

**ASSESSMENT OF THE SUSTAINABLE UTILIZATION AND
MANAGEMENT OF PAPYRUS (*CYPERUS PAPYRUS*) IN
DUNGA WETLAND, KISUMU MUNICIPALITY, KENYA**

BY

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**A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF MASTER OF
SCIENCE IN URBAN ENVIRONMENTAL PLANNING AND
MANAGEMENT**

SCHOOL OF ENVIRONMENT AND EARTH SCIENCES

MASENO UNIVERSITY

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ABSTRACT

Papyrus, a natural wetland product is an important resource for man's livelihood, and ecosystem functions. Its value in the past was not fully recognized, thus degraded. Its loss and degradation leads to loss of local livelihoods and ecosystem services. Unplanned land use in towns around papyrus ecosystem has compromised papyrus stability and functioning. Its exploitation in Dunga has been so intensified and threatened towards extinction. There is need to use papyrus wisely for environmental services and alleviation of poverty. Under the present conditions conservation of papyrus does not seem to succeed. However, during the last years significant initiatives from community, organizations and authorities have been promoted to change the situation. These current efforts seem neither enough nor totally effective to avoid papyrus depletion in urban areas. The study was conducted in the period of July – August 2007 area around Dunga wetland in Kisumu Municipality on the shores of Lake Victoria to establish utilization and management of papyrus. The objectives of the study included, to: investigate the socio-economic characteristics of Dunga Human Population; determine the state of utilization and harvesting challenges of papyrus in Dunga wetland; examine factors contributing to unsustainable utilization and management of papyrus; and generate a management model of papyrus in Dunga wetland. The study area population is about 45,375 in 13,956 households. A total random sample of 337 households engaged in papyrus harvesting, management and crafts along the edge of the wetland were interviewed using a structured questionnaire. Additional key informants interviews, focused group discussions, field surveys, photography and review of existing literature was conducted to collect data on papyrus use and its management systems. Data was analyzed by descriptive statistics. Results showed that demographics, poverty situation and social vulnerability factors led to uncontrolled use of papyrus. Utilization of papyrus was in two ways in Dunga; either commercial or non-commercial. About 81.3 % of respondents produce papyrus mats intensively for markets. Papyrus use is considered family occupation for alternative source of income and domestic use. Papyrus is abundantly used to make herbal medicine, construct houses, make fences, brooms as well as used as fuel wood among non-commercial uses. There is increasing rate of using papyrus to make value added items to fetch more incomes. The harvesting of papyrus is done randomly, a reason for great depletion of papyrus stocks in the wetland. The main challenges of harvesting papyrus include risks of drowning, insect bites and scares from animals as well as conflicts among papyrus harvesters, fishermen and livestock herders. The economic, social, settlement patterns and population growth factors have both direct and indirect impact on utilization of papyrus. Unsustainable management of papyrus is contributed by institutional factors such as weak urban planning, property rights

and land tenure, lack of conservation education and public awareness programmes, collapsed traditional conservation strategies, low community participation and legal and institutional framework. Sustainable development options have been recommended to improve papyrus use for improved livelihoods and sustainability. Papyrus can be utilized sustainably if trainings, diversification of income sources and value addition techniques are employed. Other options may include environmental planning and development of indirect uses of papyrus swamps such as recreation and eco-tourism, set aside for research, educational sites and agro forestry. Integrated scientific and indigenous knowledge systems can improve skills for wise use of papyrus. Local participation in papyrus management is of critical importance. Women, children and youth roles should be identified and strengthened. Established legal and institutional framework on papyrus in Kenya can protect papyrus swamps.

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ACRONYMS AND ABBREVIATIONS

CBO	Community Based Organization
ELCI	Environmental Liaison Center International
EMCA	National Environmental Management and Coordination Act
EPM	Environmental Planning and Management
IBA	Important Bird Area
IK	Indigenous Knowledge
INRM	Integrated Natural Resource Management
KWS	Kenya Wildlife Service
KARI	Kenya Agricultural Research Institute
KCC	Kisumu Municipal Council
LVEMP	Lake Victoria Environmental Management Programme
NBI	Nile Basin Initiative
NEAP	National Environmental Action Plan
NEMA	National Environmental Management Authority
NGO	Non-Governmental Organization
SWM	Sustainable Wetland Management
UNCED	UN Conference on environment and Development
WCED	World Commission on Environment and Development

DEFINITION OF TERMS

Absolute poverty level	Level of poverty below the minimal requirements necessary to afford minimal standards of food, clothing, health care and shelter
Agenda 21	Is a Rio de Janeiro, Brazil 1992 UN Conference on Environment and Development (UNCED) non-binding, voluntarily implemented action plan of the United Nations with regard to sustainable development focusing the 21st century
Biodiversity	Is the degree of variation of life forms within a given species, ecosystem and biome or an entire planet
Biota	The plant and animal life of a region
Brundtland Commission	It was formally known as the World Commission on Environment and Development (WCED), the Brundtland Commission's mission is to unite countries to pursue sustainable development together
Carbon fixation	Is the reduction of inorganic carbon (carbon dioxide) to organic compounds by living organisms
Commercial uses of	Making papyrus products for markets

papyrus

Conflicts Differing acts that undermine parties or users of papyrus and the swamp resources

Conservation The sustainable use as well as management of natural resources

Degradation Is the deterioration, change or disturbance of the environment through depletion of natural resources and the destruction of ecosystems and the extinction of wildlife

Diversity The number of different species and their relative frequency

Ecosystems Is a community of living organisms (plants, animals and microbes) in conjunction with the nonliving components of their environment (things like air, water and mineral soil), interacting as a system.

Endemic Organisms that are indigenous in the papyrus swamp

Encroachment Advancement into the papyrus swamp

Environment The physical and biological factors along with their chemical interactions that affect an organism

Environmental Is the process of facilitating decision making to carry out

planning	development with due consideration given to the natural environmental, social, political, economic and governance factors and provides a holistic frame work to achieve sustainable outcomes
Environmental management	A purposeful activity with the goal to maintain and improve the state of an environmental resource affected by human activities
Fisheries	Diversity of fish resources found in the area
Food poverty	Food scarcity among the human population
Habitat	Is an ecological or environmental area that is inhabited by a particular species of animal, plant or other type of organism. It is the natural environment in which an organism lives, or the physical environment that surrounds a species population
Habitat degradation	The deteriorations of species environment
Harvesting pressure	Over-harvesting beyond the sustainable level
Harvesting systems	Methods and procedures used to harvest papyrus
Hazard	Is a situation that poses a level of threat to life, health, property, or environment
Important Bird Area	Is an area recognized as being globally important habitat

	for the conservation of bird populations
Informal employment	Employment offered by the informal sector
Informal sectors	Is that part of an economy that is not taxed, monitored by any form of government, or included in any gross national product (GNP), unlike the formal economy
Information failures	Lack of perfect knowledge in the marketing of papyrus products
Institutional framework	The systems of formal laws, regulations, and procedures, and informal conventions, customs, and norms, that shape socio-economic activity and behavior
Intensification	Production that is concentrated with high inputs for maximum benefits
<i>Jua Kali</i>	Local cottage industry
Lacustrine	Still water-ecosystem wetland
Land tenure	Access is granted to rights to use, control, and transfer land, as well as associated responsibilities and restraints
Land-use change	A process by which human activities transform the landscape
Livelihoods	A set of economic activities, involving self-employment,

	and or wage employment by using one's endowments (both human and material) to generate adequate resources for meeting the requirements of the self and household on a sustainable basis with dignity
Non-commercial uses	Products made for household or domestic use and not for markets
Over-dependence on papyrus	Over- relying on papyrus for livelihoods
Over-exploitation of papyrus	Extracting papyrus beyond regenerating stock
Over-harvesting	Harvesting more papyrus as required for sustainable limits
Papyrus	A wetland sedge plant also called <i>Cyperus papyrus</i>
Papyrus ecology	The relationships and functions of papyrus in its natural environment
Papyrus protection	Setting aside papyrus by controlling its disappearance
Papyrus services	Natural human and ecological functions papyrus offers in the environment
Papyrus stock	Amount of papyrus available for ecological and human services

Papyrus swamps	Marshes or wetlands occupied by papyrus
Participation	A process of involving all stakeholders in the use and management of resources
Poverty	Lack of basic human needs
Property rights	Lawful ownership of resources
Ramsar Convention	Is an intergovernmental treaty that embodies the commitments of its member countries to maintain the ecological character of their Wetlands of International Importance and to plan for the "wise use", or sustainable use, of all of the wetlands in their territories
Socio-economic characteristics	Social and economic situation of a human population in an area
Sustainable Development	Is development that meets the needs of the present without compromising the ability of future generations to meet their own needs
Sustainable Utilization	Conserve, protect and use the components of a resource wisely while maintaining its capacity to regenerate, restore
Sustainable Management	The process of using resource developing humans while maintaining the environment, the needs of present and

	future generations, and the economy
Slum	Unplanned urban settlement
Traditional conservation	The local and indigenous strategies put in place to use, control and manage natural resources
Traditional papyrus uses	The local commercialized and non-commercialized products of papyrus made by local artisans using local skills and technologies
Value added items	These are items made by adding extras or combining other materials in the production process
Vulnerability	The degree of susceptibility of socio-economic status of people and the wetlands to be easily impacted
Water hyacinth	A free-floating perennial aquatic plant (or hygrophyte) native to tropical and sub-tropical
Wetlands	Areas of marsh, fen, peatland, or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6 meters
Wetland Policy Bill	Formal guideline and regulation formulated by government and stakeholders to protect and conserve the

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Globally papyrus swamps are part of complex environmental and socio-economic distinctive systems. In Africa, papyrus wetlands are estimated to be 400,000 ha but their extent is decreasing due to human encroachment and intensified land use changes around them (Hughes and Hughes 1992; Mafabi 2000). In Kenya, papyrus swamps are patchy and localized, and are found mainly along river inflows on the shores of Lakes: Victoria, Naivasha and Jipe (Bennun and Njoroge 1999). There is no single papyrus swamp in Kenya is formally protected or has land use change and encroachment status established (Nasirwa and Njoroge 1997; Schutter 2003; Bennun and Njoroge 1999) or wastewater reservoirs/ponds/lagoons/dams constructed by man (Abira, 1997).

Though most wetlands are important habitats worldwide, papyrus dominated wetlands are under increasing human pressure (Kibwage et al, 2003). High population densities are found around urban wetlands because of the availability of land, cheap shelter, water and valuable wetland resources such as fish, papyrus and other crafts materials, firewood, birds and medicinal plants. In Kenya, the

urban sprawl has increased in the 21st century and over-use of the wetland products is a threatening ecological phenomena.

Papyrus is mainly harvested for various social-cultural, economic and subsistence reasons (traditional uses). As many dwellers in both rural and urban experience inadequate food and income, they venture into use of wetland resources in persistence patterns. Especially papyrus in Kenyan wetlands is further cleared and burned to pave way for other land uses such as wetland agriculture, and in this way sometimes such alteration influence vegetation succession which further influence grazing in times of drought and eventual disappearance of papyrus. The total area under papyrus in Kenya in the 21st century was large enough for ecological balance and economic functions but the coverage has been decreasing at a 34 to 50 per cent rate of papyrus loss resulting in many small, fragmented patches which may lead to wetland extinction and new land uses (Owino *et al* 2007). New land uses succeeding the wetlands sometimes make environment and livelihoods vulnerable and unbearable. Papyrus support food chains and other ecological functions. The impact of papyrus harvesting has been habitat degradation or loss in the specialist species like the endemic papyrus birds (e.g. threatened *Papyrus Gonolek*) and mammals (e.g. the East Africa's only truly amphibious antelope, the sitatunga *Tragelaphus spekii*) in the case of papyrus loss (Bennun and Njoroge, 1999; Owino *et al* 2007).

Management plans of these papyrus may sustain wetlands to provide a wide range of ecological functions (such as flood control, groundwater recharge, migratory bird inhabitation and nutrient cycling) that support the livelihoods of local communities as well as to provide regional and global benefits (Schutter, 2003).

1.2 Statement of the Problem

Dunga swamp is dominated papyrus, *Cyperus papyrus*, which provides multiple resources, supporting social livelihoods of the people living in the area. The swamp is close to Kisumu town, and this puts particular strain on the papyrus (Bennun and Njoroge 1999). Papyrus harvesting in the swamp is often excessive and unsustainable. The swamp is also under increasing pressure as a result of indirect problems such degradation and maybe poor management of Lake Victoria fisheries. Due to fishing problems, a many fishermen have turned to harvesting of papyrus and sometimes do clearance of papyrus in order to cultivate crops for better income or even for settlement. Over-harvesting of papyrus for thatching and making highly market-demand products such as mats and baskets is continuous and compromising the sustainability of livelihoods and ecosystem services offered by Dunga swamp. The increasing population around Dunga swamp and also dynamics of socio-cultural and poverty makes the swamp even more vulnerable to increased degradation especially when other overriding uses of

the swamp such as agriculture, grazing and settlement exist and is growing at alarming trend.

There were considerable changes in papyrus areas occurred between 1969 and 2000 leading to over 50 % in Dunga swamp, a process caused by high population growth. Thus Owino *et al* (2007) predicts that by 2020 the smaller swamps at Dunga are likely to disappear entirely. The exploitation of papyrus in Dunga swamp has been of subsistence and small-scale level from 1960 to 1980s but changing to commercial level (Gichuki *et al.* 2001). With the rapidly increasing human population and recent collapse of industries in Kisumu town, uses of papyrus is becoming more commercial but with little control since the swamp lacks formal protection by concerned authorities. Dunga swamp lacks conservation, planning and environmental management system to govern commercial papyrus use in the current and future times. On this context Dunga urgently requires formal planning and environmental management for protection and conservation.

1.3 The Objective of the Study

The general objective was to assess the utilization and management of papyrus in Dunga wetland, Kisumu Municipality.

Specific objectives were:

- (a) To investigate the socio-economic characteristics of Dunga Human Population.
- (b) To determine the state of utilization and harvesting challenges of papyrus in Dunga wetland.
- (c) To examine factors contributing to unsustainable utilization and management of papyrus.
- (d) To generate a management model of papyrus in Dunga wetland.

1.4 Research Questions

- (a) What are the major socio-economic characteristics of Dunga Human Population?
- (b) What are the major traditional uses and harvesting systems of papyrus in Dunga wetland?
- (c) Which are the factors contributing to unsustainable utilization and management of papyrus reeds in Dunga Wetland?
- (d) Which is the management model of papyrus in Dunga Wetland?

1.5 Justification of Study

Papyrus uses have increased, and surrounding settlements also has changed; therefore there is need for research to enhance development of management

approaches or guidelines for sustainable utilization and management of such wetland resources already under pressure. The findings and recommendations of this study will be useful to the local communities; managers and policy developers to enhance sustainable management and continuous utilization of papyrus. Planners, developers, policy makers and conservationist will also find this study useful because information base developed may guide them to develop sustainable utilization and management of wetland resources such as papyrus, biodiversity, water as well as other vegetation. The study will form the basis for further research on the sustainable utilization and management of wetlands in Kenya and generate new ideas for the better and more efficient management of papyrus in Kenya. The site is already a popular area for commercial activities, recreation, ecotourism and its proximity to Kisumu gives it potential for formal protection of papyrus to ensure sustainable use and management of papyrus. Therefore the purpose of this study was to assess the utilization and management of papyrus in Dunga wetland, Kisumu Municipality.

1.6 Scope and limits of the study

The study was conducted among papyrus users living around Dunga wetland in Kisumu Municipality on Winam Gulf of Lake Victoria in Kenya. In this area, local communities over rely on the use of papyrus as raw material for several artistic socio-economic activities. The local people rely on papyrus harvesting for

income earnings and other forms of livelihoods. Due to population pressure and poverty conditions among other factors, papyrus use may increase posing a threat the entire wetland ecosystem. Such phenomenon is likely to affect management of the biodiversity or ecosystems under wetlands. Therefore, this study was specifically designed to address these issues by determining socio-economic characteristics, utilization and harvesting challenges of papyrus and management approach to control factors leading to loss of papyrus.



CHAPTER TWO

LITERATURE REVIEW

2.1 Papyrus ecology, distribution and pressure

Cyperus papyrus is a C4 carbon fixation and high productive wetland plant that grows to five meters high, and it occurs in nearly monoculture stands (Kabii, 1996). Papyrus occurs in natural habitats in large, pure stands, dense populations, often lining bodies of water such as in the Lake Victoria swamps (Simpson *et al.* 2001). The high productivity of papyrus plays a vital role in ecological functioning and is harnessed for socio-economic purposes. The plant grows in the riverine, lacustrine and floodplain areas. It has rhizomes and roots which make it rooted or form floating mats. From an ecological perspective, papyrus swamps trap sediments and pollutants entering water bodies (Boar *et al.* 1999). Papyrus is distributed in eastern, central and southern Africa between sea level and 2000 meters altitude (Jones and Muthuri, 1997). The area coverage is not known exactly and is probably changing fast due to population growth and economic development (Thompson, 1985). The predominant widespread plant species and used in African wetlands is papyrus (Archer 2003). Pressure on papyrus wetlands exist and in some places in western Kenya, 34-50 % of papyrus were lost between 1969 and 2000 (Owino *et al.* 2007) due to agriculture and papyrus harvesting. Papyrus forms extensive wetlands that are important ecosystem for biodiversity

and livelihoods of millions of people. According to Chapman *et al.* 2003 and Maclean *et al.* 2003a; 2006 papyrus offer unique ecological values to other species such as birds, mammals, amphibians, insects, snails and fish. Papyrus wetlands host biota which is relatively undiverse, extremely abundant and endemic to this habitat. Birds which are papyrus endemic in Dunga wetland have disappeared to about 50 % (Owino *et al.* 2006). Papyrus use to support livelihoods started in the Nile Valley 3000 BC, spread to Asia 1000 BC and everywhere papyrus occur, communities around use it for various uses (Haines *et al.* 1983). Studies on population growth, urbanization, poverty and settlement patterns have never yielded a wise use management model of papyrus in wetlands.

2.2 Institutionalization of papyrus Wetland and management

Ramsar Convention (1971) which defined and classified wetlands broadly, recognizes and stresses the great environmental, economic, cultural, recreational and scientific values of papyrus wetlands in human development. Papyrus wetlands provide enormous aquatic resources vital to local livelihoods. Ramsar Convention (1971) broad definition on wetlands identifies papyrus under swamps and marshes. The loss of these wetlands would be irreparable. In the past most papyrus wetlands were considered wastelands (Abila, 2002). Huge areas of wetlands were destroyed due to this illusive notion. It has taken long before the

world came to realize the importance of wetland, and it is the Ramsar Convention 1971, which has created awareness and realization of wetlands usefulness. In the Ramsar Convention (1971), there are provisioning of actions through which member states seek to deliver their commitments to wetland conservation and wise use. These requirements include wise use or sustainable use of wetlands, designation of internationally important wetlands as Ramsar sites and International Corporation or integration. The national governments have designated some wetlands as international Ramsar sites and incorporated into state land use policies. These efforts of wise use of wetlands have contributed to formation of national policies, institutionalization and regulations (Maclean *et al.* 2011) in some countries. However, there is indication that local communities are not always involved in wise use of wetlands and enforcing these policies is still difficult at local scale. Dunga wetland and many other papyrus wetlands have not been designated as Ramsar sites in Kenya.

2.3 Traditional uses of papyrus and harvesting systems

2.3.1 Traditional uses of papyrus

Papyrus use for making paper was reported first in Ancient Egypt dates back in the third millennium B.C (Steenberg, 1968). Steenberg (1968) discussed the use of papyrus for writing paper and building boards manufacture. He described the

industrial processes involved pointing out difficulties of harvesting, inadequate papyrus supply, economic and technical problems in production of pulp and lack of valuable by-products. Ancient Egyptians also used this plant for making boats, mattresses, mats, rope, sandals, and baskets (Lind and Morrison, 1974). Later on papyrus paper use was adopted in Greece, Middle East countries and Roman Empire during the fourth to fifth century BC. The utilization of papyrus from then has been growing to traditional, commercial and cultural uses. Although papyrus was considered extinct and no longer used in Egypt (Lind and Morrison, 1974), recent reports show that the art and industry of making papyrus was revived in 1969, when plantations along the banks of River Nile and nearby canals were re-introduced using papyrus imported from Ethiopia and Sudan (Michael, 2001). The new Egyptian papyrus uses include products such as plain papyrus sheets, paintings, bookmarks and papyrus coloring book (Solonika, 2001).

Recent studies on papyrus uses were conducted by Kew Botanical Garden (Anonymous1, 2000) which further established that papyrus and other sedges are used throughout the tropics for basketry and mat weaving. In parts of Africa and Asia they are even cultivated for such purposes. They are also used for thatching, fencing, rope making, pot pourri and perfumery. However, papyrus is widely distributed and utilized in central and eastern Africa (Lind and Morrison, 1974) with households living in the vicinity of wetlands deriving some good income

from papyrus (Maclean, I.M.D. 2004). The historical uses of papyrus and its products by local communities were as identified by Lind and Morrison (1974); Duke (1983); Burnmeister (2001) include making papyrus sandals, fans, fences, hats, boxes, ropes, mats, cloth, medicines, cordage, formal bouquets, funeral garlands, and building.

In Uganda, Mafabi (1996) noted that papyrus was utilized by communities living around Lake George to make roofing material and screens as well as other traditional items for domestic and commercial needs. In Tanzania, surveys conducted around wetlands infringing Lake Victoria by Katondo in late 1990s and 2000 showed various utilization forms for social and economic purposes of papyrus in various local communities. In Kenya, several uses of papyrus are mentioned in studies conducted by Gaudet (1977); Owino (2005), and Maclean *et al* (2003a); (2006) show similar trend of local use of papyrus. However, the status of such uses and economic benefits for policy and planners are not well known. Most utilization of papyrus is only mentioned in different studies or reports and no substantial analysis were undertaken.

2.3.2 Harvesting systems

The papyrus dominated swamps have traditionally been used as sites for the harvesting of papyrus used in local cottage crafts to make mats, chairs and

baskets. The tendency of informal urban and rural settlements encroaching papyrus wetlands in the world has increased illegal harvesting in recent times. The most serious threat associating with such settlement has been over-dependence and over-harvesting of papyrus using unsustainable harvesting systems. In Kenya, Van der Weghe (1981); Mafabi (2000) and Owino (2007) carried out aerial surveys on recent changes in papyrus cover around the lake shows and they gave a remarkable 30 – 50 per cent loss of papyrus: attributed by over harvesting and use of poor methods of harvesting. These studies failed to give sustainable harvesting systems or methods of papyrus in swamps threatened by human encroachment and over-exploitation. Papyrus height and density are inversely related to human disturbance including cutting, footpaths, burning, grazing and farming (Owino 2005). Osumba *et al.* (2010) investigated the effect of harvesting on temporal papyrus biomass regeneration potential among swamps in Winam Gulf wetlands of Lake Victoria Basin. They concluded that monthly harvesting was found to significantly reduce papyrus biomass regeneration potential. This study showed that frequent harvesting of papyrus is unsustainable. In recent studies socioeconomic activity with much threat to papyrus wetlands degradation or disappearance was identified as papyrus harvesting (Van de Weghe, (1981); Mafabi, (2000). Lake Victoria Environmental Management Project (LVEMP) associated much loss and threat of Lake Victoria basin papyrus wetlands with lack of sustainable harvesting systems in (LVEMP, 2001).

The rate at which the papyrus is harvested has increased markedly in recent years; largely due to the increase in the local population and to some extent as a result in changes in the local fishing economy (Owino *et al.* (2007); Kibwage *et al.* (2008). Traditionally women undertake the harvesting and mat making while men make the chairs and baskets but at present this has changed leading to unsustainable random and clear-cut of papyrus stands (Owino, 2005).

2.4 Factors contributing to unsustainable utilization and management of papyrus

Most communities in Lake Victoria basin depend heavily on the exploitation of its natural resources especially biological resources. Most of the resources are found among the very poor rural and urban communities whose livelihood depends solely on the exploitation of these resources. Sustainable conservation and development depend heavily on strengthening the capacity of local individuals and communities to implement conservation initiatives (IUCN, 1996).

Papyrus wetlands in Lake Victoria Basin are critical socio-economic and livelihood ecosystems to the local people and are of great significance for wildlife conservation (Mafabi 2000). Most of the extensive freshwater papyrus wetlands are located in the shores where rivers drain into the lake. These wetlands support a large human population who derive income directly from papyrus activities like

craft making and construction. The economic activities of papyrus if not carried out sustainably can lead to severe destruction of the wetlands. The papyrus swamps in the region are important source of livelihood to the local community, as a potential area whose agro-industrial exploitation and over-harvesting could lead to increased regional food production and as an important biodiversity hot spots. How to reconcile and harmonize these apparently conflicting interests poses a big challenge to the management of papyrus (Abila, 1998).

Currently the large scale reclamations and over – exploitations of papyrus activities in the region are underway. The short and long term ecological and socio-economic costs of such undertakings will be enormous. Abila (2002) identified factors driving papyrus wetland losses in Yala Swamp in Kenya as need for increased extra income levels and increased land scarcity in the upland. The report by Abila (2002), gave narrow overviews or principles on sustainable yields of papyrus and sustainable management considering factors such as population attributes and settlement types. Papyrus growth in the presence of sunlight is high and within optimum harvesting period of 10 to 12 months for craft industry. Osumba *et al.* (2010) established for the first time the impact of harvesting on post-harvest papyrus (*Cyperus papyrus* L.) biomass regeneration potential. The study concluded that regeneration potential is adversely (negatively) affected by monthly harvesting. Monthly harvesting reduced papyrus biomass regeneration

potential among sites but seasonal (6-monthly) harvesting did not appear to affect papyrus biomass regeneration potential. The suggestion of the study that papyrus harvesters can be kept off the swamps by establishing a riparian buffer zone of agro forestry trees and shrubs which can substitute for the papyrus as it is left to mature may be inadequate.

Policy and value addition to papyrus products have been proposed in several studies as priority strategies aiming optimal use of papyrus (Mwanikah, (2006). Papyrus wetlands are already in use and careful environmental planning and management system can adequately guarantee sustainability even though other uses are introduced (Owino, (2007). Urban environmental planning and management to protect papyrus wetlands infringing towns can enhance protection and minimizing conflict of wetland habitats and land use of towns (Owino, (2007).

2.5 Conceptual framework

Explanation of the model

The study used a conceptual framework for papyrus utilization and management as presented in figure 2.1. This framework offers a holistic approach for assessing resources and assets that are available to households and how these are linked to the strategies or skills that are used to reach desired household welfare outcomes

when exploiting a resource for livelihoods while ensuring environmental sustainability (Millennium Ecosystem Assessment, MEA 2005). Papyrus which may be available and/or accessible by a household in this case is an important resource with multiple socio-economic values on which local communities are increasingly dependent for earning their incomes as well as meeting other social needs. A number of factors are envisaged to influence the decision to harvest papyrus and /or be involved in papyrus related activities (use and managing) in the first stage. These factors can be direct and indirect which include the existing institutional and policy factors particularly at the macro level, household characteristics and location/area based factors (settlement patterns, expansion, population growth), and the livelihoods options in the surrounding papyrus production. The second stage, the household decides the level of investments to be made. This is the function of household characteristics and poverty situation as well as institution and legal frameworks governing the resource. An increase in household size reduces the ability of households to meet the subsistence needs especially where land pressure and household poverty level is high and may subsequently lead to higher amount of papyrus harvested or over-exploitation of papyrus till natural stock disappear. There is also a negative relationship between education and the amount of harvested papyrus, as education embodies awareness of the dangers of unsustainable papyrus utilization. We measure continuous disappearance of papyrus when user and wildlife conflicts become endemic.

Land tenure insecurity has been found to be a deterrent to investment in resource management and conservation (Hayes *et al.* 1997; Nowak, 1987). Thus we conjecture households that perceive insufficient security of land tenure would be less willing to reduce papyrus exploitation. The wealth and welfare situation of rural households may influence papyrus harvesting negatively. A step to improve the quality of craft goods made of papyrus so as to increase net income to those involved in the business. Thus institutional and policy framework is key to manage usage of papyrus under failed markets.

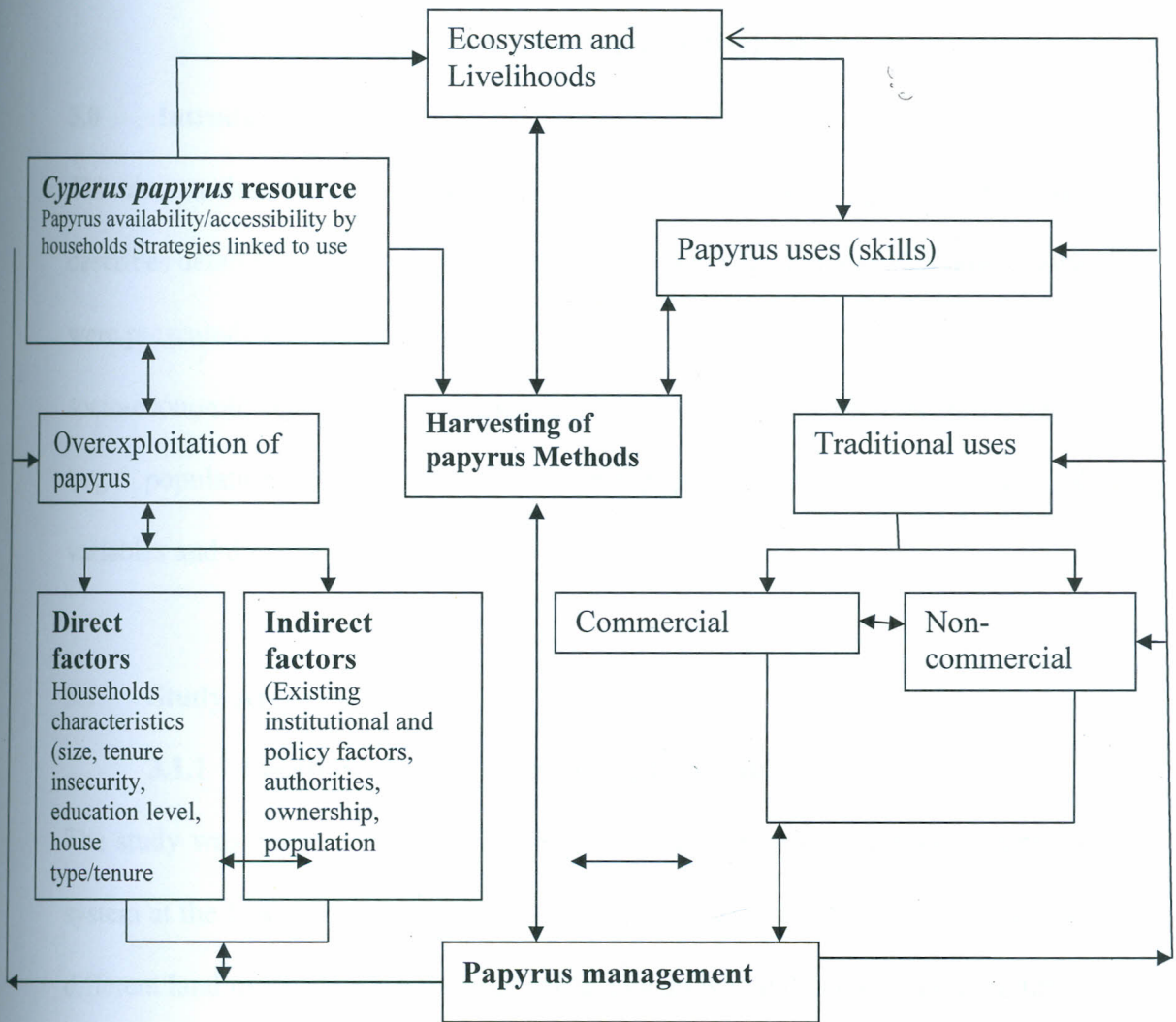


Figure 2.1 Conceptual framework modified from Millennium Ecosystem Assessment (MEA 2005)

CHAPTER THREE

STUDY AREA AND METHODOLOGY

3.0 Introduction

This chapter describes the procedures followed in the conducting study and gives describes detailed techniques used to collect and analyze data and also how results were presented. The study is been described based on biophysical, population and socio-economic features. The chapter has vividly presented the research design, target population, sample size and sampling procedure as well as types of variables and data sources.

3.1 Study Area

3.1.1 Location of study area – Dunga wetland

The study was carried out in Dunga wetland, the section of continuous papyrus system at the Lake Victoria shore in Kisumu town (Figure 3.1). Figure 3.1 shows different land use systems in the study area. Dunga wetland is located on the tip of Kisumu bay 10 km southern part of Kisumu town on the shores of Winam Gulf of Lake Victoria in Kolwa Location of Kisumu district Winam Division, Kisumu District Nyanza Province. It is located on the central coordinates of 34° 47' East and 0°10' South and the wetland covers an area of 100 hectares (10 km²) stretching from Nanga point Kibuye, and stretches southwards along the shorelines up to Nyamware. Dunga falls within block 14 of Kisumu Municipal

Council authority. The ownership of the swamp ranges from municipal council land in the Block 14 of area to trust land in the central part of the swamp to communal in the southern sections of the swamp near Nyamware. At the western limit is Dunga beach, used as a major fish landing point. *Papyrus Cyperus papyrus* pure stands stretch south-eastwards along the shore from here for 1.5 km, in a strip that varies in width from about 50m to 800m with considerable ecotourism potential for bird watching (Bennun and Njoroge 1999).



Figure 3.1 Location of the study area in Kisumu City (Source: Kisumu Municipal Council 2007)

Dunga wetland is lacustrine (Cowardin *et al.* 1979) floodplain wetlands of Lake Victoria and situated at the delta/estuary of five streams including Tako River, Nyamasaria, Odesso, Wigwa and Luanda. Wigwa now forms a stream of sewage discharging directly into the lake near the water point.

3.1.2 History of Dunga wetland

From historical accounts the area was initially a terrestrial environment settled with people until rains of 1961-63 when the lake advanced displacing the inhabitants and claiming their land (LVEMP 2001). This phenomenon contributed to the origin of many of the riparian swamps of Lake Victoria. The name Dunga, Indian in origin refers to a place of deep waters and was the initial terminus of the first railway to Kisumu.

3.1.3 Topography and soils

Dunga wetland is situated in the floodplains of rivers Nyamasaria and Luanda. The study area is generally flat with minimal gradient (Kibwage *et al.*, 2003). The altitude of the swampy area ranges from 1130 to 1140 meters above sea level. The soils are hydric and waterlogged comprising mainly clay and sand. The soil is black with plenty of organic matter and generally deep exceeding up to 0.9 m. This permits a diversity of aquatic vegetation and papyrus. The water table is high ranging from 5 m in East Kolwa and only 1 m near the lake in central Kolwa.

The wells report high saline water a phenomenon common to water aquifers near the lakeshores.

3.1.4 Climate

Dunga wetland lies within agro ecological zone of lowlands with bimodal rainfall distribution occurring between the months of March to May for the long rains and September to December for short rains. The annual rainfall averages is between 1000-1400mm per year. Daily mean temperatures range from 28.9° C to 17.3° C. The humidity is high with the highest recorded being 70. The humidity of the area is higher than most part of the District.

3.1.5 Flora and fauna

Dunga is a small wetland compared to other riparian wetlands of Lake Victoria like Yala but has a considerable unique biodiversity dominated by *Cyperus papyrus*, and is associated by ferns, grasses, sedges, reeds, cattails and other plant species. This swamp harbors fish, birds, amphibians, snakes, and other wildlife which are endemic and a rare and threatened species like *T. spekei* (Sitatunga) are in the region. Because of its uniqueness, Dunga swamp has been declared Important Bird Area (IBA). The swamp is known as the fish nursery for Lake Victoria. Dunga wetland comprises of a diversity of habitats, including swampy

area, rivers, ponds, floodplains, grassland, bush land, and Rivers (Katondo *et al.* 2002).

3.1.6 Human population

In 2000, human population of Dunga was about 30,202 (Government of Kenya, 2000). Luo, Luyha and Kisii are major ethnic groups found in the area. This area is densely populated. This forms the basis of utilization and management of papyrus for livelihood support. Women and youth bear a large share of both domestic and agricultural work.

3.1.7 Land use

Land use activities around Dunga papyrus swamp is dominated by urban settlements, cultivation of crops, and livestock grazing (Mafabi, 2000). These activities have intensified degradation of Lake Victoria due to pollution, burning and papyrus harvesting (Van de Weghe, 1981; Mafabi, 2000). Biodiversity within the swamp have been reported reduced, endangered and lost (Fishpool and Evans 2001.). Fishing is a major livelihood of the local community in the area. Fishing affect the papyrus harvesting; for baskets. The swamp suffers some cutting and burning of papyrus to allow access for fishing of swamp fish species. Papyrus swamps are recognized as being important nursery areas for lake fisheries and also habitat for a range of fish species not found in the lake. The recent town,

population and poverty growth has induced much stresses on natural resources around Dunga wetland and less efficient land-use.

Fishing today around shores of Lake Victoria is performing poorly due to water hyacinth infestation of Lake Victoria in the 1990s and low market prices. This has changed focus more towards papyrus harvesting for mat making as a source of income, farming around the swamp and livestock keeping (Bennun and Njoroge 1999; Aseto and Onga'nga 2003). Energy demands for domestic use around the site have increased and papyrus is additionally harvested and dried for domestic fuel (Gichuki *et al.*, 2001)

3.2 METHODOLOGY

3.2.1 Research design

The study was conducted through a survey research, key informant interviews and focused group discussions. The survey was designed by sampling a representative number of papyrus harvesters and administering the questionnaire (appendix 1) to them. The focused group discussion and key informant interviews were carried among key stakeholders on the management of Dunga wetland (appendix 2 and 3) in Kisumu.

3.2.2 Study Population

Dunga area of Kisumu city had a population of about 45,375 in 13,956 households by census data of 1999 (Central Bureau of Statistics, Kisumu District 1999). The target population under this study included all persons involved in harvesting papyrus for different uses in Dunga wetland for the past one year. The study population included 20 % of 13,956 households who are settling areas infringing Dunga wetland.

3.2.3 Sample size calculation

The sample size was determined using the formula and descriptions in Mugenda and Mugenda (2003). When the population is greater than 10,000, at 95 % confidence level thus using the following formulae:

$$n = \frac{Z^2 pq}{d^2}$$

Where:

n = the desired sample size (if the target population is greater than 10,000)

Z = the standard normal deviate at the required confidence level (1.96)

p = the proportion in the target population estimated to have characteristics being measured (50%)

q = 1-p (50%).

d = the level of statistical significance set (0.05)

The sample size is 384. Therefore, the calculated sample (n) is as follows:

$$n = \frac{384}{1 + \frac{384}{2792}} = \frac{384}{1.138} = 337.$$

3.2.4 Sampling Procedure

Data for this study was collected in three areas along the Dunga wetland – infringing Nyalenda slum in Kisumu town. The sample frame was a list of papyrus harvesters groups and individuals in the three areas where papyrus harvesters are found. The list was compiled in excel database and 337 papyrus harvesters were randomly selected using the simple random sampling technique (excel function of $fx = \text{RANDONBETWEEN } 1, 2792$ was used run simple random). The equal (112) representative sample was drawn each from three sites. The sampling technique focused on papyrus harvesters in the area to give information on utilization and management of papyrus of Dunga wetland. Most respondents were both men and women who have harvested papyrus for the last 12 months.

3.2.5 Data Collection

3.2.5.1 Primary data

The quantitative data was collected using interviews in the form of household structured questionnaires (Appendix 1), photography and unstructured key-informant interviews. The collected included the following:

- a) Economic activities: to establish driving factors for papyrus harvesting
- b) Social-cultural values: to determine values of papyrus without necessarily harvesting for crafts
- c) Traditional papyrus uses and crafts (craft making activities): to assess the utilization rates and demand vis-à-vis supply
- d) Harvesting systems and hazards during harvesting: determining capacity of community on sustainable harvesting of papyrus and the level of damage
- e) Papyrus management options: assess community management approaches of papyrus
- f) Institutional framework and ownership: assess legal and other management practices such as policy, customs and traditions of papyrus protection

3.2.5.2 Secondary Documentary data

The policy, legal and institutional framework analysis on papyrus management was obtained from:

- a) Environmental Management Coordination Act, 1999
- b) Wetland Policy Bill
- c) Kisumu District Development Plan 2002-2008 and Kisumu Municipal Reports
- d) Ramsar Convention's *Strategic Plan 1997-2002*, the *World Conservation Strategy, Caring for the Earth*, the report of the *Brundtland Commission*, and *Agenda 21*

3.2.6 Data analysis and presentation

Data from the field was cleaned, coded, key-punched and entered into a computer and analyzed. This analysis was enabled by using Epidemiological Information system (Epi info) a computer statistical package to process and analyzing data. These techniques of data analysis were the most suitable in the study since they enabled the researcher to identify significant comparisons in normal distributions of the sample, difference in sources of variables and comparisons of differences in means. Photographs were also used to present observations.

3.2.6.1 Quantitative data analysis

Descriptive statistics were used to analyze quantitative data. They included use of histograms or graphs, charts, averages, percentages and frequencies.

3.2.6.2 Qualitative data analysis

Qualitative data in particular was organized in categories, themes and patterns and evaluated to answer research questions. Photographs, individual interviews and observation methods generated narrative notes forming qualitative data in the study. All recordings were organized into coherent categories of focus, information, themes, patterns, connections and ideas following the questions and topics of analysis.

3.2.6.3 Results presentation

Results of the study were presented mainly using tables showing frequencies and percentages and graphical methods i.e. histograms or bar graphs and pie charts. Discussion was also used as result presentation methods especially on qualitative data. Additional presentation method involved the use of photographs (plates).

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents 3 sub-sections; analyses, findings on papyrus use and management in the study area. The socio-economic characteristics data of respondents such as gender, education level, occupation and age and their dynamics and influence on papyrus use and management are also presented and discussed in the initial parts of this chapter. The chapter also discusses findings of traditional utilization, harvesting systems, user conflicts, driving factors or threats and the state of papyrus management in the study area.

4.2 The socio-economic characteristics of Dunga Human Population

This section covers gender, education level, occupation and age as factors of socio-economic that influence utilization and management of papyrus.

4.2.1 Gender

Table 4.1 indicates female and male papyrus harvesters engaged in papyrus activities around Dunga wetland.

Table 4.1: Sex of papyrus harvesters/traders in selected areas

Sex	Frequency	Percentage
Male	115	34
Female	222	66
Total	337	100

In Table 4.1 shows the number of men and women involved in papyrus activities; harvesters, artisans and traders. About 66 % of people involved in papyrus activities were women while men were 34 %. Papyrus harvesting and weaving for a long time was performed by women and children. Most women in present days incur high expenditure meeting households' chores. This is in contrast with fishing activity where men are predominant (Nasirwa and Njoroge, 1997). In fishing activity, physical requirements and traditional beliefs discourage women from fishing. Although papyrus harvesting and other activities can be risky, tedious and tiresome, women undertake them often to meet livelihoods. Another possible explanation is that mat making and basket weaving are activities that women can easily perform and these are products that women like most. There are no taboos or traditional beliefs against women being involved in papyrus activities. Likewise, the poor and vulnerable are often female headed households (HABITAT, 1996), often depend on papyrus for their livelihoods.

4.2.2 Age

Figure 4.1 shows a graph of ages of papyrus harvesters sampled for the study.

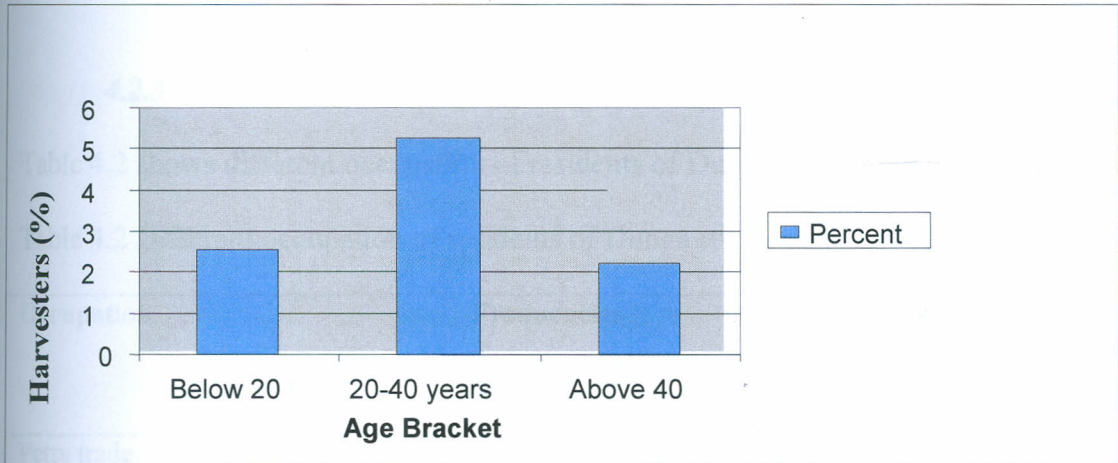


Figure 4.1: Ages of papyrus harvesters

Figure 4.1 shows that majority of papyrus harvesters about 52 % are of youthful age of 20 – 40 years participating in papyrus activities. The age under 40 years is predominant in papyrus activities. This shows how important papyrus is to meet livelihoods of young population who are always aggressive, needy and energetic to exploit a resource. This is the reason explaining the alarming extent of unsustainable papyrus harvesting or activities. Age is a very important determinant of entry into production sector since most young people are normally more innovative, risk takers and have low discount rates for the future (Abila, 1998). Harvesting papyrus is rigorous and demanding and all techniques used are basically manual, which requires a lot of energy. With huge livelihoods' demand

of a youthful population, papyrus use may be on high levels leading to depleted stock (Owino, 2007).

4.2.3 Occupation

Table 4.2 shows different occupation of residents of Dunga wetland region.

Table 4.2 Different occupation of residents of Dunga wetland

Occupation	Frequencies			Percentages
	Males	Females	Total	
Petty trade	41	62	103	30.5
Farming	20	11	31	9.3
Fishing	19	4	23	6.9
Teaching	5	2	7	2.0
Papyrus	66	97	163	48.0
Student	3	2	5	1.6
Masonry	3	2	5	1.6
Total	157	180	337	100.0

Table 4.2 above shows that majority of respondents are employed in informal sectors with the dominant occupation being 48 % on papyrus and 30.5 % on petty trade. Women dominated both sectors papyrus and petty trade. Farming is practiced by only 9.3 % and fishing by 6.9 %. Other occupations included teaching, schooling and masonry. It was noted that inadequate income and its

sources normally create overdependence on ecosystem resources such as that are the community alternative sources of income as a coping strategy. Most percentage of households in the area are low income earners, vulnerable, impoverished and poor. These results (Table 4.2) show that most inhabitants derive their resources for livelihoods from the Dunga wetland, the lake and farming despite the Kisumu town and its environment being the nerve centre for business, industry and employment. This situation could be because the economy of Kisumu has been performing poorly in the last two decades recording a slow growth rate of only 2.8 % (Kisumu City Council, 2003). Low fish stocks in Lake Victoria due to over-fishing (Abila, 1998), has made many villagers in the wetland area to diversify activities such as harvesting papyrus, vendor papyrus goods and do informal petty trades to earn a living (Kisumu City Council CDS report 2004-2009). Increased number of papyrus harvesting and poverty may increase the amount of papyrus harvested, hence depletion. This imply that increased non-papyrus source of income tend to reduce pressure on papyrus. This suggests that it is important to increase alternative sources of income in order to reduce papyrus harvesting pressure (Abila, 1998; Owino, 2005). Improvement of trade and informal sector industry in Kisumu may open livelihoods opportunities for poor persons and this can reduce pressure on papyrus.

4.2.4 Education level

In Table 4.3, analysis indicates that most papyrus harvesters (81.8%) obtained primary school education while 12.6 % and 2 % secondary and tertiary education respectively. About 3.7% of papyrus harvesters were not educated. Papyrus harvesting is associated with poverty and given people of lower education has lower capabilities and lack opportunities for technical employment that pays. Kisumu town records an adult literacy rate of 48 %, with 24.6% of urban poor having attained secondary school education (Kisumu City Development Strategies (CDS) 2004 – 2009). Table 4.3 indicates that education status of majority (82 %) are in lower level of education and the only sector which would have provided employment is informal sector (petty trade, service and cottage industry). It was noted that, the relationship between education and amount of papyrus harvested may be negative as education embodies awareness of dangers of unsustainable papyrus utilization. Such large group of poor and low education status persons become a threat to the wetland and explains the over-harvesting trend of papyrus in Dunga.

Table 4.3: Education levels of papyrus harvesters in Dunga wetland area

Highest level of education	Frequency	Percentages
Primary school	276	81.8
Secondary school	42	12.6
Tertiary school	7	2.0
None	12	3.7
Total	337	100.0

4.3 Utilization and harvesting challenges of papyrus

4.3.1 Traditional uses of papyrus

Utilization of papyrus around Dunga wetland in Kisumu evolved from traditional skills as well as from influence of other urban dwellers that lived in the area during 1960s and afterwards. Papyrus is used on both commercially and subsistence levels (Owino *et al* 2007). Table 4.1 shows residents' important utilization skills of papyrus adopted by the community.

Table 4.4: Summary of traditional uses of papyrus in Dunga area

Responses	Commercial uses		Responses	Non-commercial uses	
	Frequency	Percentage		Frequency	Percentage
Mat Making	274	81.3	Fuel wood	95	28.3

Packaging	129	38.3	House		
Materials	67	20	construction	51	15.0
Broom Making	24	7	Ropes	141	41.7
Chairs	152	45	Fencing	67	20.0
Beddings	74	22	Utensils	23	6.7
Baskets	51	15	Medicine	129	38.3
Value added			Cooking	62	18.3
items					

Table 4.4 shows that most (81.3 %) residents who use papyrus for local cottage crafts to make mostly mats for sale in Kisumu town and beyond markets. The results also show that 45% used for mat making for beddings and 38.3 % to make packaging materials. Other uses of papyrus for commercial purposes included broom making (20%), baskets (22%), value added items (such as trays, shelves, stands, furniture, baskets, baby coats, wall hangings and lampshades) (15%) and chairs (7%). Results show about 41.7 % of harvesters make ropes from papyrus, 38.3 % make herbal medicine, 28.3 % make fuel wood and 20 % use to make fence. Other non-commercial uses of papyrus include house construction, assist cooking and making utensils. The study found that the area dominated by papyrus around Winam Gulf provides substantial stock for papyrus exploitation both at

domestic and commercial levels but limited research and investments opportunities exist for more feasible commercial use.

According to Duke (1983) communities around the Lake Victoria wetland have developed local technologies in basketry, mat making and making modern items from papyrus in the swamps to satisfy the growing market demand for papyrus items which are cheap and durable (Duke, 1983). People of different ages and education levels appreciate the value of papyrus, and its usage is increasing among local communities and other many urban dwellers in Kisumu city.

4.3.1.1 Commercial/Economic uses

Mat making

This study established that papyrus is mainly harvested for making mats for commercial use and that 40% of mats made by craftsmen are sold to middlemen who transport the products for selling in various places including Kisumu and Kakamega and beyond. Mats are mainly used as beds (31.2%) and seats (11.9%). Some mats are used for building business huts in temporary or permanent local restaurants or pubs for fencing of homes and as well as ceiling and curtains in houses.

Mat making in the local urban communities around Dunga wetland at present is the major economic livelihood. Initially, the technology of mat making around Dunga was introduced by the Luo and Luyha (Wanyala) who have used sedges like *Scheonoplectus carymbosus* and papyrus to make mats (Kareri, 1992). It was found out that the ever increasing number of Kisumu town papyrus mat makers learnt from skilled weavers coming as far as from Tanzania around Simiyu wetland to make beds and seats. Discussion with the respondents showed also that the local fishermen and fishmongers in Dunga beach learnt make mats and use them for drying.

Mats are also used by farmers to dry crops and other domestic work. In town mats make sheds for petty traders. The town dwellers have completely taken over the skill and make mats for sale to fellow dwellers, villagers and middle-men for business in other outlet markets (Kareri, 1992).

Table 4.5: Periods of starting Mat making from 1970 – 1999

Periods of starting mat making	Responses	
	Frequency	Percentage
1970-1979	10	3
1980-1989	67	20
1990-1999	259	77

Table 4.5 shows a trend of making mats beginning 1970s to 1999. The results show that mat making technology has increased from 3 % to 77 % of residents' involvement in harvesting and making mats for commercial use. In 1990s locals engaged more in mat making than in the past due to rapid population growth, expanded settlements, rural-urban migration, poverty and growth of Kisumu. In the Kisumu City Development Strategies (CDS) 2004 – 2009 report the greatest challenge to develop Kisumu is its high poverty level of 48 % compared to national (Kenya) 29 %. The residents settled near papyrus have found out the importance of papyrus and have adopted it as a source of income.

Table 4.6: Artisan who harvest and also make papyrus items in Dunga area,

Kisumu

Responses	Frequency (n=337)	Percentage
Artisan	280	29
Artisan who are harvesters	195	20
Artisan not harvesters	141	15
Mat makers	246	26
Basket makers	74	8
Chair makers	21	2
Total	957	100

Table 4.6 shows the proportion of respondents making mats and other papyrus items. Mat makers (26 %) harvest papyrus by themselves. Harvesting is done by the artisans to reduce the cost of mat making and maximize the profits. Mat makers make averagely Ksh. 7575 monthly income (range Ksh. 840 – 28,000). Those who earn high monthly income from mat sales have taken it as a permanent occupation and the low earners periodically harvest for supplement income. According to Kisumu City Council CDS, 2003 report poverty situation in the slums of Kisumu such as Nyalenda, Manyatta and Kondele, most households of these areas have resorted into papyrus use, urban agriculture and livestock keeping to provide basic needs and income.

Packaging materials

Table 4.4 presented results of 38.3 % of respondents making packaging material of different shape and size for commercial use. About 22 % (Table 4.4) of these packaging materials are baskets (osera) used to transport fish and the rest for farm produce. Plate 4.1 shows a local artisan weaving a packaging material using papyrus and a local retail middleman transporting to the local market. From the study findings, most packaging materials made from papyrus are used as baskets for transporting fish, crop produce (such as tomatoes, cotton and vegetables), shopping and some are used as storage equipment in the house.



Plate 4.1: Local artisan weaving fish packaging material and sold other to a middleman cycling to the market selling to fishmongers (taken by Author on 17/11/2009 at Dunga Village).

The technique of making packaging materials from papyrus was introduced in 1970s by local fishermen after adopting it from Tanzania fish mongers who retailed smoked fish (Katondo, 2002) and also from Yala Swamp in Siaya district (Lind and Morrison, 1974). This technique has been adopted by local weavers for commercial use. Although weavers at Dunga make these packaging materials, the famous weavers are situated in rural villages such as Kendu bay and Yala far away from the wetland and even as far as Tanzania – the Wanyamwezi and the Sukuma around Simiyu Wetland (Katondo, 2002). Kisumu and other towns are main marketing centers of packaging materials made in Dunga.

Broom making

Papyrus is also used to make different types of brooms around Dunga wetland. Table 4.4 shows that 20 % of Dunga papyrus users make brooms for sale. Respondents confirmed that broom making using papyrus started in the 1990s after being adopted from other areas of wetlands. The umbels are cut and weaved to produce brooms. The brooms are believed to have long shelf life compared to others made from grass (Katondo, 2002). The use of papyrus to make brooms has increased because grass that used to make brooms is no more due to cultivation of crops. Many brooms are transported for sale in Kisumu town for outlet markets.

4.3.1.2 Non-commercial uses

Table 4.4 shows the non-commercial use also called subsistence use of papyrus. Some of the non-commercial uses (Table 4.4) of papyrus found in the study area included ropes, herbal medicine, fuel wood, fencing, cooking materials, house construction – thatching and used as utensils.

Fuel wood

Table 4.4 shows that 28.3% of respondents use papyrus as a source of fuel wood. Dry shoots of papyrus is simultaneously harvested for fuel-wood, while harvesting fresh ones for mat making. Shoots are used due to severe shortage of alternative source of fuel-wood around Dunga wetland. Dry rhizomes (makoni)

are also collected for fuel wood. These rhizomes have been found to possess high calorific value that sometimes even destroys cooking utensils (Katondo, 2002). Usage of papyrus shoots and rhizomes as fuel-wood calls for further investigations into the possibility of making energy briquettes, as practiced in Rwanda (Kabii, 1996).

House construction

Table 4.4 shows that 15% of respondents use papyrus shoots for construction of houses. Papyrus shoots are harvested, dried and used for building traditional houses and business tents. The shoots are mainly used as purlines at the roof and walls. In some cases the shoots are weaved and used as windows and doors. Few people in town thatch their houses with papyrus but use them as business tent covers. Atieli *et al* (2009) study show that house design modifications with papyrus mats as ceiling reduced indoor habitation of mosquitoes.

Ropes

About 42 % (Table 4.4) of respondents use papyrus to make ropes around Dunga wetland. The immature papyrus is harvested and their rinds stripped off, dried and used as ropes. These ropes are used in house construction and tying luggage.

Fencing

Some households, about 20% (Table 4.4) use papyrus to make fences around their homes. This is common at households in peri-urban areas of Kisumu town. Papyrus reeds or mats are used to make fences around their homes and in town are used to demarcate business areas.

Utensils

In the study area, only 6.7 % (Table 4.4) of respondents used papyrus as utensils in alternative. However the study found out that the production of such utensils has declined during recent years.

Medicine

Table 4.4 shows that 38.3 % of respondents use papyrus as a medicinal plant. The respondents gave explanations of several uses of different parts of papyrus in treating common illnesses. The dead and partially decaying shoots, which float in water, are collected for medicinal purposes. They are mainly used in treating pregnant women emotional disorders. Utilization of papyrus for medicinal purposes also calls for further investigations so that many people can benefit from this abundant plant. Duke (1983) reported that in historical times (i.e. up to 200 AD) papyrus was used to cure many diseases. The pith was recommended for widening and drying of fistula; the ash of burnt papyrus sheets was used for

certain eye diseases and checking malignant ulcers from spreading in the mouth or elsewhere; plant macerated in vinegar and burnt the ash heals wounds and cancer.

Cooking

The study shows that 18.3 % (Table 4.4) of respondents use papyrus piths in the stem to facilitate safe cooking. The piths are taken, cut into small pieces and used as support to foods (especially fish) cooked in utensils and pots. The pieces of piths are normally placed at the bottom of utensils or pots and then fish put on top of them so as to prevent scotching while the food is boiled or cooked.

Other important uses of papyrus

Although Table 4.4, show that respondents use papyrus to make items including beddings (45%), baskets 22% and chairs (7%) for sale, other commercial, cultural and ecological uses of papyrus are emerging which this study finds in scientific articles. For instance, Duke (1983) has provided other usage of papyrus adopted by local people around papyrus wetlands. According to Duke (1983), the umbel impressions were often used as handles doe mirrors, bags, fans, doors, chairs, and various household furniture. These uses are emerging in study area due to market demand and technologies. The usage of pith was somewhat different from what the ancient Egyptians did. The pith in the stem was dried up and used for fuel, and

also boiled and eaten (Solonika, 2001). In addition, the starchy rhizomes and lowermost parts of the stem were cut off and consumed raw, boiled or roasted. They were also chewed, sucked, and spit out much as sugarcane is done today (Duke, 1983).

4.3.1.3 Value added items

With reference to Table 4.4 and Table 4.7, indication of various ways of modifications and improvements, various modern papyrus commodities are emerging in the study area for a market high demand. About 15 % (Table 4.4) of respondents use papyrus to make improved products for market. Table 4.7 below shows papyrus items produced using different value addition techniques.

Table 4.7: Summary of value addition strategies on new papyrus goods

Item	Value addition techniques
Wall hangings	Variety in patterns, use of dyes
Chairs	Improved density, use dyes or paints
Book shelves	incorporate metals and designs and patterns
CD racks	incorporate metals and designs and patterns
Baby coat	incorporate metals and designs and patterns
Lamp shade	Designs, paints and patterns

TV Stand	Use of dyes, designs and patterns
CD stands	incorporate metals, variety in designs and patterns
Beds	Variety in designs, incorporate metals
Trays	Designs, grading, paintings, patterns
Stools	Use of paints, variety in patterns
Tables	use of metals, use soft materials e.g. cushion, and variety in designs
Mats and baskets	Grading, use of dyes, variety in pattern

Table 4.7 shows common modified items of papyrus fetching more income. These include wall hangings, chairs, shelves, racks, stands, beds, trays, stools and tables. These items can be used in the house, institutions and a little papyrus is used to make them. Also, Table 4.7 presents the main value addition methods for the products observed in the study area. These include: variety in patterns and designs, use of paints, improved grading systems especially on the mats, use of dyes and preservatives, improved density, use of nails and metals and diversity of products.

Papyrus use has dominated cottage industry, locally known as 'Jua Kali' used by carpenters, artwork and decorators. Locals producing high quality items such as chairs get a better financial return per kilo of papyrus harvested. This was

recommended by key informants that through such innovations papyrus swamps can be sustained. The full value of such alternatives may not always be realized immediately, but may become apparent as these wetlands are preserved over time (Barbier *et al.* 1997). Product diversification and value addition of papyrus utilization can increase income to harvesters other than selling raw material.

4.3.2 Harvesting Challenges

4.3.2.1 Harvesting methods

The results obtained indicated two ways of harvesting papyrus. The majority of respondents harvest papyrus using the random method while the remaining respondents harvest using rotational method. In the questionnaire findings, it was found out that about 81.3% of mat makers have no specific sites (random) for harvesting the papyrus materials. Only 18.7 % harvesters regularly harvest the papyrus from specific areas (rotational) within the swamp. The majority (84.5%) of craftsmen involved family members in harvesting. Field observation showed that at Dunga beach area, harvesting was done mainly at random resulting in patches of harvested and vegetated areas. Harvesters targeted areas with pure stands of papyrus, and in most cases moved over 100m further inside the wetland. Non-specific harvesting method has led to over-exploitation and complete damage of papyrus in the areas of the wetland. Plate 4.2 shows the negative impact of this method of harvesting papyrus in the study area.



Plate 4.2 Papyrus harvested using clearing method and other vegetation are succeeding after papyrus removed (taken by Author on 18/10/2009 at Dunga site)

Plate 4.2 shows a section of papyrus harvested by clearance method and a succession of alien wetland species. This harvesting system has impacted negatively to papyrus stock and progressive disappearance is witnessed. Thus although papyrus harvesting and processing is a more accessible source of income for poor families with fewer capabilities, it is labour intensive and has lower economic returns compared to other business opportunities in town and may not provide enough income to close existing poverty gap.

Field observations showed that papyrus harvesting in Dunga wetland requires local skills and it is always risk because of water, mud and wild animals. Harvesters are

advised to cut the mature papyrus from the bottom enhancing regeneration rather than uprooting the entire papyrus completely. Areas where entire uprooting harvesting system was employed always create more room for farming and degradation of papyrus rhizomes. Wetlands are part of complex environmental and socio-economic systems which require wise methods in harvesting their resources (Schutter, 2003; Katondo, 2002). Some harvesting systems may create new uses of the wetland such as farming that may lead to loss of other functions and services of the wetland in the community.

4.3.2.2 Challenges in harvesting papyrus

4.3.2.2.1 *Hazards affecting papyrus harvesters*

Table 4.8, shows frequencies of hazards experienced or encounters during harvesting of papyrus materials by harvesters.

Table 4.8: Respondents perceptions on hazards and challenges in papyrus harvesting and business activities

Responses	Frequency	Percentage
Slipping encounters	108	32
Mosquito bites encounters	78	23

Snakes encounters	64	19
Hippos encounters	34	10
Leeches encounters	34	10
Crocodiles encounters	20	6
Burning of papyrus	64	19
Lack of market	74	22
Transportation	51	15

Table 4.8 shows that the main hazards encountered during harvesting of papyrus around Dunga wetland included slipping (32%), mosquito bites (23%), snake scares (19%), Hippos (10%), leeches (10%) and crocodiles (6%). The results also show other major challenges affecting papyrus producers include burning of papyrus (19%), lack of market (22%) and transportation (15%).

4.3.2.2.2 Overall Impacts of the hazards to papyrus harvesters

Figures 4.2a to 4.2f analysis for the period of January – July showed that problems or hazards occurred at varied degrees. Slipping affected a wide range of artisans. About 32% of artisans encountered frequent slipping, whereas 27% (figure 4.2a) slipped up to 10 times. About 7% and 2% faced the same problem up to 20 and 30 times respectively. Slipping during harvesting of floating papyrus mats is common due to loose nature of floating papyrus mats. Measurements of

water depth at Dunga wetland in three harvesting sites showed depths ranging between 2.4 and 3.0m. Mosquitoes affected 23% of artisans frequently. Mosquitoes affected about 8% and 4% (figure 4.2b) up to 10 and 20 times respectively for seven months. About 19% of artisans encountered snake hazards but 95% encountered less than 95%. Snakes commonly affected 1% less than 20 times, and 4% (30 times) had frequently conflicts with snakes at Dunga wetland. Hippos, Leeches and Crocodiles threats to artisans were less than 10 encounters.

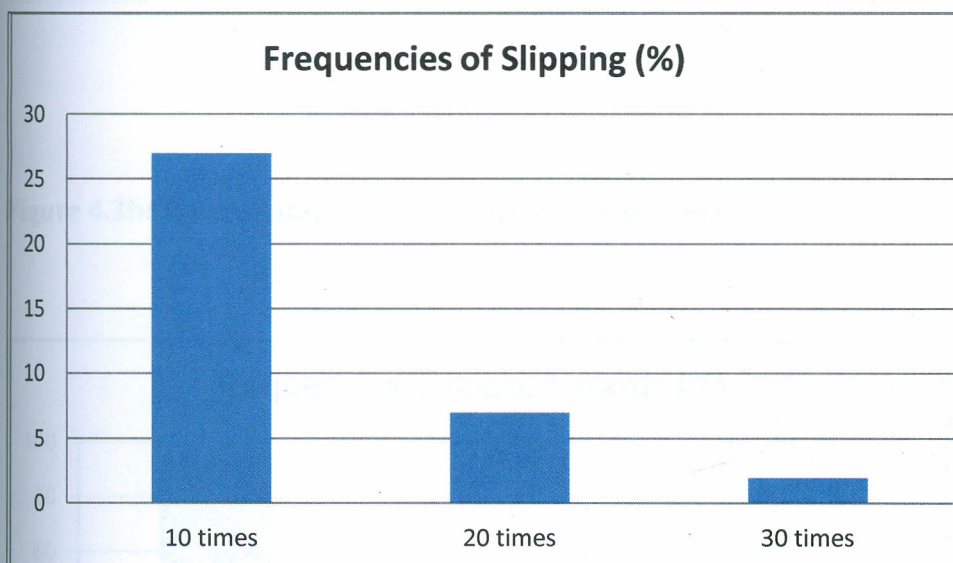


Figure 4.2a: Overall impacts of Slipping at Dunga

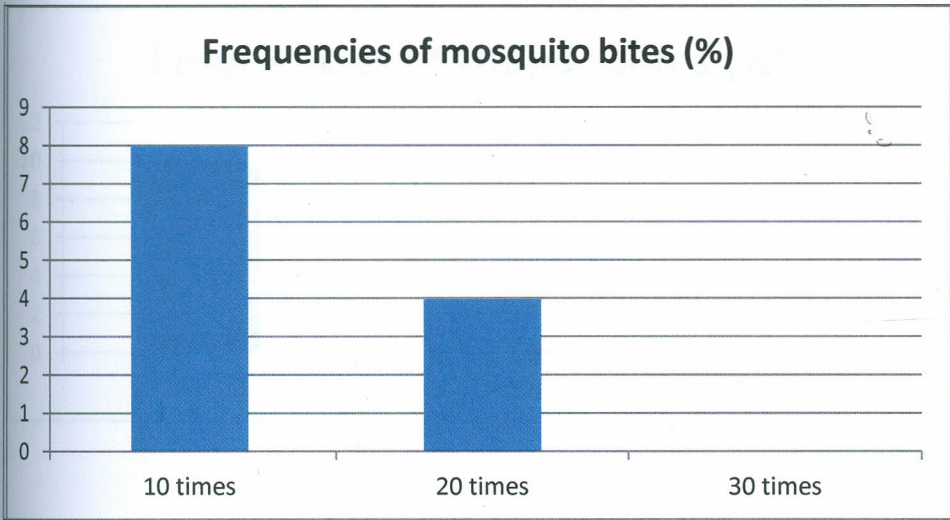


Figure 4.2b: Overall impacts of Mosquito Encounters

Figure 4.2b: Overall impacts of Mosquito Encounters

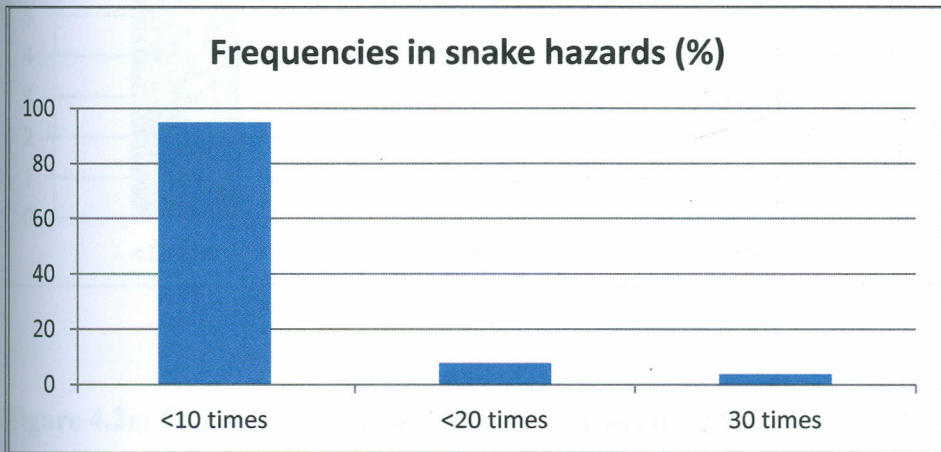


Figure 4.2c: Overall impacts of Snakes Encounters at Dunga

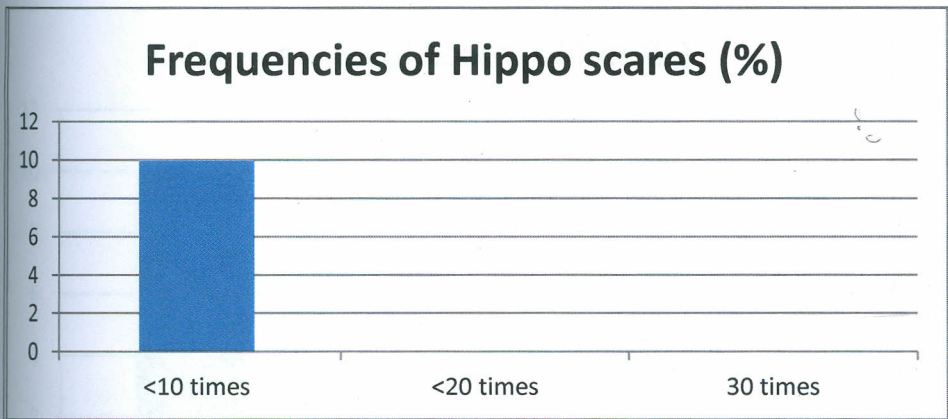


Figure 4.2d: Overall impacts of Hippo Encounters

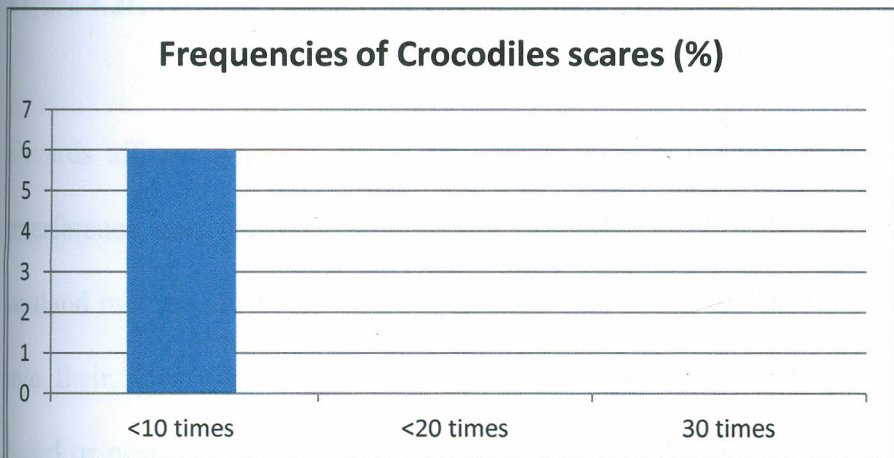


Figure 4.2e: Overall impacts of Crocodiles Encounters

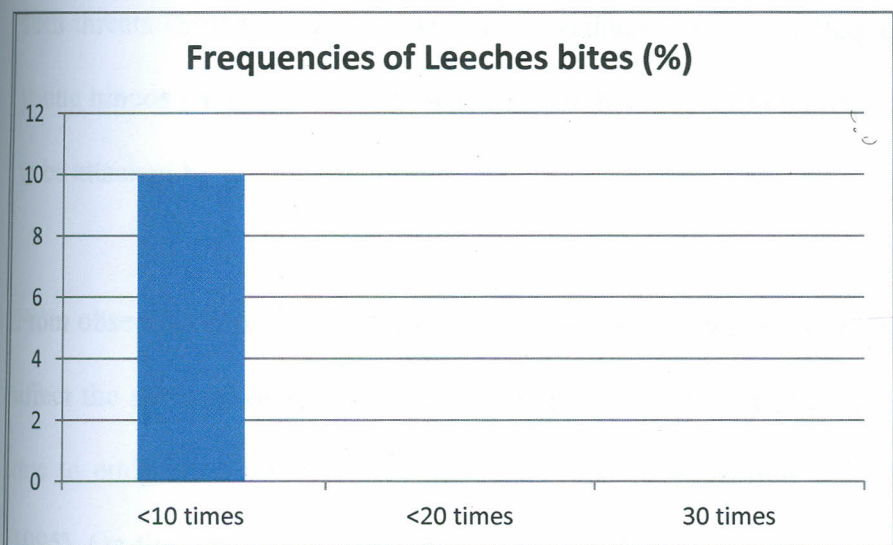


Figure 4.2f: Overall Impacts of Leeches bites

Hazards affecting harvesters of papyrus in Dunga wetland is an indication of interference with papyrus biodiversity dependence. Wildlife conflict in Dunga wetland may be attributed by poor random harvesting systems and encroachment into their territories. Papyrus is a wildlife habitat area where wildlife browse, breed or nest, and feed (preying or predate). Nowak (1995) reported that hippos prefer areas of deep (at least 1.5m) permanent water such as lakes and rivers with adjacent reed beds and grasslands. Female hippos protect young from predators for instance crocodiles (Nowak, 1995). Young hippos are also protected from male hippos that usually attack them in water, but not on land. Therefore, in papyrus reeds, female hippos may be forced to hide its young in order to avoid

such threats (Solonika, 2001). At Dunga wetland, harvesters frequently note the young hippos tend to follow and tease human beings within papyrus swamp a risk to be attacked by the mature hippos.

From observation in the field, continued disturbance by harvesters will ultimately affect the survival of these fauna. Population of these animals may be affected due to emigration and changes in feeding and reproductive successes (Nowak, 1995). On the other hand, disturbance of animals to papyrus harvesters will also affect production of sufficient value added products where few artisans can get little materials, and hence produce fewer products. Studies are needed to identify and designate potential and hotspot areas for hippos and crocodiles, so that specific areas for harvesters can be established outside home ranges of these animals (Katondo, 2002).

Mosquitoes and leeches use the papyrus swamp as shelter, breeding or living habitat. They feed on blood from animals and birds living in the swamp (Katondo, 2002). These invertebrates are opportunists: they bite any animal coming into their habitat, including humans (Nowak, 1995). Papyrus harvesters at Dunga do not use protective gears such as chest-waders to control bites from mosquitoes and leeches. The main problem remains with slipping of harvesters through papyrus cover. Though no casualty from drowning has been reported but the risk

is high. Regular burning of the blanketing dead vegetative matter may aggravate drowning, and measures should include prevention of deliberate fires and wearing of life jackets (Katondo, 2002).

4.3.2.3 User conflicts during harvesting

Table 4.9: Perception on existence of conflicts on utilization of wetland resources in Dunga

Source of conflict	Frequency	Percentage
Fellow artisans	84	25
Livestock keepers	57	17
Fishermen	34	10
Farmers	78	23
Urban developers	84	25
Total	337	100

Several conflicts among users of Dunga wetland and associated resources occur in the study area. Table 4.9 shows the sources of conflicts between mat makers and other wetland users. The main conflicts come from fellow artisan (25 %), urban developers (25%), farmers (23%), livestock keepers (17%) and fishermen (10%). Conflicts with livestock grazers are caused by damage to harvested raw materials (papyrus). Conflicts with both fishermen and farmers are due to burning of the

swamp, in which case the fire guts prepared cut materials and existing papyrus stands. At Dunga beach harvested papyrus are usually left to dry at the drawdown, just close to the swamp. In the other areas some harvesters leave the prepared materials in the swamp. All areas are susceptible to cattle that graze or pass-by within the target area.

Conflicts experienced during harvesting of papyrus at the wetland are a reflection of differences in personal interests as well as perceptions on values accrued from the wetland. Farmers, fishers, and herdsmen prefer burning the wetland so as to achieve their desires. Herdsmen also bring livestock to water or graze on abundant grasses in the wetland particularly during dry seasons because they do not have any other alternatives. Conflicts associated with wetland degradation need to be considered seriously, and wherever possible measures to eradicate the problem should be sought. Pirot *et al* (2000) noted that within the area, many communities may use the system for different purposes whereby some uses may be compatible with the constraints of the system and other may not. Pirot *et al* (2000) further learnt that conflicts always arise among such groups and cannot be solved through understanding of the ecosystem alone; the solution lies in understanding how different societies interact with the systems within which they live.

Transporting papyrus

In Table 4.8 about 15 % of artisans experienced transportation of papyrus and its products as a major challenge. About 85% of artisans use family labour in transportation of papyrus by head. Information was gathered on the means of transporting the papyrus materials. Table 4.10 shows major means of transporting papyrus.

Table 4.10: Transportation of papyrus from the wetland to homes

Responses	Frequency	Percentage
Head	324	96.1
Bicycles	13	3.9
Total	337	100.0

Table 4.10 shows that 96.1% of local artisans transport the raw materials from the wetland to their cottage sites, homes and market by head. Only 3.9% use bicycles in carrying papyrus materials to their homes. The majority of craftsmen involve family members in harvesting, processing, transportation, and weaving of mats. Papyrus transportation is labour intensive and has a cost in production and marketing.

4.4 Factors Contributing to Unsustainable Utilization and Management of Papyrus

4.4.1 Factors contributing to unsustainable utilization of papyrus

Table 4.1 presents the summarized results on factors that papyrus harvesters perceive that could lead to unsustainable utilization of papyrus.

Table 4.11: Factors those papyrus harvesters perceive to be leading to unsustainable utilization of papyrus.

Factors	Frequency(yes) n=337	Percentage
Economic factor	277	32.7
Social factor – poverty	259	30.6
Settlement patterns	169	20.0
Population pressure	141	16.7
Total	846	100.00

Table 4.11 shows factors papyrus harvesters perceive that can lead to both direct and indirect unsustainable uses of papyrus. The factors were summarized as economic (32.6%), social (30.6%), settlement patterns (20.0%) and population (16.7%). These are factors influencing or driving papyrus harvesting both at household and community levels. It was noted that in the past, the exploitation of

papyrus biomass has been on a small scale and at subsistence level mainly for products mentioned in Table 4.4. However this has changed with the exploitation of papyrus for commercial purposes (Gichuki *et al* 2001; Abila, 1998). Papyrus is used for several socio-economic purposes (Mwakubo, 2003) and excess exploitation depends on the socio-economic status of communities in the riparian areas (Abila, 1998). Factors in Table 4.11 are explained below in details with specific data on them presented in Tables 4.12 – 4.16.

4.4.1.1 Economic factor

Table 4.12 shows the economic motivational reasons why the communities use papyrus.

Table 4.12: Economic reasons why communities harvest engage in papyrus activities

Response	Frequency	Percentage
Livelihood income	223	66.3
Ready market	26	7.75
Papyrus availability	70	20.7
Others	18	5.25
Total	337	100.00

In Table 4.12, the results showed that 66.3 % of the sampled households reported source of livelihood as the major reason of being involved in papyrus activities. The same respondent proportion confirmed using more papyrus than past 5 years (ago) for income. Other economic reasons mentioned included ready market and papyrus availability (7.75%) and 20.7 % respectively. This suggests the importance of papyrus as a source of livelihood in Kisumu town. Most people in Kisumu town are employed in informal sector; which is insecure employment.

Papyrus generates income in three major ways; most commonly through the sale of raw materials to artisans, production of low cost products – rough mats and production of fine, higher-cost products such fine mats, baskets, wall hangings , book shelves and TV stands. In the recent two decades the national economy declined and also the industrial economy of Kisumu collapsed and most people (48%) are in the absolute poverty bracket (Kisumu City Council CDS, 2003). The informal sector population provides transport, petty trade, repairs, carpentry, and metal work. Papyrus has multiple socio-economic and social values on which these people depend on earning their income. It has been realized that papyrus production has low economic returns; it cannot provide enough income in the aggregate to close the poverty gap.

Hence, harvesting of papyrus should be as a source of income that prevents people from sliding further into poverty rather than as a means of escaping

poverty. There is therefore need to improve the quality of craft goods made of so as to increase net income to those involved in the business. A loss of papyrus may mean loss of asset and this means loss of income. It is from this sector that over-utilize of papyrus as an alternative source of income because the distance is short and investment cost of papyrus production and product diversity may only require labour – a harvester himself/herself.

4.4.1.2 Social factor – poverty

Table 4.13 below shows some specific poverty indices of people living in Kisumu town.

Table 4.13 Kisumu dwellers poverty indices

Poverty indicators	Percentage (%)
Informal employment	52
Absolute poverty level	48
High incidences of food poverty	53.4
HIV/Aids infection	24.4

Source: Kisumu Municipal Council, 2005

In the Table 4.13, results show that about 48 % of Kisumu residents live within the absolute poverty bracket comparing unfavorably with the national average of 29 % and might cause the unsustainable use of papyrus. The city experiences one

of the highest incidences of food insecurity, 53.4 % in comparison to Nairobi, 8.4 %, Mombasa, 38.6 %, and Nakuru 30 % (Kisumu City Council CDS, 2003). Due to high unemployment levels, incomes are relatively low resulting to increasing poverty levels and HIV/AIDS pandemic which already have affected 24.4% of the residents. Of the working population, 52 % are engaged in informal activities. The papyrus harvesters are low income urban dwellers and generally they face higher living costs (UN-HABBITAT, 1996). Poverty and environmental degradation processes are directly linked. The poor in urban centers over depend on natural resources and on the extreme event of lack of alternative livelihood sources they tend to deplete the resource (UN-HABBITAT, 1996). Some papyrus products (e.g. mats used as beddings) are cheap, hence the most demand comes from poor people creating a situation of higher supply and hence over-harvesting of the papyrus. The increase in papyrus clearing at the Dunga site is apparently due to the continued dependence on papyrus swamp as a major source of livelihood for the local people. Thus papyrus over-harvesting and intensification at Dunga could be as a result of poverty associated with multi-social aspect vulnerability (Aseto and Onga'nga, 2003). Poverty is thus still an important driver of papyrus harvesting pressure.

4.4.1.3 Settlement patterns

Figure 4.3 shows results collected on the rankings done by the locals on major causes of papyrus unsustainable use.

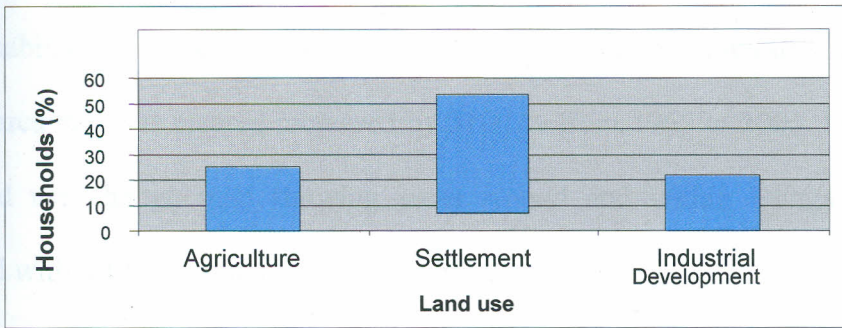
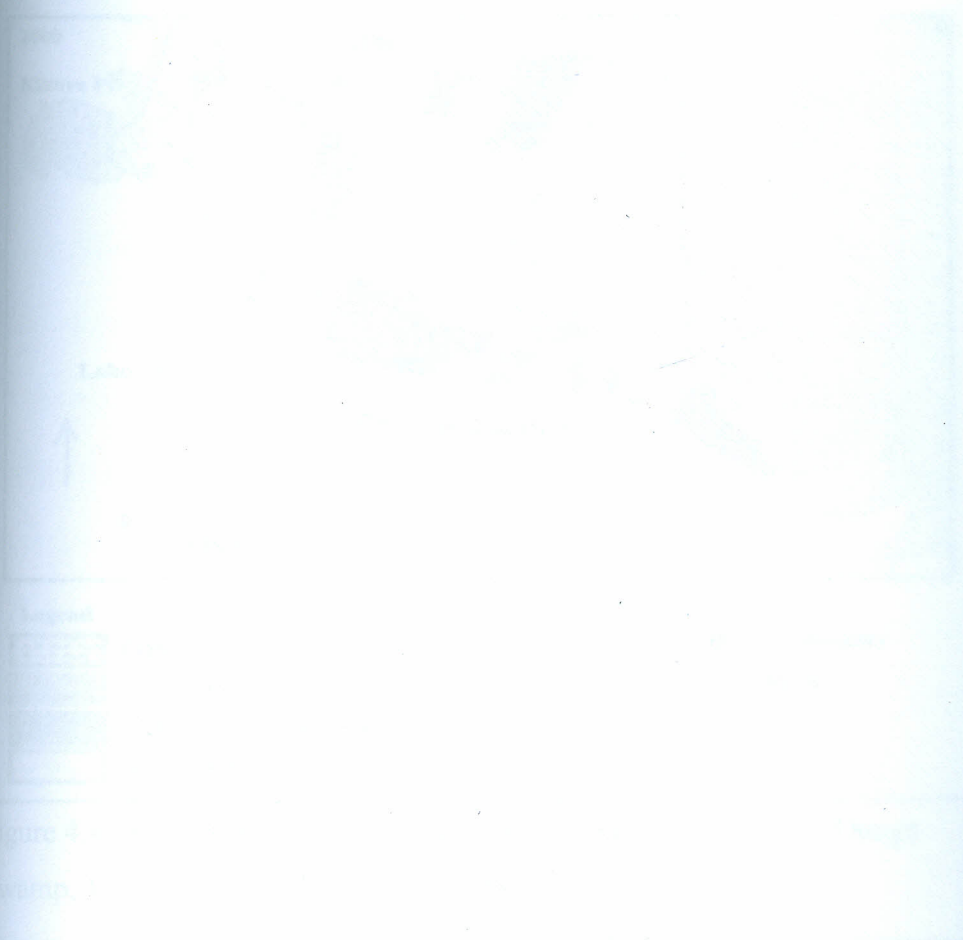


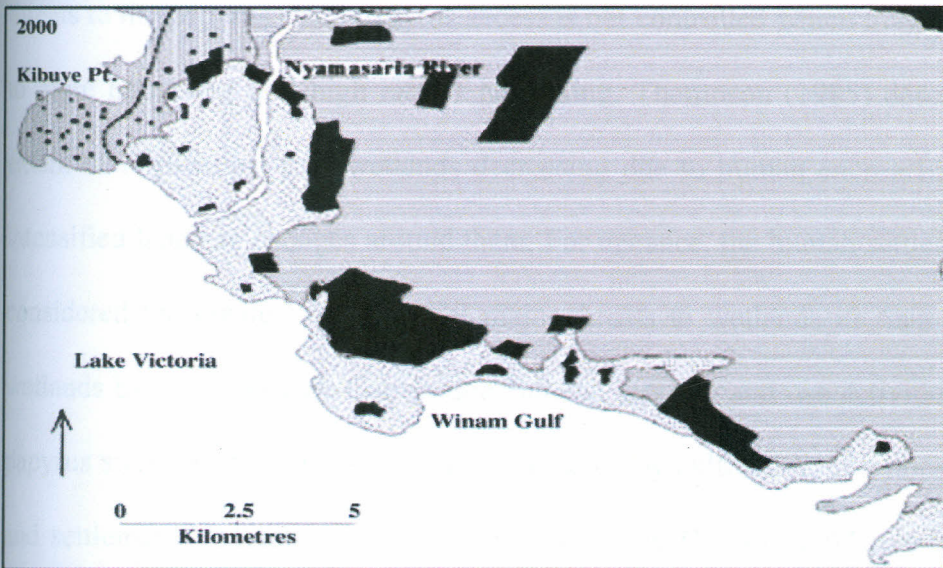
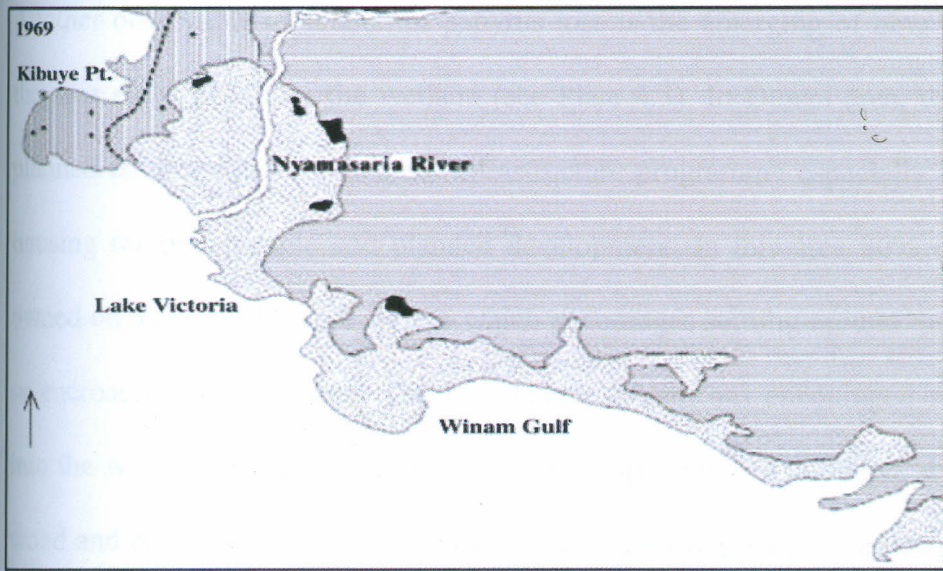
Figure 4.3: Percentages of respondents on major land use categories causing papyrus unsustainable use

In Figure 4.3, the locals highlighted human settlement as the major cause of papyrus degradation ($n = 130$; 52.7%), seconded by agriculture ($n = 62$; 25.0 %) while industrial development posed threat ($n = 55$; 22.4%). Through observations also papyrus is disturbed by residents through burning, papyrus cutting, livestock grazing, footpaths, trampling and farming. This area the land value is lower than areas near the town centre and its forms the basis for the low income class settle in the area. The major industrial activities, construction of dykes and sewage present in the upstream of the rivers generate pollutants that degrade the wetland

to influence growth of other vegetation (alien) that affect growth and abundance of papyrus to reduce.

From Owino *et al.* 2007 article also provides results on the extend of papyrus swamp habitat loss through clearance of papyrus followed by cultivation at Dunga and the area that was cleared increased by 3100 % from 1969 to 2000. Figure 4.4 is a land use change map showing areas around and within Dunga wetland impacted with settlement and human activities.





Legend







- | | | | |
|--|----------------------------------|---|-------------|
|  | Papyrus |  | Settlements |
|  | Grassland |  | Road |
|  | Cleared papyrus/cultivated areas | | |
|  | Waterbodies | | |

Figure 4.4: Spatial extents of papyrus and surrounding land use at Dunga Swamp, 1969 and 2000 (Owino *et al.* 2007)

Another observable indication of papyrus loss is the emerging of new houses in the area close or within the wetland (see Plate 4.3). In Dunga area, there is no planned environmental settlement infrastructure programme especially improved housing for poor people and planned development. In this area 80% of land is owned on a freehold tenure system which encourages settling around the wetland or encroaching the wetland. The land tenure system has encouraged settlement into the wetland area due to availability of cheap resources like land, water, fuel wood and papyrus. Such unplanned wetland neighboring human settlement poses threats to the papyrus since papyrus access is not controlled which may contribute to more harvesters and high rate of harvesting. Thompson (1985) described the extent of African papyrus wetlands decreasing due to human encroachment and intensified land use changes around them. For instance, the human settlement was considered the greatest incidence of major threats to wetlands in Asia reducing wetlands by 27% (Ramsar Convention Bureau, 1997). Land use activities around papyrus swamps of Lake Victoria are dominated by cultivation, livestock grazing and settlements (Mafabi 2000). Mafabi (2000) and Owino (2007) confirms that these activities are on increasing trend and are of particular concern as they have led to other forms of disturbances of papyrus swamps especially uncontrolled papyrus harvesting and burning.

This kind of human settlement of many poor and idle inhabitants encourages over-harvesting and unsustainable papyrus use. The present land use in the hinterland of Kisumu includes small-scale rain-fed mixed farming, large-scale sugar cane farming, fishing, small-scale river-irrigation, and settlement infrastructure (Kisumu City Council CDS, 2003). However, agriculture does not provide enough livelihood support due to frequent droughts alternating with severe floods and poorly drained intractable soils of the flat plains. Hence, farmers destroy papyrus to establish croplands within the swamp where fertile soils and water are used.

The number of years respondents were involved in papyrus harvesting range from 1 year to 25 although Owino (2007) study show 1 – 60 years with an average of 10 years. This implies that to some people, papyrus is a life-long activity. It is expected that such a variable increases papyrus-harvesting intensity. Plate 4.3 shows papyrus swamp in Dunga being encroached for housing development.



Plate 4.3 shows unplanned housing development scenario in Kisumu town. Area once covered with papyrus of Dunga wetland (Taken at Dunga Beach on 20/09/2009).

4.4.1.4 Population pressure

Figure 4.5 shows the percentage of respondents perceiving population growth, urban housing and other population related factors around Dunga wetland contributing to unsustainable use of papyrus.

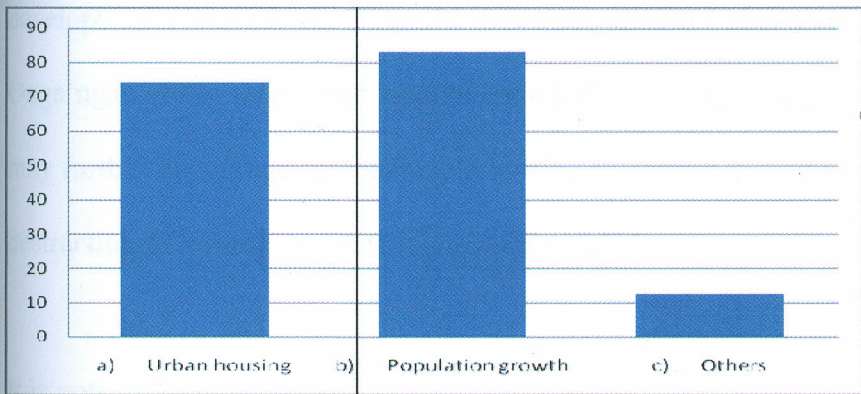


Figure 4.5 Urban housing and population growth around areas of Dunga papyrus

In Figure 4.5 results shows that papyrus is unsustainably utilized due to population growth (83%) and housing development (74%) in the wetland. High population growth creates a situation of more papyrus users as well as expansion of housing in the wetland. The area lacks formal land rights and wetland protection and among such factors makes the wetland highly vulnerable to impact of population pressure. World Bank report on water resources and environment, 1996 present Lake Victoria household size among papyrus respondents ranged from 2 to a maximum of 13 with mean of 6 people per household. This is above the national average of 5.3. The household size in an artisan house implies availability of labour and higher subsistence requirements. It thus follows, that this increases the amount of papyrus harvested and area for settlement. The population growth in the area would also mean expansion of markets, improved better transport network and cheaper transport for cut papyrus and such

developments would significantly increase papyrus exploitation (Aseto and Onga'nga, 2003). Decline of income among the population depending on papyrus may further encourage unsustainable levels of papyrus use, ultimately leading to destruction of swamp ecosystem (Mwakubo, 2003).

It is noted that rapid population growth in the area was as a result of rural-urban migration and cheap housing in the area. Cultural factors such as land inheritance, dominate migration trends, with the surrounding districts contributing the bulk of the 50 % migrants who settle in the slum belt, in the process adding to the pressure on already impoverished settlements and resources. Increased population around the papyrus and lack of regulations enhance a higher number of papyrus harvesters and harvesting beyond conservation stock.

It was observed from field observation that the papyrus coverage has reduced by 50% at the edges and inside the wetland. Owino (2007) study also shows that between 1948 and 2010 human population increased and the area under papyrus in Dunga reduced by 50%. The trend is also the same with other wetlands in the area for example Koguta wetland has disappeared by 47% while Kusa 34%. Human population growth around the wetland subjects it into land use activities, change and overexploitation of papyrus. As Lake Victoria basin continue to experience one of the highest human population growth (World Bank, 1996), the

sites whose surrounding population sizes are projected to double in the next two decades. These areas will experience more pressure and degradation of the swamps will increase. Dunga may receive more impact due to its ever increasing population density.

4.4.2 Factors contributing to unsustainable management of papyrus

Table 4.14 presents major factors contributing to unsustainable management of papyrus in Dunga area

Table 4.14: Major factors respondents perceived as contributing to unsustainable management of papyrus in Dunga area, Kisumu town

Factors affecting degradation of papyrus	Frequency (yes) n=337	Percentages
Over-exploitation of papyrus	330	17.7
Lack of environmental planning	211	11.3
Unclear property rights and land tenure	282	15.1
Information failures	334	17.9
Not using traditional conservation strategies	190	10.2
Lack of participation in decision making	273	14.6
Lack of protection status	246	13.2
Total	1866	100

The perceived main causes of unsustainable management of papyrus around Dunga wetland. Approximately 17.9% of respondents associated unsustainable management of papyrus resulting from information failures or unaware of the community to understand all functions and services of papyrus. Other major factors included over-exploitation of papyrus (17.7%), unclear property rights and land tenure (15.1%), lack of participation in decision making (14.6%), lack of protection status (13.2%), lack of environmental planning (11.3%) as well as community not using traditional conservation strategies (10.2 %). It's a fact that most papyrus swamp is found among very poor communities whose livelihoods depend solely on exploitation of papyrus (Abila, 2005). Sustainable conservation and development depend heavily on strengthening the capacity of local individuals and communities to implement conservation initiatives (IUCN, 1996)

4.4.2.1 Information failures

In Table 4.14, about 17.9% of respondents associated unsustainable management of papyrus in Dunga with information failures. Information failures are understood by the community as lack of conservation education and awareness of economic and environmental consequences of papyrus degradation. The study found that only 13.3 % have been sensitized, 6.7 % received training and 3.3 % are following the education and awareness programme from a local Non-governmental organization. Field observations showed the absence of strong

defined and well organized and government coordinated programme around the wetland. Only 5% of artisans were found involved in papyrus activities through community clubs, or local NGOs (like Lake Victoria Sunset Birders - L.V.S.B.) and Kenya Wildlife Service (KWS) protecting environment. Other organizations responsible for awareness campaigns in the area include Nature Kenya, OSIENALA, Rufford Small Grants for conservation, I.U.C.N, African Birds Conservation and Nile Basin Initiative. These organizations have not reached the majority of wetland papyrus (Turner *et al.*, 2000). The groups that make valuable papyrus products have never received technical assistance geared towards improving and diversifying the papyrus products and explore better marketing strategies. Activities like ecotourism among many, with local help can enlist the support of the local people in conservation (Dugan, 1990).

Information failure relate to the complexity and invisibility of spatial relationships among papyrus biomass and other functions and services (such as water – ground and surface) (Turner *et al.*, 2000). The failure to understand the consequences of disappearing papyrus or land use change on wetlands enhances unsustainable management of papyrus. Many wetland functions do not have a market price and as a result decision-makers do not recognize them having an economic value (Elsevier, 2004). As a results, benefits of extensive non-papyrus functions such as land and water management for crop production or infrastructure development in

the wetland are often perceived to have more economic benefits than papyrus wetland themselves. The perspectives on the relationship between humans and papyrus ecosystem or environment is not supportive with papyrus harvesters and those in decision-making authorities though sustainable management instruments like the Convention on Wetlands of International Importance which entered in force 1975 (Turner *et al.*, 2000). Wetlands are still being degraded in many parts of the world. Understanding the structure and functions of papyrus how these functions are linked to the provision of goods and services is of primary importance if intelligent decisions concerning the management and use of papyrus are to be made (Gichuki *et al.* 2001). The campaign outreach programme alone is insufficient to the community around the wetland. One of the most prominent factors underlying wetland management problems in Kenya and elsewhere is lack of or insufficient awareness of the functions and benefits of wetlands leading to inappropriate use of swamp resources (Mafabi 2000 and Gichuki *et al.* 2001).

4.4.2.2 Over-exploitation of papyrus

A further underlying cause of much papyrus degradation and unsustainable management is over-harvesting of papyrus as perceived by 17.7 % of respondents (Table 4.14). This is largely due to uncontrolled access to papyrus, many papyrus harvesters, short harvesting intervals, no cooperation among users, selling raw papyrus materials and huge papyrus dependant population around the wetland.

In most sites papyrus stands were less dense than expected depicting overharvesting, uprooting and non-regeneration and succession with alien wetland plants such as hippo grass and water hyacinth. Papyrus exploitation around Lake Victoria is excessive, uncontrolled, and unsustainable (Owino, 2005). Overharvesting of papyrus consequently destroys the meristematic components that enhance papyrus regeneration capacity. Current uncontrolled harvesting is leading to fragmentation, weak spatial connectivity, and increased swamp landscape patchiness. Shorter harvest intervals affect the ecology of swamps and hence reduce biomass yields (Kasoma 2003). The extent to which people lack information regarding the hidden benefits of papyrus, always contribute to the overuse (Mafabi 2000). Under continuous removal of papyrus, wetland floor conditions are altered and growth and establishment of other aquatic plant species such as *Cyperus latifolius*, *Learsia hexandra* and *Therepteris striata* (Kyambadde, 2002) emerge and out-compete papyrus. Small and stunted papyrus culms appear and such conditions reduce regeneration and consequently the stock is depleted (Mwakubo, 2003; Owino, 2007). And that sustainability of papyrus yield from wetlands depends on harvesting regimes (Kyambadde, 2002). The large number of papyrus harvesting underscores the need for sustainable management solutions for papyrus wetland.

4.4.2.3 Unclear property rights and land tenure

Table 4.14 shows 15.1% of respondents associating unclear property rights and land tenure as a reason for papyrus and environmental degradation. Table 4.15 show the land tenure system around Dunga wetland.

Table 4.15 Forms of land tenure system around Dunga

Ownership	Frequency	Percentages
Communal	226	67.0
Private ownership	111	33.0
Total	337	100.0

Further analysis of land ownership in areas around the wetland (Table 4.15) showed that communal land ownership is about 67.0 % while private ownership is by 33.0 % of the respondents. It was observed that much of the wetland, papyrus and water of the wetland do not have clear property rights since most respondents did not know who owns the area covered by Dunga wetland and that it is an open access natural resource. There were contradictions, confusion and ambiguity over rights and obligations of ownership of land and management of the wetland. The Kisumu Municipal Council holds Dunga wetland in trust for the people around. Indeed ill-defined property rights, boundaries and the mobility of wetland resources are often associated with unsustainable levels of resource use

(Mwakubo, 2003). This phenomenon normally causes market failures (Elsevier, 2004), because the papyrus industry market may be unable to regulate demand and supply for papyrus goods and services. The papyrus market failure might lead to negative externalities or cost to other wetland users and the vicious circle repeats until the wetland uses changes or degrade completely. The most frequently cited reasons for environmental degradation is Hardin's (1968) 'free rider' assertion, which attributes degradation to the over-use of common property resources (Elsevier, 2004). It was evident in the responses people gave when questioned about swamp ownership that most were not prevented from accessing the swamp for papyrus harvesting. Lack of ownership brings mixed fortunes, stops collective management and individualist strategies making papyrus use unsustainable reducing even social benefits (Elsevier, 2004). Unclear property rights and land tenure in wetland may lead to conversion to other land uses making papyrus to disappear forever (Abila, 2005).

4.4.2.4 Lack of participation in decision making

Table 4.14 shows that 14.6% of respondents associate the unsustainable management of papyrus with lack of participation in decision-making by the local community and its institutions. The local community in the area was made up of papyrus users, Municipal Council of Kisumu, fisher-forks, land owners, farmers, livestock keepers, indigenous people, traders, civil society, government agencies

and development partners. Some of the main forms of involvement in papyrus management include papyrus harvesters forming local groups for collective production and marketing of papyrus products. The majority are not involved in planning, forums or sessions of papyrus conservation activities such as public awareness, trainings and advocacy work. Lack of participation in papyrus management leads to ignorance about papyrus sustainability and such scenario could lead to over-exploitation of papyrus and its loss. Socio-cultural or traditional institutions, schools, local communities groups and Community Based Organizations, media stations, local NGOs, government ministries, and Kisumu Municipal Council were potential stakeholders identified to be involved in papyrus conservation efforts and decision-making process. Papyrus can be essentially managed well through active commitment and collaboration of stakeholders (Ramsar, 1971; Ramsar Convention Bureau, 1993) especially when local and indigenous people are involved and in partnership. Participatory management arrangements improve ecosystem viability; reduce management costs; assist with monitoring and surveillance; fewer infringements; and enhanced social sustainability and quality of life for communities dependent on wetlands (Ramsar Convention Bureau, 1993).

The case for local and indigenous people's involvement potential in the area is stronger as the locals and stakeholders have historically enjoyed customary/legal

rights over the wetland but the existing management regime has so far not produce evidence of wise use practices. Participatory management arrangements for wise use of papyrus can enhance maintenance of sustainable livelihoods. Establishing and strengthening local communities' participation in the management of wetlands and decision making for sites is recognized as essential in wetland management history, but very little guidance on this topic is available to the many countries managing wetlands (Ramsar COP6 1996). Without specific efforts planned to encourage active, guided and informed participation of local people at papyrus wetlands and their catchments sites, papyrus restoration and its conservation may be very complex and critical factor. Community management institutions within a community plays a different role, function, operates in a different manner and has a separate set of rules, responsibility and representation. Some are involved in the management of technical systems, some with organizational or communal labour management.

Communities at Dunga have administrative and indigenous knowledge systems useful in the management of the wetland in a manner similar to observation by Turner et al. (2000). Involving the community will enhance ownership of the wetland and also be easy to develop alternative use of papyrus such as ecotourism for enhanced papyrus stock as found in this study. Community participation in planning, management and policy-based monitoring in community development

can enhance sustainable utilization of papyrus and conservation of the wetland (Turner et al., 2000). This study found that Community outreaches including churches, markets, schools and Kisumu city authority can influence the wetland management. Involving local communities in wetland management as provided in Ramsar Convention review meetings is proving to be an effective means of meeting local needs in terms of subsistence with conservation goals. Wetland managers around Dunga should support and enhance local level institutions for effective involvement and participation of local stakeholders in wetland management. Local and indigenous people's involvement in wetland management can substantially contribute to effective management.

4.4.2.5 Lack of protection status

Table 4.14, indicated results that 13.2% of respondents associated unsustainable management of papyrus with lack of protection status of Dunga wetland. The foregoing demonstrates that like most tropical wetlands, the Dunga Wetland is important for its biodiversity and is of great socioeconomic value to the local community. During field work no single and specific legal economic or environmental legislation was known by respondents or was in place to protect papyrus or wetlands. All the papyrus harvesters none was licensed to carry out commercial papyrus based industrial activities. This has led to over-harvesting of papyrus since no control and coordination is in place. Accessibility to papyrus swamp and market for papyrus

harvesters has very few constraints since papyrus users and market are closer to the wetland hence lack of protection has resulted into papyrus overharvesting beyond unsustainable yield. The high economic potential of the Dunga Wetland and its proximity to Kisumu Town, the lack of a proper wetland policy makes it a very vulnerable ecosystem (Abila, 2005). The wetland policy framework exists. Kenya has formulated a National Wetland Conservation and Management Policy of Kenya of 2008. The need of the policy existed since 1990 when Kenya ratified the Ramsar Convention on wetlands. The policy was required to mitigate impacts of high human population increase, escalating pressure on land and natural resources. Although private ownership is suggested as an effective means of managing environmental resources (Hardin, 1968), formal protection of a papyrus can show direction to sustain access of poor people to sustainably use papyrus. Formal protection brings understanding of how benefits and costs are distributed among stakeholders managing the wetland.

Specifically, papyrus loss or unsustainable management is associated with policy intervention failures and inconsistency in enforcing government policies in a holistic approach in different sectors such as environment, nature protection and physical planning (Elsevier, 2004; Wood, 2000). Such failures arise due to the insufficient understanding of the functions and values of wetlands and thus the consequences when papyrus or wetlands are lost. In Africa, common factors that

put increasing pressure on wetlands are demographic growth, rising poverty and severe economic stress (Dugan, 1990). Thus lack of or inadequacies of policies, legislations and enforcement within such vulnerability can enhance depletion of papyrus. Stakeholders may have different interests on direct and indirect uses of papyrus (Turner et al., 2000) which may conflict with policy-makers and then faced with complex trade-offs rendering papyrus loss especially when policy direction is delayed.

Kenyan regulations of present relevant legislations for conservation and management such as the Environment Management and Co-ordination Act (EMCA 1999) section 42 and the Water Act (2000) support sustainable management of papyrus. This is in line with field results of only 3.4 % of respondents who respondent being aware of these regulations. Most papyrus harvesters are not aware of policy and laws protecting papyrus. Thus local institutional set up based on local understanding to address tenure, access and user systems, is vital in wise use of papyrus and sustainable management regime (Kibwage et al., 2008). Policies providing incentives such as tax concessions, subsidies, and conservation easements, special arrangements for licenses, increased market access, financial compensation schemes, increased infrastructure, and development activities can, if appropriately structured, enhance wise use of papyrus.

4.4.2.6 *Environmental planning*

About 11.3 % (Table 4.14) of respondents associated lack of environmental planning around Dunga wetland as a precursor to unsustainable management of papyrus. It was observed that the expansion of Kisumu town around the wetland area lacks urban environmental planning and this might have led to over use and degradation of the papyrus. The Nyalenda area is unplanned zone and its land use types influences papyrus management unsustainably. Of all papyrus users interviewed, none was involved in Kisumu Town urban planning and implementation of activities around the wetland. The poor urban planning in Kisumu is associated with unchecked sprawl of densely populated informal settlements, freehold tenure conflicts, expanded boundaries and lack of awareness and public education. The informal settlements grow as a result of rising demand for housing and private developers acquire private land for housing in the wetland areas with little consideration of statutory planning requirements. In a wetland such as Dunga that lacks formal tenure and user rights and without plan, over-exploitation is guaranteed (Kibwage *et al.*, 2008; Mafabi, 2000).

The Council was the only key planning institution for urban development but its capacity (in terms of personnel, equipment and financial resources) is inadequate to give solutions on existing challenges. The Municipal Council of Kisumu has a management role of Dunga wetland. It controls land use, land ownership, land

acquisition, land allocation and provision of development schemes to land developers. This study found out that there are housing developments which are illegal and not guided by the council legal or planning framework. For this reason close coordination and enforcement is lacking in areas around the papyrus wetland. The planning by-laws are to a large extent archaic (Kisumu City Council, 2003). Lack of environmental planning could influence human encroachment and unsustainable exploitation.

The Earth Summit, Agenda 21 chapter 7 on the Human Settlements informs policy makers of the adverse consequences of unplanned settlements in environmentally vulnerable areas. Promotion of sustainable land-use planning and management, with the objective of providing for the land requirements of human settlements development through environmentally sound physical planning and land use could have adequately managed the papyrus in Kisumu. In papyrus management no formal arrangements and action exist to conserve over-harvesting Dunga papyrus since it has not been identified as an issue by administrative structure of Kisumu town. The study found out no monitoring plan too. Without a Community Action Plan, monitoring of papyrus utilization and its management cannot be achieved.

In 2005 with the help of UN-HABITAT, the Cities Development Strategies (CDS) for improved urban management and poverty reduction in Kampala, Kisumu and

Musoma were developed. In this strategic plan papyrus management or urban wetlands were not considered. Though local knowledge is cited in the report, few formalized local environmental planning process existed.

4.4.2.7 Traditional conservation strategies

Table 4.14, about 10.2 % of respondents associated unsustainable management of papyrus with users not employing traditional conservation strategies (Indigenous Knowledge Systems) available in the area. Further analysis on awareness of traditional conservation strategies are presented in Table 4.16.

Table 4.16: Community recognition of traditional conservation strategies (rules, regulations, taboos, religious beliefs)

Awareness of traditional conservation strategies		
Responses	Frequency	Percentage
Traditional taboos	67	20
Traditional rules and regulations	39	11.7
None	231	68.3
Total	337	100

Table 4.16, shows awareness of traditional conservation strategies is on reducing trend even with experienced papyrus users. About 20 % of respondents were aware of some traditional taboos and only 11.7 % were aware of various rules and regulations which can manage papyrus and its wetland. About 20 % and 11.7 % of respondents were aware of traditional taboos and traditional rules and regulations which used to manage Dunga wetland and its papyrus. A major proportion of respondents of 68.3% were not aware of traditional taboos, rules skills and technology to conserve Dunga wetland and its papyrus.

The study found out that unaware characteristic is due to commercialization of papyrus and lack of recognition of these strategies by institutions governing resources. The elderly artisans could mention some strategies to conserve papyrus but they admitted they are not using these technologies since these technologies are not part of legal and institutional framework and are not in operation. There were several local skills and knowledge on uses of papyrus than management. Particular strategies the study found out employed formed a pattern of indigenous knowledge system which includes closed seasons, sacred days and cultural value for papyrus production similar to those studied by Dixon (2000). Tradition knowledge systems have capacity to promote alternative use and diversification of papyrus products. Unfortunately, as a result of urbanization, migration, trade, Christianity, western influence, government policies and education the traditions

and taboos are no longer respected (Dixon, 2000). The study found out that the government of Kenya lack policy on the ancestral knowledge the beliefs were strong enough to protect papyrus. Such traditional beliefs and associated taboos have shown to be effective as tools for conservation of papyrus in areas where they are respected. For example areas with abundant papyrus stands are restricted by taboos or forbidden to be harvested as they are heritage, spiritual and nesting fauna. For instance rural communities had built up a considerable body of knowledge about the dynamics of papyrus wetlands (Dixon, 2000). Sustainable indigenous or local knowledge identified in the area of study if blended with modern technologies can adequately settle management problems of papyrus. Local knowledge must evolve in order to face the challenges of growing local and external pressures on wetlands (Dixon, 2000). Ways of strengthening, integrating and developing this knowledge must be found (Dixon, 2000).

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The Dunga wetland is under severe threat as a result of intensive pressure to overuse papyrus as well as conversion to other land uses that benefits the local people in the short run. This study shows that there are several traditional uses and a number of factors that influence papyrus harvesting and its management. This chapter presents conclusion and recommendations based on findings on traditional uses and factors affecting utilization and management of papyrus.

5.2 Conclusion

Based on the objectives and available data collected by this study, the following conclusions can be made:

The socio-economic situation of papyrus users is a critical factor in sustainable use and management of papyrus. Socio-economic factors such as gender, education level, occupation and age of papyrus users influence utilization levels and sustainable management of papyrus. Papyrus craft is still dominated by women for livelihood and income. The youthful age, low education level and informal employment of people living around the wetland can form a threat of papyrus over-exploitation and land pressure on a wetland.

Papyrus swamps are critical ecosystems that require sustainable use. Papyrus is used to make products for both economic and subsistence use to meet livelihoods of artisans. Traditionally papyrus is dominantly used for mat making as well as other products such as furniture, baskets and packaging materials for commercial use and brooms, ropes, fences and medicine for subsistence use. Commercial uses enable local communities to supplement their income and it has also attracted many people to engage in papyrus harvesting. Papyrus artisans have developed traditional knowledge and skills to make modern products through value addition technologies. Identification of papyrus products around the wetland is a critical factor to consider in sustainable use of papyrus. There is over-use and intensive pressure of Dunga papyrus since it a sole livelihood earner for users. Value addition contributes significantly to the sustainability of papyrus.

Harvesting of papyrus pose threats and has many challenges. Papyrus harvesting through random and uprooting methods degrades the wetland by allowing growth of alien plant species and open spaces a process replacing papyrus and damaging its replenishing capacity. The existence of water, wildlife encounter and other wetland users such as farmers and fishermen establishes hazards and conflicts as challenges for papyrus harvesters. Challenges and conflicts faced by papyrus harvesters show the level at which papyrus is degraded. Papyrus swamps face ineffective harvesting and management of papyrus. Better harvesting techniques

can influence optimum harvesting, reduced hazards and conflicts among wetland users

Human demographic factors such as economic situation, poverty, settlement patterns and population pressure increase papyrus cutting, burning, livestock grazing, footpaths/trampling, and farming directly affect papyrus habitat conditions. Settlement however contributes significantly to papyrus loss.

Most papyrus swamps are common resources hence suffer 'tragedy of the commons'. Thus communication and awareness, defined ownership, policy and legal framework, stakeholder participation and planning are critical management factors to be considered to manage papyrus sustainably. Multipurpose use and conservation of papyrus swamps should be viewed with the context of equity and sustainable development. Socio-economic governance, policy and institutional strengthening are the best options for sustainable management of papyrus.

5.3 Recommendations

1. The papyrus artisans should be supported to diversify sources of income such as intensification of cottage industry, small businesses, microfinances

and enterprises to enhance both papyrus environmental and socio-economic sustainability

2. The value addition technologies, skills and multi-purpose uses of papyrus and wetland should be promoted for efficiency utilization of papyrus to produce high quality products.
3. Training and institutional capacity building of Dunga stakeholders through environmental public education and awareness campaigns and programmes can enhance sustainable utilization and management of papyrus in the wetland.
4. Sustainable harvesting programme can be established through selective, seasonal cycle, staggered and rotational harvesting systems to protect papyrus depletion.
5. There is need to restore, re-create and rehabilitate the destroyed papyrus areas through poor harvesting system
6. Dunga wetland should be formalized through sustainable planning, institutional and legal framework to control user rights of accessing the wetland resources, illegal encroachment, burning, agriculture and settlements among stakeholders.
7. Special buffer zones with a site action and monitoring plan should be designed or created in the swamp to protect and conserve papyrus, wildlife

and water as well as to control human-human and human-wildlife conflicts and hazards in the area.

8. Economic instruments such as taxation and licensing can ensure conservational harvesting of papyrus.
9. Community participation in decision-making process, informed local knowledge or communication and integration of Indigenous Knowledge (IK) systems in management is a wise option
10. Establishment of research and practitioners network to exchange results and to discuss basic principles as well as experience sharing of sustainable use of papyrus in different wetlands
11. Further papyrus research should be undertaken on its cultural uses, ecosystem and livelihoods services, value addition strategies, growth dynamics of papyrus and optimal papyrus harvest, other multipurpose-non-values uses, economic valuation and management of wetlands to make sound decisions on development options and set regional and national policy.

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