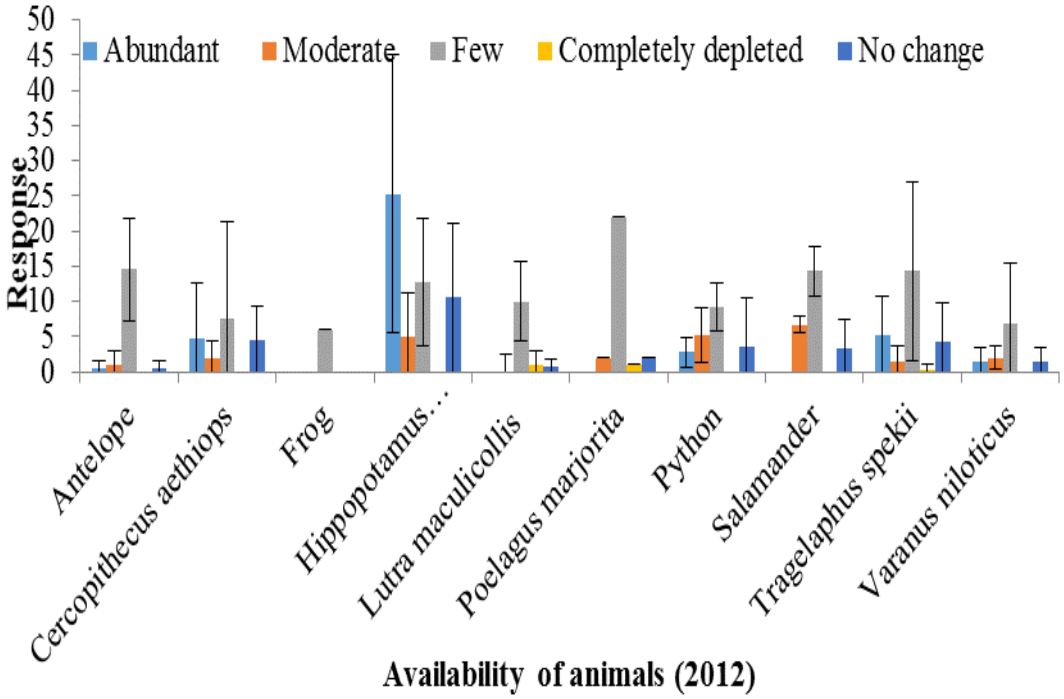

Figure 18: Respondents' Views on Current (2012) Status of Animal Availability in Nyando Wetlands

4.2.6 Wetland Insects

About 29 taxa of insects were recorded as being available in Nyando Wetland and were categorized as the second largest resource. Table 9 shows their names.

Table 9: Insects Available in Nyando Wetlands during the Study Period

TYPES OF INSECTS		
SCIENTIFIC NAME	**COMMON NAME**	**LOCAL NAME**
Lepidoptera	Moth larvae	Ombemo
Alates	Winged adult termite	Agoro
Amphipodae	Beach fleas	Miluma
Anisoptera	Dragonfly	Tik-jodongo
Anopheles spp.	Mosquito	Suna
Apis mellifera	Western honey bee	Kich
Araneae	Spider	Otieng'-otieng'
Busseola fusca	Stock borer	Kundi
Busseola fusca spp.	Pupa of stock borer	Amora-wang'
Coleoptera	Bumble bee	Kulundeng'
Coleopteran	Water beetle	Nyamilmil
Cordyceps sinensis	Caterpillar	Oyuo
Diplopoda	Millipede	Okolo
Drosophila melanongasts	Stingless bee	Ojur
Formicidae	Ant	Ochunglo
Glossina spp.	Tsetse fly	Maugo
Gryllidae	Cricket	Onjiri
Hirudinae	Leech	Chwe
Homorocoryphus nitidulus	Grasshopper	Dede
Isoptera	Termite	Bie
Lepidoptera	Stick insect	Nyamin pi
Musca domestica	Flies	Lwang'ni
Oligochaeta	Earthworm	Onias
Papilionidae	Butterfly	Oguyo
Raniceps raninus	Tadpole	Oluko
Schizonycha	Chafer grubs or white grubs	Ofunyu
Sitophillus zea-mais	Bruchids	Othuthu
Spodoptera exempta	Army worm	Kungu
Vespula vulgaris	Wasp	Pino

According to the respondents, Nyando Wetland insects were abundant in 1982 (54%). Over thirty three percent (33%) of the respondents however said that the insects were moderately available while (13%) indicated that they were few (Figure 19). 28% of the respondents reported that there was no change in insect availability (28%),26% Stated that insects were abundant, 24% alluded that the insects were few while (22%) contended that they were moderate (Figure 19).

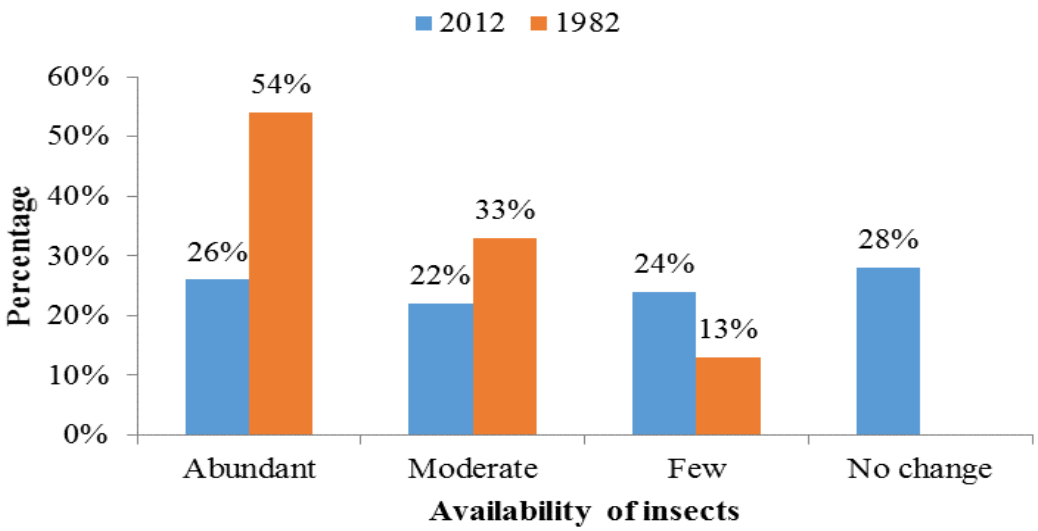

Figure 19: Respondents' Opinion on Insects Availability between 1982 and 2012

Most of the insects were either abundant or moderately available in 1982. Insects like *Hirudinae (*Chwe), *Anopheles spp. (*Suna), *Glossina spp. (*Maugo) and *Papilionidae* (Oguyo) were the most abundant. Other insects like *Apis mellifera* (Kich), (*Cordyceps sinensis)* (Caterpila), *Musca domestica* (Lwang'ni), *Coleoptera* (Kulundeng), *Schizonycha* (Ofunyu), *Sitophillus zea-mais/Brunchids* (Othuthu), *Isoptera* (Termite), *Vespula vulgaris* (Wasp) and *Homorocoryphus nitidulus* (Dede) were also relatively abundant (Figure 20). However, currently they have either become moderate or few as shown in Figure 21.

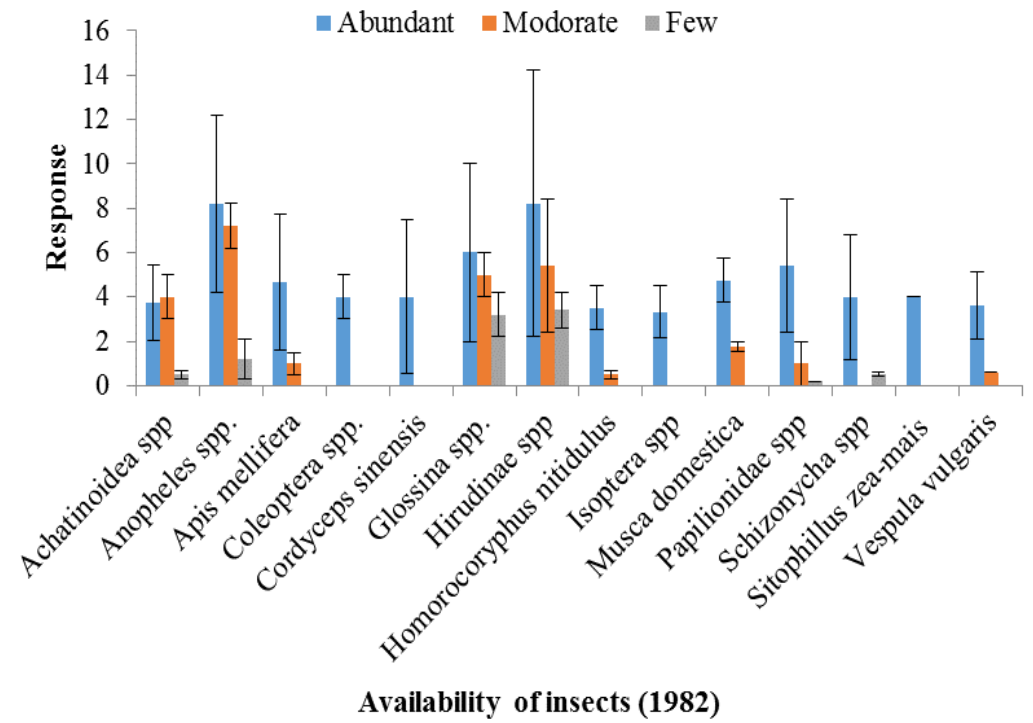

Figure 20: Views on Insect Availability in Nyando Wetlands in 1982

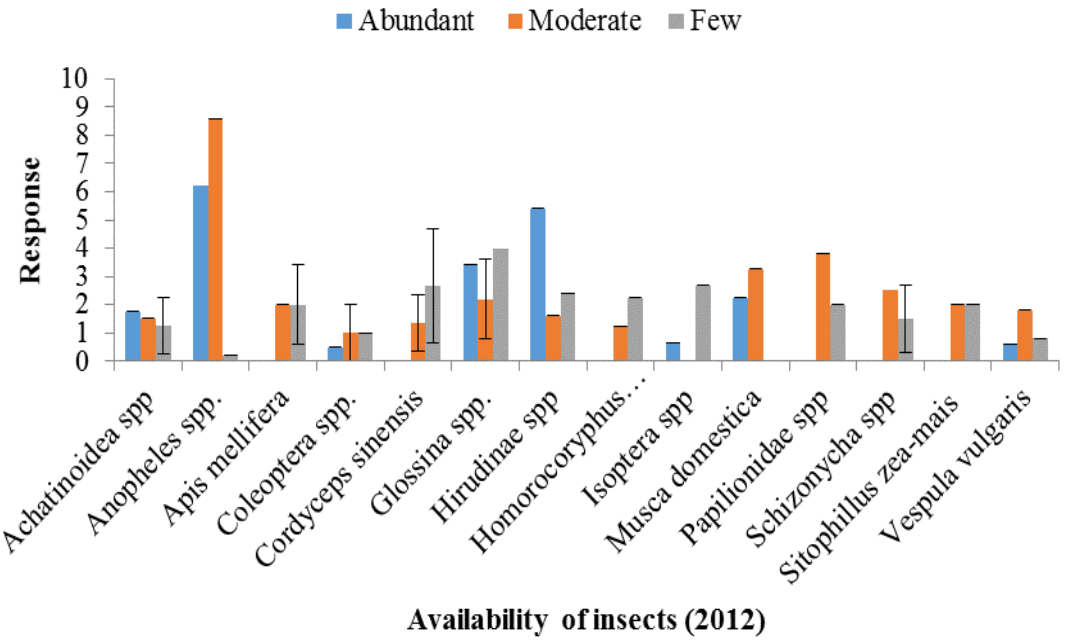

Figure 21: Opinion on Status of Insects Availability in Nyando Wetlands in 2012

The change in wetland resources over time was tested with Norminal logistic regression. The response information in reference event were abundant, moderate and few as shown in the response information in Table 10.

Table 10: Response Information of the Nominal Logistic Regression

Variable	Value	Count
Response	Abundant	319 (Reference Event)
	Moderate	217
	Few	212
	Total	748

The factors in the regression being time (at 2 levels; 1982 and 2012) and resources (at 5 levels; animals, birds, fish, insects and vegetables), Logit 1 which compared the response moderate and abundant had a p value of 0.000 with time, indicating that, time significantly affected the availability of resources from abundant to moderate. Coefficients of all resources were negative; Birds (– 0.538), Fish (-0.318), Insects (-0.535) and Vegetables (-0.338) and finaly, the frequency which also had a negative coefficient (-0.138) and a p value of 0.000, which indicated the decrease of resources from abundant to moderate, with time.

Logit 2, comparing response few and abundant of the resouces also had a p value of 0.000 and negative coefficients of the resources; Birds (-0.333), Fish (-0.760), Insects (-0.396) and Vegetables (-0.109) indiating the decrease of resources from abundant to few with time. The fish resource was signifficantly reduced to few (p=0.033), this being the most affected resourse at the wetland (Table 11).

Table 11: Nominal Logistic Regression of Response on Availability of Resource with Time in Nyando Wetlands

Factor Information						
Factor	Levels	Values				
Time	2	1982, 2012				
Resource	5	Animals, Birds, Fish, Insects, Vegetable				
Logistic Regression Table					**Odds**	**95%CI**
Predictor (Moderate/Abundant)	**Coef**	**SE Coef**	**Z**	**P**	**Ratio**	**Lower**
Logit 1:						
Constant	0.081	0.248	0.33	0.744		
Time						
2012	1.312	0.202	6.51	**0.000**	3.71	2.50
Resource						
Birds	-0.538	0.288	-1.87	0.062	0.58	0.33
Fish	-0.318	0.310	-1.02	0.306	0.73	0.40
Insects	-0.535	0.292	-1.83	0.067	0.59	0.33
Vegetable	-0.338	0.344	-0.98	0.325	0.71	0.36
Frequency	-0.138	0.029	-4.64	**0.000**	0.87	0.82
Logit 2: (Few/Abundant)						
Constant	-1.183	0.276	-4.29	**0.000**		
Time						
2012	2.486	0.216	11.50	**0.000**	12.02	7.87
Resource						
Birds	-0.333	0.310	-1.07	0.283	0.72	0.39
Fish	-0.760	0.356	-2.14	**0.033**	0.47	0.23
Insects	-0.396	0.318	-1.25	0.212	0.67	0.36
Vegetable	-0.109	0.358	-0.31	0.760	0.90	0.44
Frequency	-0.012	0.017	-0.67	0.503	0.99	0.96

The test statistics G for testing the null hypothesis that all the coefficients associated with predictors equal 0 versus them not all being zero had G = 221.277 with a *p-value* of 0.000, indicating that at a 95%, there was sufficient evidence for at least one coefficient being different from 0. In fact, none of the coefficient of the predictors was equal to zero. Log-Likelihood = -697.049 Test that all slopes are zero: (*G = 221.277, DF = 12, P-Value = 0.000*). Goodness-of-Fit Tests with Pearson and Deviance goodness-of-fit tests had p-value for the Pearson test of 0.090 and the p-value for the deviance test of 0.192, indicating that there was insufficient evidence for the model not fitting the data adequately (Table 12).

Table 12: Goodness-of-Fit Tests

Method	*Chi-Square*	*DF*	*P*
Pearson	291.038	260	0.090
Deviance	279.706	260	0.192

4.2.7 Water Resources

Water resource sources in the study area include Lake Victoria, Nyando Wetlands and the River Nyando and associated tributaries. The community perception of the quantity of water in the lake, river and wetland at Nyando is shown in Table 13. The lake, river and wetland water was more abundant in 1982 as shown by the respective response percentages 94%, 71% and 77% respectively as compared to the water level and quantity in 2012. Both lake and river water was currently observed to be moderate (54% and 45% respectively) while wetland water was observed to be low (49%) as compared to 30 years ago.

Table 13: Changes in availability of water at the Lake, Wetland and River Nyando

Water Source	Characteristic of Source	1982	Percentage	2012	Percentage
Lakes water	Abundant	220	94%	4	2%
	Moderate	10	4%	125	54%
	Few	3	1%	88	38%
	Completely depleted				
	No change			16	7%
		233	**100%**	**233**	**100%**
Wetland Water	Abundant	165	71%	31	13%
	Moderate	48	21%	58	25%
	Few	20	9%	115	49%
	Completely depleted				
	No change			29	12%
		233	**100%**	**233**	**100%**
River Water	Abundant	179	77%	44	19%
	Moderate	17	7%	104	45%
	Few	37	16%	75	32%
	Completely depleted			10	4%
	No change				
		233	**100%**	**233**	**100%**

4.3 Types and Causes of Resource Use Conflicts in Nyando Wetland

From the investigations carried out, the types of resource use conflicts that arise in Nyando Wetland according to the perception of the community are broadly categorized into three namely human-human, human-wildlife and conservation-resource utilization conflicts. Results are summarized in the sections below.

4.3.1 Human-Human Conflicts

Table 14 gives the causes of human-human resource conflicts in Nyando Wetlands. This type of conflict was mostly caused by land disputes arising from issues related to illegal ownership, grabbing, boundaries and title deed disputes (61%) besides fighting over fishing grounds (9%), natural calamities and disasters like floods and drought (6%), fighting over grazing areas within the wetland (5%) and stealing of livestock and crops. The later contributed to this type of conflict to a small extent.

Table 14: Causes of Human-Human Conflicts among Communities in Nyando Wetlands

Human–Human Conflicts	Frequency	Percentage
Destruction of agricultural farms by livestock	6	3%
Drunkenness	2	1%
Fighting over fertile land	6	3%
Fighting over fishing grounds and boundaries	20	9%
Fighting over grazing areas	12	5%
Fighting over wetland resources	5	2%
Insulting others in their business	2	1%
Lack of fairness	4	2%
Land disputes (ownership, grabbing, boundaries, title deed)	142	61%
Misunderstanding among the people	4	2%
No Conflicts	2	1%
Natural calamities/disasters	15	6%
Stealing of food crops, livestock	11	5%
Witchcraft	2	1%
Total	**233**	**100%**

4.3.2 Human-Wildlife Conflicts

Human-wildlife in Nyando Wetland can be attributed to a wide range of causes (Table 15) among them attack of wild animals that destroy crops (79%), hunting wild animals (6%), destruction of properties by wild animals (4%) inadequate food in the wetland due to drought (4%), killing of livestock by wild animals (3%) and cultivation in the wetland (3%).

Table 15: Causes of Human-Wildlife Conflicts in Nyando Wetlands during the Study Period

Human-Wildlife Conflicts	Frequency	Percentage
Attack of wild animals due to crop destruction	184	79%
Cultivation in the wetland	6	3%
Destruction of property by wild animals	9	4%
Hunting of wild animals	14	6%
Inadequate food in the wetland areas due to drought	9	4%
Killing of livestock by wild animals	6	3%
No conflicts	4	2%
Over fishing	1	0%
Total	**233**	**100%**

4.3.3 Conservation-Resource Utilization Conflicts

Conflicts resulting from conservation and resource utilization were caused by overdependence on wetland resources (19%), drought and famine (11%), burning wetland (10%) and unwise utilization (9%). Other conflicts due to conservation and resource utilization were due to clearing of the wetland for cultivation (5%), stealing resources from other people's farms (5%), lack of income (5%) and poor fishing

methods being cited by 4%. Eighteen percent (18%) of the respondents responded that there were no conflicts meaning they did not perceive the existence of any conflict as they utilized the resources. It is however important to note that this category of conflict had a diversity of causes as recorded in Table 16.

Table 16: Causes of conservation-resource utilization related conflicts in Nyando Wetlands

Conservation-Resource Utilization Conflicts	Frequency	Percentage
Burning wetland	23	10%
Clearing of wetland for cultivation	12	5%
Overdependence on the wetland resources	44	19%
Destruction of crops by wild animals	1	0%
Drought and famine	25	11%
Encroaching the conserved areas	2	1%
Fighting over boundaries	2	1%
Grazing on people's land	2	1%
Lack of knowledge	2	1%
Lack of income	11	5%
Lack of rainfall	4	2%
Limited resources	6	3%
No conflicts	41	18%
Overgrazing	1	0%
Poor cooperation between communities	6	3%
Poor fishing methods	10	4%
Poor utilization of resources	7	3%
Stealing resources from other people's farm	12	5%
Unwise utilization of wetland resources	22	9%
Total	**233**	**100%**

4.4 Relationship between Resource Use Conflicts and Food Security

Results from focus group discussions indicated that the factors that have impacted on food security were changing land use patterns (38%), changing river courses (23%), climate change (31%), conflict of interest (85%), cultural practices (38%), decline in resources (46%), degradation of resources (38%), drought (54%), flood (31%), lack of buffer zones (77%), ignorance (69%), overstocking (31%), poaching (15%), population pressure (54%), poverty (54%), shared resource (54%) and trust land (46%), Figure 22.

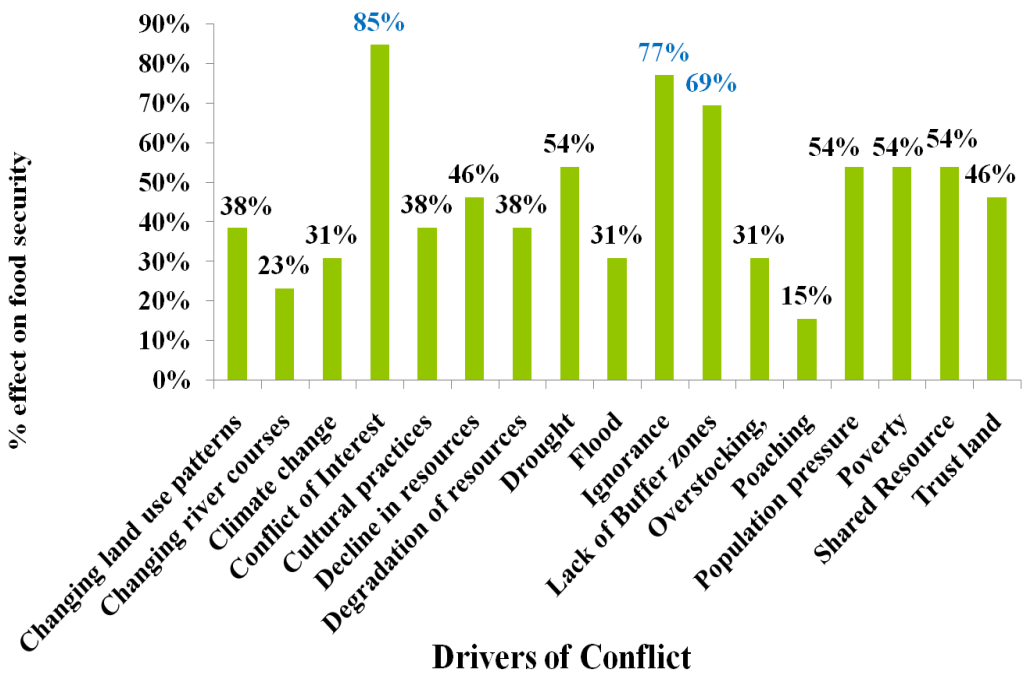

Figure 22: Drivers of Conflicts and their Level of Impact on Food Security in Nyando Wetlands

Cluster analysis grouped factors that had similar impact on food security like changing river course, climate change, degradation of resources, poaching and decline

in resources in one cluster; conflict of interest, ignorance and lack of buffer zone in another; population pressure, trust land, changing land use patterns, shared resource and cultural practices in one cluster and poverty and drought in another cluster (Figure 23).

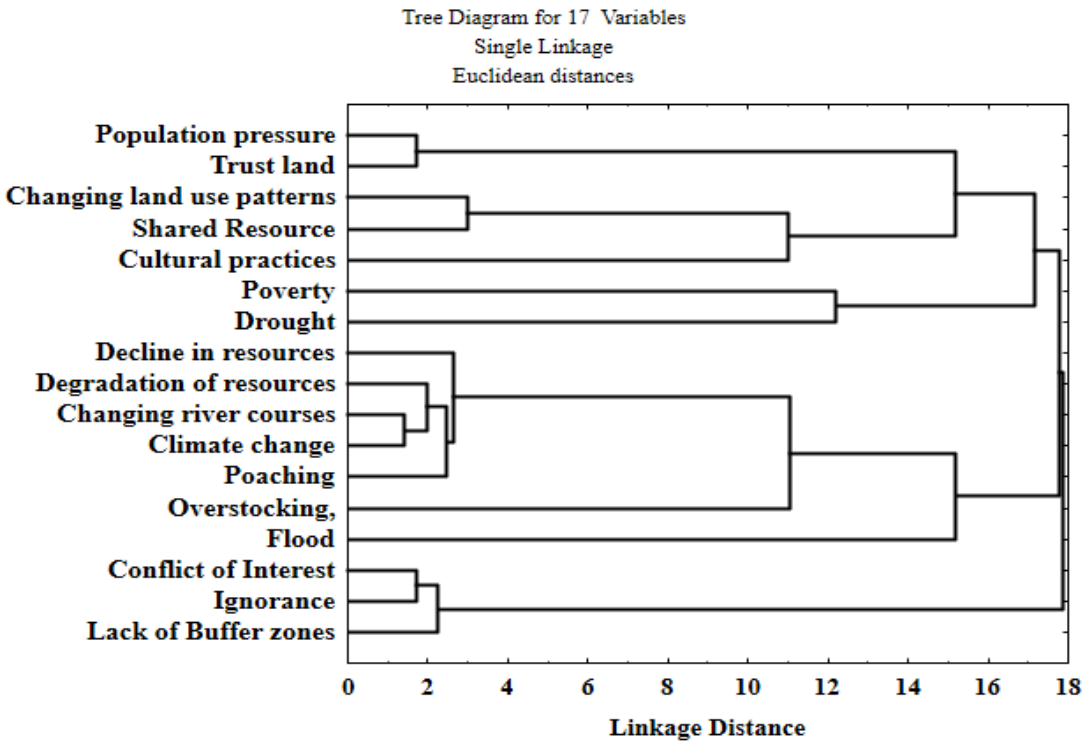

Figure 23: Dendrogram on Relationship of Drivers of Conflicts with Similar Impact on Food Security during the Study Period

According to the respondents, the major factors that resulted to conflict and their impact on food security were floods, drought, human pressure, development and changing land use. The first three factors had a negative (decrease) impact on food security, with drought having the highest impact (82%) followed by human pressure (75%) and floods (66%). Development and chaging land use had positive (increase) impact on food security, with development having 81% and changing land use 70% as shown in Figure 24.

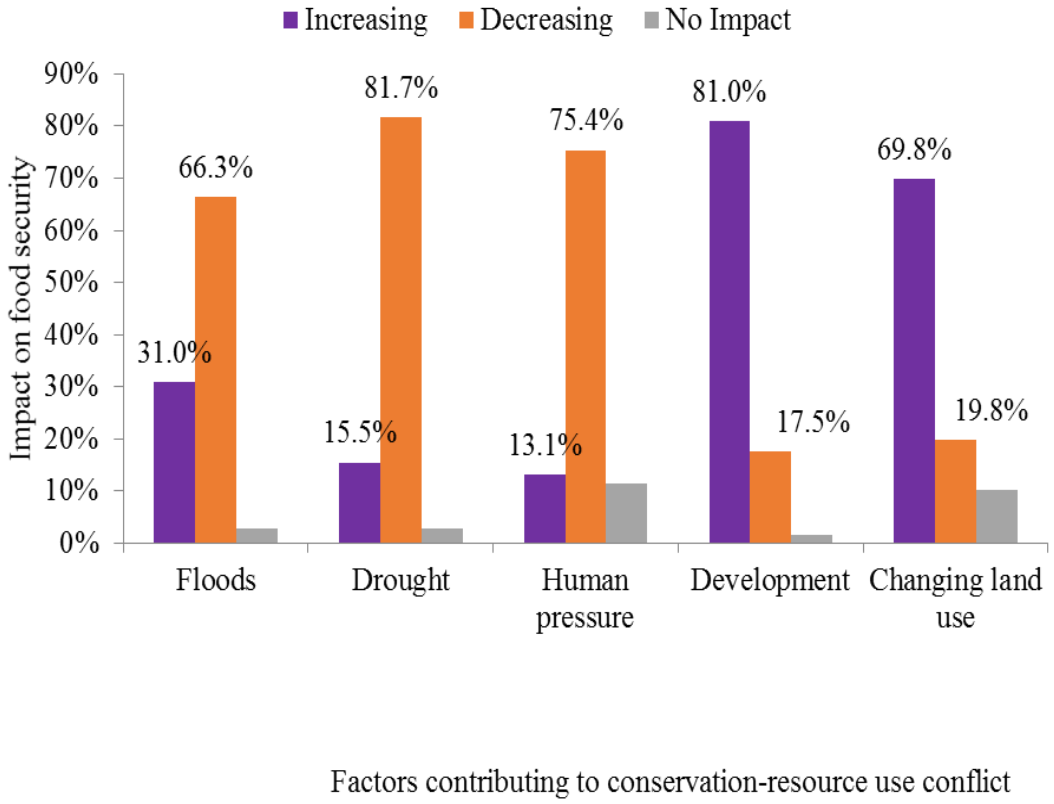

Figure 24: Factors Contributing to Conflicts and their Impact on Food Security

Spearman correlation of factors affecting food security and their impact on food security was evaluated and results are shown in Table 17. Floods, drought and human pressure had negative impact on food security with coeficients of -0.4428, -0.1497 and -0.0218 respectively while development and changing land use had a strong positive correlation (effect) on food security with values of 0.9449 and 0.9352 respectively. They also had a strong positive correlation with each other and significant a p value of 0.018 indicating that they had similar measurement effect (one measurement was a representative of the other).

Table 17: Results of Spearman Correlation of Factors Affecting Food Security and their Impact on Food Security

Marked correlations are significant at p < 0.050						
	Food security	Floods	Drought	Human pressure	Development	Changing land use
Food security		-0.443 p=.708	-0.1497 p=.904	-0.022 p=.986	-0.945 p=.212	-0.9352 p=.230
Floods	-0.4428 p=.708		0.9528 p=.196	0.906 p=.278	0.1249 p=.920	0.0967 p=.938
Drought	-0.1497 p=.904	0.9528 p=.196		0.9918 p=.082	-0.182 p=.883	-0.21 p=.865
Human pressure	-0.0218 p=.986	0.906 p=.278	0.9918 p=.082		-0.307 p=.802	-0.3336 p=.784
Development	0.9449 p=.212	-0.125 p=.920	-0.1822 p=.883	-0.307 P=.802		0.9996 **p=.018**
Changing land use	0.9352 p=.230	-0.097 p=.938	-0.21 p=.865	-0.334 P=.784	0.9996 **p=.018**	

CHAPTER FIVE

DISCUSSION

Study findings on types and changes in Nyando Wetland resources over the last three decades, conflicts that have arisen from the exploitation of the resources and the relationship between the conflicts and food security in the region are discussed in this chapter. The information used in subsequent sections was derived from household surveys, key informant interviews, focused group discussions with selected members of the community, direct observations made during the study and secondary information. Attempts have been made to discuss the findings with the aim to understand the nexus between resource use conflicts and food security situation in Nyando Wetland. The chapter starts by highlighting findings on the socio-economic status of the community studied, followed by a discussion of the observations made on wetland resources, conflicts and their relationship with food security.

5.1 Household Characteristics and their Implications on Resource use, Emerging Conflicts and Food Security

The household survey on the socio-economic status of the Nyando Wetlands community shed light on the household characteristics investigated in order to authenticate the information collected. For instance, 78% of the respondents were aged 30 years and above and those who had lived in the area for more than 30 years were 51% of the respondents. The data collected on the changes in wetland resources over the period 1982 to 2012 was derived from respondents who had first-hand

information. Some elements of the socio-economic status of this community are also worth noting as this have a bearing on the exploitation of resources. Whereas 77% of the respondents are married, a significant proportion (21%) were widows with female-headed households forming 28% of the respondents.

With a mean family size of 6–10 children constituting about 58%, over 57% earning less than Kshs.5, 000.00 per month and majority of the respondents (77%) having low level of literacy, and having primary education and below, there is a great danger to the wetland resources as this population will definitely depend largely on the exploitation of the natural resources. These extreme demographic characteristics translate into high and increasing pressure on Nyando Wetlands resources.

Past studies on Nyando Wetlands have noted that environmental degradation is often higher among communities who depend largely on the exploitation of natural resources for their livelihood (Kipkemboi, 2006; Obiero *et al*., 2012 a, 2012b). This can be confirmed by the fact that majority (73%) of the respondents derive their livelihood from farming activities and exploitation of wetland products both of which have their peak exploitation rate during the dry seasons when majority of the community (64%) experience reduction in incomes. These findings on dependence of the community on agriculture and wetland products concur with those of Obiero *et al.* (2012a) and Onyango (2013).

5.2 Nyando Wetlands Resources

Study findings revealed that the Nyando Wetlands community depended heavily on locally available resources harvested from the wetlands as a source of food. The diversity of food sources ranged from a wide range of locally available indigenous vegetables, most of which grew and were harvested from the wild. The fishes consumed by the residents of Nyando Wetlands who are predominantly a fish-eating community was very diverse and included endemic species which were harvested from the lake, rivers and the riparian wetlands. The food base of this community was further complemented by harvesting diverse species of insects, birds and mammals which were exploited as sources of protein food.

Apart from food, the community also benefited from abundant and reliable water and wetland plants which were part and parcel of their livelihood in terms of pasture for livestock, baskets, fishing gears and shelter. In spite of the foregoing observations, study findings showed that there has been very significant reduction in the various sources of food resources over the years making this community to be food insecure. Subsequent sections discuss specific wetland resources used as food in the study area and could the factors that have contributed to their reduction over the years.

5.2.1 Fishes

Nyando Wetland fish species were abundant in 1982 but over time, the fish have either been depleted or degraded as reported by 90% of the respondents. About 18 species of fish were recorded in the study area, and this provide food for the local

community. From time immemorial, fish has been a major source of protein in the diet of the local community and is also sold to generate income. The species that have recorded great reduction from 1982 to 2012 include *Protopterus aethiopicus, Claria spp., Labeo spp., Schilbe mystus, Oreochromis esculentus, Synodontis spp.,* and *Bagrus docmac* among others. These are species that were most cherished by the local community (Okeyo-Owuor, 1999; Obiero *et al.*, 2012).

From key informant interviews and FGDs carried out during the study, it was observed that most of these species inhabit the river-mouth wetlands and migrate upstream for spawning at the beginning of every rainy season. Over the years they have been over-harvested as they migrate upstream and this has led to failure to reproduce young ones to sustain their populations. Reduction of fish populations by over-harvesting gravid females ready to spawn is a phenomenon which has been reported by many authors (Ochumba and Manyala, 1992; Balirwa, 1998; Odende and Nyongesa, 2004). Reduction and/or depletion of fish species in the wetlands can also be attributed to several other anthropogenic activities that include excessive fishing pressure when fish congregate to spawn, drainage of wetlands for agriculture, massive angling for bait used in the long-line fishery of the Nile perch, siltation, pollution and use of destructive fishing techniques such as beach seines and monofilament nets in wetland areas bordering the lake (Odende and Nyongesa, 2004; Terer *et al.,* 2005; Kolding *et al*, 2008; Obiero *et al.,* 2012a). Of immediate importance is overdependence on fish as a source of food by the Nyando Wetland communities combined with lack of awareness on sustaining a fishery. This occurs mainly through fishing in breeding grounds where immature fish are captured thus shifting their demographic equilibrium. Poor fishing methods by the local communities including

the use of small mesh size nets and non-recommended fish traps that captures immature fish has led to their depletion or degradation and consequently reduced fish available for food and sales, thus contributing to food security. These findings concur with those of other studies carried out in the Kadibo Wetland which revealed that although fish species are currently available, they are rare (Maithya *et al*, 2011; Obiero *et al.*, 2012a).

Overdependence on fish as a wetland resource by communities living around Nyando Wetland is also a major cause of depletion of most of indigenous fish species. Burning of wetlands by the local communities to facilitate hunting also destroys fish habitats and hence fish migrate to other habitats thus reducing their numbers. Once habitats are burned, some fish species that live on shallow waters like *Protopterus aethiopicus* and *Clarias spp.* get stranded at the roots of papyrus and become easy target for the fishermen and hence are over-fished thus making them unable to breed. This has led to depletion of their populations.

Agriculture is also another source of fish decline in Nyando Wetland. From key informant interviews it was noted that fertilizers used in agriculture increase eutrophication thus affecting the water quality resulting to an increase in the mortality of fish and hence resource depletion. This affects the fish resident in the wetlands and those that migrate upstream to spawn. This observation concurs with the findings of many authors who have worked within the Nyando Wetland basin (Raburu, 2003; Terer *et al.*, 2005; Raburu and Okeyo-Owuor, 2005)

Apart from anthropogenic factors, reduction of fish species in Nyando Wetlands can also be attributed to natural factors. Degradation of water catchment areas for the Nyando Wetland causes siltation and reduces water levels in rivers and riverbanks leading to decline in fish. The changes in Nyando River course due to sedimentation may have also contributed to destruction or modification of the fish habitat thus contributing to the decline of migratory species (Obiero *et al.*, 2012a). Other natural causes could be attributed to drastic climatic variations, especially flooding and drought in the lower Nyando Basin where the wetland is located as also observed by Swallow *et al.,* (2008). For instance, drought makes the wetlands to dry up thus killing fish, while floods and storms dislodge and transfer organisms to other un-conducive areas. This may reduce fish food thus leading to their decline. Recent studies on Nyando Wetland have revealed that lake fisheries and the post-wetland fishery is characterized by a marked decline probably due to conversions and drying up of beaches as a result of lake recession (Obiero *et al.*, 2012a). The shallow waters are the most fruitful in terms of fish catches, and when water level is recedes, fish catches also decrease (Balirwa, 1998). This has led to loss of biodiversity thus threatening wetland ecological integrity, food security and household economic gain of the local communities. The decline in the fish resources has contributed to conflicts in resource use.

Since the community utilizes the wetlands both seasonally and on long-term basis in their quest for livelihood benefits, fish is mostly abundant during the wet season compared to the dry season when the fish numbers decline due to the decrease in water in the wetland as revealed by FGDs. Furthermore, FGDs with the local community also revealed that income from fish sales is able to pay fees for their

children and take care of basic needs while during dry season they can exchange fish for other goods when food is not available in the wetlands. The trade is however not without its social pitfalls as the female traders are either coerced or forced to succumb to sexual demands of fishermen with whom they are compelled to trade sex for fish with male fishers who are locally known as 'Jaboya'. This phenomenon of fish-for-sex along the shores of Lake Victoria has been reported by various authors (Geheb and Binns, 1997; Action Aid Kenya, 2003; Awounda, 2005; Béné and Merten, 2008).

5.2.2 Wetland Vegetables

Nyando Wetlands are a habitat for a great diversity of plants and vegetables which are used by local communities as a source of food and income. Twenty different types of vegetables are found in the wetlands. Majority of the vegetables are indigenous while the rest are exotic. From the household surveys, 81% of the respondents reported that indigenous vegetables have drastically reduced compared to their availability in 1982. The same observation on reduction in the availability of indigenous vegetables compared to thirty years ago was also recorded in FGDs and key informant interviews' results. The reduction or depletion of indigenous vegetables can be attributed to unsustainable use of the Nyando Wetland through activities such as overgrazing by livestock, burning of wetland vegetation during dry seasons, clearing land for cultivation, abstraction of water for domestic use and introduction of alien species which may have out competed indigenous plants.

Reclamation of the wetlands for settlement also contributed to the depletion of indigenous vegetables. Soil erosion due to flash floods and wind fills the wetlands

leading to sedimentation causes the wetland to dry up providing a suitable environment where some of the vegetables are grown. As a response, the local communities living around the Nyando Wetland have thus embarked on planting exotic vegetables as a source of food and alternative livelihood.

Indigenous vegetables are known to be superior in their nutritional value than exotic ones (Abukutsa, 2010). It is noteworthy that the change in the diversity of indigenous vegetables in the region has greatly affected the food security of the community. Most indigenous vegetables were obtained free from the wild when the wetland environment was pristine, and cheap and nutritious food could be accessed by the majority of the population. However, environmental degradation through burning and reclamation of the wetland ecosystem for agricultural activities based on exotic vegetable species will forever affect community livelihoods. Plant communities in wetland ecosystems normally change in response to environmental degradation (Ogutu *et al.,* 2003). Hence, the reduction of indigenous vegetables in the Nyando Wetland due to anthropogenic forces therefore conforms to what has been recorded elsewhere (Abukutsa, 2010).

5.2.3 Wetland Plants

Pressures that have led to the reduction in the abundance and diversity of indigenous vegetables have also contributed to loss of wetland plants. From the survey results, it is justifiable to deduce that the abundance and biodiversity of wetland plants have decimated due to the multiple uses the community derives from them. Unlike the vegetables, the plants contribute significantly as a source of income to the community.

These uses ranged from being sources of fuel wood, fish trap, brooms, furniture, fencing, building materials, animal fodder, medicinal, fertilizer and making several wetland products like mats and baskets. The importance of wetland plants as a source of income to riparian wetland communities has been reported about other wetland ecosystems in the Lake Victoria basin such as the Yala Swamp and Sondu-Miriu wetlands **(**Gichuki *et al.,* 2001; Schuyt, 2005, Kinaro, 2008)**.**

5.2.4 Wetland Birds

Nyando Wetland is rich in bird species because it is endowed with natural bird habitats and the nature of food that is available in the wetland. Results revealed that the wetland has 37 species of birds which were abundant in 1982 but have since experienced reduction in species numbers. Most of the bird species are found in the irrigation schemes where most of the rice paddies are found. Rice paddies are the major feeding grounds for majority of aquatic fowls while gulls dominate the lake and inshore areas. Other species of birds depend on the wetlands that are dominated by macrophytic plants like papyrus. Birds are also important in pollination in the wetlands and help in keeping the wetland plants available.

The availability of birds depends on the good health of the wetlands because this will provide them with food. Reclamation of the wetlands for agriculture and settlement has led to some bird species to migrate thus reducing their numbers as reported in FGDs. Other species come to feed but return to their habitat depending on the availability of food. This has enhanced their decline. Burning the wetland for hunting and other activities like cultivation has contributed to the destruction of the bird

habitat leading to their decline. Most of the birds reported to have declined are those which traditionally were being eaten by the community as food like *Perdix perdix, Anas luzonica,* and *Ploceus castanops* among others. The other category of birds are those which predominantly depend on the healthy wetland ecosystem as their nesting sites and breeding grounds like the *Balearica regulorum, Ixobrychus minutus, Hagedashia hagedash, Ephippiorhynchus senegalensis, Pelecanus rufescens* and *Ardea cinerea*.

The reduction of birds used as food within wetland ecosystems have also been reported by Childress *et al.* (2002) and Birdlife International (2008). Some are trapped and killed when they invade crops like maize and rice paddies in the fields leading to their decline. Overall, there has been a change in the diversity of birds from wetland dependent birds to mainly grain eaters which have taken the advantage of rice growing and other cereals that have been introduced in the wetland. This finding concurs with those of Raburu *et al*. (2012).

5.2.5 Wetland Animals

Results revealed that Nyando Wetland had a relatively high biodiversity of animals amounting to about 15 species. According to 89% of the respondents the mammalian species diversity was moderate to high in 1982, but over time they have declined. The species that have witnessed marked reduction include *Hippopotamus amphibious, Tragelaphus spekii, Varanus niloticus, Cercopithecus aethiops, Poelagus marjorita* and *Antelopes* most of which were either used as food by the local communities or

were predators to domestic crops and animals. Reptiles like *Pythons* and *Salamanders* are also currently very rare while the diversity of frog species has also declined.

Several anthropogenic factors like burning the wetlands during hunting, hunting them down by the local communities for food, skin and livelihood, trapping and killing of animals like *Cercopithecus aethiops* and *Hippopotamus amphibious* when they destroy crops and encroachment including cultivation of crops beyond the buffer zone were cited as the major causes of the decline in the animals in Nyando Wetland. According to the community members, these activities destroyed animal species habitat and increased human-wildlife conflict and thus made them either to migrate to other areas or be more vulnerable. Several studies have attributed biodiversity loss of animals in various wetlands to the anthropogenic activities mentioned above (Masese *et al.,* 2012; Morrison *et al.,* 2012).

Lack of proper mechanisms for enforcing conservation measures in unprotected wetlands in the country has also affected the animals. More often, law enforcers were never there to protect the animals with reports reaching the relevant authorities when it is too late as reported by key informants. This attitude among local residents continues to negatively impact on the biodiversity of animals and reptiles.

5.2.6 Wetland Insects

A majority of respondents (87%) identified about 29 species of insects found in the wetland to have been moderate to abundant in 1982 but are currently very few since 2012. These include *Papilionidae*, *Glossina spp.*, *Anisoptera*, *Homorocoryphus*

nitidulus, *Hirudinae*, and *Spodoptera exempta* amongst others. Most of these are insects of economic importance that serve as food for man, birds and fish while others are associated with beneficial biodiversity functions as wetland plants pollinators.

The decline in insect species is as a result of multiple factors as observed by the local community. The numbers of some like *Glossina spp,*, *Anopheles spp.* and *Spodoptera exempta* for instance, could have declined as a consequence of deliberate pest control activities in the region and increased use of pesticides in farming ends up killing the target pest as well as beneficial insects (Tillman *et al.,* 1996). Other insects like *Alates* and *Homorocoryphus nitidulus* which were exploited as food by the local communities declined in numbers as the human population in the area increased. Although some insects perform important ecological roles, conflicts may arise due to the fact that they are disease vectors such as *Anopheles spp.* (Raburu *et al.*, 2012).

In a nutshell, most of the insects which were found in the wetland played a very significant role in one way or the other. Loss of insect biodiversity is likely to interfere with ecological integrity of the wetland and livelihood of the community more so at such a time that countries are crusading for diversity in food sources to feed the ever-increasing human population. This loss has thus affected the food security of the community negatively.

5.2.7 Water

Nyando Wetland is well endowed with abundant water, although this varies seasonally depending on the prevailing climatic regime. The area experiences

extremes of weather conditions ranging from floods to drought during rainy and dry seasons respectively. Problems associated with water resources therefore are seasonal contributing to seasonal changes in all the resources which apparently depend on the quality and quantity of water in the wetland and associated rivers, streams and the lake. In this context, the water availability for domestic use is less than the average per capita water consumption. In areas worst hit by the water stress, people have to walk greater distances to fetch water for domestic purposes (Obiero *et al.,* 2012a). Decline in lake level has impacted negatively on women who are normally charged with the responsibility of collecting water for their households. This arises from them being forced to travel long distances and hence using more time in collecting water thus compromising time to be invested in other important socio-economic activities.

5.3 Types and Causes of Resource use Conflicts in Nyando Wetlands

Conflicts arise when two or more people do not agree about something. In Nyando Wetland, different types of conflicts were reported to arise while sharing the limited available resources. The conflicts occurred between humans themselves basically due to land disputes, between the humans and the wildlife habiting the Nyando Wetland due to crop destruction by the animals and conservation versus resource utilization of the Nyando Wetland due to overdependence on the wetland resources by the riparian communities. The types of conflicts associated with resource use in Nyando Wetland are categorized into three groups i.e. Human-Human, Human-Wildlife and Human-Conservation conflicts arising from frequent alterations in the river course and water levels (Obiero *et al.,* 2012a). Drivers of these conflicts include population pressure, poverty, changing land use patterns, cultural practices, decline in resources, shared

resource, conflict of interest, lack of buffer zones, drought, floods, overstocking, ignorance, poaching and the fact that the wetlands are trust lands (Raburu *et al.,* 2012; Masese *et al.,* 2012).

Apart from this, the destruction of papyrus swamps displaces wildlife such as the *Hippopotamus amphibious* causing human-wildlife conflicts. Further, burning of wetland habitats causes migration of birds into rice paddies in pursuit of new sanctuaries and feeding grounds. Apart from human-human and human-wildlife conflicts arising from use of wetland resources, human-conservation conflicts arise because some wetland uses are in conflict with natural resources protection priorities.

5.3.1 Human-Human Conflicts

Due to the fact that Nyando Wetland is a trust land and there are no demarcations put in place by the Ministry of Lands and issuance of title deeds, dispute over boundaries and land ownership have been experienced. Focus Group Discussions revealed that this is the major human-human conflict in the wetlands. Subsistence farmers compete with commercial farmers for use of the fertile floodplain of Nyando Wetland and riparian zones of the numerous rivers that drain the area. Farmers compete with herdsmen for utilization of the wetland especially during the dry season leading to conflict of interest in resource utilization. When farmers plant their crops, herders out of ignorance, drunkenness or jealousy let their livestock to graze on the farms leading to conflict, with others hacking livestock to death.

There is an increase in the number of commercial vegetable farms in response to the growing demand for tomatoes and other vegetables. Horticultural crops grown in the Nyando Wetlands provide an important source of food and income to communities living around the wetlands. However, in the process, a number of goods and services derived from the wetlands to benefit livelihoods of local people may be lost through agriculture due to reclamation of wetlands for agricultural use as also observed by Ilya *et al.* (2009).

During the dry season, the wetland area is always submerged in water and green, and herdsmen graze their livestock within it further away from the dry land outside the wetland. This often leads to destruction of crops when livestock are left unattended to and this leads to conflicts between farmers and herders. Some farmers also plant crops on foot paths leaving the livestock with no clear path to follow and they end up grazing in their farms. Due to scarcity of grazing land during the dry season, herders also compete for grazing areas. The local community also competes for wetland resources like papyrus during both the dry and the wet seasons when it is wet. However, floods make it difficult to reach the resources during this season and when it is dry the resources decline.

Conflicts also arise especially between communities from Nyakach and Kano due to the fact that some people steal other peoples' livestock and crops from the farms. Although this form of human-human conflict was ranked least, FGD and KII discussions revealed that several deaths have arisen from the same more than once. Stealing occurs when livestock venture into other people's boundaries. The change of the course of River Nyando at its mouth is also recorded to have led to boundary

disputes over a long period of time between Nyakach and Kano communities (Raburu *et al.*, 2012). Conflicts also arise over fishing grounds where different groups feel that they own a fishing ground and when one is caught on another group's fishing ground then all their fish is seized and this brings conflicts when the other group wants to retaliate.

Some conflicts have also been noted to arise due to purely socio-economic issues. The most pronounced in the area is "Sex for fish" known locally as "Jaboya". Conflicts arise when some male fishermen dictate to have sex with women fish traders before they can sell them fish. The women who give in to sex create conflict between them and other fellow traders who have also been lured to have sex with the same male fishermen in the past and later miss fish and the same is given to their rivals. The same phenomenon also creates conflict in families and has led to broken marriages because of such irresponsible behaviour. Witchcraft and pure jealousy were also cited as minor causes of conflicts. For example, this arose when rivals destroyed all the crops in farms and defecated so that one is not found.

Human–Human conflicts have been reported in several other wetland ecosystems in the region (Maithya *et al.*, 2011). From close examination, these conflicts in Nyando arise from lack of clear cut government policies on land ownership within the wetland ecosystem, poor/corrupt land adjudication due to corrupt government officers, poor delineation of the buffer zone in wetlands fringing the lake which should be left for conservation purposes and break down of cohesion among local communities where there are weak local conflict resolution mechanisms which in the past were effectively done by village elders. Another issue noted in this study is the contribution of climatic

changes, particularly during drought. This findings conform to those in the study by Obiero *et al*. (2012). However, the underlying cause of all these human – human conflicts in Nyando is the struggle by the communities for livelihood due to dwindling wetland resources.

5.3.2 Human-Wildlife Conflicts

Human-wildlife conflicts arose from crop destruction by wild animals like *Hippopotamus amphibious*, *Cercopithecus aethiops* and birds. In retaliation, the animals are attacked by humans and in the process the humans are also harmed and sometimes killed by *Hippopotamus amphibious*. High dependency on wetland resources by communities living around Nyando Wetland drives people to cultivate crops up to and including the buffer zones which should be protected to allow wild animals to graze freely without interfering with human activities. Another source of conflict as reported in FGDs was drought that led to scarcity of food in the wetland leading to over-harvesting of wetland plants like papyrus and reeds for different uses like fuel wood.

Competition for resources such as pasture and water amongst herders and wild animals like *Tragelaphus spekii* also leads to conflicts. The local residents also burn the wetland to reclaim land for agriculture and in the process destroy bird habitats and their food sources thus leading the birds to destroy crops in nearby farms of rice. In the process of burning the wetlands to facilitate hunting wild animals like *Tragelaphus spekii* for game meat and *Protopterus* where wetland water has receded they kill and reduce their species. Attacks on livestock by wild animals is also common in the study area. For example

when the wild *Genet* attacks domesticated poultry, this makes residents to lay traps to catch them and they get killed. *Cercopithecus aethiops* and rodents like the *Xerus rutilus* eat and destroy crops in rice paddies, maize and sorghum farms as a result of their natural habitats having been destroyed.

Human–wildlife conflict is widely reported in Kenya mainly from rangeland ecosystems where in most of such cases the major cause is hunting in search of game trophies (World Resources Institute, 2007). However the scenario in Nyando appears to be directly related to competition for food and habitats. Due to population pressure and possibly unreliable rainfall which limits food production, all the attention of the local residents is focused on the exploitation of wetland resources as the main source of livelihood without due consideration that birds and wild animals depend on specific wetland habitats for survival thus leading to the continued fierce conflict which affects both animal biodiversity and food production by riparian communities. The same has also been reported about Yala Swamp (Kinaro, 2008) among other wetlands.

5.3.3 Conservation-Resource Utilization Conflicts

Overdependence on utilization of Nyando Wetland resources by the local community was the major cause of conflicts between wetland conservation efforts and resource utilization. From FGDs, it was confirmed that a high rate of population growth accompanied with increased poverty rates, fishing in fish breeding and spawning sites, over fishing and harvesting of immature fish for food and sale as bait for the *Lates niloticus* bait fishery is widespread in Nyando Wetland. This reduces fish biodiversity and abundance as well as fish numbers. Ignorance plays a big role in

enhancing the misunderstanding of the fact that using the recommended net mesh sizes enhances fish availability.

Over exploitation of wetland resources like *Cyperus papyrus* for building and making mats for sale among other uses also reduces biodiversity in the wetlands. While harvesting macrophytes, some local residents uproot *Cyperus papyrus* instead of embracing its wise use to enable the *Cyperus papyrus* rhizomes grow again. On the other hand, burning of the wetland for cultivation, hunting or grazing during drought also destroys the habitat for wild animals and other indigenous fauna and flora found in the wetlands. Sand harvesting for construction also breaks the river banks. Unsustainable use of water for domestic purposes, watering of large numbers of livestock regularly in similar sites and poor irrigation practices also reduces the water quality and quantity in the wetland. Reclaiming the wetlands for settlement and development due to high population and new technologies reduces the wetland ecosystem which makes the wetland resources to either decline or be depleted completely (Swallow *et al.,* 2008)

As indicated in other types of conflicts reported in the preceding sections, it goes without say that most of the causes of conflicts cited are anthropogenic and are precipitated by the quest for better livelihoods by the riparian communities. However, from KII and FGD's, it was very clear that lack of awareness and poor understanding/ ignorance of the functioning of the wetland ecosystem played a major role in conservation vis-a-vis resource use conflicts in Nyando Wetland. Whereas the local communities were clear that the wetland ecosystem is deteriorating and that they continue to benefit lesser and lesser from it, most of them were unable to see the link

with their activities as shown in Table 16. Even some who could see this scenario, are unable to come up with locally bred solutions to address the problems and this has led to a state of apathy.

5.4 Relationship between Resource use Conflicts and Food Security

Nyando Wetland provides a variety of important goods and services to the local people including flora and fauna. They also provide socio-economic needs which constitute the basic capital to meet their needs like food, fuel, water supply amongst other requirements. Apart from providing for their socio-economic needs, wetlands also provide ecological needs which are helpful in maintaining the health of the wetlands. Socio-economically, Nyando Wetland supports family livelihoods as sources of water supply, food production, construction materials, and products for the cottage industry, tourism and recreation.

Ecologically, wetlands are instrumental in water recharge and discharge, water filtration, flood control, nutrient storage and re-cycling, and are also important habitats for bio-diversity of both flora and fauna these makes the wetland a significant habitats for food security and general livelihood of riparian communities. These observations concur with previous studies carried out elsewhere (de Groot *et al.,* 2002; MEA, 2005).

Resource use conflicts affect food security in Nyando Wetland either positively or negatively. Those that lead to decreased food security are related to unpredictable climatic changes such as floods and drought. These events normally increase

(drought) or reduce (floods) wetland areas exploited by the local community for food production. During droughts, a large number of people rush into the wetlands to exploit the productive moist lands for agricultural food production thus increasing conflicts. Livestock numbers in the wetland also increase tremendously during these seasons in search of pasture. During floods, water fills large areas of wetlands resulting in a struggle for the few raised areas to support both food production and grazing of livestock. Climatic factors have been reported to lead to wetland degradation and reduced food security (Raburu *et al.*, 2012). However, in most instances of famine risk, climate is an exogenous trigger, but underlying the social problems are the deeper cause of food crises (Barnett and Adger, 2007).

Pressure from increasing human population is another factor that affects food security negatively in Nyando Wetland. With increased numbers of people exploiting a limited resource leading to overexploitation of food resources over time resulting in loss of biodiversity and decreased food production. In Nyando this is manifested through encroachment on wetland areas through settlement, agricultural food production and livestock grazing. Evidence of population pressure on wetland goods and services is widespread and human activities and increasing population are affecting all ecosystems and not just wetlands as reported by Mainka and Trivedi (2002).

Developments in agriculture have brought significant increases in global food production due to expansion in cropland and through changes in technologies over time. This study revealed that development and changing land use especially in agriculture has led to increased food security in Nyando Wetland. Despite this, it is

important to note that these activities may degrade natural resources like soil, water and biodiversity in and around agricultural land. Further, if resources are used unsustainably, the wetland ecosystem may be destroyed completely unless this is done with wise use principles in mind (Mitsch and Gosselink, 2000).

Loss of biodiversity in habitats surrounding agricultural areas leads to disruption on ecosystem services provided by wetlands. These disturbances in turn can result in productivity declines in both on- and off- farms. Degradation of wetlands with time may lead to reduced soil moisture on which food production depends. The maintenance of environmental conditions of the floodplain to ensure flooding is therefore a priority if the food security of the wetland communities is to be guaranteed. These trends if left unchecked can cause social harm and can undermine productivity. This in turn contributes to food insecurity (Tillman *et al.*, 1996).

Results of FGDs and KIIs revealed that the decline in the diversity of food varieties has also adversely affected nutrition. Modern food markets and development technologies have been introduced making the local community to stop growing and consuming highly nutritious and diverse indigenous foods like pulses, legumes and/or high protein traditional grains, and have replaced them with uniform wheat and maize varieties which are less nutritious. In the process of doing this, diverse plant resources have been lost as uniform industrial agricultural technologies predominate. Such changes can decrease sustainability and productivity in farming systems as reported in other areas by Abukutsa (2010).

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATION

6.1 Conclusions

Nyando Wetlands are endowed with diverse resources that provide a variety of important goods and services to the local people including flora and fauna. They also provide socio-economic needs which constitute the basic capital to meet local people's needs like food, fuel, and water amongst other requirements. The wetlands also provide ecological needs like water recharge and discharge, water filtration, flood control, important habitats for diverse flora and fauna which are critical in maintaining the health of the wetlands.

Wetland resource decline and associated changes have been due to overdependence on and over exploitation of wetland resources for livelihood by the local people and this has affected the health of Nyando Wetlands consequently reducing or depleting resources available within the wetland over a long period of time.

The decline in Nyando Wetland resources precipitates conflicts over resource use as a result of competition for the available resources especially during drought and flood periods when there is competition for grazing land by wild animals and livestock, and land available for farming. Conflicts between humans and wild animals are further precipitated by the need for food by humans through irrigation. In the process of

clearing land for agriculture, resource utilization-conservation conflicts arise because the biodiversity of species is lost.

Food production at subsistence level in a wetland like Nyando contributes significantly to food stabilization in the face of increasing rural population to the extent that resource use-conservation conflicts as evidenced in this study pose a serious threat to food security not just in the study area, but also to the entire Western Kenya region and other environs at large.

6.2 Recommendations

6.2.1 Policy and Management Recommendations

i) Community based biodiversity conservation initiatives should be put in place to rehabilitate indigenous plant and animal species which were abundant and used as sources of food in the past but are currently scarce in Nyando Wetland and restore critical habitats for endangered species.

ii) There is need for education and awareness creation to equip the local communities and county wetland managers with the necessary wise use skills and practices to minimize the degradation of wetland resources.

iii) The community should be empowered to manage and resolve resource use conflicts for sustained livelihoods and biodiversity conservation.

iv) Wetland conservation policies at both the National and County government levels should have clear guidelines on land ownership, buffer zones, wise use of wetland resources and other critical issues which would make it easy to enforce such regulations for the benefit of wetland ecosystems.

v) A comprehensive and participatory wetland management plan for Nyando Wetlands should be put in place with practical suggestions addressing the findings of this study and other past studies on how changes in biodiversity can be reversed and minimize conflicts that compromise food security.

6.2.2 Further Research Recommendations

i) Further studies should be carried out in Nyando to elucidate the long-term contribution of erratic climatic changes on food security and appropriate mitigation measures. There is also need to map and protect critical habitats like breeding grounds and sanctuaries within the wetland to promote their sustainable management.

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APPENDICES

APPENDIX I: QUESTIONNAIRE

INTRODUCTION

Dear respondent, this survey aims at gathering data that will form part of the study being undertaken by **Raburu Elizabeth Awuor**, a Master of Philosophy student in the Department of Applied Environmental Social Sciences, University of Eldoret. The study aims at **investigating the Impacts of Resource Use Conflicts on Food Security in Nyando Wetlands, Kisumu County, Kenya**.

All the information given will be treated with utmost CONFIDENTIALITY and strictly used for the purpose of this study. Your cooperation in this study is therefore highly appreciated. Thank you in advance for agreeing to this interview.

SECTION A: BACKGROUND INFORMATION

Background Information

1. Interview date	
2. Name of enumerator	
3. Name of respondent	
4. District	
5. Division	
6. Location	
7. Sub-location	
8. Village	
9. Clan	

10. What is the type of household?

a. Male headed ( )

b. Female headed ( )

c. Male headed, female run ( )

d. Child headed (< 18 yrs old) ( )

e. Elderly supporting orphans ( )

11. What is the position of the respondent in the household?

a. Husband ( ) b. Wife ( ) c. Child ( ) d. Worker ( ) e. Other (specify

……)

Respondent Demographic Information

12	13	14	15
Age (yrs)	Gender	Marital status	Level of education
a=<18 b=18 to 29 c=30 to 50 d= > 50	a= Male b= Female	a= Married b= Single c= Widowed d= Divorced e= Others(specify)	a=Non b=Primary c=Secondary d=College e=University

16. How long have you lived in Nyando Wetland?

a. Upto 10 years ☐ b. Between 10 and 20 years ☐

c. Between 20 and 30 years ☐ d. Over 30 years ☐

17. How many are you in your household: ☐

18. What is your primary occupation?

a = Farmer b = Housewife c = Fisherman d = Harvesting wetland products

e = Business f = Formal employment g = Unemployed h = Student

19. How much money does your household earn from wetland resources per month (in KShs.)?

a.100 to 500 ☐ c. 500 to 1000 ☐ e. 1000 to 5000 ☐

b.5000 to 10,000 ☐ d. Above 10,000 ☐

20. In which season do you experience a reduction in income from wetland resources?

a. Rainy seasons ☐ b. Dry seasons ☐ c. Not associated to any season ☐

SECTION B: NYANDO WETLAND RESOURCES

21. Using the table below indicate the resources obtained by the community from Nyando Wetland, and any change that has occurred in their status. List the types of resources in each category and indicate the status as:

1 = Abundant, 2=Moderate, 3= Few, 4= Completely depleted 5= No Change

RESOURCES	**STATUS OF THE RESOURCE**	
	1982	**2012**
A. Fishes		
B. Vegetables		
C. Birds		
D. Wetland Animals		
E. Wetland Insects		
F. Wetland Plants		
G. Water		
i. Lake		
ii. Wetland		
iii. River		

22. Apart from plants used as food, please indicate the status of plants used for other purposes shown in the table below? Use key below to indicate the status

1 =Abundant, 2= Moderate, 3 = Scarce, 4 = Completely depleted 5= Not Changed

WETLAND PLANTS	**USES**

SECTION C: RESOURCE USE CONFLICTS EXPERIENCED

24. Using the table below, indicate the types of conflicts that arise in resource use.

SERIAL NO.	CONFLICT TYPE	CAUSES
a)	Human – Human	
b)	Human – Wildlife	
c)	Conservation – Resource Utilization	

SECTION D: FACTORS CONTRIBUTING TO RESOURCE USE CONFLICTS

25. What are the factors that contribute to resource use conflicts and their impact on food security? Use table below and the key provided to show your answers

(i) Increasing (ii) Decreasing (iii) No impact

SERIAL NO.	FACTORS CONTRIBUTING TO CONFLICTS	IMPACT ON FOOD SECURITY
a)	Floods	
b)	Drought	
c)	Human pressure	
d)	Development	
e)	Changing land use patterns	

Thank you

APPENDIX II: Nyando Wetland Plants and their uses During the Study Period

Wetland Plants	Uses	Wetland Plants	Uses
Sonchus oleraceus (Achak)	Firewood, building	*Phragmites spp.* (Odundu)	Fish traps, firewood, building, osadhi
Acacia drepanolobium (Alii)	Fencing	*Pennisetum purpureum* (Ogada)	Fodder
Pistia stratiotes (Anyuongi)	Food	*Euphorbia tirucali* (Ojuok)	Firewood, building, fencing
Sesbania spp. (Asao)	Fuel, fish trap, fencing, building, animal feed, medicinal, fertilizer	*Phyllanthus fischeri* (Olando)	Making basket
Eucalyptus grandis (Ndege)	Building	*Cyperus rotundus* (Oluga)	Medicine, control soil erosion
Eucalyptus spp. (Kaladali)	Building	*Sesbania sesban* (Omburi)	Building, fuel, animal feed, research material
Thevetia peruviana (Chamama)	Firewood, building	Ondago	Thatching
Azadirachta indica Dwele	Medicine, firewood	*Blepharis spp.* (Onduong'o)	Medicine, firewood
Eichhornia crassipes (Fod)	Making mats and chairs	*Aeschynomene laphroxylon* (Orindi)	Building, fuel, animal feed, research material, making benches, fish trap
Jacaranda mimosifolia (Jacaranda)	Firewood, building	*Mimosa pigra* (Osiri)	Fuel, fish trap, fencing, animal feed, fodder
Phyllanthus sepialis (Kagno)	Firewood	*Acacia seyal* (Otiep)	Firewood, building
Cynodon dactylon (Modhno)	Controlling soil erosion, thatching	*Triumfetta tomentosa* (Owich)	Firewood, building
Ficus spp. (Ng'ou)	Making chairs, firewood	*Nymphae alba* (Oyungu)	Roots used as food
Sacchrum officinalis (Niang')	Making sugar	*Gossypium spp.* (Pamba)	Making thread, making mats
Albizia gummifera (Ober)	Burning charcoal, medicine	*Vossia cuspidate* (Saka)	Thatching, thatching, firewood
Solanum incanum Ochok	Medicine	*Pycreus nitidus* (See)	Thatching, firewood, fodder, making broom, fish trap
Ricinus communis (Odagwa)	Firewood, thatching	*Ipomea spp.* (Selesele)	Firewood
Typha spp. (Odhong')	Firewood, thatching	*Lutea spp.* (Siala)	Building
Commelina benghalensis (Odielo)	Livestock feed	*Cyperus papyrus* (Togo)	Mat making, firewood, thatching, making ropes, furniture, broom