EFFECT OF HUMAN ACTIVITIES ON THE ECOSYSTEM OF AREAS SURROUNDING LAKE ELEMENTAITA, NAIVASHA SUB COUNTY, KENYA

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EGERTON UNIVERSITY

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DECLARATION AND RECOMMENDATION

This Thesis is my original work and to the best of my knowledge it has not been presented for a degree or diploma in any other university.

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DEDICATION

This work is dedicated to my wife Pauline and children Joe, Rose and Lynette.

ACKNOWLEDGEMENT

ABSTRACT

The environmental degradation of areas surrounding Lake Elementaita arise from the livelihood activities of the residents. Uncontrolled extraction of resources such as trees, grass and soda/salt contrasts with conservation. This is further compounded by the free access to the resources as a result of absentee landlords. This situation leads to lack of control and management of resources thus exacerbating degradation activities around the Lake and its riparian ecosystem. This study focused on the potential role of local communities in addressing ecological problems around Lake Elementaita ecosystem. The objective of the study was to identify human activities that cause environmental degradation around Lake Elementaita. The study was carried out around Lake Elementaita riparian zone and data collection was through the administration of a structured questionnaire among 183 households that were randomly selected. The data was analysed using Statistical Package for Social Sciences (SPSS).Descriptive statistics was used to determine the mean and standard deviations,' inferential statistics was used to determine the relationship among variables and between dependent and independent variables A focus group discussion was conducted and it included a one day seminar organized for different stakeholders, local community leaders, large scale ranchers, conservation groups, community based organizations and Kenya Wildlife Services to share the research findings. The results from the research confirm that rapid population growth, overstocking, poor farming practices coupled with low understanding by the community of the interrelatedness between societal needs, economic drivers and the environment is leading to negative impacts like increased soil erosion, pollution, loss of habitats and biodiversity around Lake Elementaita riparian zone. This will lead to serious environmental degradation that inevitably exacerbates poverty among the community around Lake Elementaita. There is an urgent need for the government together with all stakeholders to come up with a comprehensive participatory management wetland policy .There will also be need to strengthen and coordinate agencies or government departments whose mandate includes wetlands management. There is also need to carry out education for sustainable development awareness and implement alternative livelihoods programmes such as beekeeping, ecotourism and organic farming in areas where we have wetlands.

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DPP	District Development Plan
FNLE	Friends of Lakes Nakuru and Elementaita
GEMA	Gikuyu Embu Meru Association
GoK	Government of Kenya
IBA	Important Bird Area
KWF	Kenya Wetlands Forum
KWS	Kenya Wildlife Service
LNDP	Lake Nakuru Development Programme
MENR	Ministry of Environment and Natural Resources
NDDP	Nakuru District Development Plan
NGO	Non Governmental Organization
NWP	Naivasha Wetlands Program
PRSP	Poverty Reduction Strategy Paper
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNRISD	United National Research Institute and Strategic Development
WCK	Wildlife Clubs of Kenya
WWF	World Wide Fund for Nature
WCMC	World Conservation Monitoring Centre

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Societies all over the world are closely linked to the natural environment in which they are embedded. Human productive and social activities are shaped to a significant degree by the natural resource mix available: physical geography, weather patterns, amenability of natural conditions to transformation, and by a variety of other characteristics of the environment like soil type, prevailing temperatures, air quality and water quality and quantity. Environmental degradation, including depletion of renewable and non-renewable resources, air and water pollution and solid wastes, can be significant sources of stress upon societies. It may induce changes in settlement patterns and disrupt established social relations (UNRISD, 1994). Awareness and concern about environmental degradation have grown around the world over the last few decades. The concerns are shared by people of different nations, cultures, religion and social classes.

Environmental degradation is a process induced by human behavior and activities that damage the natural environment (Anon, 2007). High human population growth rates and economic development have led to degradation of wetlands, forests, habitats and air quality (Mennonite, 1999). High poverty levels amongst most developing countries have accelerated the rate of natural resources destruction, since the poor depend on natural resources directly for their livelihood (IUCN, 1999).

Degradation of wetlands affects both developing and developed countries. Since 1990, half of the world's wetlands have disappeared. For example, in the United States, an estimated 54% of its original wetlands no longer exist (UNEP, 1990). There is evidence that a similar pattern of wetland degradation is taking place in developing countries. Degradation of wetlands has been aggravated by the insatiable demand to meet the needs of an ever-increasing human population. Environmental degradation within the wetland ecosystems shows a diminishing natural resource base whose effect and impact is measured by the ever-increasing levels of poverty of the catchment and riparian communities (UNEP, 1992). However, the decline of wetlands globally and an appreciation of their ecological and

economic functions and values has recently generated concern from international and regional communities (Pyrovertsi and Dautopoulos, 1999).

In Kenya, the Ministry of Environment and Natural Resources (MENR) estimates that wetland ecosystems (freshwater and saline) cover only 2-3% of the country's surface area and are found mostly within the Great Rift Valley they include: Lake Nakuru, Lake Elementaita, Lake Baringo, Lake Naivasha, Lake Bogoria and Lake Magadi (NWP, 2001). Destructive and exploitative human activities are evident in the surrounding areas. These unsustainable human activities are visible in Mau escarpment, Bahati and Ndondori forests, which are the main catchment areas for Lake Nakuru, Lake Bogoria and Lake Elementaita respectively. Research on the relationships between farmers activities and wetlands is nearly nonexistent in Kenya and rather limited internationally (Wilson, G.A.1996).Similarly, quantitative analysis of the effects and impacts of agriculture on wetlands is limited (Beopoulous,N.1996) due to insufficient environmental monitoring.

Increased awareness about the adverse environmental and socio-economic consequences of the unwise exploitation of wetlands has resulted in worldwide calls for the sustainable management of fragile resources. However the unsustainable use of wetland resources has increasingly proven to be an extremely difficult and frustrating task in many developing countries. A substantial amount of literature that has appeared on this issue tends to carry the undertone that poverty is one of the major factors that make it difficult to achieve the sustainable use of wetlands. Some writers note that modern approaches to natural resource conservation are simply conflicting with the survival strategies of the poor in developing world that are dependent on wetland resources.(Mironga,J.M.2003).There has been a growth of interest in wetlands and accompanying change of attitude (William,M.1991),In some countries the rates of wetland degradation is slowing down while at international level, the protection of wetlands is clearly reflected in the Ramsar convention (Hollis et al,1994).This convention plays an important role in facilitating the protection of wetlands of international significance and Lake Elementaita is one of them.

Increased uses of chemicals like fertilizers and pesticides in agricultural activities in the catchment area are impacting negatively on the wetland ecosystems. Kenya Wildlife Service (KWS), World Wide Fund for Nature (WWF) from independent researches carried out at different time spans on lesser flamingoes in Lakes Elementaita and Nakuru established

that the Lakes were threatened by sedimentation, livestock wastes and toxic wastes (KWS ,2002   WWF 2006).Human activities like agriculture have both primary and secondary environmental effects.   Primary effects arise where agricultural activities take place, for example soil erosion.   Secondary effects are those effects on the environment away from agricultural sites, for example the use of pesticides or fertilizers in the watersheds.   These are washed off the land through erosion and end up in rivers, streams, lakes and oceans causing ecosystems to be highly eutrophicated thus destroying food chains and aquatic life.

Reports by various authors' document that environmental degradation can be worsened in situations where ownership of natural resources is undefined.   For example, Bromley, (1989) states that ownership of natural resources such as freehold or free access leads to unsustainable exploitation of natural resources and hence degradation.   More often, free access is a result of ineffective resource rights regime which claim rights over a resource but lack the means to fulfill the responsibilities involved.   The vacuum in control and management leads to uncontrolled exploitation, which is highly threatening to sustainability (Berkes, 1989).   This situation in Kenya's Rift Valley lakes that is home to flamingos is posing a serious threat to this rare birds survival since they frequent these lakes in large numbers either to breed or feed.   The lakes are also important stopovers for other migratory birds like *Spoon Billed Sand Piper, Great White Pelican and the Eurasian Marsh Harrier*. (WWF – Lake Bogoria, 2002).

In industrialized countries, the consequences of loss and degradation of wetlands have often been mitigated with expensive artificial constructions, such as major flood protection schemes or water purification plants which is not the case in developing countries because mitigation measures may take too long to be implemented mostly due to financial and technical constraints (Kotze et al, 1995).   It is from this background that this study was conducted to investigate the impact of human activities around Lake Elementaita ecosystem and look for feasible solutions for sustainable management of its riparian area as well as to seek possible livelihood alternatives for the adjacent community.   The findings could provide long term reprieve for the other Rift Valley lakes facing similar challenges.

1.2 Statement of the Problem

The area surrounding Lake Elementaita is partly private land, with a large part surrounded by small parcels of land that have been settled but some owners are not resident thus exposing their land to free access. The area surrounding Lake Elementaita is rich in biodiversity and is a habitat for numerous species of waterbirds some of which like the lesser flamingoes are threatened due to habitats being compromised. Anthropogenic activities such as catchment degradation, deforestation, charcoal burning, settlement, siltation, overgrazing, introduction of alien species, pollution and water abstraction are threatening the Lakes ecosystem, values, functions, and ecological integrity. The increasing human population in the area, the current land use practices in this water deficit area only compounds the fragile ecosystem. There is therefore need to establish the effect of diverse human activities being carried out on the ecosystem of areas surrounding Lake Elementaita so that informed decisions can be made so as to mitigate against its degradation.

1.3 Objectives

1.3.1 Broad Objective

To determine the effect of human activities on the ecosystem of areas surrounding Lake Elementaita in Naivasha Sub-County.

1.3.2 Specific Objectives

1. To identify major human activities around the Lake Elementaita riparian zone
2. To identify the resources that are exploited by communities within lower and upper viewpoint of Lake Elementaita
3. To identify and characterize the sources of pollution around Lake Elementaita riparian zone
4. To determine the local communities' perception on the conservation issues within their ecosystem

1.3.3 Research Questions

1. What are the major human activities practiced in the Lake Elementaita riparian zone?

2. Which resources are exploited by communities within the lower and upper viewpoints of Lake Elementaita?

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3. What are the major sources of pollution affecting the riparian zone of Lake Elementaita?

4. What is the local community perception towards conservation issues?

1.4 Justification

Over the years there has been diminishing vegetation cover, through deforestation and overgrazing in areas surrounding Lake Elementaita. While most deforestation is done by cutting of trees for fuel wood and charcoal production, overgrazing is done by migratory livestock (KWS, 2000). There is uncontrolled charcoal burning, soda/salt mining around the shores of the lake and overgrazing in the surrounding rangelands leading to diminishing vegetation and soil erosion.

The problem is compounded by the fact that the area lies in a semi-arid area where rainfall is low and also unreliable. This has led to situations where the lake has almost dried up completely, a manifestation of catchment destruction and water abstraction from rivers leading to reduced flow of water reaching Lake Elementaita. The depth of the lake fluctuates between 0.7-1.0metres (KWS, 2010).This only confirms the need to reduce activities that may lead to the death of this ecosystem. As a result of frequent dry spells and poor crop yields from their land the surrounding communities eke their living through exploitation of the natural resources within their ecosystem. These activities enhance environmental degradation. A review of secondary information about Lake Elementaita shows that little information exists about the potential of Lake Elementaita and no research has been done to ascertain the effects of human activities on the ecosystem of areas surrounding the Lake.

Lake Elementaita was designated as the 5th Ramsar site in Kenya in 2005 when it was enlisted as a wetland of international importance due to its role as a refuge for threatened, vulnerable and endangered bird species. The environs surrounding the Lake are rich in biodiversity and were designated as one of the Important Bird Areas in Kenya in 1999. Lake Elementaita and its surrounding riparian lands was also proclaimed as a National Wildlife Sanctuary in 2010.In 2011,Lake Elementaita,Lake Nakuru and Lake Bogoria were all inscribed by UNESCO as part of Kenya Lakes System in the Great Rift Valley Heritage Site. The international status bestowed on this ecosystem makes it imperative to protect and conserve it for posterity. The research was purposed at integrating the local people's needs,

their valued resource base within the ecosystem and perceptions about the future of the riparian area. The results from the study will provide .essential information to policy makers, implementing agencies, researchers, communities and other interested stakeholders to understand the need for community participation in identification, analysis, mitigation of environmental degradation around Lake Elementaita ecosystem.The results from the research will be useful in finding long term integrated approach to the conservation of natural resources around Lake Elementaita and other parts of the country facing similar challenges. From the aforementioned, areas surrounding Lake Elementaita formed an ideal study site to do research on effects of human activities.

1.5 Scope and Limitations

The research was carried out around the riparian zone of Lake Elementaita but confined to not more than 3km from the lake shore areas under settlement :to the North east, North West and South East. The main limitation to the research was the inability to establish the effect of the pastoralists grazing in the area and the effect of other activities being carried out beyond the 3km from the Lake shore.

1.6 Assumptions

The main assumptions were that the weather conditions prevailing during the research would not change drastically, the population of the area will remain fairly constant and their would be no sub division of land or new settlements in the area

1.7 Definition of Terms

Community: This is a sociological group of people with their animals, plant organisms sharing an environment

Lake: a lake is a hollow depression or a basin on the earth surface where water has accumulated or collected. Lakes vary in size, depth and performance

Degradation: This is the deterioration of any of the environmental resources such as water, air, soil, and biological resources

Independent Variables: These are controlled or selected by the researcher to determine their relationship to an observed phenomenon. In this study, the independent variables are the socio-economic activities carried out by the community around Lake Elementaita.

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Dependent Variables: The dependent variable usually cannot be directly controlled. According to the study, the dependent variable is degradation of the Lake Elementaita, which will solely depend on the socio-economic activities of the households living around the lake.

Intervening Variables: These were assumed to be manifestations of the on-going degradation around the lake. These included soil erosion, depletion of the environmental resources around the lake that lead to loss of biodiversity and threat to livelihoods.

Socio-economic activities: These are activities carried out by people for the purpose of earning a living. Around Lake Elementaita, the activities include charcoal burning, salt harvesting, agriculture and livestock rearing.

Status: This is the environmental position or situation in terms of conservation and degradation of an ecosystem, in this case, the areas surrounding Lake Elementaita.

Absentee Land Owners: These are people who own land around lake Elementaita but they are not physically present thus enabling free accessibility to their parcels of land and resources around the lake.

1.8 Operationalization of Variables

Human activities: These are activities done by individual community members to meet their daily needs and will be achieved by response to the question "what are your main sources of income?"

Soil erosion: This was verified by the observable degradation and perceptions of land degradation, the level of bareness of the land by both the respondent and the interviewer. It will be achieved by the response to the question 'how do you rate the level of soil erosion in both the respondent's home and surrounding?'. Also, the interviewer will have a checklist of observable topographical characteristics within the Lake and its environs.

Depletion of resources: This was the deteriorating state of the natural resources both in quality and quantity. This was achieved by the response to the question 'are the natural resources increasing within the lake? And 'Is the quality of the resources within the lake increasing?'

Threatened household livelihoods: This was verified by the economic status of the households in terms of their socio-economic activities within the Lake. It was achieved by the response to the question 'How much income do you get from the agricultural produce? How much income do you get from the resources harvested from the lakes environ? How do you rate your household well being since you settled in the environ?

Loss of biodiversity: This was the diminishing state and numbers of the biodiversity within the ecosystem and its environs. It was achieved by response to the question, has the number of flamingoes and other wildlife been increasing? Rate the status of the environment for biodiversity within the Lake?

Degradation of the lake: This was the degraded Lake's environ and it was achieved by the response to the question 'has the size of the lake diminished? Is the lake water polluted? Has vegetation cover within the lake diminished? Has the bird population diminished?

Community participation: This was the direct involvement of the community in identifying environmental issues within the lake and its environs, stating how the issues could be addressed and commitment to implement the research findings. This was gauged by the response to questions 'What mitigation measures do you propose to be implemented at the household level to conserve the lake? 'Would you and your household be willing to participate in the conservation of Lake Elementaita ecosystem?'

CHAPTER TWO

LITERATURE REVIEW

2.1 Wetland ecosystems

The Ramsar convention on wetlands of international importance defines wetlands as "areas of marsh, fern, peat land or water, whether natural or artificial, permanent or temporary, that is static, flowing, fresh, brackish or salty including areas of marine whose depth at low tide does not exceed six meters" (Ramsar, 2003). Wetland ecosystems were the first to receive international attention through the "Convention on Wetlands of International Importance" especially as habitats for waterfowls opened for signature at Ramsar, Iran in February 1971. According to Williams (1990), Barbier and Edward (1994), since 1990 over half of the world's wetlands have disappeared. Although wetlands had earlier been considered to be wastelands and therefore worthless, today their value in sustaining ecological integrity is appreciated. Their hydrological-physical, chemical, biological and socio-economic benefits are acknowledged. For example, according to Doust & Doust (1995), wetlands have been described as nature's kidneys. They also describe wetlands as nature's womb (nursery for organisms) and liver (detoxification centre for pollutants and excess nutrients). It is estimated that as many as 45% of the endangered animals and 26% of plants either live in wetlands or depend on them for their continued existence (Botkin & Keller, 1995). Many ecologically and economically important species call wetlands home for at least part of their lives. For instance, commercially important fishes and shellfish, including shrimp, bluecrab, oysters, salmon, trout and seastrout rely on or are associated with wetlands. Wetlands are also critical habitats for migratory birds and waterfowl, including ducks, egrets and geese. In fact more than one-third of the species listed as threatened or endangered in the United states live solely in wetlands and nearly half use wetlands at some point in their lives (USEPA, 1995).As such many wetlands are often recognized as important conservation or restoration targets

Wetlands also act as carbon sinks; provide protection to coast fronted by salt marshes and mangrove (Berry, 1994). They are also important in removal of non-point sources of pollution as they are capable of removing up to 90% of sediments and nitrates and up to 50% of phosphates entering wetlands (Gilliam, 1994).While covering only 6% of the Earth's

surface, wetlands provide a disproportionately high number of ecosystem services, in addition to maintaining biodiversity. For instance wetlands also mitigate floods, protect coastal areas from storms, improve water quality, recharge underground aquifers, serve as sinks, sources or transformers of materials and produce food and goods for human use. When evaluating economic value of these various functions, Constanza *et al.*(1997) concluded that the economic value provided by wetlands ecosystems exceeded that provided by lakes,streams,forests and grasslands and was second only to that provided by coastal estuaries. Wetlands therefore, constitute some of the most important biological and ecological ecosystems on the face of the earth.

2.2 Wetlands of Kenya

Kenya ratified RAMSAR convention in 1990. Since then, the country has designated Lakes Nakuru,Bogoria,Elementaita and Naivasha as wetlands of international importance (Ramsar sites) in accordance with the requirements thereof (Kiai and Maillu, 1992). According to the Kenya National Environment Action Plan (NEAP), a substantial proportion of Kenya's water resources are found in wetlands, which cover 2% to 3% of the country's surface area (Government of Kenya, 1994).Wetland ecosystems in Kenya are diverse and important natural resources which include areas of ecological importance and conservation value both nationally and internationally. They are vital components of the hydrological cycle and essential breeding, rearing and feeding habitats for many species of fish, waterfowl and other wildlife. Kenya wetlands are exploited on both seasonal and long term sustained basis through grazing, direct harvesting of plant material and fishing. They provide opportunities for recreation and tourism besides being major sources of water for industrial works, domestic, livestock and agricultural uses (Mavuti, 1989).

Most natural wetlands ecosystems in Kenya and other tropical countries are threatened by hydrological, agricultural and other human activities (Mavuti, 1989). Increasing national and international recognition of the values of wetlands has intensified the need for reliable information on the status and extent of these natural resources. Some of the larger wetlands of Kenya include the shallow Lakes: Nakuru, Naivasha, Magadi, Kanyaboli, Jipe, Chala, Elementaita, Baringo, Ol Bolossat, Amboseli, the edges of Lake Victoria, Lorian, Saiwa, Yala, Shampole swamps; Lotakipi, Kano Plains, Kisii valley bottoms, Tana delta, coastal wetlands including the mangrove swamps, sandy beaches, sea

grasses and coral reefs. The Kenyan wetlands play a fundamental ecological role and have potential as resources of great economic, cultural and scientific value. Among the critical values are:

- Wetlands provide critical habitats for a wide range of flora and fauna. Their biodiversity includes a large number of aquatic plants, fish, herbivores and avifauna of resident and migratory birds;

- Wetlands are important sources of water for human consumption, agriculture and watering of livestock. They recharge wells and springs that are often the only source of water to some rural communities, for livestock watering and for wildlife support systems. The recharging of aquifers, raises the water table making groundwater easily accessible. This has been the case in western Kenya, along the Tana river corridor and in the Chyulu hills catchment area for Mzima springs and the Nol-Turesh water supply system.

- Wetlands provide economic benefits through fisheries and generation of products such as fuelwood, building material, medicine, honey and various types of natural foods;

- Wetlands are important grazing areas. They are the only sources of water and pasture/fodder for the pastoral communities during drought in the ASALs;

- Wetlands serve a wide variety of ecosystem functions including flood control, water purification, shoreline stabilization and sequestration of carbon dioxide;

- Wetlands are areas of great scenic beauty. They are a tourist attraction, form important recreation sites for game and birds watching, swimming, photography and sailing;

- Wetlands have great potential for multiple uses (including agricultural) so long as precautionary measures are taken for sustainable development.(GOK,1994)

By 1990, when Kenya ratified the Ramsar convention, most of the country's wetlands had been degraded. Drainage, land reclamation, overgrazing, eutrophication of inland waters caused by agricultural pollution are among the impacts of agriculture on Kenya's wetlands.

2.3 Lake Elementaita Ecosystem

Lake Elementaita ecosystem provides habitat for both endangered birds like the lesser and greater flamingo. These species are threatened because of their habitat specificity . The world famed flamingoes have made the Lake their alternate "home" especially after the 1994 severe drought that caused Lake Nakuru to dry up. Other birds like the Black Heron, Little Bittern, White Backed Duck, Maccao Duck, African Marsh Harrier, Allen's Gallinule, Black tailed Godwit and , migratory species like Eurasian Marsh Harrier, Spoon Billed Sand Piper and various species of Avocets are also found in the locality. The lake is also a breeding site for a number of bird species among them the white backed pelicans, Red-knobbed Coot the African Jacana, the Blacksmith Plover and the African Snipe (KWS & NWP, 2000).

The riparian land around Lake Elementaita functions as an important grazing area for local people and migrant pastoralists from as far as Narok County. The pastoralists have annual cycles of transhumance (Aboud, 1992), where they move with their livestock in search of pastures. The free access to Lake Elementaita riparian land makes it an ideal fall back for dry season grazing for migrant pastoralists. Lake Elementaita and other lakes like Nakuru, Bogoria, Magadi and Shampole wetland attract both local and foreign tourists, being alkaline in nature they form important habitats ecosystems for the world famed birds; the flamingoes. Lake Elementaita's uniqueness lies in the fact that it is very shallow and the presence of the extensive stand of pristine acacia woodland at its northern end; a habitat for different woodland birds (Mwaura and Ogendo, 1993). The intricate relationship between these alkaline lakes offers perfect balance of food availability in times of drastic weather fluctuations that is common in rift valley lakes (Harper et al, 2003). These alkaline lake ecosystems are valued for their aesthetics, recreational areas, nature reserves or national parks (Williams, 1990). However, these benefits are threatened by unsustainable anthropogenic activities within the riparian land and the catchments. Moreover, due to its outstanding scenic beauty, coupled with the spectacle of mass bird movements and the unique ecology of its harsh saline lake ecosystems, Lake Elementaita was recommended for inscription on the world heritage list. This lends credence for this study to develop a feasible programme suited for its conservation.

2.4 Causes of Wetlands Degradation

Wetlands are among the most productive ecosystems due to their functions and attributes despite the fact that they have the potential of contributing significantly to the socio-economic development of Kenya, they face diverse and severe threats. These threats include among others inappropriate human activities within the catchments and in the wetlands, lack of coordinated and holistic policy guidelines and climate change (KWF, 2010).The threats have induced changes that have eroded the ecological and socio-economic values and services derived from wetlands. The underlying threat remains lack of recognition of the importance of these wetlands.

Environmental degradation entails deterioration of any of the environmental resources, water, air, soil and biological resources. Agriculture is the biggest land use in terms of area globally and also the most significant in terms of impacts (Mathus, 1986). For example, intensive agricultural activities in the catchment areas such as the Mau complex, Mt.Kenya, Cherangani Hills, Aberdares ranges and Mt Elgon have increased since the early 1990"s.when uncontrolled human encroachment and settlement took place. These activities have led to increased use of chemicals such as fertilizers and pesticides. Through surface run off, these chemicals are washed to the wetlands thus affecting biodiversity and impacting negatively on Lake Ecosystem. For instance, in the period 1994-1995, it was found that there were massive flamingo deaths caused by heavy metals and toxins in Lake Nakuru. These metals and other toxic substances were from Nakuru town resulting in the overgrowth of cyanobacteria species and toxic blue-green algae species in the lake (L.N.D.P-WWF, 1995). On the other hand Raini, (1995).shows that soil erosion is the major cause of degradation from agricultural lands causing siltation of dams, rivers and lakes. In the early 1980s the recorded depth of Lake Baringo was 8.9m, Lake Nakuru was 4.5m and Elementaita was 2.0m, while today are usually less that 2m for Lake Baringo, less than 2.0m for Lake Nakuru and less than 1.0m for Lake Elementaita.(WWF,1995).

Moreover, between 1970-1986, more than 400 sq.km of forest and areas under natural vegetation within Lake Nakuru catchment were estimated to have been cleared for cultivation and settlement. Large farm holdings purchased from European owners were fragmented into smaller individually owned parcels of land. (Nakuru District Environment Report,1987). In the catchment, rural population densities were lower, but have continued to raise from 164

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sq.km in 1979 to more than 375 persons per square km in 1999 .The population increase inevitably leads to more land being cleared for settlement and agricultural activities thus exacerbating soil erosion. The depletion of natural ground cover is also thought to have altered the hydrological regime of the catchment thus leading to more repository of sediment and nutrient loads carried by feed rivers.(Kimani et al, 1992).

Lake Naivasha which is the only freshwater lake in the rift valley is threatened by the land use transformation in the watershed. The population of the areas surrounding the lake has rapidly grown from 43,867 in 1969 to the current figure of about 250,000.Since independence in 1963, the area around the lake has witnessed rapid land use transformation from commercial ranching to a mixture of rapidly growing smallholder agriculture activities around the riparian area..The poor farming activities result in surface run off that is loaded with a lot of nutrients that cause eutrophication of Lake Naivasha as evidenced by the lash growth of hyacinth .This is posing a negative impact on the sustainability of the lake (Mireri,2005).

Lake Elementaita is located in a water deficit area and this is due to the semi arid conditions that characterize the area. The erratic and unreliable rainfall creates a very fragile ecosystem around the riparian zone. The human encroachment and resultant deforestation of the catchment areas such as Mau, Nyandarua, Ndondori and Bahati forests has compounded the already delicate situation by reducing the volume of water flowing into the lake (KWWG, 2000). This has led to the water level going down. For example, the lake declined from 40 sq.km in 1995 to 36.5 km square in 2000 (WWF, 2002).

Livestock keeping is one of the agricultural activities that contribute significantly to the economy and livelihood of the people in semi arid areas. However, livestock keeping are among the main causes of land degradation in areas of rainfall deficit especially around wetlands. The situation is compounded during the dry seasons when wetlands traditionally become fallback areas for livestock and wild herbivores. For example, Fisher et al, (2005) while carrying water quality and solute concentration in the rivers that drain into Lake Naivasha found out that the levels of nitrate-nitrogen concentration in a river correlate highly to the stocking density in a given catchment. Even the amount of coliforms present in water has been found to relate to livestock activities in a given watershed (Fisher et al, 2005). According to Kenya Wildlife Service and Naivasha Wetland Programme, livestock grazing in

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the wetland destroys nests for ground nesting birds. Livestock also accelerates the process of soil erosion through trampling and removal of vegetation cover especially where the land's carrying capacity has been exceeded, leading to overgrazing.

2.5 Community Participation in Natural Resources Conservation

Since the early 1990s there has been a significant paradigm shift in conservation and natural resource management away from state centred control towards approaches in which local people play a much more active role - often referred to as devolved, or community based natural resource management. This shift in thinking has been brought about by increasing recognition that centralized decision making, control and enforcement of natural resource management through government agencies, have often proven ineffective and brought about resource degradation rather than sustainable use (Wyckoff-Baird, 1997). The main assumption underpinning participatory natural resource management is that greater participation in decision-making is a positive good in itself, and has multiple benefits. Such decentralized arrangements allow more community participation, leading to better representation and empowerment. Participation and decentralization have been shown to promote equity and social development through greater retention and sharing of the benefits derived from natural resources at the local level (Ribot, 1999). A further assumption is that if resources are managed at the local level by communities, they will be looked after better, and more efficiently, resulting in improved opportunities for sustainable livelihoods (SLSA, 2003). This increases the likelihood of positive outcomes for the natural environment - the argument that people are less likely to degrade their resource base if they feel a sense of ownership in decision making and see positive returns from the careful use of available natural capital.

The need to ensure sustainable human activities and improved community livelihood is a national goal in Kenya (PRSP, 2004). However, most development projects have not improved the living standards of the target groups. This has been attributed to the fact that most of the projects were top-down with no input from would be beneficiaries. This scenario led to failure of the projects since people felt completely alienated (Mathus, 1986). The involvement of the community in decision-making process on the use and management of natural resources leads to a change of attitude (Martin, 1986).

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A good example is the Communal Areas Management Program for Indigenous Resources (CAMPFIRE) project that was started in Zimbabwe in the 1980s. This project is credited for transforming community attitudes towards wildlife conservation on communal lands. Previously, wildlife was under the exclusive protection of the government and the legalized hunting a preserve of the few rich. This brought about intense human wildlife conflict and increased poaching activities. The local community who lived with this wildlife felt ignored and saw no economic benefit of the wildlife resource. The CAMPFIRE project was started to give full control of wildlife management to rural communities by creating appropriate institutions under which natural resources would be utilized in a sustainable manner. The nature based enterprises set up by the communities brought about benefits which were shared to individual households. This changed the community attitudes and they became good wildlife managers and cases of human-wildlife-government conflict reduced drastically. The success was because the community were involved in decision making process (Jansen,1980) .

Arabuko Sokoke Kipepeo Project (ASKP) is a successful initiative of community participation in the management and use of Arabuko's natural forest. The forest is of international importance because of the endemic and endangered bird species (Ashley, 1998). The forest was faced with threats arising from illegal invasion of squatters, unsustainable resource harvesting and pressure for degazettement to give room for agricultural activities and human settlement. The change of attitude arose through training community members on how to rear pupae within the forest for export. The once "unfriendly" community became ardent crusaders for the conservation of Arabuko Sokoke forest since they were getting financial benefits from the Kipepeo project. The experience from Kipepeo project demonstrates that communities are not averse to conservation (Lelo, 1994). Failure to consider community interests in conservation can lead to more degradation as people struggle to meet their livelihood needs.

2.6 Conceptual Framework

The conceptual framework (Figure 1) demonstrates the relationship of the study variables. Human activities form the independent variable that results in the intervening variables such as soil erosion, depletion of environmental resources such as water, forest products; threatened livelihoods due to degrading and declining resources (land), loss of

biodiversity among other loses. The intervening variables are the manifestations of Lake Elementaita"s degradation; which is the dependent variable of the study. The ecosystem degradation is also the resultant effect of all the aforementioned activities on the environment.

The present situation is such that there is free access to Lake Elementaita ecosystem and this has created a situation where exploitative human activities like salt/sand mining, charcoal burning and overgrazing are carried out with little regard to the integrity of Lake Elementaita. The study aims to develop feasible programme that would be adopted by the households within the ecosystem in order to conserve the lake. Once the programmes are adopted, it is anticipated to mitigate most of the degradation that is within the area.
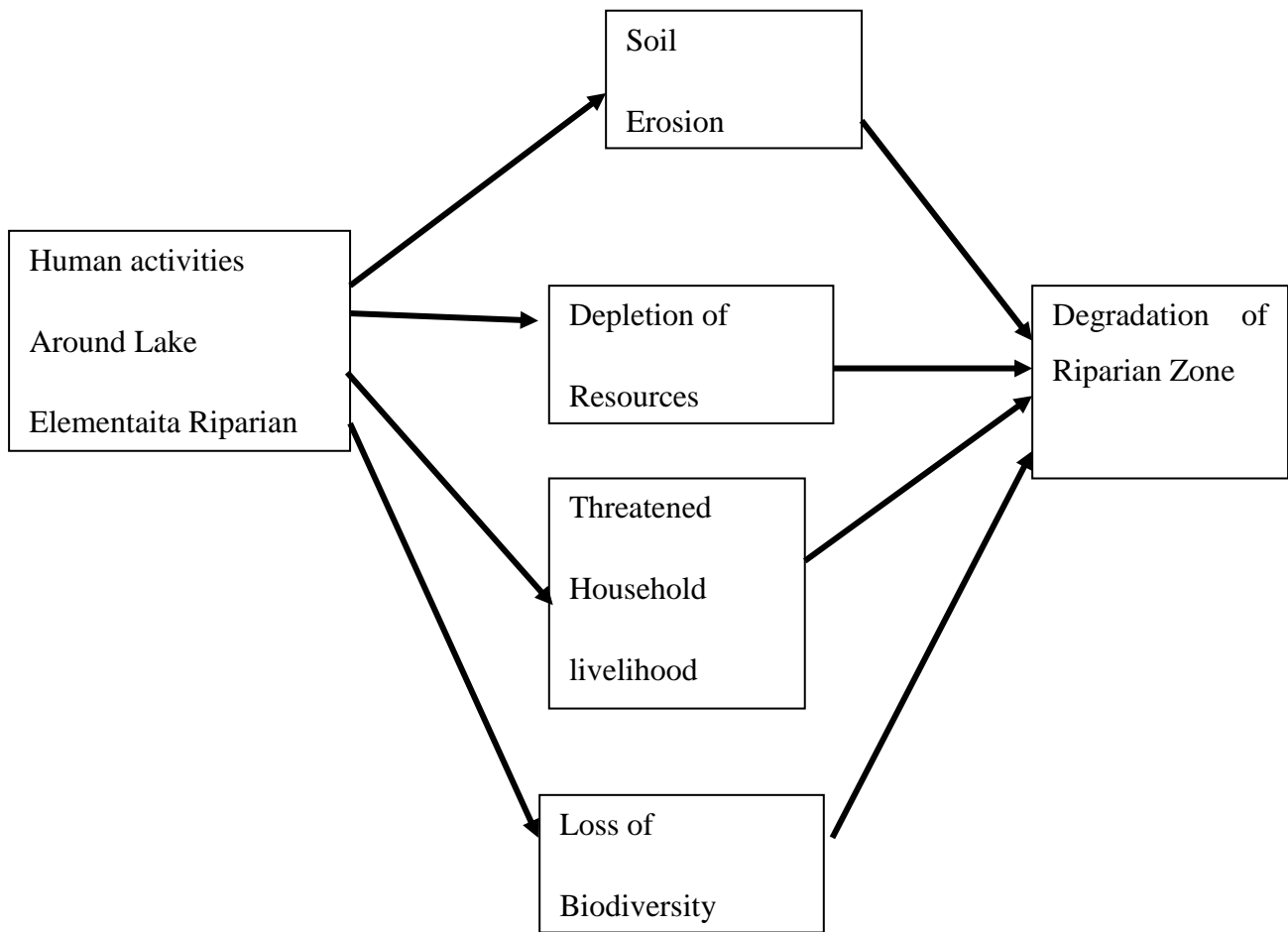
Figure 1: Conceptual framework

CHAPTER THREE

METHODOLOGY

3.1 Description of the Study Area

Lake Elementaita is situated in Gilgil location, Naivasha District (Figure 2) and is 0^0 27"S and 36^0 15E. in Naivasha District was curved from the greater Nakuru District in 2007. It lies on the Eastern floor of the Great Rift Valley within the Rift Valley province of Kenya. Geographically, it is surrounded by Nyandarua hills to the North East and Eburru hills to the south. The Nakuru – Nairobi highway dissects the division. The Lake (Figure 3) is 1772 meters above sea level and is served by rivers Meroroni, Mbaruk and Kariandusi. The Lake has a maximum depth of one metre and occupies an area of 36.5 sq. km (NDDP, 2002). The study covered the area from the lake shore and its environs as shown on figure 3. A distance of about 3km on the northeastern side, the acacia woodlands and the settlement bordering Soysambu farm.

3.1.1 Climate

Lake Elementaita is located in ecological zone IV, which is classified as semi-arid, characterized by low and erratic rainfall. Climatic conditions around Lake Elementaita are strongly influenced by altitude and physical features. The maximum temperatures are about 30ºC, December to January being the hottest months. The area receives an annual rainfall of less than 750 mm per annum with evaporation rate of 46%. The main economic activity is livestock keeping and subsistence farming. Most of the livestock are local indigenous breeds of cattle, sheep and goats. (NDDP, 2002).,that include *Acacia* woodland, dry bush land, lake-side grasslands and swamps (Mwaura and Ogendo, 1993). The woodland vegetation is concentrated around the rivers with the *Acacia xanthophloea* as the dominant species. The dry bushland covers part of the eastern and much of the southern part of the southern part of the lake. The main tree species are *Acacia xanthophloea* and *Euphorbia candelabrum*. Bush species are dominated by *Rhus natalensis* and *Sesbania sesban.*
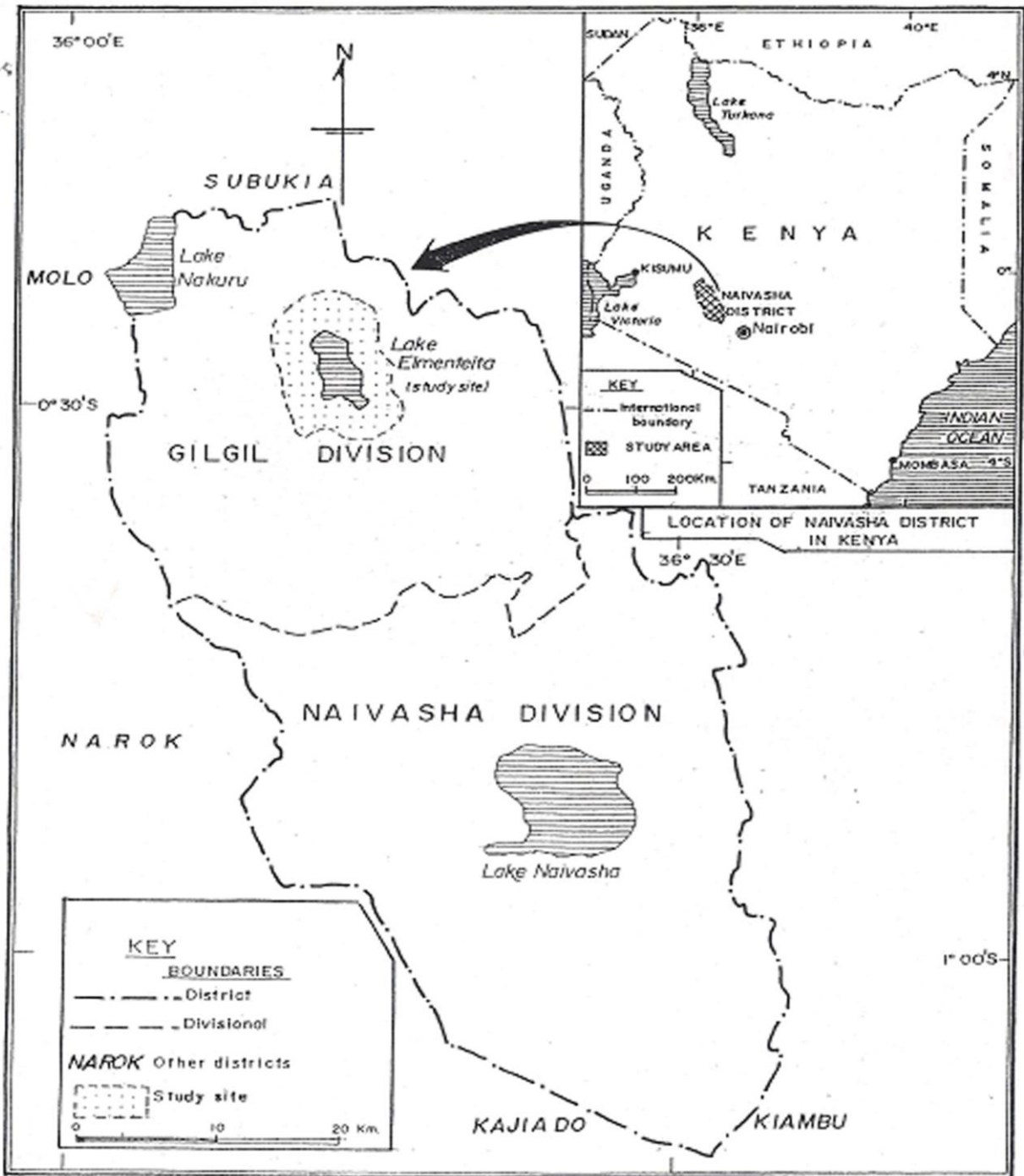
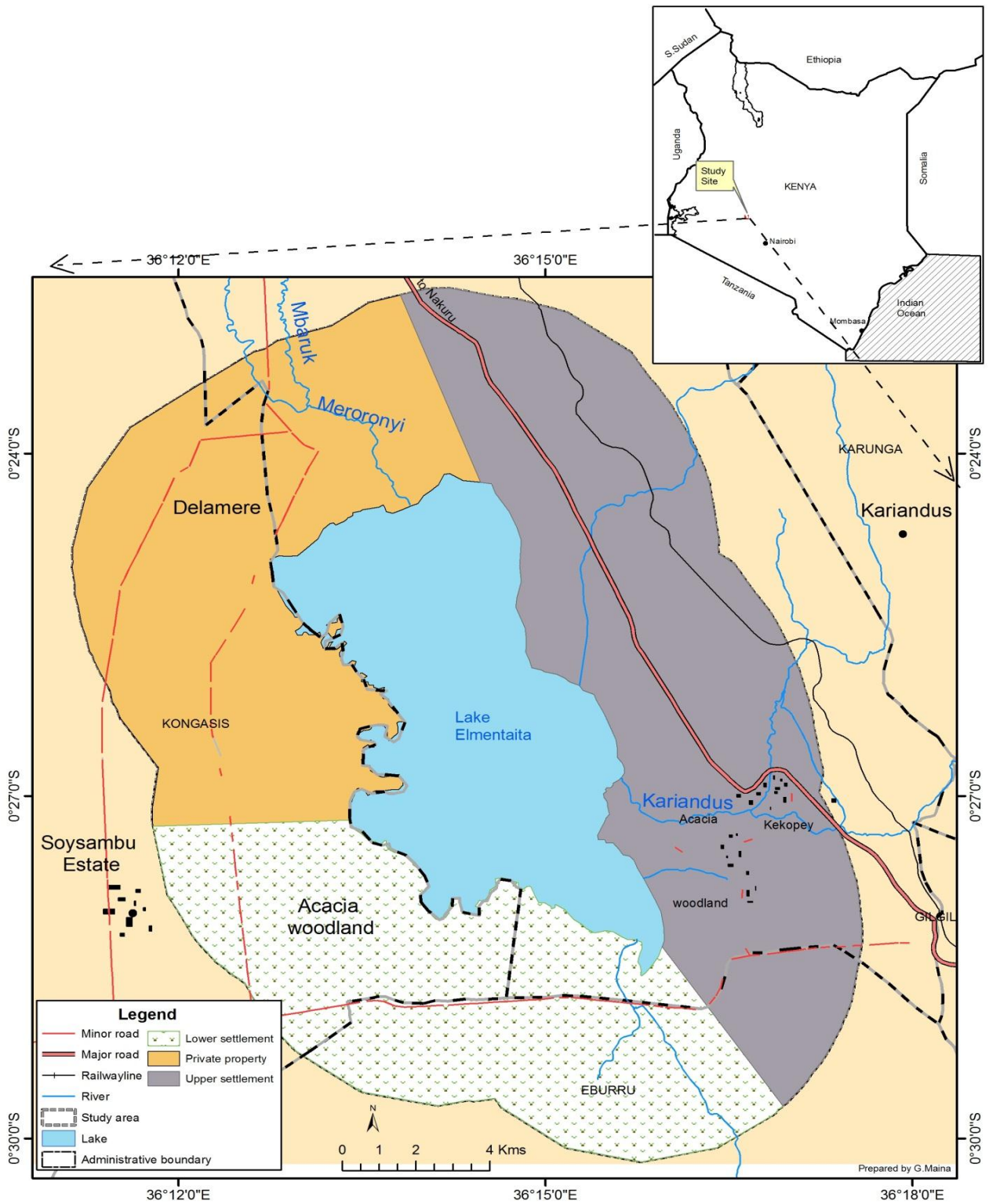**Fig. 2 Map of Naivasha District showing the study site**

Fig 3 Map of Lake Elementaita showing the study site

The area around the lake is surrounded by short salt tolerant grass, *sporobolus spicatus* (Mwaura and Ogendo, 1993). Swamps cover part of the south eastern area of the lake. These comprise mainly of *Typha spp* and *Cyperus papyrus*. The *Cyperus species* is widespread over the northern and other parts of the lake.

3.1.3 Population and Human Settlement

The area around Lake Elementaita was settled in the early 1990's when the land was sub-divided by Gikuyu, Embu and Meru Association (GEMA), a land buying company. When the sub-division was done not all owners settled due to the harsh climatic conditions (FLNE & WWF, 2001, Lelo et al, 1993). The population of Naivasha district was 225,546 in 2009 (CCN,2009) and according to the population census of 1999 it is growing at an average of 4.85% annually. This si a high growth rate that has the potential of impacting negatively on the available natural resources, in view of the semi-arid climate that is prevalent in the district. The district has population density of 98 persons per square Km for Naivasha division and 96 persons per square for Gilgil division respectively (CCN, 2009).

3.2 Research Design

A survey research design was conducted for this study from April to August 2011. Data collection was through the administration of structured questionnaire and researcher's observation.

3.3 Data collection

Data was collected through researcher's observations and administration of questionnaires The researcher made observations and analysed what was happening in the study area guided by an observation checklist (Appendix II).The researcher took a transect walk from Lake Elementaita Lodge to the Lakeshore. This approach is important in comparing the published information with the actual occurrences in the study area. This was used to assess variables like trees planted within the individual plots, extent of deforestation, slope of the land and extent of soil erosion among others. This was necessary in order to corroborate information got from secondary data and from the key informants. The informal discussions with people encountered along the route will enrich and clarify various aspects of resource use. The field notes taken were compiled and documented in a chart format. The

method was important to establish the communities pressing problems and opportunities available to solve the problems.

3.3.1 Questionnaire

A questionnaire consisting of open ended and closed ended questions was administered to household heads. The questionnaire (Appendix 1) was administered to household heads randomly selected within the study area. The questionnaire was to provide socio-economic information about the households related to the lake, degradation trends of the lake and its environs as well as perceptions of the local communities about the lake. This included information on land occupancy, land use, land tenure and socio-economic activities of households among others. The questionnaire was administered after being pre-tested to ensure it elicits reliable, valid and accurate data.

3.4 Sampling Procedure

Stratified random sampling method was applied to obtain a sample of household resident within 3 Km from the shores of the lake to the northeastern side, the acacia woodlands and the settlements bordering Soysambu farm and the area was divided into 3 blocks (see map of study are figure 3) to which the questionnaire was administered to every 2nd household. This is a techniques whereby a group of subjects (a sample) is selected for study from a larger group (a population). Each individual is chosen entirely by chance and each member of the population has an equal chance of being included in the sample. Every possible sample of a given size had the same chance of being selected. The unit of analysis was the household and the subject of analysis was the household head. A total of 350 households around Lake Elementaita and its environ constituted the sampling frame. According to Kathuri and Pals, (1993) the sample size used was based on the following formula:

$$S = \frac{\underline{X^2NP(1-P)}}{d^2(N-1) + X^2P(1-P)}$$

Where:

S   =   required sample size

N   =   sample frame (the given population size)

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P   =   population proportion that for the table construction has assumed to be

                 0.50 as this magnitude yields maximum possible sample size required

d   =   degree of accuracy as reflected by the amount of error that can be tolerated

                 in the fluctuation of a sample Proportion P

X^2 =   chi-square value corresponding to one degree of freedom relative to the

desired level of confidence (95%): 1 degree of freedom. From the sample frame of 500 if the required degree of accuracy is 0.05, a sample proportion of 50% (0.5) and a chi-square value of 3.84 at 95% confidence level, substituting;

Sample size   =   3.841 (350) (0.5) (1 − 0.5)

                         0.052 (350 − 1) + 3.84 (0.5) (1 − 0.5)

           =   336.0875

                         0.8725 + 0.96025

           =   336.0875/1.83275 = 183.378 which adjusted, comes to 183

Therefore, the questionnaire was administered to 183 households.

3.5 Data Analysis

The data was coded and analyzed using Statistical Package for Social Sciences (SPSS) version 17 and MS Excel packages. Descriptive statistics was used which included the use of frequency tables, cross-tabulations and measures of central tendency and dispersion (means, modes, medians, standard deviations, percentages and variances. A chi square test was carried out to determine whether there was any association between the three study locations and the perception about conservation (degradation) of the Lake Elementaita riparian area. Socioeconomic aspects of the households such as sources of their livelihoods and resources within the ecosystem, degradation trends and such resources within the ecosystem, mitigation measures proposed by the community for conservation of ecosystem among others was analyzed using inferential statistics.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Demographic characteristics of the households

The highest (43%) and the lowest (4%) proportions of respondents were drawn from the viewpoint village within the upper-viewpoint study site.
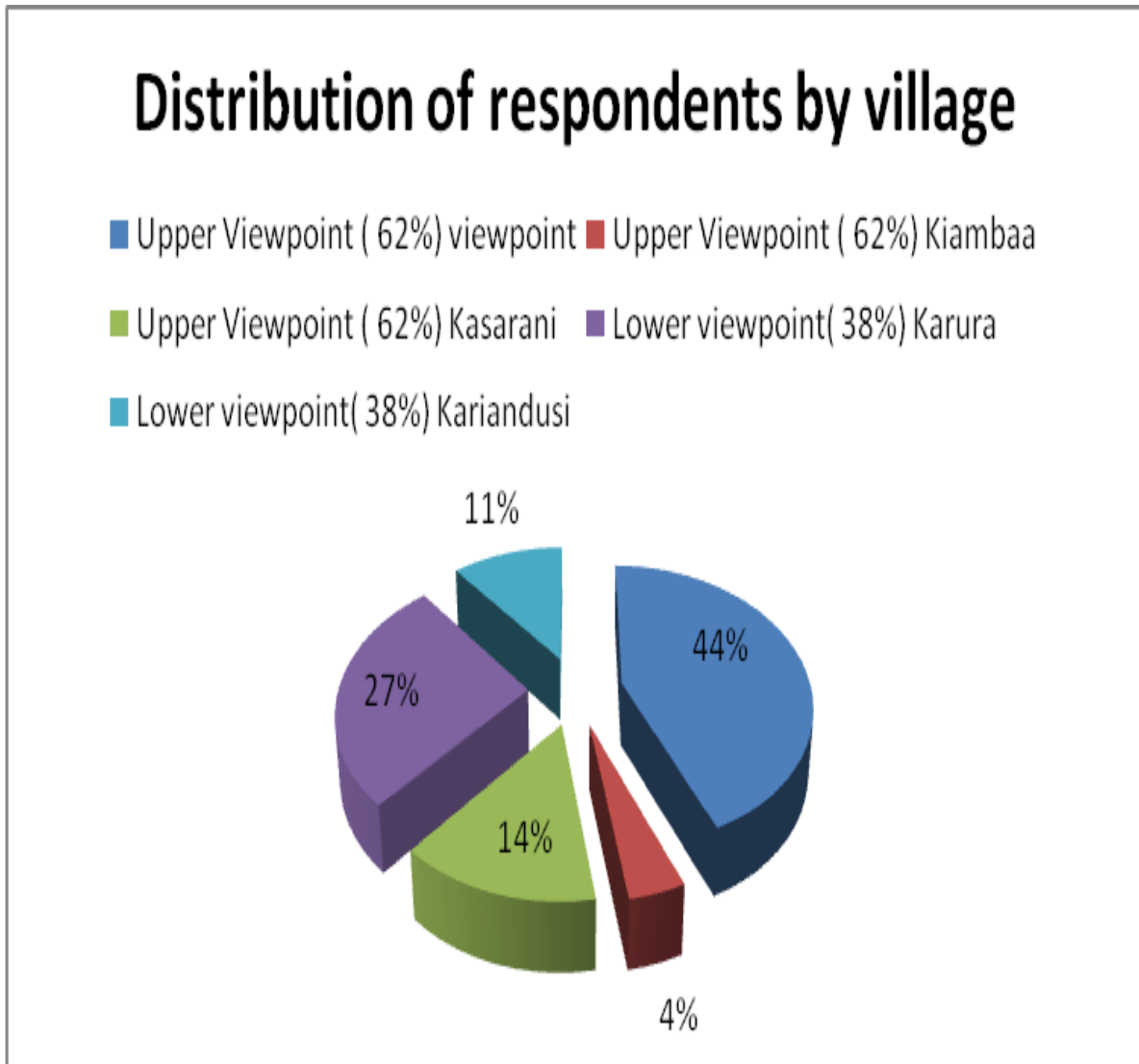
Figure 4: Distribution of respondents by village
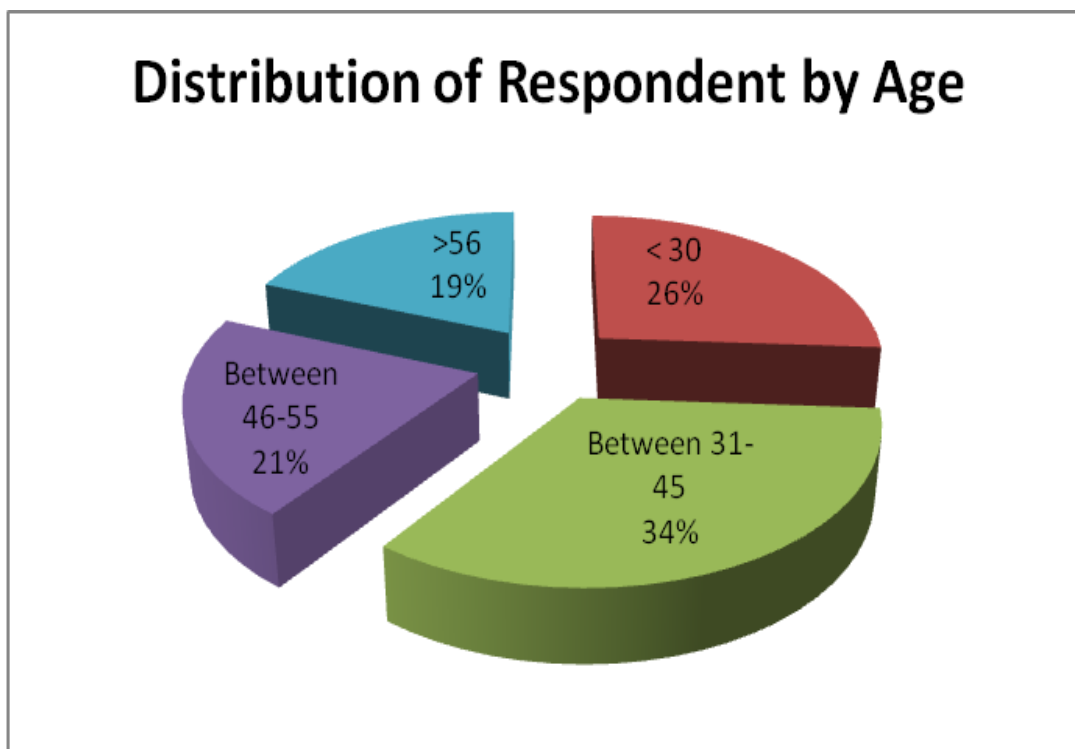
Figure 5: Distribution of respondents by age

Thirty four percent of the respondents were within the age bracket of 31-45years, with those above 56 years old constituting 19.4% (Fig 5).

A majority of respondents were between <30 and <55years.This represents an active and youthful age bracket that is receptive to new ways of engaging in sustainable livelihoods. The high utilisation of resources around the lake without knowledge of interrelatedness of environmental factors of production will impact adversely on the fragile riparian ecosystem and this will ultimately lead to land degradation. It will be important that their energy is harnessed towards getting education on conservation and equipped with the requisite methodologies on Education for Sustainable Development (ESD).

This would enable every community member around Lake Elementaita to acquire the knowledge, skills, attitudes and values necessary to shape a sustainable future and understand the interrelatedness between economic development, societal dynamics and environmental integrity (The UNESCO, 2009).

Gender-wise, 55% of the respondents were male while 45% were female (Fig 6).

Gender distribution of respondents
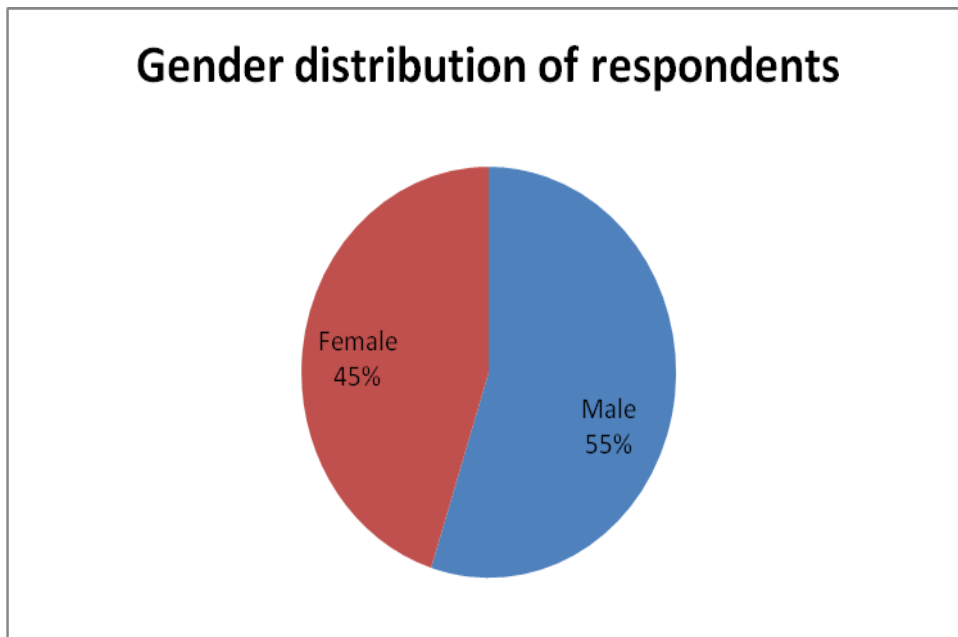
Female
45%

Male
55%

Figure 6: Gender Distribution of Respondents

The use, accessibility and control of natural resources by male and females are unique and cannot be generalized. In the developing world, women and girls interact with natural resources as they carry out their responsibilities of fetching water, firewood and other domestic chores. The role of male and male child are mainly around taking care of livestock and supplementing family livelihood with small businesses. Women manage and use natural resources daily in their roles as farmers and as household providers of resources like firewood and water. Despite their important role, they have problems on decision making and access on issues related land use and ownership (FAO, 2011).The results of this research show that more males than females were interviewed. This invariably means that men have a bigger stake in terms of how the resources are used around Lake Elementaita. Most of the environmentally degrading activities like charcoal burning, sand extraction and livestock grazing around Lake Elementaita are carried out by men thus impacting negatively on the riparian zone. The decision on what economic activities to undertake are controlled by men. These findings are in agreement with results by UNICEF (1990) which states that generally in developing countries, at all levels of decision making, women are not provided equitable voices in decision making. Women and men are more likely to make environmentally sound land management decisions when they all have secure ownership entitlement to natural

resources. This will reduce the likelihood of severe degradation of areas surrounding Lake Elementaita.

Sixty one percent of the respondents had at least primary level of education as opposed to those who had tertiary level of education 5% (Fig 7).
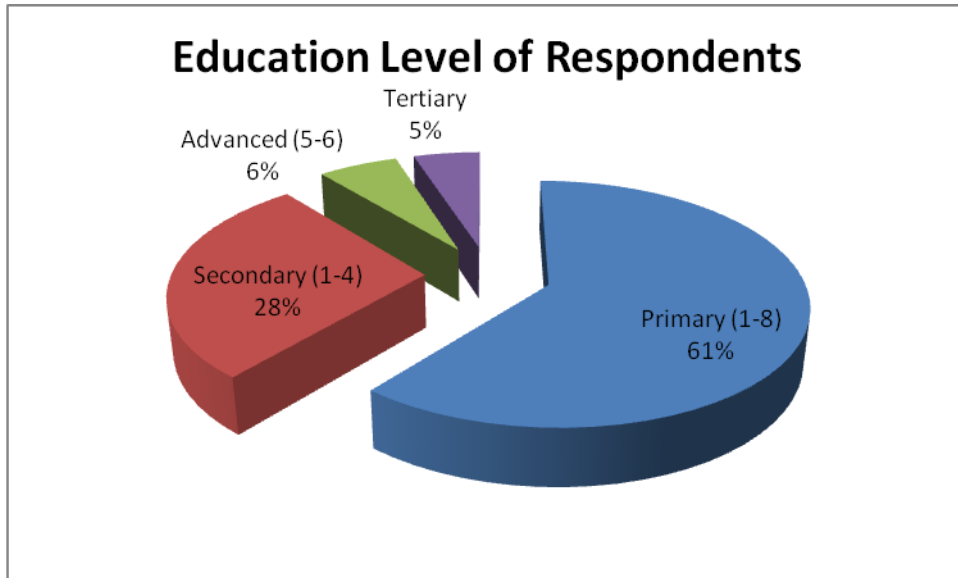
Figure 7: Education Level of the Respondents

Education is a process of learning and acquiring information either formally or informally. The community around Lake Elementaita is educated, though there is need to provide more of environmental education on the relationship between their activities and the impact on natural resources. The environmental problems like deforestation, pollution, soil erosion and poor farming methods are a result of lack of understanding by the community. The level of education and access to information generally with regard to natural resource management is a barrier that impacts on women more than men in rural areas (Lambrou, 2006). This has implications for sustained gender inequality and continued cycles of chronic poverty and natural resource degradation. To effectively participate in conservation around Lake Elementaita the community needs education that will equip them with the requisite skills that will enable them to ask informed questions on resource use, participate in advisory and policy making committees and also support sound legislation directed at solving environmental problems (William B.Sapp,*et al*,1999).

The community around Lake Elementaita is comprised of people who came from other places and settled here from 1990's after the giant land buying company GEMA subdivided the land to its members. This coupled with absentee land owners and limited conservation knowledge amongst the community calls for relevant environmental education so that they can make informed choices that will not impact negatively on the riparian area of Lake Elementaita.

Majority (73%) of the respondents interviewed were married as opposed to singles 26% (Fig 8).
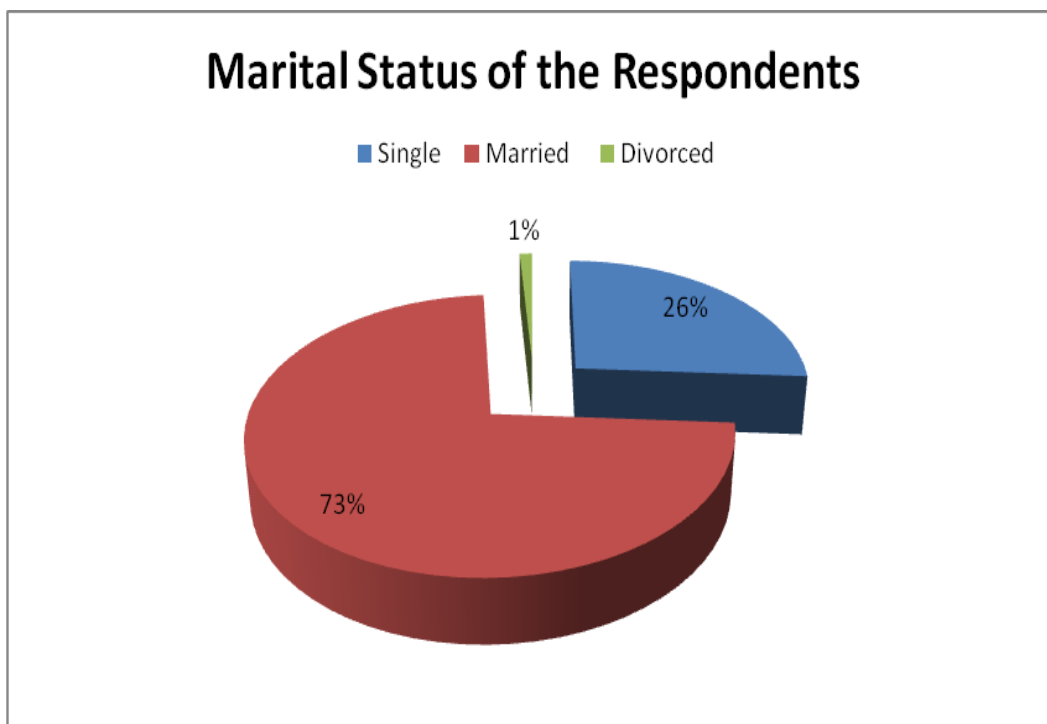
Figure 8: Marital Status of the Respondents

Households with dependents between 1 and 4 constituted the highest (48%) proportion of respondents whereas those with zero dependants constituted 3 % (Fig 9).

The results (Fig 8) of marital status and (Fig 9) the number of dependents are very closely linked; thus the impact of population on natural resource use.
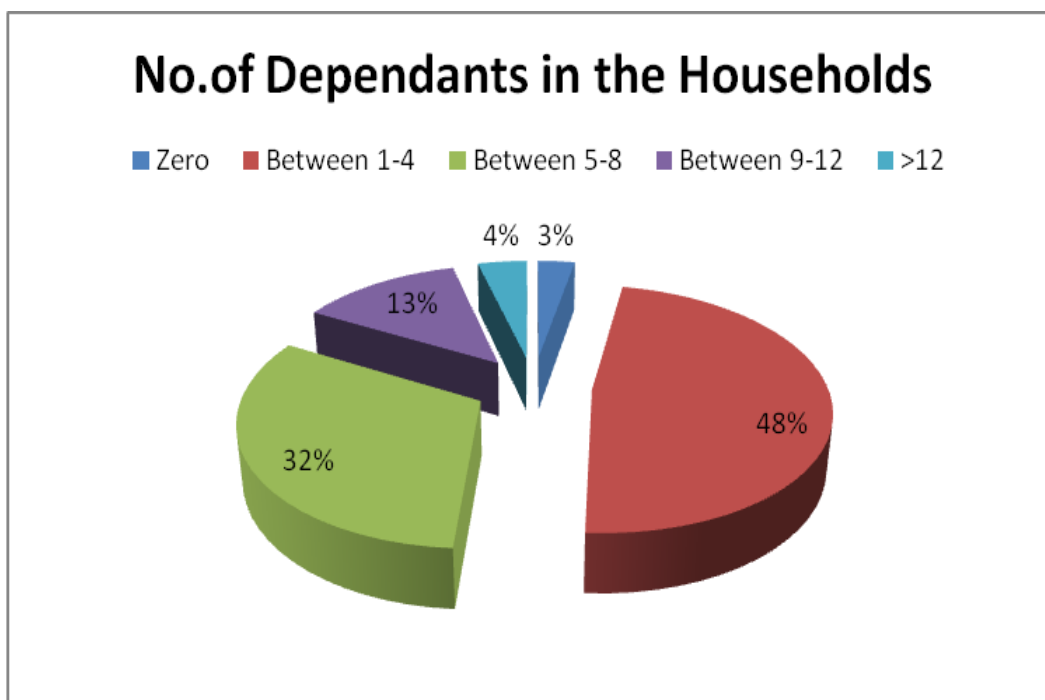
Figure 9: Number of dependents in the household

An increasing population results in increasing pressure on natural resources and may lead to unsustainable use and environmental degradation (Peter P Rodgers *et, al*, 2009). All these dependants need food, shelter, land and source of livelihood. The demand on the natural ecosystems services like firewood, salt and aesthetics from the community will outstrip the rate of regeneration thereby exacerbating degradation. Expanding rural population implies increased harvest and offtake when more people use, harvest free access and common property resources. Besides, population growth has the effect of pushing people to adopt farming activities on less productive lands leading to soil erosion, deforestation and diminished soil fertility (Pinstrup-Anderson and Pandya-Lorch, 1994). This degradation features are further compounded by the semi arid and fragile ecosystem of the area.

4.2 Land tenure

The number of respondents who owned land in the study site constituted 75.6% (Fig 10). Per capita land available for utilization for various purposes by respondents was 1.3±0.09 acres (Fig 11).

Figure 10: Land Tenure System of the Land Occupied by Respondents

Table 1:Acreage of land owned and used
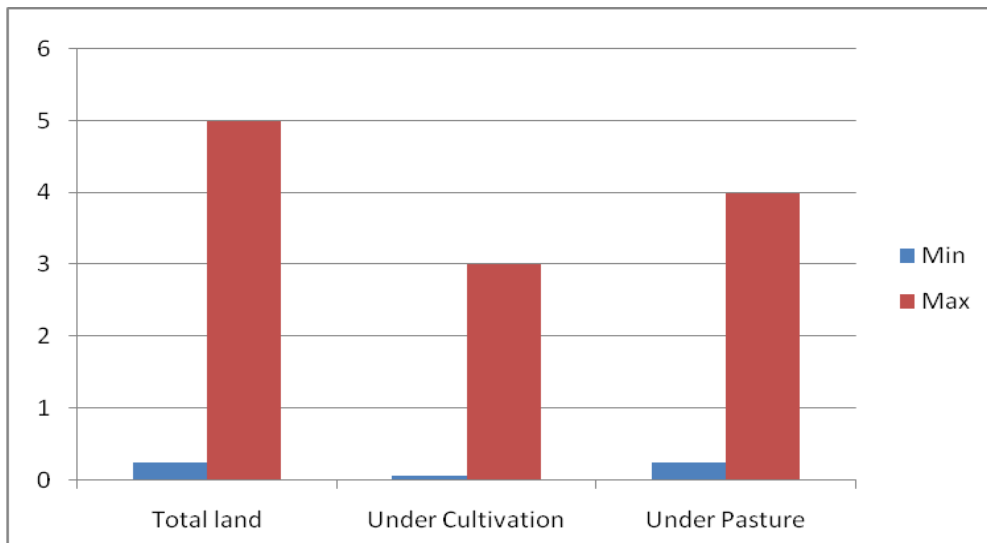
The terms and conditions under which land is held, used and transacted has a lot of impact on resource use. Land tenure is important in rural development interventions which place emphasis on building peoples endowments of assets so that they can enjoy sustainable livelihoods. There are several types of land tenure around Lake Elementaita. Those who are categorized as squatters and leasers have one thing in common: there is uncertainty on how long they can hold onto the land parcels they are using. This scenario provides little or no incentive to manage the resources sustainably thus leading to likelihood of enhancing degradation.

Those who own the land and have title deeds confers on the owners property rights to use the resources. Due to long term commitment these owners are more likely to be receptive to undertake activities that will ensure resources are not degraded .Lands with title deeds and owned have a positive influence on investment incentives, resource conservation, productivity and efficiency (Barrows and Roth 1990; Besley, 1995). Those parcels of land that are owned but have no title still confers on the owner the right to use the resources. The risk of resource degradation will arise in the event the owner is absent. The absentee landlord situation creates a scenario where anyone can come in and abstract as much as he or she can without recourse for sustainability this exacerbates degradation. In all this tenure systems, there is need for enforcement of rules on the use of natural resources around Lake Elementaita. This is even more critical considering the small parcels of land owned in this area and semi arid climate conditions.

Table 2: Statistical Tools used in Data Analysis

Research Questions	Variables	Analysis
What are the major human activities practiced in the Lake Elementaita riparian zone	• Livestock production • Salt/sand harvesting • Farming • Firewood harvesting • Charcoal burning	Frequencies/percentages and descriptive
Which resources are exploited by communities within the lower and upper viewpoints	• Land for farming • Pasture/grass • Firewood harvesting • Charcoal sales	Frequencies, descriptive and chi-square test
What are the major sources of pollution affecting the riparian area of lake Elementaita	• Soil erosion, • Agrochemicals/pesticides • Domestic • Industrial discharge	Frequencies, Percentages descriptive
What is the local community perceptions towards conservation issues	• Degradation	Percentages frequencies Chi-test

4.3 Human activities

Grazing and farming were the major human activities carried out by respondents in the entire study area (Table 9). This concurs with the findings of (Stevenson, 1991) who realized that the common property resources around the rural landscape within developing

countries are a set of dependable resources, which provide a variety of economic and environmental security for the whole community. In common property regimes, the community or state have the option of putting in place rules of how to use the resource. There is always a problem of enforcement of conservation measures. The common property resources and especially those with free open access are at the risk of degradation and overuse (Ostrom,1990;Oakerson,1992). Although other human activities were minimal, the harvesting of firewood and other natural products without recourse for direct consumption and income generation exacerbates environmental degradation (IUCN, 1999).

Table 3: Resource Useage around Lake Elementaita Riparian Zone

Lower view point (n=72)
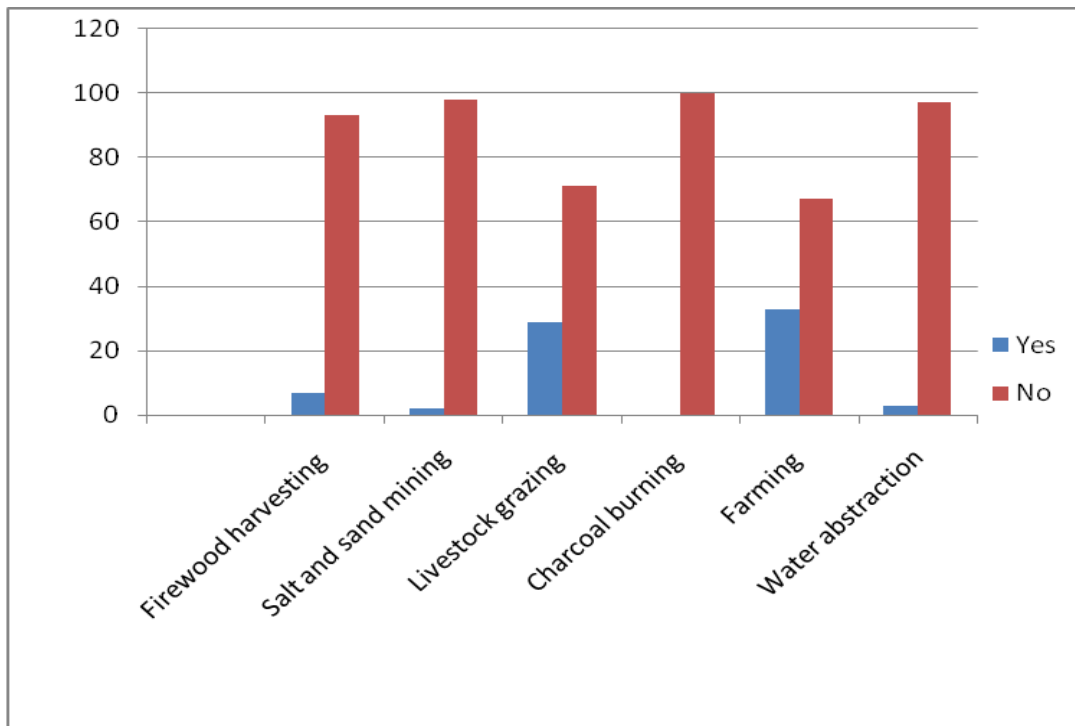
Upper view point (n=113)
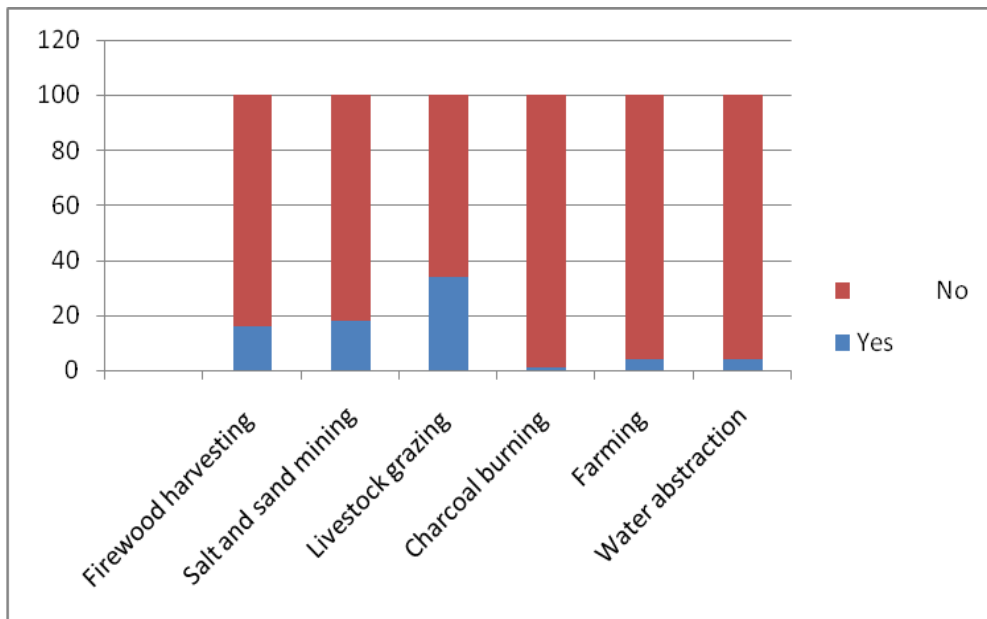
4.4 Resources around Lake Elementaita

The most important resources utilized by majority of respondents in the study area were farmland, grazing land and water, (Figure 3). According to UNEP and World Conservation Monitoring Centre (WCMC) 2011 report, terrestrial vegetation around Lake Elementaita consists of upland forest, woodland, dry bushland dominated by Acacia *xanthophloea* and *Eurphobia candelabrum*, scrubland dominated by *Olea* sp. and *Tarchonanthus camphorates* and grassland of *Cynodon dactylon, Chloris gayana* and *Panicum spp.* Marshes located in the southern part of the lake are dominated by *Cyperus laevigatus* and *Typha spp.*

The human activities carried out around Lake Elementaita have far reaching effects on the survival of the fragile ecosystem. The land degradation and serious soil erosion around the ecosystem has been enhanced by the residents carrying out agricultural activities that are incompatible with the climatic conditions that prevail in the area. The situation has been made worse by overgrazing as a result of large herds of livestock brought in by pastoralists who come from as far as Narok County and the mining of salt and sand. Potential impacts related to livestock grazing may include, overgrazing, and trampling of soils and plants. The significance of these impacts would depend upon the timing, duration, and intensity of grazing. A decrease in the abundance, distribution, and vigor of plant species resulting from livestock overgrazing may, in turn, decrease the amount of ground-cover (vegetation and litter) and soil organic matter, and increase the amount of bare soil. This would inevitably

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accelerate soil erosion leading to a change in the water quality of the lake. The loss of woody riparian species (cottonwoods and willows) by livestock is particularly detrimental. The loss of these species that stabilize river banks (Collins et al. 1998) end up decreasing the areas of Lake Ecosystems such as Elementaita.

The tree cover of the world is currently at 30% though originally the forests covered 50% of the earth. This is as a result of continued deforestation, land degradation and human encroachment among other factors.. Forests are homes for millions of animal species ranging from insects, animals, bacteria and fungus among others making forests rich habitats of biodiversity. The species find their food and shelter in the forest and are protected from extinction. Forests are also valuable for humans since they are a source of food and some of the tree species have medicinal values (Hanson, C.2008). Firewood and charcoal burning as communities search for fuel is another factor that is aggravating deforestation. The emergence of commercial charcoal burners has led to massive deforestation as the businessmen aim to maximize their profits by producing more charcoal and firewood without consideration of the environment (Clare, 1990).

The high demand for charcoal by the nearby community of Kekopey and Gilgil town has led to overexploitation of acacia woodlands. This has led to loss of habitats for woodland birds like the ground hornbills, the rich flora and fauna that epitomizes biodiversity of the Great Rift Valley. These findings are consistent with a report by the World Resources Institute (WRI,1999) that states that as early as 1993 one –quarter of the vegetated land area of the earth had been highly disturbed by unsustainable and uncontrolled exploitation of natural resources through anthropogenic activities.
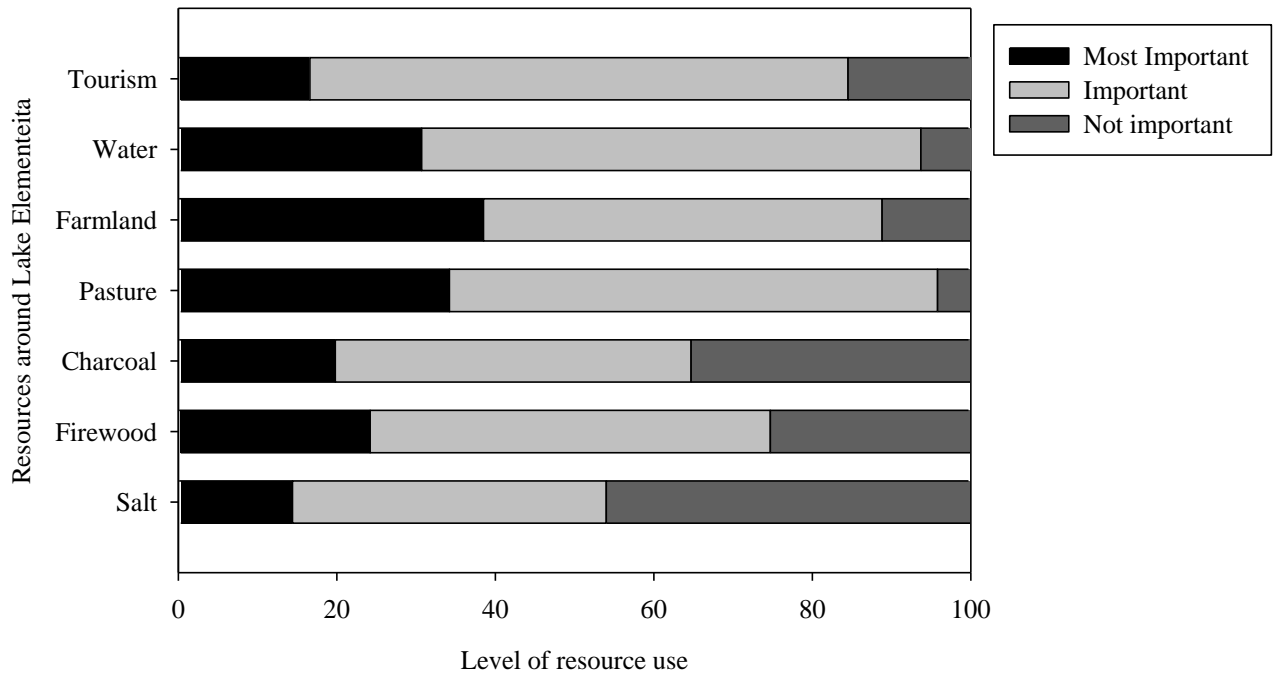
Figure 11: Resources use in Lake Elementaita riparian zone

The income generated from livestock sales and crop productions are high as compared to other resources used within the study area. This confirms why pasture and farmland were perceived to be the major resources used by the majority of the respondents (Tables 9 and 10). According to UNEP and WCMC 2011, extraction of salt and sand occurs along the northwestern shore of Lake Elementaita and grazing by nomadic pastoralists occurs in the southern area of Elementaita.

Table 4: Income generated from the various human activities around Lake Elementaita
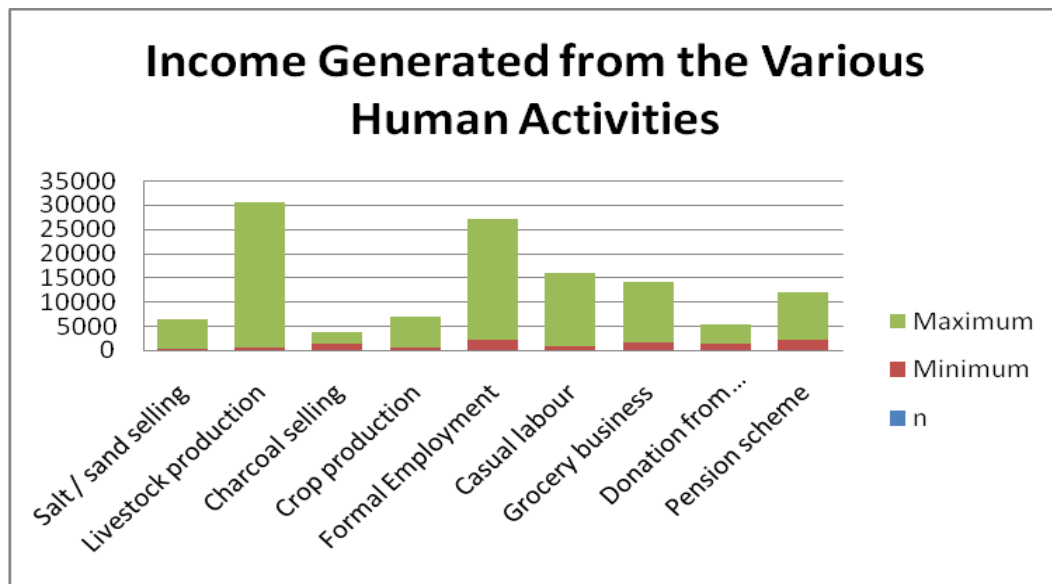
The higher the income realized from crop and livestock production means that more land is opened up for cultivation and high number of livestock kept or allowed in the area so as to meet the insatiable demand for these goods. Table 10 shows clearly that livestock production is the main activity that yields high income. This can be linked to the lucrative market at Kekopey centre for the meat from travelers on the busy Nairobi-Nakuru highway. The fact that most land here is owned by absentee landlords lends credence to the possibility of overstocking which exacerbates overgrazing thus leading to degradation. Other economic activities like charcoal burning and salt/sand harvesting aggravates the fragile situation. There is need to have more people engaged in other forms of employment, this would make it possible to train and educate them on alternative sustainable livelihoods like apiculture, ecotourism, agroforestry and organic farming which would minimise the degradation of areas surrounding lake Elementaita ecosystem.

4.5 Pollution in the Lake Elementaita Riparian Zone

Most wetlands are being affected by increasing human population which leads to more land being opened up for cultivation which then necessitates increased use of pesticide and other agrochemicals which are eventually washed down through surface run-off leading to pollution in wetlands (Kitaka,N.2000).. This affects drinking water sources and biological diversity. Drainage and run-off from fertilized crops and pesticides used in industry introduce nitrogen and phosphorous nutrients and other toxins like mercury to water sources. These

chemicals can affect the health and reproduction of species, posing a serious threat to biological diversity. From the results, upper view point was overgrazed and high levels of agrochemical use observed (Figure 4 and 5). This results concurs with the findings of Mennonite, (1999) who attests that in many parts of the world, overgrazing has resulted in wide spread soil erosion especially in places of high human population growth and economic development compounding degradation of wetlands, forests, habitats and air quality
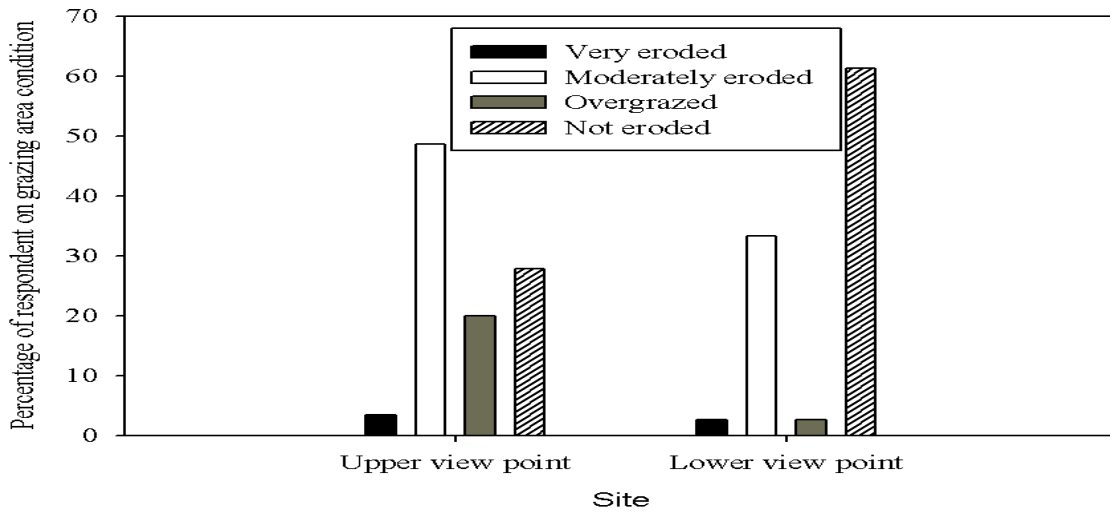
Figure 12: Respondents' perception on soil erosion
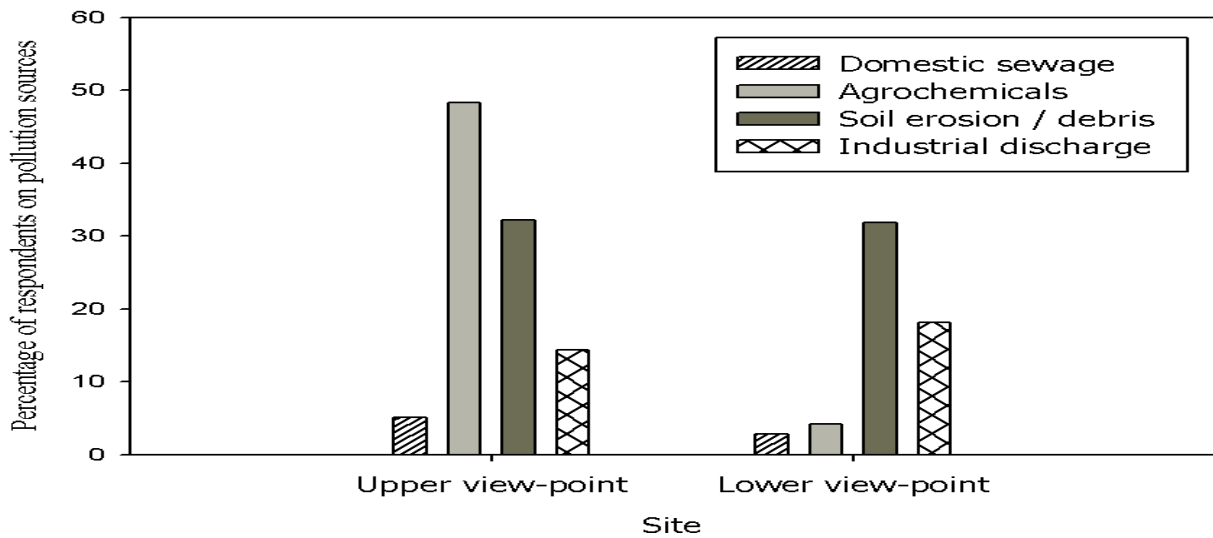
Figure 13: Pollution sources

As resources are being used in the study area, other negative impacts were being felt, especially pollution from agrochemicals waste and soil erosion. The Lakes riparian ecosystems are rich in biodiversity and provide essential livelihood products to their riparian communities (NWP, 2001). Vegetation around the riparian zone plays an important role in intercepting surface runoff and store non point pollutants like sediments, nutrients and certain heavy metals that would otherwise end up in the lake. The overstocking and the resultant overgrazing from livestock lives the ground bare Surface run off from agrochemicals used on crops and pesticides used on livestock are easily washed down to Lake Elementaita as a result of soil erosion. These pollutants end up distorting the food chain and reproduction of species within and around the ecosystem thus destroying biodiversity (WWF, 2001). This ecosystem is faced with rising demand for food, energy and other supplies to sustain the increasing population within and adjacent to these area. This has led to a situation where acacia forests are cleared for charcoal burning to make room for agricultural activities and settlement. Siltation and pollution of the wetlands is a critical problem in most lakes of the great rift valley like Lake Nakuru,Bogoria,Naivasha due to change in hydrological regime within the catchment (Kimani. et al,1992).

4.6 Perception on conservation issues in the lake Elementaita riparian zone

More than 72% of respondents were of the opinion that there has been decrease in land productivity while about sixty seven percent of believed that soil erosion has increased over the years (Table 5).

Table 5: Perception of conservation issues

Statement	(%) Degree of agreement					
	Strongly disagree	Disagree	Not sure	Agree	Strongly agree	N
Land productivity has been decreasing in the last ten years	4	17	7	56	16	190
Quality of water in streams and rivers has been reducing	3	23	6	55	13	183
Amount of water in streams, rivers and lake has been reducing	4	20	5	57	14	186
Grass/vegetation cover around the lake has been reducing	7	28	8	45	12	187
Amount of tree cover in forests around has been decreasing	5	31	11	41	12	185
Number and types of birds has been decreasing in and around the lake	6	22	21	36	15	190

Number and type of wild animals in and around the lake has decreased	7	25	24	29	14	187
Availability of forest materials has been decreasing	4	14	11	51	20	187
Soil erosion has been increasing	5	22	7	47	20	185
Availability of livestock feeds grass/browse has been decreasing:	5	23	11	49	13	186
Number of livestock grazing around the lake has increased	9	25	13	44	9	188
River, stream and spring water use for irrigation is causing the lake to dry	13	15	13	44	15	191
Use of agrochemicals can affect water quality in streams rivers and the lake	16	18	10	41	15	189
Cutting of trees in the forest can affect the flow of streams and rivers	9	9	11	55	16	189

Destruction of the forests around can increase soil erosion	6	10	11	53	20	187
Grazing animals around the lake can affect the wetland ecosystem negatively	6	21	22	38	12	190
Overgrazing increases soil erosion	9	14	6	53	18	187
Abstraction of streams entering the lake cannot affect the survival of the lake	29	33	12	19	7	189
Are you willing to carry out conservation of Lake Elementaita ?	3	4	14	58	21	190

Wetlands have the potential of contributing significantly to the socio-economic development of any country, but they face diverse threats. These threats include among others inappropriate human activities within the catchments and in the wetland riparian zones, lack of coordinated and holistic policy guidelines and climate change. The threats have induced changes that have eroded the ecological and socio economic values and services derived from wetlands. The underlying threat remains lack of knowledge and understanding of their importance (KWF, 2010).

The results from the research corroborate the information. The fact that the community members have noted evidence of environmental degradation around Lake Elementaita and the fact that there is a decline of ecosystem services both in quality and quantity as shown by their perceptions results (Table 11) is a clear indicator of their concern. A majority (72%) of the community around Lake Elementaita are in agreement that their land productivity has declined. They are very much aware of the fact that high population in creating a huge demand for food, wood fuel and sand/salt harvesting. The interrelatedness between the activities being carried out, semi arid climatic conditions and decline in land productivity may not be clear to them unless they are exposed to environmental education.

The community living around is willing to conserve Lake Elementaita as shown by more than 79% of the respondents, a demonstration of their awareness of the need to do something to arrest further decline. This positive perception of the community towards environmental issues is important since they will be part of solving environmental problems affecting the area.

The positive attitude will make it feasible to develop a holistic conservation programme that will be embraced by all inhabitants so as to reduce the negative impact of human activities on the surrounding areas of the lake and ensure sustainable development for posterity.

4.7 Chi-Square Test

Two major research questions were investigated in this study. To test these research questions a chi test was done to compare association between the study sites and perception about the importance of resources.

A chi-square test was carried out to determine whether there was any association between the three study locations and the perception about conservation (degradation) of the riparian area. As shown in the table below, there was no significant association in the perceptions on conservation of the residents in the three sites (X2 =5.881, d.f=4,p=.208). This means that perception about conservation in the study area were similar amongst residents of the three sites.

Respondent site of residents	Firewood as important resource derived from Lake Elementaita and its environs			Total
	Most important	Important	Not important	
Upper-View point	24	48	14	86
Lower-View point	17	30	27	74
Soysambu	4	16	6	26
Total	45	94	47	186

X2 =5.881, d.f=4,   p=.208;

Chi-square test for association between perceptions about the importance of resources for residents in the three sites. The table below shows that it is only perception about importance of firewood that was significantly associated with the site of residence of the respondents

Dependent	Independent	Chi-SquareValue	df	Asymp. Sig. (2-sided)(p-value)
Firewood		10.414	4	.034
Grazing land		7.910	4	.095
Farmland	The three sites	4.920	4	.296
Water		8.282	4	.082

Note: Significant association is resent when the p-value is less than 0.05

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Based on the findings of this study the following conclusions were drawn:

1. Livestock rearing and crop production constituted the most important human activities carried out by the residents of Lake Elementaita riparian zone. Therefore, these activities necessitate increased demand for more land to be opened up for food production to satisfy the increasing human population. The presence of a busy meat market at the Kekopey centre has led to more livestock coming into the area to graze thus exacerbating degradation.

2. Water, grazing land and farmland were identified as the main resources utilized by the residents.

3. Soil erosion and pollution from agrochemicals were considered to be the foremost causes of land degradation in the study area and hence the need for soil conservation measures and education on proper farm practices to reduce pollution

5.2 Recommendations

Based on the results of this project, the following recommendations are made:

1. Encourage appropriate modern farming methods to avoid degradation of the riparian zones. The community should be exposed through training to alternative environmentally friendly farming methods like apiculture. The youth should be encouraged to form community based organizations so as to engage in income generating activity like ecotourism. This is a viable venture in this area

2. The community around Lake Elementaita should be trained in alternative environmentally friendly farm practices like afforestation with correct tree species

and agro-forestry practices to increase vegetation cover and reduce soil erosion around the riparian zone.

3. There is need to increase the use of biopesticides, reduce the use of agrochemical, increase the use of organic fertilizers and integrated pest control practices on the parcels of land around Lake Elementaita.

4. There is need for further research to establish the magnitude and impact of human activities within the riparian zone and establish how it is affecting the wetland.

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APPENDIX 1

QUESTIONAIRE

These questions are for research purposes only. The information you provide will be treated with utmost confidentiality. Your assistance in answering the questions truthfully and accurately will be high appreciated.

Division: ……………Location: ………….. Village: ……………Site………….…….

A: RESPONDENTS PERSONAL INFORMATION

 Name (optional):……………………………………………………………..

Age: (a)   Above 56 years

        (b)   46 – 55 years

        (c)   31 – 45 years

        (d)   <30 years

        3. Sex: (a)   Male

                        (b)   Female

        4. Educational level

                        (a)   Tertiary Level

                        (b)   Secondary Form 5 – 6

                        (d)   Secondary Form 1 – 4

                        (e)   Standard 4 – 8

(f) < Standard 4

5. Marital Status

       (a)   Single

       (b)   Married

       (c)   Divorced

       (d)   Widowed

       (e)   Widower

6. Number of dependents

       (a)   1 – 4

       (b)   5 – 8

       (c)   9 – 12

       (d)   > 12

7. What are your main sources of income?

       (a)   Salt/Sand Selling

       (b)   Charcoal Business

       (c)   Employment

       (d)   Livestock,   (e)   Others (specify)

SECTION A

8. Are you the owner of this land which you occupy?

(a)   Yes

(b)   No

If yes:

9. What is the size of your farm?...................................(Acres)

     (a)   Cultivated land…………………...(Acres)

     (b)   Pasture land………………………(Acres)

If no:

10. Who is the owner of the land you occupy?..

11. For how long have you occupied this land?

     (a)   0 – 5 years

     (b)   6 – 10 years

     (c)   11 – 15 years

     (d)   More than 16 years

12. Under what land ownership is your land?

     (a)   Squatter

     (b)   Leased

     (c)   Borrowed

     (d)   Communal

     (e)   Own land without title deed

(d)   Own with title deed

13. How far is your land from the Lake Elementaita?

(i)   How far is your land from lake Elementaita?

(a)   < 1 km

(b)   1 – 2 km

(c)   2 – 3 km

(d)   > 3 km

14. What are the most important resources you derive from Lake Elementaita and

it environs?

Firewood

Charcoal

Grazing land/pastures

Farming Land

Water

Other (specify)

15. What are the major land degradation problems in your farm?

(a)   Soil erosion

(b)   Overgrazing

(c)   Others (specify)

16. Which grazing system do you practice around Lake Elementaita?

        (a)   Zero grazing/stall feeding

        (b)   Overgrazing

        (c)   Others (specify)

17. What is the condition of your grazing areas?

        (a)   Very eroded

        (b)   Tethering

        (c)   Moderately eroded

        (d)   Not eroded

18. State the type of crops that you cultivate around Lake Elementaita

        (a)   ………………………………..

        (b)   ………………………………….

19. Which of the following soil fertility methods do you use in your farm?

        (a)   Organic manure

        (b)   Chemical fertilizers

        (c)   Burning of trash

        (d)   Others (specify)

20. What are some of the chemicals you use?:……………………………….

21. What are the sources of pollution into the Lake?

      (a)   From domestic sewerage

      (b)   herbicides and pesticides used on the farm

      (c)   Soil erosion debris washed into the lake

      (d)   Other (specify)

22. Which of the following resources do you use and where do you obtain them?

Form of energy	Source	Distance
Firewood		
Charcoal		
Crop remains		
Others		

23. What are the main sources of water for domestic consumption?

      (a)   Rain

      (b)   Well

      (c)   Spring

      (d)   Borehole

      (e)   Swamp

      (f)   Dam

      (g)   River/Stream

      (h)   Lake

24. Who makes decision regarding what farming operation be undertaken?

> (a)   Husband
>
> (b)   Wife
>
> (c)   Husband/Wife jointly
>
> (d)   Elder son
>
> (e)   Others (specify)

25. How much do you make from the above named sources (state whether on monthly or on annual basis)?

Source	Amounts (Kshs.)
Salt/Sand selling	
Livestock	
Charcoal business	
Employment	
Others (Specify)	
Providing labout	

State whether you:

Strongly disagree

Disagree

Not sure

Agree

Strongly agree with the following statement

26. The productivity of land has been decreasing in the last ten years:

        (a)   Strongly disagree

        (b)   Disagree

        (c)   Not sure

        (d)   Agree

        (e)   Strongly Agree

27. The quality of water in the streams and rivers around has been reducing:

        (a)   Strongly disagree

        (b)   Disagree

        (c)   Not sure

        (d)   Agree

        (e)   Strongly agree

28. The amount of water in the streams, rivers and lake has been reducing:

        (a)   Strongly disagree

        (b)   Disagree

        (c)   Not sure

        (d)   Agree

        (e)   Strongly agree

29. The grass/vegetation cover around the lake has been reducing:

        (a)   Strongly disagree

(b)   Disagree

(c)   Not sure

(d)   Agree

(e)   Strongly agree

30. The amount of tree cover in forests around has been decreasing:

      (a)   Strongly disagree

      (b)   Disagree

      (c)   Not sure

      (d)   Agree

      (e)   Strongly agree

31. The number and types of birds has been decreasing in and around the lake:

      (a)   Strongly disagree

      (b)   Disagree

      (c)   Not sure

      (d)   Agree

      (e)   Strongly agree

32. The number and type of wild animals in and around the lake has decreased:

      (a)   Strongly disagree

      (b)   Disagree

      (c)   Not sure

(d)   Agree

(e)   Strongly agree

33. The availability of forest materials (firewood, construction materials) has been

decreasing:

(a)   Strongly disagree

(b)   Disagree

(c)   Not sure

(d)   Agree

(e)   Strongly agree

34. Soil erosion has been increasing:

(a)   Strongly disagree

(b)   Disagree

(c)   Not sure

(d)   Agree

(e)   Strongly agree

35. Availability of livestock feeds (grass, browse) has been decreasing:

(a)   Strongly disagree

(b)   Disagree

(c)   Not sure

(d)   Agree

(e) Strongly agree

36. The number of livestock grazing around the lake has increased:

(a) Strongly disagree

(b) Disagree

(c) Not sure

(d) Agree

(e) Strongly agree

37. Use of water from fivers, streams and springs entering the lake for irrigation is

causing the lake to dry:

(a) Strongly disagree

(b) Disagree

(c) Not sure

(d) Agree

(e) Strongly agree

38. Use of chemical fertilizers and pesticides can affect the water quality in streams,

rivers and the lake:

(a) Strongly disagree

(b) Disagree

(c) Not sure

(d) Agree

(e)   Strongly agree

39. Cutting of trees in the forest around can affect the flow of streams and rivers:

        (a)   Strongly disagree

        (b)   Disagree

        (c)   Not sure

        (d)   Agree

        (e)   Strongly agree

40. Destruction of the forests around can increase soil erosion:

        (a)   Strongly disagree

        (b)   Disagree

        (c)   Not sure

        (d)   Agree

        (e)   Strongly agree

41. Grazing animals around the lake can affect the wetland ecosystem negatively:

        (a)   Strongly disagree

        (b)   Disagree

        (c)   Not sure

        (d)   Agree

        (e)   Strongly agree

42. Overgrazing increases soil erosion:

     (a) Strongly disagree

     (b) Disagree

     (c) Not sure

     (d) Agree

     (e) Strongly agree

43. Abstraction of streams entering the lake cannot affect the survival of the lake:

     (a) Strongly disagree

     (b) Disagree

     (c) Not sure

     (d) Agree

     (e) Strongly agree

44. Please rank in order of importance (using 1, 2, 3 with 1 being the most important) the

 benefits you derive from the wetland:

     (a) Strongly disagree

     (b) Disagree

     (c) Not sure

     (d) Agree

     (e) Strongly agree

45. Please rate your hold wellbeing in comparison to when you settled and presently:

> (a) Dropping
>
> (b) Constant
>
> (c) Improving

46. Would you and your household be willing to participate on the conservation of Lake Elementaita?

> (a) Yes
>
> (b) No

47. What mitigation measures do you propose to be implemented at the household level to conserve the ecosystem?

………………………………………………………………………………………

………………………………………………………………………………………

…………………………………………………………………………………….