EFFECTS OF NATURAL RESOURCE BASED CONFLICTS ON COMMUNITY LIVELIHOODS IN LAKE OL’BOLOSSAT CATCHMENT AREA, NYANDARUA COUNTY, KENYA

By

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AUGUST 2013
DECLARATION

Student’s Declaration
This thesis is my original work and has not been presented for a degree in any other university.

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We confirm that this thesis has been submitted for examination with our approval as university supervisors.

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DEDICATION

This study is dedicated to my husband, David Mathenge, my daughter Naomi Watetu and son Martin Mairu who saw me through this study with undying love, encouragement and unwavering support.
ACKNOWLEDGEMENT

I extend my sincere thanks to the following people and institution for their kind assistance and tolerance without which the study would not have been successful. Kenyatta University which has facilitated completion of both coursework and research work, supervisors, Dr. James Koske and Dr. Cecilia Gichuki who worked beyond the call of duty. Their guidance, professional advice and constructive critique kept me going up to the end. All the lecturers in the Environmental Education Department need extension of my gratitude for their participation in teaching and guidance. Respondents, who happen to live in my home area, need to be praised for their cooperation and participation in the study. My special appreciation is expressed to my loving husband David Mathenge, my children Naomi and Martin, my parents Kimondo and Waguthi for their understanding, support and prayers during the time of my study. My most sincere appreciation goes to my brothers and sisters who always assured me that I would make it. Above all, I thank the Almighty God for giving me strength to work and providing for all my needs, not to forget that He gave me a supportive family until I have achieved my life time dream.
ABSTRACT

One of the major challenges to sustainable use of wetlands is lack of awareness by communities on the values of these ecosystems. Wetland resources are important for socio-economic, cultural and ecological supply of goods and services. Despite their importance, wetlands have remained unprotected and they are exploited beyond what they can endure. The main objective of the study was to establish the effects of natural resource based conflicts on community livelihoods in Ol’Bolossat catchment area in Nyandarua County. The study was conducted in twenty villages, simple random sampling of 252 households and purposive sampling of key institutions such as KARI, KWS and KFS was carried out. Household questionnaires were issued to sampled households, interviews were held with conservation group leaders and FGDs with the local leaders were carried out to establish environmental issues in the study area. Transect walks, direct observation and photography revealed that there was human encroachment, crop and livestock farming in the basin. The results indicated that there was co-relation between human population increase and land use changes r = 0.30, n= 252 and p= 0.01, which have led to wetland degradation and conflicts. The results also indicated that there was a significant difference in the rating of wetland uses for water, fodder, cultivation and apiary, Chi square (6.619), df (2), p (0.037) at 95% level of confidence. It was found out that the people living near the lake (within 1km) depend on wetland resources more than those living further away and the former experiences more conflicts. The FGDs and interviews indicated that the livelihood activities such as crop and livestock farming were based on water, land and biodiversity utilization. The study concludes that the conflicts in Ol’Bolossat catchment area are natural resource based (NRBC) and they affect the community livelihoods. The human population increase, land fragmentation, access and competition for scarce natural resources between humans, wildlife and livestock have brought about conflicts. The community livelihood is affected when wild animals destroy crops, injure and kill humans, besides transmitting zoonotic diseases to livestock with which they share the same resources. It is recommended that conservation of the natural resources ought to be enhanced through community participation and stakeholder involvement. More trees should be planted to replace those that have been cut. The farmers ought to diversify crop farming and improve on food storage in order to mitigate vulnerability to climatic conditions. The Government should educate the community on methods to mitigate human-wildlife conflicts so that residents utilize the natural resources safely, to improve their livelihoods.
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LIST OF ABBREVIATIONS AND ACRONYMS

ACCORD - African Center for the Constructive Resolution of Disputes
CITES - Convention on International Trade in Endangered Species
EE - Environmental Education
IBA - International Bird Area
INRM - Integrated Natural Resource Management
KARI - Kenya Agricultural Research Institute
KFS - Kenya Forest Service
KWS - Kenya Wildlife Service
NEMA - National Environment Management Authority
NESC - National Environmental Steering Committee
NGO - Non Governmental Organizations
NMK - National Museums of Kenya
NRBC - Natural resource-based conflicts
CHAPTER ONE: INTRODUCTION

1.1 Background Information

Lake Ol’Bolossat contributes to the livelihoods of the local community in diverse ways. It supplies goods and services to many people who compete for this same natural resource and depend on it for livelihood support. According to Wallensteen (2007), there is conflict in a situation where two or more actors strive to acquire at the same moment in time an available natural resource.

The original inhabitants of the study area were Masai pastoralists and the land belonged to the community as there was no individual land ownership. Crop farming was done on very small scale without use of chemical fertilizers. The farmers relied on human labour and dairy products were stored in pots and gourds. Cereals such as millet and sorghum were stored in ventilated baskets. The cattle were smeared with tobacco to control pests and diseases. East Coast Fever was treated by burning swollen glands with hot iron. The pastoralists killed livestock for meat and did not kill wild animals (Ruhiu, 2000). The community had their own rules and regulations controlling the use of natural resources for medicine, craft and thatching their traditional houses (manyattas). The rules were centered on the preservation of sacred areas for traditional rituals and not for commercial benefits (Mungai, 2003). Currently, the dominant community members are the Kikuyu and they have converted part of the wetland into farms where maize and wheat are grown for commercial purposes.

Lake Ol’Bolossat is a high altitude wetland located in Satima Escarpment. The streams and springs that feed lake flow from the Aberdare Ranges through Satima escarpment and pass across farms. The farming practices in the basin make the lake subject to siltation and landslides (Ruhiu, 2000). Soil eroded from the neighboring farms reduces the water storage capacity of the lake. The Lake water is moderately saline but fresh water from springs and streams dilute the water before it is discharged into Ewaso Narok River which exits the lake in the north. Kenya has an obligation to balance water utilization with restoration, for socio-economic benefits and supporting livelihoods. The local Community livelihoods have much more to
do with fresh water availability than quantity because communities can adjust their water needs according to the quantities available (G.O.K. 2009).

Globally, the wetlands cover about 26% of the earth’s surface and in Kenya, they cover about 2-3% of her land surface (Owiti, 2006). Wetlands have ecological, socio-cultural, economic and aesthetic benefits. They clean water by trapping sediments and capturing nutrients from the water. The natural water purification saves communities expenses that would have been spent in putting up water treatment facilities. They control floods by soaking up and storing excess water (Crafters et al., 2008). Wetlands are areas of marsh, fen, peat or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salty, including areas of marine water, the depth of which at low tide does not exceed six meters (Ramsar, 2006). The wetlands have been recognized as World Heritage Sites since the convention on wetlands was adopted in 1971 in Iranian City of Ramsar. Kenya is a contracting party to the Ramsar Convention and upholds the principle of wise use of wetlands. This calls for concerted effort in conservation and management strategies. It requires time and resources to curb degradation and maximize wetland benefits to the community. Despite their valuable functions, wetland resources are often regarded as wasteland and are degraded through conversion for agricultural, settlement and industrial development, hence deterioration of the environmental quality as indicated by the status of birds (Table 1.1).

Lake Ol’Bolossat provides a unique and important habitat for several species of birds, insects, reptiles and mammals. A rare species of yellow butterflies (*Catopsilia florella*) was collected from Ol’Kalou and others were collected from the Aberdares (NMK, 2006). Lake Ol’Bolossat has a high bird conservation value and it qualifies for conservation under criteria A1 (globally threatened), A2 (restricted range) and A3 (biome-restricted). This listing elevates the wetland conservation status both locally and internationally (Wamiti et al., 2007). The swamp vegetation comprises of, *Phalaria arudinacca*, *Cyperus rigidifolia* and *Cyperus papyrus*. 
Table 1.1: Some species of birds around Lake Ol’Bolossat and their conservation status

<table>
<thead>
<tr>
<th>Species</th>
<th>Status</th>
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<tbody>
<tr>
<td>Sharpe’s Longclaw (<em>Macronyx sharpie</em>)</td>
<td>EN</td>
</tr>
<tr>
<td>Jackson’s Windowbird (<em>Euplectes jacksoni</em>)</td>
<td>NT</td>
</tr>
<tr>
<td>Great (White) Egret (<em>Casmero diusalba</em>)</td>
<td>VU</td>
</tr>
<tr>
<td>Maccoi Duck (<em>Oxyura maccoa</em>)</td>
<td>EN</td>
</tr>
<tr>
<td>Saddle-billed stork (<em>Ephippio rhynchus senegelensis</em>)</td>
<td>VU</td>
</tr>
<tr>
<td>Great Crested Grebe (<em>Podicep cristatus</em>)</td>
<td>CR</td>
</tr>
<tr>
<td>Long-tailed Window bird (<em>Euplectes progne</em>)</td>
<td>VU</td>
</tr>
<tr>
<td>White-backed Duck (<em>Thalassornis leuconotus</em>)</td>
<td>VU</td>
</tr>
<tr>
<td>Hunter’s Cist cola (<em>Cistico lahunteri</em>)</td>
<td>VU</td>
</tr>
<tr>
<td>African Marsh Harrier (<em>Circus ranivorus</em>)</td>
<td>VU</td>
</tr>
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Key:

EN- Endangered, NT- Near threatened, CR-Critical and VU-Vulnerable

Data source: NEMA (2007), Lake Ol’Bolossat Management Plan
1.2 Statement of the Problem

There are environmental concerns related to increasing uses of wetlands for agriculture and other livelihood activities. Lake Ol’Bolossat has been subjected to extensive degradation and this has threatened its very existence (NMK, 2006). There are conflicting interests marked with sharing of resources between livestock and water animals and this may have compromised its ability to make a meaningful contribution in supporting the local community livelihood and the country’s economy (KWS, 2009). According to Laue (1993), a conflict is an escalated natural competition between two or more parties for the same scarce resources. The Natural Resource Based Conflicts (NRBCs) are manifestations of the inter-dependence (web of life) between environmental components such as animals, vegetation, soil and water. The occurrence of local conflicts highlights the need for balancing short term and long term resource needs since the destruction of one element has repercussions on other components of the environment. If degradation continued, it would take a relatively long time to rehabilitate Lake Ol’Bolossat since a lot of biodiversity would be lost. A survey by the National Museums of Kenya (NMK, 2006) revealed that farmers use agro-chemicals such as pesticides and fertilizers without standard measurements. The chemicals infiltrate into the soil and run-off to pollute the lake. Pollution from toxic chemicals kills the aquatic animals, plants and microorganisms.

The local community benefits from the wetland through agriculture, fishing, hunting and grazing but little or no concern is shown in conservation of the same. The immediate survival needs of the people such as the demand for food and water, contradicts with the long term conservation strategies and this is indicated by overfishing and overgrazing. The over-use of natural resources leads to (NRBCs) and loss of ecologically important species such as pollinators and biological control agents of pests (Crafters et al., 2008).

Despite the international recognition of the significance of wetlands, these ecosystems have continued to be degraded and over-exploited. The human activities in Ol’Bolossat Catchment area are causing imbalance between biological and physical components of the environment. The lake is losing its ecological integrity
through clearance of vegetation and disappearance of wildlife. The natural resources needed by humans to support their livelihoods and for local subsistence economy are being degraded (Ruiu, 2000). It is evident that human activities and encroachment into the watershed are causing the ecological imbalance. In response to human disturbance, the aquatic animals invade farms in search of foliage and they destroy crops. There is an urgent need, therefore, to step up management interventions in order to reverse the negative trends. The study sought to investigate the possible preventive and resolution options which could mitigate conflicts and improve livelihoods. The NRBCs hinder the normal regeneration rate of the natural resources and the local community has failed to achieve maximum benefits from the wetland resources. The ecological value of the lake is undermined by conflicts of interest and contestation for natural resources between humans and wildlife. The state of equilibrium between various entities has been disturbed and disharmony has resulted from lack of integration between conservation and utilization of natural resources (ACCORD, 2002).

1.3 Justification of the Study

Wetlands are important natural resources with enormous socio-economic, cultural and ecological value, which are necessary for achievement of Vision 2030. This vision emphasizes conservation of resources in a natural manner (NESC, 2006). However, environmental degradation and diminishing natural resources are linked to conflicts at international, national and local levels (Okech, 2010). The current study can provide the necessary information for conservation, protection and management of the study area for livelihood support. All these strategies require an in-depth understanding of parameters that threaten conservation of Lake Ol’Bolessat.

1.4 Research Questions

The study was guided by the following research questions:

1. Which natural resources support livelihoods in Ol’Bolessat basin and watershed?
2. What are the causes and types of Natural Resource Based Conflicts (NRBCs) found at Ol’Bolessat area?
3. What are the effects of NRBC on Ol’Bolessat community livelihoods?
4. What are the possible preventive and resolution options for the NRBC in Ol’Bolossat area?

1.5 Research Hypotheses
1. The natural resources in the study area do not support the community livelihoods.
2. All conflicts in Ol’Bolossat Catchment area are not NRBCs.
3. Competition for natural resources is not the cause of conflicts in Ol’Bolossat Catchment area.
4. The livelihood activities in the study area are not affected by NRBCs.
5. There are no preventive and resolution options for NRBCs in Ol’Bolossat catchment area.

1.6 Research Objectives

1.6.1 General Objective
In this study the general objective was to establish the effects of NRBC on community livelihoods in the catchment area of Lake Ol’Bolossat.

1.6.2 Specific Objectives
1. To identify the key natural resources which are used by the community to support livelihoods in Ol’Bolossat catchment area.
2. To identify the Natural Resource Based conflicts in the study area.
3. To determine the causes of conflicts in Ol’Bolossat catchment area.
4. To suggest the possible preventive and resolution options for the NRBC in the study area.

1.7 Significance of the Study
Although Natural Resource Based Conflicts are on the increase, this remains a relatively neglected area of research (Okech, 2010). Conflicts have several impacts which may include physical harm to both humans and the natural resource base. They also impact on productivity levels and economic development. It is hoped that the findings of the study will aid in improving the management, conservation,
sustainable utilization and protection of the lake. This will maximize economic benefits to the local community through revenue collected from ecotourism. The research findings should help to minimize vulnerability of the people and wildlife through prohibition of retrogressive water and land use practices which bring conflicts, and thereby improve livelihoods.

1.8 Limitation and scope of the Study

The study limited itself to Lake Ol’Bolossat catchment area. The results can only be generalized to Lake Ol’Bolossat Catchment area. Due to limitation of resources, it was not possible to study all the villages in the basin, hence the need for sampling.

1.9 Conceptual Framework

The conceptual framework shows the inter-relatedness of various variables of the study. The economic, socio-cultural and ecological uses of natural resources are in conflict with each other. The study conceptualizes that productive uses of the natural resources require good environmental education model that encompasses all the components of the environment in order to harmonize conservation and utilization of the same. EE empowers community members to make informed decisions to overcome challenges and thereby get maximum benefits from the resources at their disposal.

Education develops necessary skills and knowledge to address environmental challenges. EE fosters attitudes, motivation and commitment to make informed decisions and take responsible action (UNESCO, Tbilisi Declaration, 1978) as shown in the development of conceptual framework (Fig. 1.1).
Figure 1.1: Conceptual Framework showing conflicting uses of wetland

ECONOMIC USES
- Agriculture and livestock
- Trees for sale and fuel
- Fish for sale and domestic

ECOLOGICAL USES
- Habitat for wildlife
- Water storage
- Pasture for livestock
- Carbon sequestration
- Ecotourism activities

SOCIO-CULTURAL USES
- Recreation / Tourism
- Subsistence fishing
- Sight-seeing and bird watching
- Photography

ENVIRONMENTAL EDUCATION
- Awareness creation
- Acquisition of knowledge and skills
- Community Participation
- Change of attitude and values

BENEFITS
- Diversified economic activities
- Job creation
- Water conservation
- Aesthetic and ecological stability
- Infrastructure development and improved
Definition of Terms

**Uni-modal**: Rainfall pattern that has one peak for a stated period of time such as one year.

**Biodiversity**: Referred to a variety of plants and animals in the wetland ecosystem.

**Catchment area**: Referred to agricultural and settlement areas around the lake, springs and streams that empty into Ol’Bolossat Basin and watershed.

**Community**: All the people living close to the lake and this group utilizes the resource, or its way of life is affected by the presence of the resource.

**Conflict**: Incompatibility caused by divergence of needs, values and interests.

**Ecosystem services**: This refers to the benefits people obtain from ecosystems such as provision, regulation, cultural and biological services such as pollination.

**Freehold**: Referred to tenure system that confers absolute right of ownership of land for an indefinite period of time.

**Livelihood**: Comprises the capabilities (social and material resources) and activities required for a means of living.

**Natural resources**: Are sources of wealth that occur in a natural state.
CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Review of related literature focused on the value of wetlands, types of environmental conflicts, their causes and impact on community livelihoods. Wetlands contribute to livelihoods of many people in diverse ways but Natural Resource Based Conflicts (NRBC) undermine sustainable use of wetlands. According to Gleditsch et al., (2006), one of the major challenges to sustainable use of wetlands is competition for shared resources, which leads to NRBC. According to Wallesteen (2007), a conflict involves two or more actors who strive to acquire at the same moment and space, an available set of scarce resources. The African Centre for the Constructive Resolution of Disputes (ACCORD, 2002) argues that a conflict is a state of human interaction where there is disharmony or a perceived divergence of interests, needs or goals. The conflicts have several effects on productivity level of the natural resource base and on livelihood of the local community. The livelihood issues include food security, health and recreation. Human beings exert pressure on the natural resources and they impact directly or indirectly on their lives.

2.2 Wetland Resources

Wetland habitats include marshes, swamps, and lakes, ponds, marine and estuarine. Lakes are large while ponds are small and shallow. The main wetland resources include water, unique water-associated soils, vegetation and water animals (Ndang’ang’a, 2003). The nature of the soil determines the type of vegetation in an area. It contains decomposed plant material and in Ol’Bolossat it has a characteristic odor of rotten eggs (Ruhiu, 2000). Some wetland soil is sandy but it is mixed with dead plant material (detritus). The plant types include cattails, bulrushes, water lilies, sphagnum moss, bald cypress, sedges and rushes. There are salt tolerant plants which include giant cord grass and bulrush. The hydrophytes have special adaptations that allow them to survive in a waterlogged environment (Kok et al., 2009). Wetlands have high primary productivity due to ability of water plants to capture large amounts of the sun’s energy and store it. The grazing food chain is very productive in wetland systems (Chris, 2010). Wetland plants and
animals interact with each other but some dominant species exert more pressure on the wetland as well as water and vegetation stress (Crafter et al., 2008). Mammals, Fish, amphibians and insects compete for the same natural resources. The largest herbivores in the basin are the hippopotamuses. The cattle grazing in the basin are abundant in the dry season. The hippopotamus population density is 3.6 animals per Km², which is one of the highest in Kenya (NEMA, 2007). The grazing activities influence the structure and composition of the natural vegetation which supports a large number of herbivores and grasshoppers. Continued overgrazing maintains a low grass biomass (Ndang’ang’a, 2003). Trampling by animals affects ground-nesting birds negatively. The other water animals include waterfowls, ducks and geese and they are indicators of environmental quality. The areas with high concentration of different species of birds are also rich in diversity of other animal species as well. There are about 74 species of birds in Ol’Bolossat that have been identified (Birdlife International, 2000). Some wading birds are migrants and others are residents. Few birds of prey utilize the swamp and its grassland. The Egyptian vulture, Lanner Falcon and African Fish-Eagle inhabit the basin (Bennum and Njoroge, 2001).

A survey that was conducted in 2007 by Wamiti et al., reported that there are twenty nine individuals of the globally-threatened grassland endemic species of birds. Regionally threatened species were also found. The lake has a potential for conserving highland grassland birds, genetic resources of medicinal plants and attracting high altitude sport tourism, avi-tourism and fishing. It provides habitats for globally threatened bird species as well as other biodiversity (Bennum and Njoroge, 2001). Sharpes Longclaw, a globally threatened bird has been recorded in the Lake’s open grasslands during a water fowl census (Mungai and Manegene, 1998). The riparian land has unique montane highland grasslands most of which is found in Kinangop plateau (Wamiti et al., 2007). The swamps are dominated by woody plant community but some of the largest swamps are associated with river systems such as the Savannah and Santee (Chris, 2010). Water lilies, reeds and some grasses grow in the open water. A variety of grass species are seen growing suspended in water but rooted in the mud (Ndang’ang’a, 2003). Grasses and sedges
make up the main vegetation in the basin. The lake is highly threatened through destruction of the wetland and its catchment by farmers in the area (Ruhui, 2000).

Wetlands provide products that humans use for supporting their livelihoods. Aquatic wildlife are hunted or trapped by man for food and clothing. The animals sometimes leave the wetland and graze on the surrounding farms (NEMA, 2007). The vegetation is used for grazing and it has a high nutritional value for domestic livestock. The argument advanced in this study is that each natural resource has a role to play in maintenance of ecological productivity and harmony in the wetland. Wetlands are characterized by continuous plant growth and hence maintain high primary productivity through nutrient cycling and energy transfers (Chris, 2010). The wetland degradation can be expected to bring about environmental conflicts between the living organisms that feed on aquatic vegetation.

2.2.1 Land Issues that Affect Livelihoods

Wetland soils are known as hydric soils and they develop from conditions devoid of oxygen due to the presence of water for long periods of time. The lake basin has black cotton soil which is poorly drained. The soil consists of decomposed plant material or it may be sandy. Some wetland soils contain minerals necessary for animal health. There are salt licks for livestock. Most of Ol' Bolossat area has igneous rocks and a few areas have metamorphic rocks. The rock types are determined by the geology and drainage of the basin. The rock structure is similar to that found in the Rift Valley. They originated from volcanicity and tectonic movements which occurred in geological times (Jaetzold and Schmidt, 1983). The rock structure originated from the formation of the Rift Valley. It is a result of faulting and volcanicity due to tectonic movements which occurred in geological times. The Basalt rocks in the area are Porphyric in texture and they stretch from Satima escarpment in the East to Malewa gorge in the South. The other types of rocks include phonolites and trachytes. The soil types depend on the drainage and geology of the basin. The soil originates from igneous rocks and volcanic ashes. There are rocks called Simbara basalts and they originated from Kipipiri and Simbara. The lake basin has black cotton soil which is poorly drained. There are clay and loam soils in the swamp which are calcereous but generally the soil is fertile.
for farming and livestock rearing. Satima escarpment is composed of igneous and metamorphic rocks. The soils are grey loams dominated by andosols and phaeozems. In the lake basin there is black cotton soil which is poorly drained and it is dominated by nitosols and xerosols while the western side is dominated by andosols and phaeozems (NEMA, 2007).

Land ownership influences the socio-economic and political positions of different groups of people. The land in sub-Saharan Africa has been a subject for conflicts, conquest and exploitation resulting in many types of inequalities and discrepancies. There are many land conflicts in the catchment and the past inequalities have persisted as they remain unresolved (Okech, 2010). In most sub-Saharan countries, the land dispossession and contestation has resulted in a skewed distribution of land resources (Kok et al., 2009). Land issues are related to poverty, inequality and land reformation processes. Contestations over land are most noticeable among the poor, who lack alternative means of supporting their livelihoods (UNDP, 2006).

Land provides security in cases where formal employment opportunities and access to resources is lacking. Land has major cultural, spiritual and historical significance as it is a symbol of unity and gives a sense of belonging to household members. Accessibility and availability of land resources are paramount in ensuring improvement of long lasting socio-economic and political well-being of societies, especially the marginalized groups. The amount of land available determines the stability and food security of a local community, yet in Africa, land is becoming scarce in many parts of the continent (Odgaard, 2006). According to Kagwanji (2009), social dimensions such as class, gender and religion affect accessibility and ownership of land. In Eastern Africa, land and related resources have been the center of conflicts between communities. Ownership and control of land and related resources are associated with decision making and the power to effect changes. The local culture can deny rights of ownership to certain groups such as women.

### 2.2.2 Water Utilization

Water is a life support system for both animals and plants. Sustainable management and development of water resources is the basis for promoting socio-economic development and poverty alleviation (Creel, 2003). The demand for water increases
with increase in human population. Water utilization includes agricultural, domestic, industrial, recreational and environmental activities. The water uses require fresh water but 97% of the Earth’s water is salty while 3% is fresh. Part of the fresh water is frozen in glaciers and polar ice caps (Gleditsch et al., 2006).

Fresh water is a renewable resource but the world’s water is decreasing steadily (Creel, 2003). The demand for water highly exceeds the supply and as the world population continues to rise, so does the demand for water. The importance of preserving water for ecosystem services has recently emerged as many wetlands have been lost together with their valuable services. The sources of fresh water include surface water, frozen water, desalination, ground water and under river flow. Ground or sub-surface water is fresh water in the pore spaces of the soil and rocks. Surface water is found in rivers, lakes and fresh water wetlands. The quantity of water depends on precipitation and storage capacity, permeability of the soil beneath the water mass, run-off characteristics of the land in the water-shed and the local evaporation rates. If the sub-surface water source has high evaporation, the water becomes saline. Desalination is the process by which saline water is purified; however, the process is very expensive (G.O.K. 2009).

Human activities affect the water availability by increasing storage capacity and by draining wetlands (Onuoha, 2008). The natural input to subsurface water is from rivers and streams. About 15% of worldwide water is used for domestic purposes such as drinking, bathing, cooking, sanitation and gardening. Basic household water requirement is estimated at solicitors/person/day. The uses include construction of artificial lakes which are created for wildlife habitat (Chris, 2010). The environmental usage is non-consumptive but it reduces water availability for other purposes. Recreation water is mostly found in reservoirs and it is required in small amounts. The water recreation activities include boat racing, boat-rowing, swimming, fishing and skiing.

The Ol’Bolossat catchment area includes springs and streams which feed the lake and support livelihoods but the lake is characterized by fresh water scarcity supposedly due to climate change and high evapotranspiration (Wamiti et al., 2007). There are seasonal prolonged dry periods so the community relies heavily on
underground water. The lake recharges boreholes and is an important source of water for the local community. The ground water is slightly saline due to the nature of rocks. Wetlands filter water by intercepting surface run-off from the upper catchment. As the run-off water passes on, the wetland retains excess nutrients, some pollutants and sediments that would clog water-ways. The wetlands function as sponges that slowly release surface water, rain, ground and flood water. More than one-third of the endangered animals and plants in the United States live in wetlands (Chris, 2010). Adequate availability of fresh water impacts positively on the lives of citizens. Lake Ol’Blossat is a seasonal lake with a high rate of evapotranspiration, so the local community relies heavily on ground water and rivers flowing from the surrounding highlands.

The open water is saline although it gets filtered as it flows through the swamp. The water flowing into Ewaso Nyiro to the North is fresh. The lake is fed by streams from Satima Escarpment. However, the physical and chemical characteristics vary with seasons. The electrical conductivity and alkalinity rise during the dry season due to evaporation and dilution during the wet season (NEMA, 2007). On the southern side the lake water is unsuitable for domestic consumption and irrigation due to alkalinity. The springs and streams from Satima Escarpment and Ndudori hills recharge the lake. There are underground streams that recharge the lake as subsurface flow. The lake water appears as pools separated by emergent macrophytes.

The wetland hydrology refers to the presence of water above the soil surface or within the soil. The wetland is an internal drainage basin which receives water from rainfall and underground seepage. The swamps are saline due to the nature of underground rock and high rate of evaporation in the equatorial region. The catchment area comprises of habitats ranging from open water, marshes, grasslands and riverine forests. The hydrology is highly influenced by seasonal variations in climate and altitude which ranges from 2340-2400 meters above sea level. The water flows Northwards through Thompsons Falls. The drainage system comprises of springs, streams and open water. Some streams flow for a distance and then disappear underground (Wamiti et al., 2007). The lake passes through the dry Laikipia and Samburu Counties as Ewaso Ngiro. It then empties at Lorian swamps.
and the North Eastern Province. The river supports large populations of people, wildlife and livestock in three provinces. It supports Samburu National Reserve, Buffalo Springs and Shaba Game Reserves. The wetland is in the rain shadow of the Aberdare Ranges. The water level varies from 0.75m in the South to 2.5m in the North. Accumulation of organic matter and silt from the surrounding farmland has contributed to water pollution. The water level fluctuates from zero to 2.5m depending on the rainfall, surface run-off and seepage from the basin (Wamiti et al., 2007).

Wetland degradation used to go unnoticed since the ecosystems were considered to be unproductive and were leading to poor health (Irandu, 2003). They were drained to clear land for agriculture, livestock production and to destroy breeding sites for mosquitoes and other disease vectors. There is domestic and agricultural pollution due to unsustainable farming practices which lead to occurrence of waterborne diseases such as cholera and typhoid (Ruhiu, 2000). There is accumulation of lead shots from bird shooters (Crafter et al., 1996). The lake water is slightly saline with electrical conductivity ranging from 150 to 300 by 106µS / cm. The alkalinity of the water varies from 6.7 to 8.3 at 200º C (NEMA, 2007).

2.2.3 Community Utilization of Wetland Vegetation
It is widely claimed that Kenya’s forest or vegetation cover is too low. From the information given by Kenya Forest Service (KFS), the forest cover stands at 2% as opposed to the internationally accepted figure of 10%. Forests have been converted to settlements, farmlands, pasture, parks, roads, dams, schools and churches. The demand for timber and other forest products has risen. Unsustainable exploitation of forests has brought repercussions that are related to climate change. The rivers are drying up and rainy seasons are no longer predictable. Many animal, plant and insect species are fast disappearing due to human activities (Irandu, 2003). Communities need to put measures in place to mitigate their own mistakes by planting trees since the water sources are endangered by wanton destruction of forests (G.O.K., 2009). Forests are classified into state forests administered by (KFS), local authority forests under jurisdiction of the local authorities and private forests which are owned by individuals or private organizations. The forest cover is
useful as water catchment as well as natural carbon sinks that clean the air. The local authorities are the biggest partners. According to the Forest Act 2005, KFS has the responsibility of managing Kenyan Forests. The law allows for collaboration and participation of the local community living adjacent to the forest in conservation of the forest in question. In return, the community earns a living through extraction of non-wood products. The communities also participate in restoring degraded forests by planting trees together with food crops in a well-managed and controlled manner. This approach is called Plantation Establishment and Livelihood Improvement Scheme (PELIS). Sustainable uses of forests ensure survival of the forest and improvement of the livelihoods of the local community. Arabuko Sokoke community in the coast province discovered that they could save their forest if they found alternative ways of using the forest to earn a living. They came up with Kipepeo Project when they discovered that the forest harbours unique butterfly species that are not found elsewhere. They started butterfly farming and embraced tree planting on their farms to improve the forest cover and meet their own wood product needs. They also practiced bee keeping, sericulture or moth farming and mushroom farming.

According to Kenya Forest Service at Ol’Kalou, Kenya has approximately 120,000 hectares of plantation forest established for industrial purposes. These include exotic species such as pine, cypress and eucalyptus (KFS, 2005). Of late, individual farmers have taken to planting eucalyptus trees for transmission poles. The Kenya Forest Service has opened an inventory to determine the trees in plantations, natural forests and on farmlands. The tree cover is essential for the provision of wood, non-wood products, protection of water catchment and for other ecological processes. The forest adjacent to Lake Ol’Bolossat is called Ol’Bolossat Forest and it is in Ol-Joro-Orok Division in Nyandarua County. The forest is marked with uncontrolled felling of trees and deliberate fires resulting in loss of tree cover. Cultivation on steep land aggravates the problem. The Satima escarpment is degraded and its sloping nature accelerates soil erosion (NEMA, 2007).

Wetlands are important sources of water and pasture for wildlife and livestock especially during the dry season. The wetland vegetation is harvested for thatching
cottage industries, making canoes, traps and fishing baskets. The vegetation is divided into free-floating macrophytes, submerged and emergent plant species. There are many species including *Najas pectinatus, Ludwiga stolonifera* and *Nymphaea caeruleae*. The invasive weeds include *Eirrchorhina crassipes* (water hyacinth) and *Salvinia molesta*. The grass species include *Themeda triandra* and *Pennisetum clandestinum*. Some legumes such as oxalis occur together with the grasses. The basin and its catchment has six categories of natural vegetation consisting of open grassland, scattered acacia, cedar with thick undergrowth, reed and swamp grass, *Themeda pennisetum* grassland mixed with aquatic floating macrophytes. Human induced changes have affected the structure and composition of the natural vegetation. The swamp vegetation includes *Cyperus immensus, Cyperus rigidifolia, Cirsium vulgare, Phalaria arudinacea, Cyperus papyrus* and *Cyperus latifolia*. The basin and its catchment has characteristic natural vegetation of grassland, acacia, forest, cedar forest with thin undergrowth, reeds, swamp grass, *Themeda pennisetum* grasses and floating macrophytes (Wamiti et al., 2007). The human induced changes in the composition of vegetation include planted eucalyptus trees. Removal of vegetation cover or deforestation leads to drying up of the lake, soil erosion, global warming and conflicts between various groups of people. The vegetation provides a home for biodiversity and conserves the water catchment. It serves as a source of building materials, supports tourism and other economic activities. Vegetation provides a carbon sink when aquatic plants take up carbon dioxide from the atmosphere during photosynthesis, thereby reducing the global warming. The global warming has resulted from accumulation of green-house gases such as carbon dioxide in the atmosphere (Ericksen and Lind, 2005).

In Kenya, a lot of vegetation has been cleared for fuel and energy sources. The vegetation clearing has been aggravated by households seeking wood fuel because they cannot afford electricity. The main source of fuel in Ol’Bolossat Catchment area was and has remained wood, charcoal and paraffin for cooking and lighting houses. The limited access to a basic need, coupled with a high demand for the same, has led to conflicts of interest between various wetland users.
2.2.4 Wildlife Resource Use and Conflicts

Kenya has diverse species of endemic mammals, birds, butterflies, fish and amphibians (NEMA, 2007). The country has lost wetland biodiversity due to extensive irrigation, drainage and grazing livestock in the wetland during the dry season. Wetlands are home for countless wild animals and vegetation. The destruction of some animal and plant species affects the functional relationship between humans and the physical environment. Extinction of animals disrupts the ecosystem and man suffers in the end. Wetlands provide many wildlife resources and products such as reptile skins and ornamental fish (aquarium). Many communities harvest these resources to enhance and improve their livelihoods (KWS, 2002). The highest proportion of animals in the lake includes birds, hippopotamus, rats, amphibians and reptiles. Gazelles and hyenas inhabit the basin and leopards are sometimes sighted and they attack livestock at night. Coypu rat is an invasive mammal that has no natural enemies (Ruhiu, 2000). The rat has threatened the existence of cyperus reeds. Water birds are the most common wildlife in the lake and the abundant species are ducks, geese, water fowls, redknobbed coot, African Jacana, Black-winged Plover African Snipe, Gallinago nigripennis, Gray Crowned Crane, Blacksmith Plover and yellow-billed Duck. A bird survey that was carried out in Kianjata, Manguo, Gatumbiro and Rurii confirmed the presence of endemic and endangered Sharpes Longclaw bird (Wamiti et al.2007).

Hippopotamuses are the most conspicuous mammals affecting livelihoods in the catchment area. The distribution of hippopotamuses on the lake is dependent on primary productivity in the riparian area. There are invertebrates such as grasshoppers and crickets.

2.2.5 Fisheries

Wetlands are important for fresh water fish, most of which require shallow water for breeding site. The thick vegetation provides protection for smaller fish against predators (Creel, 2003). The marshes and swamps support catfish while dams in the study area are stocked with several fish species such as tilapia and common carp. Exploitation of the fisheries resource is limited by lack of fishing gears.
Commercial fisheries in the study area are non-existing. There is subsistence fishing in the northern parts of the lake but it is hampered by weeds that have taken root. There are no fish in the open water due to high rate of evaporation and alkalinity of the waters. Fishing affects livelihoods positively by supplementing the community protein food. The wetlands sustain subsistence and commercial fisheries in many areas. They are fish nursery grounds replenishing fish stocks for over 70% internationally. Fish farming in wetlands is a viable alternative to natural production (Nyakundi et al., 2007). In 2005, fishermen earned a fortune from fish farming in Lake Victoria. This showed a steady growth in the industry. Wetlands potential for fish production has not been fully exploited in Kenya. Improving the infrastructure, storage and market opportunities for wetland products could improve livelihoods of the local communities (Mbonile, 2005). The use of agro-chemicals leads to bio-accumulation in fish and is dangerous to human health, kills fish and causes extinction of other species (G.O.K. 2009).

In 1972, the Fisheries Department established that Lake Ol’Bolossat water is too turbid for fresh water fish and they cannot survive in it. The mud fish could do well in the prevailing conditions. Habitat loss and degradation ruin the fisheries through water abstraction, removal of vegetation for development and agriculture (Nielsen et al., 2004). Aquaculture is an alternative and is the world fastest growing food production activity. It plays an essential role in supporting livelihoods (Creel, 2003). Aquaculture and fisheries provide nutrition, foreign exchange earnings and employment. The contribution that aquaculture makes in providing goods and services are substantial but their economic activities are generally ignored by policy makers.

2.3 Causes of Environmental Conflicts

The causes of conflicts vary from control over vital environmental resources to contestation over natural resources at the community and household level. The manifestations of conflicts vary from wars and genocide to disagreements at the local level. Non-violent conflicts are caused by demographic change, natural resource management, development pressure and structural injustices (ACCORD,
Accessibility and competition for scarce resources are the driving force for conflicts in wetland use, management and conservation (Okech, 2010).

Residents of Ol’Bolossat Catchment area acknowledge that there is free accessibility into the wetland. There are, however, no regulatory measures taken by the Government or the community to prevent over-use and degradation. The catchment area is a zone which filters water which seeps downstream into Ewaso Nyiro while at the same recharging groundwater. The water table is quite high and most people depend on wells for water supply. There is a direct link between the catchment and the water source, which is Lake Ol’Bolossat (NEMA, 2007). The Water Resource Management Authority (WRMA) is mandated by the Water Act 2002 to regulate and protect water resources and the catchment. It liaises with other bodies for proper management and protection of water resources. Accessibility to good quality water improves the living conditions of the local community since the time that would be used for fetching water is spared for other economic activities.

2.3.1 Socio-economic status of the Community

The poor marginalized groups are worst hit by environmental degradation and conflicts. Poverty and environmental degradation are cardinal issues related to environmental conflicts (Bob, 2010). The poor are often dependent on environmental resources for livelihoods and energy supply leading to environmental degradation (Campbell et al., 2009). Environmental degradation and diminishing natural resources are linked to local, national and international conflicts (Okech, 2010). The riparian community in the study area engages in destructive farming practices, cutting trees for charcoal burning, draining the wetland for cultivation and overgrazing. The immediate survival needs of the community take precedence at the expense of sustainability and management of the wetland. The people lack knowledge of conservation and non-consumptive wetland uses such as eco-tourism and recreation. The area has poor infrastructure, whereby people lack adequate health facilities, clean water and electricity (NEMA, 2007). This has led to overuse, misuse and degradation of wetland resources (Castro and Nielson, 2003). Deforestation and catchment destruction has led to habitat degradation, loss of biodiversity and alteration of hydrology. The livestock grazing and water
abstraction lead to conflicts between crop and livestock farmers. The wetlands are used for human settlement and encroachment leads to loss of biodiversity and extinction of species (Muchai et al., 2002). In the search for livelihoods, the community engages in over-cultivation leading to reduced volume of water stored in the wetland and habitat loss. Drainage for agriculture, over-fishing leads to loss of wetland resources.

2.3.2 Human Population Pressure

Increasing human population has caused land fragmentation, dispersal of animal communities, habitat loss, degradation and species extinction. Land sub-division has resulted in small land units that require intensive farming in order to maximize crop yields. The Earth is inhabited by people who consume resources and produce waste. The waste has to return to the Earth in some form and the process of waste disposal alters ecological integrity and pollutes water resources. Pollution is contamination of resources so that they become unsuitable for their intended use (Creel, 2003). The demand for high yield has led to over-use of agro-chemicals and consequent environmental degradation. Fertilizers are beneficial in the farmers field but not in a lake where they promote the growth of weeds and algae which reduce the ecological value of the water. Wetland degradation used to go on unnoticed since these ecosystems were considered unproductive and unhealthy (Creel, 2003). It was drained to provide land for agriculture and destroy breeding sites for disease vectors such as bilharzias worms and mosquitoes. Changes in settlement have reduced mortality and there is migration from other districts in search of land. The population density was increased from 66 persons per square kilometer to 150 persons / km² (G.O.K. 2009). The same information was given by Olukoye et al., (2003). The data collected from the district statistics Office in Nyahururu indicated, the population for both females and males has increased by an average of three thousand each year (G.O.K., 2009). The pressure of rapid population growth engenders environmental problems. Traditional agriculture in tropical regions is characterized by environmental hazards such as leaching, soil depletion resulting from cultivation of infertile soil, soil erosion through variable heavy rainfall and prolonged droughts coupled with extensive vegetation clearing through slash and burning techniques.
Some people living in Ol’Bolossat Catchment Area rear livestock and grow crops on small parcels of land ranging from 2.5 to 10 acres. Most of the residents own less than 5 acres of land. Since accessibility to the wetland is free, most of them own more livestock than their 5 acre pieces of land can support. The existing land is under heavy demographic pressure, based on the district figures on the national population census (G.O.K., 2009). The former large-scale farms have been subdivided and allocated to immigrant people from different parts of the country.

2.3.3 Development Pressure

Agricultural development involves transformation of low productivity systems into systems where productivity is increased. For this transformation to take place, cultivation practices on the existing land are improved. The infrastructure of facilities and services for agricultural production are expanded. New land is brought under cultivation through extensive systems of irrigation and basin development. These changes are crucial but they generate environmental side effects (Peters, 2004).

Development pressure or need for economic growth has led to over-exploitation of natural resources, the cost of which outweighs the benefits of economic growth. According to Irandu (2003), there is “environmental injustice whereby, “A lot of emphasis is put on economic growth at the expense of the environment.” The natural resources have been subdued by the humankind as people are more inclined to maintaining development than sustaining the environment (ACCORD, 2002). The people in developing areas rely heavily on the infrastructure for safety against natural hazards and to support their well-being. Pressure from urbanization and the support of sustainable development ideas is a challenge to the local authorities and society who are struggling with contradictory demands. The demands are associated with ensuring economic growth, provision of services, resisting social exclusion and maintaining local democracy (Parnell, 2000). A case in point refers to the major challenges facing South African Government which are combating poverty and social inequality (Glavovic and Boonzaier, 2007). United Nations Development Programme (UNDP) revealed that South Africa is riddled with unemployment, poverty, HIV. infection and wide urban versus rural disparity (UNDP, 2006).
Wetlands offer development opportunities which may promote local economic development in ecotourism. Infrastructure in pollution prevention issues such as sewerage, waste water and solid waste disposal has fallen behind schedule due to inadequate planning, legislation and financing in many countries (Burok et al., 2004). There is rampant pollution of ground and surface water from untreated sewer and other contaminants.

Urban development has led to increased modification, destruction and degradation of terrestrial and aquatic habitats (Grimm et al., 2008). The impacts on livelihoods are greatly felt by the populations with high dependency on natural resources and those in marginalized areas (Barret and McPeak, 2005). In most developing countries, the authority to manage resources is not vested in local institutions but in distant Government Agencies with powerful private interests resulting in “winners” and “losers” in allocation and use of natural resources (Olsen and Christie, 2000). Countries with high population densities have the lowest ecosystem service product values due to intense exploitation leading to degradation. This culminates in unsustainable development.

Land-use changes favouring agriculture, rural and urban development have led to modification and reduction of wild areas. This has led to extinction of wild species and their natural habitats. Kenya’s wildlife reservoir is threatened and it may cease to contribute effectively to growth, wealth and employment. According to Irandu (2003), the local communities living near conservation areas are the first to suffer the destruction of natural habitats. They pay the price through destruction of property, death and injuries caused by wild animals. Recent studies indicate that the majority of people living around conservation areas have negative feelings about conservation programmes. They do not reap the benefits of conservation. The wildlife is under threat from human encroachment, poaching, habitat degradation, loss of migration and dispersal areas and increasing human-wildlife conflicts. In cases where wildlife induced damages to human property and life are not controlled and compensated, there are negative local attitudes towards conservation (Okello and Wishitemi, 2006). The situation is worse when the community does not benefit from wildlife resources such as tourism industry. The communities feel that wildlife
is more valued than their lives, livelihoods or their aspirations. They retaliate by opposing conservation initiatives. Agricultural expansion fuels conflicts by destroying natural habitats.

2.3.4 Land Tenure Systems

Globally, and mostly in Africa, the majority of people depend on land to earn their living (Deininger and Castagnini, 2006). There are three main land tenure systems in Kenya which are; Government or public land, private (freehold and lease land) and trust land held by the local authorities in trust for the local community. Land scarcity and ambiguous property rights can contribute to escalation of conflicts (Grimm et al., 2008). The issue is more notable when a community lacks alternative livelihoods (Bob, 2010). The most common land tenure system in Africa is freehold in which case the land owner has absolute rights and privileges of using the land and the individual is issued with a title deed. Changes in land tenure have resulted in a lack of land use co-ordination and environmental insecurity (Majeke, 2005). Free choice of land use and access through buying and selling has led to wetland loss and degradation. According to Kagwanji (2009), social settings such as class, gender, religion and ethnicity influence accessibility to land and ownership. The use, ownership and accessibility to diminishing land resources festers conflicts between long standing owners and new-comers. The ownership and control of land and related resources influences decision making and the power to effect changes (Rugege et al., 2007). The land distribution determines the power relations and differentiation between poverty and inequality in South Africa. Poverty refers to the ability to command enough resources to satisfy acceptable standard of living (Bob, 2010).

Communal land tenure can influence conflicts and disagreements between households and the neighbourhoods. There are differences in the practices of particular communities and the differences undermine the collective action that is necessary in order to manage the common property natural resources. The human security and land security are influenced by vulnerability as well as access to and control over land-related resources. The land conflicts relate to tenure rights, access to resources, inheritance and gender.
Land reforms in many African countries have been a source of conflicts (Deininger and Castagnini, 2006). Land holding patterns are the most sensitive issues facing African Governments. Land reform addresses issues pertaining to land allocation, compensation and land rights of disadvantaged groups. The land reform policy makers are faced with the challenge of balancing socio-economic and political reforms. Multiple demands and a high number of beneficiaries have resulted in land conflicts. In relation to the reforms, the Government considers that there are specific priority groups and that there are limited resources that need to be utilized effectively and efficiently. Market oriented land reforms result in wealthier sections of the society benefiting.

The role of the local Government and traditional authorities in land control is highly contested (Rugege et al., 2007). According to Rugege et al., (2007), the major challenges faced by land management in local authority in South Africa are corruption, discrimination and contradiction of traditional practices with modernity. There is discrimination against women and a move towards commercial practices. Commercial agriculture results in a new class which accumulates wealth and land. This results in landlessness of marginalized groups as wealthy farmers buy out land from residents who cannot sustain productivity and survival due to competition. Likewise, the wildlife competes with the local community for land, water and forests.

2.4 Types of Conflicts
The Natural Resource-Based conflicts in an area are influenced by the types of natural resources present (Wallensteen, 2007) and they range from biodiversity, water, land and management conflicts. According to ACCORD (2002), a conflict is a state of human interaction where there is disharmony or a perceived divergence of interests, needs or goals. There is a perception that interests, needs or goals cannot be achieved due to interference from the other person(s). Biodiversity conflicts arise between people about wildlife and other aspects of biodiversity (White et al., 2009). The conflicts arise when conservation and environmental management policies are not holistically formulated in order to balance conservation with the needs of the people. Environmental conflicts therefore, are manifestations of the inter-
relatedness among the environmental components and they range from intra-personal, inter-personal to inter-state conflicts (Alida et al., 2009). Every living organism is interconnected with nature from its micro to macro levels. The conflicts arise in local situations where there is little or no concern about the future of the environment and this challenges the local, regional, national and international security. According to Bob (2010), the key types of conflicts include biodiversity, environmental air quality, forestry, water, land, gender-related and management conflicts. Biodiversity conflicts are between people and about wildlife or any other aspect of biodiversity (White et al., 2009). They include conflicts relating to conservation of protected areas, patenting rights and indigenous knowledge linked to natural resources. In Lake Ol’Bolessat Catchment area, the key natural resources include water, land and biodiversity. Generally, conflicts result from the interaction between people and their environment, the relationships (gender) and issues that are associated with policies pertaining to wetland accessibility (Kok et al., 2009).

Environmental conflicts have no boundaries since the natural resources such as water and air are delimited. The environmental problems in one area are common occurrences elsewhere. People are privileged to live on Earth and they cannot opt out of it, so they are obliged to live and let other living organisms of both genders live without strive or war. Competition for finite environmental resources, beliefs and divergent attitudes as well as institutional framework can trigger or exacerbate environmental conflicts (Okech, 2010). Some conflicts disproportionately affect women since women are often vulnerable physically, socially and politically. They often face the biggest challenge of the effects of conflicts (Perry and Bob, 2010)
2.4.1 Land-related conflicts

Globally, and specifically in Africa, majority of the people depend on land for sustenance (Kok et al., 2009). Land determines the ability of people to make a living and scarcity can contribute to grievances especially when alternative livelihoods are absent. As the global population continues to rise the demand for land continues to grow. There is a significant potential for conflicts over land to intensify. Demographic pressure, urbanization, inequitable access to and shortage of land coupled with resource depletion are predicted to intensify gradually (Nelson et al., 2006). Environmental degradation is a prerequisite to conflicts and land plays a major role, once it is degraded. The conflicts emerge when stakeholders have incompatible interests, values, perceptions and power (Castro and Nielsen, 2003). Desertification and unsustainable wetland use can bring communities with competing livelihoods into conflict. The size of land a person has, determines his social status and hence power over other members of a society (Borgale, 2006). A person’s livelihood becomes vulnerable with decreasing size of his farm. Deforestation and degradation of land creates tension and vulnerability.

Land and other related resources such as water and biodiversity are vital to the rural community as they offer livelihood opportunities. The amount of land available to household is critical to food production. It offers a sense of security in cases where the access to resources is limited. Land issues are sources of conflict and contestation (Bob and Moodley, 2003). Land is becoming an increasingly scarce resource in Africa. Accessibility, control of land and related resources produce conflicts between groups of people. There are varying degrees of land tenure in Africa such as freehold, communal, public and squatting. Access and control to land depend on one’s bargaining power, economic and political quantity and quality of land available, the local economy and culture. The internal factors are demographic aspects such as gender, age, status and lineage. The culture denies rights to certain people and not the others. Women are generally marginalized in land accessibility and decision making (Creel, 2003). Land tenure confers property rights and control over natural resources that exist on the land. It spells out how people own, occupy and transact land. Poverty is characterized by inability of communities to command sufficient resources to satisfy an acceptable standard of living. The inequality is a
consequence of political, economic and social processes that concentrate resources in certain hands and not the others. In sub-Saharan Africa, the majority of people have limited access to land ownership and related natural resources therefore land control and use is a highly contested issue among stakeholders such as local communities and institutions with differing interests (Bob and Moodley, 2003). The conflicts exist between households, neighborhoods and neighboring communities, traditional and nontraditional, inheritance related conflicts between new-comers and long standing residents, generational conflict over land use between interest groups, distribution of benefits and gender conflict of access, use and appropriation of land benefits. Scarcity induced land-related conflicts in Ethiopia resulted in household vulnerability. The absence of clearly defined property rights and management led to over exploitation of the hill sides leading to poverty and food insecurity (Bogale, 2006).

Land security and low prices of agricultural products exacerbate conflicts. However, most of Africa’s marginal lands have the necessary elements for successful reclamation through improved management techniques. Effective management of conflicts is also required in order to come up with sustainable solutions and in order that the quality of life of the local community is improved.

2.4.2 Biodiversity Conflicts

Kenya is rich in biodiversity and wildlife resources comprise the largest proportion. Majority of the local people around conservation areas have a negative attitude towards environmental policies and conservation programs (KWS, 2002). Wildlife habitats are usually converted into grazing land at the expense of tourism and biodiversity (Caalders et al., 2000). The African wildlife policy is questioned as to whether it leads to “people versus animals” conflicts. Humans overstock, overgraze and damage natural ecosystems but the animals are seen to exist in harmony with their surroundings (Okeyo, 1999). The wildlife-human conflicts originate from resource utilization in conservation areas; the animals harm people and property, thereby leading to retaliatory killing of wildlife in 82 % of the unprotected areas (Otieno, 2003).
Most of Kenya’s protected areas and wetlands are recognized as World Heritage Sites. Kenya’s diverse wildlife contributes to a unique natural heritage that is nationally and internationally significant. The wildlife resources contribute to local and national economy through revenue collection (KWS, 2005). Kenyans depend on wildlife for livelihood, shelter and other ecosystem goods and services. The wildlife fulfills ecological functions for the interconnectedness of life-supporting systems. It has socio-cultural and aesthetic values and a negative effect on the ecosystem alters the human’s ability to survive. Kenya’s reservoir of wildlife continues to be lost in favor of development, wealth and employment (Nyakundi et al., 2007).

The local communities living near conservation areas are the first to suffer for failing to conserve wildlife so they experience destruction of their property, human death and injuries caused by wildlife (Deininger and Castagnini, 2006). The factors contributing to conflicts include socio-economic and political, land tenure systems, insecurity, weakened traditions and competition with wildlife. Livelihoods are lost through crop damage, killing humans, livestock pests and diseases. Furthermore the animals move in and out of neighboring farms in response to spatial and seasonal distribution of fodder and water. The increasing rate of human-wildlife conflict could lead to major crisis if the situation is not controlled (Ogodo, 2003). The farms near conservation areas serve as dispersal areas. They are threatened by land subdivision, agricultural expansion, development and tourist accommodation. There is need for local support if tourism-led conservation is to be successful. The wildlife has the capacity to live with many diseases without serious consequences, yet the disease vectors frustrate the local livestock-keeping. The wildlife makes cultivation unprofitable by destroying crops in the neighboring farms. The threat factors that act against biodiversity in conservation areas include illegal killing of wildlife for meat, intensity of human-wildlife conflicts, poaching, human encroachment, habitat loss, conversion and degradation, unsustainable water and land-uses, coupled with agricultural expansion (Okech, 2010).

In Kenya, poor environmental law enforcement in protection and management makes people vulnerable to wild animals attack. People feel that animals are better
treated than humans. They resent the animals and retaliate by killing them for meat, to protect their crops or to kill disease vectors (Okech, 2010). Environmental conflicts are political, socio-economical or territorial. They lead to environmental degradation which is characterized by over-use of renewable resources, pollution and impoverishment of the space of living. Degradation in turn, leads to competition for scarce resources (ACCORD, 2002). Conflicts over natural resources can escalate into violent conflicts if they are left unchecked.

2.4.3 Water-related Conflicts

Competition for water impinges on security and threatens livelihoods at the local level. Gleditsch et al., (2006) states that increased demand for water could produce conflicts. Water pollution and diminishing water resources create conflicts and undermine livelihood activities. Land degradation, drought, deforestation and water scarcity can lead to food insecurity and environmental migration. Countries that share rivers have a high risk of disputes or water wars due to increasing demand for water (Okeyo, 1999). Local and international competition for water is likely to impact on security and threaten livelihoods. Degradations and diminishing water resources in Lake Chad have created conflicts and threatened livelihood sustaining activities in Cameroon, Nigeria, Niger and Chad. There are conflicts between fisherman, pastoralists and farmers (Onuoha, 2008). Water conflicts are related directly to food security and provision of fresh water. Water is crucial for agricultural productivity. Contestations over water rights and access undermine agricultural productivity. Water degradation is related to biodiversity migration including people. People migrate in search of better sources of water. In North-East Tanzania migration has led to convergence of pastoralists and farmers and increased population of people and livestock (Mbonile, 2005). Different interests in water use also bring about conflicts such as irrigation and hydropower generation.

In modern (mechanized) agriculture, environmental degradation arises due to chemical control of weeds and pests. The pesticides and insecticides are toxic to fish and water birds found beyond the target areas. Irrigation projects that are not matched with drainage facilities result in salinity and water-logging while tillage by mechanization damages the soil structure.
2.4.4 Gender-related Conflicts

There are many overt and covert factors that impede women’s participation in environmental management. Despite the international Human Rights Law which guarantees all people equal rights irrespective of sex, race and caste, in many African countries women are denied equal rights with men to land property, mobility, education, employment opportunity, shelter and food. Perry (2002) urges eradication of all obstacles to women participation in sustainable development. Under-representation of women in development is fostered through myths like, “Women do not have what it takes to be leaders”. Cultural contradictions have been perceived as inherent in management positions (Fred-Mensah, 2003). Women play an active role in ensuring family survival by way of diversifying income generating activities. Nowadays, there has been an increase in the number of female-headed households in both rural and urban communities. The women, however, are vulnerable to insecurity and conflict. Since they are responsible for children, they are unable to flee. The women have poor customary rights to land and livestock. Once a woman is married, she belongs to her husband and clan. Women participation in decision making at individual household level is low in relation to resource use and allocation. Decisions are made by men or community elders who are mostly composed of men. According to Brody et al., (2008) female headed households are more vulnerable to poverty than married ones. The women in female headed households cannot own livestock if they do not have a son or if they cannot afford to employ herders. It is important to build the capacity of women and men, boys and girls so that they all contribute knowledge and insight in environmental management. Women are usually absent in decision making at household, community, national or international levels. They either do not have time, confidence or resources to contribute (Eriksen and Lind, 2005). Natural resources are crucial for productive and reproductive role of women in Africa (ACCORD, 2002). The resources diversify livelihoods and enhance the survival strategies of women. Environmental conflicts in Africa have a gendered connotation as men and women experience conflict differently (Pillay, 2009). The conflicts increase vulnerability of women and reduce the quantity and quality of environmental resources. Access to resources influences the way women achieve sustainable
livelihoods and attain food security (Okech, 2010). A livelihood is sustainable when it can withstand stress and maintain capabilities now and in future, without compromising the natural resource base. The gender-based violence results from assertion of power and control over females. The violence entails bullying, insulting and physical harm to others (Perry, 2002). In marginalized communities, poverty, overcrowding, hunger and land tenure systems environmental conflicts increase vulnerability. The women rely heavily on natural resources and are affected negatively by conflicts that further degrade resources. The gendered nature of land relations sometimes leads to violence against women. Land induced violence has gender implications and the role of women organizations should be put in place as they improve the women’s economic conditions and access to land (Campbell et al., 2009). The women are important land managers with user rights but they have limited rights of land ownership and decision-making (Huggins et al., 2005).

2.4.5 Environmental Policy

Land reform has occurred in almost all countries in Sub-Saharan Africa and it has been a source of numerous conflicts. The existing land policies intensify land scarcity and amplify gender, ethnic and wealth inequalities with respect to land access and can lead to a downward spiral of conflicts, resource degradation and social strife. This has a negative effect on natural resource conservation and agricultural productivity (Deininger and Castagnini, 2006). Africa’s land holding patterns is one of the most sensitive issues facing the Governments in the continent. Land reform can take various forms including allocation of land, compensation, subsidies, and land protection laws of disadvantaged groups. The greatest challenge faced by land reform policy makers is how to balance the conflicting social, economic and political reforms. It has resulted in a range of land conflicts related to land reform processes. Land reforms identify specific beneficiaries or priority groups since there are limited resources to be utilized. This leads to conflicts as some people feel that they are disadvantaged and do not benefit from the reform process (Huggins et al., 2005). Redistribution of land from weaker to stronger parties can fuel conflicts. Several conflicts arise when the allocated land is deemed inappropriate or inadequate. Market oriented reform projects usually result in the wealthier members of the community benefiting. The role of the local Government
and traditional authorities related to land control and use in rural communities is highly contested (Deininger and Castagnini, 2006). The formal institutions for land administration were superimposed on traditional structures without delineation of responsibilities.

Customary systems of land holdings and land uses are flawed. The social divisions and class formations are intensifying land conflicts. In South Africa for instance, there is contestation between traditional institutions and local Government structures to allocate and manage land. Rugege et al., (2007) assert that the land management in South Africa is faced with problems of corruption, contradiction between modern and traditional systems, selling and controlling land for personal benefits and discrimination. The discrimination is against women, commercial practices and accumulation. The commercial agriculture results in a new class of people who are encouraged to accumulate wealth and land. This leads to an increase of the landless as wealthy people buy land from disadvantaged members of society. The gendered nature of land relations sometimes leads to violence against women (Pillay, 2009). In traditional African society, land is not allocated to women but men. Land induced violence has gender implications. The frustration of young men unable to acquire land and a homestead contribute to abuse of women. Communal owned resources experience problems when being shared. The problems could be in form of unequal sharing of the resources, dissimilar resource usage, dissimilar priorities, location of the resource, dissimilar cultures and unequal representation in the management committee (Okech, 2010). A case in point involved the Masai pastoralists and the Kikuyu farmers at Mai Mahiu in the Rift Valley of Kenya (Campbell et al., 2009). Public policies have a potential to either exacerbate conflicts or help to manage the conflicts. It all depends on how the policies are implemented and how they are understood. A policy framework that fails to recognize the need for engaging the key parties and generating expert technical solutions is bound to generate conflicts (Tyler, 1999). The state is a legitimate arbitrator and has the power to enforce and support implementation processes in investment, training and offering technical advice. Policies that lack transparency and deny the public access to information have exacerbated conflicts (Kok, 2009). The natural resource management policies should engage external professional
intermediaries or culturally appropriate “insiders” such as the “Njuri Njeke” committee of elders in Meru, Central province. Environmental policies need to incorporate expert guidance from individuals and institutions to be able to gain the trust of all stakeholders. A select committee should manage the resource so long as it has wide representation and a transparent way of selecting members. Holding regular meetings would help to discuss issues of mutual interest and create awareness for the benefit of joint resource management. The environmental policy should enhance equal accessibility to all interested parties and give the public information on the achievements of the management. Training opportunities for the managers of the project and networking would help to update clients (NEMA, 2007). Lack of policy integration and harmonization between Government departments and weak enforcement of policies are issues of concern in environmental management. The relevant departments in the wetland conservation include Kenya Forest Service, Water ministry and the Kenya Wildlife Service. The local Government, through Nyandarua County Council is a custodian of Lake Ol’Bolossat and is entrusted with management of the wetland resource. The integration of environmental concern in development requires national action in a broad perspective. The major policy areas that need to be considered include the location of industries, land use policy, urban-rural interaction and community development. The developing countries require more information and knowledge than they currently have. The developing countries should carry out a survey of the present state of the environment and the major hazards they are exposed to. It is important to compile all legislations regarding environmental control and regulations dealing with urban zoning and protection of natural resources. Lack of specific management plans has seen wetland integrity ruined and misused. It is only the wetlands with conservation status or international importance that have management plans.

From the literature that was reviewed, the relationship between conflicts and livelihoods has not been studied and documented. The study aims at bridging this gap as illustrated in the conceptual framework (Fig.1.1). There is disconnect between natural resource use and conservation and the strategies that people have should be brought in the limelight to generate data for future use.
CHAPTER THREE: RESEARCH METHODOLOGY AND STUDY AREA

3.1 Introduction

This chapter describes the procedures that were followed in conducting the study. It describes the study area, research design, materials and methods of data collection.

3.1.1 Location of the Study Area

Lake Ol’Bolessat is bordered by Ndaragwa, Olkalou and Ol-joro-orok Divisions. It is situated in a wedge-shaped Rift Valley floor sloping eastwards and northwards. Lake Ol’Bolessat is approximately 195 km North of Nairobi. It lies between latitudes 0° 09’S and longitudes 36° 26’E in Nyandarua County (Fig. 3.1). The lake has an area of 90 km² at an altitude of 2,340m above sea level. The lake and the catchment cover 4800km²(NEMA, 2007).

3.1.2 Drainage

There is seasonal inflow of water from streams in the eastern side and there are underground springs that replenish the lake in the west. The lake is fed by streams from Satima Escarpment on the eastern side. There is a seasonal water recharge in the south and the lake supplies water to River Ewaso Nyiro in the north. Most streams flow for a distance and then disappear underground (NEMA, 2007). The water level is highest during the rains especially in July.

3.1.3 Climate

The rainfall ranges between 700mm-1000mm with long rains in April-July and short rains in November. The rainfall distribution pattern is uni-modal as it has a peak in July-August (Fig.3.2). The temperature varies with altitude and local wind patterns. The mean temperature is 23.5°C with little monthly variations. Extremely cold winds originate on the moorlands of the Aberdares Ranges and blow to Ol’Bolessat valley. They bring about frost which destroys food crops and wild vegetation especially grass. The cold winds are trapped in the valley and hence the area experiences night frost nearly every month of the year. Instability of the air at the Equator causes rain especially in July. The highest temperatures are experienced in December and January. Extremely cold temperatures occur in July (Wamiti et al., 2007).
Figure 3.1: Lake Ol’Bolesson basin showing the main Geographic features in the study area: June 2010 (redrawn from Survey of Kenya topographic maps, scale 1:50000 sheet 105/4 and 119/2).
3.2 Research Design

The research design was descriptive survey in which the community members gave information to describe their behavior, perceptions and values. This design was deemed suitable for the study since through data collection from respondents, it would determine the natural resource uses, livelihood activities and the conflicts encountered there-of. The community perception about pollution of the lake and suggestions for mitigation were recorded. The respondents were encouraged to answer questions to the best of their knowledge without guesswork. The research assistants were guided by the key informants as they went round administering the questionnaires while the researcher supervised the exercise by making spot-checks.

3.3 Target Population

The human population in the lake basin and the watershed averages at 202 per Km$^2$(G.O.K. 2009). The study area has an accessible population of 16658 people,
(8353) males and (8305) females. A sample size of 252 households determined by the formula below (Mugenda and Mugenda, 2003) was used.

\[ n = \left( \frac{Z^2 pq}{d^2} \right) = (1.96)^2(0.2)(0.8) \div (0.05)^2 \]

n= the desired sample size

Z= the standard normal deviation (1.96)

P= the proportion in the target population estimated to have the characteristics being measured

q = 1-p

d = the level of statistical significance (0.05)

The study targeted local farmers, community leaders, KARI, KWS, KFS and NEMA in Ol’Bolossat Catchment Area in Nyandarua County. The farmers grow crops and rear livestock on small parcels of land averaging at 2.5 acres. Most of them own more livestock than their plots of land can support (G.O.K. 2009).

The human population in Ol’Bolossat Catchment Area has been increasing gradually from 169113 in year 2008 to 186711 in the year 2011. Both males and females have recorded an upward trend in population increase (Table 3.1) below.

<table>
<thead>
<tr>
<th>Gender</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>80495</td>
<td>83195</td>
<td>85986</td>
<td>88871</td>
</tr>
<tr>
<td>Female</td>
<td>88618</td>
<td>91591</td>
<td>94664</td>
<td>97840</td>
</tr>
<tr>
<td>Total</td>
<td>169113</td>
<td>174786</td>
<td>180650</td>
<td>186711</td>
</tr>
</tbody>
</table>
3.4 Sampling Design
Since Lake Ol’Bolossat is narrow and lies in a north-south direction, it appears to form a boundary between west and east. Twenty out of 204 villages that lie in the basin and in close proximity to the lake were systematically selected using a sampling interval of ten (Table 3.2). The villages lie about 2 Km apart and the sampling started in the north, moving in a clockwise direction. Ten of the villages are located in the eastern side while the other ten lie in the west. One household was randomly selected after which every 10th household was selected from lists given by the chiefs. Purposive sampling of institutions was used to gather expert opinion from officers in NEMA, KARI, KFS and KWS. The officers had sufficient knowledge about the environment and they formed the key respondents for the study.

3.5 Data Collection Instruments
Water samples were collected using sterile WHIRL-PAK bags which were 10ml each. The water was taken to the laboratory and analyzed for chemicals in the water. The water quality guidelines were provided by Athi Water services. Piloting of research instruments was carried out to ascertain validity and reliability of the instruments (Kombo and Tromp, 2006). Both qualitative and quantitative data was collected using household questionnaires, interview schedule, Focus Group Discussion guide for the local leaders, photography and observation checklists.

3.5.1: Questionnaire
Questionnaires were administered to sampled households to generate data on uses of the wetland resources for livelihood support and the conflicts encountered thereof. The questionnaire was divided into three sections. The first section covers the demographic characteristics of respondents. The second section is about the inter-relatedness between various organisms in the wetland. The last section deals with the ecological importance of the wetland resources. Besides, the livelihood activities were captured using questionnaires as they provide stimulus to all subjects and they allowed respondents to give information independently without influence from the researcher (Kombo and Tromp, 2006). The questionnaires were issued to sampled households and collected after a period of one week, which was enough
time for them to respond to all the questions. The households were visited by research assistants as guided by key informants of sampled villages.

3.5.2 Interviews

Interviews were held with key institutions and Conservation Groups to gather expert opinion about conflicts from people with good knowledge about the environment. The experts formed the key respondents in the study. The interviewer probed the respondents through conversation and questions. Some key informants (village elders) who were also resource users were incorporated in the interviews. This allowed the researcher to explain the subject of discussion clearly and accommodate both literate and illiterate members of the community to respond to questions.

3.5.3: Focus Group Discussions (FGDs)

FGDs were held with a game warden, four game rangers working with KWS at Nyahururu, a forester at Olkalou and an environmental officer working with NEMA. The discussions were held in different forums to give background information about the peoples’ behavior and attitudes. Secondary data was collected from National Environment Authority (NEMA), KARI, KFS and KWS at Nyahururu. The collected data covered environmental issues pertaining to the study objectives.

3.5.4 Observations

Observations were made during transect walks and data was collected as guided by observation checklist to show activities and features. Photography revealed information related to natural resource degradation that the community may not have been aware of. The Likert scale was used to establish the rating of the community’s view on the importance of wetland resources (Saul, 2007).
Table 2.2: Distribution of respondents originating from different villages

<table>
<thead>
<tr>
<th>Villages</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kiharo</td>
<td>13</td>
<td>5.2</td>
</tr>
<tr>
<td>Muthakwa</td>
<td>13</td>
<td>5.2</td>
</tr>
<tr>
<td>Munyeki</td>
<td>13</td>
<td>5.2</td>
</tr>
<tr>
<td>Munanda</td>
<td>13</td>
<td>5.2</td>
</tr>
<tr>
<td>Kianjata</td>
<td>12</td>
<td>4.8</td>
</tr>
<tr>
<td>Kariamu</td>
<td>12</td>
<td>4.8</td>
</tr>
<tr>
<td>Githungucu</td>
<td>12</td>
<td>4.8</td>
</tr>
<tr>
<td>Karandi</td>
<td>12</td>
<td>4.8</td>
</tr>
<tr>
<td>Karachi</td>
<td>12</td>
<td>4.8</td>
</tr>
<tr>
<td>Shamata</td>
<td>12</td>
<td>4.8</td>
</tr>
<tr>
<td>Mutaro</td>
<td>12</td>
<td>4.8</td>
</tr>
<tr>
<td>Kamukwa</td>
<td>13</td>
<td>5.2</td>
</tr>
<tr>
<td>Kanguo</td>
<td>12</td>
<td>4.8</td>
</tr>
<tr>
<td>Gatumbiro</td>
<td>12</td>
<td>4.8</td>
</tr>
<tr>
<td>Miharati</td>
<td>13</td>
<td>5.2</td>
</tr>
<tr>
<td>Ziwani</td>
<td>13</td>
<td>5.2</td>
</tr>
<tr>
<td>Makereka</td>
<td>12</td>
<td>4.8</td>
</tr>
<tr>
<td>Manguo</td>
<td>12</td>
<td>4.8</td>
</tr>
<tr>
<td>Shimba</td>
<td>12</td>
<td>4.8</td>
</tr>
<tr>
<td>Total</td>
<td>252</td>
<td>100.0</td>
</tr>
</tbody>
</table>
CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Introduction

This chapter discusses the data analysis, presentation and interpretation. The chapter is divided into three sections. The first section discusses the demographic characteristics of respondents according to gender, age, occupation and duration of stay in the study area. The second section analyses the key resources in the study area and the conflicts in their use. The third section discusses the effects of conflicts on livelihoods and the possible resolution options that could mitigate the challenges. The main objective of the study was to establish the effects of Natural Resource Based Conflicts on community livelihoods in Ol’Bolossat catchment area.

4.2 Demographic Information of Respondents

Information about the respondents was based on gender, age, education, village of residence, duration of residence on his farm adjacent to Lake Ol’Bolossat and socio-economic status. The existing land is under heavy demographic pressure as shown by the national population census (2009). Due to increasing population mentioned earlier (Table 3.1), there is a high demand for arable land and for settlement. Small land units have tended to produce insufficient food for the families that were interviewed. The population in Ol’Bolossat basin is projected to reach 400,000 people by the year 2013 (Fig. 4.1).
4.2.1 Gender of respondents

According to the findings, (56.7%) of the respondents were males while the females were (43.3) % (Fig.4.2). Most household heads are men and they turned up to respond to questions. Women responded to questions only where the men happened to be absent from home. In cases where both parents were absent, the eldest son aged 18 years or above could take charge and fill the questionnaire. There is gender stereotyping in the community since males are entrusted with decision-making while females have very little decision making powers. In relation to the education level of respondents, there were no significant differences between males and females.
Figure 4.2: Gender of respondents in Ol’Bolossat Basin

4.2.2 Age of the respondent

The youth aged between 18-25 years are a special group since most of them are jobless. They earn their living by casual labour and subsistence fishing in the lake. Some youth who were involved in conservation complained that they do not find any tangible benefits from their conservation efforts. They claimed that conservation activities would not interest them unless they were made more profitable. According to the study, 7.8% of the population was aged between 0-30 years, 83.4% was aged between 31-50 years while 8.8% of the respondents were aged above 50 years (Table 4.1). The people aged between 31-50 years happen to have moved from other districts bought land in the study area to develop themselves.

Table 3.1: Age distribution of respondents

<table>
<thead>
<tr>
<th>Age in years</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 30 yrs</td>
<td>19</td>
<td>7.8</td>
</tr>
<tr>
<td>31-50 yrs</td>
<td>180</td>
<td>83.4</td>
</tr>
<tr>
<td>Above 50 yrs</td>
<td>53</td>
<td>8.8</td>
</tr>
<tr>
<td>Total</td>
<td>252</td>
<td></td>
</tr>
</tbody>
</table>
4.2.3: Average Monthly Income in Kenya shillings (Kshs)

Only 50% of the residents earn more than Ksh 4500, (48.2%) earn between Kshs 1501- 4500 while 1.8 earn less than Ksh 1500 (Table 4.2). This was a relatively low income, considering that most of the households have more than five members. The people need supplementary sources of income. The low income and small land sizes are factors that contribute to dependence on wetland resources and unsustainable land use practices. The riparian area is an alternative source of livelihood for the community. Fish farming is being introduced as a supplementary source of animal protein for the residents. It saves them some capital that could otherwise be spent on buying meat. Commercial fisheries are non-existent but fish farming is practiced in ponds and dams where tilapia and the common carp are reared. Some of the people are involved in casual labour in neighbouring flower farms such as Primarosa and Suera. They are paid low wages that do not sustain the families fully. They supplement their daily income with poultry and bee keeping.

Table 4.2: Distribution of respondents’ monthly income for various villages

<table>
<thead>
<tr>
<th>Monthly income (Kshs)</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1500</td>
<td>1.8</td>
</tr>
<tr>
<td>1501- 4500</td>
<td>48.2</td>
</tr>
<tr>
<td>Above 4500</td>
<td>50</td>
</tr>
</tbody>
</table>

There was no significant variation in economic status of different villages (Table 4.3).

A one-way ANOVA was conducted to test whether the monthly average income of respondents in different villages around the lake were significantly different. The significance of the difference was established at 95% level of significance. It was found out that the income level of respondents in various villages was not significantly different. The villages are situated within the same geographical location and they are influenced by the same environmental conditions and culture. It is expected that the socio-economic characteristics of the respondents do not defer
Remarkably. Likewise, the average monthly income of the residents does not defer according to how far they live away from the lake.

Table 4.3: Average monthly income in Kshs for various villages

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>5.723E8</td>
<td>19</td>
<td>3.012E7</td>
<td>1.271</td>
<td>.205</td>
</tr>
<tr>
<td>Within Groups</td>
<td>5.334E9</td>
<td>225</td>
<td>2.371E7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>5.906E9</td>
<td>244</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.2.4 Education Level of Respondents

The results indicated that (49.2%) of the community members had primary level of education, 33.2% had secondary level while 13.6% had tertiary level of education. Only (4%) of the population had never attended school. Overall, 96% can read or write (Table 4.4).

Table 4.4: Education level of respondents

<table>
<thead>
<tr>
<th>Level of education</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-primary</td>
<td>4.0</td>
</tr>
<tr>
<td>Primary</td>
<td>49.2</td>
</tr>
<tr>
<td>Secondary</td>
<td>33.2</td>
</tr>
<tr>
<td>Tertiary</td>
<td>13.6</td>
</tr>
</tbody>
</table>

Apparently the community’s acquisition of formal education has helped to improve their perception of wetland values and need for conservation. However, the members need environmental education (EEN) to help them conserve the environment and cope with human-wildlife conflicts. The Government ought to educate the community that they are the owners of the wetland and the
Government’s role is to regulate utilization of the natural resource. Although the community views the lake as a public good, they get economic benefits by using the wetland for various purposes such as cultivation, fodder, fuel, honey and water provision, (Table 4.5).

Table 4.5: Education level of respondents versus their mean for wetland uses

<table>
<thead>
<tr>
<th>EDUCATION LEVEL</th>
<th>CULTIVATION</th>
<th>FODDER</th>
<th>FUEL WOOD</th>
<th>HONEY</th>
<th>WATER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-primary</td>
<td>8.77a</td>
<td>8.259a</td>
<td>4.22a</td>
<td>2.81a</td>
<td>6.11a</td>
</tr>
<tr>
<td>Prim</td>
<td>9.10a</td>
<td>8.24a</td>
<td>4.00a</td>
<td>2.89a</td>
<td>6.65a</td>
</tr>
<tr>
<td>Sec</td>
<td>9.10a</td>
<td>8.90a</td>
<td>3.90a</td>
<td>3.60a</td>
<td>6.00a</td>
</tr>
<tr>
<td>Tertiary</td>
<td>9.00a</td>
<td>8.00a</td>
<td>3.50a</td>
<td>2.50a</td>
<td>6.50a</td>
</tr>
</tbody>
</table>

The means followed by a downwards are not significantly different according to Turkey-HSD test at 0.05 level of significance and p < 0.05. The respondents’ level of education was not related to the wetland resource that he used.

4.2.5 Duration of time respondent had been on the farm

Responses indicated that 52.7 % of farmers had been on the current farm for a period ranging between 15–20 years (Table 4.6). The period was long enough for farmers to have effected changes in their farms and in the environment by way of planting or cutting down trees.

The older residents, aged more than forty years have been on their farms for twenty years and above. Most of the residents who migrated from other districts are middle-aged. This can be attributed to the fact that middle-aged group is more mobile than the old.
Table 4.6: Duration of time respondent has resided on his farm

<table>
<thead>
<tr>
<th>Time in years</th>
<th>Frequency</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 15 yrs.</td>
<td>57</td>
<td>23.3</td>
</tr>
<tr>
<td>15-20 yrs.</td>
<td>129</td>
<td>52.7</td>
</tr>
<tr>
<td>21-30 yrs.</td>
<td>27</td>
<td>11.0</td>
</tr>
<tr>
<td>31-40 yrs.</td>
<td>4</td>
<td>1.6</td>
</tr>
<tr>
<td>41-50</td>
<td>27</td>
<td>11.0</td>
</tr>
<tr>
<td>Above 50 yrs.</td>
<td>8</td>
<td>.4</td>
</tr>
<tr>
<td>Total</td>
<td>252</td>
<td>100</td>
</tr>
</tbody>
</table>

### 4.2.6 Supplementary Income source

The residents in Ol’Bolossat are low income earners with small pieces of land (Table 4.7). The females have an average monthly income of Ksh. 4,757.80 while the males earn Ksh. 6,259. The supplementary sources of income are casual labour, employment, business and jua kali artisan. The average size of their farms is 3.5 acres for female headed households and 3.7 acres for males but they keep poultry to supplement their daily income.
Table 4.7: Respondents monthly income versus land sizes

<table>
<thead>
<tr>
<th>Gender</th>
<th>Land sizes in acres (Mean)</th>
<th>Mean Income (monthly) in Ksh.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Females</td>
<td>3.5</td>
<td>4,757.80</td>
</tr>
<tr>
<td>Males</td>
<td>3.7</td>
<td>6,259.70</td>
</tr>
</tbody>
</table>

From the foregoing, men are more empowered than women since on average they own bigger pieces of land (3.7 acres) as compared to women (3.5 acres). The men are more stable financially than women and the empowerment is deep rooted in culture. There was a positive co-relation between culture, knowledge, length of stay and the farming practices that the respondents employed (Table 4.8). The long standing farmers engage in indigenous methods of organic farming while the new comers apply inorganic fertilizers.

Table 4.8: Relationship between duration of residence, knowledge and culture

<table>
<thead>
<tr>
<th>Variable</th>
<th>(r) values n=252</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.Length of stay</td>
<td>0.40*</td>
</tr>
<tr>
<td>2.Lack of knowledge</td>
<td>-0.16*</td>
</tr>
<tr>
<td>3.Culture</td>
<td>0.18*</td>
</tr>
<tr>
<td>4.Diseases</td>
<td>0.17*</td>
</tr>
<tr>
<td>5.Good farming practices</td>
<td>-0.20*</td>
</tr>
</tbody>
</table>

*= values significant at p=0.05 ***=values significant at p=0.01
From the data that was generated, the duration of residence was related to the culture and farming practices of individual farmers. The long standing farmers do not plant trees as much as the new-comers. There was a positive correlation between education and conservation such as tree planting, \( r = 0.22, n=252 \) and \( p = 0.01 \)(Table 4.8). Farmers with high education diversify crop farming and destroy social norms such as communal land ownership and land fragmentation marked with displacements leading to loss of livelihoods.

Most elderly farmers are casual labourers and they lack management skills for self-reliance such as terracing and contour ploughing. However, the farmers apply farmyard manure on their farms, which is a better alternative to the use of chemical fertilizers.

The results showed that (83%) of the respondents had stayed in the area for more than 15 years. It was illustrated that most respondents were aged 40 years and above. There was no farmer in the study area whose age was less than 18 years. Most young people work in towns and they leave the elderly in the farms. The elderly members of the community were found to be conservative. They stick to traditional farming methods with environmental conservation strategies. Livestock and crop farming are the major livelihood activities but they are affected by loss of soil fertility, lack of markets for the farm produce, pests and diseases, small land units and NRBCs. Low farm production leads to economic instability, food insecurity and over-reliance on natural resources for pasture, thatching and building houses, basketry and medicine, thereby leading to environmental degradation. Over-exploitation of the available resources has led to challenges that are indicated in (Table 4.9).
Table 4.9: Livelihoods and Constraints

<table>
<thead>
<tr>
<th>Livelihood</th>
<th>Constraint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash crop farming</td>
<td>Credit facilities</td>
</tr>
<tr>
<td></td>
<td>Weather</td>
</tr>
<tr>
<td></td>
<td>Land sizes</td>
</tr>
<tr>
<td></td>
<td>Poor market</td>
</tr>
<tr>
<td></td>
<td>Pests and diseases</td>
</tr>
<tr>
<td></td>
<td>Soil fertility</td>
</tr>
<tr>
<td>Dairy farming</td>
<td>Diseases and pests</td>
</tr>
<tr>
<td></td>
<td>Low milk prices</td>
</tr>
<tr>
<td></td>
<td>High Cost treatment</td>
</tr>
<tr>
<td></td>
<td>High cost AI service</td>
</tr>
<tr>
<td>Subsistence</td>
<td>Small land</td>
</tr>
<tr>
<td></td>
<td>Lack farm input seeds</td>
</tr>
<tr>
<td></td>
<td>Lack farm fertilizers</td>
</tr>
</tbody>
</table>

Farmers who diversify their farming practices are not vulnerable to difficult environmental conditions. They practice stall feeding of their cattle and do not depend on the wetland vegetation for pasture, hence they do not over-use the wetland.
4.3 The Natural Resources in the wetland that affect livelihoods

Preliminary studies and observations indicated that the key resources which affect the community’s quality of life include water, land, grassy vegetation and wildlife. Most of the respondents indicated that fresh water is the most important natural resource that affects their livelihood.

4.3.1 Land Use Changes

There is land contestation between ‘new comers’ who have stayed in the catchment area for less than ten years and long standing residents. The new comers have smaller pieces of land ranging between 0 to 3.5 hectares bought from former residents. However, most of the new comers do not depend on the wetland for grazing cattle but they practice stall feeding. The wetland is communally owned but most of the respondents said that it belongs to the government.

The wetland has been fragmented for agriculture and settlement. The existing land tenure system of inheritance has led to land subdivisions. The wetland has continued to be sub-divided to cater for the increasing population (Table 4.10). This has resulted in continued encroachment into the wetland for various uses as farms become small (plate 4. 1). The wetland has been used as an alternative source of grazing land. Animals are freely grazed and watered in the wetland.
Human settlement in the un-protected area

Plate 4.1: Encroachment in Ol’Bolessat Basin by farmers. The settlements on the right side of the row of trees are in the unprotected part of the basin.
Photograph taken on 10th April, 2012.
4.3.2 Inter-dependence of animals in the basin

All the animals depend on wetland vegetation for food and habitation. The birds pollinate plants and disperse seeds which are fed on by animals in the ecosystem. The birds feed on ticks from the hippopotamuses bodies, thereby removing parasites that cause diseases (Ruhiu, 2000). There are strong associations among all the animals in the ecosystem and destruction of one species has negative effects on the others and conflicts ensue (Table 4.10).

Birds such as the Yellow-billed duck, Red knobbed Coot and Glossy ibis are indicators of environmental quality and the hippopotamuses in the lake are about 200 in number. Coypu rat is an invasive species of mammals that has no natural enemies. It threatens the existence of reeds such as Cyperus *ridigifolia*. Buffaloes and water bucks have disappeared in a period of about ten years. Thomson’s gazelles have reduced in number due to human settlement and agriculture. A few gazelles are still in existence together with hyenas and leopards.

4.3.3 Effects of Human Activities on Vegetation

Responses indicated that there was limited accessibility to wood sources due to the Government Policy to protect forests from destruction by the people using firewood. The fuel wood and timber had become expensive due to the policy (G.O.K. 2009). The alternatives that the community had were clearing vegetation in the wetland, intercropping trees with crops and starting woodlots.

Nevertheless, eastern side of the lake is characterized by deforestation, burning charcoal and vegetation to clear land for cultivation. The burning of vegetation poses danger of spreading fires. It leaves tracts of land bare and prone to soil erosion and loss of soil fertility. Some conservation groups have established tree nurseries but progress is hampered by lack of suitable seeds and limited space for siting the nurseries. It was noted that large areas around the lake are covered with eucalyptus trees. These are the wrong tree species to be planted in the wetland since they take up a lot of water from the water table and lose it by transpiration.
The vegetation comprises of marshland, open water vegetation, swamp and grassland. The plants in the marshes include *Panicum repens*, *Cyperus ridigifolia*, *Cyperus papyrus*, *Cirsium vulgare* and *latifolia*.

The open water vegetation comprises of rooted submerged, emergent and floating macrophytes. The macrophytes include *Nymphae caerulene*, *Ludwiga stolonifera* and *Najas pectinatus*. The invasive species include *Salvinia molesta* (water hyancith) and *Pistia stratioles*. There are dominant grasses such as *Pennisetum sphacelata*, *Themeda triandra* and sprobolus species. Other species include setaria and virgate (Ndang’ang’a, 2003). Legumes occur together with the grasses and they are used as fodder for cattle.

### 4.3.4 Uses of water

Responses indicated that water is the most important natural resource in the catchment area, which supports livelihoods (Table 4.10).

**Table 4.10: Wetland used for water supply**

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uses lake water</td>
<td>145</td>
<td>57.5</td>
</tr>
<tr>
<td>Uses other sources</td>
<td>107</td>
<td>42.5</td>
</tr>
<tr>
<td>Total</td>
<td>252</td>
<td>100</td>
</tr>
</tbody>
</table>

The community (57.5%) uses the lake water (Table 4.9), while (42.5%) depend on other sources of. Multiple uses of water bring about conflicts between various users. Ol’Bolossat wetland contributes to ground water recharge by holding the water until it is absorbed through the soil into the underground aquifer. The water table is high and likely to be contaminated by pit latrines during the rainy season (Table 4.11). The community’s mode of human waste disposal is through pit latrines. Apart from using water from the lake, the community members get water from boreholes for
either domestic or irrigation and are likely to have colon bacteria. Unless the water is well treated it is unfit for human consumption. Water from shallow wells is unfit for domestic use as it endangers human health. The wetland removes pollutants and excess nutrients from the water that enters them. Ol’Bolossat is an avenue for recreation such as hunting, trapping, sightseeing, bird watching and photography. It is a green space where people go to relax and enjoy their picnic.

Hippopotamuses and cattle compete for water in the lake although the hippopotamuses graze at night and the cattle graze at day time. The grazing has led to continued drying up and siltation due to removal of vegetation cover. It was observed that there are flower farms such as Suera and Primarosa which extend up to the riparian grazing land and pollute the lake water. This has led to disappearance of several migratory birds whose breeding sites have been destroyed (Table 1.1).

4.4 Causes of Conflicts
On demographic data the findings indicate that the majority of the community members are peasant farmers and livestock production accounts 24 % of the total agricultural output. The livestock graze with hippopotamuses in the wetland and share pasture.

The overall poverty or absolute poverty is 74 % and food poverty is 81 % (G.O.K., 2009). There is no meaningful conservation that can be achieved without support of the local community (Beresford and Philips 2000). The community livelihood is vulnerable to wildlife attacks (Fig.4.7). Poor communities are usually vulnerable to environmental conflicts since they lack alternatives and resources that would help them to cope with natural conditions such as availability of water resources and quality of land. The issue is not the strength of the disasters but how strong it is in relation to the people’s ability to withstand it.

4.4.1: Human Population Pressure
The average population density is 202/km² and has been increasing over the years just as was predicted NEMA in Ol’Bolossat Strategic Plan (NEMA 2007). Population pressure is a challenge to crop production as human settlement has taken most of the arable land. Rapid population growth leads to poverty and
environmental degradation (Borgale, 2006). Land subdivisions have given rise to smaller land units, which undermined food security and community livelihoods (Table 4.11). The decrease in land sizes has led to less crop production.

Table 4.11: Changes of land sizes in Ol’Bolossat for the last 10 years

<table>
<thead>
<tr>
<th>Responses</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size not changed</td>
<td>33</td>
<td>9.5</td>
</tr>
<tr>
<td>Reduced</td>
<td>219</td>
<td>90.5</td>
</tr>
<tr>
<td>Total</td>
<td>252</td>
<td>100</td>
</tr>
</tbody>
</table>

High human population density has caused land fragmentation, dispersal of animal communities, habitat loss, degradation and species extinction (Ruhiu, 2000). Wetland degradation used to go unnoticed since this ecosystem was considered unproductive and unhealthy (Irandu, 2003). It was drained to provide land for agriculture and destroy breeding sites for disease vectors such as bilharzia worms and mosquitoes. Changes in settlement have reduced mortality and there is human migration from other districts in search of land (Census, 2009). The population density increased from 66 persons per square kilometer to 115 persons / km² (NEMA, 2007).

Most of the community members are low income peasant farmers who depend on the wetland for pasture. Responses indicated (17.1%) cases of people who have been attacked by wild animals (Table 4.11). Hippopotamuses make life miserable for residents in Ol’Bolossat since they stray into farms and destroy food and cash crops which amount to big losses to the residents (Fig.4.7). The farmers accused KWS of inaction when called upon to protect the residents from animal attacks.
Sometimes the farmers take the law in their hands and kill the hippopotamuses in an attempt to secure their livelihoods. High crop yields are hard to come-by since the water birds feed on wheat, which is the major cash crop in the area. The hippopotamuses feeding on maize, cabbages and beans dwindle the farmers’ hopes of ever getting good harvests. KWS on its part cites lack of transport when called upon to help the farmers but when an animal is killed they find a vehicle and roam about issuing threats of arrest to the culprits. The plight of farmers is compounded by lack of compensation when the crops are destroyed. According to the District warden at Nyahururu, Conservation Management Act provides for compensation if attacks lead to human injury or death. The law does not provide for destroyed crops and property but it allows for compensation of up to Kshs 50,000 for injury and Kshs 200,000 for death. The new bill will raise the death compensation to Kshs 1.5 million.

Table 4.12: Occurrence of animal attacks

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Common</td>
<td>157</td>
<td>81.3</td>
<td>81.3</td>
</tr>
<tr>
<td>Common</td>
<td>33</td>
<td>17.1</td>
<td>98.4</td>
</tr>
<tr>
<td>Very Common</td>
<td>62</td>
<td>1.6</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>252</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The community is vulnerable to attacks by wildlife but they get very little compensation from KWS. The majority of respondents (81.3%) reported that animal attacks are not common but they occur from time to time (Table 4.12) above. Only 17.1% of the respondents found animal attacks on humans common while 1.6% found them very common.
4.4.2 Development Pressure

Development pressure or need for economic growth has led to over-exploitation of natural resources. The cost of exploiting the resources outweighs the benefits of economic growth. There is “environmental injustice (Okech, 2010).” A lot of emphasis is put on economic growth at the expense of the environment. The natural resources have been subdued by the humankind since the community is more inclined to sustaining development than sustaining the environment. The Nyandarua County Council allows stone excavation in quarries and this leads to water pollution (Plate 4.2).
Plate 4.2: Stone excavations in Ol’Bolessat Basin. Stones are dug out of the quarry on the left side. Photograph taken on 10th April 2012.
4.4.3 Human Activities

The major cause of human-wildlife conflict is human interference with animal habitats. A KWS officer in Nyahururu said that human beings intrude into the animal corridors resulting in their straying into human settlement areas. The wetland is under pressure from human activities such as intensive farming in neighboring farms, charcoal burning, vegetation clearing, overgrazing, encroachment, poaching and over-fishing. The fore-mentioned activities threaten the sustainability of the ecosystem and they are not in line with conservation strategies. The activities destroy animal habitats and the aquatic animals leave the lake. The livestock grazed in the study area include, cows, goats, sheep and donkeys (Table 4.13). Vegetation clearing leaves the land bare and exposed to erosion (Plate 4.3).

Table 4.13: Livestock Population

<table>
<thead>
<tr>
<th>Livestock</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy cattle</td>
<td>12000</td>
</tr>
<tr>
<td>Sheep</td>
<td>8500</td>
</tr>
<tr>
<td>Goats</td>
<td>3500</td>
</tr>
<tr>
<td>Donkeys</td>
<td>250</td>
</tr>
<tr>
<td>Total</td>
<td>24250</td>
</tr>
</tbody>
</table>
Plate 4.3: Photograph Showing Soil Erosion around Lake Ol’Bolessat. Photograph taken on 10th April 2012.
4.4.4 Socio-economic and Environmental Status in the Study Area

The community members who are subsistence farmers depend on the wetland for pasture. Scarcity of resources in their farms has led to environmental degradation as farmers seek alternative livelihoods in the wetland (Fig. 4.6). The problems are compounded by poor infrastructure and lack of revenue sharing from the proceeds of ecotourism. Poor infrastructure has ruined the marketing of farm produce to point whereby the farmers sell produce at low prices since they lack alternatives. The farmers are exploited by middle men who buy produce at low prices and sell the same at high prices in towns. Unclear policies and lack of guiding principles has guaranteed minimum returns. There are inadequate storage facilities and cooling plants for milk and horticultural products. Decrease in land sizes owing to increasing human population has led to low crop production and economic instability.

4.4.5 Management

Management of the wetland resource is under Nyandarua County Council. Economic motivations and competition for natural resources has led to human-wildlife conflicts where opposing political actors have colluded to extract stones from quarries neighboring the wetland. There is uncontrolled grazing of livestock in the wetland and this deprives water animals of their food and water. These findings were also made by Ross (2004). Vegetation is harvested for fuel wood and timber for building houses. Forest and timber provide livelihood opportunities to the community through forest products, cosmetics and medicine.

There are groups and organizations which deal with poverty eradication, environmental conservation, and agriculture, creating awareness about HIV/AIDS and uplifting the standard of living. The groups and institutions have incorporated environmental issues with livelihood improvement (Fig. 4.3).
Figure 4.3: Groups and organizations in Ol’Bolessat Catchment Area (Adapted from NEMA: Ol’Bolessat Management Plan).

Key:

ECGs (Environmental Conservation Groups) _25%

Institutions-13%

SHGs (Self-Help groups) -58%

Others - 4%

Among the institutions for conservation network, 58% are self-help groups for generating income. Environmental Conservation Groups accounted for 25%, 13% were institutions such as schools and the others (4%) are associations and individuals.

4.4.6 Land Tenure Systems

The majority of Ol’Bolessat residents (94.4) per cent have freehold type of land ownership. The land has been acquired through inheritance and purchase. 0.4 per
cent have temporary lease of Government land beside the roads, along railway lines and near shopping centers (peri-urban). The rented farms from individual land owners comprise (5.2%).

Ninety five per cent of the community members have freehold type of land ownership and 5% have rented farms (Fig. 4.4).

There is patriarchal type of land ownership where sons inherit land from their fathers. The females do not inherit land but they have user rights. Women need empowerment since they have a great impact on the environment as they carry out their daily chores of firewood collection and fetching water. Gender disparity is an issue of concern in the study area. Women support family livelihoods but do not have absolute rights of land ownership.

![Figure 4.4: Type of land ownership in Ol’Bolossat Catchment area](image)

### 4.5 Types of Natural Resource Based Conflicts

The conflicts in Lake Ol’Bolossat include land and water use, biodiversity, gender and policy conflicts. Traditional land use systems such as subsistence farming permitted settled farmers to co-exist with wildlife. Nowadays, sharing and competition for scarce natural resources has led to environmental conflicts. From the research, it was found out that reported cases of human-wildlife conflicts have greatly reduced (Fig 4.5).
The reported cases of human-wildlife conflicts have reduced from 300 in the year 2007, to 280 in year 2008, to 100 in year 2009 and 40 in the year 2010. This can be attributed to the fact that KWS no longer compensates victims for loss of property and crop damages. The victims are therefore reluctant to report. They only report human injuries and deaths. Nevertheless, according to Nyahururu District Warden, KWS has become swift in responding to people who raise alarm when wild animals stray into human settlement areas. Whereas they used to have one vehicle, they now have two. They have also cautioned the community to keep away from the animal habitats and they have encouraged them to conserve the wetland resource. From 2002-2011, the number of human-hippopotamus conflicts were 12 persons injured by the mammals and one person was killed in year 2002 alone.

4.5.1 Water-related Conflicts

Irrigation in the Eastern side curtails flow of water into the lake and this has brought conflicts between farmers in the upper and lower catchment area. There is water abstraction in the upper catchment area for agriculture from springs and streams that drain into the lake. After the abstraction the farmers in the lower region are deprived of water for domestic use. The community members living close to the wetland fetch water directly from the lake for domestic consumption. The responses and researcher observations indicated that the community living nearest to the wetland is quite unprepared for dry periods. They have no water storage facilities.
for harvesting rain-water, hence they fetch water from watering points that they share with livestock.

The respondents indicated that crop production was insufficient and intensive cultivation has therefore been employed in order to increase crop production by way of applying chemical fertilizers. These farming practices have negative consequences on the wetland. They have led to water pollution and disappearance of aquatic animals. It was observed that town effluent, siltation, human and animal waste found their way into the lake. Water pollution can be viewed as the interference that prevents the beneficial use of water. Polluted water is harmful to the welfare, health and safety of human beings. It is also harmful to the environment, which includes aquatic and non-aquatic life. The water quality in the catchment area has declined over the years. There are cattle dips, slaughterhouses, sewers and car washing sites near the lake. Surface run-off was collected from water channels flowing towards the lake. The water was found to contain human waste from pit latrines and chemicals from farms (Table 4.14).
# Table 4.14: Lake Ol’Bolessat water sample analysis showing the water quality

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Results</th>
<th>Max. Kenya Drinking WQ Guidelines. Source: Athi water services.</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>pH scale</td>
<td>A-7.4 C-6.9 B-6.8 D-7.2</td>
<td>6.5-8.5</td>
</tr>
<tr>
<td>Turbidity</td>
<td>NTU</td>
<td>A-89.2 C-647 B-37.1 D-32</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>TDS</td>
<td>Mg/l</td>
<td>A-55 C-76 B-95 D-89</td>
<td>1000</td>
</tr>
<tr>
<td>Color</td>
<td>TCU</td>
<td>A-15 C-30 B-10 D-10</td>
<td>15</td>
</tr>
<tr>
<td>Nitrate (NO$_3$)</td>
<td>Mg/l</td>
<td>A-0.5 C-1.2 B-1.1 D-1.0</td>
<td>10</td>
</tr>
<tr>
<td>E. Conductivity</td>
<td>µs/cm</td>
<td>A-230 C-284 B-390 D-330</td>
<td>1,500</td>
</tr>
<tr>
<td>Total Iron (Fe)</td>
<td>mg/l</td>
<td>A-0.9 C-1.3 B-0.9 D-1.0</td>
<td>0.3</td>
</tr>
<tr>
<td>Ammonia (NH$_3$-N)</td>
<td>Mg/l</td>
<td>A-0.14 C-0.37 B-0.1 D-0.2</td>
<td>0.5</td>
</tr>
<tr>
<td>Phosphorus (PO$_4$)</td>
<td>Mg/l</td>
<td>A-0.36 C-1.3 B-0.41 D-0.85</td>
<td></td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>Mg/l</td>
<td>A-0.12 C-0.0 B-0.2 D-0.0</td>
<td>0.1</td>
</tr>
<tr>
<td>Total coliforms</td>
<td>MPN/100ml</td>
<td>A-1553 C-&gt;2419 B-&gt;2419 D-&gt;2419</td>
<td>Nil</td>
</tr>
</tbody>
</table>
KEY:

A- Kariko water runoff near the lake collected from water channels

B- Gathima water runoff at the entry point into the lake

C- Murram water collected from the Southern part of the lake

D- Quarry water collected from the Northern part of the lake

NB: The water was analyzed by the Ministry of Water District Headquarters at Nyahururu.

Two water samples collected from two different points in the lake and two samples from run-off flowing towards the lake were taken to the laboratory and tested for pollution. The lake water was found to be highly contaminated and unfit for domestic use. The concentration of minerals in the lake water was lower than that of the run-off water. This indicates that the contamination originated from surrounding farms but once it enters the lake gets diluted by clean water from springs and streams that drain into the lake. The existing water sources are over-exploited by the community which seems quite unprepared for dry periods. Irrigation in the Eastern side curtails flow of water into the lake. The catchment area is characterized by water scarcity due to seasonal prolonged dry periods, so the community relies heavily on underground water. The lake recharges boreholes and it is an important source of water for the local community. The ground water is slightly saline due to the nature of rocks (Jaetzold and Schmidt, 1983). The water was found to be contaminated with human and animal waste besides chemicals from the nearby cattle dips (Plate 4.4).
Plate 4.4: Livestock grazing near cattle dip in Ol’Boossat watershed. Photograph taken on 10\textsuperscript{th} April, 2012.
Traditional regulatory mechanisms conserved water catchment areas and biodiversity which were labeled sacred and “untouchable since wetlands improve water quality by absorbing nutrients and breaking down organic matter. Water is vital for organisms and humans for drinking, bathing, sanitation, industry, transport and recreation. Competition for water use by both humans and wildlife creates undue stress to the resource base and consequent drying up.

There is scarcity of fresh water due to pollution, inadequately treated sewage, industrial waste, catchment destruction, poor agricultural practices and river diversions. The pollutants harm aquatic life and threaten water supply. Food supply depends on water availability. However, Lake Ol’Bolossat water is unsuitable for agricultural production since it is saline. There are poor soils that require application of chemical fertilizers which in turn contribute to water pollution in the lake. Clearing vegetation and failure to plant more trees leads to reduced amount of rainfall. This has made the lake to reduce in size progressively in a period of ten years. Water is polluted when any chemical in water becomes detrimental to aquatic organisms. It also gets polluted through sediments from weathering wetland and soil erosion which carries silt with chemicals from neighboring farms. The people and livestock share the same watering points, thereby contaminating the water (Fig.4.5)
4.5.2 Land-use Conflicts

Destruction of social norms such as communal land ownership and land fragmentation, marked with displacements has brought about loss of livelihood.

Only 0.2% have more than 5 acres of land, (68.0%) of the farmers have 2.1 to 5 acres and 31.8% have 0-2 acres (Table 4.15). Currently, land sizes in Ol’Bolessat have reduced to an average of 3.6 acres down from 12 acres which were common land ownership to farmers. Some farmers encroach into the wetland, clearing vegetation for cultivation and they destroy habitats.

Table 4.15: Land units for respondents in Ol’Bolessat area

<table>
<thead>
<tr>
<th>Land size in acres</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above 5.0 acres</td>
<td>0.2</td>
</tr>
<tr>
<td>2.1-5.0 acres</td>
<td>68.0</td>
</tr>
<tr>
<td>0-2 acres</td>
<td>31.8</td>
</tr>
</tbody>
</table>

Land fragmentation has given rise to land use changes such as agro-forestry, changes in vegetation cover and loss of soil fertility (Table 4.16).

It was observed that the wetland is under pressure from human activities such as intensive farming in neighboring farms, charcoal burning, vegetation clearing, overgrazing, encroachment, poaching and over-fishing. The human activities destroy animal habitats and the water animals leave the lake to look for feeds in nearby farms. Responses indicated that the crop raids have led to low tolerance for wildlife by farmers. The increasing number of livestock grazing in the wetland and rangers failure to respond promptly when problem animals strike, have contributed to conflicts in the wetland.
Table 4.16: Relationship between human population increase and land use changes

<table>
<thead>
<tr>
<th>Variable</th>
<th>(r)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population pressure</td>
<td>0.16**</td>
</tr>
<tr>
<td>Agro-forestry</td>
<td>0.18*</td>
</tr>
<tr>
<td>Crop cover</td>
<td>0.18*</td>
</tr>
<tr>
<td>Soil fertility</td>
<td>0.19*</td>
</tr>
</tbody>
</table>

There was positive correlation between human population and land-use changes ($r = 0.30$, $n = 252$, $p = 0.01$).

*= Values significant at $p= 0.05$

**= Values significant at $p= 0.01$

It was noted that 20% of the households are female headed and 80% are male headed. The community is paternal as men take the responsibility of household heads and make decisions concerning land. The women are not empowered but they utilize the land without right of ownership and decision making. The major decisions such as land sub-division and tree planting are made by men. The women in male headed households consult the men on all major issues that affect the family. The majority of respondents were men since the women could only respond in the absence of male counterparts. The roles of women are reproductive, hospitality and farming. According to respondents, women have a greater impact on the environment since they fetch water, collect firewood and take care of their families. The female heads are bread winners and source of livelihood for their households. The men on the other hand are the decision makers even in matters pertaining to the environment. Males engender the environment in the same way they do to their female counterparts. They tend to feel that they are in charge and not part of the environment.
4.5.3: Biodiversity Conflicts

The wetland is important for flood control during high water level when the lake forms a reservoir for water retention, reduces floods and soil erosion. Despite their importance to ecosystem (co-existence), 88% of the community members have had their crops destroyed by wild animals (Fig. 4.7). As crops get destroyed, so are natural habitats for frogs, fish, birds and wildlife. The conflicts impoverish the local community’s life since they depend on agriculture for subsistence and sale.

Wetlands are important habitats for fish and wildlife, flood control, ground water recharge, cleaning water by trapping sediments, recreation, scientific and educational values and human services. Clearing vegetation removes protection from fish and other animal species. Animals such as ducks and water fowls have disappeared from Lake Ol’Bolossat and this can be linked to the destruction of their breeding sites (Table 4.17).

Biodiversity conservation conflicts are brought about by human activities. Unsustainable land use practices have reduced natural ecosystems and altered their status through changes in vegetation cover, pollution and introduction of invasive species which compete with indigenous ones.

Responses from community members indicated that antelopes, leopards, hyenas and wild dogs used to stray far away from the lake about ten years ago, however, they are no longer sighted. The people living near the wetland within 1 kilometer from the lake have been witnessing cases of livestock attacked by leopards and wild dogs at night. The fact that the animals are only sighted far away from the lake is an indication that the number of the fore-mentioned animals has reduced and they do not venture far away from the wetland.
Table 4.17: Distance from the lake versus animals no longer sighted

<table>
<thead>
<tr>
<th>Animal</th>
<th>Chi square</th>
<th>Df</th>
<th>p-Value</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antelope</td>
<td>20.714</td>
<td>2</td>
<td>0.000</td>
<td>Significant relationship</td>
</tr>
<tr>
<td>Gazelles</td>
<td>3.330</td>
<td>2</td>
<td>0.189</td>
<td></td>
</tr>
<tr>
<td>Leopards</td>
<td>15.281</td>
<td>2</td>
<td>0.000</td>
<td>Significant relationship</td>
</tr>
<tr>
<td>Hyena</td>
<td>5.901</td>
<td>2</td>
<td>0.052</td>
<td>Significant relationship</td>
</tr>
<tr>
<td>Migratory birds</td>
<td>4.236</td>
<td>2</td>
<td>0.120</td>
<td></td>
</tr>
<tr>
<td>Guinea fowls</td>
<td>0.296</td>
<td>2</td>
<td>0.863</td>
<td></td>
</tr>
<tr>
<td>Waterbucks</td>
<td>2.519</td>
<td>2</td>
<td>0.284</td>
<td></td>
</tr>
<tr>
<td>Buffalo</td>
<td>1.739</td>
<td>2</td>
<td>0.419</td>
<td></td>
</tr>
<tr>
<td>Jackals</td>
<td>2.225</td>
<td>2</td>
<td>0.329</td>
<td></td>
</tr>
<tr>
<td>Lions</td>
<td>4.518</td>
<td>2</td>
<td>0.104</td>
<td></td>
</tr>
<tr>
<td>Wild dogs</td>
<td>5.898</td>
<td>2</td>
<td>0.052</td>
<td>Significant relationship</td>
</tr>
<tr>
<td>Others</td>
<td>3.672</td>
<td>2</td>
<td>0.159</td>
<td></td>
</tr>
</tbody>
</table>

KWS rangers who were interviewed reported that they have trapped and translocated leopards that were problem animals posing threat to the community. The problem animals have reduced in number due to poaching and the antelopes have been hunted for bush-meat almost to extinction. It is only the people living near the wetland who reported to have continued seeing the fore-mentioned animals to date. Some aquatic animals leave the watershed in the evenings and return early in the morning when children are going to school.
Plate 4.6: Hippopotamuses grazing near Lake Ol’Bołożat, one of the main tourist attractions in Nyandarua County. Photograph taken on 10th April, 2012.
4.5.4 Conflicts in Environmental Policies and legislation

There is no integration among Water Act, Forestry Act, KWS and land use policy. Lake Ol’Bolossat management lies under the docket of Nyandarua County Council, the Forest Department and Kenya Wildlife Service. The Forest Department uses the Forest Act (no. 7 of 2005) while KWS policy of 2011 is intended to revise the wildlife conservation and management Act (Cap 376) and focus on balancing people’s needs with conservation. The last two institutions contradict each other although they have signed a memorandum of understanding. The Forest Department allows use of forest products while KWS does not allow utilization or accessibility to the gazetted areas. The fore-mentioned institutions do not work harmoniously in management of natural resources and the current environmental laws do not arrest degradation or protect natural resources. Due to political interference the laws are not adequately enforced. There is lack of incentives, lack of awareness in environmental conservation and gaps in the institutional framework. The farmers need education in agro-forestry and woodlot formation. Most of the respondents in the western side reported that they have been planting trees in their farms; however, there is extensive degradation in the East that has brought about soil erosion and siltation.

4.6 Uses of the Wetland for Livelihood Activities

The wetland supports the community livelihood through fishing, livestock grazing, apiary and arable farming. The water sources sustain the community through activities such as ecotourism and livestock herding. The lake supplies fresh water to Manguo residents in the North-Eastern side of the Lake. The springs that drain into the lake is significant water sources to the community.

The majority (74.3%) of respondents are farmers while the rest are Government employees, jua kali artisans and traders. Agriculture is the mainstay of Kenya’s economy. It is estimated that 75% of Kenya’s population earns its livelihood from agriculture and agro-based industries. Freshwater is an important resource central to sustainable development and poverty alleviation. Access to save drinking water is a human right that was underscored by the world summit (UNDP, 2006). Lake Ol’Bolossat is an important water source for domestic purposes, rain-fed and
irrigation agriculture. The farmers in the study area mostly depend on rain fed agriculture but in horticulture farms they practice irrigated agriculture.

4.6.1 Uses of the lake for water supply

There is a significant relationship between the number of people who depend on the lake for water supply especially during the dry season and the distance that the people live away from the lake (Table 4.18) as indicated by Chi square (6.619), df (2), p (0.037) at 95%.

Those living further away have water storage facilities such as tanks and some have dug bore-holes, so they do not depend on the lake for water supply. The nearer the people are to the wetland, the more they depend on the wetland and the more vulnerable they are to environmental conflicts in the catchment area.

Table 4.18: Respondents who obtain water from the wetland versus distance they reside away from the lake

<table>
<thead>
<tr>
<th>Distance from lake</th>
<th>Obtains water from the wetland</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>0-500m</td>
<td>61</td>
<td>127</td>
</tr>
<tr>
<td>501-1000m</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>1001-6000m</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>0-500m</td>
<td>51</td>
<td>112</td>
</tr>
<tr>
<td>501-1000m</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>1001-6000m</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>239</td>
</tr>
<tr>
<td></td>
<td>112</td>
<td></td>
</tr>
<tr>
<td></td>
<td>71</td>
<td></td>
</tr>
<tr>
<td></td>
<td>56</td>
<td></td>
</tr>
</tbody>
</table>

4.6.2 Uses of wetland for grazing livestock

The economic uses of the wetland encompass livestock grazing and cultivation. There was a significant relationship between dependence on the wetland for livestock feeding and the distance from the wetland. The residents feed their livestock on who depend on the wetland for feeding livestock decreases with distance where they live away from the lake. Uncontrolled grazing suppresses
weeds in the wetland leading to biodiversity loss and competition for foliage between livestock and hippopotamuses. The wetland is unprotected and all the community members have free access to the resource to graze their cattle on aquatic vegetation (Table 4.19). This has led to loss of vegetation and degradation of wetland resources, leading to conflicts between livestock and wildlife.

**Table 4.19: Plants used as fodder for feeding livestock**

<table>
<thead>
<tr>
<th>Botanical name</th>
<th>Local name</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Commelina latifolia</em></td>
<td>Mukengeria</td>
</tr>
<tr>
<td><em>Launaea cornuta</em></td>
<td>Muthunga</td>
</tr>
<tr>
<td><em>Bidens pilosa</em></td>
<td>Munyugunyugu</td>
</tr>
<tr>
<td><em>Cyperus papyrus</em></td>
<td>Mirura</td>
</tr>
<tr>
<td><em>Cynodon dactylon</em></td>
<td>Igoka</td>
</tr>
<tr>
<td><em>Solanum incanum</em></td>
<td>Mutongu</td>
</tr>
<tr>
<td><em>Justicia unyorensis</em></td>
<td>Muchege</td>
</tr>
<tr>
<td><em>Pennisetum trachyphyllum</em></td>
<td>Githaara</td>
</tr>
<tr>
<td><em>Heteromorpha trifoliata</em></td>
<td>Munoria thenge</td>
</tr>
<tr>
<td><em>Lantana camara</em></td>
<td>Mucumoro</td>
</tr>
<tr>
<td><em>Indigofera atricepo</em></td>
<td>Karundu ka mburi</td>
</tr>
</tbody>
</table>

The animals grazed in the wetland include cows, goats, sheep and donkeys (Plate
Plate 4.7: Animals grazing in Ol’Bolossat Basin. Photograph taken on 10th April, 2012
4.6.3 *Uses of wetland for farming*

Subsistence and cash crop farming support livelihood but they are affected by poor water-logged soil, low market prices of farm products, small uneconomical land units and human-wildlife conflicts between humans and birds. Most of the farmers (71.3%) practice mixed farming, 26.7% grow crops while 2.0% keep livestock alone (Fig.4.6).

![Farming practices](image)

**Figure 4.6: Farming Practices in Ol’bolossat Basin**

4.6.4 *Uses of wetland for tourism*

The tourism potential of the area is not fully exploited since local tourism is almost non-existent. Foreign tourists visit the wetland to watch a variety of birds, hippopotamuses and a beautiful landscape as the main attractions. Tourism in the area promotes the economy, education and conservation. The community appreciates the importance of the wetland for tourism attraction but only a few residents visit the wetland for recreation such as swimming, fishing and sightseeing. The residents do not get direct benefits derived from ecotourism activities such as bird-watching. They therefore detest it when water birds raid their farms and destroy crops, yet the Government does not compensate for loss of property.
4.6.5 Wetland vegetation as a source of timber and other plant products

In Lake Ol’Bolossat wetland, a lot of vegetation has been cleared for fuel and energy sources. The vegetation clearing has been aggravated by households seeking wood fuel because they cannot afford electricity. The main sources of fuel in the catchment area were and have remained as wood, charcoal and paraffin for cooking and lighting houses. According to households interviewed, there was limited accessibility to wood sources due to the Government Policy to protect forests from destruction by people using firewood. The firewood and timber had become expensive due to the policy. The alternatives that the community had were clearing vegetation in the wetland, intercropping trees with crops and starting woodlots.

The plant products provide the community with fuel wood, charcoal and timber for building. The wetland vegetation also provides roofing materials (Table 4.20).

Table 4.20: Plants used for thatching

<table>
<thead>
<tr>
<th>Botanical name</th>
<th>Local name</th>
<th>Frequency</th>
<th>Percent(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Cyprus papyrus</em></td>
<td>Marura</td>
<td>20</td>
<td>15.4</td>
</tr>
<tr>
<td><em>Cynodon dactylon</em></td>
<td>Igoka</td>
<td>38</td>
<td>55.9</td>
</tr>
<tr>
<td><em>Pteridium aquilinum</em></td>
<td>Ruthiru</td>
<td>5</td>
<td>7.4</td>
</tr>
<tr>
<td><em>Cyperus latifolia</em></td>
<td>Ithanji</td>
<td>50</td>
<td>73.5</td>
</tr>
</tbody>
</table>

The local community gets timber from eucalyptus trees grown around the wetland. There has been illegal logging for charcoal burning especially in the Eastern side of the lake. There are uncontrolled human activities in the buffer zone that are incompatible with conservation such as collection of medicinal plants, cutting trees for firewood and grass for thatching houses. The community has a habit of starting fires during the dry period. The fire is started by charcoal burners, cigarette smokers, honey-harvesters and farmers who clear their land by burning vegetation.
4.6.6 Importance of wetland for apiary

There are community-based organizations that engage in eco-friendly activities such as bee-keeping. Apiary is a traditional occupation which should be encouraged for environmental sustainability. The leaves of *Ocimum gratissimum* are used to fumigate the hives. *Cordia africana* plant was used to construct the hives. *Acacia polyacantha* was used for hanging the hives while *Vernonia lasiopus* was used for smoking bees. The bees are kept in orchards near the lake where they pollinate the fruit trees and drink water from the lake. The honey produced is used as food and medicine for subsistence and commercial purpose.

4.6.7 Uses of wetland for recreation

The community rarely uses the wetland for recreation. School going children, however, were reported to visit the lake occasionally for education purpose. Neither the young nor the old were said to predominantly use the lake for recreation (Table 4.21). The community, however, utilizes the wetland for grazing and fishing, activities which are not purely recreational. In the course of engaging in economic activities as their major priorities, the residents hunt wildlife, watch birds and other aquatic wildlife in the wetland.
Table 4.21 Age of respondent versus wetland use for recreation

<table>
<thead>
<tr>
<th>Age of respondent</th>
<th>Wetland use for recreation</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>Yes</td>
<td>Total</td>
</tr>
<tr>
<td>Up to 30 years</td>
<td>16</td>
<td>3</td>
<td>19</td>
</tr>
<tr>
<td>31-40 years</td>
<td>66</td>
<td>16</td>
<td>82</td>
</tr>
<tr>
<td>41-50 years</td>
<td>82</td>
<td>21</td>
<td>103</td>
</tr>
<tr>
<td>51-60 years</td>
<td>32</td>
<td>6</td>
<td>38</td>
</tr>
<tr>
<td>Above 60 years</td>
<td>8</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>204</td>
<td>46</td>
<td>250</td>
</tr>
</tbody>
</table>

There was no significant difference between the respondents’ age and their use of the wetland for recreation. The local community does not appreciate the social value of the lake since only 46 respondents indicated to have visited the wetland for swimming, fishing or bird-watching. However, foreign tourists were reported to visit the lake occasionally for bird-watching.

4.7 Effects of Conflicts on Community Livelihoods

The effects of conflicts range from physical harm to humans and the natural resource base to productivity and economic development. There is a direct relationship between livelihoods and Natural Resource-Based Conflicts. The environmental conflicts affect livelihoods and health, exacerbate poverty and inequality. People exert control over the natural environment with negative consequences on themselves and on the bio-physical environment. The community members in Ol’Bolossat Catchment area depend on the wetland for pasture, water supply and farming. They own more livestock than their small pieces of land can support (average of 2.5 acres). They graze their livestock in the wetland and aquatic animals are deprived of their pasture by livestock. The water animals leave the wetland and look for pasture in the neighbouring farms (Fig.4.7). Human security is
not guaranteed since people are injured or killed by stray hippopotamuses. There is
limited movement of human beings and psychological effect of people knowing that
they are not safe to move about in the evenings. At night they hire motor bicycles to
take them home. School going children are delayed and frustrated early in the
morning as they sometimes encounter the beasts going back to the watershed after
night raids. There is a poor relationship between the local community and KWS as
the people feel they are not protected. When wild animals are cited, they are
frightened away by shouting and drumming. This produces noise pollution and poor
relationship with KWS which protects the animals.

Water birds invade farms, destroy crops and bring about food insecurity to the local
community. Other aquatic animals such as hippopotamuses attack, injure and kill
livestock and humans. The injured are incapacitated or maimed thereby affecting
their livelihood negatively.

The crop production for 79.8 % of respondents is insufficient due to destruction of
the crops by wild animals and birds (Table 4.22). The residents had to seek
supplementary sources of food and income. The rest, 20.2 per cent had sufficient
crop production from their farms.

**Table 4.22: Responses that Crop production is sufficient**

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>194</td>
<td>79.8</td>
</tr>
<tr>
<td>Yes</td>
<td>58</td>
<td>20.2</td>
</tr>
<tr>
<td>Total</td>
<td>252</td>
<td>100</td>
</tr>
</tbody>
</table>
4.7.1 Factors contributing to crop losses

Unsuitable farming practices and waterlogged soils may have contributed to low crop production. Due to waterlogging, the soil loses nutrients through leaching. Poor state of roads hampers access and exploitation of the wetland resources. Marketing of farm products is made difficult by poor infrastructure and the agricultural potential of the study area is not fully exploited.

Most respondents (88.0 per cent) have encountered losses as crops got destroyed by wild animals in the catchment area. Only 11.2 per cent claimed they lack knowledge in solving conflicts between humans and wildlife. The other factors that contribute to crop destruction include flooding affecting (55.0%) of the respondents, poor water-logged soils (52.2%), farming practices and drought (11.2%). According to the respondents, crop destruction by wild animals is the biggest drawback to farming as it accounts for (88.0 %) of the respondents being affected (Fig. 4.7).

![Figure 4.7: Factors contributing to crop losses in Ol'Bolossat Basin and watershed]

The community is affected by conflicts through livestock and animal health. The livestock which graze in the wetland are infested by pests and diseases that were transferred from wild animals to livestock. The wetland is associated with livestock
diseases such as East Coast Fever (ECF), Foot and Mouth disease and liver fluke infestation on livestock. A lot of capital is used for veterinary and clinical services. The area is characterized by waterborne diseases such as bilharzia and malaria, which cost the community a lot of money on seeking medical attention. The responses indicated that malaria had become evident in Ol’Bolossat Catchment area whereas previously it was rare. The current prevalence of the disease could be attributed to human changes in disease resistance, overcrowding, population movements, poverty and increased breeding sites for the mosquitoes.

Water-logging and poor drainage has brought about waterborne diseases which affect livestock and human health. The diseases cost farmers a lot of money for veterinary and medical attention. The diseases also affect livestock production, thereby impoverishing the community. Traditionally, livestock used to co-exist with wildlife. The indigenous methods of pests and disease control were not harmful to wildlife and the animal habitats. It involved smearing tobacco on cattle and the wetlands were conserved and treated as sacred. Nowadays, are drained to clear land for agriculture and to destroy breeding sites for mosquitoes and other disease vectors. Domestic and agricultural pollution due to poor sanitation and unsuitable farming practices have led to occurrence of waterborne diseases such as cholera and typhoid. The community members claim to be affected by waterborne diseases from time to time. A lot of capital is spent on seeking medical and veterinary attention for both humans and livestock respectively.

Most of the respondents (85.5 %) reported that cholera disease is common in the area, 10.4 % said that typhoid is common and only 4.1 % who said that bilharzia is common (Table 4.23).
Table 4.23: Occurrence of water-borne diseases

<table>
<thead>
<tr>
<th>Disease</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilharzia</td>
<td>8</td>
<td>4.1</td>
</tr>
<tr>
<td>Cholera</td>
<td>165</td>
<td>85.5</td>
</tr>
<tr>
<td>Typhoid</td>
<td>20</td>
<td>10.4</td>
</tr>
<tr>
<td>Total</td>
<td>193</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Wild animals have the capacity to live with many diseases without serious consequences but the disease vectors frustrate and kill the livestock that share pasture with wildlife. Apparently, livestock have less resistance to diseases than wild animals.

4.8 Mitigation and Resolution Options

Proper management of the wetland is crucial for survival and wellbeing of the people who depend on its waters. The Ol’Bolossat community has undertaken short-term measures to address human-wildlife conflicts (Table 4.24). Hippopotamuses raid human settlement areas at night and they pose a threat to residents who attempt to go home late in the evenings or to school going children who leave home at dawn. The residents scare the wild animals away but they (animals) later come back to look for pasture.
## Table 4.24: The current conflict mitigation measures

<table>
<thead>
<tr>
<th>Method</th>
<th>Respondents %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Report to the rangers</td>
<td>1.4</td>
</tr>
<tr>
<td>Chase away</td>
<td>65.0</td>
</tr>
<tr>
<td>Chase away and report</td>
<td>32.1</td>
</tr>
<tr>
<td>Kill the animal for meat</td>
<td>1.5</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>

Human activities have led to environmental degradation and natural resource based conflicts (NRBC). The community members themselves are the solutions to the problems they have created. Reinforcing community participation in conservation would solve environmental problems. The farmers suggested that community participation should be enhanced through financing of conservation groups. Some respondents (11.2 %) reported that they have inadequate knowledge in solving the Natural Resource-Based Conflicts (Fig. 4.7). They suggested that there was need to educate the community on mitigation measures to control the conflicts. Environmental Education is a tool that would sensitize the community on the values of the wetland and the coping strategies that could be used to deal with environmental conflicts. Environmental laws should be reviewed to protect wetland vegetation from destruction by human beings for agriculture and settlement. Responses in the questionnaires indicated that community members would like the wetland fenced off and gates or barriers put at strategic points so that the community members can gain access into the wetland but the animals are barred from entering the neighboring farms.

The drainage of the catchment area should be improved by digging trenches. The farmers should be sensitized to re-organize their land uses and application of manure instead of chemical fertilizers. Manure is not easily carried away by rain water. It persists in the soil for a long time for crops to retrieve nutrients, so it is unlikely to pollute water. Sustainable land uses should prevent soil erosion, reduce water
pollution and thereby conserve biodiversity. Water harvesting and storage methods should be improved in the catchment area to reduce over-reliance on the lake and prevent conflict between livestock and aquatic animals. Agro-forestry should be practised to give alternative sources of fuel wood and timber for building. Edible plants such as Ssesebania and Grevilea should be inter-cropped to provide pasture. The farmers should be educated to grow crop varieties that are resistant to frost.

The policy makers should implement a functioning land registration and resolve conflicts by moderation, mediation and arbitration. The land management ought to clarify land rights and security of tenure. Counseling programs should be set up to help people who get afflicted by human-wildlife conflicts. Psychotherapeutic approaches could help the victims to develop coping mechanisms to deal with the insecurity caused by stray animals. The KWS, however, should restrain the animals so that they do not venture into the human settlement areas. The problem animals that threaten the lives of human beings should be translocated to places far away from human settlement. The counseling would help people to absorb shock and retain their capabilities despite the interference caused by animals. It would help them to learn self-organization and adaptation. Respondents suggested that ranger out-posts should be increased so that KWS can manage the menace of problem animals promptly other than take too long to respond. Nyahururu KWS officers recommended that the area should be designated as a protected Natural Environment in order for KWS to manage the core areas as mandated by wildlife conservation and management act cap 395.

Respondents emphasized the need to build the capacity of conservation groups to enhance self-reliance and reduce over-dependence on the wetland. There are conservation groups (Table 4.25) engaged in water storage, bee keeping, tree planting and fish farming activities. The group activities have contributed to improving the community’s livelihoods and standard of living. Nevertheless, there are constraints that hinder members from participating fully in the group activities. Due to insecurity, proceeds from conservation activities are sometimes stolen and the members get low returns from their work. The groups whose leaders were interviewed are shown below.
Table 4.25: Conservation Groups

<table>
<thead>
<tr>
<th>Group Name</th>
<th>Year Started</th>
<th>When Started</th>
<th>No. of Members</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Maji Mazuri</td>
<td>2000</td>
<td>20</td>
<td>Water Harvesting</td>
<td></td>
</tr>
<tr>
<td>2. Iriaíni Single mothers</td>
<td>2003</td>
<td>50</td>
<td>Tree planting</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bee-keeping</td>
<td></td>
</tr>
<tr>
<td>3. Mama Samaki</td>
<td>2007</td>
<td>40</td>
<td>Commercial fish farming</td>
<td></td>
</tr>
<tr>
<td>4. Oraimutiarua</td>
<td>2008</td>
<td>100</td>
<td>Rehabilitate water sources</td>
<td></td>
</tr>
<tr>
<td>5. Fenhed</td>
<td>2007</td>
<td>30</td>
<td>Sensitize community about HIV</td>
<td></td>
</tr>
</tbody>
</table>

1. **Maji Mazuri Group** was started in year 2000 and it has registered 20 members. They harvest water and grow fruit trees. They draw members from the middle economic level. They have managed to filter water using a gabion (Porous Dam). Road water is diverted and passed through gravel, charcoal and sand. The water is stored in an underground tank of 100000 litres. The water is pumped to irrigate orange fruits in a 2 acre-farm. Some of the water is diverted to greenhouses, where tomatoes are grown. The proceeds from the farm are used to buy seeds and fertilizers. The remaining water is chlorinated and used for domestic purpose. There are challenges experienced during the rainy season when it becomes impossible to capture all the water. When pests such as aphids attack crops it becomes difficult to control them biologically but they spray them with ashes since they practice organic farming. The group has to consult a nearby research institute (KARI) for expert advice. The members receive no external aid as it is a self-help group. The group experiences conflict when hippopotamuses enter the farm and destroy crops. The members react by scaring the animals away or calling KWS for help.
2. **Iria-ini Single mothers Group** is found in Kiharo village and it has a membership of 50 women. It was started in 2003 and the activities in the group include tree planting and bee-keeping. The members were recruited on gender and marital status. They are all unmarried women. The group has succeeded in starting tree nurseries and selling seedlings to the local community. The challenges encountered include lack of funds and insecurity when their seedlings and honey are stolen. There is lack of co-operation among members when sharing duties. The members get advice from social workers. The group does not experience conflicts so the women do not have to deal with conflicts.

3. **Mama Samaki Group** rears fish in ponds. The group was started in 2007. It has a membership of 40 women who own small plots of land where ponds have been constructed. They breed fish for domestic consumption and selling in the local market. They get challenges of theft and predators eating their fish. There is siltation during the rainy season and drying of ponds during drought. They get advice from the fisheries department and from individuals who know about fish farming. They experience conflict with predators such as eagles. They construct scarecrows to frighten the eagles.

4. **Oraimutiarua Group** has 100 members, both men and women. It was registered in 2008. It is involved in rehabilitation of water sources such as springs and dams. They have volunteered to sensitize the community on the importance of water sources. They face resistance when they request private farm owners to allow them construct dams. Once the dams are constructed individuals assume absolute right of ownership. The group seeks advice from Agricultural extension Officers, the local administration and the water board. Sometimes they get assistance from the Water Trust Board for capacity building. The conflicts involve the members and the private land owners. The disputes are settled by the local authorities.

The group leaders who were interviewed have lived in the study area for varied period of time ranging between 10-20 years. They reported that the groups face many challenges such as lack of funds, lack of technical advice, lack of co-operation among members and lack of motivation when animals destroy their fences. Despite the many challenges, the members have shown their commitment through
participation. They advocate for Integrated Resource Management with community participation as a priority in conservation strategies. This is in line with Millennium Development Goal 7 on environmental sustainability.

5. **Fenhed Group** was started in 2009 with a recruitment of 30 members, 19 being women and 11 are men. They sensitize the community on HIV/AIDS and about caring for the environment. The members are above 18 years and the registration fee is Ksh.2000. They all reside within the local area. They are aided by NGOs and they share the benefits equally. They educate the community on proper disposal of polythene paper. There is a Community Forest Association with a Memorandum of Understanding with the forest Department to carry out afforestation. They are aided by the Forest Department with seedlings and tools.

Wetland resources require a large group of stakeholders to participate in their conservation. The key stakeholders such as the local community should participate in project identification, implementation and benefit sharing. There is an urgent need to define wetland systems and identify management strategies. All the stakeholders such as Government departments, research institutions, NGOs, Community Based Organizations (CBOs) and village committees should be identified and their roles defined.

People can play both constructive and destructive roles in environmental issues. As the human population has continued to increase in the catchment area, land subdivision has set in, thereby leading to small land holdings (Table 4.13). To meet the growing need for food production, the local farmers practise intensive cultivation with extensive use of pesticides, herbicides and fertilizers. The agro-chemicals pollute the soil and consequently the ground water which found its way into Lake Ol’Bolossat (Table 4.11). Fertilizers are beneficial in the farms but not in the wetland since they promote excessive growth of weeds and algae which reduce the ecological value of the lake (Chris, 2010). Water is the key resource that supports livelihood in the catchment area but pollution has led to loss of biodiversity arising from migration of some animals and death of others, with negative consequences on the local community which depends on the wetland for supporting livelihoods. The lake is uninhabitable for fresh water fish but it is a habitat for the mudfish. Local
fishermen catch the fish for subsistence and to complement the protein needs of the community. Owing to low economic status of the residents, some people have taken to stone excavation on the western side of the lake. The lake water is polluted by stone debris and some water animals have migrated due to habitat destruction (Table 4.18). Water birds leave the lake and feed on crops in the neighbouring farms. The local people install scarecrows to frighten the birds away but they lack long term solutions to environmental problems (Fig.4.7).

A lot of vegetation has been cleared for arable farming thereby leaving the land bare and prone to soil erosion especially in the eastern side of the lake where there are steep slopes. The animal habitats have been ruined through conversion into farm land, sub-division, encroachment on foraging areas and competition with livestock. The above factors can be attributed to the ever increasing number of natural resource based conflicts (Ruhiu, 2000). There are incidences of environmental conflicts and they affect the well-fare of the local community through crop damage by wild animals, human injury and deaths, waterborne diseases, water-logging and poor infrastructure with impassable roads.

At times hippopotamus develop aggressive tendency and attack humans in response to human hostility and reduced forage. The victims pay the price by suffering injuries, deaths, and crop destruction, destruction of cattle sheds and fences as well as interruption of socio-economic activities.

Due to relatively low socio-economic status and unemployment, the farmers adjacent the wetland rely heavily on the wetland resources for livelihoods. The unemployed youths engage themselves with fishing but there are no regulatory measures to control fishing. According to some youths who were interviewed, it is extremely hard to catch a grown fish since the fish count has gone down.

The study can provide information that is useful for enhancing co-existence between wildlife and the local community in the basin. Interviews with local leaders and focused group discussions revealed that the community has a poor attitude towards conservation of the wetland since they do not get immediate benefits from conservation efforts. The community relies heavily on the wetland resources which include water, land, wild animals and vegetation. Over-exploitation of the natural
resources has resulted to land-use, water-use, biodiversity and human-wildlife conflicts. Wetlands have socio-economic and ecological benefits, owing to their high primary productivity and they purify the air by acting as carbon sinks (Creel, 2003). The variety of plants in the wetland use carbon dioxide from the air during photosynthesis. They trap silt and control floods thereby acting as temporary water storage systems and a carbon sink. Ol’Bolossat wetland comprises of open water, marshes and swamp. It offers a good recreation site for bird-watching, bird-shooting, fishing and site-seeing. Reeds in the marshes are cut for weaving and basketry. A lot of vegetation has been cleared on the Eastern side of the lake for charcoal burning, settlement and agriculture.

The economic activities in the wetland include fishing, ecotourism and livestock grazing. It is expected that the local community benefits a lot from the wetland. However, this is not the case since the community experiences crop damages from the same wildlife which attracts tourists. The humans disturb the ecological balance of the wetland by over-exploiting the wetland resources. Resources scarcity drives the animals out of the wetland into the neighboring farms in search of foliage. The community members have created their own problems by intruding into the animal habitats and they have solutions to these problems through engaging in stakeholder participation in conservation strategies. Currently there are no clear policies for balancing wetland use and conservation and the number of livestock grazing in the wetland is more than the wetland can support and no regulatory measures have been put in place (Benum and Njoroge, 2001).

KWS is mandated with the responsibility of safeguarding wildlife. Nevertheless, they pay little attention to the needs of the people. When interviewed, KWS warden at Nyahururu, Forester at Ol’kalou and an environmental officer working with NEMA indicated that the community is not committed to conserving the environment. They view the lake as a public good rather than an economic good. Ol’Bolossat suffers ‘the tragedy of the’ commons’, in which case everybody uses the resource but nobody takes accountability.

The wetland is under pressure from human activities such as cultivation, charcoal burning, overgrazing, encroachment, poaching, siltation and burning vegetation to
clear land for cultivation. Agriculture is the main economic activity in the area. The cash crops grown include wheat and pyrethrum while the food crops include maize, potatoes, beans, peas and vegetables. There are horticultural crops such as fruits and carnation flowers that are exported out of the country. Other livelihood activities include fish-farming in ponds, agroforestry and bee-keeping. Based on the study findings, 75 per cent of the residents earn their living from agricultural-based economic activities. The land sizes have been decreasing while the human population has continued to increase (G.O.K. 1999, 2009). It was found out that 70 per cent of the households in the study area have less than 3 acres of land (Table 4.3). Most of the community members are small scale subsistence farmers with an average income of Kshs 3000. Based on the findings, it was found out that unsustainable land-use practices such as intensive cultivation and excessive application of chemical fertilizers, pesticides and herbicides have degraded the wetland (Table 4.17). Degradation has compromised the ecological integrity of the wetland and its significance as a tourist attraction.

Overgrazing has reduced vegetation cover and led to siltation and reduced water storage capacity of the lake. It has also reduced the number and vitality of the plant species (Luz, 2000). The sharing of pasture between hippos, livestock and birds has reduced the quality and quantity of the animal feeds. Several animals such as the waterbucks, gazelles, foxes and leopards have migrated from the wetland.

Sustainable development and management of water resources requires that development is controlled. Usually there are conflicts in management strategies which have to do with balancing priorities to ensure that the resource is enhanced, adverse effects on other resources are considered, future development is not forestalled and efficiency in water and capital use are considered in strategy selection. The water related conflicts have various effects on the community livelihoods which include disruption of settlements by inhabiting parasites and waterborne disease vectors such as schistosomiasis, plasmodium, filariasis and liver flukes (Table 4.22). There is an ecological impact on flora and fauna through the spread of aquatic weeds such as water hyacinth which spreads quickly and causes water loss through evapotranspiration (Chris, 2010). The livelihoods have been
affected by prevalence of diseases such as malaria, pneumonia, typhoid, cholera and bilharzia, yet there are no hospitals in the catchment area. The liver flukes attack and kill livestock especially during the dry period when scarcity of vegetation elsewhere makes people graze cattle in the basin. The medical and veterinary care needed cost the farmers a lot of capital that could otherwise be used to improve their standard of living. Responses indicated that 89.5 per cent of the respondents claimed that they have encountered crop losses from animal destruction while 70.2 per cent have witnessed cases of people and livestock injured by water animals that stray into human settlement areas (Fig.4.7). Free movement of Ol’Bolessat residents in the evenings is curtailed by fear of being attacked by hippopotamuses. The people suffer psychological torture of knowing that they are not safe at night since the hippopotamuses strike unexpectedly. The people who happen to go home late in the evenings are bound to hire motor cycles (Boda Boda) to take them home safely. When hippopotamuses stray in the neighborhood at night, people have to beat drums and shout to scare them away (Table 4.18). This causes noise pollution and negatively affects the community livelihood. The people do not trust KWS to intervene and contain the animals. There is a poor relationship between KWS and the community since the community feels that wildlife is more valued than people. There is a poor transport and communication network due to waterlogging and the roads are impassible. This has retarded development in the area to some extent. Farmland has extended into the riparian reserve and this has led to human-wildlife conflicts due to competition for pasture. According to Ruhiu (2000), 80 hippopotamuses died between 1984 and 2000 and 31 per cent were killed in year 2000 alone. About 58 per cent hippopotamuses were killed by KWS as problem animals posing threat to human life. Hippopotamuses become aggressive due to human interference with animal habitat and invade the human settlement areas. The community livelihood is affected through human and livestock deaths and there is no compensation for injury, crop losses, destruction of cattle byres, fences, trees and interruption of their socio-economic activities (KWS, 2002).

Availability of fresh water for households, farming and small scale industrial activities improves community living standard and can increase opportunities for productive employment through constructing, operating and maintaining water
distribution infrastructure. This is particularly so because women and children in the rural areas spend a lot of time daily to fetch water from distant sources. Bringing water closer to the people can afford them time to generate income through productive activities such as farming and commerce. It would also improve their health greatly by improving sanitation. Ground water use is faced with challenges such as run-down of existing boreholes and poor quality water from boreholes, infiltration of agro-chemicals from agricultural farms, increasing demand and encroachment of recharge areas. Some bore-holes require rehabilitation or total replacement. In most boreholes, the water is hard and it contains varying degrees of salinity.
CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

The research findings established that Natural Resource Based Conflicts affect the community livelihood activities in Ol’Bolossat Catchment area in Nyandarua County. There are both benefits and losses in using the wetland resources. The local community is affected through food insecurity as their crops get damaged by wild animals. The study revealed that human population growth, agricultural intensification and unsustainable land use practices have resulted in habitat loss, water pollution, natural resources scarcity and consequent straying of animals into people’s farms. The victims of crop losses (farmers) have reiterated by killing wildlife for meat as an alternative source of food. The whole scenario has led to human induced conflicts. The outcome of the study can be used in formulating suitable resource utilization policies with intensive community involvement. The first research question sought to determine the natural resources that support livelihood activities and they were found to be water, land, vegetation and wildlife. The other questions deal with types and causes of conflicts and resolution options that can be employed to mitigate the environmental conflicts. The conflicts were found to be related to the types of resources available in the basin and competition leads to scarcity and conflicts between resource users. The study can enable policy makers to draw soil, water, vegetation and animal conservation programs more accurately. The results could be used to estimate the damages caused by human interference in the catchment area and the repercussions encountered there-of.

From the foregoing discussion, the importance of Lake Ol’Bolossat to the local community cannot be over-emphasized. There is a relationship between natural resource-based conflicts (NRBC) and livelihoods. The lake supports humans, livestock and wildlife communities which live adjacent or within the wetland. The community has free access to the communally-owned wetland resources but there is over-use of the same by livestock grazers and wildlife.
5.2 Conclusions

The key resources which support community livelihoods include water, land, aquatic vegetation and wildlife; in order of their importance. The sharing and competition for the same resources leads to land, water and biodiversity related conflicts. From the data collected, it is evident that there are natural resource based conflicts which affect the local community livelihoods. The conflicts are human induced through environmental degradation and competition for scarce natural resources between humans and animals. The main causes of environmental conflicts are increasing human population pressure, land fragmentation, intensive agriculture, poor agricultural practices, clearing vegetation, overgrazing, steep slopes, quarrying, and ignorance in environmental issues, poverty and unemployment. Herbivores and birds were reported to be the most problematic animals in the basin. Protection of the wetland should involve all the stakeholders especially the local community which has either benefited or suffered from the existence of the wetland. Community participation should be enhanced since the Natural Resource-Based Conflicts have affected the Ol’Bolossat community livelihoods negatively. Urgent and stringent measures ought to be taken by the Government in order to save the lake and prevent violent conflicts.

5.3 Recommendations

The aim of this study was to determine the effects of environmental conflicts in order to come up with productive measures for the benefit of the local people. The community ought to emphasize on conservation action, pollution control and rehabilitation of a degraded ecosystem.

a. Sustainable land use practices such as organic farming, cross-breeding exotic and indigenous cattle, controlled forest resource uses and infrastructure development should be carried out so as to maintain the usefulness of natural resources.

b. Riparian reserves and buffer zones need to be provided and rules regarding settlement near river banks could be enforced to minimize changes in river channels.

c. The water resources management needs to protect Lake Ol’Bolossat from degradation by locating the industries and cattle dips far away from water sources in
order to reduce pollution. Statutory powers ought to be given to the water management authority in charge of the basin. The management needs to control pollution through river monitoring, laboratory analysis, surveillance and prosecution. Polluters should be charged on the polluters pay principle. There is need to undertake water quality assessment based on the requirements for domestic, commercial, agriculture and ecological sustenance.

d. Sewerage and sanitation facilities should be properly planned and regulated for sustainable water resource management in the basin. Water resources availability sustains life and it is an economic good since it facilitates the production and processing of economic goods and products. It is therefore necessary to pay for it as a commodity and to develop infrastructure for its delivery to the users. The payment would meet the cost of conservation, river regulation, infrastructure maintenance and development, pollution control and acquisition of necessary data.

e. If Lake Ol’Bolossat is to survive, indigenous knowledge and traditional norms of co-existence between humans and wildlife should be adopted.

f. The carrying capacity of the wetland should be determined and the number of animals controlled in order to reduce over-stocking.

g. Rain water harvesting should be improved in order to provide alternative sources of water for irrigation instead of abstracting from streams and springs that feed the lake. The community should focus on water storage structures to capture rain water and run-off to ensure availability of water during the dry periods and minimize conflicts related to water demand and use. Water abstraction forces wildlife dependent on the lake to move upstream in search of water. The movement leads to conflict between farmers and pastoral communities and between farmers and wildlife. The water of the basin needs to be managed through appropriate and innovative water conservation methods and by protection of the water catchment. g. The community members should be educated to know the negative effects of their activities which degrade the wetland such as excessive use of agro-chemicals and planting eucalyptus trees (water-demanding species). They ought to own the wetland and know that the Government’s responsibility is to oversee the management of the resource. The Government should manage the water-shed by
financing the conservation groups. The natural resource use should be reconciled with conservation strategies by designating the area a protected Natural Environment.

h. Wetlands should be rehabilitated through capacity building by training conservation groups. Encroachment should be prohibited and suitable trees planted in the catchment area.

i. No-go zones should be created to prohibit further subdivision of the wetland and ensure it remains viable for livelihood improvement through revenue collection. Conserving the wetland would protect human lives and ensure that crops are not devastated by water animals. The Government should reduce vulnerability of the community to animal raids by building capacity to withstand conflicts.

j. The community should pro-actively guard against deforestation, charcoal burning and other activities that endanger water resources. Community self-reliance should be promoted through the use of appropriate agricultural technology and frost-resistant crop varieties to promote food security and reduce overdependence on the wetland resource. Since over-use of wetland resources leads to degradation and movement of animals from the wetland into people’s farms, the wetland should be designated as a Protected Natural Environment with intensive community participation and stakeholder involvement since other conservation regimes such as National Park and National Reserve would exclude the human settlement. Specifically, the Government should reclaim the most critical areas such as the marshland. The affected (displaced) persons should be compensated according to the Land Acquisition Act (G.O.K. 2009).

k. The respondents suggested that an electric fence should be installed around the lake and have gates to allow people access to the watershed. Fencing would restrict movement of aquatic animals out of the wetland. A balance should be struck between wetland use and conservation in order to improve livelihoods and utilize maximum potential of the wetland as a community resource.

l. KWS should solve issues amicably, promote and establish viable wildlife user rights. These should include community trusts, sanctuaries and conservancies. This would ensure sustainable wetland management and promote sustainable
Ol’Bolossat community livelihoods. The respondents suggested that the compensation bill should be reviewed in order to cater for damaged crops and property. However, they pointed out that stringent measures should be put in place to contain the animals in their natural habitat other than stray in settlement areas. Prevention is better than cure.

m. A bottom-up approach of natural resource management strategy should be applied in decision-making by allowing the community to decide what actions to take in managing resources. Environmentally friendly technologies should be developed through participatory research so that they meet the local needs of the community, suit the local conditions and take into consideration the roles of men and women. The technology should be efficient, affordable, usable and repairable by the local people.

n. Oxidation ponds could be constructed to purify water run-off from farms before it enters the lake. Oxidation ponds deal with nutrient enrichment in water bodies by having micro-organisms decompose organic matter which is consequently absorbed by green vegetation. The under and unemployed community members in the catchment area could be paid to construct ponds, terraces and carry out re-afforestation programs. The community participation in conservation should be appreciated and supported financially in order to produce long-term benefits of the wetland to the community. The local Government, community, and other interest groups should partner with central Government to ensure that all groups express and defend their interests. All the community members need to play a role in decisions that affect their livelihoods.

The community and individuals need a secure access to natural resources and equitable share in managing them so that they are motivated to manage the resources sustainably. They also require information in their own language and involvement in analysis and assembly of environmental data. Provided the community sees the research as useful, they are sure to own it if they are involved in setting priorities.
The following recommendations are made for further research:

i. Further research should be carried out to investigate whether the invasive species of weeds in Lake Ol’Bolessat are poisonous and how they can benefit the human beings in the surrounding. Ethno botany will help people make the best use of wild plants (Cunningham, 2001).

ii. Similar studies should be conducted in other parts of the country to find out the extent to which environmental conflicts affect livelihoods and how they can be minimized in order to improve community standard of living.

iii. Investigations should be conducted to find out the challenges faced by KWS in the course of protecting people from wildlife.

iv. Further research should be carried out to help formulate guidelines for protection and prescribe measures for integrated natural resource management.
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APPENDICES

APPENDIX 1: Demographic Characteristics of Respondents

<table>
<thead>
<tr>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>Occupation</td>
</tr>
<tr>
<td>Education Level</td>
</tr>
</tbody>
</table>

APPENDIX 11: Observation Check List

<table>
<thead>
<tr>
<th></th>
<th>Number of farmers</th>
<th>Acreage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage for Agriculture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grazing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tree Planting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bee Keeping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Settlement</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX 111: A Self-administered Questionnaire for Residents around Lake Ol’Bolossat

This questionnaire is intended to help in evaluating the effects of Natural Resource Based Conflicts (NRBC) on community livelihoods in Lake Ol’Bolossat catchment area, Nyandarua County, Kenya. The outcome of this study will aid policy makers to improve on sustainable management of the lake. I am humbly requesting for your honest response. The information will be treated with the utmost confidentiality and will only be used for the purpose of this research. Do not write your names or any other form of identification on the questionnaires. Put a tick ( ) for the correct response or write down the answers in the space provided.

PART 1: Background information on the wetland user

1.  a) What is your gender? Male ( ) Female ( )
    b) What is your age in years?.................................................................
    c) Which village do you come from?......................................................

2. What is your occupation?........................................................................

3. What is your highest level of education?
   (i). Primary ( )
   (ii). Secondary ( )
   (iii). College ( )
   (iv). University ( )
       Others (specify)........................................................................

4. What is the size of your farm in acres?..................................................

5. What is the average family income per month?.......................................

6. What type of ownership is your land?
   (i). Rented ( )
   (ii). Freehold ( )

7. How long have you been on your farm?..................................................

8. Is crop production from your land sufficient for your household?
Yes ( )  No ( )

C ) If no, list supplementary sources of income
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

D ) Which of the following reasons contribute to insufficient income generation from your land ( you can select more than one reason)

(i). Poor soils ( )

(ii). Poor farming practices ( )

(iii). Flooding ( )

(iv). Drought ( )

(v). Destruction of crops by wild animals ( )

(vi). Lack of capital for putting up farm structures e.g. fences, hives and ponds

(vii). Lack of knowledge in solving human-animal conflicts

9) a) Which of the following farming practices are adopted on your farm?

i) Crop farming ( )

ii) Livestock production ( )

iii) Mixed farming ( )

b) Do you plant trees in your farm?

Yes ( )  No ( )

c) If yes in (b) above which tree species do you grow?
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

PART 2: Information on Wetlands

10. Approximately how many kilometers is Lake Ol’Bolossat from your land?
........................................................................................................................................

11) Wetlands have potential for different uses. In which of the following ways do you use the wetland (you can choose more than one)
(i). Growing crops ( )

(ii). Fishing ( )

(iii). Feeding livestock ( )

(iv). Source of building materials ( )

(v). Water supply ( )

(vi). Recreation ( )

(vii). Others (specify) ......................

(viii). ......................................................

12. a) To what extent do you think the following activities can alter the wetland.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. Draining</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ii. Clearing vegetation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iii. Waters abstraction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b) For what reasons were these actions taken? (you can choose more than one)

(i). Agriculture ( )

(ii). Settlement ( )

(iii). Cultural activities ( )

Others (specify) .................................................................

13. a) Which of the following undesirable effects arising from the lake have been observed in your village? Tick where appropriate.

<table>
<thead>
<tr>
<th>Effects</th>
<th>Not common</th>
<th>Common</th>
<th>Very common</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water-borne diseases</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Damage to crops by wild animals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Death of humans due to wild animal attack</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Death of livestock due to wild animal attack</td>
<td></td>
<td>( )</td>
<td></td>
</tr>
</tbody>
</table>
b) What measures does the community take to protect itself from undesirable effects stated above?

i. Kill problem animals  ( )

ii. Seek medical attention  ( )

iii. Report to KWS  ( )

iv. Scare animals away by shouting and drumming  ( )

c) State whether the following measures taken by the Government to protect the community are helpful and to what extent.

i. Translocating problem animals

................................................................................................................

ii. ............................................................................................................

iii. Giving compensation for loss of human life injury or crops damaged by animals

iv. ............................................................................................................

v. iii. Increasing the number of ranger outposts

................................................................................................................

vi. ............................................................................................................

vii. iv. Install electric fence around the lake..............................................

14 a) Do you face any problems in using the wetland?

Yes ( ) No ( )

b) If yes, which ones of the following

i. Water logging,  ( )

ii. Water animals destroying crops  ( )

iii. Domestic animals destroying crops  ( )

vi. Water animals attacking people  ( )

v. Restricted access to the watershed  ( )
Any other
(specify).................................................................................................

c) How have you tried to solve these problems?
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

15. State whether or not the Lake Ol’Bolossat size has changed over a period of ten years.
   (i). Reduced (   )
   (ii). Size not changed (   )
   (iii). Expanded (   )

16. a) Is livestock grazing in the wetland free for everyone? Yes (   ) No (   )
   
   b) If no, specify terms of access
........................................................................................................................................
........................................................................................................................................

c) During which times of the year do you use the wetland for the following reasons?

<table>
<thead>
<tr>
<th>Wet season</th>
<th>Dry Season</th>
<th>All seasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Livestock grazing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growing crops</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fishing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water supply</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source of building materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recreation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

17. Using the Likert scale provided tick the extent to which the statements best describe your opinion

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agrochemical are the key source of pollutants in the wetland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Draining the wetland for crop cultivation is the major cause of reduced wetland size.

Wetland contributes more than your other sources of income?

Access to the wetland should be regulated by the community.

Part 3: Ecological Uses

18. Tick to indicate the extent to which the following groups of animals cause problems to the community.

<table>
<thead>
<tr>
<th>Animals</th>
<th>Least problematic</th>
<th>Problematic</th>
<th>Most problematic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herbivores</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carnivores</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scavengers</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

19. a) Are there some animals which were there but are no longer found?
   Yes ( )     No ( )

b) If yes, name them

..................................................................................................................................................
..................................................................................................................................................
..................................................................................................................................................

19. c) Why do you think the animals have disappeared over the last ten years?
   i. Reduced size of watershed ( )
   ii. Destruction of their breeding sites ( )
   iii. Poaching ( )
   iv. Migration due to human wildlife conflict ( )
v. Pollution

vi. Any other (specify)

20. a) Do you obtain water from the wetland? Yes ( ) No ( )

   b) If yes, is the water from the wetland clean? Yes ( ) No ( )

   c) If no, give reasons that have contributed to water contamination

21. a) What do you think is the best use of wetlands?

   b) How best can wetlands be improved if they are getting degraded?

Thank you for your co-operation.
APPENDIX IV: Interviews with Conservation Group (Leaders)

Name of group………………………………………………………………………………… s

Village…………………………………………………………………………………………

Number of members    Males    ......................

Females.........................

1. When was the group started?

2. What are the main activities of the group?

3. What criteria were used in drawing the group members together?
   Gender ( ) Income level ( ) Age ( ) Others (specify)

4. What are the achievements of the group?

5. What challenges has the group faced?

6. Where do you get advice in case of problems arising from the group?
   Government ( ) Local leaders ( ) Others (specify)

7. Has this group received any assistance? Yes ( )
   No ( )
   If yes, from whom? Church ( ) Government ( ) NGO’S ( )
   Others (specify) ( )
   Kind of assistance: Money ( ) Materials ( )
Do the local people experience conflict with wild animals?
Yes ( ) No ( )
If yes, which animals create conflict?

List animals starting with the most problematic animal

<table>
<thead>
<tr>
<th>Problematic animal</th>
<th>Nature of conflict</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9. How do people mitigate the conflicts?
Report to KWS ( ) Kill the animals ( ) Chase the animals away ( ) Don’t know ( )
Others (specify)

10. What are the benefits that people get from wetland?
Water ( ) Food source ( ) Employment ( ) Pastures ( ) Medicinal plants ( )
Others (specify)

11. Has the local community affected the state of the wetland?
Yes ( ) No ( )
If yes how have they affected the wetland?
Clearing vegetation ( ) Grazing ( ) Poaching ( ) Encroachment ( )
Draining ( ) Others (specify)

12. What challenges does the community face as it tries to exploit the natural resource?

13. What are the attitudes of the community towards conservation of the wetland?
APPENDIX V: Focused Group Discussion with Local Leaders.

Name…………………………………………………………………………………………………………………………

Organization …………………………………………………………………………………………………………………

Position ………………………………………………………………………………………………………………………

1. How long have you worked in this area?

2. What is the relationship between the Organization and the Community?

3. What are the attitudes of the Local people towards conservation of Ol’ Bolossat wetland?

4. What role has the community played in the conservation of the same?

5. What type of community based Organization (CBO’s) do you have within your area?

6. What activities have the CBO’s played in conservation issues?

7. What are the main problems that face the CBO’s?

8. What do you think can be done to solve the problems and enhance Community Participation?

How effective are the methods of resolving human wildlife conflicts?
   Compensation ( )  Fencing ( )  Killing ( )  Translocating ( )  Ranger outposts ( )

10. What do you think can be done to resolve the conflicts in integrated natural resource management?

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APPENDIX VI: Letter of Introduction

KENYATTA UNIVERSITY,
DEPARTMENT OF ENVIRONMENTAL EDUCATION,
P.O BOX 43844-100,
NAIROBI.
29-08-2012.

The chief,
______________ Location,

Dear Sir / Madam,

I am a postgraduate student pursuing a masters’ degree in Environmental Education, Kenyatta University. I am conducting research for my final year thesis which is a requirement of the degree program. The research topic is Natural Resource Based conflicts and their impact on Livelihood in Lake Ol’Bolossat catchment area in Nyandarua County, Kenya. The findings of this study will aid policy makers to take measures that can improve on sustainable wetland utilization. I kindly request, you to allow me administer questionnaires to respondents in your location.

Yours faithfully,
Margaret Wambui Mathenge,
(M.Sc. student, Kenyatta University)