INFLUENCE OF WATER HYACINTH ON LIVELIHOODS OF THE RIPARIAN COMMUNITY OF SOUTH WEST SEME LOCATION, KISUMU COUNTY, KENYA

BY

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DECLARATION

This research project report is my original work and has not been presented for an award in any other university.

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DEDICATION

This work is dedicated to my wife Irene Were and daughter Jardin for their love, constant encouragement and support throughout my study period

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To the Almighty God I am grateful for favor, grace, wisdom and knowledge that have seen me through this process. I pass my gratitude to Dr. Nyonje, my resident lecturer at the University of Nairobi, Kisumu campus for his un-rivaled support towards the development of this project report. Special acknowledgement goes to my supervisors, Dr. Paul Odundo and Dr. Benson Ojwang' for their tireless guidance throughout the development of this project report, through positive criticism. I am also grateful for their encouragement and guidance during the hard times of the process.

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May the Almighty God bless you all!

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ABBREVIATIONS

AME	Africa and the middle East
BMU	Beach Management Unit
CBD	Convention on Biological Diversity
CBO	Community Based Organisation
FAO	Food and Agriculture Organisation
GDP	Gross Domestic Product
GOK	Government of Kenya
IBM	International Business Machines
KARI	Kenya Agricultural Research Institute
KNBS	Kenya National Bureau of Statistics
LVEMP	Lake Victoria Environmental Management Project
NAS	National Academy of Science
NACOSTI	National Commission for Science, Technology and Innovation
NGO	Non-Governmental Organisation
PASW	Predictive Analytics Software
SPSS	Statistical Package for Social Scientists
UNEP	United Nations Environment Programme
UNWDR	Uganda National Water Development Report
USD	United States Dollars
WB	World Bank

ABSTRACT

The water hyacinth, a free-floating perennial aquatic plant native to tropical South America, is suffocating Lake Victoria, the second-largest fresh-water lake in the world. Since its emergence in Kenya, the water hyacinth has been a menace to the riparian communities, causing several problems. The purpose of this study was to investigate the influence of water hyacinth on the livelihoods of the riparian communities around Lake Victoria, focusing on South West Seme Location in Kisumu County. Specifically, the study sought to establish the influence of water hyacinth on agricultural activities of the community, to examine the influence of water hyacinth on the fishing activities of the community, and to assess the extent to which water hyacinth influences the business initiatives of the community. Using the descriptive survey research design, the study targeted the 1648 households covering West Kadinga and South Alungo Sub Locations. The sample size of the study was 310 households estimated to give results at 95% level of confidence within ±0.5 margin of error. The study area was zoned into 2 Sub Location clusters and simple random sampling used to proportionately select the study sample based on the number of households represented by each Sub Location cluster. Data collection instruments included a questionnaire for the community members and a key informant interview guide. The questionnaire was validated through a pilot-test on a sample of 10 household respondents drawn from Usoma Beach which has similar characteristics as the area of study. The reliability of the questionnaire was determined using the test-retest approach. Data collected was cleaned, coded and analyzed with the aid of the Statistical Package for Social Scientists. Quantitative data was analyzed into percentages, frequencies and means and the results presented in frequency distribution tables. Qualitative data was extracted and transcribed, the common themes identified, organized and discussed under the main objectives of the study. From the research, 106(35.3%) of the respondents reported that the emergence of the plant is linked to the decrease of agricultural prices. Further, 254(84.7%) respondents reported a change in fish species that were caught during periods of hyacinth infestation. It was concluded that the weed led to diversification of agriculture and adaptation of new technology in agriculture. New businesses involving the use of the weed as a raw material have also been established. It was recommended that government should encourage the residents to embrace the economic importance of the weed and also encourage the consumption hyacinth tolerant fish species.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Water hyacinth (*Eichhornia crassipes*) is an alien, floating water weed that has spread throughout vital freshwater bodies and wetlands of Africa and the Middle East (AME) since the late 1800s. Fresh water bodies constitute a vital component of a wide variety of living environments as integral water resource base in many human societies in the world. They have been regarded as key strategic resources essential for sustaining human livelihood, promoting economic development and maintaining the environment [Uganda National Water Development Report (UNWDR), 2005]. By the beginning of the 1990's the Lake Victoria experienced a landmark phenomenon with the infestation by water hyacinth. Under heavy infestation the socio-economic structure, food supply and health of the communities residing around the lake are seriously disturbed (Gopal 1987, Wawire Unpubl., Onditi 1997, Otieno 1997 and Carvine 1997, Mboya 2001).

Lake Victoria serves the three East Africa countries, namely, Tanzania, Uganda and Kenya constituting 51%, 43% and 6% of the total surface area, respectively. It forms the main source of food, water for domestic, industrial and agricultural activities and employment for the people residing around the lake and beyond (LVEMP 1999, GoK 2002b). The water hyacinth effect has been greatly felt in the fish industry. Available literature (Gopal 1987, LVEMP, 1999, Onditi 1997, Otieno 1997, Carvine 1997) links water hyacinth infestation to fish production. In Lake Victoria, fish catch rates have decreased because water hyacinth mats block access to fishing grounds, delayed access to markets, and

increased fishing costs (effort and materials) (Kateregga & Sterner, 2009).Water hyacinth is perceived to affect fisheries through reduced levels of production, a reduction in species diversity, poor quality fish, rising cost of operation resulting in lower income to fishers and higher prices to consumers (LVEMP 1995). Reduction of oxygen levels in the water creates and environment unsuitable for fish survival, subsequently reducing species diversity Lake Victoria, which supports a thriving fishing industry, supplying affordable protein, income and employment to more than 10 million people (Ochumba 1984) was adversely affected by the infestation.

Negative impacts of the dense hyacinth mats included physical interference with commercial transportation of people and goods; physical interference with access to urban and rural water supply and added costs for purification of water with high concentrations of suspended organic matter; provision of habitats for unwanted organisms like bilharzia-carrying snails, mosquitoes and snakes; and physical interference with fishing operations, especially in bays where fish are brought ashore to piers and landing beaches (UNEP/CBD, 2003). Water hyacinth also interferes with water treatment, irrigation, and water supply (Opande, Onyango, and Wagai 2004).

Dense impenetrable mats restrict access to water, negatively impacting fisheries and related commercial activities, the effectiveness of irrigation canals, navigation and transport, hydroelectric programmes and tourism (Navarro and Phiri, 2000). Other problems include property damage during floods as a result of water hyacinth building up against bridges, fences, walls, which obstruct water flow and increase flood levels. Water hyacinth seriously alters the livelihoods of any community with high dependence on freshwater waterways for subsistence or commercial food, transport and clean water.

Ecologically, benthic and littoral diversity is significantly reduced (Masifwa *et al.*, 2001; Toft *et al*., 2003; Midgley *et al*., 2006). Increases in the populations of vectors of human and animal diseases, such as bilharzia, malaria and cholera, are also associated with water hyacinth infestation (Harley *et al*., 1996). Because of its rapid growth rate, water hyacinth is able to outcompete native aquatic plants by utilising the available nutrients in the water, and successfully competing for space and sunlight (Cilliers, 1991).

In Europe, the water hyacinth was possibly introduced as an ornamental plant in the first third of the 20th century in Portugal, because the first reference to its presence there dates from 1939. Since then, it has spread over the central-west of the country through irrigation canals and currently exists in the middle and lower Sado and Tagus Basins (Guerreiro 1976; Figueiredo *et al*. 1984; Amaral and Rocha 1994). Hyacinth infestations block access to recreational areas and decrease waterfront property values, oftentimes harming the economies of communities that depend upon fishing and water sports for revenue. Shifting water hyacinth mats sometimes prevent boats from reaching shore, trapping the occupants and exposing them to environmental hazards (Harley, 1990). Water hyacinth infestations intensify mosquito problems by hindering insecticide application, interfering with predators, increasing habitat for species that attach to plants, and impeding runoff and water circulation (Seabrook, 1962).

The first reference to water hyacinth in the United States was at the beginning of the 20th century on the occasion of the Louisiana Purchase (Sculthorpe 1967). The spread continued to Florida where there are many references to control the spread and infestations that occurred (Schardt 1984). It was also introduced into North and South Carolina. In the countries of South America, there are reports of its presence in 1902 in Brazil, 1942 in

Argentina, 1959 in Paraguay, Uruguay, Bolivia, Ecuador, and Colombia, 1976 in Venezuela, and 1979 in Chile. In Central America, it is cited in Mexico, Nicaragua, Costa Rica, and El Salvador in 1965, Panama in 1966, and Puerto Rico and the Dominican Republic from 1971. Water hyacinth grows rapidly (Penfound and Earle, 1948) forming expansive colonies of tall, interwoven floating plants. It blankets large water bodies, creating impenetrable barriers and obstructing navigation (Gowanloch and Bajkov, 1948; Zeiger, 1962). It has been reported that floating mats block drainage, causing flooding or preventing subsidence of floodwaters. Large rafts accumulate where water channels narrow, sometimes causing bridges to collapse. Water hyacinth hinders irrigation by impeding water flow, by clogging irrigation pumps, and by interfering with weirs (Penfound and Earle, 1948).

In Africa, the water hyacinth was first reported in Egypt between 1879 and 1893. It is considered one of the most notorious weed species in tropical West Africa (Food and Agriculture Organization (FAO), 2000). Water hyacinth infestation of freshwater ecosystems has been recently reported by several workers (Luken and Thieret, 1997; Bolorunduro, 2000; Osumo, 2001; Masami *et al*., 2008); and its major effect appears to be disruption of normal ecological functioning of aquatic ecosystems where it is found thriving.

The weed has led to a variety of socioeconomic problems among communities and organizations that depend on the affected water bodies, threatening not only food security but also marine transportation and the health of local communities (Njiwa 1996). For instance, water hyacinth has clogged the Kafue River, which is regarded as one of the most important rivers in Zambia, supporting 40% of the country's 8 million people (Kamyomeka

1997). In Malawi, it is found throughout the Shire River system, including the country's major hydroelectric installations near the intake point that supplies the country's main commercial city of Blantyre (Phiri 1997).

However, in some areas, uses are being found for the water hyacinth, such as; paper manufacture, fibre board production, yarn, rope, charcoal briquetting, and biogas production. In settlements where water hyacinth has destroyed economy (fishing, river transport, etc.) populations have reoriented to manufacturing of art paper, crafts, ropes, furniture and other things from water hyacinth which will positively influence to reduction of unemployment and increase of income (Lindsey and Hirt, 1999). Beneficial effects of the water hyacinth have also been reported as an aid in water purification through conversion of toxic ammonia to usable nitrates as well as capacity to absorb heavy metals and organic compounds from water body (Simeon *et al.,* 1987; Cowx and Welcomme, 1998; Ingole and Bhole, 2002). The influence of aquatic macrophytes on the limnological properties of water bodies has been recognized (Petre, 2000; Lee and McNaughton, 2004). They may, therefore, be regarded as efficient indicators of water quality.

The House and Building Research Institute in Dhaka has carried out experimental work on the production of fibre boards from water hyacinth fibre and other indigenous materials (Haider, 1989). According to Haider, 1989, chopped water hyacinth stalks are reduced by boiling and then washed and beaten. The pulp is bleached and mixed with waste paper pulp and a filter agent such as china clay and the pH is balanced. The boards are floated in a vat on water and then finished in a hand press and hung to dry. The physical properties of the board are sufficiently good for use on indoor partition walls and ceilings.

The fibre from the stems of the water hyacinth plant can be used to make ropes. The stalk from the plant is shredded lengthways to expose the fibers and then left to dry for several days. The rope making process is similar to that of jute rope. The finished rope is used by a local furniture manufacturer who wind the rope around a cane frame to produce an elegant finished product (Haider, 1989). In the Philippines water hyacinth is dried and used to make baskets and matting for domestic use (NAS, 1976 cited in Ndimele *et al*, 2011). The key to a good product is to ensure that the stalks are properly dried before being used. If the stalks still contain moisture, then this can cause the product to rot quite quickly. In India, water hyacinth is also used to produce similar goods for the tourist industry. Traditional basket making and weaving skills are used (Calvert, 2002).

It is also worth noting that, in China, the water hyacinth is an important fish feed. The Chinese grass carp is a fast growing fish which eats aquatic plants. It grows at a tremendous rate and reaches sizes of up to 32 kg (National Academy of Science (NAS), 1979). It can eat both submerged and floating plants. The fish can be used for weed control and will eat up to 18 – 40% of its own body weight in a single day (Gopal, 1987). Also, dehydrated water hyacinth has been added to the diet of channel catfish fingerlings to increase their growth, hence used indirectly to feed fish (Gopal, 1987). According to Gopal, 1987 decay of water hyacinth after chemical control also releases nutrients which promote the growth of phytoplankton with subsequent increases in fish yield.

Studies have also shown that the nutrients in water hyacinth are available to ruminants. In Southeast Asia some non-ruminant animals are fed rations containing water hyacinth. In China, pig farmers boil chopped water hyacinth with vegetable waste, rice bran, copra cake and salt to make a suitable feed. In Malaysia, fresh water hyacinth is cooked with rice bran

and fishmeal and mixed with copra meal as feed for pigs, ducks and pond fish. Similar practices are much used in Indonesia, the Philippines and Thailand (National Academy of Sciences, 1976). The high water and mineral content mean that it is not suited to all animals.

The use of water hyacinth for animal feed in developing countries could help solve some of the nutritional problems that exist in these countries. Animal feed is often in short supply and although humans cannot eat water hyacinth directly, they can feed it to cattle and other animals which can convert the nutrient into useful food products for human consumption (National Academy of Sciences, 1976). These negative impacts of water hyacinth have led to crop intensification with wider economic effects and the adoption of new technology .e.g. green house farming.

1.2 Statement of the Problem

Lake Victoria is the second largest freshwater lake in the world and currently supports approximately 30 million people. Fishing is the main source of income to many communities living along Lake Victoria and plays an important role in the Kenyan economy. The sector provides employment to over 500,000 Kenyans engaged in fish production and fish related enterprises. Approximately two million people depend on the fish industry (LVEMP 1999). These include fishermen, their families (dependents), traders (middle men and hawkers), fish industry employees and investors, and auxiliary/tertiary traders. The fisheries sub-sector is however unable to realize its full potential due to among other factors water hyacinth infestation (Wafula *et al*, 2005).

Infestation of water hyacinth in the lake has been a serious nuisance, generating public outcry (World Agro Forestry Centre, 2006, Kateregga and Sterner 2007, Gichuki *et al.* 2012). At its peak, it was estimated that the weed was growing at 3 hectares (12 acres) per day on the lake (Ayodo and Jagero 2012). Water hyacinth is challenging the ecological stability of freshwater water bodies (Khanna *et al.* 2011, Gichuki *et al.* 2012), out-competing all other species growing in the vicinity, posing a threat to aquatic biodiversity (Patel 2012). Besides suppressing the growth of native plants and negatively affecting microbes, water hyacinth prevents the growth and abundance of phytoplankton under large mats, ultimately affecting fisheries (Gichuki *et al.* 2012, Villamagna and Murphy 2010).

The dense mats disrupt socioeconomic and subsistence activities (ship and boat navigation, restricted access to water for recreation, fisheries, and tourism) if waterways are blocked or water pipes clogged (Ndimele *et al.* 2011, Patel 2012). The floating mats may limit access to breeding, nursery and feeding grounds for some economically important fish species (Villamagna and Murphy 2010). In Lake Victoria, fish catch rates on the Kenyan section decreased by 45% because water hyacinth mats blocked access to fishing grounds, delayed access to markets and increased costs (effort and materials) of fishing (Kateregga and Sterner 2009).

For the individual fisherman, the hyacinth mats reduced their catch by covering fishing grounds, delaying access to markets due to loss of output, increasing fishing costs due to the time and effort spent clearing waterways, forcing translocation, and causing loss of nets. Mailu's (2001) report cited declines of 14 percent, 37 percent, and 59 percent in the catches of Oreochromis (a large genus of tilapia), Clarias (a genus of catfish), and Mormyrus (a genus of bottom-feeding breams), respectively, in the Kenyan section of the

lake. Twongo (1998) noted that the weed mats sealed off breeding, nursery,feeding, and fishing grounds for various inshore fish species, like tilapia and young Nile perch.

In the shore line sub locations of South West Seme Location, such mats have been located in beaches where the mat has been present for even more than six months in a given year. This is the most destructive mat since it impairs all socioeconomic activities around the lake. The rich biodiversity of the Location, as well as its economic importance as a source of livelihood for the local community, all make it very important to the riparian communities. This study therefore attempted to evaluate the influence of water hyacinth on the livelihoods on the riparian communities within South West Seme, in Kisumu County, Kenya.

1.3 Purpose of the Study

The purpose of this study was to investigate the influence of water hyacinth on the livelihoods of the community along Lake Victoria, focusing on 2 Sub Locations within South West Seme Location in Kisumu County.

1.4 Objectives of the Study

The study was guided by the following objectives:

i. To establish the influence of water hyacinth on agricultural activities of the riparian community of South West Seme Location of Kisumu County

ii. To examine the influence of water hyacinth on the fishing activities of the riparian community of South West Seme Location of Kisumu County

iii. To assess the extent to which water hyacinth influences the business initiatives of the riparian community of South West Seme Location of Kisumu County

1.5 Research Questions

The study sought to answer the following research questions:

i. How does the water hyacinth influence agricultural activities of the riparian community of South West Seme Location of Kisumu County?

ii. What influence does the water hyacinth have on the fishing activities of the riparian community of South West Seme Location of Kisumu County?

iii. To what extent does the water hyacinth influence the business initiative of the riparian community of South West Seme Location of Kisumu County?

1.6 Research Hypothesis

A hypothesis is a preposition which predicts the relation between two or more variables and has been tested in terms which are testable (Potter, 2002). The truth of a hypothesis can be tested as it attempts to predict a phenomenon thus hypothesis is used to guide how the statement predicted might be tested. A hypothesis may be rejected when not supported by empirical evidence (Cresswell, 2009). The study therefore will adopt the following null hypotheses derived from the research questions.

Ho_1: Water Hyacinth has a negative influence on agricultural activities of the riparian community of South West Seme Location of Kisumu County.

Ho_2: Water Hyacinth has have a significant influence on the fishing activities of the riparian community of South West Seme Location of Kisumu County.

Ho_3: Water hyacinth has influenced the business initiative of the riparian community of South West Seme Location of Kisumu County to a larger extent.

1.7 Significance of the Study

It was hoped that the study will provide information to decision-makers who are concerned with the protection of the aquatic environment to make appropriate decisions and invest in various projects aimed at preventing the spread of water hyacinth within Lake Victoria. This will reduce the negative impacts of existing infestations on the riparian communities.

1.8 Basic Assumptions of the Study

In conducting the study, it was assumed that the responses were genuine, independent and reflect true perceptions of the influence of the water hyacinth on livelihoods. The study also assumed that the livelihood indicators will remain the same throughout the period of study and that the effects of the water hyacinth cut across all the economic segments of the target community.

1.9 Limitations of the Study

The major limitation of this study was that the targeted study participants carry out their entrepreneurial activities at different times of the day, which presented a formidable challenge in respect of a cumulative data collection process. This challenge was overcome

by moving to the target respondents only at the specific times when they were conducting their business activities.

The study was a descriptive survey and relied on a selected sample of community members within West Kadinga and South Alungo of South West Seme Location. Although interpretation of the data was predicated upon the information gathered from the sample and the findings of the research study were generalized to the target population, it is important to note that livelihood indicators vary from one individual to another and from one area to another. Due caution was therefore needed to be exercised in generalizing the findings of the study beyond the study area.

1.10 Delimitation of the Study

This study investigated the influence of water hyacinth on the livelihoods of the community members of 2 Sub locations within South West Seme Location. The study was restricted to West Kadinga and South Alungo and only covered 310 respondents sampled from the various beaches. Despite the fact that other areas along Winam Gulf equally experience similar challenges for the infestation of the water hyacinth, South West Seme presented a unique situation since its total population is relatively smaller compared to other locations in the area but it has a higher number of BMUs presenting a scenario of high dependence on the Lake for survival. In addition, this part of the gulf is closed and whereas in other areas the hyacinth takes a shorter period of time to receded and open up the water surface, it takes relatively longer time at these beaches.

1.11 Definitions of significant terms used in the study

Agricultural Activities The practice of cultivating the land and/or raising stock

Beach Management Unit An organization of fishers, fish traders, boat owners, fish processors and other beach stakeholders who traditionally depend on fisheries activities for their livelihoods;

Business Activities the activity of providing goods and services involving financial, commercial and industrial aspects

Fishing Activities All activities that are involved from the point of fish extraction from the lake to selling of the fish to the consumer. In this study, fishing industry will constitute the fishermen, fish vendors and boat owners.

Livelihood A person's livelihood refers to their "means of securing the basic necessities -food, water, shelter and clothing- of life". In this study, livelihood will be defined as a set of activities, involving securing income, food, fodder, raw materials and the capacity to acquire above necessities working either individually or as a group by using endowments (both human and material) for meeting the requirements of the self and his/her household on a sustainable basis with dignity. The activities are usually carried out repeatedly. For instance, a fisherman's livelihood depends on the availability and

	accessibility of fish.
Riparian Communities	Communities living along the shores of Lake Victoria
Water Hyacinth	Refers to an aquatic weed that invades the lake and spreads rapidly.

1.12 Organization of the study

This research contains five chapters. Chapter one provides an introduction to the study and is discussed under sub-filters of: background of the study; statement of the problem; purpose of the study; the research objectives; research questions that will guide the study; significance of the study; delimitations and limitations of the study; basic assumptions of the study and finally definitions of significant terms used in the study.

Chapter two is a review of literature from previous studies in the area of water hyacinth and its influence on the livelihood systems of the communities around the fresh water bodies. The chapter seeks to identify the gaps in research on the influence of the water hyacinth on the livelihoods of the communities, specifically around South West Seme Location of Lake Victoria. This section also provides the theoretical and conceptual frameworks of the study.

Chapter three is a description of the Research Methodology that was used. The research design and target population is explained. There is also a description of the sample size and sample selection. A description of the research instruments used, piloting of the instruments, their validity and reliability are also discussed. The later part of the chapter provides a description of data collection procedures.

Chapter four presents the results of the study and the discussions of the findings which have been divided into four major sections. The first section provided the results on the response of the demographic data of the respondents, which includes age, gender, location, size of the family, and by extent the respondent's occupation. The second section shows the influence of water hyacinth on agricultural activities of the community around riparian communities within South West Seme Location of Kisumu County, the third section examines the influence of water hyacinth on the fishing activities of the community and finally the last part assesses the extent to which water hyacinth influences the business initiatives of the community.

Chapter five contains summary of findings as per the objectives of the study, conclusion, recommendations, contributions to the body of knowledge and suggestions for further research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This section gives a brief analysis of existing information which is relevant to the topic under study and also seeks to identify gaps in knowledge that need attention or further research.

2.2 Evolution of Water Hyacinth

Water hyacinth is a freshwater weed species. It is a free-floating plant and draws all its nutrients directly from water. Currents and wind help in its distribution and dispersal. It comprises 95% water and 5% per cent dry matter of which 50% is silica, 30% potassium, 15% nitrogen and 5% protein (Makhanu 1997). It has been known to thrive well in nutrient-enriched fresh waters in tropical climatic zones. For this purpose it has been used in wastewater treatment facilities. The weed is mainly found in inshore and shallow areas to which it is swept by currents and sometimes in patchy offshore areas. It spreads fast in shallow (< 6m) bays and inlets with mud bed surfaces. Lake Victoria's tropical location, shallow depth and nutrient enrichment provide favorable conditions for its proliferation (Mitchell 1976).

In shallow lakes and where plant production is great, complete deoxygenation of the sediments and deeper water can occur. Such conditions are not compatible for the survival of fishes and invertebrates. Moreover, under anoxic conditions, ammonia, iron, manganese and hydrogen sulphide concentrations can rise to levels deleterious to biota. In addition,

phosphate and ammonium are released into the water from anoxic sediments, further enriching the ecosystem (International Development Research Centre 2000).

The weed's economic significance stems from its potential to produce negative consequences for the habitat quality of water bodies. The 'mats' of aquatic plants reduce dissolved oxygen by restricting the exchange of oxygen across the air/water interface. They also affect wind-driven water movement and impede mixing of oxygen-rich surface water (Smith-Rogers 1999). It also generates large amounts of organic matter. As the organic matter decomposes, biological oxygen demand increases and water quality deteriorates. The oxygen can be reduced to such low levels that it leads to massive fish kills due to oxygen depletion in the water column (Ochumba and Kibaara 1989). This results in loss of aquatic biodiversity (Muli 1996).

It is reported that water hyacinth is indigenous to Brazil having first been described from wild plants collected from Francisco River in 1824. In Africa, the water hyacinth was first reported in Egypt between 1879 and 1893. It is considered one of the most notorious weed species in tropical West Africa (Food and Agriculture Organization (FAO), 2000). It is widely reported that water hyacinth is indigenous to Brazil having been first described from wild plants collected from the Fransico River in 1824 (MONSANTO, 1996). On the African continent, water hyacinth was first reported in Egypt between 1879 and 1893; in South Africa in 1908; Zimbabwe (1937); Zaire and Sudan (1957); Senegal (1964); Nigeria (1983) and Uganda (1987). It is now popularly believed that water hyacinth entered Lake Victoria via the Kagera River which drains the Rwanda and Burundi water catchments in 1990 (OSIENALA, 1990).

The weed constitutes a very important economic aquatic weed species in tropical sub-Saharan African countries and its impact on water bodies where they occur affects the living conditions of the human populace dependent on such water bodies for their livelihood. Freshwater bodies constitute a vital component of a wide variety of living environments as integral water resource base in many human societies of tropical Africa. They have been regarded as key strategic resources essential for sustaining human livelihood, promoting economic development and maintaining the environment (UNWDR, 2005).

Water hyacinth was first sited in the Kenyan side of the lake in 1992 (Republic of Uganda, 2005). Water hyacinth occurred in form of stationary mats in sheltered bays and along much of the lakeshore, in addition to the mobile mats that were propelled around the lake by winds, waves and water currents (Balirwa, Wanda, and Muyodi, 2009). Despite water hyacinth's invasive nature and dominance in Lake Victoria in the 1990s, the weed largely disappeared from Lake Victoria by the end of 1999. For instance, no water hyacinth was found on the Gulf from April 2002 until October 2004, only appearing again at the next measurement date of December 2005 (Gichuki *et al*, 2011).

One theory is that water hyacinth actually escaped from an ornamental pond in Rwanda into the Kagera River, which is a major tributary of Lake Victoria. Ironically, water hyacinth is also well known for its very attractive blue flowers. From the late 1980's and early 1990's the weed has spread very rapidly to virtually every country in Africa and it is feared that before long all fresh water bodies in Africa are likely to be infested by this 'killer' weed as manifested by its numerous negative consequences.

In Lake Victoria pollution from domestic, industrial and agricultural activities have increased the nutrient levels leading to algal blooms, oxygen depletion and subsequent periodic fish kills and migration. The altered conditions paved the way for invading species i.e. the water hyacinth and the Nile perch that have severely affected the Lake Victoria ecosystem with entailing socio-economic problems (Scheren *et al*. 2000, Lung'ayia *et al.* 2000).

Lake Victoria, the second largest fresh water body in the world and the largest in the tropics has a surface area of 68,000 Km2 and its adjoining catchment area 184,000 Km2 (World Bank, 1996). Lake Victoria has a maximum depth of 80 m and an average depth of about 40 m with a shoreline of about 3,500 km, enclosing innumerable small, shallow bays and inlets, many of which include swamps and wetlands. Three countries: Tanzania, Kenya and Uganda share the lake with Tanzania having the biggest share with 51% against 43% for Uganda and only 6% for Kenya (Odada *et al*., 2004). The lake is rich in natural resources, which have supported the livelihood of over 30 million people living in its basin.

2.3 The relationship between water hyacinth, agriculture and livelihoods

When sun-dried, water hyacinth has been found to be rich in protein, vitamins and minerals and serves as a high quality feedstock for some non-ruminant animals, poultry and fishery in Indonesia, China, the Philippines and Thailand (Lu *et al.* 2010, Saha and Ray 2011). But it is not recommended for use if primarily used for removal of heavy metals and toxic substances from wastewater (Chunkao *et al.* 2012). Decomposed water hyacinth can also be used as green manure or as compost that improves poor quality soils

(Ndimele *et al.* 2011). However, its high alkalinity (pH>9) and potentially toxic heavy metals contents would restrict its use to flowering-plants, with no allowable application to horticulture for edible vegetables (Chunkao *et al.* 2012, Zhang 2012).

Studies have shown that the nutrients in water hyacinth are available to ruminants. In Southeast Asia some non-ruminant animals are fed rations containing water hyacinth. In China pig farmers boil chopped water hyacinth with vegetable waste, rice bran, copra cake and salt to make a suitable feed. In Malaysia fresh water hyacinth is cooked with rice bran and fishmeal and mixed with copra meal as feed for pigs, ducks and pond fish. Similar practices are much used in Indonesia, the Philippines and Thailand (National Academy of Sciences, 1976). The high water and mineral content mean that it is not suited to all animals.

Eichhornia crassipes can be used on the land either as a green manure or as compost. As a green manure it can be either ploughed into the ground or used as a mulch. The plant is ideal for composting. After removing the plant from the water it can be left to dry for a few days before being mixed with ash, soil and some animal manure. Microbial decomposition breaks down the fats, lipids, proteins, sugars and starches. The mixture can be left in piles to compost, the warmer climate of tropical countries accelerating the process and producing a rich pathogen free compost which can be applied directly to the soil. The compost increases soil fertility and crop yield and generally improves the quality of the soil (National Academy of Sciences, 1976).

The Chinese grass carp is a fast growing fish which eats aquatic plants. It grows at a tremendous rate and reach sizes of up to 32kg (National Academy of Sciences, 1979). It is

an edible fish with a tasty white meat. It will eat submerged or floating plants and also bank grasses. Water hyacinth has also been used indirectly to feed fish. Dehydrated water hyacinth has been added to the diet of channel catfish fingerlings to increase their growth (Gopal 1987).

The water hyacinth also causes major detrimental impacts on water use. In drainage canals it greatly reduces flow, which can result in flooding and damage to canal banks and structures. In irrigation canals it impedes flow and clogs intakes of pumps used for conveying irrigation water (Center *et al.,* 2002). The weed blocks drainage systems causing flooding or preventing withdrawal of floodwaters. This aquatic macrophyte obstructs irrigation by preventing predicted water flow in channels, clogging irrigation pumps and destroying dams (Penfound and Earle, 1948, cit. Center *et al*., 2002).

In the rural areas, particularly in Nyakach, Osodo, Kendu and Homa Bays, the weed has reduced the availability and lowered the quality of water for humans and livestock at specific periods in the year. Wawire (unpublished report) notes that the local communities spend more time and money to obtain clean water when the physical presence of thick mats of water hyacinth denies them access to water.

2.2 The relationship between water hyacinth, fish production and livelihoods

Eichhornia crassipes affects access to fishing grounds and fish catch-ability (Kateregga & Sterner, 2009). Reports from around the world indicate some villages where people have died from heavy water hyacinth infestations; notably through starvation because they could not reach food sources and protein deficiency resulting from unavailability of fish (Navarro & Phiri, 2000). Water hyacinth causes severe problems to fishermen in the riparian

communities. When weed infestation is present, access to fishing sites become difficult for riparian communities which rely solely on fishing as their main economic activity (Munjigni, 2012). This leads to increase in their expenditure on fuel for engine boats and further increase in the cost of the meagre quantities of fish they catch, for the society as a whole. There is often loss of fishing gears when nets or lines become tangled in the root systems of the weed. All these lead to reduction in fish catch and subsequent loss of livelihood. Center *et al.* (2002) reported that water hyacinth invasions reduce available light for submerged plants hence depleting oxygen, alters the composition of invertebrate communities, impacts fisheries, displaces native plants and wildlife, and increases sediment loading.

Water hyacinth can greatly affect a fishery if it induces changes in fish community composition, or if catch-ability of harvested species is changed. Diversity in fish stocks is often affected with some benefiting and others suffering from the proliferation of water hyacinth (Calvert, 2002). The influence of water hyacinth on biodiversity is controversial. It is speculated that, in the Winam Gulf, there was an increase in catches of traditional fish species, such as *Bagrus* (Ningu), *Clarias* (Mumi) and *Protopterus* (Kamongo), and a corresponding reduction in catches of commercial fish species, *Lates* (Nile Perch), *Oreochromis* (Tilapia) and *Rastrineobola* (Omena), after the invasion by water hyacinth. Water hyacinth can greatly affect a fishery if it induces changes in fish community composition, or if catch-ability of harvested species is changed. Diversity in fish stocks is often affected with some benefiting and others suffering from the proliferation of water hyacinth (Calvert, 2002).

In Ghana, water hyacinth was found for the first time in Tano lagoon, apparently entering this water body from Cote d'Ivoire. More recently fishermen reported a decline in fish catches and it was suggested that this was due to the presence of the water hyacinth. Much of the water hyacinth in Tano lagoon is mobile, being moved by wind or water currents. Holcik (1995), who investigated the situation, thought that the low catches are not due to the decline in fish stocks but rather a result of both the inefficient deployment of nets and of the difficult access to the fishing grounds due to the water hyacinth cover.

The Kenyan fishery handles an average of 175,410 tons of fish annually since 1986 with the current weight being 206,441 tons in the year 2000. This production has increased to 212,948 tons in 2001 (GOK 2002a). These consist of the fresh water fish derived from the various lakes (Victoria, Turkana, Baringo, Naivasha, Jipe, and river dams and fish farms), marine fish and crustaceans. Lake Victoria accounts for the bulk of this production averaging 91.6% of the total weight and an average of 85.6% of the total value annually. There was a notable decline in the percentage contribution of fish emanating from Lake Victoria between the periods 1995-1999 which apparently coincided with the time when the lake was heavily infested with water hyacinth implying that it may have had a significant impact to the quantity of fish landed. The percent contribution of L. Victoria to the National fish production dropped from 95.4% in 1994 to 91.5% in 1999.

Information from the Fisheries Department, Kenya according to Mailu (2001) indicated that there was a 28% increase in total annual fish catches between 1986–1991 and 1991–1997, from 133,097 tonnes to 169,890 tonnes. There was an increase in all species of fish caught except *Oreochromis, Clarias* and *Mormyrus,* which showed declines of 14, 37 and 59%, respectively, over the same period. These declines may have been associated with the

inability of fishermen to access the fishing grounds for those species because of water hyacinth infestation. Generally therefore, as a result of water hyacinth infestation, accessibility to land and water has been hindered, resulting in reduced fish catches, especially of tilapia and mudfish which are found mainly along the shores. Fisherfolk, however, reported increased fish catches from suitable breeding grounds provided by water hyacinth e.g. tilapia, *synodontis*, *protopterus* and *labeo*. A reduced fish catch would have an adverse effect on the quality of life of the communities around the lake and consequently affect sustainable development in the region

2.3 Business opportunities provided by presence of water hyacinth and influence on livelihoods

Although water hyacinth is seen in many countries as a weed and is responsible for many of the problems outlined earlier in this project report, many individuals, groups and institutions have been able to turn the problem around and find useful applications for the plant. The plant itself, although more than 95% water, has a fibrous tissue and a high energy and protein content, and can be used for a variety of useful applications.

In settlements where water hyacinth has destroyed economy (fishing and river transport) population can reorient to manufacturing of art paper, crafts, ropes, furniture and other things from water hyacinth which will positively influence to reduction of unemployment and increase of income (Lindsey and Hirt, 1999). As a readily available resource, water hyacinth has been used in several small cottage industries in the Philippines, Indonesia and India for paper, rope, basket, mats, shoes, sandals, bags, wallets, vases, etc (Ndimele *et al.* 2011, Patel 2012).The House and Building Research Institute in Dhaka has carried out

experimental work on the production of fibre boards from water hyacinth fibre and other indigenous materials (Haider, 1989). According to Haider, 1989, chopped water hyacinth stalks are reduced by boiling and then washed and beaten. The pulp is bleached and mixed with waste paper pulp and a filter agent such as china clay and the pH is balanced. The boards are floated in a vat on water and then finished in a hand press and hung to dry. The physical properties of the board are sufficiently good for use on indoor partition walls and ceilings.

In the Philippines, water hyacinth is dried and used to make baskets and matting for domestic use. The key to a good product is to ensure that the stalks are properly dried before being used. If the stalks still contain moisture then this can cause the product to rot quite quickly. In India, water hyacinth is also used to produce similar goods for the tourist industry. Traditional basket making and weaving skills are used.

Eden (1994) considers the requirements for large-scale production of charcoal briquettes from water hyacinth. This is an idea which has been proposed in Kenya to deal with the rapidly expanding carpets of water hyacinth which are evident on many parts of Lake Victoria. The proposal is to develop a suitable technology for the briquetting of charcoal dust from the pyrolysis of water hyacinth. The project is still very much at the idea stage and both a technical and a socio-economic study are planned to evaluate the prospects for such a project. It is suggested that a small-scale water hyacinth charcoal briquetting industry could have several beneficial aspects for the lakeside communities.

Water hyacinth fulfills all the criteria deemed necessary for bioenergy production – it is perennial, abundantly available, non-crop plant, biodegradable and has high cellulose

content; however its strong disadvantage is that it has over 90% water content which complicates harvesting and processing. The biomass can be subjected to biogas production to generate energy for household uses in rural areas (Chuang *et al.* 2011). Experiments in China show that mixing biomass of water hyacinth with pig manure leads to a much higher biogas production than by using pig manure alone (Lu *et al.* 2010). It can also be used for producing ethanol, but technical and logistical challenges need to be overcome before the commercial scale ethanol production becomes a reality because of the high tissue water content (Ndimele *et al.* 2011).The use of water hyacinth for digestion in a traditional digester presents some problems. Water hyacinth has a very high water content and therefore harvesting effort yields a low reward in terms of organic matter for conversion to biogas (Gopal 1987). Most of the experiments have used a mixture of animal waste and water hyacinth. There is still no firm consensus on the design of an appropriate water hyacinth biogas digester.

Water hyacinth can be used to aid the process of water purification either for drinking water or for liquid effluent from sewage systems. In a drinking water treatment plant water hyacinth have been used as part of the pretreatment purification step. Clean, healthy plants have been incorporated into water clarifiers and help with the removal of small flocs that remain after initial coagulation and floc removal or settling (Haider 1989). Equally, water hyacinth has been reported as an aid in water purification through conversion of toxic ammonia to usable nitrates as well as capacity to absorb heavy metals and organic compounds from water body (Simeon *et al*., 1987; Cowx and Welcomme, 1998; Ingole and Bhole, 2002).

In sewage systems, the root structures of water hyacinth (and other aquatic plants) provide a suitable environment for aerobic bacteria to function. Aerobic bacteria feed on nutrients and produce inorganic compounds which in turn provide food for the plants. The plants grow quickly and can be harvested to provide rich and valuable compost. Water hyacinth has also been used for the removal or reduction of nutrients, heavy metals, organic compounds and pathogens from water (Gopal 1987).

2.4 Theoretical Framework of the Study

The study was based on the Opportunity-Based Entrepreneurship theory by Drucker (1985). The theory asserts that entrepreneurs do not cause change but exploit the opportunities that change creates in technology and consumer preferences (Drucker, 1985). The entrepreneur always searches for change, responds to it, and exploits it as an opportunity. What is apparent in Drucker's opportunity construct is that entrepreneurs have an eye more for possibilities created by change than the problems.

Stevenson (1990) extends Drucker's opportunity-based construct to include resourcefulness. He concludes that the hub of entrepreneurial management is the pursuit of opportunity without regard to resources currently controlled. Entrepreneurs identify business opportunities to create and deliver value for stakeholders in prospective ventures. While elements of opportunities may be recognized, opportunities are made, not found. Careful investigation of and sensitivity to market needs and as well as an ability to spot suboptimal deployment of resources may help an entrepreneur begin to develop an opportunity (which may or may not result in the formation of a business). But opportunity development also involves entrepreneurs' creative work. Therefore, ''opportunity

development'' rather than ''opportunity recognition,'' will be the focus of this study. In the case of this study, the members of identified sub locations, in spite of the problems created by the presence of the water hyacinth on the surface of Lake Victoria, some take advantage of the entrepreneurial opportunities created by its infestation while others premise their entrepreneurial activities on the absence of the water hyacinth.

2.5 Conceptual Framework of the Study

The conceptual framework (Figure 1) shows the relationship between the independent variable i.e. water hyacinth and the dependent variables i.e. indicators used to assess livelihood. It is conceptualized that when water hyacinth covers the water surface, there is a reduction in the biodiversity in the Lake. Other aquatic plants have difficulty in surviving. This causes an imbalance in the aquatic micro-ecosystem and often means that a range of fauna that relies on a diversity of plant life for its existence will become extinct. Diversity of fish stocks is often affected with some benefiting and others suffering from the proliferation of water hyacinth.

It is conceptualized that in settlements where water hyacinth has destroyed fishing activities, population can reorient to intensified agricultural practices by adopting new technology e.g. greenhouses, fish farming, irrigation, use of hyacinth as mulch, manure or animal feed which will positively influence the reduction of unemployment and increase of income.

With regard to the fishing industry, it is conceptualized that the coverage of the water by the water hyacinth impedes fishing thus reducing the number of fish caught. The water hyacinth entangles the fishing equipment, making fishing difficult. Diversity of fish stocks

is often affected with some benefiting and others suffering from the proliferation of water hyacinth. Some of the beneficiaries of the water hyacinth are the Cat fish and Lungfish that thrive in the low oxygen levels created by the Hyacinth, improved catch of these two species have been reported by the fishermen on Lake Victoria. The major losers are the native cichlid fish species and tilapia spp.

When the hyacinth is harvested, it may be used as raw material in the weaving industry for making some forms of furniture, baskets, ropes and other craft that are sold to earn income. Some of the items made from the hyacinth may attract tourists thus promoting tourist activities.

The interaction between the water hyacinth and the economic activities may be moderated by seasonal movements of the water hyacinth which either opens up the water or covers the water surface thus impeding any activities. The level of infestation of the hyacinth also determines the level of exposure of the water surface to allow for both biological activities and other human activities in the water. The conceptual framework of the study is as shown in Figure 1.

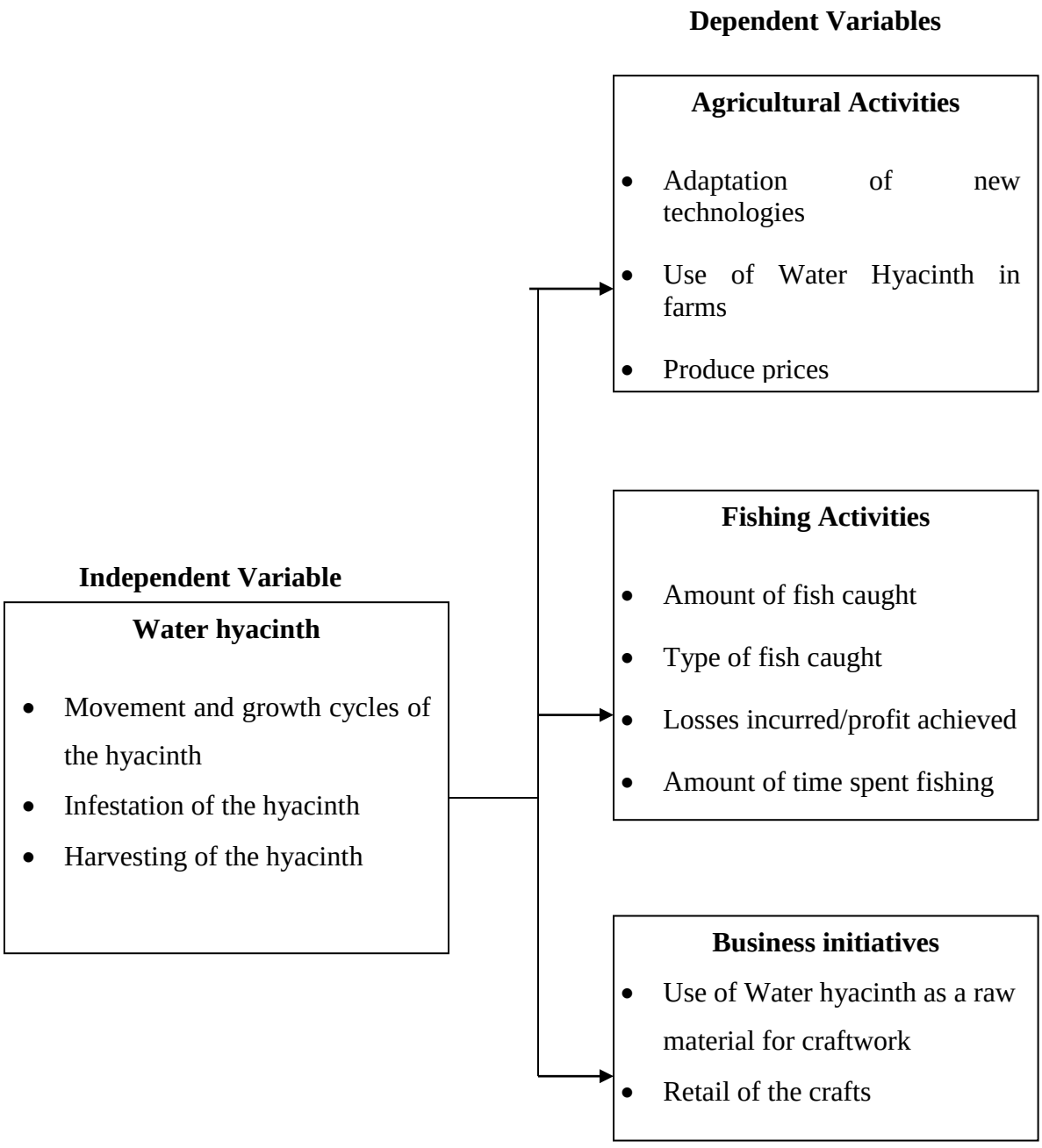

Figure 1: Conceptual Framework of the Study

Source: Author's Own Design, 2014

2.6 Gaps in the literature

A lot of studies have been done on the environmental impacts of the water hyacinth, but few studies have been done to establish the effects of this aquatic weed on its influence to the riparian communities who derive their livelihoods from the fresh water Lake and especially on the practical application of water hyacinth.

2.7 Summary of Literature Review

The preceding sections reviewed both theoretical and empirical literature related to the main objective areas of the study. From the empirical review, it was noted that several studies have linked water hyacinth to economic agricultural applications such as use as manure, mulch, animal feed (Gopal, 1987. NAS, 1979). This study will determine how water hyacinth influences agricultural activities.

Review of literature related to fishing (Kateregga & Sterner, 2009; Navarro & Phiri, 2000; Munjigni, 2010; Kateregga & Sterner, 2009) indicates that water hyacinth reduces fish populations and hinders catch-ability of fish and causes severe problems to fishermen in the riparian communities. When weed infestation is present, access to fishing sites become difficult increasing expenditure on fuel for engine boats and further increase in the cost of the meager quantities of fish they catch, for the society as a whole. Other studies showed (Center *et al*., 2002; Calvert, 2002) reported that water hyacinth invasions reduce available light for submerged plants hence depleting oxygen and impacts on fisheries while others argued that the water hyacinth is an important fish feed (NAS, 1979; Gopal, 1987).

With respect to business initiatives, review of prior studies indicates that water hyacinth has been used in art/craftwork such as manufacturing of art paper, crafts, ropes, furniture and other things creates unemployment and increase of income (Lindsey and Hirt, 1999; Haider, 1989 and Ndimele *et al*, 2011). These studies therefore depict the economic potential of the hyacinth utilization, which the proposed study intends to investigate further by studying the influence of the hyacinth on the business initiatives in the community around South West Seme.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

In this chapter, the study area, research design, study population and sampling procedures are outlined. In addition, the chapter also details the data collection procedures, data analysis and presentation.

3.2 Research Design

The study adopted the descriptive survey research design with both quantitative and qualitative approaches. A survey is an attempt to collect data from members of a population in order to determine the current status of that population (Mugenda and Mugenda, 1999). This design was appropriated to the study since it facilitates the description of the characteristics and the relationship between the water hyacinth infestation and the livelihoods of the communities in the area of study. Descriptive survey describes “what is” and is concerned with conditions or relationships that exist, opinions that are held, processes that are going on, effects that are evident or trends that are developing (Best and Khan, 1993). According to Lokesh (1984) descriptive studies are designed to obtain pertinent and precise information concerning the status of phenomena and whenever possible to draw valid general conclusions from the facts discovered. Therefore, the design guided the study in seeking to find out the effect of the water hyacinth on the economic activities of the community around the study area.

3.3 Target Population

Mugenda and Mugenda (1999) define target population as that population to which a researcher wants to generalize the results of the study. The ideal setting for research study is one that directly satisfies the researcher's interest and should be accessible to the researcher (Singleton, 1993). The target population for the study comprised all the households of West Kadinga and South Alungo of South West Seme Location which is found in Winam Division in Seme Sub County who derives their livelihoods from Lake Victoria. The National Population and Housing Census provide a listing of 1,648 households in the 2 Sub Locations (Kenya National Bureau of Statistics (KNBS), 2010). This was used as a sampling frame from which a representative sample was selected for the study.

3.4 Sample Size and Sampling Procedures

This section describes the sample size and the procedures used to select the sampled subjects for the study.

3.4.1 Sample Size

Krejcie and Morgan's (1970) have provided a table of determining sample size for different populations (Appendix V). The table is based on a formula which gives a sample size that when drawn randomly from a finite population size, is such that the sample was within ±.05 of the population proportion with a 95% level of confidence. Therefore, the sample size for the study was 310 respondents.

3.4.2 Sampling Procedures

Sampling refers to the selection of some part of an aggregate or totality on the basis of which a judgment or inference about aggregate or totality is made. In other words, it is the process of obtaining information about an entire population by examining only a part of it (Kothari, 2004). A sample size is a definite plan determined before data is actually collected for obtaining a sample from a given population (Orodho, 2005).

From the onset, cluster sampling was adopted where the study area was clustered into 2 Sub Locations of South West Seme namely West Kadinga and South Alungo. Out of the six sub locations within the location, the two are closest to the lake shore and have more beach management units indicating a reliance in fishing as a main source of livelihood. Cluster sampling is most appropriate where there is an attempt to study characteristics in their natural settings or to ensure geographic representation of intact groups whose distinct characteristics are of interest in a research (Osuji, 2006). The next step involved the selection of the study subjects, which was done through simple random sampling. This approach ensured that, each number of the population had an equal and independent chance of being selected. Random lists of numbers that correspond to the number of households represented in the sub-locations were generated then the participating households picked at random from each list.

The key informants were selected purposively, two from each BMU within the sub locations (male and female), one from the Ministry of Agriculture, and one from the Fisheries department of the Environment, Water and Natural Resources Ministry. A total of 12 key informants were therefore interviewed.

3.5 Data Collection Instruments

Permission to conduct research was sought from the University of Nairobi and then a research permit from the National Commission for of Science, Technology and Innovation (NACOSTI). The researcher then made an exploratory visit to the area of study to meet with local leaders specifically community leaders and beach leaders who assisted in mapping out the area to identify the households within the sub locations. The next stage was the actual field work and entailed collecting primary data from the sampled respondents.

The researcher designed three instruments, a questionnaire, a key informant guide and an observation guide. The questionnaire with both closed and open-ended items was used to collect primary data from individual respondents. The questionnaire had four main parts. The first part sought information on the respondent's profile such as source of income, sex and working experience at the beach. The second, third and fourth part addressed issues related to the study objectives and research questions and the responses received were used to address the study's objectives and answer the research questions. The questionnaire was administered to the individual respondents by the researcher and one research assistant, assuring the respondents that information gathered will be treated confidentially and purely for the purposes of research. The researcher delivered the questionnaires in person and waited as respondents filled in their responses, then collected them immediately as the research assistant also did the same in other households.

Key informant interviews was undertaken with identified community leaders and officials from stakeholder institutions to gain a deeper understanding of the issues under

investigation. The key informants were selected purposively, two from each BMU (male and female) and one from the Ministry of Agriculture and another from the Fisheries Department of the Ministry of Environment, Water and Natural resources. A total of 12 key informants were therefore interviewed. The key informant guide had unstructured questions that were directly related to the themes of the study. This was used to guide interviews with the stakeholders identified. Interviews with the key informants were organized so as to gather data and information that was useful in filling in gaps or making clarifications.

Non-participant observation was used alongside the two instruments. Here, the researcher watched the subjects of the study, with their knowledge, but without taking an active part in the situation under scrutiny. Indicators of interest to the objectives of the study were recorded for comparison with and addition to the other information collected. An observation guide was developed to aid in data collection.

3.5.1 Validity of the instruments

According to Saunders *et al.* (2007) validity is the extent to which data collection method accurately measure what they are intended to measure. It indicates the degree to which an instrument measures the construct under investigation (Gall. *et al.*, 2003). When applying this to data collected through a questionnaire it means that the data collected is the data that actually should be collected. Saunders *et al.* (2007) stresses that the questions have to be understood in the way that was the purpose from the researcher, it has to be answered in the way that was thought from the researcher and the answer must be interpreted by the researcher in the way intended by the respondent. Therefore, in construction of the

instrument items, the researcher used simple English language that the respondents easily understood. Attempts to translate the contents of the questionnaire into the local language to the illiterate were also made where necessary. Effort were made to ensure that the items are clear and precise without any ambiguity, ensuring that the items addressed the objectives of the study. The instruments were given to the supervisor and other research experts at the University of Nairobi for expert judgment and review of content and face validity.

3.5.2 Reliability of the Instruments

Mugenda and Mugenda (2003) states that reliability is a measure of the design to which, a research instrument yields consistent result or data after repeated trails. Therefore a reliable instrument is the one that consistently produce the result when used more than ones to collect data from two samples randomly drawn from the sample population.

The test-retest approach was used. According to Mugenda and Mugenda (2003) this approach involves administrating the same instrument twice on the sample group of the subject at different times. Machmaids and Nachmias (1996) in addition states that instrument is administered at two different times and then computes the correlation between the sets of scores. The questionnaire was pilot-tested on a sample of 10 households drawn from Usoma beach which had similar characteristics as the area of study. After two weeks the same questionnaire was administered to be same population and correlated. A Pearson correlation coefficient of 0.8 was achieved.

3.6 Data Analysis and presentation

Both quantitative and qualitative data analysis methods were used since the data collected based on the questionnaire generated both quantitative and qualitative information. The collected data was coded after validation and editing, then entered into the computer. Data analyses was done with the aid of the IBM Predictive Analytics SoftWare (PASW) (formerly Statistical Package for Social Scientists (SPSS). The objectives were analyzed using simple means to determine the influence of the water hyacinth on the livelihoods of the community around the study area. Qualitative data obtained from the open-ended questions in the questionnaires and key informant interviews were extracted and transcribed, the common themes identified, organized and then discussed under the main objective areas of the study. Results from data analyzed were presented using tables to provide a clear understanding.

3.7 Ethical considerations

Ethical measures are principles which the researcher should bind himself with in conducting his/her research. In this study, the researcher sought the requisite approvals for conducting the research before data collection (McMillan & Schumacher 1993).

Authority to conduct this study was granted by the National Commission for Science, Technology and Innovation (NACOSTI) through the University of Nairobi. The local Area Chief was also informed and his authority sought. Informed consent was sought from the respondents after explaining the purpose and importance of the study.

McMillan and Schumacher (1993) recommend that information on participants should be regarded as confidential unless otherwise agreed on through informed consent. In this study, participants' confidentialities was adhered to, as they were not asked to provide their names during data collection.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION, INTERPRETATION AND DISCUSSION OF FINDINGS

4.1 Introduction

This chapter presents the results of the study and the discussions of the findings which have been divided into four major sections. The first section provided the results on the response of the demographic data of the respondents, which includes age, gender, location, size of the family and by extent the respondents' occupation. The second section shows the influence of water hyacinth on agricultural activities of the community around riparian communities within South West Seme Location of Kisumu County, the third section examines the influence of water hyacinth on the fishing activities of the community and finally the last part assesses the extent to which water hyacinth influences the business initiatives of the community. Both qualitative and quantitative techniques were used in data analyses. This is because some objectives require in depth information (qualitative) while other objectives need quantitative data for drawing analysis and conclusions. Quantitative data was analyzed using descriptive statistics such as means and percentages. For qualitative data, the researcher created notes of the interviews; these notes were edited and cleaned up as the researcher is organizing the work, it was then categorized to themes in line with study objectives and the data were analyzed. The results were presented in form of text, report and quotations.

4.1 Response Rate

This section is a summary of the number of household respondents who participated in the study with respect to the designed sample size. Table 4.1 shows the response rates.

Table 4.1: Response return rate

	Predicted Sample size	**Percentage**	**Sample return**	**percentage**
Total Response	310	100.0	300	97
Total	**310**	**100.0**	**300**	**97**

A total of 300(97%) of the response was obtained after administration of 310(100%) of the stipulated sample size, this shows that the response was good and thus fit for data validation.

4.2 Socio-demographic characteristics

To find out the demographic data of the respondents, they were asked to state their gender, age, location, number of people in a household, and by extension, the respondent's occupation. The results were analyzed in frequency counts and percentages**.**

4.2.1. Gender of the Respondents

To establish the respondent's gender, they were asked to state on the choices given, whether they were male or female. The results are presented in the Table 4.2.

Table 4.2: Gender of the Respondents

Gender	Frequency	Percent
Male	186	62.0
Female	114	38.0
Total	**300**	**100.0**

From Table 4.2, the results show that among the respondents, 186(62.0%) were male while 114(38.0%) were female respondents. This shows that there was gender balance in data collection and responses, thus there was no biasness in the responses, as the results would accommodate every sphere of the gender. According to the observation by the researcher, most of the people who carried out fishing activities were male, while most of those who engaged in fish selling were female.

4.2.2. Respondent's Location

To ensure that the entire study area of South West Seme was covered, the respondents were asked to indicate their sub location .The two sub-locations were, West Kadianga and South Alungo. The representation is as shown in Table 4.3;

Table 4.3: Location of the respondents

Sub location	Frequency	Percent
West Kadinga	133	44.3
South Alungo	167	55.7
Total	**300**	**100.0**

From Table 4.3, 133(44.3%) indicated respondents from West Kadinga and 167(55.7%) respondents from South Alungo. The results show that the study area was well covered although South Alungo having slightly more respondents than West Kadinga.

4.2.3. Household size

The researcher was also able to determine the household size of the respondents. This was done by indication of the number of people in each house hold. This was done in order to estimate the entire population affected by water hyacinth in South West Seme location. The results are as shown in Table 4.4

Table 4.4 House Hold Size

Size of household	**Frequency**	**Percent**
1 member	16	5.3
2 members	14	4.7
3 members	42	14.0
4 members	90	30.0
more than 4	138	46.0
Total	**300**	**100.0**

From the result in Table 4.4, it is shown that 16(5.3%) household has one person, 14(4.7%) has two people, 42 (14.0%) has three people, 90(30%) has four people and 138(46.0%) has more than four people. The results show that most households in South West Seme

location comprise of more than four people hence an indication that a large population is affected by water hyacinth.

4.2.4. Respondents' occupation

It was also necessary to establish the respondents' occupation so that the effect of water hyacinth to the economic activities of the respondents could be determined. The results were presented in tabular form as shown in Table 4.5.

Table 4.5: Respondents' Occupation

Occupation	Frequency	Percent
Fishermen	116	38.7
Trader	74	24.7
Employed	14	4.7
boat owner	16	5.3
Farmer	80	26.7
Total	**300**	**100.0**

From Table 4.5, 116(38.7%) shows the respondents were fishermen, 74(24.7%) traders, 14(4.7%) boat owners and 80(26.7%) are farmers. The results show that a large proportion of the respondents are fishermen hence, if affected by water hyacinth as they undertake their activities, then the effect may significantly affect the entire population of the area.

4.2.5. Respondents' Age Category

In order to find the age distribution of the respondents, they were asked to pick on the choices the range of ages they were given. Age categories was transformed and recoded into three categories; young, middle aged, and old. The young age group consisted of those aged 30 years and below, middle aged were those between 31 years to 49 and the older category was that of 50 years and above. The results of the respondents' age groups was tabulated and presented in frequency counts and percentages as shown in Table 4.6.

Table 4.6: Age Categories

Age	Frequency	Percent
Young	100	33.3
middle aged	153	51.0
Old	47	15.7
Total	**300**	**100.0**

From the results in Table 4.6 , a large percentage of the respondents ranged in the middle age group,153(51.0%), and second in count was young people 100(33.3%) and the last age group with fewest respondents was 47(15.7%).These results show responsible sample that can give reliable results, since older people could be tired and having less energy but have experience and knowledge about water hyacinth, whereas young and middle aged energetic people have the full potential to carry out farming, fishing or trading activities hence have enough experience. According to the observation by the researcher, most of the fishermen were middle aged.

4.3. History of Water Hyacinth around the Lake Region

4.3.1. Year when Water Hyacinth Noticed on Lake

It was also necessary to establish the year that water hyacinth was noticed on the lake. The respondents therefore were given a range of years to choose from, in categories, which ranged from 1994 to 2007.The results were presented in frequency counts and percentages as in Table 4.7.

Table 4.7: Approximation of the year water hyacinth was noticed on the lake

Year water hyacinth noticed on lake	Frequency	Percent
1994-1999	238	79.3
2000-2004	46	15.3
2005-2007	16	5.3
Total	**300**	**100.0**

The results in Table 4.7 show that water hyacinth was discovered between 1994 and 1999, according to the respondents views, 238(79.3%) of the respondents, 46(15.3%) of the respondents say that it was discovered between 2000-2004 and 16(5.3%) realized it between 2005-2007. These results are not far from the previous research which established that water hyacinth was first sited in the Kenyan side of the lake in 1992 (Republic of Uganda, 2005),with a small period gap of 2 years.

4.3.2. Year Water Hyacinth noticed on Beach

The researcher went ahead to establish the exact year that water hyacinth was noticed on the beach, apart from the lake. The range of years remained constant, with estimation of year when it was noticed on the lake. The results were presented in Table 4.8 .

Table 4.8: Approximation of the year water hyacinth was noticed on the Beach

Year water hyacinth noticed on beach	Frequency	Percent
1994-1999	219	73.0
2000-2004	58	19.3
2005-2007	23	7.7
Total	**300**	**100.0**

The results in Table 4.8 shows that the water plant was discovered on the lake between year 1994 and 1999, as responded by 219(73.0%) of the respondents, 58(19.34%) noticed the plant on the beach between 2000-2004, while 23(7.7%) learnt of the water hyacinth between 2005 and 2007.These results are not different from the previous results, which established that the plant was noticed in the lake between 1994 and 1999, when it was almost disappearing.

4.3.3. Period Water Hyacinth Covered the Lake

In an art to establish the period that water hyacinth covered the lake, the respondents were asked to give their views according to their observation or their knowledge of the period of

coverage. The results were tabulated and presented in frequency counts and percentages as shown in Table 4.9.

Table 4.9: Average number of Months Hyacinth Covers on the Beach

No of months	1	2	3	4	5	=>6
Respondents	9(3.0)	21(7.0)	100(33.3)	56(18.7)	40(13.3)	74(24.7)

From the results in Table 4.9, the highest approximation of the number of days that water hyacinth covers the lake is 3 months, as reported by 100(33.3%) of the respondents, followed by 6 months, 74(24.7%). It can therefore be estimated that water hyacinth covers the lake in a period of approximately 4-6 months. This is a good period to make a considerable effect on the activities around the lake especially fishing activity.

4.3.4. Months Water Hyacinth infestation becomes Critical at the Lake

In order to find the relationship between the resident's activities and the month that water hyacinth covers the lake, it was important to establish the month that water hyacinth infestation was critical at the beach. Respondents were asked to select on the choices given the month that they thought had critical water hyacinth infestation. The results were tabulated in frequency counts and percentages as shown in Table 4.10.

Table 4.10 Month Hyacinth Infestation Critical at the Beach

Month hyacinth infestation critical at the beach	Frequency	Percent
January	3	1.0
February	2	.7
March	2	.7
April	9	3.0
May	15	5.0
June	4	1.3
Juicy	8	2.7
August	40	13.3
September	46	15.3
October	55	18.3
November	51	17.0
December	65	21.7
Total	**300**	**100.0**

From the results in Table 4.10, it is clear that water hyacinth covers the lake between the month of August and December, with mostly being the months of December as stated by 65(21.7%) of the respondents. This was followed by October, 55(18.3%) and November, 51(17.0%).The least months that were mentioned were February and March, with 2(.7%) each.

4.3.5. Years that Water Hyacinth infestation was Critical

The researcher also went ahead to find out the years that water hyacinth infestation was critical, the respondents were given choices of the years ranging from 1999 to date. The results are presented in Table 4.11.

Table 4.11: Year hyacinth infestation critical

year hyacinth infestation critical	Frequency	Percent
1991	10	3.3
1992	2	.7
1996	3	1.0
1997	4	1.3
1998	75	25.0
1999	45	15.0
2000 to date	161	53.7
Total	**300**	**100.0**

From the results in table 4.11, water hyacinth has been rampant of recent years to date. This is approved by 161(53.7%) of the respondents who observed the infestation between 2000 up to now. A good number of the respondents also observed the effect as rampant in the year 1998, with some observing it in 1999.The results support Gichuki *et al,* (2011) findings, of the emergence of water hyacinth in December 2005.

4.4. Effect of Water Hyacinth on Agricultural Activities

In an attempt to establish the influence of water hyacinth on agricultural activities around the lake region, respondents were asked about their involvement in Agricultural activities around the lake. Among the questions asked was their participation in agriculture, whether water hyacinth was used in the farm, how water hyacinth was used in the farm, crops grown around the lake and their prices.

4.4.1. Participation in Agriculture

Establishment of respondent's participation in agricultural activities was achieved by asking them to sate whether they participated in agricultural activities. Their responses were as shown in Table 4.12.

Table 4.12: Participation in Agriculture

Participate in Agriculture	Frequency	Percent
Yes	51	17.0
No	7	2.3
Sometimes	242	80.7
Total	**300**	**100.0**

From the results in Table 4.12, 51(17.0%) of the respondents participated in Agricultural activities, 242(80.7%) participated sometimes and only 7(2.3%) of the respondents did not participate in these activities. It can be concluded that a good number of the residents of

this region participated in Agricultural activities. The researcher therefore proceeded to establish the kind of activities, whether farming or raring of animals and in which amounts. This was relevant especially in relation to the impact of water hyacinth on these activities that was also assessed.

4.4.2. Water hyacinth as a farm input

The respondents were therefore asked the kind of crops that they planted, the land acreage and the output in terms of bags and monetary value. Interviews were given and the results estimated, therefore an approximation of the findings was presented as shown in Table 4.13.

Table 4.13 Water hyacinth used as input in farm

water hyacinth used as input in farm	Frequency	Percent
Yes	190	63.3
No	10	3.3
not sure	100	33.3
Total	**300**	**100.0**

Table 4.13 shows the percentages of the respondent's views on the use of water hyacinth on the farm. Majority of the respondents saw that hyacinth was used as a farm input, 190(63.3%) accepted that water hyacinth was used as a farm input while 10(3.3%) declined, 100(33.3%) saw that the hyacinth was used sometimes.

4.4.3. How Water Hyacinth used on Farms

It was also necessary to establish how the water hyacinth was used in the farm, and therefore the respondents were asked to state the uses, among the choices were manure and mulching. The results were tabulated in a frequency table with frequency counts and percentages. The results are presented as shown in Table 4.14.

Table 4.14 How Hyacinth used on Farm

how hyacinth is used on farm	Frequency	Percent
Not sure	100	33.3
Manure	155	51.7
Mulching	45	15.0
Total	**300**	**100.0**

From table 4.14, water hyacinth has an agricultural benefit of manure, as respondent by 155(51.75%) of the respondents, 45(15.0%) attributed it to the use as mulching and 100(33.3%) observed that it was used both as manure and for purposes of mulching.

4.4.4. Crops Grown Around the Lake Region

The researcher wanted to know whether the community had been influenced by new agricultural practices and technologies, so that he could find out whether the weed had affected their traditional farming activities. The respondents were therefore asked whether

they participated in these activities. The average results of committed farmers in the region who were interviewed were transcribed and reported in Table 4.15 as shown.

Table 4.15 Crops Grown Around the Lake Region

Crops grown	Acre	Total/bag	Price(Ksh)
Maize	1-3	3-6	3000-6000
Millet/Sorghum	1-2	1-3	3000-4000
Beans	4-5	1-3	3000-6000
Vegetables	1-3	5-10	4000-10000

From the Table 4.15 , an interview with a group of respondents reveals that farmers earned from agricultural products, particularly due to horticultural crops mainly vegetables. This output is largely attributed to the promotion of green houses, findings that were established after an interview with respondents. They were asked how they produced this harvest and if water hyacinth contributed to the produce. Key informants linked the produce to green houses and manure that was taken from the farm.

4.4.5. Relationship between Water Hyacinth and Price of Agricultural Products

From the assumption that water hyacinth altered Agricultural prices there was need to find out if there was a relationship between water hyacinth and prices of Agricultural products. The respondents were therefore asked to give their views on the relationship between price

increase and coverage of water hyacinth in the lake. Table 4.16 shows the results of the responses.

Table 4.16 Prices of Agricultural products reduced when?

Prices reduced when?	Frequency	Percent
there is no hyacinth on water	12	4.0
water in the lake is partially covered by hyacinth	106	35.3
water in the lake completely covered by hyacinth	78	26.0
not sure	104	34.7
Total	**300**	**100.0**

Table 4.16 shows that the respondents attributed price increase to the period when water hyacinth covered. Those who linked prices to partial coverage of water hyacinth were 106(35.3%), full coverage were 78(26.0%) and there were those who were not sure, representing 104(34.7%) of the respondents. It is clear from the results that water hyacinth causes reduction in the prices of agricultural crop products. This reduction of prices however is attributed to increased production due to intensification of agriculture (mechanized agriculture) and adaptation of new practices (green houses) during periods when water hyacinth covers the lake. Besides such uses, an interesting fact is that the plant has not been fully utilized, for instance in Malaysia ,fresh water hyacinth is cooked with rice bran and fishmeal and mixed with copra meal as feed for pigs, ducks and pond fish. Similar practices are much used in Indonesia, the Philippines and Thailand (National

Academy of Sciences, 1976). These findings therefore show that the plant is very useful both in farm agriculture and animal keeping.

4.6 Effect of Water Hyacinth on Fishing

From the hypothesis that water hyacinth had a significant effect on fishing activities around the lake region, it was also necessary to establish the effect of water hyacinth on fishing activities on the residents of the area around Lake Victoria. Factors that contributed towards the effect included; fish catch and fish species.

4.6.1. Fish Catch and Water Hyacinth

Respondents were asked to contribute their views the effect of water hyacinth on caching of fish. The results are tabulated in frequency counts and percentages as shown in Table 4.17.

Table 4.17 Effect of water hyacinth on fish catch

Water hyacinth leads to reduction of fish	Frequency	Percent
Yes	264	88.0
No	36	12.0
Total	**300**	**100.0**

From Table 4.17, 264(88.0%) of the respondents associated reduction in fish catch to coverage of water hyacinth on the lake, 36(12.0%) did not find any association. The results show that at least water hyacinth causes some difficulty in catching fish. Furthermore,

respondents were asked to share their views on whether change in fish species is as well associated with water hyacinth, the results are shown in Table 4.18.

An interview with a group of key informants revealed similar results when they were asked to give their views on some of the effects of water hyacinth on fishing. The results were transcribed and reported verbatim as follows,

> '*We experience loss of fishing gear, time wasting during fishing and difficulty in movement, and even sometimes prevent people from fishing'*

Mailu's (2001) report stated that for the individual fisherman, the hyacinth mats reduced their catch by covering fishing grounds, delaying access to markets due to loss of output, increasing fishing costs due to the time and effort spent clearing waterways, forcing translocation, and causing loss of nets.

Besides these quotations, some respondents added that,

> *"The plant led to transport barriers on water thus hindering better access to fishing point".*

These are among the many effects that were reported. Penfound and Earle, (1948) also found that water hyacinth grows rapidly, forming expansive colonies of tall, interwoven floating plants. It blankets large water bodies, creating impenetrable barriers and obstructing navigation, as supported by Gowanloch and Bajkov, 1948; Zeiger, (1962).

4.6.2. Water Hyacinth and Fish Species

The respondents were asked whether change in fish species were associated with water hyacinth.

Table 4.18: Relationship between water hyacinth and fish species

change in fish species associated with water hyacinth	Frequency	Percent
Yes	254	84.7
No	46	15.3
Total	**300**	**100.0**

From Table 4.18 , majority of the respondents associated change in fish species with water hyacinth, at most 254(84.7%) whereas 46(15.3%) saw no association in the change of fish species with water hyacinth. The results are consistent with Calvert's findings, that diversity in fish stocks is often affected with some benefiting and others suffering from the proliferation of water hyacinth (Calvert, 2002).

4.6.3. Change in fish species associated with water hyacinth

To establish the month that different types of fish species were caught, respondents specifically fishermen were asked to estimate the months and the types of fish that were caught in those specific moth. The responses were tabulated as shown in Table 4.19

Table 4.19: Change in fish species associated with water hyacinth

Type of fish	Jan-Feb	Mar – Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec
Tilapia (*Ngege*)	100(33.3)	74(24.7)	56(18.7)	40(13.3)	21(7.0)	9(3.0)
Cat fish (*Kamongo*)	5(1.7)	14(4.7)	39(13.0)	40(13.3)	97(32.3)	105(35.0)
Mud Fish(*mumi*)	0(0.0)	30(10.0)	74(24.7)	40(13.3)	56(18.7)	100(33.3)

From the frequency Table 4.19, Tilapia was mostly caught between January and February, 100(33.3) while Cat fish and Mud fish were caught in plenty during the months of November.

Interviews with the fishermen also revealed that there were specific fish species that disappeared due to water hyacinth infestation, whereas there were other fish species that could survive well in these conditions. Transcribed quotations with the fishermen,

> *"We experience loss of tilapia and 'omena' species, but we are able to harvest mudfish, cat fish which are caught in plenty, but are commercially not preferable and economically they do not earn us good money as tilapia fish type".*

This is not far from Mailu (2001) report which cited the declines of 14 percent, 37 percent, and 59 percent in the catches of Oreochromis (a large genus of tilapia), Clarias (a genus of

catfish), and Mormyrus (a genus of bottom-feeding breams), respectively, in the Kenyan section of the lake. Twongo (1998) noted that the weed mats sealed off breeding, nursery, feeding, and fishing grounds for various inshore fish species, like tilapia and young Nile perch.The results shows that water hyacinth had adverse effect on the change of fish species, thus causing a loss in fish industries and economic slowdown to fishermen.

However, an interesting finding was realized when another interview was done with a group of five fishermen as they complained that hyacinth was in fact of more important when it existed.

> *"Water hyacinth in fact protects fish breeding areas as it restricts the fishing of juvenile fish with fishermen experiencing large catches in areas infested by water hyacinth. Indeed, we pray for the weed to return to our shores as we currently experience low catches without it".*

This findings although contradicting, are supported by (Gopal, 1987) who found that water hyacinth has also been used as fish feed especially for tilapia, silver carp and the silver dollar fish. This can also be corroborated by (Villamagna and Murphy 2010) whose research established that the floating mats may limit access to breeding, nursery and feeding grounds for some economically important fish species. This shows a positive side of hyacinth which helps in protection of fish breeding sites.

A one way analysis of variance was also carried out to find out the differences in the perception of the respondents based on their occupation, on the effect of hyacinth on fishing activities. The results are presented in the ANOVA table 4.20.

Table 4.20: ANOVA for Impact of Water Hyacinth on Fishing Activities by Local Community

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	3.664	4	.916	4.409	.002
Within Groups	61.283	295	.208		
Total	**64.947**	**299**			

KEY: df-degrees of freedom, sig-significant value (value below stipulated error)

From Table 4.20, the results indicate that there is a significant effect of water hyacinth on fishing activities around the lake region. $F(4, 295) = 4.09$, $p < .05$.

Since there was no significant difference in the perception of the respondents with respect to their occupation, post hoc tests were not considered, their means were; fishermen (M=2.71, SD=.64), traders (M=2.92, SD=.275), those employed (M=2.79,SD=.579), boat owners (M=3.0, SD=.000), farmers (M=2.95, SD=.22). The results therefore indicated a higher mean, which implied that all the participants saw a heavy impart of water hyacinth on fishing activity, particularly difficulty in caching of fish. This shows that as much as water hyacinth was considered of economic importance on agricultural activities, its impact on fishing were un-impressing. The findings are consistent with those of Center *et al* (2002) report that water hyacinth invasions reduce available light for submerged plants

hence depleting oxygen, alter the composition of invertebrate communities, impacts fisheries, and displace native plants and wildlife, and increases sediment loading. Other related research findings also brought out the same feedback, that water hyacinth causes severe problems to fishermen in the riparian communities. When weed infestation is present, access to fishing sites becomes difficult for riparian communities which rely solely on fishing as their main economic activity (Munjigni, 2001). Hence, as much as water hyacinth is viewed to be of economic importance in some of its uses; it has had a negative impact on fishing, as it causes difficulty in fishing.

4.7. Effect of water hyacinth on Economic Activities

To find out the effect of water hyacinth on economic activities of the residents of South West Seme Location, Kisumu County-Kenya, they were asked to state whether there were instances when the plant was harvested and used as a raw material. The results were presented in Table 4.21 in frequency counts and percentages**.**

Table 4.21: Instances when water hyacinth is harvested and used as a raw material

	Frequency	**Percent**
Don't know	22	7.4
Yes	238	79.3
No	40	13.3
Total	**300**	**100.0**

The results from Table 4.21 shows that majority of the respondents benefited from harvest of water hyacinth as a raw material, 238(79.3%), a few of the respondents did not benefit from this plant, perhaps saw it as a hazard more than being helpful, while 22(7.4%) did not know much about the usefulness or effect of this plant. The results show that the plant was very vital especially when used as a raw material. This forms economic importance to the community residents of the area region. An interview with a group of the key informants revealed that the plant was of very high economic importance, for instance, many items were made from the plant, which in turn were sold at a very good price. One of the key informant interviewee was quoted saying,

> *"We harvest water hyacinth, which we use to make baskets, mats and ropes. Community self-help groups which specialize in making hyacinth products and looking for markets have also been formed. Individual artisans also sell it thus earning some income".*

From the results in the interview schedule, it can be said that water hyacinth has numerous economic importance. This is evident as in in settlements where water hyacinth has destroyed economy (fishing, river transport, etc.) populations have reoriented to manufacturing of art paper, crafts, ropes, furniture and other things from water hyacinth which will positively influence to reduction of unemployment and increase of income (Lindsey and Hirt, 1999), according to these findings. The plant is also found useful in other ways, for instance, the House and Building Research Institute in Dhaka has carried

out experimental work on the production of fiber boards from water hyacinth fiber and other indigenous materials (Haider, 1989).

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATION

5.1 Introduction

This chapter contains summary of findings as per the objectives of the study, conclusion, recommendations, contributions to the body of knowledge and suggestions for further research.

5.2 Summary of Findings

The study sought to investigate the influence of water hyacinth on the livelihoods of the riparian community along Lake Victoria, focusing on two Sub Locations within South West Seme Location in Kisumu County. The study results realized reliable sample respondents in terms of age, location and occupation as per the activities they carried out around the lake region. Most of the residents were fishermen, 116(38.7%), followed by farmers, 80(26.7%) and finally traders 74(24.7%) thus making the targeted respondents complete. Findings were also exhaustive according to the objectives of the study.

The first objective was to establish the influence of water hyacinth on agricultural activities of the riparian community within South West Seme Location of Kisumu County. Results from questionnaire and interview schedule analysis revealed that the water hyacinth had a significant impact on the area residence, according to the historical findings. The plant had caused a tendency of fluctuation in agricultural prices, for instance, when it covered the lake, price of agricultural products went down due to increased production and lack of

markets. This was attributed to its usefulness especially as manure, mulch and adaptation of green houses as revealed by interview and questionnaire analysis. For instance, 106(35.3%) of the respondents reported that the emergence of the plant is linked to the decrease of agricultural prices. 155(51.7%) had experienced its use as manure and 45(15.0%) saw its use in mulching, especially in horticultural crops that were mainly vegetables. It is therefore clear that this plant is very useful to the economic activities of the residents around the lake region.

The second objective was to examine the influence of water hyacinth on the fishing activities of the community around Beach. Unlike in agricultural practices, respondents had observed a negative effect of the plant on their activities. Fishing being the source of income to the majority, as 116(38.7%) of the sample respondents, the results could easily be generalized to the entire beach residents. The results revealed a reduction in fishing and consequent increase in fish prices when the plant covered the lake. At least 264(88.0%) of the respondents reported a reduction of fish caught during times of critical influence of the weed. A large number 254(84.7%) of the respondents further reported a change in fish species that were caught, which entailed reduction of commercial fish like *omena* and tilapia, rare and persistence fish species were the only ones that could be caught at such times. Interview schedules also revealed that it is generally difficult to catch fish during periods of rampart effect of water hyacinth, there was loss of fishing gears, and it was difficult to navigate through the waters due to interwoven nature of the plant. Time was also consumed in fishing and therefore it was terrible. It can thus be observed that though the plant was considered of economic importance, to caused economic depression to the community, thus slowing economic growth.

The third objective was to assess the extent to which water hyacinth influences the business initiatives of the riparian communities. The researcher therefore wanted assess its general effect apart from causing changes in agricultural output and fishing activities, even though they were part of the economic activities of the residents of the region. The study revealed that the weed was harvested as raw material. Majority of the respondents saw its importance as a raw material in production of various useful products, 238(79.3%) agreed when they were told that the plant was useful, only a small percentage declined, 40(13.3%) and few were not sure. Interview with key informants further revealed that even hawkers earned from the sale of baskets, ropes, chairs and tables as a products of water hyacinth. The plant therefore had a significant economic importance, ranging from agricultural importance to fishing and even creation of employment activities. The usefulness of the weed therefore exceeds the drawbacks economically.

5.3 Conclusions

From the study findings, various conclusions can be drawn. First, the negative perception of the plant as a weed just turned to be of agricultural importance, serving as manure and at the same time mulching. The plant is very important and helped improve the agricultural output of the community around the lake region. The weed has influenced the traditional agricultural practices of the community, with hyacinth being used as mulch and manure and adaptation of green houses. This has led to diversification of agriculture especially involvement in horticulture. The plant has therefore numerous importance, including the use of the plant in other countries as fodder, food for fish and pigs.

The plant also has its contradicting sides on the fishing activities, it is seen to hinder the activity of fishing by causing consumption of more time and even resulting into loss of fishing gears, a serious loss to fishermen. Fish species are also disappearing due to the effect of water hyacinth. An example is *tilapia* and *omena* which were found migrate or die due to inability to adopt in times when the plant covered the lake, as discussed in the literature review. It has therefore resulted into a negative effect on fishing activities of the residents, by leading to a reduction in the fish.

Economic growth and retardation to the residents of the area around South West Seme was realized. Growth because the plant was used as a raw material to make ropes, furniture, and mats. In addition, the plant was found to create employment to traders, thus improving business activities and in turn improving the economy of the residents. On the other hand, the plant also slows down fishing and even leads to reduction of the fish caught in the community. The loss of the some fish is a serious problem as fish are these are viewed to be economically viable. The loss of fishing gears leads to monetary loss as these items are bought, fishermen may also be discouraged due to waste of time in navigation in the lake waters as they try to fish. The weed is therefore both good and bad, in the context in which the community views it, but generally, it has caused economic improvement to farmers and businessmen while causing an economic nightmare to the fishermen.

5.4 Recommendations

Based on these findings, the study discovered some of the recommendations that can be of use both to the future studies and to the community of the area of study.

To begin with the government and NGOs should come in and encourage the residents not only to rely on fishing activities but also embrace the plant as of economic importance. This can be achieved if the government can establish cottage industries that can harvest the plant and use its use in processing of board are sufficiently good for use on indoor partition walls and ceilings.

The serious damage of the ecological system of the area around the lake caused by water hyacinth can be controlled by using the plant in large-scale production of charcoal briquettes from water hyacinth as discovered by Eden (1994).

The possibility of converting water hyacinth to biogas should also be embraced. Conversion of other organic matter, usually animal or human waste, is a well-established small and medium scale technology in a number of developing countries, notably in China and India.

The government should encourage the consumption of the perceived less economically important fish species and encourage value addition technics to increase their economic viability.

5.5 Contribution to the Body of Knowledge

Table 5.1: Contribution of the Study to the Body of Knowledge

Objectives	Contributions to the Body of Knowledge
1. To establish the influence of water hyacinth on agricultural activities of the riparian communities within South West Seme Location of Kisumu County	Government to encourage use of the plant for manure and agricultural products in order to enable harvesting of the plant in large quantities.
2. To examine the influence of water hyacinth on the fishing activities of the riparian communities within South West Seme Location of Kisumu County	The government should encourage the consumption of the perceived less economical fish species and encourage value addition technics to increase their economic viability.
3. To assess the extent to which water hyacinth influences the business	Encourage community residents to come up with other activities that can see utilization of the weed rather than viewing it as a hazard. This can improve

initiatives of the riparian communities within South West Seme Location of Kisumu County	the economy of the area residents and to the country as a whole

5.6 Suggestions for Further Research

This study did not explore the economic situation of the area residents of the riparian community within South West Seme Location of Kisumu County. Furthermore, it did not establish in detail the uses of water hyacinth beyond its view as a weed. What the community, the government and the NGOs do towards improvement of fishing activities.

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APPENDICES

APPENDIX I: LETTER OF TRANSMITTAL

Odidi Mitchel Otieno,
P.O Box 7664-40100,
Kisumu,

The Chief
South West Seme Location

Re: Data Collection for Research Study.

I am a student of the University of Nairobi, pursuing a Master of Arts Degree in Project Planning and Management. Currently I am in the process of undertaking research on the influence of water hyacinth on the livelihood of communities living within West Kadinga and South Alungo of South West Seme Location, Kisumu County.

The study will involve collecting data from the community around the beaches. The purpose of this letter therefore is to request your office to grant me permission to carry out the study in the area.

Yours faithfully,

Odidi Mitchel.

APPENDIX II: STUDY QUESTIONNAIRE

This questionnaire seeks to collect information for the purpose of assessment of the influence of water hyacinth on income in South West Seme Location, Kisumu County-Kenya for academic purposes **ONLY.**

PLEASE ANSWER THE FOLLOWING QUESTIONS BY CROSSING (𝒳) THE RELEVANT BLOCK OR WRITING DOWN YOUR ANSWER IN THE SPACE PROVIDED.

EXAMPLE of how to complete this questionnaire:

Your gender?
If you are female:

Male	1
Female	2

SECTION A: BACKGROUND INFORMATION

This section of the questionnaire refers to background or biographical information. Although we are aware of the sensitivity of the questions in this section, the information will allow us to compare groups of respondents. Once again, we assure you that your response will remain anonymous. Your cooperation is appreciated.

1. Gender

Male	1
Female	2

2. Age (in complete years)

3. From Which Sub Location do you come from?

West Kadinga	1
South Alungo	2

4. Size of your household, i.e. the number of people, including yourself, who live in your house/dwelling

Live alone	1
2	2
3	3
4	4
More than 4	5

5. What is your occupation

Fisherman	1
Trader	2
Employed	3
Boat Owner	4
Farmer	5

Other (specify)……

6. When did you first notice water hyacinth on the lake?…Year…… Month…….….

7. When did you first notice the water hyacinth at your beach? Year…… Month…….

8. Which month are critical in water hyacinth infestation at your beach/fishing ground?

Jan-Feb	**Mar –Apr**	**May-Jun**	**Jul-Aug**	**Sep-Oct**	**Nov-Dec**

9. In the table below, indicate the period when the water hyacinth moves away from this part of the lake:

Jan-Feb	**Mar –Apr**	**May-Jun**	**Jul-Aug**	**Sep-Oct**	**Nov-Dec**

10. Which year(s) have been critical in water hyacinth infestation?

    Year 199- = 1- [ ] 2- [ ] 3-] 4-[ ] 5-[ ]6-[ ] 7-[ ] 8-[ ] 9-[ ] =2000- [ ]

11. Can you please classify the impact of water hyacinth on local communities around your beach: Low….[ ] Moderate….[ ] Heavy….[ ]

SECTION B: RESPONDENTS VIEWS/OPINION (AGRICULTURAL ACTIVITIES)

This section of the questionnaire refers examines the influence of hyacinth on the agricultural activities. *(Questions to be answered by farmers)*

1. Which Crops are grown per acre?

Crop type	**Acre (s)**	**Total output (bags/Tones/Kgs.)**	**Price (Ksh.)**
Maize			
Millet/Sorghum			
Beans			
Vegetables			

Other (specify)----------

2. Which animals are kept?

Animal	**No.**
Chicken	
Goats	
Sheep	
Cattle	
Pigs	

Other (specify)…….

3. Are there times of the year when the price of farm produce increases or decreases?

☐ Yes

☐ No

4. If yes, when do these price changes occur? Indicate in the table below:

Price increases when…..	**Tick any**
When there is no hyacinth on water	1
When water in the lake is partially covered by hyacinth	2
When water in the lake completely covered by Hyacinth	3
Not sure	4

5. Is Water Hyacinth used as an input in the farm yes [ ] No [ ]

6. If yes, how is it used?

Manure	1
Mulching	2
Animal feed	3
Not sure	4

7. Which of the following forms of agriculture do you practice?

Zero grazing	
irrigation	
Green housing	
Mechanized agriculture	

SECTION C: RESPONDENTS VIEWS/OPINION (FISHING ACTIVITIES)

This section of the questionnaire refers examines the influence of hyacinth on the fishing activities. *(Questions to be answered by fishermen/boat owners)*

8. In your opinion, how does the water hyacinth affect fishing activities in the lake? -
_____
_____
_____

9. Do you realize a change in amount of fish catch associated with water hyacinth?

Change	**YES**	**NO**
Increase		
Decrease		
Not Sure		

10. Have you experienced any change in the fish species composition associated with water hyacinth? Yes…[ ] No……[ ]

11. In the table below, indicate the period when the number of fish caught from this part of the lake is **HIGHEST**:

Tilapia *(ngege)*

Jan-Feb	Mar –Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec

Cat Fish (*kamongo)*

Jan-Feb	Mar –Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec

Mud Fish (*mumi)*

Jan-Feb	Mar –Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec

12. Are there times of the year when the price of fish increases or decreases?

☐ Yes

☐ No

13. If yes, when do these price changes occur? Indicate in the table below:

Price increases when…..	Tick One
When there is no hyacinth on water	1
When water in the lake is partially covered by hyacinth	2
When water in the lake completely covered by Hyacinth	3
Not Sure	4

14. How many hours do you take fishing?

More than six hours	
Less than six hours	

SECTION D: RESPONDENTS' VIEWS/OPINION (BUSINESS INITIATIVES)

This section of the questionnaire refers examines the influence of hyacinth on the fishing activities. *(Questions to be answered by artisans)*

15. In this area, are there instances when the water hyacinth is harvested for use as raw material for craft work

☐ Yes

☐ No

16. If yes, list some of the items that are made from the hyacinth:

_____

_____

17. Are these items sold in markets for income?

- ☐ Yes
- ☐ No

Thank you for your participation

APPENDIX III: OBSERVATION GUIDE FOR THE STUDY

Name of study site_____ Replicate No_____
Date/Time_____

No.	Observations within and along the river channel	Yes	No	Comments
1.	Presence of water hyacinth in the lake			
2.	Presence of green houses			
3.	Irrigated agriculture			
4.	Types of businesses in the area			
5.	Production and sale of water hyacinth products			
6.	Presence of fishermen and fish traders in the BMUs			
7.	Fish landing sites operational			
8.	Amount of fish harvested			
9.	Presence of boats in the lake			
10.	Species of fish harvested			
11.	Other uses of water hyacinth			
12.	Alternative livelihood sources			

APPENDIX IV: KEY INFORMANT INTERVIEW GUIDE

Date:…… **Name of Interviewer**:……

Instructions

- The Respondent is kindly requested to listen and answer every question appropriately.
- The respondent is assured that the information obtained will be handled in confidence.

General Perception of water Hyacinth

1. General information:
    a) Which institution/organisation do you work for?
    b) How long have you worked for the institution/organisation?
    c) What is your position in the institution/organisation?
    d) How long have you been in that position?
    e) How long have you worked in Seme Sub County?
2. What is the history of Water Hyacinth in the area?
3. Is Water Hyacinth perceived as a problem?
4. What institutions and communities are affected by or concerned about Water Hyacinth in the area?
5. Are the problems associated with water hyacinth locally Social, Economic or Environmental?
6. Were/are there any difficulties in responding to a growing Water Hyacinth problem in the area?

This section seeks to get information about the influence of water hyacinth on Agricultural activities

1. Has the presence/absence of water hyacinth influenced agricultural practices in the Area?
    a) If yes, how has it influenced agriculture?
2. Have any new agricultural technologies been adopted?
3. In your view has agriculture improved due to presence or absence of water hyacinth?
4. Is water hyacinth used on farm?
5. In your view, have farm yields /produce improved or not?
6. Has the income from farming increased?
7. Can this be attributed to the presence/ absence of water hyacinth?

This section seeks to get information about the influence of water hyacinth on fishing activities?

1. In your view has the number of fish catches reduced?
2. Have some species of fish disappeared?
3. Is fishing profitable with the presence or absence of water hyacinth?
4. Can the cost of operations be attributed to water hyacinth?

This section seeks to get information about the influence of water hyacinth on Business initiatives?

1. Are there any general economic gains associated to water hyacinth?
2. Is water hyacinth harvested for other uses?

Thank you very much for your time and patience!

APPENDIX V: KREJCIE AND MORGAN (1970) TABLE

N-n	N-n	N-n	N-n	N-n
10-10	100-80	280-162	800-260	2800-338
15-14	110-86	290-165	850-265	3000-341
20-19	120-92	300-169	900-269	3500-346
25-24	130-97	320-175	950-274	4000-351
30-28	140-103	340-181	1000-278	4500-354
35-32	150-108	360-186	1100-285	5000-357
40-36	160-113	380-191	1200-291	6000-361
45-40	170-118	400-196	1300-297	7000-364
50-44	180-123	420-201	1400-302	8000-367
55-48	190-127	440-205	1500-306	9000-368
60-52	200-132	460-210	1600-310	10000-370
65-56	210-136	480-241	1700-313	15000-375
70-59	220-140	500-217	1800-317	20000-377
75-63	230-144	550-226	1900-320	30000-379
80-66	240-148	600-234	2000-322	40000-380
85-70	250-152	650-242	2200-327	50000-381
90-73	260-155	700-248	2400-331	75000-382
95-76	270-159	750-254	2600-335	1000000-384

APPENDIX VI: LETTER FROM THE UNIVERSITY

UNIVERSITY OF NAIROBI
COLLEGE OF EDUCATION AND EXTERNAL STUDIES
SCHOOL OF CONTINUING AND DISTANCE EDUCATION

Our Ref.: UON/CEES/KSM/1/16

University of Nairobi Plaza,
Oginga Odinga Street
P.O. BOX 825,
KISUMU.

Telephone: Kisumu 057-2021534

15th May 2014

TO WHOM IT MAY CONCERN

RE: ODIDI MITCHEL NO: L50/84301/2012

This is to inform you that the above named **Odidi Mitchel** is a student in the University of Nairobi School of Continuing and Distance Education pursuing Post Graduate Diploma in Project Planning and Management in Kisumu Campus.

Mitchel has completed his course work and examinations successfully and is currently undertaking research project work on "***Influence of water hyacinth on livelihoods of the Riparian community of south west seme location, Kisumu county, kenya.***" as a pre-requisite for the programme in the second year. He has identified your area as a resourceful centre for the information he needs for his research work.

We would therefore appreciate if he could be allowed to access information for his study as the data he needs is for academic purposes and not for other things. For further information do not hesitate to contact the undersigned.

Thank you.

DR. RAPHAEL O. NYONJE, PhD
SENIOR LECTURER
DEPARTMENT OF EXTRA MURAL STUDIES
UNIVERSITY OF NAIROBI
KISUMU CAMPUS

UNIVERSITY OF NAIROBI
15 MAY 2014
TEL: 057-2021534
KISUMU CAMPUS

ISO 9001: 2008 CERTIFIED
The Fountain of Knowledge Providing Leadership in Academic Excellence

APPENDIX VII: LETTER FROM NACOSTI

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471,
2241349, 310571, 2219420
Fax: +254-20-318245, 318249
Email: secretary@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No.

Date:

4th September, 2014

NACOSTI/P/14/4188/2662

Mitchel Otieno Odidi
University of Nairobi.
P.O. Box 30197-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Influence of water hyacinth on livelihoods of the Riparian community of South West Seme Location, Kisumu County, Kenya,"*** I am pleased to inform you that you have been authorized to undertake research in **Kisumu County** for a period ending **14th November, 2014.**

You are advised to report to **the County Commissioner and the County Director of Education, Kisumu County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

DR. S. K LANGAT, OGW
FOR: SECRETARY/CEO

Copy to:

The County Commissioner
The County Director of Education
Kisumu County.

National Commission for Science, Technology and Innovation is ISO 9001: 2008 Certified

APPENDIX VIII: RESEARCH PERMIT

THIS IS TO CERTIFY THAT:
MR. MITCHEL OTIENO ODIDI
of UNIVERSITY OF NAIROBI, 0-40100
KISUMU,has been permitted to conduct
research in *Kisumu County*

on the topic: *INFLUENCE OF WATER HYACINTH ON LIVELIHOODS OF THE RIPARIAN COMMUNITY OF SOUTH WEST SEME LOCATION, KISUMU COUNTY, KENYA.*

for the period ending:
14th November,2014

.....
Applicant's
Signature

Permit No : NACOSTI/P/14/4188/2662
Date Of Issue : 4th September,2014
Fee Recieved :Ksh 1,000

.....
Secretary
National Commission for Science,
Technology & Innovation