UTILIZATION AND CONSERVATION OF PAPYRUS PLANTS FOR
SUSTAINABLE LIVELIHOODS IN KUSA SWAMP, LAKE VICTORIA, KENYA

BY

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Science in Integrated Watershed Management in the School of Pure and Applied
Sciences of Kenyatta University

SEPTEMBER 2012
DECLARATION

CANDIDATE

The work reported in this thesis is my original work and has not been submitted to any other university for the award of a degree. All sources of information have been acknowledged by way of references.

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DEDICATION

To my parents, Mr. John Auma Awiti and Mrs Yunia Akongo Auma, my husband, Tom Okeyo Adwek, my children, Euphemia Adhiambo Okeyo, and Elton Brooks Okeyo, and my brothers and sisters for their inspiration, support and encouragement that always made me to keep hope alive.
ACKNOWLEDGEMENTS

This project would not have been complete without support from many people and organizations to whom the highest possible accolades will not be adequate to register the thanks that I feel.

I would like to express my deepest sense of gratitude to International Centre for Research in Agro Forestry (ICRAF) for generously supporting this study. They funded the research through World Agroforestry Memorial Fellowship. This work would not have been possible without the local community’s co-operation and all stakeholders that I interacted with on the ground. I express my deepest sense of gratitude for their views, participation and co-ordination throughout the study period.

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God bless you all!
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OPERATIONAL DEFINITION OF TERMS

Wetland: This is an area that is permanently or seasonally flooded with water and plants and animals are adapted to it for example swamps and mashes.

Papyrus

These are plants adapted to the swamp ecosystem which are used by the local community for crafts making at home.

Papyrus swamp

This is a type of wetland dominated by papyrus plants.

Papyrus utilization

It is the exploitation of papyrus resources domestically and industrially to make papyrus products for sale and use at home.

Wetland conservation

It is use of measures and strategies to promote wetlands protection to maintain its pristine state and control the wetland resources over-exploitation to ensure sustainability.

Livelihood activity

These are activities that the community members are involved in for their survival.
# Abbreviations Used in the Study

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<thead>
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<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>BMU</td>
<td>Beach Management Unit</td>
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<td>BWG</td>
<td>Bugo Women Group</td>
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<td>CBO’s</td>
<td>Community Based Organizations</td>
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<td>ECOLIVE</td>
<td>Ecology and Livelihoods</td>
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<td>EIA</td>
<td>Environmental Impact Assessment</td>
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<td>EMCA</td>
<td>Environmental Management and Coordination Act</td>
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<td>EWWRP</td>
<td>Ethiopian Wetlands Research Programme</td>
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<td>FGD</td>
<td>Focus Group Discussion</td>
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<td>GWNW</td>
<td>Global Water News Watch</td>
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<td>GoK</td>
<td>Government of Kenya</td>
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<td>GIS</td>
<td>Geographic Information Systems</td>
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<td>GLCF</td>
<td>Google Land Cover Facility</td>
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<td>IBA</td>
<td>Important Biodiversity Area</td>
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<td>ICRAF</td>
<td>International Center for Research in Agro-forestry</td>
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<tr>
<td>ILWIS</td>
<td>Integrated Land and Water Information System</td>
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<td>ITA</td>
<td>Irrigated Terrestrial Agriculture</td>
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<td>IUCEA</td>
<td>Inter-University Council for East Africa</td>
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<td>IUCN</td>
<td>International Union for Conservation of Nature</td>
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<td>KII</td>
<td>Key Informant Interviews</td>
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<td>KNBS</td>
<td>Kenya National Bureau of Statistics</td>
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<td>KPUA</td>
<td>Kusa Papyrus User Association</td>
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<tr>
<td>Acronym</td>
<td>Full Form</td>
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<td>KWMC:</td>
<td>Kusa Wetland Management Committee</td>
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<tr>
<td>LV:</td>
<td>Lake Victoria</td>
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<tr>
<td>LVB:</td>
<td>Lake Victoria Basin</td>
</tr>
<tr>
<td>LVSB:</td>
<td>Lake Victoria Sunset Birders</td>
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<td>MBG:</td>
<td>Missouri Botanical Garden</td>
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<td>MDGs:</td>
<td>Millennium Development Goals</td>
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<td>NEMA:</td>
<td>National Environmental Management Authority</td>
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<tr>
<td>NGO:</td>
<td>Non-Governmental Organization</td>
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<td>PA:</td>
<td>Provincial Administration</td>
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<tr>
<td>PC:</td>
<td>ProVention Contortium</td>
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<tr>
<td>PIA:</td>
<td>Project Implementation Agency</td>
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<td>PRA:</td>
<td>Participatory Rural Appraisal</td>
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<td>PUA:</td>
<td>Papyrus User Association</td>
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<td>RCS:</td>
<td>Ramsar Convention Secretariat</td>
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<td>RS:</td>
<td>Remote Sensing</td>
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<td>SIA:</td>
<td>Social Impact Assessment</td>
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<td>SPSS:</td>
<td>Statistical Package for Social Sciences</td>
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<td>STRP:</td>
<td>Scientific Technical Review Panel</td>
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<td>SWM:</td>
<td>Sustainable Wetland Management</td>
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<tr>
<td>TM:</td>
<td>Thematic Mapper</td>
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<tr>
<td>UNDP:</td>
<td>United Nations Development Programme</td>
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<tr>
<td>UWE:</td>
<td>University of the West of England</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Name</td>
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<tr>
<td>VIRED</td>
<td>Victoria Institute for Research on Environment and Development</td>
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<tr>
<td>WRUA</td>
<td>Water Resource User Associations</td>
</tr>
<tr>
<td>WCED</td>
<td>World Commission on Environment and Development</td>
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<tr>
<td>WRMA</td>
<td>Water Resources Management Authority</td>
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<tr>
<td>WMC</td>
<td>Wetland Management Committee</td>
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ABSTRACT

Kusa swamp has been adversely affected by degradation due to increase in human and livestock population coupled with poor farming methods, overgrazing and harvesting of papyrus which endangers the livelihood of the community. This study hypothesizes that there is no significant relationship between quantities of papyrus harvested per day and change in the area covered by papyrus; papyrus bundles used per day to make mats and those used to make baskets and ropes; and opinion the community hold on conservation of the swamp and the number of community members involved in awareness creation, planned harvesting of papyrus and institutional arrangements. The main objective was to assess the utilization and conservation of papyrus in Kusa Swamp. To achieve this, Geographic Information Systems (GIS) was used where Google Land Cover Facility (GLCF) was used to download aerial images of Kusa swamp between the years 1985 and 2008; and a household survey comprising 96 households of respondents in the study area was carried out. Interviews were also administered to selected key informants. The research instruments included questionnaires, Key Informant Interviews (KII), direct observation, Focus Group Discussion (FGD). Data were analyzed using descriptive statistics. To test the hypotheses, correlation analysis was used. Remote Sensing (RS) and GIS software (Integrated Land and Water Information System (ILWIS)) was used to analyze the RS images to show the change in area covered by papyrus. The area covered by papyrus in 1985, 1988, 1995, 2000 and 2008 was 66.7 km² (41%), 68.9 km² (43%), 51.7 km² (32%), 41.6 km² (26%) and 37.7 km² (23%) respectively. Papyrus utilization is dominated by females (53.1%) and it is high among those with low or no educational attainment (80.2%). Papyrus utilization has resulted in papyrus habitat decline where the overall loss in area covered by papyrus between 1985 and 2008 was 43%, but a larger area was lost between 1988 and 2000 (37%). This trend shows that 86% of the area might be lost by 2031. It has also resulted in reduction in papyrus availability (67%), migration (75%) and death (22.9%) of animals; and change in fish diversity (36.5%). Majority (70%) of the respondents use papyrus for mat making while 30% use it for basket weaving, thatching houses, chair making, partitioning houses and ceiling. Baskets and ropes are widely used in the area. About 79% are in favour of swamp conservation while only 4.2% are currently involved in conservation activities. Initially, the community used institutional arrangements (21%), planned harvesting (31%) and awareness creation (48%) as conservation measures but they were discouraged due to lack of internal and external support. The riparian communities proposed new measures to be implemented for sustainability of the ecosystem. Kusa community continues to depend on the swamp for their livelihoods which include papyrus harvesting, farming, grazing and water. To meet these benefits against increasing population and poverty, there is need for a management strategy that accounts for both peoples’ livelihoods balanced with conservation initiatives. This calls for consideration of alternative sustainable livelihood and development options by stakeholders which include recreation, research and educational sites and irrigated terrestrial agriculture where agro-forestry is practiced to help compensate for loss of papyrus. Sensitization through multi-media approach on importance of natural ecosystems will help enhance conservation efforts.
CHAPTER ONE: INTRODUCTION

1.1 Background to the Study

Wetlands are areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six meters (Ramsar, 1971). Wetlands are highly productive ecosystems being only second to the tropical rainforests (GoK, 2008). They are vital to the health of all other biomes and to wildlife and humans everywhere, and because of their many cleansing benefits, wetlands have been compared to kidneys. The analogy is a good one since both wetlands and kidneys help control water flow and cleanse the system (MBG, 2002). Globally, wetlands occupy about 6% of the earth’s surface (GoK, 2002 and GoK, 2008).

Wetlands provide many ecological and socio-economic goods and services which include water supply and products for the cottage industry like papyrus plants, among others (Kirtsen, 2005; GoK, 2008). They also reduce severity of droughts and floods by regulating stream flow, and provide superb recreational areas for people (Kotze, 1996; Wyatt, 1999). They provide food and income, support biodiversity and form a hydrological and ecological buffer between upland areas and water bodies (Van Dam et al., 2006). These are not only of benefit to local populations but also to people living outside the periphery of the wetland (Innocent, 2007). The functions and benefits provided by wetlands are especially important for the general public as they support
agriculture, tourism, industry, biodiversity conservation, socio-economic and cultural activities (GoK, 2008).

There is growing concern worldwide on sustainable utilization of the environment to enhance the already threatened human benefit. According to the Millennium Development Goals (MDGs), the world should achieve environmental sustainability and combat poverty by the year 2015 and this can be achieved by integrating the principles of sustainable development into country’s policies and programmes and reversing the loss of environmental resources (UNDP, 2002). In addition, sustainable growth, as envisaged in the Kenya’s vision 2030, requires that the growth strategy takes into account social and environmental concerns (GoK, 2009). According to Global Water News Watch (GWNW) (2009), 60% of global wetlands, and 90% of wetlands in Europe, have disappeared due to development and related impacts. In the United States, it is estimated that 54% of original wetlands have been lost, 87% of which to agricultural development and 8% to urban development (Schuyt & Brander, 2004).

Papyrus (Cyperus papyrus) (Tächholm et al., 1959) swamps characterize many wetlands of tropical Africa, and like most wetland habitats worldwide, they are under increasing human pressure due to harvesting and reclamation for agriculture (Owino & Ryan, 2006). In developing countries, the need to use natural resources wisely is greatest as biodiversity is higher in these regions and basic needs are most acute (Mwakubo & Ikiara, 2008; Maclean et al., 2004).
In Kenya, wetlands occupy about 3% to 4%, which is approximately 14,000 km² of the land surface and increases to 6% in the rainy seasons (GoK, 2002; Mwakubo & Ikiara, 2005; GoK, 2008). The degradation and loss of papyrus swamps in the country has been exacerbated as the existing policies apparently encourage drainage of papyrus swamps for large-scale farming by private companies in the region (Kairu, 2001). Land use activities around papyrus swamps of Lake Victoria (LV) are dominated by cultivation, livestock grazing and settlements. These activities have intensified in recent years and are of particular concern as they have led to other forms of interference to papyrus swamps such as pollution, burning and papyrus harvesting (Owino & Ryan, 2006). Conversion and degradation of papyrus appear prominent in the Kenyan sector of LV, driven by high demand for agricultural land and papyrus products used mainly by the local people for making crafts.

Kusa swamp supports a large human population that derives its income directly from farming and mat-making. Currently, the swamp is faced by increasing degradation that has highly reduced the papyrus area and affected the livelihood of the area residents negatively. To curb the situation, adequate information should be availed to the stakeholders on utilization and conservation of papyrus swamps. This study therefore, sought to assess the utilization and conservation of papyrus with the aim of availing this information to stakeholders to enable them to develop best practices for conservation of the swamp.
1.2 Problem Statement

Kusa swamp has been adversely affected by degradation through over-utilization of its resources. This is due to the increase in human and livestock population, poor farming methods and overgrazing, among others. This has led to decrease in the area covered by papyrus. Harvesting of papyrus without conservation measures in place may endanger the mat-making and other papyrus-based activities that the community thrives on, thus threatening their livelihood. There are no conservation measures undertaken by the community and the government to safeguard the sustainability of the papyrus resource base. The harvesting of the plant has occurred against a backdrop of limited information about its utilization and conservation. It is therefore, imperative that information on the utilization and conservation of papyrus is documented, and this study is one such effort in realizing that.

1.3 Justification of the Study

Papyrus plants are an important resource in a swamp ecosystem. The local community uses papyrus resources, for example, in mat-making and therefore, their economic base depends on papyrus. Utilization and conservation of papyrus in Kusa Swamp is, therefore, a necessary step for sustainability of the community livelihoods.

The information collected would add value to the available information on utilization and conservation of papyrus for sustainable livelihoods. It will help in achieving the MDGs.
and the Kenya’s vision 2030 on environmental sustainability if the information gathered is used to create awareness and educate the society on ecosystem sustainability.

1.4 Research Questions

The study addresses the following research questions:

i. What is the effect of papyrus utilization on Kusa swamp?

ii. How is papyrus resource used by the local community?

iii. What conservation measures are put in place to conserve the papyrus ecosystem in Kusa swamp?

1.5 Research Hypotheses

Ho₁: There is no significant relationship between quantities of papyrus harvested per day and change in area covered by papyrus.

Ho₂: There is no significant relationship between papyrus bundles used per day to make mats and those used to make baskets and ropes.

Ho₃: There is no significant relationship between the opinion the community hold on conservation of the swamp and the number of community members involved in awareness creation, planned harvesting of papyrus and institutional arrangements.
1.6 Study Objectives

1.6.1 General Objective

The general objective of this study is to assess the utilization and conservation of papyrus in Kusa Swamp.

1.6.2 Specific Objectives

i. To examine the effect of papyrus resource utilization by local communities on the papyrus ecosystem in Kusa Swamp.

ii. To examine the uses of papyrus resource in Kusa Swamp.

iii. To evaluate different local measures used to promote conservation of papyrus ecosystem in Kusa Swamp.

1.7 Significance of the Study and Anticipated Output

This study focuses on assessment of the utilization and conservation of papyrus swamps in the study area. The research findings document effects of papyrus resource use on the swamp ecosystem, uses of papyrus and measures used to conserve papyrus swamps. The information obtained from this study can be used by the community, government and relevant agencies in determining the importance of wetlands and devise proper utilization methods to ensure sustainability. This will also help in identifying the potential solutions to the existing problems in the study area. The findings will not only be applied in the study area, but also used to solve problems in other areas.
1.8 Scope and Limitation of the Study

This study was carried out in Kusa Swamp in LV, Kenya. It assessed the utilization and conservation of papyrus plants at household level. This covered effects of papyrus resource use on the swamp ecosystem, uses of papyrus by the local community and measures used by the local community to conserve the swamp ecosystem. It dealt with those who use the swamp in various ways like farmers, fishermen and papyrus harvesters. Relevant officials and experts were also consulted and their views incorporated.

The study was limited in three respects. First, papyrus users believe that researchers exploit them, thus getting information from them is difficult as many researchers have promised to bring change in the area but all in vain. Second, the respondent’s definition of conservation of a natural ecosystem was subjective and not clear. Therefore, proper explanation was required in order to get information on conservation measures from the respondents. This took much time. Third, the perception of the local community is that researchers are supposed to give money in exchange with information gathered from them, thus some of the respondents were requesting for money before or after interview. Failure to give them money demoralized some of them which might have led to giving incorrect information.
1.9 Chapter Summary

The chapter covered background to the study problem, exploring various issues regarding wetlands globally, regionally and locally. The chapter also tackled the statement of the problem; research questions; hypotheses and objectives; justification of the study; significance of the study and anticipated output; and scope and limitation of the study. The chapter concludes that swamps are a significant ecosystem both for environmental balance and health, as well as a source of human livelihoods. Therefore, their sustainability through conservation measures is critical.
CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This section reviews relevant literature on the utilization and conservation of papyrus. The review primarily focuses on uses of papyrus resources, impacts of papyrus resource use to papyrus ecosystems and measures used in promoting conservation of papyrus ecosystems. The review also considered a Sustainable Wetland Management framework (SWM).

2.2 Impact of Papyrus Resource use to Papyrus Dominated Ecosystems

Maclean et al. (2004) examined the effects of papyrus harvesting and swamp reclamation on the net present value of papyrus swamps fringing Lake Bunyonyi in southwest Uganda. The value of harvested papyrus, crops and fish obtained from the swamp was modelled in relation to swamp area, using a production function approach. Parameter values were estimated from interview data. Results indicated that the net present value of swamps was maximized when between 27-33% of the swamp is utilized for harvesting, but when optimal cultivation levels were less than 2%, they argued that provision of goods and services changes continuously, although not necessarily smoothly, in response to levels of resource use or habitat conversion.

They maintained that the optimal ratio of harvesting, cultivation and conservation is comparatively robust to most model parameter estimates. However, a reduction in wages or the perceived value of people’s time, leads to a large increase in optimal levels of
harvesting and cultivation, trapping people into a vicious circle of poverty. According to Turner 1991 & Maclean et al. (2004), for the net benefits of an ecosystem to be maximized, an appropriate balance must be struck between conservation, conversion and utilization. Turner and Maclean et al did not identify the conservation measures to be put in place for the net benefits of an ecosystem to be maximized. This study identified the conservation measures that can help maximize the ecosystem benefits.

2.3 Uses of Papyrus Resources

The papyrus plant, *Cyperus papyrus*, is a triangular stemmed reed in the sedge family. Each plant often grow to a height of 6 to 10 feet (1.5 to 3 meters) and is topped with a bushy cluster of fine green thread-like strands with small flowers at their ends (Lister, 2005). Papyrus is thought to be the mythical bulrush from which the ancient Egyptians constructed boats or skiffs of papyrus, believing the plant to be abhorred by crocodiles with which the Nile seethed (Sculthorpe, 1967). Papyrus plants had a multitude of uses. Their roots were source of food, medicine, perfume and fuel. Their stems were used to make baskets, floor mats, ropes, clothing, footwear, boats, assorted building materials, and the most important writing material in the ancient world.

Nevertheless, the most important use was for making the writing material known as "papyrus", the word that ultimately gave us the word “paper” (Lister, 2005). The piths of the plant were used to manufacture paper (Kariuki, 2000). The superficial fibrous material was peeled off, then, the pith was sliced longitudinally into wafer strips and
arranged side by side on a flat surface. They were then moistened with water and stuck together under pressure. The papyrus sheets were cut and rolled as required when dry. Egyptians also used papyrus to make maps. The ancient Egyptian map which was discovered in the Nubian Desert has been dated to approximately 1150 BC and has become quite well-known to paper folders (Lister, 2005).

Baskets were also made in ancient times. Basket making is one of the world’s oldest forms of craft, and therefore, not surprisingly a part of ancient Egyptian tradition (Bizzari, 2010). He maintained that basketry is known from the earliest sites in Egypt and remains of baskets have been found in the Fayoum dating to the Neolithic period, about 5000 BC. The baskets were of very high quality as compared to the ones made today. This study therefore, examined the uses of papyrus by neighbouring communities of Kusa Swamp.

According to Ong’or (2005), swamps are sources of papyrus (*Cyperus papyrus*) which are dried and used to make mats. He maintained that this use pattern of papyrus has increasingly gained importance as demand for mats rises. The study has only identified one use of papyrus resource but not the other uses. Our study identified and discussed the other uses of papyrus.
2.4 Measures Used in Promoting Conservation of Papyrus Ecosystems

Schuyt and Brannder (2004) identified swamp functions as regulation, production, carrier and information and swamp values as ecological, socio-cultural and economic. They argued that conservation and wise use of swamps is in the economic interest not only of local populations’ dependence on these swamps for their livelihoods but of society as a whole. According to them, the swamps are vital ecosystems in society and therefore, they should be conserved. The two authors did not however, identify and discuss the conservation measures to be put in place to conserve the swamp ecosystem. However, our study identified the conservation measures that can be implemented to promote conservation of the swamp.

Proper utilization of swamps will provide new hope for people, create more jobs and help improve their local economies (Luoga, 2005). She maintains that swamps perform a wide range of functions that are essential for supporting plant and animal life and maintaining the quality of the environment. This explains how crucial the issue of sustainable use of wetlands is in the overall process of tackling the ecological and economic problems currently facing developing countries, including communities within the LV region. The study did not however, propose the conservation measures used to protect the wetland ecosystem but looked into these conservation measures.

Nyakana (2008) assessed sustainable wetland resource utilization of Sango Bay through eco-tourism development. He argued that eco-tourism embraces environmental
conservation, maintenance of biodiversity, a satisfying experience for the visitors, study and appreciation of nature and sustainable community development. The study focused on eco-tourism as the only way through which wetlands can be conserved and never identified other methods of conservation. However, this study went further to identify the other methods of conserving the wetland ecosystem which include papyrus cultivation and land use zoning, among others.

Most wetlands have been radically transformed and/or over-exploited, and therefore, doing nothing to conserve the wetlands is a threat to biodiversity because wetlands are a refuge for the very large fauna community (IUCN, 1994). Owino and Ryan (2006) assessed recent papyrus swamp habitat loss and conservation implication in western Kenya. They argued that the continued papyrus habitat loss and degradation represents a significant threat to biodiversity conservation particularly for papyrus-specialist birds and other papyrus-reliant species in western Kenya. They further observed the pattern of papyrus extents and land-use changes at all sites which provided the site-scale information necessary for papyrus conservation planning. In particular, conservation action is needed most urgently at Dunga and Koguta as they face severe land-use pressures. Owino and Ryan (2006) concluded in their study that conservation is necessary at the two sites; but they did not recommend what should be done to ensure proper utilization and conservation of papyrus swamps in the LV region. This study went further to identify the methods of conserving the swamp ecosystem.
According to Kabumbuli & Kiwazi (2009), community livelihood is closely intertwined with the wetland. The findings of their study showed that 69% of the respondents derive their entire household income from wetland activities which include cultivation (86%), brick making (5.6%), papyrus harvesting (4.2%), fishing (1.4%), sand harvesting (1.4%) and others (1.4%).

Their study concluded that sustainable utilization and management of wetlands call for participatory planning, management and alternative livelihoods for poor wetland-dependent communities in Kampala, Uganda. They proposed that the immediate strategy should be to reduce the wetland cultivation as it is the most prevalent mode of encroachment among the poor, and to promote the non-wetland activities. Our study has come up with conservation measures which are participatory and stakeholder oriented for sustainability of the livelihood activities within the swamp ecosystem.

2.5 Conceptual Framework

Wetlands like other ecosystems are organized in systematic interactions where relationships do exist between various components within, and also with externalities including human society in a socio-ecological circle (Kinaro, 2008). They are integrated systems with complex and dynamic relationships between the resources (water, soil and biodiversity), technology, institutions and the economy. With increasing use pressures on wetlands, the main elements in the relationship need to be coordinated and integrated into the overall wetland management through participatory and holistic planning for
sustainable wetland management. This calls for reduced degradation and increased productivity, use of appropriate and cost-effective technologies suitable to the locality and good governance. Therefore, it is important that a framework to illustrate this is in place for clear visualization of the interrelationship. The concept of Sustainable Wetland Management (SWM) was found appropriate in the study of sustainable utilization of resources for sustainable livelihoods in Kusa Swamp. The framework (Figure 2.1) was found suitable for the Kusa Swamp scenario as it organizes the four elements and states the best practices that can help in achieving sustainable utilization of papyrus plants for sustainable livelihoods in the study area.

2.5.1 Sustainable Wetland Management (SWM)

Sustainable development was defined in “Our Common Future” in the Brundland report of the World Commission on Environment and Development (WCED) (1987) as “development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs”. Subsequently, many authors have used the term sustainable development for specific development activities like sustainable agriculture, sustainable forestry, and sustainable energy development among others (Vishnudas et al., 2008). A single development may be considered successful if it is weighed against its specific performance criteria (Vishnudas et al., 2008). To attain sustainability, an integrated approach is essential as all different aspects of development should be considered simultaneously.
Sustainable Wetland Management (SWM) is defined as management of a wetland system with sustainable technology options, which ensures the sustainability of its ecosystem functioning and contribution to livelihoods to conserve natural resources, with adequate institutional and economic options. To achieve this, the four main elements: natural resources, technology, institution and economics should be considered. The study adopted a framework used by Vishnudas et al. (2008) to analyze sustainable watershed management projects. Their framework helps in understanding the different aspects and elements of sustainable management and their interactions. They explained that for a watershed project to be sustainable, four groups of criteria should be considered related to natural resources, technology, institutions and economics, respectively.
Figure 2.1: Conceptual framework for sustainable wetland management

Source: Adopted from Vishnudas et al. (2008)
As illustrated in Figure 2.1, sustainable wetland management requires integrated approach where the four main elements: natural resources, technology, institution and economics are integrated for sustainable utilization of wetland resources by the local community to maintain the natural resource base. To achieve sustainability, the community must adopt the best practices indicated below each main element (Figure 2.1).

2.5.1.1 Natural Resources
The available natural resources in Kusa Swamp are; water, soil and biodiversity. According to Figure 2.1, these natural resources should be protected from degradation and maintained for good production by reducing soil erosion, increasing water availability and increasing biomass production. Degradation of the soil and vegetation resources threatens papyrus productivity and water availability in the swamp. This can be facilitated through appropriate soil and water management. This enhances infiltration and increases soil moisture content.

2.5.1.2 Technologies
Within one area, there may exist different resource types and people usually make use of them alongside each other, for example in a wetland there can be cultivation of crops, irrigation, grazing livestock, fishing, aquaculture, papyrus harvesting at different levels with varying benefits for the local community (Kinaro, 2008). Utilization and conservation of these resources should be a simultaneous process for sustainability to be attained. Technology used for conservations measures should be cost-effective and
affordable to the local community. So, there is need for appropriate structures and processes (formal and informal), that mediates the complex and highly differentiated process of achieving sustainable livelihoods. Based on Figure 2.1, sustainable utilization of these resources requires appropriate and sustainable technologies that depend on various components. Thus, the technologies used should be: suitable to the locality or geographic situation and simple to construct; make use of materials and unskilled labour that is readily and locally available. In addition, indigenous technology should not be abolished but put to use as it complements the modern technology. However, the technology should be ecologically protective, socially acceptable, economically productive and viable.

2.5.1.3 Institutions

Integrated wetland management is not merely limited to water, soil and biomass, but also concerned with integration for self-reliance and holistic development of the rural poor. In operational context, this would mean integrating different uses and management of resources, different departments with sectoral interests through inter disciplinary approaches and towards alleviation of poverty (Mollinga, 2000). The main stakeholders involved are; internal agencies (Self-help groups, user groups or watershed communities) and external agencies (Government, NGOs, researchers, local administration and politicians). All these actors should be actively involved in the management of the wetland.
According to Figure 2.1, it is clear that integrated wetland management requires sustainable institutions that bring all these actors together. Institutions are the social cement which link stakeholders to access to capital of different kinds to the means of exercising power and so define the gateways through which they pass on the route to positive or negative adaptation (Scoones, 1998). According to Bauman (2002), the creation of an enabling institutional environment is critical for changing the terms on which the rural poor can access the natural resources.

Based on Figure 2.1, the institutions put in place should be guided by good governance where accountability, transparency, equity and efficiency of the governance structure are ensured. People’s participation and participation of the Project Implementation Agency (PIA) is a key element in achieving sustainability. Correspondence with rules and regulations and customs should be observed by the stakeholders as they also consider property rights and collective action; and land tenure. However, the stakeholders should be empowered to participate in decision-making and institutional activities. The SWM framework gives authority to the official organization to make legal decisions about their functions (inter-jurisdictional). In Kusa community, there is need for formation of appropriate institutions for example; Kusa Wetland Management Committee (KWMC) and Kusa Papyrus User Association (KPUA). Through these institutions, people’s participation in wetland projects can be ensured. When the people are fully involved in institutional activities for instance; conservation of swamp ecosystem, they thus own the property and will endeavour to sustain it.
2.5.1.4 Economics

Conservation of the wetland resources requires ideal measures. Any new technique or measures proposed for soil, water and biodiversity conservation must be economically viable, otherwise the people will not accept it and it will be doomed to fail. As illustrated in the SWM framework, components of this element are: construction and maintenance costs, labour cost, price of materials, the value of output, income generation, access to capital, ability to pay, eligibility to subsidies and the cost of labour contribution. In relation to this, sustainability can only be achieved if all these components are considered. This will determine whether the conservation measures put in place are cost-effective and affordable to the people.

Will the conservation measures put in place change the Kusa Swamp scenario? To achieve this, conservation measures put in place must result in generation of enough benefits from the swamp to offset costs of implementation and maintenance of the conservation measures. Positive results depends on wise use of the resources available in the swamp, choice of appropriate technology that the people can maintain themselves, putting in place institution with good governance and choice of conservation measures that are economically viable.

2.6 Chapter Summary

This chapter reviewed relevant literature on the utilization and conservation of papyrus. The review primarily focuses on impacts of papyrus resource use to papyrus ecosystems,
uses of papyrus resources and measures used in promoting conservation of papyrus ecosystems. The review also considered a Sustainable Wetland Management framework (SWM). The review, which also identified gaps in knowledge, is summarized in Table 2.1
Table 2.1: Selected literature and identified gaps

<table>
<thead>
<tr>
<th>AUTHOR</th>
<th>OBJECTIVE</th>
<th>METHOD</th>
<th>SETTING</th>
<th>MAIN FINDINGS</th>
<th>GAPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Maclean et al., (2004)</td>
<td>To examine the effect of papyrus resources utilization by the local communities on the papyrus ecosystem in Kusa Swamp</td>
<td>Questionnaire Direct observation Focus group discussion Interview (KII)</td>
<td>Lake Bunyonyi in southwest Uganda</td>
<td>Net benefit of an ecosystem is maximized when an appropriate balance is struck between conservation and utilization.</td>
<td>The conservation measures that can be used to maximize ecosystem benefits were not identified</td>
</tr>
<tr>
<td>2) Ongo’r (2005)</td>
<td>To examine the uses of papyrus resource in Kusa Swamp</td>
<td>Interview (KII) Questionnaire Direct observation Focus group discussion</td>
<td>Lake Victoria Basin</td>
<td>Wetlands are sources of papyrus (Cyperus papyrus), which is dried and used to make mats. This use pattern has increasingly gained importance as demand for mats rises.</td>
<td>The study has only identified one use of papyrus resource. This study identified, discussed the other uses.</td>
</tr>
<tr>
<td>3) Vishnudas et al., (2008)</td>
<td>To evaluate different local measures used to promote conservation of papyrus ecosystem in Kusa Swamp</td>
<td>Questionnaire Interview Direct observation Focus group discussion</td>
<td>Kerela</td>
<td>The SWM framework was used in Kerela to analyze sustainable watershed management projects.</td>
<td>The framework was not used in Kusa swamp to analyze sustainable management of Kusa swamp.</td>
</tr>
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</table>
CHAPTER THREE: MATERIALS AND METHODS

3.1 Introduction

This section deals with an overview of the study area, sampling procedure, data collection, and tools and methods used in data analysis.

3.2 Study Area

The study was carried out in Kusa Swamp, LV, Kenya. Kusa Swamp contributes significantly to the ecological and hydrological functions of the Lake as well as to the economy of the rural communities, especially in subsistence farming, grazing and papyrus use for building and commercial products like mats, crafts and furniture. The swamp is a highly productive ecosystem as characterized by the diverse growth of papyrus (*Cyperus papyrus*), which is the most dominant macrophyte in the swamp (Owino & Ryan, 2006) and its general biodiversity richness. It is a source of water for domestic and livestock use, as well as non-wood products (Maclean *et al*., 2004 and Luoga, 2005). It also provides a habitat for certain species of animals that have disappeared from the main LV including invertebrates, birds and fish. Fish, reliant on the papyrus swamps, are an important source of protein to the diet of local people and generate income (Maclean *et al*., 2004).

Despite this recognized importance and value of Kusa swamp (Figure 3.1), there is increasing pressure to reclaim the swamp, mainly to ensure food security and diversify livelihoods in the area. The natural vegetation at the edges of the swamp is heavily
affected by human settlement, widespread cultivation and cutting of trees for fuel-wood. Uncontrolled cutting of papyrus and increased rate of papyrus harvesting has also negatively affected the swamp biodiversity. Papyrus regeneration is very poor (Osumba et al., 2010). Animals migrate as their habitat is destroyed. In addition, pollution and siltation from the rivers Nyando and Asawo are serious threats (Owino and Ryan, 2006).

3.2.1 Geographical Location

Kusa swamp (Figure 3.1) is located at the easternmost end of Winam Gulf adjacent to Nyakach Bay at the mouth of River Nyando, with an area of 180 km². It is bounded by latitudes 0° 19 S and 0° 25 N and longitudes 34° 51 E and 34° 55 E. It is situated at an altitude of 1,130m above sea level (Nasirwa and Njoroge, 1997). Administratively, the swamp is found in Lower Nyakach Division, Nyakach District in Kisumu County.

The swamp is mainly fed by River Awach, Asawo, Bugo and Ragen which floods the swamp and this is a greater contribution to its ecological and hydrological functions. Contribution of River Bugo and Ragen are very minimal because they are seasonal rivers.
Figure 3.1: Study area
3.2.2 Human Population

According to the Central Bureau of Statistics, in 2010 the population of Kusa community was 26,746 (460 households) with a density of 148 persons per square kilometre (GoK, 2010). The area is dominated by the Luo community. The other tribes found in the area due to intermarriages are Luyha, Kisii and Kalenjin. The area supports one of the densely populated and poorest rural areas in East Africa (SearNet.Briefs, 2005). Poverty is a very big threat to economic development in the area.

3.2.3 Climate and Vegetation

The climate of the study area is sub-humid with a mean annual rainfall of 1000mm; and average temperature of 25°C (Mwanikah, 2006). The rainfall pattern is bimodal with peaks during long rains (March-May) and in August (Njogu, 2000). In addition, the climatic conditions determine the vegetation of the area. The vegetation comprises grass, shrubs, trees, papyrus (Cyperus papyrus) and other macrophytes.

There are two main distinct ecosystems that form the resource base for the local community: (1) the natural wetland (swamp), which consists of emergent macrophyte vegetation dominated by papyrus, which is mainly harvested for mat making and forms an important asset for community livelihood; and (2) the terrestrial ecosystem that consists of arable land scattered bushes and grasslands (Luoga, 2005).
3.2.4 Socio-economic Activities

The livelihood activities in the area are fishing, crafts making, and farming. Crops planted are; arrowroots, beans, onions, millet, potatoes, tomatoes, maize, bananas and vegetables (GoK, 2000). Fishing is the major livelihood of the local community of Kusa village. Kusa beach, directly adjacent to Kusa Swamp is one of the main fish landing points in the local area. Fisheries are performing poorly due to water hyacinth infestation of LV, over-fishing in the lake, degradation of papyrus ecosystem which is the breeding habitat for fish and low market prices. This has changed focus more towards farming around the swamps, livestock keeping and papyrus harvesting for mat-making as a source of income (Mwanikah, 2006). Integrated small holder aquaculture-agricultural systems were introduced in natural wetland in 2002 (Luoga, 2005).

3.3 Sampling Procedure

This study was carried out in Kusa swamp, LV, Kenya. The area was purposively selected as the study location since it is one of the Site Support Groups in LV Important Biodiversity Area (IBA). In addition, papyrus is a source of livelihood to the local community. Thus, conservation is required to sustain both the resource base and the people’s livelihood. Three methods namely analysis of Landsat Images, Participatory Rural Appraisal (PRA) and direct observation were used to collect data on effects of papyrus resource use on the swamp ecosystem, uses of papyrus and measures used to conserve papyrus swamps.
3.4 Landsat Images

Global Land Cover Facility (GLCF) was used to download Landsat aerial images (georeferenced or geotiff) of Kusa Swamp of the years 1985, 1988, 1995, 2000 and 2008. Using images with ten year interval between one image and the next for example, 1985, 1995 and 2005 was the researcher’s original intention but, some images were not available, for example that one of 2005. Therefore, all the available images between the year 1985 and 2010 were used to gather data on changes in area covered by papyrus; land use and land cover changes within the swamp ecosystem. The images were imported to Integrated Land and Water Information System (ILWIS) 3.2 in bands 1-7 for analysis. These Thematic Mapper (TM) satellite images are designed to achieve higher image resolution, sharper spectral separation, improved geometric fidelity and greater radiometric accuracy and resolution.

3.4.1 Data Processing and Analysis

Data analysis involved preparation and processing of data such as cleaning, coding and editing. The coded data were analyzed using Statistical Package for Social Sciences (SPSS) and Microsoft Excel computer programmes. Both qualitative and quantitative techniques were used which involved descriptive and inferential statistics. The qualitative analysis included the description of uses of papyrus, change in papyrus ecosystem and conservation measures used to conserve the papyrus ecosystem. The quantitative techniques included frequencies, means, percentages and modes.
To test hypotheses one, two and three, that there is no significant relationship between quantities of papyrus harvested per day and change in area covered by papyrus; no significant relationship between papyrus bundles used per day to make mats and those used to make baskets and ropes and that there is no significant relationship between the opinion the community hold on conservation of the swamp and the number of community members involved in awareness creation, planned harvesting of papyrus and institutional arrangements, correlation analysis was used. In both cases, Two-tailed Pearson Correlation at 0.05 levels was used. Correlation is a technique for investigating the relationship between two quantitative, continuous variables (UWE, 2007). Pearson’s correlation coefficient (r) is a measure of the strength of the association between the two variables (UWE, 2007). According to Simon (2008), the formula for calculating Pearson’s correlation (r) is,

$$ r = \frac{\sum_{i=1}^{n} (x_i - \bar{x})(y_i - \bar{y})}{(n-1)s_x s_y} $$

(1)

Where:

n = Number of pairs of scores

\( \sum \) = Sum of

X and Y = Variables

\( \bar{X} \) and \( \bar{Y} \) = Means of variables

\( S_X \) and \( S_Y \) = Standard deviations of the variables
Remote Sensing (RS), Geographic Information Systems (GIS) software and ILWIS were used to analyze data on change in coverage of the papyrus ecosystem. This involved analysis of change in area covered by papyrus between the years 1985 and 2008. The Landsat images (georeferenced or geotiff) were imported to ILWIS 3.2 in bands 1-7. False colour classification was done where colour composite 3, 4, 5 was used. To get the area covered by papyrus in a given year, the pixel measurements were used. One pixel measuring 30m×30m was automatically multiplied by the number of pixels that make up the total area covered by papyrus. The area was given in m\(^2\) after which it was converted to km\(^2\). Overall change in area was then calculated in percentage by getting the percentage decrease in area (Percent decrease in area = area covered by papyrus in 1985 minus area covered by papyrus in 2008 divided by area covered by papyrus in 1985 × 100).

3.5 Socioeconomic Data

Purposively, a sample size of 96 households was chosen. A simple random sampling method was used to identify these households which involved numbering all the 460 households in ballot papers. The ballot papers were folded and mixed properly. They were chosen one at a time without replacement until 96 ballots were attained. Out of the 96 respondents, the head of the household was interviewed and the following strata was determined: 34 papyrus harvesters, 36 papyrus weavers, 12 farmers, 8 fishermen and 6 business people.
One (1) WRMA and two (2) WRUA officials, two (2) private experts, Two (2) members of Provincial Administration (PA) (Chief and Assistant Chief), one (1) local NGO, two (2) professionals were also selected for Key Informant Interviews (KII). Selected papyrus users (2), papyrus harvesters (2) and farmers (2) were also interviewed to generate more information. Additionally, two Focus Group Discussions (FGD) involving 27 women and 3 males were conducted.

3.5.1 Data Collection

The study employed both primary and secondary sources in collecting data. Secondary data were gathered from published and unpublished materials about swamps and papyrus use and conservation in the study area. Primary data were collected from the field using questionnaires, KII, direct observation and FGD.

3.5.1.1 Questionnaire

A structured questionnaire (Appendix I) with both closed and open-ended questions was administered to the 96 households. The questionnaires were used to gather data on effects of papyrus resource use on swamp ecosystem, uses of papyrus resources and conservation measures used to protect the swamp ecosystem. The questionnaires were administered by the researcher and two field assistants to the individual swamp users, for example, papyrus harvesters and farmers at household level.
3.5.1.2 Key Informant Interviews (KII)

Key Informant Interview guide (Appendix II) was used to establish the response of the key informants namely WRMA, WRUA, BMU, PA and local NGO on effects of papyrus resource use on the swamp ecosystem, uses of papyrus and conservation measures used to promote conservation of the swamp. Selected papyrus users, harvesters and farmers were also interviewed to generate more information.

Interviews with WRMA officials were done in Kisumu regional office. WRUA officials were interviewed at Katito Market where information on utilization and conservation of wetland resources, especially papyrus, was gathered. At Kusa beach, the chairman and the secretary of BMU were interviewed on activities taking place at the beach, activities within the swamp ecosystem and uses of papyrus. Their views on conservation were also incorporated. VIRED International official was interviewed in Kisumu and Rabuor. The interviews were based on the uses of papyrus, activities taking place in the swamp, their effects on the ecosystem and measures used to conserve the swamp ecosystem.

3.5.1.3 Focus Group Discussion (FGD)

Focus Group Discussion (FGD) guide (Appendix III) was used to gather information from two community groups. The groups comprised papyrus product sellers, papyrus harvesters, farmers and fish sellers. A Focus Group Discussion (FGD) with Bugo Women Group (BWG) (20 participants) at Nyalunya yielded data on uses of papyrus, conservation of the swamp ecosystem, marketing of papyrus products especially mats,
and identified problems and proposed some solutions to the problems facing them and other papyrus users. A FGD held at Kusa beach with fish retailers and farmers (10 participants comprising of 7 women and 3 men) also yielded the same type of data.

3.5.1.4 Direct Field Observation
Field observation by the researcher was handy in gathering the data on utilization of the swamp resources and activities taking place in the swamp. The researcher made observations on farming, harvesting and grazing activities in the swamp. Fishing activities were also observed at Kusa beach where the fishermen land.

Key Informant Interview (KII) data and FGD data were recorded, transcribed and the content analyzed and used as integral parts of written text.

3.6 Chapter Summary
The study was carried out in Kusa swamp, Lake Victoria, Kenya with a population of 26,746 persons (460 households). Kusa swamp contributes significantly to the ecological and hydrological functions of the Lake as well as to the economy of the rural communities, especially in subsistence farming, grazing and papyrus use for building and commercial products like mats, crafts and furniture. The livelihood activities in the area are fishing, craft making and farming. Despite the recognized importance and value of Kusa swamp, there is increasing pressure to reclaim the swamp, mainly to ensure food security and diversify livelihoods in the area.
The climate of the study area is sub-humid with a mean annual rainfall of 1000mm; and average temperature of 25°C. The rainfall pattern is bimodal with peaks during long rains (March-May) and in August. The vegetation of Kusa comprises grass, shrubs, trees, papyrus (*Cyperus papyrus*) and other macrophytes. The natural vegetation at the edges of the swamp is heavily affected by human settlement, widespread cultivation and cutting of trees for fuel-wood. Uncontrolled cutting of papyrus and increased rate of papyrus harvesting has also negatively affected the swamp biodiversity.

Purposively, 96 households were selected for interview. The study used both primary and secondary sources in collecting data. A structured questionnaire with both closed and open-ended questions was administered to the 96 households. Data were also collected through KII, FGD, direct observation and Landsat images. Data analysis involved preparation and processing of data such as cleaning, coding and editing. The coded data were analyzed using Statistical Package for Social Sciences (SPSS) and Microsoft Excel computer programmes.
CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Introduction

This chapter deals with presentation, interpretation and discussion of the findings of the study upon which conclusions were made. The findings were presented in form of images, frequency tables, graphs and pie charts. Photographs taken in the field also formed part of the data presentation. These findings were discussed with a view to generating logical conclusions in response to the stated study objectives as appropriate.

Household characteristics (sex, age, level of education, family size and respondent’s monthly income), effects of utilization of papyrus resources on the swamp ecosystem, activities carried out in the swamp, rate of papyrus harvesting, utilization of papyrus resources, and conservation of the swamp were discussed.

4.2 Household Characteristics

This section documents the various characteristics of the respondents in Kusa study area which included gender, age, level of education, family size, occupation, monthly income and farm size.

4.2.1 Gender

This variable was included to ascertain if utilization and conservation of papyrus ecosystem vary by gender. About 46.9% of those utilizing papyrus are males while 53.1% are females. This may be due to the fact that mat making and basket weaving are
activities that women can easily perform. This corroborates with the finding by Mwakubo and Ikiara (2005) that 53% of those involved in papyrus activities in Yala swamp are women because they often use papyrus for firewood, mat making and basket weaving.

4.2.2 Age

The study used this variable to observe the age mostly involved in papyrus activities, middle age, minimum and maximum age of those utilizing papyrus. The study findings show that those who are mostly involved in papyrus activities are 30 years old and the median age is 45, while the maximum and minimum age are 86 and 20 respectively. This finding suggests that youths are more involved in papyrus activities. This could mean that papyrus utilization requires people with enough energy and hence are strong to harvest papyrus, transport the harvested papyrus home, air them and weave mats. Alternatively, these may be the unemployed in society who are likely to indulge in the poorly paying papyrus activity to earn a living. The adults (aged 86) involved in papyrus activity may be explained by the fact that they are very poor and have nobody to give them financial support. They must try as much as possible to survive in such difficult economic environment.

4.2.3 Level of Education

The study sought to establish the level of educational attainment of papyrus users in Kusa locality. The study findings are shown in Table 4.1.
Table 4.1: Respondents level of education

<table>
<thead>
<tr>
<th>Level of education</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>15</td>
<td>15.6</td>
</tr>
<tr>
<td>Primary</td>
<td>62</td>
<td>64.6</td>
</tr>
<tr>
<td>Secondary</td>
<td>17</td>
<td>17.8</td>
</tr>
<tr>
<td>College</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>University</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>Total</td>
<td>96</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Based on Table 4.1, 64.6% of papyrus users have attained primary level of education, while only 19.8% have attained at least secondary and above level of education. Fifteen point six had no formal education. The finding shows that papyrus utilization is high among those with low or no educational attainment. The finding may be explained by the fact that the better educated are enlightened on the dangers of unsustainable papyrus utilization hence low rate of papyrus utilization. In addition they are more likely to be on employment and have higher income and may not involve themselves in the low paying papyrus activities. Mwakubo and Ikiara (2005) also conjectured a negative relationship between education and amount of harvested papyrus as education embodies awareness of the dangers of unsustainable papyrus utilization.

4.2.4 Nuclear Family Size

Respondents were asked to give information about the size of their families. This variable was included to ascertain if papyrus utilization vary by family size. The average (mean) family size of those involved in papyrus activities was found to be 7.01 with a standard deviation of 3.95. The maximum and minimum family sizes were thirty and one
member(s) respectively. These findings suggest that papyrus utilization cuts across family size. That is, those with larger families as well as those with smaller families use papyrus.

4.2.5 Occupation

Respondent’s occupation was used to find out those who are fully involved in papyrus activities as sources of their income. The findings are shown in Table 4.2.

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Number involved</th>
<th>% involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mat maker</td>
<td>28</td>
<td>29.2</td>
</tr>
<tr>
<td>Farmer</td>
<td>19</td>
<td>19.8</td>
</tr>
<tr>
<td>Fishermen/women</td>
<td>6</td>
<td>6.2</td>
</tr>
<tr>
<td>Papyrus harvester</td>
<td>31</td>
<td>32.3</td>
</tr>
<tr>
<td>Businessman/woman</td>
<td>5</td>
<td>5.2</td>
</tr>
<tr>
<td>Carpenter</td>
<td>2</td>
<td>2.1</td>
</tr>
<tr>
<td>Tailor</td>
<td>4</td>
<td>4.2</td>
</tr>
<tr>
<td>Masonry</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>96</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

As illustrated in Table 4.2, majority (61.5%) are mat-makers and papyrus harvesters, while the rest of the respondents (38.5%) are in different occupations. The finding shows that mat-makers and papyrus harvesters are fully involved in papyrus activities as their only source of income. This finding may imply that the respondents in other occupations as their source of income are not involved in papyrus activities.
4.2.6 Monthly Income

The study sought to establish papyrus user’s monthly income. The variable was to ascertain if papyrus utilization varies by income. Figure 4.1 shows the respondents monthly income.

As illustrated in Figure 4.1, majority (78.2%) of the respondents had a monthly income of Ksh 2,500 and above. The finding probably explains why they are involved in papyrus activities.
4.2.7 Farm Size

The study used this variable to find out whether swamp utilization depends on the respondents’ farm size. The findings are shown in Table 4.3.

Table 4.3: Respondents farm size in Kusa during study period

<table>
<thead>
<tr>
<th>Farm size</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 5 acres</td>
<td>83</td>
<td>86.5</td>
</tr>
<tr>
<td>5-10 acres</td>
<td>11</td>
<td>11.5</td>
</tr>
<tr>
<td>More than 10 acres</td>
<td>2</td>
<td>2.1</td>
</tr>
<tr>
<td>Total</td>
<td>96</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Based on Table 4.3, 86.5% of the respondents own less than 5 acres of land, while only 13.6% own 5 and above acres of land. The finding that most respondents own small pieces of land explains why they utilize papyrus resource through papyrus harvesting and crafts making. On the contrary, the size of the farm does not necessarily determine high economic returns, but more so the means to develop it.

4.3 Effects of Papyrus Resource Utilization on the Swamp Ecosystem

The results presented in the following sections are based on RS image analysis and the findings from the field study conducted at the Kusa Swamp regarding the utilization and conservation of papyrus plants for sustainable livelihoods. It is important to note that the findings were based on the willingness of the people to respond to the issues raised by the study and most responses revolved around their views concerning utilization and
conservation of the swamp resources. Papyrus users were very positive in their responses as opposed to farmers who thought they will be evicted from the ecosystem immediately.

Papyrus resource is utilized through harvesting in Kusa swamp. This might have resulted in papyrus habitat decline and reduction in papyrus availability as depicted in the results from RS image analysis discussed in the following section.

4.3.1 Results from RS Image Analysis

The RS image analysis was included in the study to enable the researcher to gather information on change in area covered by papyrus. The analysis of RS images of the year 1985, 1988, 1995, 2000 and 2008 showed that a Landsat image of Kusa Swamp ecosystem for 1985 (Figure 4.2) had the area covered by papyrus (Green) being 65.7 km\(^2\) (41% of the total area) (Figure 4.3). The area covered by the other land cover categories was 95.56 km\(^2\) (59% of the total area). This meant that a larger area was covered by papyrus (41%) as compared to settlement, bare ground and farming which covered 30% (Red) and 21% (Grey) respectively. Probably, there was very minimal disturbance of the papyrus ecosystem by the local community as the population might have been low and therefore, papyrus harvesters were few. In addition, community members might have been involved in other livelihood activities.
Figure 4.2: Landsat aerial image™ of Kusa swamp for 1985

Source: Global Land Cover Facility (GLCF) (2010)
Figure 4.4 shows the Landsat image for the year 1988. The area that was covered by papyrus in 1988 was 68.9 km\(^2\) (43% of the total area), while bare ground and farming occupied 24.44 km\(^2\) (15%) (Figure 4.3). This implies that between 1985 and 1888, the papyrus area increased by 3.2 km\(^2\) (2%). On the other hand, bare ground and farming area decreased from 21% in 1985 to 15% in 1988. There was very minimal anthropogenic interference of the papyrus ecosystem in terms of settlement, cultivation, burning and papyrus harvesting. This was due to seasonal flooding that made the swamp inaccessible. This implied that the local community was involved in terrestrial agriculture and alternative sources of income like fishing, tailoring and masonry, among others.
The area that was covered by papyrus in 1995 (Figure 4.5) was 51.74 km² (32% of the total area) (Figure 4.3). This meant that papyrus area decreased by 13.96 km² (9%) between 1995 and 1988. This was because more land (42%) was either put to farming or settlement, and this might have resulted in clearing of papyrus hence the decline in area covered by papyrus. Alternatively, the rate of papyrus utilization might have increased due to increase in human population and hence more papyrus was harvested from the landward side of the swamp creating room for settlement. Nevertheless, with all these increased activity, the local community might have not put any measures in place to conserve the swamp ecosystem.

**Figure 4.4: Landsat aerial image™ of Kusa swamp for 1988**

Source: Global Land Cover Facility (GLCF) (2010)
The area that was covered by papyrus in the year 2000 (Figure 4.6) was 41.58 km² (26% of the total area) (Figure 4.3), while the area covered by bare ground and farming was 16% and that covered by settlement was 34%. This implied that papyrus area decreased by 10.16 km² (6%), while bare ground and farming area; and settlement area increased by 3% and 5% respectively as compared to that of 1995. This meant that more papyrus area was cleared which gave room for settlement, farming and grazing. Respondents explained that people found their way back into the swamp as the effect of El Niño rains of 1997-1998 that made the swamp inaccessible due to seasonal flooding was clearing out. This result corroborates with that of Wagner et al. (2005) that the El Niño rains of
1997-98 destroyed physical infrastructure and severe stress on the environmental resources supporting most of the rural population’s livelihoods reduced. Emergence of the activities that were previously carried out in the swamp before the El Niño rains might have interfered with papyrus growth and regeneration hence reduction in papyrus area and increase in area under other land use activities.

Figure 4.6: Landsat aerial image™ of Kusa swamp for 2000
Source: Global Land Cover Facility (GLCF) (2010)

Figure 4.7 shows a Landsat image for the year 2008. The area that was covered by papyrus in 2008 was 37.68 km² (23% of the total area) (Figure 4.3). This means that papyrus area has decreased by 3.9 km² (2%) as compared to that of the year 2000. Based
on interview data, the area was affected by drought between the years 2004 and 2006 and people did not expect any yield from terrestrial agriculture, and as a result, they decided to clear and burn papyrus to convert the swamp area to farm land.

Figure 4.7: Landsat aerial image\textsuperscript{TM} of Kusa swamp for 2008
Source: Global Land Cover Facility (GLCF) (2010)

4.3.2 Papyrus Habitat Decline and Reduction in Papyrus Availability

Considerable changes in papyrus areas and land use in Kusa swamp occurred between 1985 and 2008 with area under papyrus decreasing by 43%. Larger area was lost between 1988 and 2000 (37%). Area under settlement increased by 61% showing that population
might have increased which equally increased demand for papyrus and papyrus land for other land use activities. More land under papyrus was lost during this period as was predicted by Owino and Ryan (2006) that area loss in Kusa swamp could be even faster if the population grows above the year 2000 rates (3.6%) with concomitant increase in demand for papyrus land for other land use activities. This is a great threat to the swamp and papyrus area may decrease by 86% in the year 2031 if conservation initiative is not taken urgently. Figure 4.8 shows the trend in change in area covered by papyrus between 1985 and 2008.

Figure 4.8: Trend of change in area covered by papyrus between 1985 and 2008

In addition, 45.8% of the respondents agreed that papyrus harvesting resulted in papyrus habitat decline, while 54.2% disagreed (Figure 4.9). Through interview, there was a serious decline in area covered by papyrus (Cyperus papyrus) despite remarkable rate of
papyrus regeneration. This meant that the area covered by papyrus has probably reduced. This can be explained that 54.2% of the respondents who disagreed that papyrus harvesting does not result in papyrus habitat decline assume that papyrus is a God-given natural resource that will keep regenerating in all conditions despite anthropogenic interference and cannot be depleted.

Figure 4.9: Effects of papyrus resource utilization on Kusa swamp ecosystem

Decrease in papyrus area automatically results in reduction in papyrus availability. Therefore, decrease in papyrus area by 43% means that papyrus availability has also reduced by the same percentage. About 67% (Figure 4.9) of the respondents agreed that papyrus harvesting results in reduction in papyrus availability. Interviews with papyrus harvesters and FGD with BWG also revealed that people go searching for papyrus in far places especially on the lakeward side of the swamp using boats. These findings show that papyrus that was in the landward side is depleted. This may be due to unsustainable
harvesting and clearing of papyrus to prepare land for farming. This might have resulted in land cover changes where papyrus is replaced by crops.

In addition, area under bare ground and farming fluctuated during this period where it decreased from 33.9 km$^2$ (21%) in 1985 to 20.5 km$^2$ (13%) in 1995 and increased to 25.5 km$^2$ (16%) in 2000. Finally, it decreased to 20.2 km$^2$ (13%) in 2008 (Figure 4.3). This can be explained that farming activities within the swamp are not only controlled by the ability of the farmer to clear and till the land and increase in population. It is also controlled by physical factors like rainfall intensity, reliability and duration which may result in flooding. This in turn may lead to increased papyrus regeneration rate hence reduction in area covered by bare ground and farming. Flooding discourages farmers as their crops are swept away by flood water into the lake while some rot in the swamp.

### 4.3.3 Migration and Death of Animals

As illustrated in Figure 4.9, animals suffered the most due to papyrus harvesting as 75% and 77.1% agreed that, animals in the ecosystem migrated and died respectively. This suggests that papyrus harvesting drove away animals from the ecosystem. Kusa Swamp ecosystem contains numerous animals that are of aesthetic and economic value. In spite of these, the study results show that their habitat is being destroyed. For example, the antelope (*Tragelaphus spekii*) (Bennun & Njoroge, 1999) though already rare, are also being hunted by the local people for food since it is edible. Conservation of these animals requires creation of a game reserve within the swamp ecosystem to promote ecotourism.
The lakeward side is almost choked by water-hyacinth (*Eichornia crassipes*) (Mart). As in many parts of Lake Victoria, infestation by this exotic weed (Plate 4.1) has prevented fishermen from fishing, thus forcing them to seek alternative forms of livelihood, and adding greatly to the human pressure on the swamp. In addition, some animals like hippopotamus and African python are killed for security purposes as they attack the harvester at times hence reduction in their population.

**Plate 4.1: Lake ward side of Lake Victoria infested by water hyacinth**
4.3.4 Change in Fish Diversity

About 37% of the respondents agreed that papyrus harvesting has resulted in change in fish diversity. The swamp ecosystem is a habitat for fish and provides a breeding ground. There are new species in the ecosystem which might have emerged as a result of habitat disturbance and the species that were there like mud fish and tilapia have disappeared. This finding concurred with that of IUCEA (2005) that habitat disturbance in shallow wetlands, such as bays and rivers, may also interfere with hatching of eggs and growth of young fish, household needs notwithstanding. The finding that 63.5% of the respondents said that papyrus harvesting does not change fish diversity meant that the respondents rely on fish from the lake for food and sale than fish from the swamp. As such, they are not aware of change in fish diversity in the swamp.

4.4 Activities carried out in the Swamp

The activities in the swamp were included in the study to enable the researcher to gather information on papyrus harvesting and other activities carried out in the swamp. The respondents were required to give an evaluation of the extent to which activities in the swamp has had an effect on the papyrus ecosystem. Based on the interview with the BMU, local authority, farmers and papyrus users, the riparian communities depend on the swamp for food and income from fishing, seasonal agriculture, grazing and harvesting of wetland products.
As illustrated in Figure 4.10, majority (88.5%) are involved in papyrus harvesting followed by farming (40.6%) while 16.7%, 11.5% and 1% are involved in grazing, fishing and settlement respectively. This means that the major activities carried out in the swamp are papyrus harvesting and farming. This is due to the fact that papyrus harvesting generates more income to the family than the other activities, and farming is a direct source of food which is a basic need to everyone. Fishing in the swamp is not a priority because a lot of fish is got from the lake than the swamp. On the other hand, majority (88.5%) are involved in papyrus harvesting because it is not expensive and papyrus is a natural resource that is readily and locally available. Involvement in papyrus harvesting only requires the equipment to be used in harvesting unlike other activities like farming that require financial expenditure, for example in purchase of seeds and fertilizer.

Figure 4.10: Respondents’ involvement in different activities in Kusa swamp during the study period
4.4.1 Settlement

People have settled in part of the swamp and according to FGD and observation, the swamp has reduced in size as some members of the riparian community have extended their compound or settled in land that was originally part of the swamp. Some rice farmers have also built temporary houses within the swamp ecosystem. They live there to scare away the wild animals that destroy rice in the farm. It was found from questionnaire data that only 1% of the respondents have settled in the swamp ecosystem. This means that majority (99%) have not settled in the swamp ecosystem. This shows that settlement is not a major threat to the ecological functions of the swamp. On the other hand, people fear settling in the swamp ecosystem because it is risky in that, during long rains the swamp is flooded and their houses may be swept away by flood waters and leave them homeless.

4.4.2 Fishing

Results from questionnaires showed that only 11.5% of the respondents are involved in fishing in the swamp. The swamp is a breeding habitat for fish like Nile tilapia (Oreochromis niloticus) (Aloo, 2003) and mud fish. Through interview with BMU it was found out that fish breed in the swamp ecosystem then migrate into the Lake. The finding agrees with that of Twong’o and Sikoyo (2003) where they found that some fish including the tilapia spawned and had nurseries in the zone and most juvenile fishes, including the Nile perch, regularly feed there. Similarly, Muthuri (1989); Bennun and
Njoroge (1999) found that Koguta and Kusa are important refugia for Lake Victoria’s haplochromine fish species.

This finding implies that majority (88.5%) are not involved in fishing in the swamp. Fishing activities are mostly carried out in the Lake as Kusa is adjacent to a major fish landing point Kusa Beach. This gives room for breeding to occur for sustainable fishing in the lake. According to the respondents, fishing in the swamp is done by clearing the papyrus and then a sharp spear is used to look for fish from the muddy swamp water (*chwoyo gi bidhi*). Fishing is a temporary activity papyrus harvesters are involved in as they harvest papyrus.

### 4.4.3 Grazing

The Kusa community practices mixed farming that has resulted in grazing within the swamp ecosystem (Plate 4.2). Grazing is common during drought period when the adjacent land to Kusa Swamp is dry and therefore the swamp provides good grazing ground. This finding agrees with that of Twong’o and Sikoyo (2003) that the floodplain wetland zones were often used for grazing livestock especially during the dry season.
Plate 4.2: Cattle grazing at Kusa Beach during the study period

Based on questionnaire, only 16.7% of the respondents are involved in grazing in the swamp ecosystem, while 83.3% are not involved. Grazing has little impact on the swamp ecosystem as a few (16.7%) are involved in grazing but, has led to conflict over the route to the swamp between those who own large numbers of cattle and those who own a few or none. They explained that the path followed by cattle continuously to the swamp is prone to erosion hence increased erosion in the area. A lot of soil is lost and deposited in the swamp. They added that the area Chief and Assistant Chief already have the report and they are yet to convene a meeting on conflict resolution even though some people have gone ahead to fence the paths passing through their land.
These findings meant that majority (83.3%) of the respondents either do not own cattle or they have alternative grazing fields. In addition, people fear owning cattle due to inaccessibility of the swamp. Those who own cattle may be living near the swamp and do not pass through any one’s farm to the swamp.

4.4.4 Farming
About 41% of the respondents are involved in farming activities in the swamp. The local community practices wetland agriculture to augment terrestrial production in which they grow seasonal, annual and biennial crops. Crop farming activities in the swamp are seasonal. The crops grown are maize, sugarcane, pawpaw, beans, bananas, tomatoes, arrow roots, sweet potatoes, cassava, rice and trees (eucalyptus). Farming boosts food production but on the other hand impacts negatively on the swamp ecosystem due to unsustainable farming methods. Farmers clear papyrus to create space for farming, they then drain water out of the swamp, uproot papyrus rhizomes to stop regeneration and burn the peat lands for easy cultivation.

Benefits from the swamp are lost as a result of these farming activities carried out in the swamp. This tallies with the finding of Maclean et al. (2004) that although crops provide an important source of food and income, a number of goods and services derived from the swamps, that benefit the livelihoods of local people, are lost when wetlands are drained. Based on KII, water drained from the wetland runs into the Lake directly before filtration and this poses a threat to the ecology of the lake bearing in mind that one
ecological function of a wetland is to filter water. Similarly, Kabumbuli and Kiwazi (2009) found that the drainage channels constructed for cultivation lead the water directly into the lake without filtration which poses a greater ecological risk.

It came out clearly that farmers are not aware that swamps are among the most effective ecosystems for carbon storage and that destruction of swamps through clearing and burning should be avoided. As documented by Kariuki (2000), the swamp vegetation takes up carbon from the atmosphere and converts it into plant biomass during the process of photosynthesis. In many wetlands, waterlogged soil conditions prevent decomposition of the plant material thereby retaining carbon in the form of undecomposed organic matter (Peat) (Kabumbuli and Kiwazi, 2009; GoK, 2008). The long retention of carbon in wetlands prevents excessive amounts of atmospheric carbon, thereby reducing global warming (Kariuki, 2000 and GoK, 2008). On the contrary, the retained carbon in the swamp is easily released into the atmosphere wherever peat lands are drained and exposed to fires (GoK, 2008).

Farming in the swamp has resulted in land cover changes and the lakeward side of the swamp which was initially covered by papyrus, is today covered by Hippo grass (Vossia cuspidata) (Steve Hurst) due to macrophyte succession. It is also associated with the emergence of Swamp cabbage (Ipomoea aquatica) (Plate 4.3). It resembles sweet potato plant when viewed from far.
Swamp cabbage (*Ipomoea aquatica*) is a runner plant and a climber that covers the ground and climbs any plant within its reach. The weed climbs and covers crops if not weeded frequently. It interferes with their growth as it bends them to loop downwards depriving them from sunlight. Therefore, it is a threat to regeneration and growth of papyrus plants. In cases where the weight of the weed is overwhelming, the papyrus plants bend to the ground completely and rot. This finding implies that infestation of the weed brings down ecological functions and economic benefits of the swamp. That is, it hinders regeneration and growth of papyrus, papyrus harvesting and fishing.

Land tenure system is a major factor affecting activities within the swamp ecosystem especially farming as communal ownership has given the riparian communities equal rights of ownership and use of its resources. This corroborates with the finding by
Swallow et al. (2008) that in both government land and trust land areas, there is land that is not alienated to any specific user in Nyando Basin; and that public land is very vulnerable and is often subject to abuse because of *de facto* open access. Mwakubo and Ikiara (2005) also found out that the national wetlands draft policy acknowledges this problem of open access to wetlands. This finding means that the area one prepares for farming depends on one’s physical and financial capability. After land preparation, the farm is privatized (owned by the individual farmer). While private property generally offers the tenure security that is desirable to provide incentives to prevent degradation, inappropriate privatization can also cause problems, such as when the layout of plots results in many holdings cut across steep hillsides, or when key watershed points for example spring heads and wetlands that have spatial benefits that go beyond the individual household are privatized and put under the control of one household.

### 4.4.5 Papyrus Harvesting

Papyrus harvesting is done by cutting the stem at some metres above the ground. According to the respondents, papyrus cutting should be done uniformly and selectively, meaning that only mature ones should be harvested but this is not the case in the field. This shows that papyrus is cut randomly and non-uniformly (Plate 4.4) in the swamp affecting both the lakeward and landward sections in that other plant and grass species emerge like hippo grass and swamp cabbage. The finding can be explained by the fact that papyrus harvesters cut both mature and premature papyrus which interferes with papyrus regeneration and growth.
Plate 4.4: Papyrus cut at different levels in Kusa swamp during the study period

Papyrus harvesting has probably intensified in the swamp over time causing extensive damage to the swamp ecosystem. Coupled with other activities, which include; farming and overgrazing, great threats are posed on the swamp ecosystem. As stipulated in key message ten (10) and twelve (12) of the Scientific and Technical Review Panel’s (STRP’s) 14 Key Messages for the Ramsar Convention and the future of wetlands,

"[The continuing loss and degradation of wetlands are leading to reduction in the delivery of wetland ecosystem services, yet at the same time demand for these same services is projected to increase and the projected continued loss and degradation of wetlands will result in further reduction in human well-being, especially for poorer people in less developed countries where technological solutions are not as readily available” (RCS, 2007 p.7)]."

Since papyrus harvesting is the major activity carried out in the swamp, (88.5% of the respondents are involved in papyrus harvesting as their source of livelihood), it has led to
decrease in papyrus population as majority (96.9%) of the respondent’s rate change in papyrus population as decreased, while only 3.1% rate the change as constant. The finding that most respondents (96.9%) rate change in papyrus population as decreased means that the area covered by papyrus has decreased as discussed in section 4.3.

4.4.5.1 Gender Involvement in Papyrus Harvesting

This variable (gender) was included in the study to help find out the variation in male and female involvement in papyrus harvesting. As illustrated in Table 4.4, 53% of the respondents involved in papyrus harvesting are females, while 46% are males. This finding corroborates with that of Mwakubo and Ikiara (2008) that, although papyrus activities are tiresome, women undertake these as they often use papyrus for firewood and there are no taboos or traditional beliefs against women being involved in papyrus activities. Mwakubo and Ikiara (2008) continue to explain that mat-making which is the major use of papyrus in the area is an activity that women can easily undertake; and that other activities involving the use of papyrus such as baskets, brooms, among others are liked by women.
Table 4.4: Gender involvement in papyrus harvesting

<table>
<thead>
<tr>
<th>Respondent’s gender</th>
<th>Total</th>
<th>Number involved</th>
<th>Number not involved</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>45</td>
<td>44</td>
<td>1</td>
<td>45</td>
</tr>
<tr>
<td>Female</td>
<td>51</td>
<td>51</td>
<td>0</td>
<td>51</td>
</tr>
<tr>
<td>Total</td>
<td>96</td>
<td>95</td>
<td>1</td>
<td>96</td>
</tr>
</tbody>
</table>

4.4.5.2: Rate of Papyrus Harvesting

Majority of the respondents (80%) harvest papyrus daily and only 20% do not (Figure 4.11). This suggests that a lot of papyrus is harvested per day which may lead to reduction in the area covered by papyrus in the swamp. This may be as a result of non-uniform and random cutting of papyrus which may interfere with regeneration and growth of papyrus hence emergence of new plant and grass species in the swamp.
4.4.5.3 Quantity of Papyrus Harvested

Quantity of papyrus harvested as a variable was included to enable the researcher to find out how papyrus harvesting may affect the swamp ecosystem. Percentages of bundles currently harvested for each category per day were compared with those in 5-10 years ago (Figure 4.12).
As illustrated in Figure 4.12, more bundles (82.3%) of category 1 to 3 were harvested daily from the swamp currently, while in 5 to 10 years ago, 43.8% of the same category was harvested. Initially (5 to 10 years ago) 2.4% of bundles of category 10 and above were harvested, while currently none is harvested. Through observation, interview and FGD, it was found out that harvesters are now struggling to look for papyrus all over the swamp; and instead of harvesting papyrus on the landward side of the swamp as before; they now harvest papyrus on the lakeward side. These findings suggest that papyrus is over-harvested. This may have resulted in reduction in papyrus availability and coverage.

The first objective of the study was to examine the effect of papyrus resources utilization by the local communities on the papyrus ecosystem in Kusa swamp. The study results have shown that, papyrus utilization has led to papyrus habitat decline and reduction in
papyrus availability; migration and death of animals; and change in fish diversity. The overall loss in area covered by papyrus between 1985 and 2008 was 43%. This is a great threat to the swamp ecosystem and incase conservation measures are not put in place immediately, then the papyrus ecosystem will reduce by 86% in the year 2031. Correlation analysis applied to verify the null hypothesis that there is no significant relationship between quantities of papyrus harvested per day and change in area covered by papyrus gave the following results; \( r = -0.523, \ p = 0.477 \) and \( r^2 = 0.274 \ (27\%) \). This means that 27% of decrease in area covered by papyrus can be explained by the quantity of papyrus harvested per day which implies that there is no significant relationship between quantities of papyrus harvested per day and change in area covered by papyrus. Other factors for example conversion of the swamp to farm land might have also contributed to the change in area. The null hypothesis was therefore accepted.

### 4.5 Utilization of Papyrus Resources

The study sought to examine the uses of papyrus by the neighbouring communities of Kusa swamp. The respondents were required to give an evaluation of how papyrus is used by the local community. The findings showed that 61.5% of the total population depends on papyrus directly through harvesting and mat-making. This means that papyrus is the major resource base to the local community. Thus, its depletion may cost the community a lot. According to the findings, various uses of papyrus are given in Figure 4.13.
Figure 4.13: Uses of papyrus in Kusa during the study period

It was found that 70% of the respondents use papyrus for mat making, while 30% use papyrus for basket weaving, thatching houses, chair making, partitioning houses and ceiling. This result corroborates with that of Abila (2005) and Lopez (2002) that papyrus reeds are used as a raw material to make a variety of products which include mats, ropes, roof ceiling materials, chairs and even as building materials and fuel. Through direct observation, mat-making activity was witnessed in approximately 96% of the households visited. This finding implies that demand for mats is higher than other papyrus products. Thus, the major use of papyrus in the study area is mat making.
4.5.1 Mat-making

Direct observation revealed that papyrus plant has three body parts, that is, the root (rhizome), stem (culm) and the umbel (the top most part or leaves). Part of papyrus used for mat-making is the stem (culm). It was found that papyrus is cut and the culms are left to dry to reduce the moisture content in them (Plate 4.5a). They are then transported home in head-load bundles (Plate 4.5b) and dried further until they turn brownish in colour. They are then used to weave mats as shown in Plate 4.6.

Plate 4.5(a) Cut papyrus left to dry in Plate 4.5(b) Papyrus being transported from Kusa swamp during the study period

Kusa swamp during the study period
Based on FGD with BWG, the mats are then sold in the local market or bought by wholesalers directly from households. They explained that there is no mat collection centre in the area and means of transport is very poor. The mats are transported to the market on head loads or by use of carts (carts are used by those who are referred to as financially able). This implies that mat-making is an activity carried out by poor individuals who are involved in the activity to provide for their family needs. This finding corroborates that of Mwakubo and Ikiara (2005) that the poor and vulnerable that are often female headed households, often depend on papyrus for their livelihoods.

Key Informant Interview (KII) data revealed that mat prices are low and keep fluctuating as was stated by 98% of the respondents. According to BWG, a large size mat is sold for Ksh 60 and small size ones are sold for Ksh 35 during crop harvesting period (maize and
sorghum). They further explained that the mat prices are low during drought. During this period, large mats are sold for Ksh 35 while the small ones are sold for Ksh 20 or Ksh 15 depending on the buyer’s bargaining power. Questionnaire data also gave the same results as 83% of the respondents stated that mat prices are low and fluctuate. This indicates that mat prices are controlled by the seasons. The mat prices are high during the harvesting season due to high demand as mats are needed for drying the grains.

4.5.2 Thatching Houses

Completely mature papyrus (Oudho) that cannot be used for crafts making is used for thatching houses. Mature papyrus is cut, dried in the sun completely after which they are used for thatching houses (Plate 4.7). According to the respondents, only 7% of the study population still uses papyrus for thatching houses while the rest (93%) do not. The finding may be explained that people are no longer interested in using papyrus for thatching their houses or completely mature papyrus are getting depleted.
Plate 4.7: Houses thatched using papyrus in Kusa community during the study period

4.5.3 Basket Weaving

Basket weaving is a common activity in Kusa locality as it is second to mat making. Sixteen percent of the study population uses papyrus for basket weaving. This indicates that baskets are the second widely used papyrus product in the area. Observation and KII data revealed that the baskets are marketable and attractive as women commonly use them at household level for different purposes, for instance, decorating their houses, and for shopping and storage of valuable household items.

4.5.4 Other uses of Papyrus

The findings shown in Figure 4.14 indicated that other uses of papyrus are; rope making (45%), making baby cots (5%) and brooms (15%). It is also used as firewood (35%).
This shows that ropes are widely used in the area especially for tying livestock and in fishing activities. Dry rhizomes and culms are also commonly used as firewood (35%) in the area. This is because dominant vegetation in the area is shrubs which give limited firewood. This implies that there is very little firewood and the major source of firewood is papyrus. Alternatively, they buy firewood from suppliers from Okanowach or Nyamarimba. In addition, BWG and the local administration stated other uses of papyrus as making of picture frames, tables, doors, lamp stands and window curtains. This implies that papyrus is widely used in Kusa community.

**4.6 Papyrus Bundles Used to make Mats and Other Papyrus Products per Day**

Questionnaire data showed that 86.5% of the respondents use between 2 to 6 bundles for mat making per day while only 13.5% use the same category per day for making baskets
and ropes. This implies that more bundles are used for mat making than baskets and ropes.

The second objective of the study was to examine the uses of papyrus resources in Kusa swamp. The study results have shown that the major use of papyrus resources in Kusa locality is making of mats (70%) for commercial and domestic use. Apart from mats, it is used for baskets weaving (14%), thatching houses (7%), ceiling (6%) and chair making (1%). The resources are also used to make other products for domestic and commercial use which included brooms (15%), ropes (45%) and baby cots (5%); and as fuelwood (35%). Correlation analysis carried out to test hypothesis one that, there is no significant relationship between papyrus bundles used per day to make mats and those used to make baskets and ropes gave the following results; $r=0.751$, $p=0.000$ and $r^2=0.56$ (56%). This means that 56% of the variation in the bundles used to make mats can be explained by changes in bundles used to make baskets and ropes. This implies that there is a significant relationship between the variables which show that mats, ropes and baskets are widely used in that area. The null hypothesis was therefore rejected.
4.7 Conservation of the Swamp

The third objective of the study was to evaluate different local measures used to promote conservation of papyrus ecosystem in Kusa Swamp. The respondents were required to state their opinion on conservation, involvement in conservation of the swamp and give an evaluation of the measures they use to conserve the papyrus ecosystem. The following sub-sections outline the results obtained from the interviews with respondents.

4.7.1 Opinion on Swamp Conservation

This variable was included to enable the researcher to find out whether the respondents understand and have positive attitude towards environmental conservation. The findings are shown in Table 4.5.

<table>
<thead>
<tr>
<th>Opinion on conservation</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>In favour</td>
<td>76</td>
<td>79.2</td>
</tr>
<tr>
<td>Against</td>
<td>7</td>
<td>7.3</td>
</tr>
<tr>
<td>Undecided</td>
<td>13</td>
<td>13.5</td>
</tr>
<tr>
<td>Total</td>
<td>96</td>
<td>100.0</td>
</tr>
</tbody>
</table>

As illustrated in Table 4.5, 79.2% of the respondents are in favour of swamp conservation. This implies that the local communities are willing to conserve the swamp because it is the only way through which they can sustain their resource base and livelihoods. The 7.3% of the respondents who are against conservation may be thinking that conservation of an ecosystem like Kusa Swamp means taking full control of all the
activities carried out in the swamp. This shall bar them from farming and papyrus harvesting. On the other hand, those who are undecided (13.5%) may not be aware of what conservation entails hence they cannot risk accepting or denying to conserve the ecosystem.

4.7.2 Involvement in Swamp Conservation

Respondents’ involvement in swamp conservation was included to enable the researcher to verify whether willingness to conserve the swamp results in conservation action. Majority (95.8%) of the respondents are not currently involved in swamp conservation, while only 4.2% are involved. According to the 95.8% of the respondents, they are willing to conserve the swamp but lack both internal and external support to enable them carryout the conservation activities. Secondly, they think that conservation of the swamp is total evacuation of the local community from the swamp by the government. This means that the community ceases from carrying out any activity in the swamp. As such, their willingness to conserve the swamp may determine their involvement in conservation if they are encouraged and supported. This explains why Kusa Swamp is degraded as majority of the people are not involved in its conservation. Those involved in conservation (4.2%) defined conservation in an oral interview as the act of putting in place relevant measures that can help maintain existence of a natural resource for example rotational harvesting and cultivation of papyrus. Their effort to conserve the ecosystem is overwhelmed by the degrading activities like farming and burning of papyrus.
4.7.3 Measures used to conserve the swamp ecosystem

The study sought to find out the measures used to conserve the swamp ecosystem. Kusa community was initially involved in conservation of the swamp before they gave up due to lack of internal and external support. The findings are shown in Figure 4.15.

![Conservation Measures](image)

**Figure 4.15: Local measures which were used to conserve the papyrus ecosystem**

As illustrated in Figure 4.15, 48%, 31% and 21% of the community members were involved in awareness creation, planned harvesting and institutional arrangements respectively. All these efforts died due to lack of both internal and external support from stakeholders. They were therefore discouraged and majority (95.8%) of them stopped involving themselves in conservation activities. This implied that only 4.2% are still participating.
Based on interview and FGD data, the local communities currently depend on natural factors for conservation of the swamp which include flooding and the ability of papyrus to regenerate naturally after failure of the following measures;

- Institutional arrangements where *Konyri Kendi* group was formed to supervise on papyrus utilization. This picked up but later collapsed as papyrus users (stakeholders) disagreed over controlled harvesting (20 members).

- Controlled or planned harvesting of papyrus by skipping some days (30 community members were involved). This could not work because as one skips days of the week and harvests papyrus once or twice in a week, others go daily. Therefore, it had no impact.

- Awareness creation where 46 community members volunteered to continuously advice papyrus harvesters to allow room for regeneration by harvesting mature papyrus and this landed on deaf ears. In addition, the group discouraged farmers from cutting young papyrus plants, uprooting rhizomes and burning papyrus. This did not work as farmers have their union that fully supports farming activities in the swamp. Farmers argued that they earn more income than mat makers because mat business is hand to mouth kind of business that you cannot save any cent from.
4.7.4 Proposed Conservation Measures

The respondents were requested to propose the conservation measures which when put in place can help in sustainable utilization of papyrus in the swamp ecosystem and their livelihood activities. They suggested the following conservation measures:

- Land use zoning
- Involvement of NGOs
- Papyrus cultivation
- Weed control
- Policy framework
- Institutional arrangements and stakeholder involvement (Participatory management)
- Rechanneling of Agembo canal
- Education and awareness creation
- Irrigated terrestrial agriculture
- Sustainable papyrus harvesting
- Alternative livelihood option

Some of these suggestions corroborates with the ones made by Yala swamp community during the study by Mwakubo and Ikiara (2005). They suggested formation of Community Based Organizations (CBO’s) (7.6%), regulations against burning (48.1%), co-management (7%) and category of others included: help from government, creation of other income earning activities, education and awareness creation.
4.7.4.1 Land Use Zoning

The swamp ecosystem is not used wisely. There are no boundaries to specify the area where a given human activity like farming should be carried out. The current trend is that one just clears an area he or she feels is fertile or is good for crop production, cultivates and plants the crops. Therefore, 10.4% (Table 4.6) of the respondents suggested that land use zoning is a very important step that can save the swamp ecosystem from degradation and take care of both human and ecological security. Similar finding was documented by Onyango et al. (2005) that zoning a watershed on the basis of both water and land management systems takes care of both human and ecological security. This meant that the swamp ecosystem and terrestrial land should be sub-divided in a way that a given area is set aside for farming, papyrus production and grazing. Farming, for example, should be carried out on terrestrial land.
Table 4.6: Percentage respondents’ proposal of conservation measures

<table>
<thead>
<tr>
<th>Conservation measure</th>
<th>% Yes</th>
<th>% No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land use zoning</td>
<td>10.4</td>
<td>89.6</td>
</tr>
<tr>
<td>Involvement of NGOs</td>
<td>3.1</td>
<td>96.9</td>
</tr>
<tr>
<td>Papyrus cultivation</td>
<td>6.2</td>
<td>93.8</td>
</tr>
<tr>
<td>Weed control</td>
<td>2.1</td>
<td>97.9</td>
</tr>
<tr>
<td>Policy framework</td>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td>Institutional arrangements and Stakeholder</td>
<td>15.6</td>
<td>84.4</td>
</tr>
<tr>
<td>involvement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rechanneling of Agembo canal</td>
<td>90</td>
<td>10</td>
</tr>
<tr>
<td>Education and awareness creation</td>
<td>6.2</td>
<td>93.8</td>
</tr>
<tr>
<td>Irrigated terrestrial agriculture</td>
<td>20.8</td>
<td>79.2</td>
</tr>
<tr>
<td>Sustainable papyrus harvesting</td>
<td>16.7</td>
<td>83.3</td>
</tr>
<tr>
<td>Alternative livelihood option</td>
<td>4.2</td>
<td>95.8</td>
</tr>
</tbody>
</table>

4.7.4.2 Involvement of NGOs

As illustrated in Table 4.6, minority (3.1%) of the respondents proposed the involvement of NGOs as one way through which wetlands can be conserved. This implied that 96.9% are not aware that NGOs can help in conservation of the swamp ecosystem. Collaboration of NGOs and other stakeholders especially swamp users and the government may help in conservation of the ecosystem. The projects that have been implemented in Kusa swamp include Finger Ponds wetland project by Egerton University, ECOLIVE project by VIRED International and a parallel community based wetland conservation project. The NGOs through their officials have talked to the local community on the importance of the swamp and its resources, value addition to improve the quality of the papyrus products and alternative uses of papyrus.
In Kenya, VIRED International in collaboration with other organizations and funded by the UNDP is conducting research, mobilizing communities, creating awareness, and empowering local communities to sustainably manage wetland resources in the Lake Victoria Basin (VIRED International, 2008). The focus of this programme is prudent utilization of the Nyando River wetland products for improving livelihood of the local communities (VIRED International, 2008). These activities require cooperation of the riparian community to enable the NGOs to work well.

4.7.4.3 Papyrus Cultivation

Based on KII and FGDs, papyrus harvesting has occurred over the years and people have depended on regeneration only as a way of sustaining the resource base. Cultivation of papyrus can be done by preparing the land then planting the rhizomes. Even though this has never been practised in the area in large scale, some farmers confirmed that they have tried it in their farms and it works. Based on findings in Table 4.6, cultivation of papyrus was proposed by 6.2% of the respondents as a conservation measure that can help increase papyrus coverage and ensure sustainability of the natural resource in the ecosystem. This means that 93.8% of the respondents who did not have this idea are not aware that papyrus can be cultivated. This has led to unsustainable utilization of papyrus without efforts to increase the papyrus population in the swamp ecosystem hence reduced papyrus coverage. Key Informant Interviews (KII) and FGDs data gave different results where more than 50% of the respondents said that papyrus should be cultivated to sustain the resource base. Harmonization of these mixed reactions may result in cultivation of
papyrus. According to SWM framework (See section 2.5.1), increased productivity of natural resources like in this case papyrus in Kusa Swamp is a component of integrated wetland management and cultivation of papyrus to achieve positive livelihood outcomes and sustainability of the swamp and their livelihoods in an effort in this direction.

4.7.4.4 Weed Control
Kusa swamp is infested by Swamp cabbage (*Ipomoea aquatica*) that interferes with papyrus growth and regeneration. More than 90% of the respondents said that farmers should stop clearing papyrus area for crop production as this activity largely contributes to the emergence of the weed. It was also found that the weed is heavier in some parts of the swamp than the others. Only 2.1% of the respondents (Table 4.6) proposed that the weed should be controlled. While a majority (97.9%) did not. This implies that the majority are still not sure of what should be done to clear the weed from the ecosystem. These results indicate that the weed is a threat to regeneration and growth of papyrus which is the major source of livelihood to the local community. It also hinders them from performing other activities within the swamp like papyrus harvesting, farming and grazing.

4.7.4.5 Policy Framework
According to questionnaire results 10% of the respondents (Table 4.6) suggested putting in place a policy framework that can help in swamp conservation. There are no wetland policies that can be implemented at the local level to help conserve the swamp.
Conversely, they said that the existing policies support agricultural and development activities within the swamp which in the process degrade the swamp ecosystem. A similar finding was documented by GoK (2008); Mwakubo and Ikiara (2005); Lopez (2002) that Kenya pursued a sectoral approach to conservation and development in the past, which has not addressed the cross cutting environmental and conservation issues and this has led to intersectoral inconsistencies leading to further loss of the country's natural resources including wetlands. These results indicate a major failure of the government to conserve the swamp.

Policy framework as suggested in the study results is a management strategy that can help in conservation of Kusa swamp. Therefore, management of Kusa Swamp calls for formulation of wetland management policy. Similarly, Kenya is a signatory to Ramsar Convention and as such is under obligation to take legal and policy measures to protect its wetlands like Kusa swamp and these include the actions stipulated in the Ramsar Convention (Odote et al., 2008). In addition, the country has laws and policies that seek to address the conservation and wise use of wetlands which include the Environmental Management and Coordination Act (EMCA) of 1999, the Water Act 2002, the water policy and the Forest Policy 2007; and the Wildlife (Conservation and Management) Act (GoK, 2008 and Odote et al., 2008). Despite the existence of these laws, wetlands including the Kusa swamp continue to be degraded and at the risk of extinction.
This result is similar to that of GoK (2008) and Odote et al. (2008) that in recognition of the need to involve more actors to ensure an integrated and harmonized conservation and management by the government as well as the other affected players, the government has seen the need for a wetland management policy framework that seeks to ensure that the plans and activities of the government and wetland stakeholders promote conservation and sustainable/wise use of wetlands. The policy provides a framework for actions to improve institutional and organizational arrangements, address legislation and government policies, increase knowledge and awareness of wetlands and values, review the status of and identify priorities for wetlands in a national context, and address problems at particular wetland sites such as Kusa swamp.

4.7.4.6 Institutional Arrangements and Stakeholder Involvement

The institutions that are in place are WRMA, WRUAs and BMU that are not doing much to protect the wetlands. There is an urgent need to form a very active WMC that works closely with the community, government, NGOs and other institutions like BMU, among others, to solve the problems and conserve the swamp for sustainability of the resource base. As illustrated in Table 4.6, 15.6% of the respondents proposed a participatory management strategy of institutional arrangements and stakeholder involvement as a conservation measure. This finding corroborates to that of Kabumbuli and Kiwazi (2009) that community participation is a prerequisite to the management of natural resources, and to the achievement of alternative livelihoods.
The community fully supported the formation of local institutions to help them manage the swamp sustainably. This is because the entire riparian community depends on papyrus for their livelihoods hence depletion of papyrus is a threat to their livelihood. Similar finding was documented by Mwakubo and Ikiara (2005) where Yala swamp community suggested formation of CBO’s as a way of effectively controlling papyrus harvesting in that it provides some sort of ownership hence controlled access to papyrus. According to SWM framework (See Section 2.5.1), integrated wetland management requires proper governance (accountability, transparency, equity and efficiency), participation and empowerment (Vishnudas et al., 2008). The institutions formed should depict these qualities for sustainability of both the institutions and the swamp to be achieved, thus safeguarding community livelihoods.

4.7.4.7 Re-channeling of Agembo Canal or River Omwaga (Nyando tributary)

It was found out through interview that Agembo canal emptied its water into the swamp before it was blocked by downstream water users. This finding is similar to that of IUCEA (2005) that the canal no longer receives water from river Nyando leading to declining ecological integrity in the swamp. Ninety percent (Table 4.6) of the respondents proposed rechanneling of Agembo canal as a conservation measure. This implies that minority (10%) have not identified the relationship between the canal and swamp conservation. As a result, they have not bothered to fight for rechanneling of this canal to bring water into the swamp. Opening the canal will increase the water level hence improved ecological functions of the swamp. Revival of the river will also increase the
rate of papyrus regeneration and naturally control human activities in the swamp like farming.

4.7.4.8 Education and Awareness Creation

Education and awareness creation was proposed by 6.2% (Table 4.6) of the respondents as a conservation measure. This implied that 93.8% (majority) did not. This can be explained that majority of the people in the community are not aware that education and awareness creation is a tool to ecosystem conservation. This implied that riparian communities of Kusa swamp need sensitization by experts on conservation in organized seminars, stakeholder and community meetings to improve their understanding of the functions, services and importance of the swamp. This might equally improve their conservation skills and hence adoption of sustainable utilization and management of the ecosystem for sustainable livelihoods.

4.7.4.9 Irrigated Terrestrial Agriculture (ITA)

Irrigated Terrestrial Agriculture (ITA) as a conservation measure was proposed by 20.8% of the respondents (Table 4.6). Compared to all the other measures, ITA was proposed by many respondents which meant that the local communities are willing to reduce the rate of swamp cultivation. They have already realized that wetland agriculture is a threat to conservation of the swamp ecosystem and may result in conflict between conservation and cultivation and depletion of the swamp resources hence reduced swamp benefits and functions. Lopez (2002) documented a similar finding that conflicts between
conservation and cultivation purposes occurred in papyrus swamps around Lake Naivasha due to development pressure.

Through observation, it was found that farming activities are carried out up to the interior parts of the swamp (Plate 4.8). More crop yield is obtained from the swamp than terrestrial land because wetland soil is more fertile and contains enough water and moisture that sustains the crops. This implies that improved farming practices which included irrigation and application of fertilizers to improve soil fertility may give high yields from terrestrial agriculture.

Plate 4.8: A farmer weeding maize at the interior part of the swamp during the study period
4.7.4.10 Sustainable Papyrus Harvesting

Table 4.6 shows that 16.7% of the respondents proposed sustainable papyrus harvesting as a conservation measure, while 83.3% did not. It is likely that 83.3% of the respondents could be feeling that sustainable papyrus harvesting will bar them from cutting papyrus daily and this is their only livelihood option. This is because they believe that papyrus regenerate immediately after cutting and no other measures are needed to sustain it.

Unsustainable cutting of papyrus for the local mat-making industry has the potential to destroy the swamp. This finding corroborates with that of Oumba et al. (2010); Abbot and Afework (2001) that unsustainable harvesting of papyrus brings with it ecological changes in the swamp as monthly harvesting reduced papyrus biomass regeneration potential. However, seasonal (6-monthly) harvesting did not appear to affect papyrus biomass regeneration potential (Oumba et al., 2010).

On the other hand, it is likely that 16.7% of the respondents have realized that papyrus harvesting should be controlled to sustain the resource base. This implies that the riparian communities should practice rotational harvesting (a portion of the papyrus ecosystem is left for a specified duration to regenerate as the other portion is harvested). In addition, supervision of papyrus cutting for selective and uniform cutting may help conserve the swamp. Observation of off harvesting days is another strategy to ensure sustainability of the resources base.
4.7.4.11 Alternative Livelihood Activity

As illustrated in Table 4.6, 4.2% of the respondents proposed alternative livelihood activity as a conservation measure. These respondents have probably realized that continued dependence on papyrus utilization will lead to depletion of papyrus, degradation and loss of the swamp ecosystem; and consequently loss of their livelihood. This clearly shows that majority (95.8%) of the respondents are deeply involved in papyrus utilization. Responses from KII and FGDs echoed similar views of seeking alternative livelihood options instead of depending solely on papyrus utilization. This explains why some community members are already involved in business, terrestrial farming or masonry as an alternative livelihood option. This finding corroborates that of Kinaro (2008) that availing other production options like financial and human empowerment, other livelihood strategies can be constructed like engagement in non-farm activities that generate income. Similarly, he echoed that the strategies include opportunities to access education, skills and knowledge to help take other livelihood choices; access to financial resources including wage employment, credit facilities and social networks and cooperatives.

The study results also show that the riparian communities of Kusa swamp are fully dependent on the swamp for their livelihoods through papyrus harvesting for mat making and farming. This creates pressure on the swamp that results in degradation and loss of the swamp, hence reduction in benefits obtained from the swamp. Unsustainable resource utilization therefore results in unsustainable livelihoods as the available resources are not
conserved for the future generation. This finding is similar to that of Kipkemboi et al. (2002) that encroachment and loss of African wetlands is expected to have a profound impact on the riparian livelihoods with time. A livelihood is sustainable when it can cope with and recover from external stresses and shocks, and maintain or enhance its capabilities and assets now and in the future (PC, 2007).

The third objective of the study was to evaluate different local measures used to promote conservation of papyrus ecosystem in Kusa swamp. The study results have shown that 79.2% are in favour of swamp conservation. The local community initially conserved the swamp through awareness creation (48%), planned harvesting (31%) and institutional arrangements (21%). Due to lack of both internal and external support, they were discouraged and currently they depend on flooding and the natural ability of papyrus to regenerate. These measures are not adequate. In light of these, the respondents proposed certain measures which if put in place could help conserve the ecosystem. These included ITA (20.8%), sustainable papyrus harvesting (16.7%), institutional arrangements and stakeholder involvement (15.6%); and land use zoning (10.4%), among others. Correlation analysis applied to verify the null hypothesis that there is no significant relationship between the opinion the community hold on conservation of the swamp and the number of community members involved in awareness creation, planned harvesting of papyrus and institutional arrangements gave the following results; $r = 0.892$, $p = 0.299$ and $r^2 = 0.796$ (80%). This means that 80% of the opinion the community members hold on swamp conservation may result in implementation of the conservation measures
which implies that there is indeed a significant relationship between the variables hence the null hypothesis was rejected.
CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter deals with summary of main findings, conclusions, and the recommendations of this study and areas for further research. The main objective of this study was to assess the utilization and conservation of papyrus plants in Kusa swamp, Lake Victoria. The summary of findings, conclusions and recommendations outlined in this chapter were based on this primary objective.

5.2 Summary of Main Findings

The first objective of the study was to examine the effect of papyrus resources utilization by the local communities on the papyrus ecosystem in Kusa swamp. The study results have shown that, papyrus utilization has led to; papyrus habitat decline, reduction in papyrus availability, migration and death of animals; and change in fish diversity. The overall loss in area covered by papyrus between 1985 and 2008 was 43%. This is a great threat to the swamp ecosystem and in case conservation measures are not put in place immediately, then the papyrus ecosystem will reduce by 86% in the year 2031. Correlation analysis applied to verify the null hypothesis that there is no significant relationship between quantities of papyrus harvested per day and change in area covered by papyrus was accepted.
The second objective of the study was to examine the uses of papyrus resources in Kusa swamp. The study results have shown that the major use of papyrus resources in Kusa locality is making of mats for commercial and domestic use. The resources are also used to make other products for domestic use which included baskets, chairs, brooms, ropes and ceiling houses. Apart from these, papyrus is also used for thatching houses and as fuelwood. Correlation analysis carried out to test hypothesis one that, there is no significant relationship between papyrus bundles used per day to make mats and those used to make baskets and ropes was rejected.

The third objective of the study was to evaluate different local measures used to promote conservation of papyrus ecosystem in Kusa swamp. The study results have shown that, the local community currently depends on flooding and the natural ability of papyrus to regenerate. This natural state of regeneration is being treated as a conservation measure in the study area. In light of this, the respondents proposed certain measures which if put in place could help conserve the ecosystem. These included, policy framework, institutional arrangements and stakeholder involvement; alternative livelihood options, education and awareness creation; irrigated terrestrial agriculture, sustainable papyrus harvesting, involvement of NGOs, land use zoning, weed control, papyrus cultivation and rechanneling of Agembo canal as appropriate conservation measures that can be put in place to conserve the swamp. Correlation analysis applied to verify the null hypothesis that there is no significant relationship between the opinion the community hold on
conservation of the swamp and the number of community members involved in awareness creation, planned harvesting of papyrus and institutional arrangements was rejected.

5.2 Conclusion

The study made the following conclusions:

1. Utilization of papyrus resources by the local community has affected the Kusa Swamp ecosystem in various ways, which included, decrease in area covered by papyrus, reduction in papyrus availability, migration and death of animals adapted to the ecosystem and change in fish diversity. Farming also contributes to decrease in the area covered by papyrus.

2. Quantities of papyrus harvested daily do not necessarily lead to decrease in area covered by papyrus. It is attributed largely to conversion of the swamp to agricultural land and infestation of the swamp by the invasive weed. Therefore, there is no significant relationship between quantities of papyrus harvested daily and change in area covered by papyrus.

3. Clearance of papyrus beds for agricultural activities (farming) renders the swamp less suitable for the plants and animals that are adapted to the ecosystem, and grazing ground for cattle at times of drought. On the other hand, papyrus harvesting and conversion of the swamp is not bad at all for they have provided for the local community and helped enhance the livelihood base. Development could have both positive and negative sides and at times may require that some sacrifices are made, like discarding some of the traditional lifestyles and adapting
new and modern systems including irrigation and controlled harvesting of wetland resources.

4. Making of mats is the major use of papyrus in Kusa locality. Making of mats has gained popularity in the area as it is the major source of income to the area residents. Papyrus is also used for making of baskets, ropes, brooms and for fuel (firewood). There is no significant relationship between papyrus bundles used per day to make mats and those used to make the other papyrus products. Baskets, ropes and fuelwood are widely used in the area and as such value addition techniques will create market to the local community hence creation of more livelihood opportunities.

5. The local community living around the swamp continues to depend on the swamp for their livelihoods which include papyrus harvesting, farming, fishing, grazing and water, amongst many other benefits.

5.3 Recommendations

Environmental conservation is a key issue in development agenda as depicted in Agenda 21, the Kenya Vision 2030 and the Millennium Development Goals. Papyrus use should be sustainable hence minimizing the effects of its harvesting on the swamp ecosystem. The study came up with the following recommendations which are vital for the sustainability of Kusa Swamp and continuity of livelihood activities within the swamp ecosystem.
i. To help compensate for loss of papyrus, alternative sustainable livelihood and development options need to be considered by the stakeholders including recreation, research and educational sites and irrigated terrestrial agriculture where agro-forestry is practiced. It is hoped that such management principles should be put in place by the stakeholders to help meet the needs of an increasing population while conserving the swamp ecosystem.

ii. The local community should be sensitized through multi-media approach by experts (stakeholders) on the importance of the natural ecosystems like swamps for them to have wider knowledge about them to enhance their conservation efforts.

iii. Conservation and general management of the swamp requires multi-stakeholder approach. Involvement has to be promoted through empowerment in skills development, education, public awareness and information exchange. This will also increase their level of participation in conservation activities.

iv. Construction of product display centers where papyrus products are shown for customers to make their choices and educate the local community on alternative uses of papyrus should be a priority.

v. Promotion of ecotourism by the government in the area will help create employment, provide market for the crafts and generate income to the local community and the entire nation. Kusa beach, for example, is a very good tourism site because it is a fish landing point where boat riding can be done. In addition, finger ponds provide good scenery for research and individual development. Birds
(various species), wild animals like hippopotamus, antelopes among others and unique plants like papyrus provide good tourism sceneries. Improving the area for this activity will provide alternative livelihood activities to the local community.

vi. Stakeholders should come up with wetland policies as a key development agenda. This will help in conservation of papyrus swamp ecosystems and other wetland ecosystems in general. Formulation of these policies has been a nightmare in the past. The government should take charge as the umbrella stakeholder to involve the other stakeholders in the formulation of these policies and means of enforcing them.

vii. Industrialization as envisaged in the Kenyan vision 2030 could be enhanced by Kusa area having a cottage industry to manufacture papyrus products of high quality. The local community is highly in favour of this as it will provide employment to the youth and develop the roads.

viii. Achieving sustainability requires integrated wetland management where natural resources, technology, institutions and economics are considered. SWM has been integrated in the study to help in understanding of the intricate inter-linkages between natural resources, technology, institutions and economics in sustainable management of natural resources. There is need for the willingness of key stakeholders to work together and explore how separate and often divergent views can be shared in balancing trade-offs in the wise and sustainable utilization of papyrus and the swamp to meet both present and future needs. Considering the controversies that have been witnessed before regarding the activities in the
swamp, an elaborate Environmental Impact Assessment (EIA) should always be in place and be strictly enforced, prior to the decisions to develop the swamp further and that local involvement and participation be present in all stages.

ix. Sustainable utilization of Kusa Swamp requires that, the proposed conservation measures which included land use zoning, involvement of NGOs, papyrus cultivation, weed control, policy framework, Institutional arrangements and stakeholder involvement; rechanneling of Agembo canal, education and awareness creation; irrigated terrestrial agriculture, sustainable papyrus harvesting and alternative livelihood options are implemented. Involvement in conservation of the swamp is a very vital step for the implementation of these proposed measures.

5.4 Areas for Further Research

The study of the Kusa Swamp was by no means exhaustive, and the following areas are recommended for further research.

- Since the beginning, style and design of mat making by riparian communities of Kusa Swamp has never improved. Research should be done on value addition on papyrus products. This can help improve their quality, create market and increase the income of the riparian communities of Kusa Swamp.
- There should be studies on the effect of Swamp cabbage (*Ipomoea aquatic*) on Kusa Swamp ecosystem. This may help in examining the potentials and constraints of the invasive weed on papyrus plants and farming activities in the
swamp. This will also assist in planning for conservation of Kusa Swamp ecosystem.

- Future of Kusa swamp studies need to include gender and related contemporary issues. For instance, the influence of culture and role of women and youth in the conservation and development of Kusa swamp resources should be studied including the contribution of wetland-based enterprises towards the alleviation of poverty.
REFERENCES


APPENDICES

APPENDIX I: QUESTIONNAIRE

PREAMBLE

Dear Sir/Madam, I am Ms Janet Auma, a Master’s student at Kenyatta University. I would appreciate your contribution to this study dealing with assessment of the utilization and conservation of wetland papyrus plants for sustainable livelihoods in Kusa Swamp. Please be free to give answers to the best of your knowledge. I am assuring you that the response you give will be kept confidential according to the research regulations of Kenyatta University.

Thank you for your willingness to participate in this research.

A: PERSONAL INFORMATION

1) Name _____________________________________________________________

2) Gender

Male  □  Female  □

3) Sub-location ______________________________________________________

4) What is your age in years? ________________________________________

5) What is your level of formal education?

   a) None  □  b) Primary  □  c) Secondary  □
   d) College  □  e) University  □

6) What is the size of your family? _________________________________

7) What is your occupation? ________________________________
8) What is the size of your farm? ______________________
   a) Less than 5 acres □  b) 5-10 acres □  c) More than 10 acres □

9) What is your total monthly income bracket?
   a) Below Ksh2500 □  b) Ksh2500-5000 □  c) Ksh5000-10000 □
   d) Ksh10000-20000 □  e) Above Ksh20000 □

B: UTILIZATION OF PAPYRUS

10) Which activity(s) take place in the swamp area?
    a) Farming □  b) Fishing □  c) Settlement □
    d) Papyrus harvesting □  e) Grazing □
    Other (specify) _____________________________________________

11) Which of the above activities are you involved in? ______________________

12) If you are involved in papyrus harvesting as one of the activities stated in ‘12’ above, how many bundles do you harvest in a day?
    a) 1-3 bundles □  b) 3-6 bundles □
    c) 6-9 bundles □  d) 10 bundles and above □

13) How many bundles were you harvesting before (5-10 years ago)?
    a) 1-3 bundles □  b) 3-6 bundles □
    c) 6-9 bundles □  d) 10 bundles and above □

14) How often do you harvest papyrus?
    a) Daily □  b) Weekly □  c) Monthly □  d) Annually □
15) What do you use the papyrus for?
   a) Mat making       Yes ☐  No ☐
   b) Basket weaving   Yes ☐  No ☐
   c) Chair making     Yes ☐  No ☐
   d) Thatching houses Yes ☐  No ☐
   e) Partitioning houses and ceiling Yes ☐  No ☐
   f) Other specify ________________________________________________

16) How many bundles do you use per day for?
   a) Mat making ________  b) Other uses stated above ______________________

17) Are there small-scale or large-scale industries that use papyrus in the area?
   Yes ☐  No ☐

18) What problems do you experience with papyrus, if any?
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________

19) Are you aware of the effects of papyrus resource utilization on;
   i) the environment?
      a) Yes ☐       b) No ☐
   ii) If yes in (i) above, what is the effect?
      a) Papyrus habitat decline Yes ☐  No ☐
      b) Migration of animals and birds adapted in the wetland ecosystem
c) Death of animals and birds adapted in the wetland ecosystem
   Yes [ ] No [ ]

d) Reduction in the availability of papyrus as a raw material for cottage industry
   Yes [ ] No [ ]

e) Change in fish diversity Yes [ ] No [ ]

g) Other specify _________________________________________________________

C: CONSERVATION OF PAPYRUS

20) When did you start seeing papyrus in this area?
   a) Less than 2 years [ ] b) 2-5 years [ ] c) 5-10 years [ ] d) Over 10 years [ ]

21) How was the papyrus when you first settled here?
   a) Thick [ ] b) Scattered [ ] c) Not there [ ]
   d) Other specify _______________________________________________________

22) Is there a change in papyrus population? Yes [ ] No [ ]
   i) If yes, then, how do you rate the change?
   a) Decreased [ ] b) Constant [ ] c) Increased [ ]

23) In case the papyrus population is decreasing, what is your opinion about papyrus conservation?
   a) In favor [ ] b) Against [ ] c) Undecided [ ]
   d) Other specify________________________________________________________

24) Are you involved in conservation of papyrus ecosystem?
a) Yes □  b) No □

25) Which measures are you using to promote conservation of papyrus ecosystem?

____________________________________________________

____________________________________________________

____________________________________________________

____________________________________________________

26) What do you think can be done by the local community to promote papyrus conservation?

____________________________________________________

____________________________________________________

____________________________________________________

____________________________________________________

27) What support do you need from the government and other relevant authorities like WRMA, WRUAs, NEMA and NGOs to conserve the papyrus ecosystem?

____________________________________________________

____________________________________________________

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____________________________________________________

____________________________________________________
Kindly use the space below for any additional information.

________________________________________________________________________

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THANK YOU FOR YOUR TIME AND PARTICIPATION
APPENDIX II: INTERVIEW GUIDE FOR KEY INFORMANTS

INTRODUCTION

Dear Sir/Madam, I am Ms Janet Auma, a Master’s student at Kenyatta University. I would appreciate your contribution to this study dealing with assessment of the utilization and conservation of wetland papyrus plants for sustainable livelihoods in Kusa Swamp. Please be free to give answers to the best of your knowledge. I am assuring you that the response you give will be kept confidential according to the research regulations of Kenyatta University.

Thank you for your willingness to participate in this research.

NAME OF INSTITUTION

__________________________________________________________________________________

Location

__________________________________________________________________________________

Name of officer

__________________________________________________________________________________

Designation of the Officer

__________________________________________________________________________________

1. What are the uses of papyrus plants in Kusa area? Name them.

2. Does papyrus utilization improve the socio-economic status of the people in Kusa area?

3. What are the effects of over harvesting papyrus on the papyrus ecosystem?

4. What is your opinion about the conservation of papyrus in Kusa Swamp?
5. Which conservation measures are put in place to protect papyrus and the swamp?

6. How can papyrus utilization co-exist with the livelihood activities in the wetland area?

THANK YOU FOR YOUR TIME AND PARTICIPATION
APPENDIX III: FGD GUIDE

1. What are the uses of papyrus plants in Kusa area?

2. Does papyrus utilization improve the socio-economic status of the people in Kusa area?

3. What are the effects of over harvesting papyrus on the papyrus ecosystem?

4. What is your opinion about conservation of papyrus in Kusa Swamp?

5. Are you involved in conservation of papyrus in the swamp? How?

6. Apart from the conservation measures mentioned in 5 above, which other measures are put in place to protect papyrus and the swamp?

7. How can papyrus utilization co-exist with the livelihood activities in the wetland area?