SUSTAINABLE MANAGEMENT OF WETLAND RESOURCES: A CASE STUDY OF KABULA LOCATION, BUNGOMA DISTRICT

BY

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DECLARATION

This Thesis is my original work and has not been presented for a degree in any other university.

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This Thesis has been submitted for examination with my approval as university supervisor.

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April, 2001.

DEDICATION

This work is dedicated to my Mother Theresa Simiyu.

Your love and care since my childhood has made me what Iam.

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ABBREVIATIONS

ASALS - Arid and Semi Arid Lands.

CBO - Community Based Organization.

CPTI - Conservation Potential/Threat Index.

EIA - Environmental Impact Assessment.

FAO - United Nations Food and Agriculture Organization.

GIS - Geograghical Information Systems.

ITDG - Intermediate Technology Development Group.

IUCN - Internaional Union for Conservation of Nature.

KWWG - Kenya Wetland Working Group.

KWS - Kenya Wildlife Service.

NGO - Non Governmental Organization.

OTA - Organization Trade Agency.

USA - United States of America.

WWF - World Wildlife Fund.

ABSTRACT

Wetlands serve multi purpose functions that have physical, ecological as well as socio-economic values. However, these values are threatened by the increasing human activities such as livestock rearing, settlement, urbanization, industrialization and deforestation. Small scale wetlands owned by individuals have been given little attention in studies and in the policy framework. However, these wetlands face greater threats of extinction. This prompted this study in Kabula Location of Bungoma District.

The objectives of the study were: to establish the functions of the wetlands in Kabula Location; appraise the values the community attach on wetlands; analyze the issues arising from utilization and management of the wetlands in Kabula Location, and to propose strategies for their sustainable management.

Primary and secondary methods of data collection were used during the study. These included literature review, interviews, administering questionnaires, observation, photography, survey and mapping. Quantitative and qualitative data analysis techniques were used. These included the Chi-square, Spearman's rank correlation, Spearman's product moment correlation, means, variance, totals and discussions.

The analysis revealed that the community in Kabula Location relies on wetlands for basic needs such as water, fuelwood and building materials. Wetlands also serve economic puposes such as sugar cane farming, maize farming and livestock grazing. Growth of Eucalyptus trees also takes a good part of the wetland acreage. The economic uses are the greatest threats to wetlands. The other use is socio-cultural activities such as circumcision ceremonies, recreation, collection of herbs, vegetables and materials, bathing and washing are friendlier to the wetland ecology. The community values wetlands as their own resources.

The study has proposed strategies that promote uses reinforcing economic and socio-cultural functions of the wetlands and which could enhance of their conservation. It is through the

integration of utility of wetlands and conservation objectives that their sustainability can be achieved.

CHAPTER ONE

INTRODUCTION

1.0 Background

Wetlands are areas of marsh, fen, peatlands or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of six meters. They are diverse including mountain lakes, rivers, flood plains, mangroves, estuaries, open-marshes, peatlands, swamps among other examples (Gowan, 1995). Wetlands are among the world's valuable resources, whether in their natural state or when they are under human utilization. According to UNEP (1992), the majority of the world population considers wetlands as wastelands so long they remain in their natural state. Wetlands therefore are considered useful so long as they support tangible socio-economic activities such as farming and brick making.

The World Conservation Union (1987) classifies wetlands as the third most important ecological system on this planet. Wetlands are places where marine, aquatic and terrestrial animals meet and interact. They support enormous variety of plants, invertebrates, fish, reptiles, birds and mammals. Many species can survive nowhere else.

Wetlands do moderate water quantity and quality. Acting as natural filters and vast sponges, wetlands take up run off, reduce erosion, recharge ground water, trap sediments, recycle nutrients, oxygenate the water and release purified water gradually into the natural system. As a matter of fact, spring water is some of the most purified water one can find in the world, and most of the African people depend on the wetland spring water for survival (Machena, 1992).

Species that inhabit the tidal areas and then swim to open sea account for two thirds of the world's fish harvest. Shrimp exports from developing to the developed countries earn at least £ 900 million a year (UNEP, 1992). Wetlands also limit the damages of floods, and provide water during draughts. They serve as "lifesavers" in very dry areas in form of oases in deserts. Wetlands do act as the basic but the most effective form of drainage and flood control systems. On the Charles River in Massachusetts in USA, the Us Army Corps of England recommended the protection of wetlands as a means of flood control by naturally absorbing flood waters rather than building dykes or dams. In India, where the city of Calcutta has no chemical waste - treatment plant, a series of salt lake wetlands have for 50 years served to treat sewage and support fish farms that produce 6,000 tones of fish annually. In addition, many coastal wetlands are providing important protection from ocean storms. In the U.S.A for example, federal regulations state that insured communities shall prohibit the destruction of mangroves, or else lose federal flood control insurance (IUCN, 1996).

Hydrological, nutrient material cycles and energy flows in wetlands on a regional scale have stabilizing effect on local climate conditions especially rainfall and temperature. The presence of vegetation and water moderates and increases rainfall. This, in turn, has influence on any agricultural or resource based activities as well as the stability of the natural ecosystems and the wetland itself. In 1986, local concern for the effect on the effect of loss of wetlands on microclimates in the valley of Southwest Uganda, led to the ban of wetland drainage (IUCN, 1992).

Williams (1991), explains that wetlands act as carbon sinks, a function that is reduced or actually lost once wetlands are drained for socio- economic uses. He further explains that brick making and peat burning in wetlands add carbon to the atmosphere that adds to global warming.

Not withstanding these problems a number of products from wetlands are of significant value to man. These include medicinal products, water, food, fuelwood,

material for building, fodder and raw materials for handicrafts, and many more. In Africa, most of the rural populations depend on wetland spring or rivers for domestic water (Darkoh, 1990; Howward-Williams 1975, Mavuti 1992, Gichuki 1990). The Maasais of Kenya graze their animals in wetlands during the dry seasons. Babukusu of Bungoma District in Western Kenya have a diverse number of cultural functions that take place in wetlands, the most significant being circumcision ceremonies and funeral rites.

The list of uses of wetlands is long, as different communities have attached importance and uses to them. This diverse uses and values attached to wetlands by different communities imply a dichotomy of planning and management for wetland resources. The goals of wetland preservation and those of wetland exploitation do not necessarily agree. As Gichuki (1992), puts it, all user activities on a wetland have definite negative impact(s) on the ecological functions of the wetland. Conservationists, for example, have put a case for the absolute protection of wetlands in order to retain their natural state. Economic development minded people on the other hand see wetlands as potential resources for exploitation.

The question that arises out of this is: what is the best way to protect the wetlands while using their enormous resource potential?

1.1 Statement of the problem

Different people attach different values to wetland resources. The values are derived from both ecological and socio-economic uses. These two broad functional values do not always agree. In particular, economic and socio-cultural functions have an impact on the ecological functions of the wetlands. The significance of the impact depends on the nature of the human activity: magnitude, intensity and technology applied. Conflicts between ecological functions and the human values are more significant in small sized wetlands. IUCN (1996) notes that:

> The smaller the wetland, the less the carrying capacity in terms of both biodiversity and support to the human activities.

This demonstrate that small wetlands are exposed to faster ecological deterioration once opened for economic and socio-cultural functions that are not planned nor managed well. The small wetlands are prone to private ownership as well (Masese, 1996). Land sub-divisions over time imply that wetlands are sub-divided to household units. Following this the private individuals have the liberty to utilize the wetlands in whatever way they want.

In Kenya wetlands located in valley bottoms are degraded by agriculture activities. For example the Kisii bottom valley wetlands In Nyanza Province have been greatly degraded due to land sub-divisions and agriculture. The rivers that get their water from these wetlands have greatly reduced in volume. Another case is the Yala swamp in Nyanza Province where extensive drainage for rice farming has immensely altered its ecological character. Further, the Thika swamps on the urmlands of Thika town initially played an important ecological role as fresh water sources but have been greatly affected by industrialization and urban development.

The problems cited for the Kisii wetlands, and the Yala and Thika swamps in Kenya are not unique. These problems affect other wetlands in Kenya. Wetlands in Kabula Location in Bungoma District that are the subject of this study therefore face similar problems but do have unique characteristics. Up to 1980, wetlands in Kabula Location, which is the study area, were owned as communal resources. The wetlands were open sites accessible to all members of the community. At that time, population was low and people viewed them as marginal areas or wastelands that had limited functions. The wetlands were mainly left in their natural state with a few economic functions. They were mainly used for socio-cultural functions. The main economic and socio-cultural functions included fishing, grazing, harvesting soils for house plastering and pot making, harvesting building materials such as grass, sticks and posts, hunting and recreation. More so, they were used for circumcision ceremonies, funeral rites and cleansing rites.

These economic and socio-cultural activities had a limited impact on the wetlands in Kabula Location for various reasons. The population was low and therefore their intensity was limited. Secondly, the technological capacity used in farming was predominantly manual with small sized tools such as machetes and hand hoes. Thirdly, the community had strict social controls and norms regulating how people used wetlands. Resource use activities therefore remained within the carrying capacity of wetlands. Over time, the population in Kabula Location increased due to natural growth and migration. This has had a chain of impacts on land use patterns, ownership and management. In the past, land sub-divisions were concentrated in the dry parts of the farms. Wetland areas were left under family ownership, open and freely accessible to the extended families. More land sub-divisions have resulted to encroachment to the wetlands. This has resulted to fragmentation of wetlands as more and more human activities are carried out on them.

Sub-division of wetlands means that they become privately owned. Private ownership has denied access by other members of the community. Socio-cultural and economic activities dependent on wetlands have therefore been adversely affected. Grazing livestock freely for example is limited. Access to materials is attached to a cost and therefore posses increased economic value. Sites for communal cultural functions such as circumcision rites have become private property and could be drained for other perceived more profitable purposes.

Change from communal ownership to private ownership has transformed predominant uses from socio-cultural to economic. The economic value positively correlates with increased technological in put and exploitation. There is a potential for serious resource use conflicts especially between private rights and communal uses. There is also risk of increased conflicts between ecological function and human values.

Requirements for more food and income meant that the population had to begin searching for alternative sources. Consequently agricultural activities were intensified.

In 1979, Mumias Sugar Company introduced the outgrowers' scheme for sugar cane farming in the dry parts of the farms. Sugar cane has steadily continued to take up most of the dry parts of the farms. This has effectively relegated food crop farming and livestock grazing to the wetlands. These together with other activities such as fuelwood harvesting, eucalyptus tree growth and direct settlement on wetlands have intensified.

Initially, there was a policy that sugar cane was not to be planted in the wetlands. The policy did not aim at protecting the wetlands, but was due to limited technology to aid in the cultivation of sugar cane in wetlands. This was coupled with the limited sugar cane crashing capacities of the factories. Increased crashing capacity and improved technology and mechanization have facilitated the cultivation of sugar cane growing in wetlands. This poses the greatest threat to wetlands survival.

This developments in the use and management of wetlands have led to drainage, clearing of vegetation, fencing, chemical spraying, irrigation, diverting watercourses, obstructing flow of water, planting inappropriate tree species, among others intensify right in the wetlands. This study therefore intended to investigate into the ways planning could reconcile the conflicting functions of the wetlands.

1.2 Research questions

The study aimed at answering the following questions:

1. What are the main functions of the wetlands in Kabula Location?

2. What values does the society in Kabula attach to the wetlands?

3. What issues arise from the utilization and management of the wetlands?

4. What appropriate strategies can be used in sustainable management of the wetlands?

1.3 Research objectives

Considering the opposing ecological and socio-economic functions of the wetlands, the small size of the wetlands and the fact that the society to use the wetlands, the following research objectives were formulated:

Main objective:

To propose a strategy for the sustainable management of wetlands in Kabula Location.

Specific objectives:

1. To establish the main functions of the wetlands in Kabula Location. Functions include extraction of materials such as fuelwood and thatch grass, direct production on wetlands such as farming, socio-cultural and service functions such as circumcision. Identification and quantification of such functions give an insight into importance of wetlands and help identify management strategies. This information will be collected through quantification of activities in the wetlands, land sub-divisions and trends in land uses over time.

2. To establish the values that Kabula society attaches to wetlands in Kabula Location. Values play a critical role in the way the community utilizes and manage the wetland resources. Values are derived from the historical utility and management aspects of the wetlands. It is through analyzing how the community has managed wetlands that current values of wetlands are understood.

3. To analyze the issues that arises from the utilization and management of the wetlands in Kabula Location. Issues encompass both opportunities and challenges that arise from the wetland utilization and management strategies being applied by the community.

4. To recommend strategies that can conserve and promote the utility of wetlands.

1.4 Justification of the study

Increase of population impacts on the way land resources are used. As expected the increase in population in Kabula Location has led to more socio-economic activities being carried out on wetlands. This shift has negative impact on the ecological functions of the wetlands. The concern for a sustainable use of the wetlands therefore justifies this study.

In the past, policies and implementation of strategies to conserve wetlands have focussed mainly on big wetlands. These have assumed the small wetlands yet they play a crucial role. They are more vulnerable to intensive human activities. Given that they are mainly privately owned, their management approaches and policies have to be individual farmer targeted, as opposed to the state or communally owned or managed wetlands. This research focuses on these micro-farmer-managed wetlands. Indigenous systems for resource management have since time immemorial played a significant role in conservation of resources. However the changing requirements such as the changing technology in food production may render the indigenous technology obsolete. Management strategies therefore have to be evolved purposely to march the changing times. These strategies should be culture based incorporating the value system of the community. The strategies should facilitate the material gain out of the wetlands. The strategies should integrate modern technologies in production, legal systems and policies. It is highly appreciated that such strategies are still ill developed and are deem necessary. This research aims at proposing strategies that can sustainably manage wetlands.

Policy guidelines on wetlands are ill developed internationally. Developing countries have pre-maturely developed policies on environmental management. The wetland area suffers a great deficit in policy address. In Kenya for example, policies are not clear, they are not enforced, people are not aware of them and they do clash. The water Act for example calls for the preservation of wetlands, while the Agriculture development policy calls for the draining of wetlands for agricultural production. Rejoinder management policies to achieve conservation are necessary.

1.5 Scope and Assumptions of the Study

The study covered the whole of Kabula Location. The research is limited on the human values and activities on the wetlands. It therefore appraises the economic and socio-cultural values of the wetlands, indicated how the activities interact among themselves and their ecological implications. The research is founded on the assumptions that economic activities are the greatest threat to wetlands in Kabula Location while socio-cultural activities assist in conserving wetlands in the location.

1.6 Definition of Terms

- **Wetland** - Areas of marsh, fen, peatlands or water, whether natural of artificial, permanent or temporary, with water that is static or flowing, fresh, blackish or salty, including areas of marine water the depth of six meters (Gowan, 1995). The study adopts this definition and focus on Kabula marshes as a type of wetland.
- **Conservation**- Using a resource sparingly for a positive reason, especially for future use.
- **Sustainability**- Achieving development that satisfies current population needs and sparing some of the resources for other use and for future generations.
- **Perception**- Awareness of things and events through senses and impression formed as a result (Schiffman and Ritgers, 1976). This study will adopt this definition in trying to find out the impression that people have formed on wetlands.

- **Resources**- something useful, or can be turned to use. Something with value or can have value if technology is applied to it.
- **Technology**- A way of doing some activity or work. Is the skill applied to accomplish some work.
- **Location**- An administrative area or region headed by a chief. It could be marked out by ecological, physical or imaginary boundary
- **Model**- Is a representation of some real thing, feature or phenomena.
- **Management**- Encompasses both utilization and conservation of a resource.

1.7 Summary

This chapter has presented the purpose of the research. Wetlands as important resources have two broad functions: ecological and socio-economic. Socio-economic functions if not well planned for threaten the ecological functions. Kabula Location, which is the study area, presents a scenario where socio-economic uses threaten ecological functions of the wetlands. The study therefore aims at proposing strategies to sustainably manage the wetland resources in Kabula Location. To achieve this goal, the trends of wetland management across the globe are considered in the next chapter.

CHAPTER TWO

GLOBAL ISSUES ON WETLANDS

2.0 Introduction

Wetlands account for 6 percent of the global land area and are considered by many authorities to be among the most threatened ecosystems (Masese, 1996). The Ramsar Convention, defines wetlands as:

> Areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of six meters. They are diverse including mountain lakes, rivers, flood plains, mangroves, estuaries, open marshes, peastlands and swamps, among others (Ramsar Conservation Bureau, 1992: 93).

Wetland management is undergoing change globally. Awareness of the local communities on the importance of wetlands is an important component in this change. According to Howard and Njuguna (1992), the most effective means of educating the people about the importance of wetlands is to allow them access the resources for their own use. Howard suggests the construction of improved and protected water springs for their water needs as one way towards this goal. Reticulated water projects may source their water from existing wetlands to encourage communities to protect them. The handicraft industry utilization of wetland resources such as papyrus reeds and soils would also make the communities concerned relate to the wetlands in a more sustainable way. Machena (1992), has also suggested direct involvement of local communities in wetlands management decisions.

According to Magadza (1994), all wetland conservation projects in Zimbabwe rely on customary laws and indigenous technology. One of the very successful projects is where people are discouraged from intensive agriculture. Instead, an external market for wetland products such as mats, chairs and decorating flowerpots was found. People, therefore,

prefer improving skills and techniques employed in making these products and the ways to improve the productivity of their wetlands.

In Mozambique there is already awareness that economic forces can overwhelm ecological and environmental needs (Massinga, 1993). According to Massinga, economic uses of wetlands should be an integral part of environmental management efforts. IUCN (1994), adds that the economic objectives of utilizing wetlands should account for ecological processes sustaining the wetland in order to ensure sustainability.

Masese (1996) summarizes the dichotomy of wetlands planning this way:

> Man and his technology must struggle to fit into the physical form of wetlands because wetlands can afford to do without man, but man can never do without wetlands (Masese, 1996: 102).

2.1 Global Status of Wetlands

The status of wetlands differs from region to region and from country to country. Human activities are the major threat to these ecosystems (UNEP, 1992). The extent of the threat varies globally and regionally. In Latin America and the Caribbean, for instance, the major threats to wetlands are pollution, hunting of wildlife and drainage for agriculture. On the other hand, East Asia, the major threats are reclamation of wetlands for human settlement and industrial development. In South Africa wetland resources are threatened by commercial hunting, human settlement, commercial forestry and domestic woodcutting (Masese, 1996).

Extensive areas of tropical wetlands therefore are lost either as a result of conversion to intensive agriculture or industrial use, pollution and unsustainable levels of livestock population and fishing activities (Turner and Jone, 1984; Finlayson and Moser, 1989). Goodland and Ledec (1989) have asserted that until two decades ago, large proportions of the world wild land including wetlands were protected by their marginal usefulness for agriculture and other activities. The last 30 to 50 years have, however, witnessed rapid conversion of wetlands in all developing countries. For instance in Asia, 50% of wetland are moderately or severely threatened. This figure rises to 86% in Malaysia and 82% in

Bangladesh. In Europe, out of 318 wetlands recorded in the 17th century, there are only 58 left (Ledec 1989). By 1980, 69% of the wetlands in the United Kingdom and the Netherlands had been lost (UNEP, 1992; Finlayson and Moser, 1989).

Although Africa has retained most of its natural wetlands, they are increasingly under threat from drainage for agriculture, industrial development, settlement, over fishing and wildlife extraction and pollution. Ochumba (1990), has argued that the canal on Jonglei will reduce the Sudd swamp in Sudan by 40%. This, in turn, may reduce water tables and lead to drier conditions. This change will also reduce primary production and reduce the biomass. It will also lead to emergence of urban centers, increased population and make wetlands more open to negative uses. Wetlands in Africa are also threatened indirectly through forest destruction, which leads to siltation. This is true of the wetlands of the Niger and Congo forests. Mining of swamp peat for energy in Rwanda, and for dam construction such as the Aswan High dam on the River Nile, Kainji on the Niger and Kariba on the Zambezi, have also been great threats to wetlands conservation (Finlayson and Moser, 1991).

2.2 The Role of Wetlands

Wetlands have many positive ecological and environmental functions. Tiner (1989) give three categories of functions. The first is fish and wildlife values. The second is environmental quality values and the third is socio-economic values. Organization Trade Agency (1984), on the other hand, gives two categories of functions namely, the intensive values, on the one hand and the ecological services and resource values on the other. Most writers adopt the OTA categorization of the wetlands.

2.2.1 Flood Control

Floods destroy human settlements in low land areas. Where wetlands are drained for other purposes the flood problem becomes a permanent life-threatening phenomenon. This is because the wetlands function as temporary storage of surface run-off water to regulate the flow down stream (Michael, 1975). The reservoir function of the wetlands assists in the slow release of the water from a number of tributaries (Tiner, 1984), following which not all floodwater reach the main channel at the same time. Many other studies show that

wetlands reduce stream flow and reduce floods. For example, potholes in the North Dokota Prairies store nearly 75 percent of total run-off (Noutziki, 1977, Ludden et al. 1983). Peak floods would be 60-65 percent less if a watershed had at least 15 percent of its area in wetlands or lakes compared with a situation where no lakes or wetlands were present (Zinn and Copeland, 1982).

The implications of wetland conservation in less developed countries would be enormous. Instead of costly dam building and dredging, the retention of fringes of wetlands with the continuation of land uses sympathetic of the watercourses might yield major dividends in flood control (IUCN, 1996). Centuries of embarking and reclamation on the Gange-Brahmaputra delta have reduced wetlands by many hundreds of square kilometers and this is part of the cause of the severity of the downstream flooding that has occurred there with heavy loss of life in 1975 and almost annually since then (IUCN, ibid).

On the Charles River in Massachusetts, The US Army Corps of England recommended that the most effective means of flood control was to protect the existing wetlands, which naturally absorb flood waters rather than to build dykes or dams (IUCN, ibid).

From the foregoing arguments, wetlands can be said to be constantly at risk of losing their combined economic, environment and cultural functions to those whose livelihood system are intertwined within the natural existence.

2.2.2 Plants and Animal habitats

Wetlands provide habitats for a variety of plants and animals. For example, wetlands are an important ecological link between the Northern and Southern hemispheres for millions of migratory birds that travel between the two hemispheres twice every year (Masese, 1996). For example, the blue twinkled teals commutes 6000km from Canada to Argentina and Uruguay. On the other hand, the northern pintait and garguey birds travel every year from the Siberian tundra and twiga in Russia to the tropical wetland of Chad and Senegal in Africa. The journey of these birds requires an unbroken string of wetlands as stopping places along their route (KWWG, 1998). Interfering with these wetlands would mean that

these natural bird migrations will be disturbed and this would affect other activities such as tourism.

In the USA, Prairie wetlands are highly valued wildlife habitats. These wetlands serve as the most critical habitat for migratory birds in North America. The area constitutes only about 10% of the wetland acreage in USA, yet it produces half of North America's ducks in an average year and up to two-thirds in some years. Prairie wetlands make up brooding areas for 80% of all ducks in the Great Plains and they are critical nesting and staging habitats for dozens of species of non-game migratory birds, from whooping cranes to pelicans to arocets and other shore birds (Hook et al, 1998).

Further still, wetlands provide habitat for invertebrates and cold-blooded vertebrates which contribute to the support of the wetland faunal community as a whole through both trophic and non-trophic roles (Clarke, 1979). Consequently, wetlands figure largely in the cycle of many fresh water and coastal fish that are wetland food dependent, use the wetlands as nursery grounds and often spawn in the aquatic habitats of the wetlands (Peters et al, 1979). The type and abundance of plant life in the wetland also affect the animal population (Turner and Boesch, 1988).

The bulk of the USA commercial and salt-water fish catch is at the coastal estuaries and wetlands. Between 66% and 90% of the commercial fish and shell fish species on the Atlantic and Gulf coasts rely on coastal marshes and estuarine habitat for at least a portion of their life cycle (McHugh, 1976). At the Pacific coast, wetlands are essential for the spawning of the salmon species. The evidence is that in other continents something approaching the same proportions of fish and shell fish are dependent on wetlands, a factor that is of greater importance in countries of developing regions because fish is often about the only source of protein available (McHugh, ibid).

Significant animal populations also entirely depend on wetlands for their continued survival. For example, in North America the muskrat, nutria, beaver and marsh rat fall into the 100% dependent group. Others such as the mink, racoon and a number of deer species fall into the non-dependent group (Weller, 1981). Each animal has its own particular

territorial range, with the muskrat and beaver having the broadest range from the Arctic to the warm South-east of the American continent in both salt and fresh water, while the nutria are restricted to Louisiana and surrounding states with warm and fresh water. Larger animals such as the alligator and crocodile inhabit the coastal wetlands of Florida, North Carolina and west to Texas, as well as the northern territory in Australia.

Fresh water wetlands contribute 80% of the fish production in Tanzania. Common species in the lakeshores, muddy bays and surrounding marshy areas include *Propterus aesthiopicus* (lungfish, "kamongo"), *Clarias mossambicus* (catfish, "mumi" or "kambale"), and species of Tilapia, or *Eochromis* and *Sarotherodoa*. Mangroves characterize estuarine ecosystems and are grounds for feeding, breeding and nursery grounds for many species (Semesi et al 1990), and they support a variety of insects, birds and small animals. They also provide protection from storms, act as windbreaks, control erosion, stabilize shorelines and enhance water quality in coastal stream estuaries.

2.2.3 Water and Shoreline Protection

It is clear that a coastal marsh absorbs wave energy and reduces physical impact of waves and currents on shorelines. This is a buffer role that reduces erosive power on the land. More than 50% of wave energy is dissipated within the first 2.5m of the wetland. In the absence of the wetland, the 50% wave energy has the capacity to destroy hectares of human settlements (IUCN, 1996).

Coastal marshes absorb wave energy and reduce erosion on estuarine shorelines and so buffer the lands from storms. Many coastal wetlands are now recognized as providing important protection from storm. Thus in USA, federal regulations state that insured communities shall prohibit the destruction of mangroves or loose federal flood insurance.

Rising sea levels are a result of many factors, the key ones being global warming and soil deposits in the sea due to soil erosion. Wetlands are known to trap silt and release purified water. Conservation of wetlands could, therefore, be one of the essential strategies in reducing sea rise and thus reduction of dangers in sea flood damages.

2.2.4 Pollution Control

Pollution control is very expensive and beyond the capacity of many developing countries and local governments to manage. The rise in soil and water pollution incidences requires more advanced technology to clean the waters. This is seldom affordable for most developing countries. Wetlands intercept the run-off from the uplands before it reaches channels trapping and filtering out pollutants. This improves the quality of the water that flows downstream (Kadlec and Kadlec, 1979). Wetlands also remove substantial nitrogen and phosphate components that find their way into water ways from the large quantities of nitrogenous and superphosphate fertilizers (Van der Valk et al 1979; and William et al, 1988).

Wetlands also have a sewerage treatment function, especially in the digestive process of human and animal waste (Valiela, 1990). In Uganda, the National Sewerage and Water Corporation supports conservation of papyrus swamps and other wetlands in Kampala's environs because of the role they play in absorbing sewerage and in purifying water supplies (IUCN, 1992). Once they are absorbed the non-biodegradable metals sink to the bottom of a wetland and are buried as the sediments accumulate and decay into bog (Mavuti, 1992).

2.3 Efforts to Conserve Wetlands Through the Ramsar Convention

The Ramsar Convention is a major international treaty that is dedicated to the conservation of selected wetland ecosystem types along with the species dependent upon them. The convention entered force in late 1975 following the accession of the seventh party, Greece. Kenya is one of the contracting parties.

The convention stresses the value of wetlands for the conservation and management of numerous species, for economic benefits from fisheries, agriculture, water storage and flood control, as well as for tourism and recreation and for moral or aesthetic reasons. Appreciation of these values of wetlands is ever improving. So too is awareness rising about the sorry situation that wetlands are seriously degraded by transboundary air and water pollution, and much of the wetland fauna are migratory species whose conservation and management require international cooperation.

The main principles of the Ramsar Convention include wetland conservation being included and given due consideration within national land use planning. Land use planning should be formulated and implemented so as to promote the wise use of wetlands within countries, designation of wetlands for inclusion in a list of wetlands of international importance and the contracting country informing the Convention Bureau of any likely changes in the ecological characters of the listed sites. Other principles include establishment of wetland nature reserves and parks, and training of personnel competent in wetland research and management to provide a professional working group.

2.4 Case Studies of Wetland Management in Various Countries

This section examines the different experiences and lessons learned from varying cases of wetland management around the world. The experiences offer different wetland dynamics and management strategies.

2.4.1 The National Wetlands Program in Uganda

The problem in Uganda is that while mapping exercise can readily identify larger sites such as Lake Kyoga, and the fringing wetlands around Lake Victoria, many smaller sites are missed. Yet, these small wetlands may be of great importance for the conservation of biological diversity. Indeed the interface between these wetlands and dryland is of special importance for conservation of biological diversity and use of human communities. These small wetlands are therefore deserving of high priority within a wider use program (Mafabi and Taylor, 1993).

Despite the great importance of Uganda's wetland resources, the rising population together with agricultural and industrial production are diminishing the wetlands at a first pace, through large scale agricultural conversion, drainage, industrial pollution, excessive harvesting of natural products and settlement.

In 1986, the government released an interim ban on all large-scale wetland drainage. Three years later a national Wetlands Conservation and Management program was initiated based in the department of Environment Protection and a selective inventory of

representative wetlands under stress was carried out. Identification of the values and services provided by the wetlands Makerere University found out values to be fisheries, socio-cultural values, sustainable use of papyrus, and swamps as filters of pollutants. Further identification and quantification of threats to wetlands was done coupled with a detailed review of previous wetland development activities. On top of this, provision of technical capacity at the department of Environment Protection was carried out which culminated in developing a national wetland policy that emphasized governmental and public awareness. These efforts have had a major effect of conserving wetlands in Uganda.

2.4.2. Indigenous Management Systems and Integration of Small-Scale Interventions in the Logone Flood Plains in Chad

This case study looks at the positive role traditional systems and small interventions can play in supporting sustainable use of wetland resources and improving sustainable development in rural wetland areas, in particular in the Middle Valley of Logone between Eve and Lai. For centuries, the productive and fertile flood plains of the Logone have attracted invading tribes. In recent years an increasing number of nomadic pastoralists, Fulbe and Shoa-Arabs, have moved into the region and become permanent residents in the face of deteriorating conditions for the animals in the Sahel zone. Foreign NGOs are active in the region with small projects. Since 1987, a local NGO Association d' APPu aux Initiatives locales de D'evelopment (ASSAIHD), has supported local activities by facilitating credits, education, training and technical assistance (Kodi and Jeroen, 1993).

Due to the increasing pressure on the flood plains the government developed policies to conserve the wetlands that included protection and regeneration of forests, pastures, fish and wildlife; the use of flooding and inundation for production of cereals, fish, rice and meat. Flood development activities are given more priority than irrigation technology Further, the Lake Chad Basin Commission regards water allocation as the essential issue for the sustainable resource utilization of the whole Lake Chad Basin. New projects are assessed for their water demands before being cleared. Socio-ecological balance is given as the basis for sound development and active cooperation, and consultations with the local population are considered essential for restoration and development activities.

Foreign and local NGOs are widely accepted by the government as the main source of development interventions, prioritizing participation of the people.

2.4.3 Use of Floodplain Wetlands in the Kafue Flats in Zambia

The WWF - Zambia wetlands project activities in the Kafue Flats Project area firmly link flood plain wetland management with human socio-economic development at the local and supra – local community level. The assumption upon which the project is based is that the Kafue flat project area will remain primarily a protected area for wildlife management purposes. However, this assumption is demonstrated by accepting that the principal human interventions developed at the Kafue Flats are a reflection of real human needs. They should therefore be integrated into a wetland management scheme (Jeffrey, 1993).

Indigenous local communities are involved in small activities friendly to wetlands such as dry season grazing, subsistence farming and fishing. On the other hand, large-scale commercial zones have invaded central wetlands, such as the Nakambala Sugar Estate, which threaten the sustainability of wetlands.

Surprisingly, in as much as the local people benefit from the sugar, they resent the project because it largely overlooked local needs and also claimed traditional grazing grounds. Less obvious is the fact that irrigated agricultural schemes are major consumers of the Kafue Flats water resources. •People prefer small industries in wetlands that support grazing and fishing, brick making and farming. The people therefore have formed committees seeking government intervention to protect wetlands for grazing, fishing and wildlife rearing.

The government has responded by developing a natural resource management infrastructure involving different stakeholders and giving central authority to local people to decide on what the wetlands should be used for, developing community and economic infrastructure. In economic infrastructure, 40% of wildlife proceeds go to wildlife management practices, 35% to local community development activities and 15% to water development.

2.5 Lessons Learned From the Case Studies

A national wetlands program gives wetlands their due value in the country. Further, without co-operation of different government arms, private bodies, industries, NGOs and individuals, no much success can be achieved in wetlands conservation. It is also realized that participatory awareness is central in developing a wetland policy and inventory of all wetlands is key to the conservation of the wetlands. People are capable of managing the natural resources around them through the maintenance of traditional practices combined with new technology. Further still, responsibility or ownership of resources, and the right to use and profit from them, forms a better basis for their sustainable use than free use open to everybody. Not all-traditional management systems are sustainable. Integrated small-scale development and people participation are necessary to match growing demand and ensure continuation of sustainable resource use. Development of a management strategy to maximize the local and national benefits from existing and proposed land use practices boosts local people's appreciation of wetlands. Finally, providing the means for local communities to participate in natural resource management and for them to implement their own community development programs, and to develop their capacities for active professional and business inputs to their home areas would go a long way in conserving wetlands.

2.6 Summary

This chapter has presented wetland issues across the world. It has underlined the ecological and physical importance of wetland resources. Due to the realization of these impotencies, different countries and specific communities have developed management strategies to protect the wetlands. It is widely recognized that integration of the needs of the adjacent communities to wetlands is a priority if wetlands are to be sustainably managed. The next chapter evaluates the Kenyan wetland situation in light of the global trends.

CHAPTER THREE

WETLANDS SITUATION IN KENYA

3.0 Introduction

Kenya is endowed with a diversity of wetlands ranging from the coastal marine marshes, fresh water lakes such as Lake Victoria and Naivasha, swamps such as Kabula and Yala, peats, mountain bogs and man made water dams such as Kindaruma and Masinga. These wetlands have diverse socio-economic and ecological functions. Lake Nakuru, for example, hosts millions of flamingoes that play a significant role in promoting the tourism industry in the country. On the other hand, the Yala swamp plays an important ecological role of purifying the water from the heavily settled catchment areas before releasing it to Lake Victoria. A research done by the Kenya Wildlife Service in 1993 revealed that the chemical content of water from River Nzoia entering the Yala swamp upstream is 61% higher compared to the water leaving the swamp to Lake Victoria (KWS, 1993). This swamp therefore contributes tremendously to maintaining the freshness of lake Victoria and in balancing the lake's ecological diversity (Okondo, 1989). The swamp is heavily utilized for crop production. The existence of the wetlands is, however, threatened by the pressure from different human activities including farming, industrialization, urbanization and human settlements.

3.1 Socio-Economic Values of Wetlands in Kenya

The life, culture and history of the people living near wetlands are linked to the particular resources found in such wetlands. Farming, fishing, hunting, religion often reflect the use people attach to the wetland resources in their locality. Whether hunter-gatherers or traditional fishermen, there are always useful resources that are drawn from the wetlands to satisfy certain ceremonial requirements, handicrafts, industrial inputs, medicine, clean water and food (Krhoda, 1994).

Indigenous African land use systems encouraged land use practices that supported balanced use of natural resources. Shifting cultivation and common grazing are good examples. Among the Babukusu people and other sub-groups of the AbaLuyia people in

Western Kenya, the circumcision ceremony was and still is a highly important social and cultural event. Wetlands where prospective initiates are smeared with mud before circumcision rites are sacred sites. The criteria used in the choice of a site include privacy and presence of ample water and mud. At the onset of the ceremony, the Babukusu youths are taken to the sacred wetland sites where they are smeared thoroughly with mud, and then they are escorted back home. There are two symbolic meanings attached to this. First, the soil gives protection similar to that of the mother's womb-keeping the young man warm as he undergoes the ceremony. Secondly, this is the last time that the young man is expected by the society never to go naked as he has been initiated into manhood.

It is important to note that the muddy soil is only found in some places in the wetlands. The traditional beliefs about these sites, in line with the traditional needs are such that these places must not be interfered with and should not be fenced even when privately owned (Ogutu, 1987).

Hunting of wild animals was a popular social and economic activity among the Luo and Abaluyia. Birds and animals were hunted for food, skins and feathers. According to Ogutu (1987), the points which rivers Yala and Nzoia enter Lake Victoria were swampy and bushy enough for the water-related beasts to inhabit. The hunters could easily lay traps in these concealed wetlands for big animals such as the Hippopotamus, or small rodents such as *anyier*. The hunters knew that these animals preferred to live next to water bodies. The wetlands in this case provided suitable hunting grounds. Honey collection for local alcoholic drinks and medicine was dependent on the cheap availability of bee- hive construction materials from the local wetlands (Ogutu, ibid).

Abaluyia and Luos collected a lot of vegetable and fruits from wetlands to supplement the supply of cultivated vegetables. The Abaluyia collected wild greens locally called *enderema* and *lubiliabila* from the wetlands. These plants were also used to cure certain ailments of the stomach. The fact that the land (wetlands) was commonly owned meant that one could collect fruits and vegetable that grew on wetlands without restriction. The changing land ownership system that encourages privatization of land has drastically reduced the importance of gathering wild greens (Krhoda, 1987).

Clay is a wetland product with a long history of economic and social-cultural importance. In building construction, clay of different types was used for plastering the walls and floors of houses (Odak, 1987). The clay varied depending on the local availability but those obtained from wetlands were usually preferred. Such wetland clay has also been used extensively in providing commodities such as cooking pots of different types and sizes and smoking pipes (Odak, ibid).

The herbaceous vegetation from the wetlands was harvested with the clay and used in the construction of houses and granaries. Traditional Abaluyia houses for example, had walls constructed from a framework of sticks or reeds and the roof was assembled separately from reeds or maize stalks tied to rings or grass (Were and Soper, 1986).

Basketry is another important indigenous industry that depends on the availability of twigs and grass (Odak, 1987). Mat making is a popular art among the Abaluyia people living in or near wetlands. The popular *marachi* sofas are made from *amaduru* reeds and branches of the *lusiola* tree. They are often colored with natural black and yellow dyes made from the wetland plants called *litodo* (Were and Soper, ibid).

Were and Soper (1986), comment that,

> Extraction of house construction materials from the wetlands is likely to continue in the future with slight modification as better technology is acquired. Although the traditional grass-thatched is slowly being replaced by corrugated iron sheet, the former is likely to be the only source of roofing material for poor families. Unfortunately sources of traditional thatch are becoming scarce due to over-exploitation of wetlands therefore there is an urgent need to encourage sustainable exploitation of wetland resources (Were and Soper 1986: 45).

Fishing is one of the key activities undertaken by communities living close to wetlands. Fishing has always been a major occupation of the people living along the Nzoia, Yala, Nyando, Sondu and Sio Rivers and their tributaries. In the traditional setting, the wetlands were utilized not only for fishing but also as essential sources of the raw materials used in making of fishing equipment. The conical basket traps *esivu* and

omukono, used by the Abaluyia people, were woven from reeds from wetlands, and were arranged in hexagonal patterns (Ogutu, 1987). It is possible that a number of people derived their livelihood out of making fish traps and baskets from raw materials harvested from the wetlands.

Livestock grazing in wetlands was, and still is, a common practice for many communities in Kenya. Ogutu (ibid), notes that the only notable difference today is that the social controls of these resources are quickly disintegrating.

The Njemps people living around Loboi/Kesubo swamps are an example of a people who have through generations maintained a socially acceptable system of "wise use" of wetlands. The wetlands are used for dry season grazing only. At the onset of rains, people and the animals move away from the wetlands to other areas for grazing and will only return when the dry season starts. A council of elders is vested with the high authority to decide when to start grazing in the wetlands again. Grazing is organized in such a way that overgrazing is minimized (Kimosop, 1990).

There are many other non-consumption benefits derived from wetlands including scenic beauty, recreational, educational, aesthetic, archaeological, scientific heritage and historical benefits that are difficult to define, let alone quantity. These non-consumptive and non-tangible values have usually been considered of secondary importance compared with the direct consumptive values. One would see how important a value like recreation in a wetland would be if one equates it to tourism. Kenya for example earned Ksh. 3.6 billion in 1988 and Ksh. 4.4 billion in 1989 from the Lake Nakuru wetland ecology, which supports flamingoes (GOK 1997). Destruction of such a wetland would mean a major drawback in the Kenyan economy.

One of the greatest functions of wetlands that is easily appreciated is the large capacity of wetlands to support agriculture. According to Mavuti (1992), wetlands can sustain agriculture throughout the year, whether in dry or wet seasons. The Mwea Rice Scheme is an example of a wetland ecology that can produce enormous food in terms of rice. Reclaimed wetlands produce new soils that are the basis of an enlarged food production. This has been the main reason for wetland transformation and diminution throughout the

centuries. The Yala swamp also produces tones of rice. However, according to Ogutu (1987), draining of wetlands for agriculture could be the greatest threat for wetland survival.

3.2 Status of Wetlands in Kenya

Wetland ecosystems in Kenya are being threatened by human activities such as reclamation for agriculture, establishment of industries and settlements as a result of rapid population growth since the 1950s (Njuguna, 1985). At the start of the 20th century, Lake Victoria and the associated wetlands such as the Yala swamp have undergone drastic ecological changes. Notable among the changes are the decline of endemic fish species, eutrophication and growth of the Water Hyacinth. These changes have been attributed to introduction of endemic species, pollution, drainage, increased agriculture, industrialization and urbanization (Odero, 1985; Gitonga 1992). One of the sad trends is the conversion of seasonal wetlands for the growth of luxury horticultural products for export such as what is done around lake Nakuru (Finlayson and Moser, 1991), a phenomenon that has reduced wetlands in the ASALs. This trend must be controlled if the loss of wetlands is to be prevented.

According to Masese (1996), most Kisii Valley bottoms with peat soils have been drained since the 1950s for agriculture. The inception of the Lake Basin Development Authority marked the beginning of extensive reclamation of the valley for agriculture. Over time the important functions of the valleys, as wetlands were lost. Effects such as the irregular flow of downstream rivers in Kuja have been the result. The tourist landscape has also been lost and a lot of soil erosion has taken place (Masese 1996).

In most of the cash crop estates, most of the dryland parts are put under the cash crops. Food cultivation and livestock grazing have therefore been pushed to wetlands. Intensive agriculture composed of drainage and use of machines and pesticides transferred to wetlands are some of the greatest threats to wetland.

Thika swamps and Ondiri wetlands are adversely affected by urbanization, industrialization and infrastructure development. Their fresh water status is polluted.

Thika swamps are rated as some of the most heavily polluted in Africa (IUCN, 1997). The Ondiri swamp has tremendously been drained to levels of drying up.

Because of the enormous threats to the wetlands in Kenya, the government has tried to put in measures to reduce the threats. Importance of wetlands in Kenya was first stated by the Kenya Government in its 1963 manifesto on conservation of natural resources. According to Masese (1996), the approach for wetland conservation has involved protective measurers characteristic of game reserves, national parks and nature reserves. The Kenya Wildlife Service is in charge of this. It is mainly concerned with the national parks and game reserves.

3.3 Laws and Regulations Governing Wetlands in Kenya

There are various Acts of parliament in Kenya, which have an implication on the utilization and conservation of wetlands. According to UNEP (1992), wetland conservation can only be achieved if guided by clear and articulate policies and laws. UNEP (1992), also says that many developing countries have scattered laws touching on wetlands, a factor coupled with lack of enforcement and inadequate public awareness that make the laws ineffective. In Kenya some of the laws that have implications on wetlands utilization include:

3.3.1 The Survey Act, Chapter 299

Surveyors play a critical role in land use planning, control and development. As UNEP (1992) puts it, surveyors could be effectively utilized to sanction wetland conservation and preservation since they are in direct implementation of land subdivisions.

Section 114 of the Survey Act directs the surveyor in defining the wetland boundaries during land sub-division as follows,

> Where an area fronts on a swamp, a give and take straight-line boundary should be adopted wherever possible. Indefinite media lines, which cannot be re-established by survey, shall be avoided. Swamps of an average width of 150 meters or more shall be excluded from farms, and a straight-line boundary along the edge of the swamp shall be surveyed and beaconed.

In this case, the Act is quite clear on the fact that any swamp with a width of 150m should not be subdivided, and therefore should be free of human development activities. Farms fronting swamps should have straight-line leaveways from swamps to conserve the wetlands.

The Survey Act section 110 (1) gives guidelines on surveying land with coast wetlands. It states,

> Where un alienated government land fronting on the seacoast is being surveyed for alienation, a strip of land not less than 60 meters in width shall normally be reserved above high water mark for government purposes.

The Act in Section 111 gives guidelines on surveying of land fronting tidal river reservations. It states:

> On all tidal rivers, a reservation of not less than 30 meters in width from the water edge at ordinary high water shall be made for government purposes.

In section 112, the Act directs on lake frontage wetland reservations as follows:

> For boundaries fronting on lakes, a reservation of not less than 30m in width from the water edge at ordinary high water shall be made for government purposes.

From the Survey Act, it is noted that the subdivision and beaconing of land has to give adequate space for the existing of water land frontage. Most of the small wetlands exist within a range of 68m from the water bodies. If these laws were enforced, then a good amount of wetlands would be intact. However, the law does not specifically deal with water bodies away from major waters such as rivers or lakes.

3.3.2 The Agriculture Act, Chapter 318

Agriculture as a land use could probably be the greatest threat to the survival of wetlands. Most of the wetlands worldwide are being drained for agricultural production. For the conservation of wetlands, it would be expected that policies and laws on agriculture should clearly define how wetlands should be utilized.

Section 48 (1) of the Act state:

> Whenever the Minister considers it necessary or expedient so to do for the purposes of the conservation of the soil, or the prevention of the adverse effects of soil erosion, any land he may, with the concurrence of the Central Agricultural Board, make rules for any or all of the following matters, for the preservation of soil on ridges, or slopes or in valleys, for the maintenance of water in a body of water within the meaning of the water Act, and the protection of slopes, and catchment areas.

This Act empowers the Minister to conserve any area as a catchment area. Many small wetlands do form the catchment areas for wide regions. Unfortunately, many of these small wetlands are not easily recognizable, and are missed during mapping and inventories. The Minister thus maps big wetlands and big forests as the catchment areas to be addressed by law. These many small wetlands are poorly catered for in the policy framework. If the small wetlands spread out on the private farms were not conserved, the big catchment areas would dry up. This is because the big catchment areas source their water from the small wetlands.

3.3.3 The water Act, Chapter 372

Hook (1988), defines wetlands "merely" as watery areas. The term wet refers to water. Therefore, for the conservation of wetlands, policies and laws dealing with water become central. The water Act section 16 states:

> Where the Minister after consultation with, or on the advise of the Water Resources Authority, is satisfied that special measurers are necessary for the protection of the water resources in or derived from any area, he may declare such area, or any part thereof, to be a protected catchment area, and may by order require regulate or

> prohibit the doing by any person in such protected catchment area of any act which he considers necessary for the protection of such area or for the protection of the water supply obtained there from, and any person ordered who fails to comply with the provisions of such order shall be guilty of an offence and liable to a fine not exceeding Ksh. 10, 000.

In this case, the Minister has the powers to monitor all-important catchment areas, and come up with policies to guide the use of such areas. The Minister has institutions on the ground to do monitoring. However, the fine for going against the order is too lenient.

The water Act (15) states:

> There shall be for each province a Regional Water Committee appointed by the Minister, whose duties and responsibilities in respect of such a province shall be, to advice the minister on water conservation development and policy.

The law, therefore, established machinery in which the wetland resources could effectively receive policies on utilization. It was expected, for example, that the Regional Water Committee would monitor the application of the Survey Act when land subdivisions are done. Wetlands with a radius beyond 150m for example should be zoned as catchment areas.

In section 37 (1), the Water Act states:

> No person shall drain, abstract or otherwise interfere with any swamp unless such swamp has been declared under section 31 of this Act not to be a water course, without having an authorization or permit under this Act.

It is therefore expected that all farmers have to seek for legal clearance before utilization in any form of the wetlands in their vicinity. The Regional Water Authority actually is the chief guide on how the wetlands should be utilized. However, for the efficient operations of the law, and for the law to be well known and appreciated by the local

people, they should be represented at the Regional Water Board. It is only through the education of the people, that the public will appreciate the laws.

Section 21 (1) of the Water Act states:

> The Water Resources Authority may require any person to furnish information relating to any existing or proposed waterworks of such person, including particulars as to the use of, and demands for, water supplies.

This section provides an efficient monitoring framework for the utilization of wetlands. Projects with harsh environmental impacts on wetlands could be rejected.

Section 21 (2) of the Water Act states:

> The Water Resources Authority may require any person to keep such records and furnish such returns as to the quantity and quality of water abstracted of him from any source and to such matters relating to such source as may be required by the Water Resources Act.

Heavy projects such as irrigation works and domestic water pumping from wetlands therefore need to be on record, approved and monitored. This would protect the wetlands from complete drainage.

Section 13 of the Water Act deals with compensation to the drainage of wetlands. This section states:

> If there exists wholly or partly upon any land, any swamp or any obstruction to the natural flow of water as determined by the Water Apportionment Board which is not authorized by the board and which tends to cause a diminution of the flow by evaporation, absorption or otherwise, the minister, upon application by Water Apportionment Board, and on the advice of the Water Resources Authority, and subject to payment of such compensation as may be decided, may order that such swamp be drained or that such

> obstruction be removed, and, in this sub-section, 'drained' includes the by-passing of the flow around any swamp.

This section indicates that for efficient management of the water resources including wetlands, the different government arms should work closely. Secondly, their actions and policies should be based on sound local and professional information. The manpower in natural resources management should therefore be developed. The Regional Water Board purportedly should have a wide involvement of the local community and their value systems on the wetlands.

3.3.4 The Physical Planning Act, 1996

The Physical Planning Act contains planning regulations on all interim areas and any other area that the president may specify. Where these regulations apply, no person shall carry out any development except with the consent of a local authority. The Act gives powers to the Physical Planning Department to prepare land use plans for all regions in the country. The department should therefore be on the forefront, working with District Boards in developing inventories of natural resources. Regional Physical Development Plans as provided for in section 16 gives the planners the powers to zone any area as a catchment area or area of scenic beauty and ecological importance. Gazetting them as catchment zones could effectively conserve wetlands that qualify under this category.

Watershed management is, therefore, a key role that Physical Planning Department should be undertaking. It should be having first hand inventories of all the existing wetlands, monitoring their exploitation and, therefore, developing policy guidelines on their utilization.

3.3.5 The Environmental Management and Coordination Act, 1999

This Act provides for the preservation and conservation of wetlands as catchment zones, areas of scenic and scientific importance, and areas of important ecological and cultural values. In section 42 (1), the Act states:

> No person without prior written approval of the Director-General given after an environmental impact assessment, in relation to a river, lake or wetland in Kenya, carry out any of the following

> activities, disturb the wetland, introduce any animal whether alien or indigenous, introduce any plant whether indigenous or alien, deposit any substance, block moving water or drain it.

This section therefore gives all the monitoring frameworks for wetland management. Sub-section (2) further states:

> The Minister may declare a wetland to be a protected area and impose such restrictions as he considers necessary. In declaring such a wetland protected, the Minister has to consider the geographical size and the interests of the communities resident around the wetland.

The communities staying around the wetlands can therefore seek for protection of their resources. They therefore have a *locus standi* to be *litigious* of their resources.

Section 43 states:

> The Minister may, by notice in the gazette, declare the traditional interests of local communities customarily resident within or around a lakeshore, wetland, coastal zone or riverbank or forest to be protected interests.

Traditional cultural sites could therefore be protected under this section. Sub section (3) further mandates the Minister to prepare development plans taking care of sectoral interests, control of erosion and protection of the wetlands. Therefore, the legal framework on wetland conservation is not lacking. However, it is possible that these laws are not effectively being enforced on the ground.

3.6 Gaps Identified From Global and Kenyan Wetland Issues

From the literature foregoing two chapters, it is apparent that many efforts have been invested in trying to come up with strategies, which can be used to conserve wetlands. However, gaps still exist.

Most efforts are geared towards the big and expansive wetlands like the Yala swamp in

Kenya, the Kafue Flats of Zambia and the Logone flood plains of Chad. These efforts 'uniquely' leave out the many small and widely distributed wetlands in the rural areas. Therefore knowledge, research, inventory and policies on these small wetlands are terribly missing. Unfortunately, most of the rural populations do interact with these small wetlands, and not the big expansive wetlands.

Given that the small and widely distributed wetlands fit into people's farmsteads, households mostly own them. Most of the efforts of wetland conservation and policies are geared towards the big wetlands as in (i) above. Therefore, the laws, policies and strategies involving the local communities are geared towards communally managed wetlands. The scenario of law and policies to involve the private individual wetland owners is missing. Unfortunately, the increasing population has it that land subdivisions will continue to make wetlands privately owned. More conservation efforts should, therefore target the individual wetland owner.

Policies guiding the conservation of wetlands by most governments, including Kenya, use the approach of zoning out the wetlands and declaring the conservation areas for wildlife or water catchment. This approach has in most cases completely fallen short of realizing the economic and socio-cultural values of the inherent populations. Wetlands are natural resources that should be utilized by the people for their well-being and development.

There is a lot of knowledge on the physical/ecological/environmental importance of the wetlands, and thereby the associated issues. Very little knowledge however exists on the socio-cultural and perceptive and attitude values of the local communities. Unfortunately, for conservation to succeed, the people should be the central target. To make the situation even worse, the great knowledge of the ecological functions of the wetlands may be only in the books, and not in the knowledge of the people who interact with the wetlands. Techniques of how to make the inherent populations to appreciate those "scientific" ecological functions are poorly developed.

It is highly noted in the literature that indigenous wetland management models are important in wetland conservation. It is even implied in the literature that these

indigenous wetland management technologies are the best in conservation. However, it is not clearly defined as to what extend these indigenous technologies function. It should be appreciated that with the increasing population, improvement in technology and industrialisation, the indigenous knowledge begins to lose grip in management of local resources. A good note is where wetlands are no longer community owned, but individual owned. Therefore, social values evolve into individual values. The communal laws may therefore not apply. The knowledge does not therefore effectively address the integration of modern technology and indigenous technology, and other supportive infrastructure such as law and physical planning.

3.7 Theoretical Framework

Several theories have guided approaches to natural resource management. The theories have mainly been biological and later transformed into ecological theories. These include Positivism, Reductionism and Preservation theories.

3.7.1 The Scientific Theory

Since the early seventeenth century, the Cartesian paradigm, usually termed positivism or rationalism has dominated conservation science. This posits that there exists a reality driven by immutable laws. This process involves trying to break down components of a complex ecology into discrete parts, analyzing them and then planning for them. Laws are developed to strictly manage the resources.

It is partly this positivist approach that has led to the application of virtually a uniform model for protected wetlands (as parks). Yet, there are some fundamental contradictions, particularly when it comes to concerns of sustainability. Sustainability in conservation terms thus has meant not damaging the natural resources. It has however become increasingly important to clarify what is being sustained, for how long, for whose benefit and at what cost.

The problem has been that scientific methods have failed to take conservation in a holistic way. According to Michel and Julius (1995), the trouble with positivist theory is that it gives credibility to opinion only when it is defined in scientific language. This may be inadequate in defining the complex and changing experiences of the people and other

actors in conservation. As it results, this approach has alienated most of the actors. Positivism has thus missed the complexity of ecological and social relationships at the local level.

3.7.2 Reductionism Science and Disciplinary Specialization Theory

Conservationist scientists and field officers tend to perceive ecosystems through the narrow window of their own professional discipline. Their training has taught them to look at just that aspect of the ecosystem in which they specialize, which may be medicinal plants, rare orchids, trees, birds or elephants. This then becomes the focus of their conservation efforts of the rich wetland. As a result, they commonly adopt just one or two criteria for deciding on priorities and measuring the success of the conservation efforts. This might be a simple measure of the number of birds in the wetland.

Conservation planning has thus remained largely rooted in natural science categories. For example, the conservation potential/threat index (CPTI) compares biological richness with wetland size, size of remaining forest cover, and deforestation rate, among other issues (Dinerstein, 1993). But there are still fundamental problems. These data bases under estimate the species diversity. Combined with Geographic Information Systems (GIS), this totally reduces the emphasis on giving more attention and learning from the users of the wetlands. The approach shifts attention upwards and away from people, from their means of subsistence and their local resource management. The knowledge, perceptions and conservation priorities of local resource users are rarely included in the new generation of rapid assessments that provide quality data in very short periods.

But what the approach miss are the complex internal linkages that matter in biologically diverse environments. Disciplinary specialization often militates against understanding the factors behind success of indigenous systems of natural resource management. As a result, opportunities to design culturally appropriate biodiversiy conservation plans are missed. What Nabhan et al. (1993) say about plant conservation illustrates the general problem of western, positivist, disciplinary science and its inherent ethnocentric bias:

> Regardless of the potential for building on indigenous peoples plant traditions to further the conservation of rare species, certain ethnocentric attitudes remain among Western trained conservation

> biologists which keep this potential from being fully realized. Because many biologists are intent on analyzing so-called natural systems, they often ignore that they are really observing relationships between organisms and environments that have been influenced by humankind over thousands of years... Even when they do not ignore human influences, such "natural systems" biologists typically treat human presence as a purely negative phenomenon, a nuisance or intrusion.

Indigenous and rural people, as managers of complex systems, have many different criteria that they weigh up and combine in the choice of management activities that influence the fate of biological diversity at a genetic, species and ecosystem level. This raises some important questions. Whose knowledge should count in the design of wetland conservation? Whose priorities and preferences should count for the successful conservation of wetlands? Is it those of the scientists or those of the rural people who participate in the making and reproduction of both wetland's diversity and their own cultural specific livelihood systems?

3.7.3 The Preservationist Theory

Over the last century or so, some Western ideologies have exalted the values associated with both the preservation of unspoiled wilderness and restoration of degraded areas to a pristine condition. For deep ecologists, preserving nature has an intrinsic worth apart from any benefits preservation may provide to future generations. Interventions in nature, they claim, should be guided primarily by the need to preserve biological diversity and integrity rather than by the needs of humans.

Several people have criticized these opinions of ecologists. Guha et al (1995) says:

> This frankly imperialist manifesto highlights the multiple dangers of the preoccupation with wilderness preservation that is characteristic of ecology... it seriously compounds the neglect of far more pressing environmental problems within the third world-environmental problems that impinge far more directly on the lives of the poor, e.g. food, fuelwood, fodder, housing and water.

3.7.4 Emerging Themes

In view of the weaknesses of the foregoing approaches, new paradigms have evolved These are covered under the wider theme of "sustainable development". They include participation, integration of indigenous knowledge, application of appropriate technology and stakeholder involvement. Sustainable utilization of wetlands means to use the wetlands for human socio-economic and cultural development while at the same time maintaining the ecological, physical and environmental functions of the wetlands (IUCN, 1992). In other words, this means reducing the impacts of human land uses as much as possible to preserve the natural functions of the wetlands, or, maintaining the wetlands as much as possible to their "pure" or "natural" state. The strategy to effectively manage and use wetlands has to be integrative, participatory and multi-disciplinary Various factors and patners have to be involved in the whole management process.

At the forefront of the management of wetlands should be the application of indigenous technology. The inherent population has interacted with the wetlands probably since time immemorial. They therefore have wetland management strategies, which may not be written but are implied in their activities and value systems. The strategies have made achievements, which should be appreciated and integrated in the land use planning. In addition, the indigenous knowledge have possibly some loopholes in managing the wetlands. These have to be appreciated and integrated in the planning strategies.

Building from the indigenous knowledge is the socio-economic value of the wetlands to the people. This could be seen in terms of the land activities in the wetlands. These land use activities practically show how the people value and perceive the wetlands. The activities determine the physical state of the wetlands. It is from analysis of the socio-cultural- economic values of the wetlands to the people that one can actually define a suiting land use plan.

From the land uses, an analysis has to be done of the technology the people use. Technological features that will affect the wetlands in future have to be planned for. Technological changes that have already affected the state of the wetlands have to be carefully modified and replaced with appropriate technology. Technology determines whether the wetlands are utilized well or not. A wetland management strategy therefore

has to design appropriate technologies that will facilitate both the socio-economic development of the people and the conservation of the wetlands. Technological changes are associated with the changing geographic patterns and the socio-economic aspirations of the people. Growing population, for example, influences size of land ownership and settlement patterns. This coupled with the changing socio-economic needs, directly influences the way the wetlands are to be utilised.

Management of a wetland should give a central focus to the ecological, physical, and environmental functions of the wetlands. Recommendations, for example, on the kind of technological application on the wetlands should incorporate these ecological, physical and environmental functions. It is appreciated that elimination of these natural functions of wetlands will affect the socio-economic well being of the society.

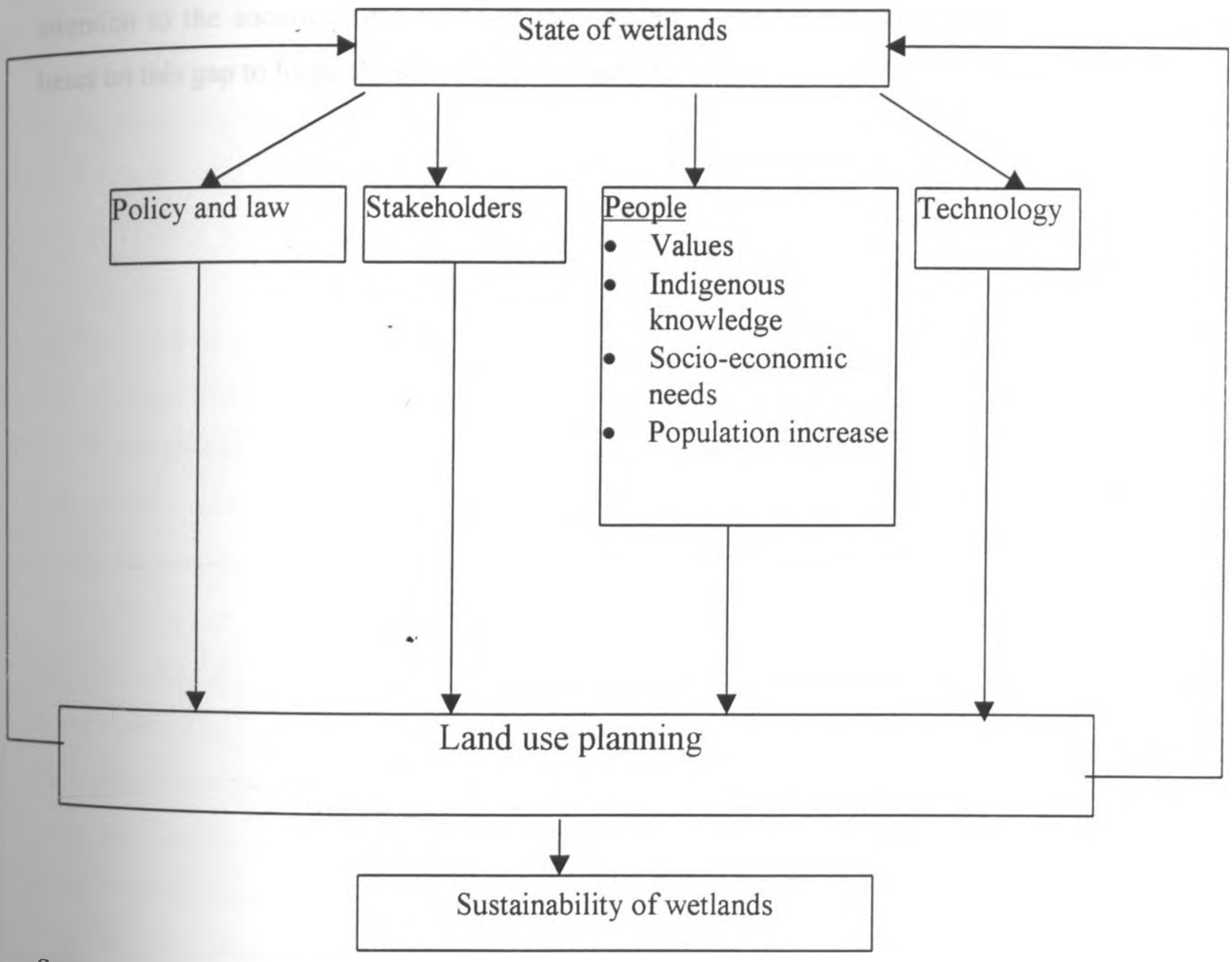
At the centre of a strategy for management of a natural resource should be the policy and legal framework. Policies should be developed on information and knowledge of the scientists, policy makers, and the local people. Policies have to address specific issues clearly and give responsibilities to specific institutions. The people managing such resources have to be mandated and backed by a strong and clear legal framework. There has to be established clear responsible bodies in enforcing the law. It is through the effective participation of each relevant stakeholder that wetlands can effectively be managed. Such policies should be integrative of the indigenous resource control systems.

The stakeholders have to play a role in the conservation of the wetland resources. Specific focus has to be on building the local capacities to manage their own resources. Physical plans, for example, can effectively be managed through the established Locational Development Committees. Such committees could integrate the groups with special interests in wetlands to develop programs of conserving them. The formal system of managing the resources has, however, to ensure that it does not over shadow the already existing indigenous management systems of the people.

All the above factors have to be co-ordinated through land use planning. Regional land use plans should incorporate inventory of wetlands to the smallest scale. District planning authorities should be at the central point of co-ordinating different stakeholders in

effecting the effective utilisation and management of wetlands. Land use laws affecting wetlands should, for example, be co-ordinated in an environmental law that will effectively be articulated by land use planners. Physical planning in collaboration with other stakeholders such as Surveyors, the Regional Water Authorities, and local authorities can enforce and implement the wetland utilization plan. The above foundation of knowledge can be represented in a theoretical model as given in the figure below.

Figure 3.1: Theoretical Model



Source: Author

3.8 Summary

This chapter has discussed issues concerning wetlands in Kenya. Wetlands in Kenya have immense socio-economic values such as farming, fishing, hunting and religious values. However, expanding human population is putting immense pressure on them leading to degradation. Due to this, the Kenya government has taken policy and legal measures to conserve wetlands. Acts that try to conserve wetlands include the Water Act, Environment Act, Survey Act, Agriculture Act and Physical Planning Act. Theories of resource conservation are biased to biological and physical concerns. There is little attention to the socio-cultural needs of the adjacent communities. The study therefore bases on this gap to forge ahead to integrate them in Kabula Location.

CHAPTER FOUR

THE STUDY AREA

4.0 Introduction

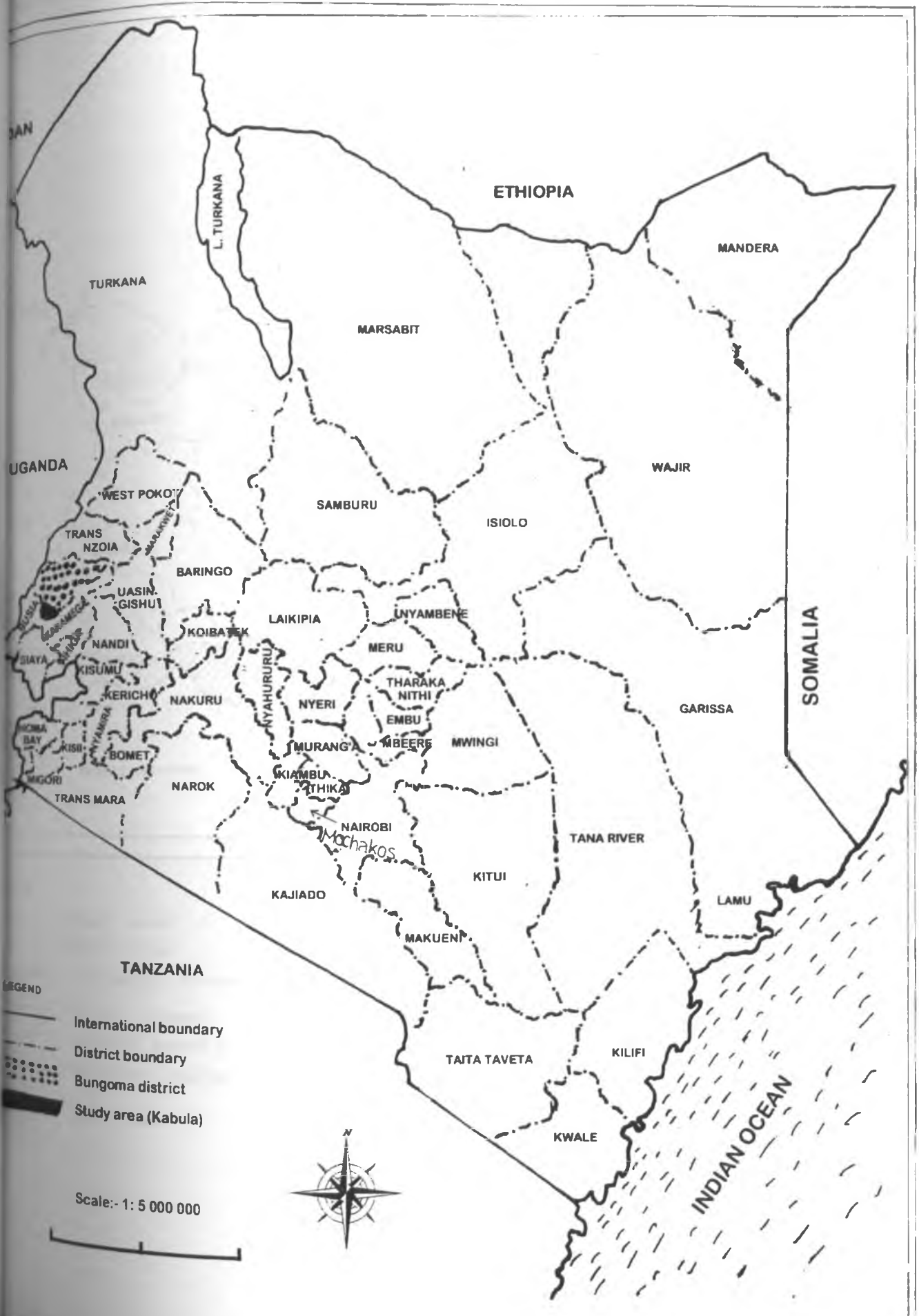
This chapter describes Kabula Location (study area) in the regional context. It considers the natural conditions, population characteristics, infrastructure and resource use patterns.

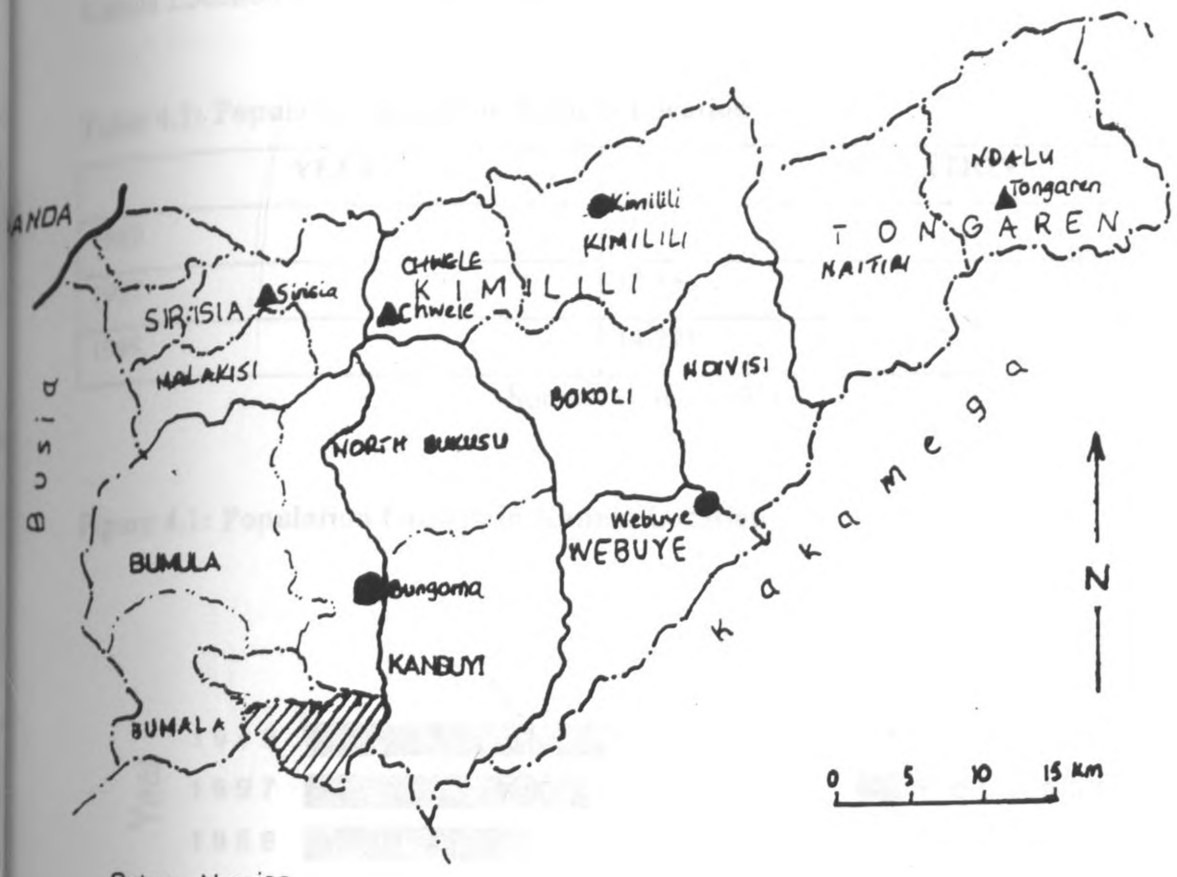
4.1 Position and Size

Kabula location is in Bungoma District. Bungoma District lies in Western Province. It forms one of the six districts of Western province. The district lies between latitude 0^{o} 25.3^{1} North and 0^{o} 53.2^{1} North, and Longitude 34^{0} 21.4^{1} East and 35^{o} 04^{1} East. It covers an area of 2063 square kilometers (Map 4.1).

Kabula Location is one of the 39 locations of Bungoma District. The location covers an area of approximately 44.1 square kilometers forming 2.13% of the district. The location falls within Bumula Division that forms Bumula Constituency. Kabula Location forms the Kabula Ward (Map 4.2). The administrative systems in the country play an important role in natural resource management and facilitation of development. The district focus for rural development for example works through the locational, divisional and districts hierarchy for the channeling of information, plans and proposals to the central government. The Locational Development Committee for example is an essential agent for the conservation of wetlands at the local level. Common resources at the County Council level such as the larger wetlands are under Locational Committees. Kabula Location makes one of the border locations between Bungoma District and the Butere-Mumias District (Map 4.1). This is an opportunity for inter-regional linkages such as business and migrations. Produce fro the Kabula Location wetlands could easily find their way into other districts through the Bungoma – Mumias- Kisumu road.

Map 4.1: Location of Bungoma District and Kabula Location in Kenya





KEY

- Urban center
- Rural center
- International boundary
- District boundary
- Divisional boundary
- Locational boundary
- Study area

4.2 Population Aspects

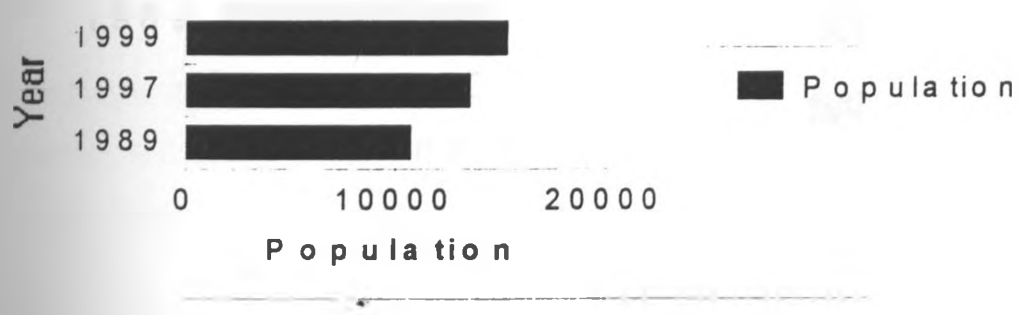
In 1999 Kabula Location had a total population of 14 291 people (Chief's office). This Growth is as a result of migrations and natural increase. Since 1989, the population of Kabula Location has grown as shown in table 4.1.

Table 4.1: Population growth in Kabula Location

YEAR	POPULATION
1989	10 750
1997	13 556
1999	14 291

Source: GOK (1997).

Figure 4.1: Population Growth in Kabula Location



Source: GOK (2000).

From figure 4.1, population in the location has steadily been growing since 1989 at the rate of 1.9%. The growth rate tallies with the Bungoma District population growth rate of 1.91%. Population increase has an impact on the utilization of resources especially land. Increase in population means an increase in density in land settlement. This has an increased land sub-division rate. Since wetlands are land resources owned by people on their farms, they are therefore also sub-divided and possibly put under more intensive use. The increase in population density is as shown in figure 4.2.

Table 4.2: Density over land in Kabula Location

YEAR	DENSITY
1989	244
1997	307
1999	326

Source: (GOK, 1997)

Figure 4.2: Density over land in Kabula Location

Source: GOK (2000)

From figure 4.2, population density in the location has been growing at the rate of 1.1%. Of the population in 1999, 64% was youthful, between 0-19 years (GOK, 1997). Out of this, males take 17%. This implies that in the near future they will require land to be further sub-divided. This has a direct impact on the utilization and management of wetland resources.

4.3 Physical Characteristics

This includes the rocks, relief, drainage and soils.

4.3.1 Physiograghic Features.

Rocks in Kabula Location are of Kavirondian system formed during the pre-Cambrian times and are between 400-3200 million years old. They are mainly sand and mudstone sediments together with boulder conglomerates. They are associated with pre-Cambrian granite intrusives (Simiyu, 1978).

These rocks appear in nearly all the micro area hills such as Syoya, Remwa, Talitia, and Wamunyiri (Map 4.3). Techtonic movements of Kavirondian period affected this area creating folds and faults (Simiyu, 1978). The movements were of east-west trend, creating anticlines and synclines that trend from north to south. In effect, these anticlines and synclines determine the sources and settlement of water therefore giving a spatial spread of wetlands in the location. The synclines posses most of the wetlands (Map 4.4).

Kabula Location lies on one of the anticlines while the other anticlinal folds form the neighboring Bulondo area on the east, and Mateka-Lumboka area on the west. The southward facing synclines are occupied by the two major rivers that flow on the eastern and western sides of the location (Khalaba and Sio rivers respectively) (Map 4.5). The two rivers form the regional boundaries of Kabula Location and they posses many small wetlands. There are numerous consequent streams on the slopes of the hills facing the two rivers. These numerous rivers consequently become very important in this study because they form the spatial basis of wetland organization (Map 4.5).

4.3.2 Drainage

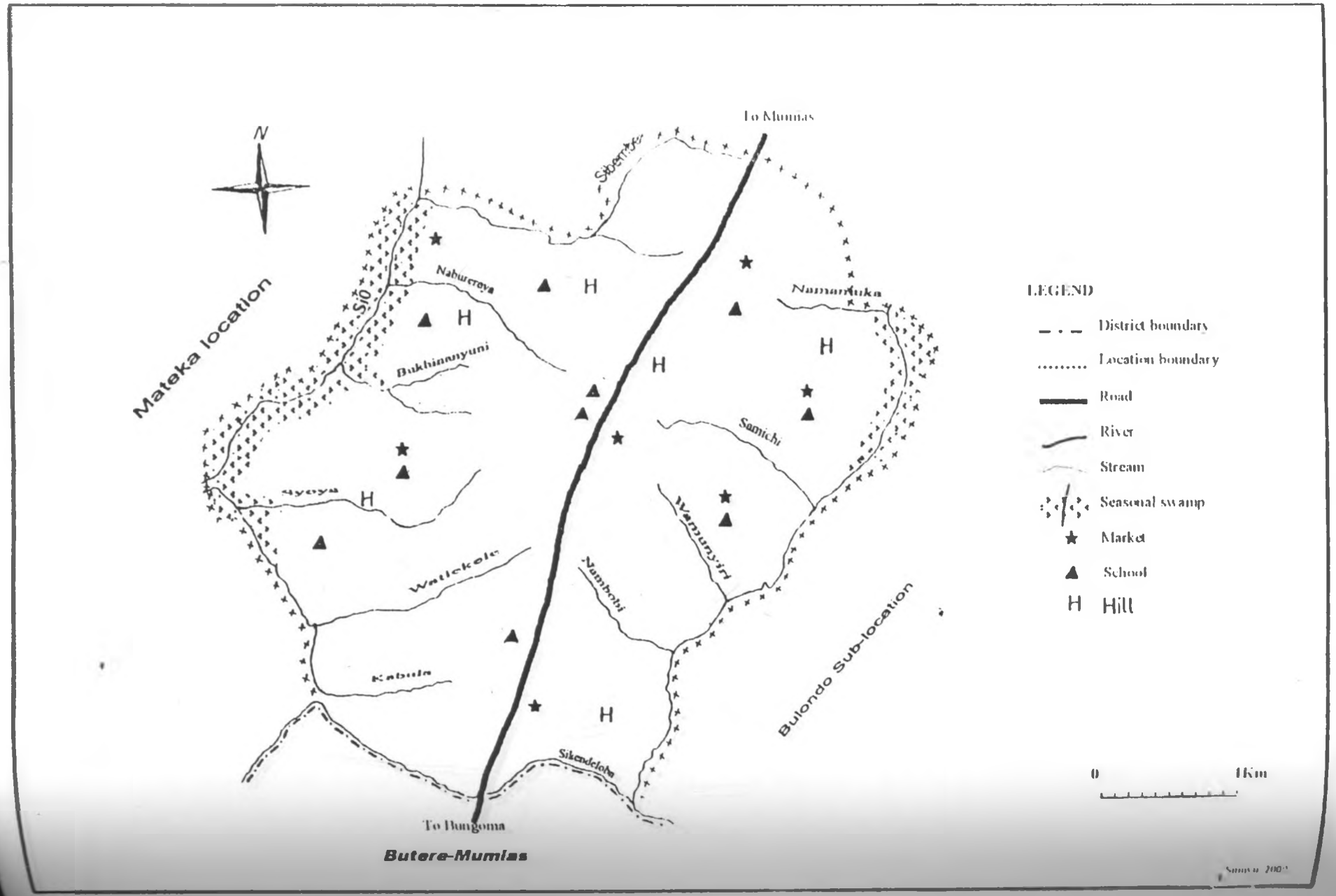
The flow of rivers and streams is governed by the physiograghy of the location. The two big rivers flowing in this area are Khalaba on the eastern side and Sio on the western side. The two rivers have the biggest wetlands in the location such as the Khalaba wetland on Khalaba River and the Bull come wetland on Sio River respectively (Map 4.6).

The Kabula ridge has a north-south trend with the highest spots a little above 1400 meters above the sea level. This ridge is highest around Kabula and Mwiruti schools. From this high points, consequent streams flow in the east-west directions, occupying the contour structural faults on the slopes. The streams that flow eastwards are Namamuka, Samichi, Wamunyiri, Wamumali, Nambobi and Sikendoloba. Those that flow westwards are Kabula, Watiekele, Syoya, Talitia, Naburereya, Namasanda and Sibembe (Map 4.5). Through these streams, Kabula Location is well drained, especially the higher parts of the ridge, which are suitable for habitation. The lower parts where rivers converge then form wetlands (Map 4.6). These wetlands then lead to other small streams.

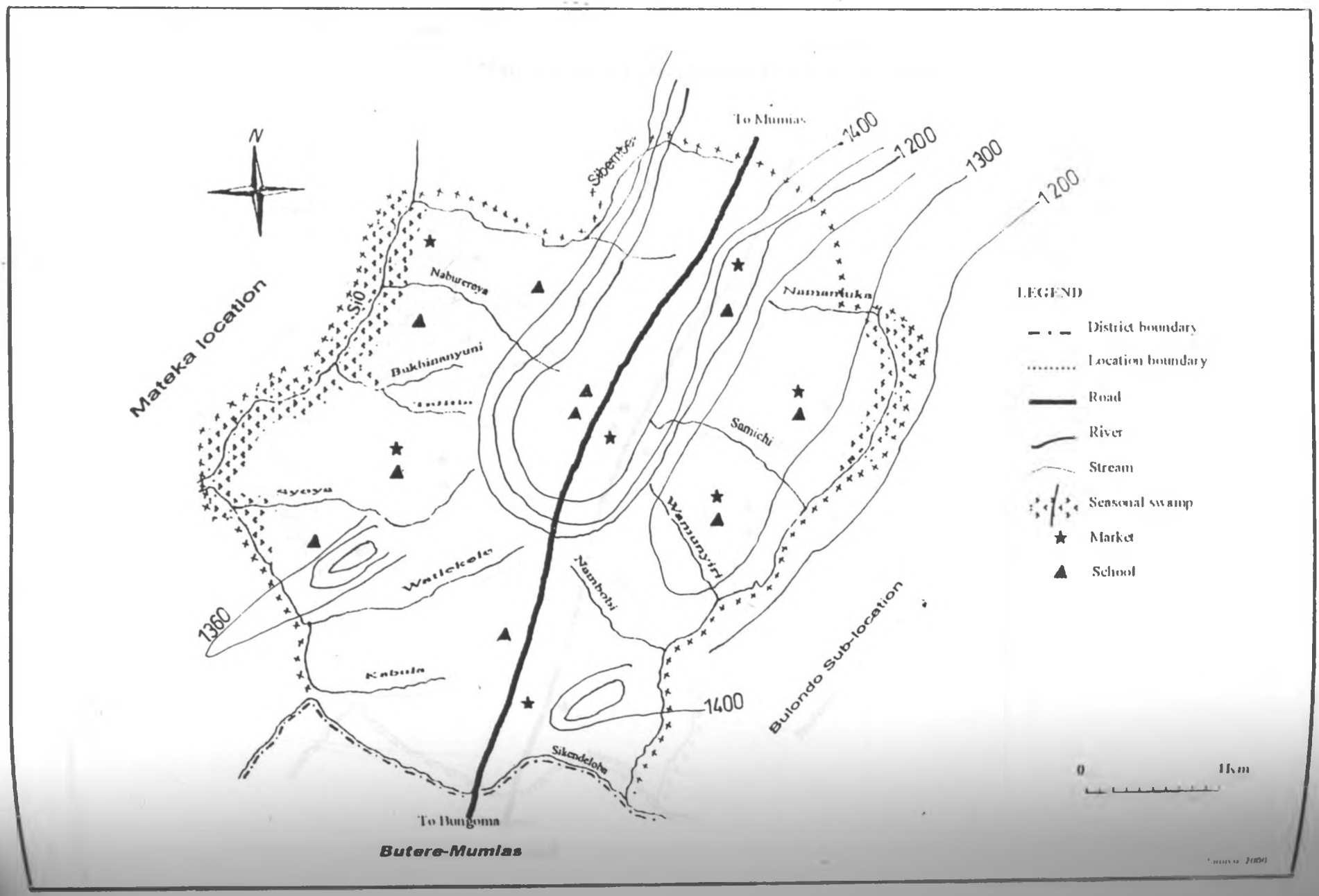
Impeded drainage in the river valleys makes the soil waterlogged and acidic, therefore suitable for cultivation only after having used technology and labour for drainage and application of fertilizers. The acidity of the soils has serious implications in terms of input weight required per unit area. According to Mumias Sugar Company (2000), wetlands require about twice the fertilizer input in drylands. One acre of sugar cane in a wetland requires approximately 900 kilograms of urea while the dryland require about 400 kilograms of the same fertilizer. This is necessary to reduce the high acidity content of the wetland soils to enable production. This therefore makes production in wetlands not only expensive but also detrimental to the ecology. Such soil characteristics therefore dictate what farmers can carry out on the wetlands. Land use planning policies therefore have to take into consideration such factors.

Drainage has negative impacts on the ecological functions of the wetlands. Tunnels that run along the slopes extensively reduce the water content and storage capacities of wetlands. Quick flow of the water in the tunnels promotes soil erosion and leaching.

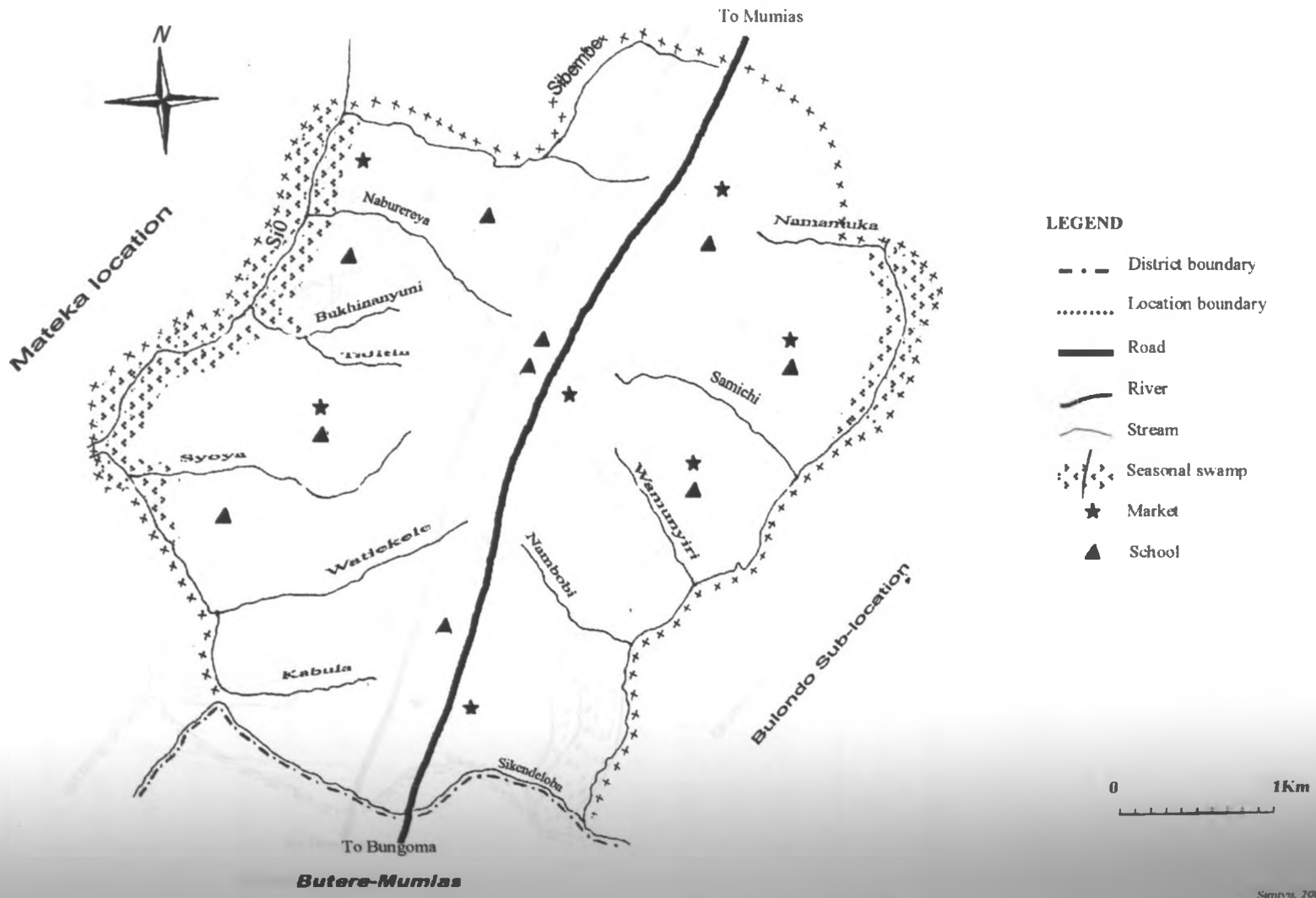
Map 4.3: Hills in Kabula Location



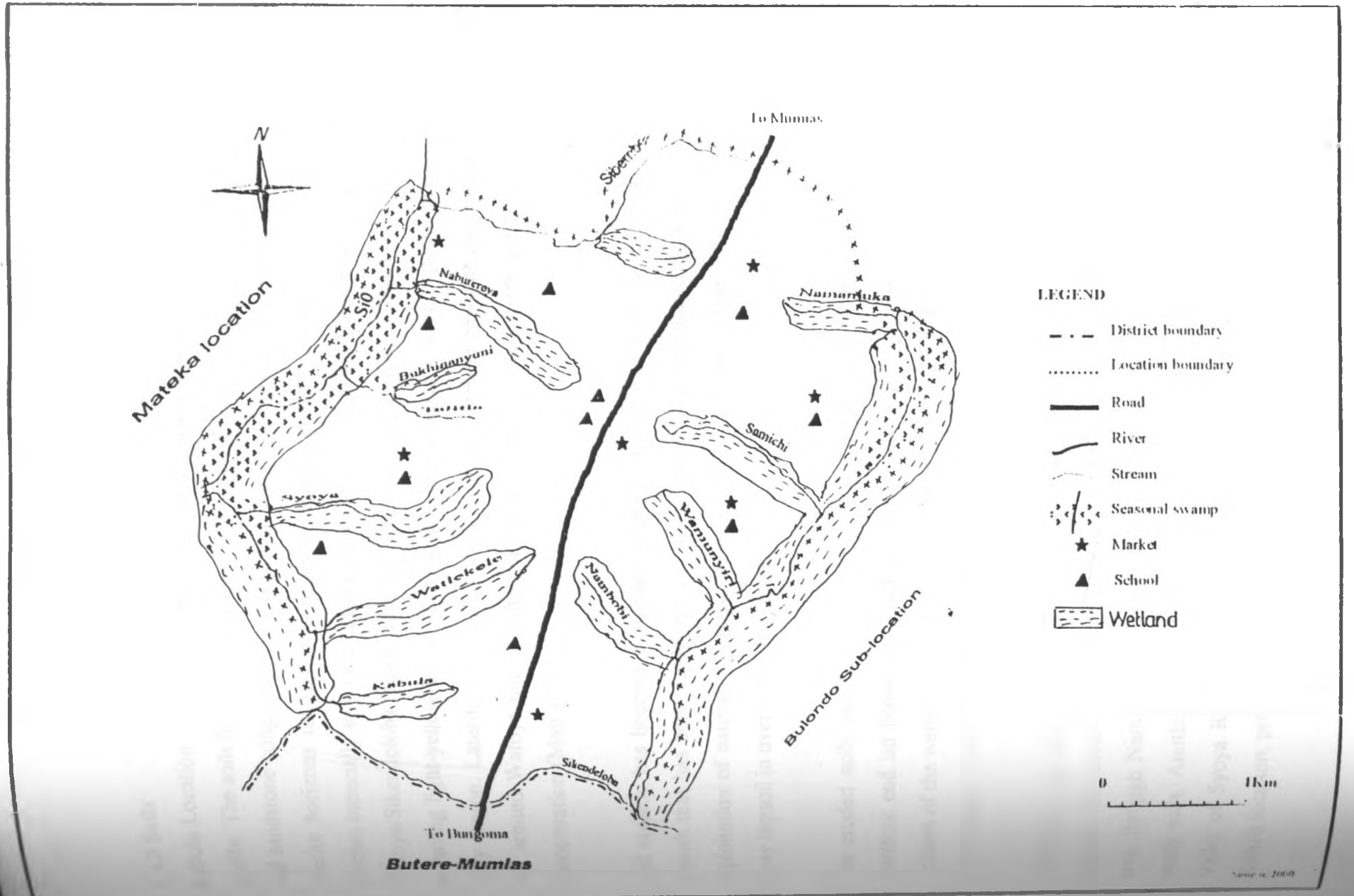
Map 4.4: Anticlines and Syclines in Kabula Location



Map 4.5: Rivers and streams in Kabula location



Map 4.6: Wetlands in Kabula Location



4.3.3 Soils

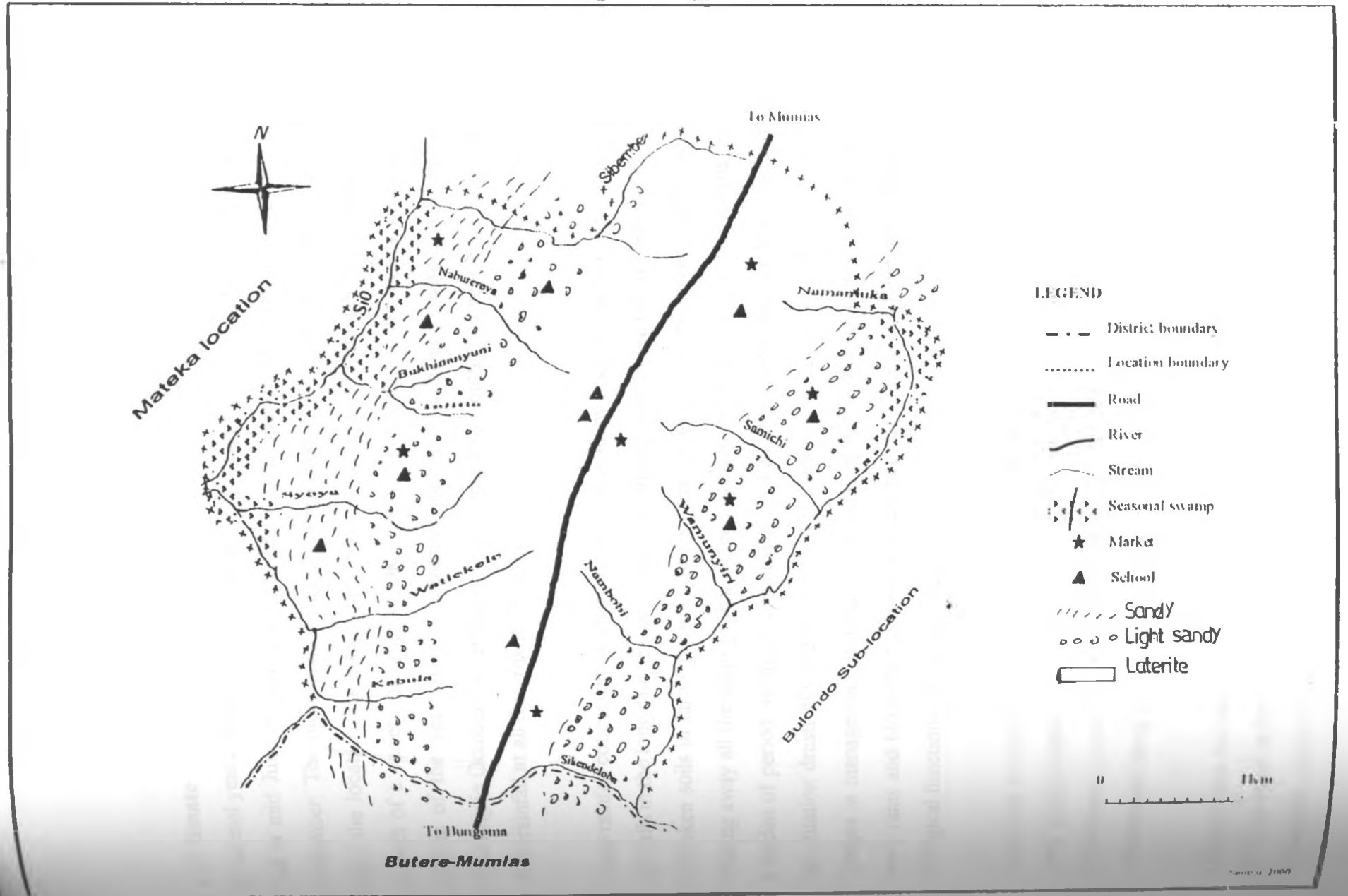
Kabula Location is a sub-miocene erosional surface whose soils are of great diversity in depths. The soils in the location are of mixed pattern having weathered from different sand and sandstone conglomerates. These soils vary from light yellow-brown sandy loams with laterite horizons to dark brown sandy loams. The latter types of loams are found in patches especially so on the eastern slopes of this area along Namamuka stream valley and Watoya/Sikendoloba region (Simiyu, 1978). The east of Kabula Location can be classified as having light-yellow brown sandy loam soil that tends to have impeded drainage in the rainy season. Laterite soils are common, especially around Mwiruti and Kabula schools and around Watoya market, and consequently these areas present the poorest wetland concentration (Map 4.7).

Soil erosion has become a problem in most parts of this area due to rapid population growth that has been experienced in recent years. The population increase means rapid exploitation of natural vegetation to give way to cultivation. Sheet erosion has washed away topsoil in over cultivated farms.

The eroded soils end up being deposited down the slope in wetlands. The wetlands therefore end up being more fertile than the higher parts of the location. Due to the richness of the wetlands, farming activities shift to wetlands. The pressure on wetlands for agriculture is bound to increase in future from the increased soil erosion in the dry lands.

Deposition of soils on the concave slopes has created differences in soil fertility and depths. The lower ridges of the slope flanking rivers Sio and Naburereya in Talitia micro-area, through Namasanda market and along Namasanda river valley tend to have fertile sandy soils. Another area that has deep and fertile soils is Remwa micro-area along the Valley of Syoya River. Notably then, wetlands come out as the most fertile areas in Kabula location, presenting a scenario which deserves prudent planning and management.

Map 4.7: Soils in Kabula Location



4.4 Climate

In normal years, Kabula experiences two rainy seasons. The long rains come in March and end in mid June or early July. The short rains start in October and have their peak in November. The mean annual rainfall varies from 1200mm to 1800 mm, (Map 4.8), and since the location has a moisture index of 10 units, the rainfall is just enough for the growth of a variety of crops (GOK, 1997). The rainfall is not evenly distributed in all months of the year. It is concentrated in the March-June season, with lighter rain occurring in October-November period so that five months in a year experience very little or no rainfall at all for growth of crops.

These rainfall concentration characteristics have many disadvantages, especially so the rain that falls in the long rain season. Within the short period of rainfall, the infiltration capacity of broken soils in farms is diminished so that erosion takes place very easily, sometimes washing away all the crops grown on land situated on steep slopes. It also means that over a sudden of period, wetlands are heavily soaked up in water and eroded soils, and again the situation drastically changes in the dry period. This is heavily reflected in the drastic changes in management systems of wetlands in terms of very heavy drainage tunnels in heavy rains and blocking the tunnels in dry periods. This could have great effects on the ecological functions of the wetlands.

According to GOK, (1997), over time, rainfall patterns are changing yearly, depicting a more undistributed rainfall pattern, and a lesser total amount. This, according to the Government, could be used to the destruction of the natural environment, which of late is concentrated along wetland areas.

Temperatures are also very variable in this location. Dry bulb house night temperatures have recorded as low as 16°c (62°F), especially in the months of July, August and early September. About 33°c (92°F) house temperatures have been recorded as highest daytime

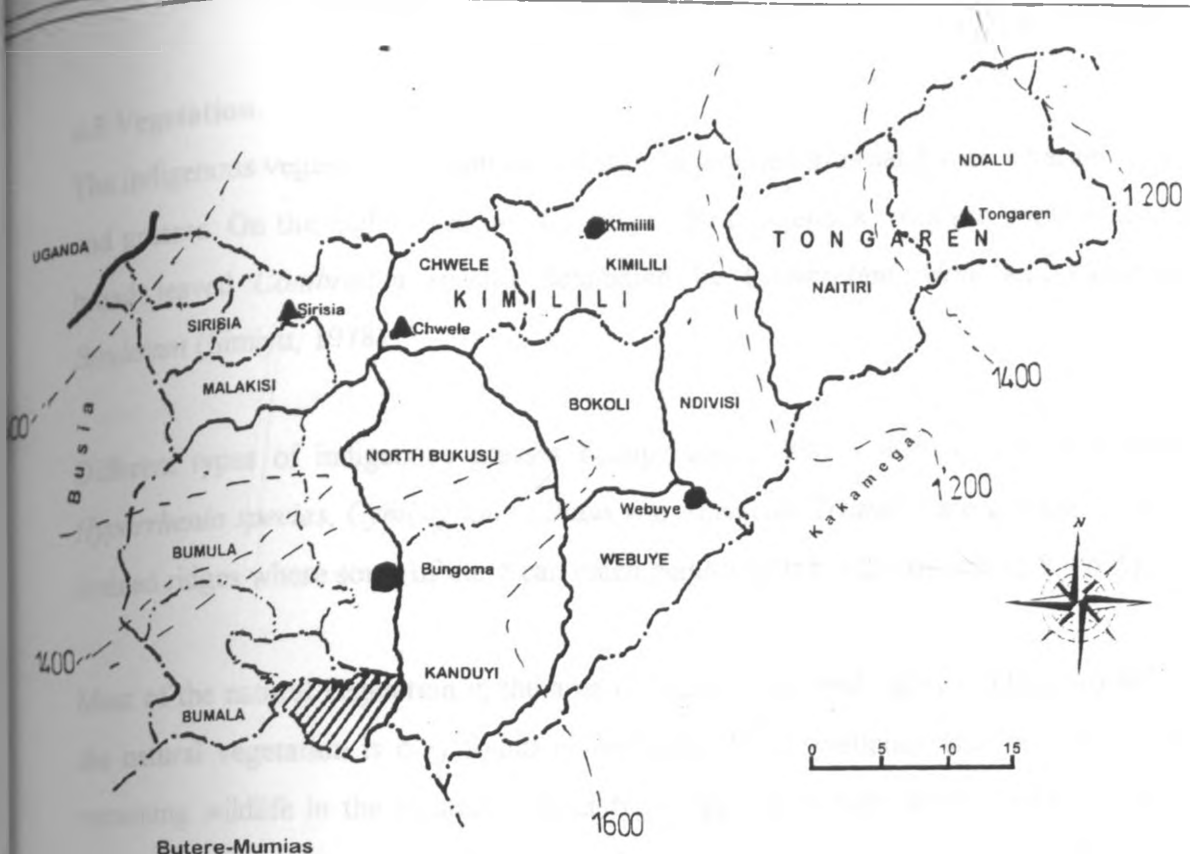
temperatures which occur in the dry months of December, January and sometimes part of February (GOK, 1997).

According to the Government, these fluctuating climatic conditions are tied to drastic changes in the natural environment especially in the loss of forests and wetlands. Wetlands maintain temperatures of regions to close oscillations. Fluctuations therefore do increase with reduced wetlands. These fluctuating climatic conditions are detrimental to the health and the body vitality of the people. People do very little manual work during the dry hot months, which are increasing with the reduction of wetlands. On the onset of the wet season, people change suddenly to do intensive work on the farms to grow food crops (unfortunately wetland destruction through extensive socio-economic activities could reduce the span of wet seasons, hence less production in dry lands). Most of the farming therefore could turn to wetland areas, hence could lead to environmental disaster over time.

Bodies have to make constant adjustments to extremes of daily and seasonal temperatures. This process of sudden changes in work patterns and body adjustments to temperatures have the ill effects of reducing resistance to malaria, which is a common killer disease in this region. Malaria cases are reported so high when very hot long dry seasons are followed by short heavy wet seasons a phenomena which could be common with a destruction of wetlands (GOK, 1997).

The break of rainfall in November offers a great opportunity to the farmers in Kabula Location to maximize the economic value of the wetlands. The region generally lacks vegetables and horticulture produce since the dry lands go dry. The wetlands at this time present a conducive character for agriculture. Water levels in the wetlands reduce and therefore the farmers could do crop farming without deep drainage tunnels. This would not only reduce the production costs but help in the conservation of wetlands. Vegetables and tomatoes fetch high prices in the markets and the urban centers.

Map 4.8: Average annual rainfall in Bungoma District



LEGEND

- Urban centre
- Rural centre
- International boundary
- District boundary
- Divisional boundary
- Locational boundary
- Study area

Simiyu. 2000

4.5 Vegetation

The indigenous vegetation of Kabula Location is wooded grassland with a variety of trees and grasses. On the higher well drained ridges the indigenous trees are composed of the broad leaved *Combretum species* dominated by *Combretum Mole* and *Combretum Binderam* (Simiyu, 1978).

Different types of indigenous grasses occupy about 30% - 40% of the land surface. *Hyparrhenia species*, *Cymbognon vallidus* and *Themeda Triandra* are dominant on well-drained ridges where some of these can reach heights of 0.8 – 2.0 meters (2.5 – 6 ft):

Most of the natural vegetation in the area is found in wetland valleys. Infact, 70-80 % of the natural vegetation is only found in wetlands. These wetlands also contain the little remaining wildlife in the location. Upper high ridge parts have been cleared for human settlement and socio–economic activities. This scenario is alarming and calls for wetland conservation.

Along the streams and river valleys (wetland areas) *Laudetia Kagerensis* and sedge grass dominate. Over time, wetland areas have remained as the main areas, which have natural vegetation. According to GOK, (1997), most of the indigenous tree species can be found in wetland areas.

Human population increase has had a toll on flora and fauna. Intensive agricultural activities have necessitated the removal of most of the natural plants. Most of the land acreage is under sugar cane plantations intertwined with other crops such as coffee, maize, bananas and vegetables. Exotic trees such as Cypress, Eucalyptus, Whistling pine and many other shrubs are common near the residential estates.

Lantana Camara have become a very common species along roads and in farms. The main reasons being that they germinate and multiply fast. Due to intensive agriculture, slow growing shrub and tree species have been eliminated, or are on the verge of being

eliminated. Unfortunately, most of the indigenous tree species fall in this class. The few remaining in the wetlands therefore require conservation.

The aggressive and fast growing *chrsanthellum species* are very common in farms where they are troublesome to eliminate as weeds, and are the common species along the roads. There are many other destructive plants such as *Witch weed*, which reduce crop yields considerably.

Grasses are common mainly along the rivers and un-utilized wetlands. They have been over grazed in some parts of the location where cattle are still found in large numbers. The Sio, Syoya, and Naburereya wetlands are good examples where cattle depend on grasses in wetland areas (Map 4.9).

Grass in the wetlands poses potentials of high economic value. The people for example use the grass for building houses, toilets and stores. Farmers who have kept the grass also make an income out of it. Papyrus reeds also have diverse ecological and economic gains. They serve as buffer for soil erosion and conserve water in the farms. At the same time, they have immense socio-cultural and economic values. The reeds are used in construction of stores and houses. They are also used in handicrafts, for making tables, baskets and chairs. They therefore have an economic value both to the owners of the farms where they are harvested and to the handicrafts people.

Given that vegetation has both ecological and socio-economic values, there is bound to arise resource use conflicts. The utility of forests for fuelwood for example could lead to deforestation that may lead to reduction in river flows and hence reduction in wetland water volumes. Management of the vegetation thus has to prudently incorporate the utility aspects and the ecological functions.

Map 4.9: Vegetation in Kabula Location

Plate 4.1: Wetland vegetation

In plate 4.1 note the rich species diversity in the wetland. Such a rich diversity has the capacity to support many different kinds of animal species. Such vegetation also protects the wetland water from evapotranspiration. The vegetation can also be used in many ways.

4.6 Infrastructure Facilities

These include roads, electricity supply, water sources, schools, health facilities and market centers.

4.6.1 Trunk Infrastructure

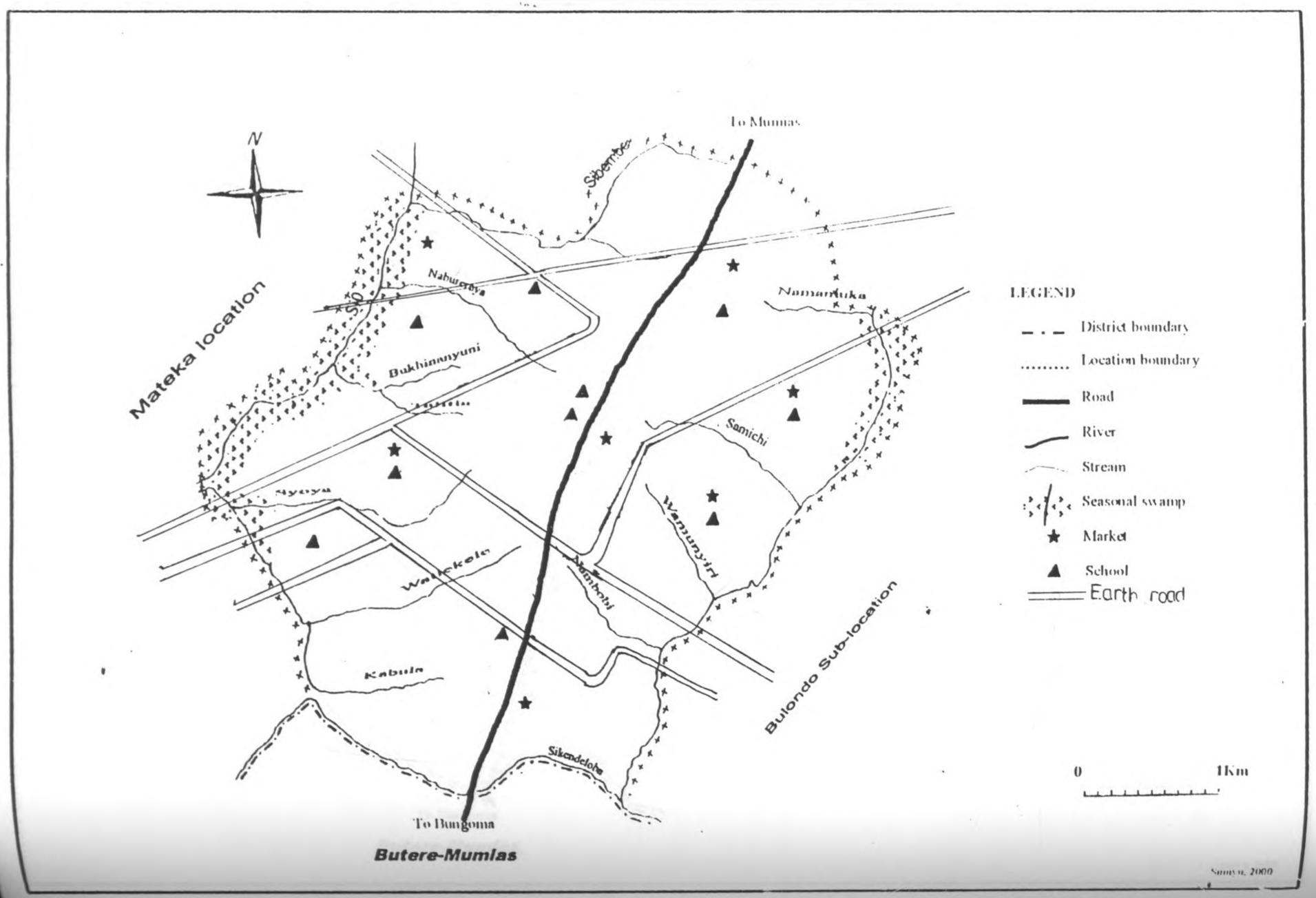
Kabula location is well served by roads. The location is truncated in the middle by a tarmacked road running from Bungoma to Kakamega through Mumias town (Map 4.10). Due to the heavy sugar cane agriculture in the location, many rural access roads have been opened up by the Mumias Sugar Company. On average, all the 11 villages of the location are well accessed (Map 4.10).

A small percentage of the population has been supplied by electricity. These are mainly the households along the main tarmac, the Bungoma - Kakamega road (Map 4.11). Lack of electricity by the majority of the population therefore means that the source of energy is mainly fuelwood. The remaining source of fuelwood is wetland trees and shrubs, which are diminishing at a very fast rate.

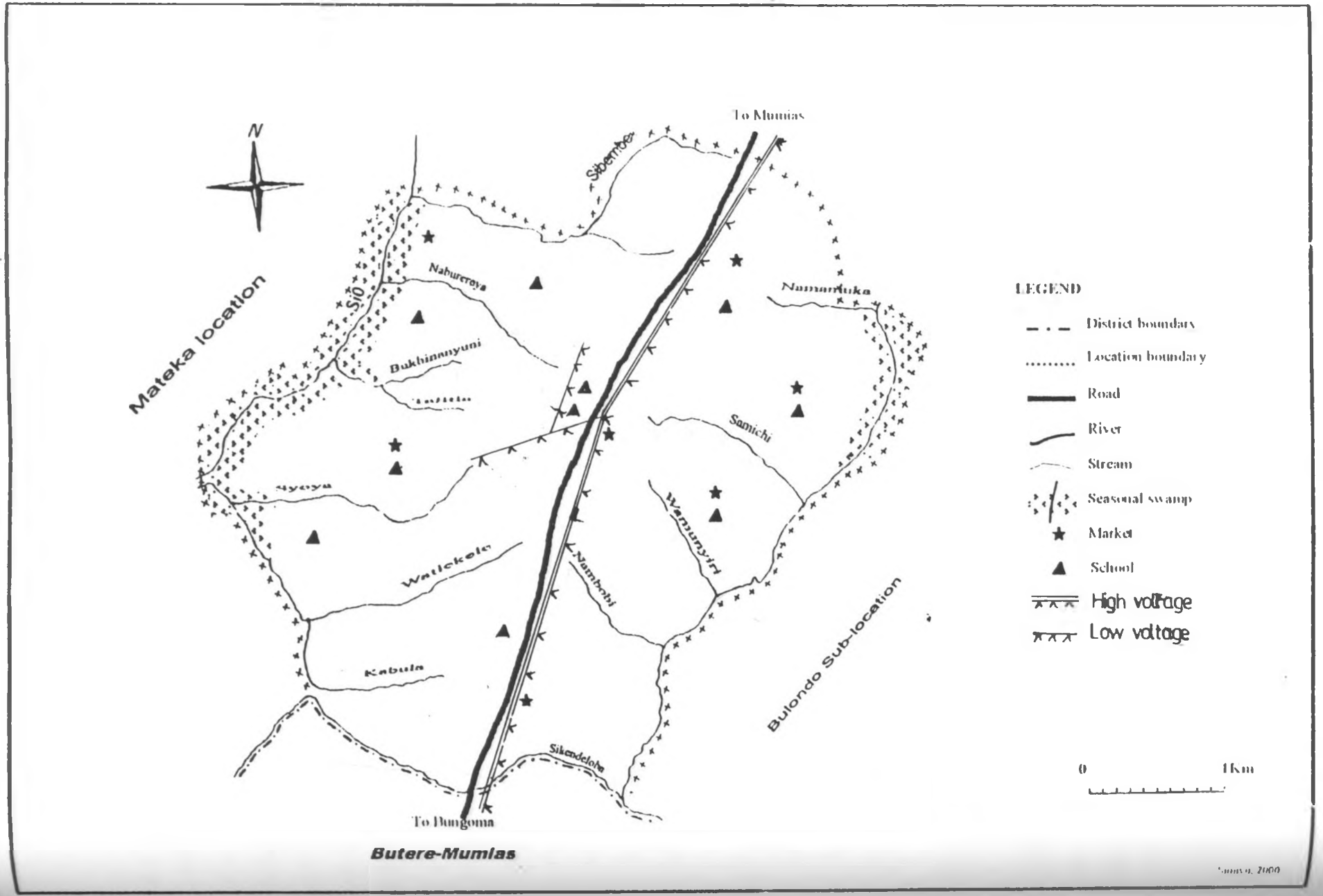
The location is not served by any piped water, therefore people mainly depend on water from the natural springs found in wetlands (Map 4.12). Others depend on water boreholes at community level or in individual homes. The many number of communal and individual owned boreholes threatens to lower the water table in the location.

The road drainage system has mainly been directed to empty in lowlands, which mainly happen to be wetlands. A lot of erosion matter therefore ends up in wetlands enriching them, therefore making them more attractive for farming. On the other hand, road pollution in terms of oil, fertilizers and many other chemicals end up in wetlands.

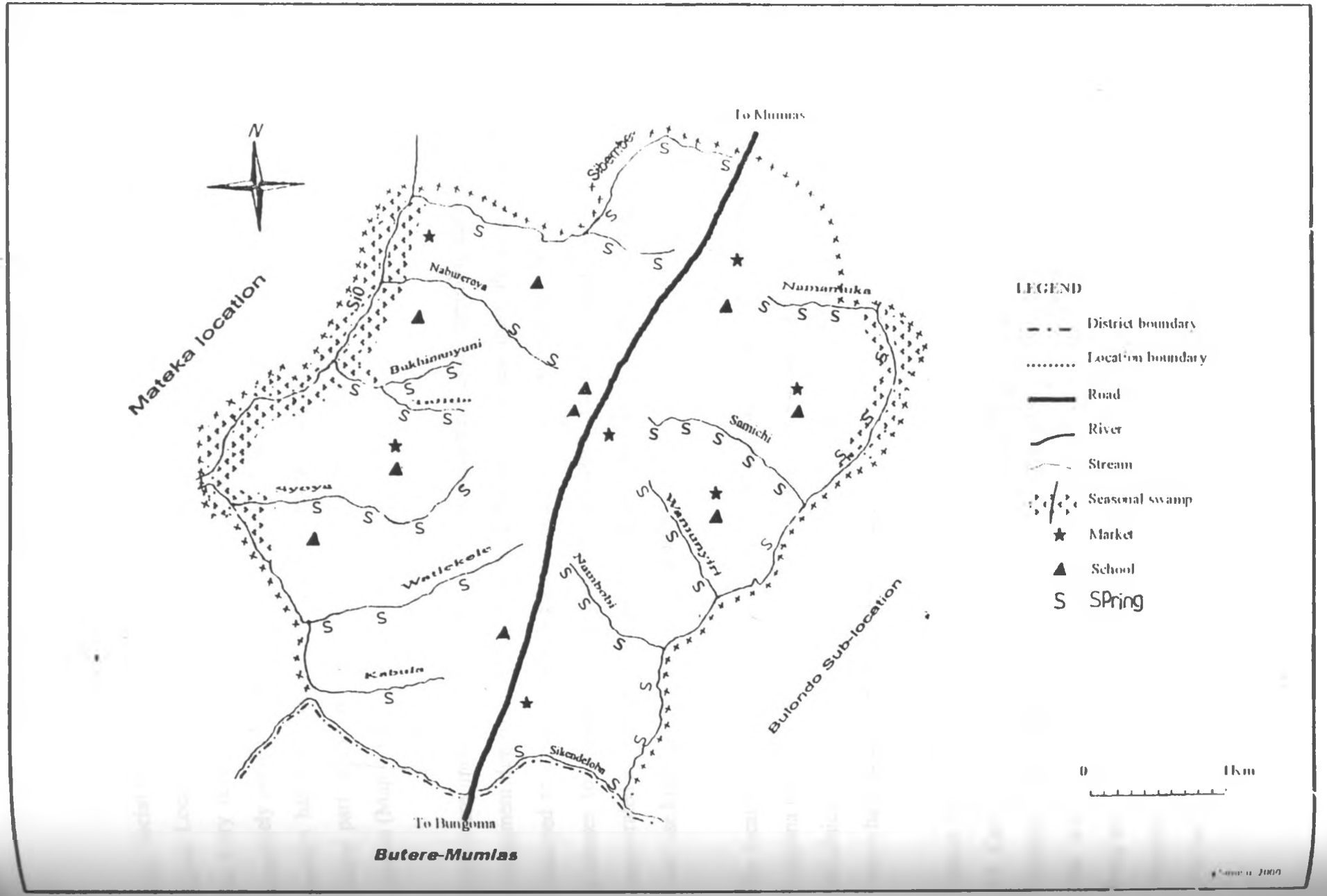
Map 4.10: Roads in Kabula Location



Map 4.11: Electricity Supply in Kabula Location



Map 4.12: Natural Water Springs in Kabula Location



4.6.2 Social Infrastructure

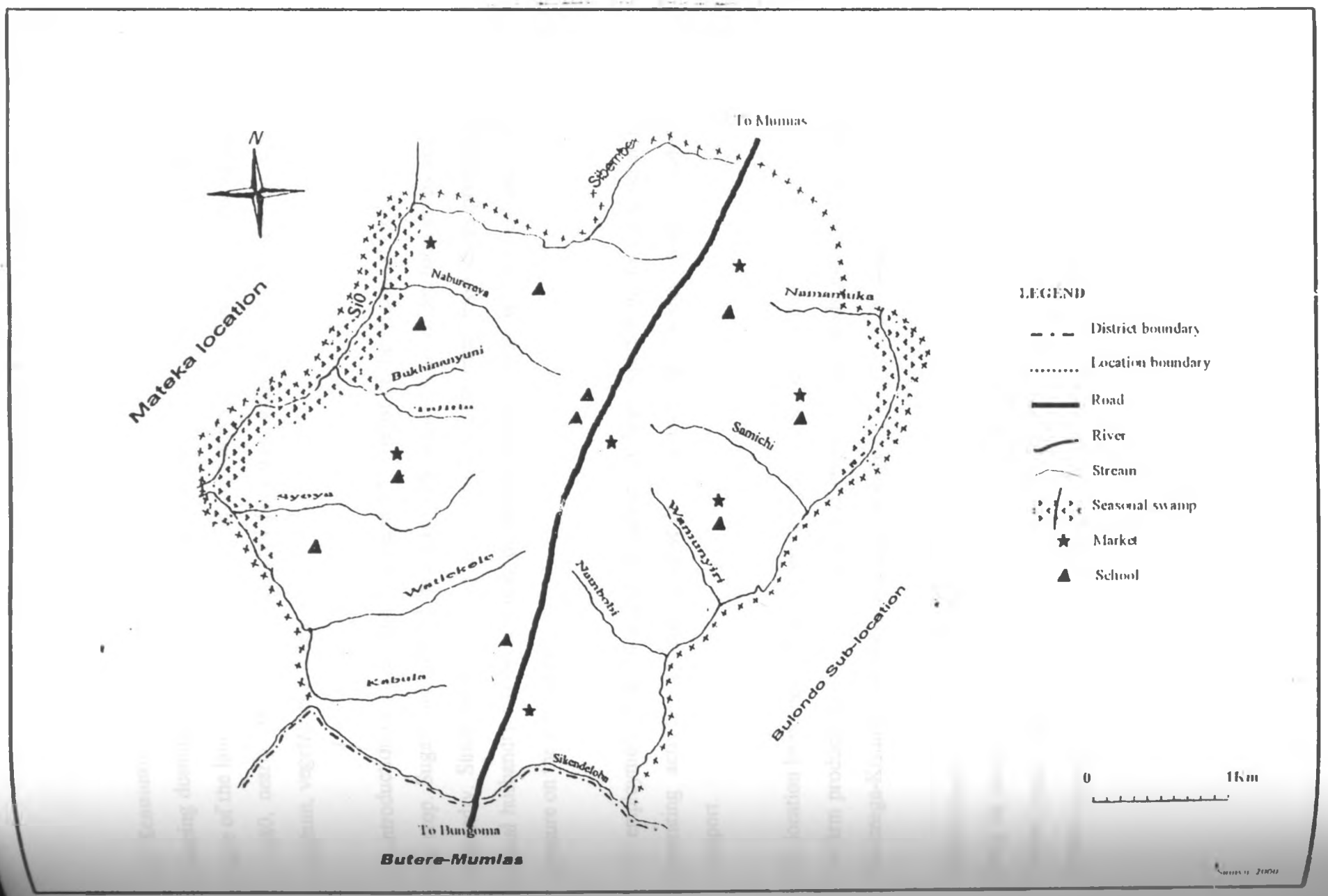
Kabula Location has 10 primary schools (Map 4.13). Going by the planning standard, that for every rural population of 3500 people a primary is required; Kabula Location is adequately served by primary schools. Each of the 11 villages has a primary school. The location has two secondary schools namely Kabula Secondary School located in the central part of the location and Mwiruti Secondary School on the eastern part of the location (Map 4.13).

Schools are important stakeholders in any development issues including natural resources management due to the enlightenment of the public on resources. Policies that could be developed to govern and manage wetlands could for example be integrated in school syllabuses to prepare the posterity to be better managers. Local schools could be incorporated as entry points in local wetlands conservation projects. Teaching on wetlands could use local wetlands as the laboratories.

The location is adequately served by the Bungoma District Hospital 8Km away in Bungoma town, the Mumias Mission Hospital 20 Kms away and 7 other private hospitals and clinics in neighboring towns including Webuye, Kimilili and Kakamega. Local market centers have private clinics numbering 6 in total.

Market centers are evenly distributed out in each micro-region. The main market centers are Kabula market, Sibembe market and Watoya market, all located on the main Bungoma-Kakamega road (Map 4.14). Kabula Location being an area trunkated by a main road, and being close to Bungoma and Mumias towns, enjoys a locational advantage of being able to market most of its farm produce. For example, dry season products such as vegetables, tomatoes and milk, mainly from wetland areas, go for very high market prices in urban centers. This could encourage heavy wetland cultivation and grazing.

Map 4.13: Schools in Kabula Location



4.7 Economic Activities

Farming dominates any other economic activity. According to Simiyu (1978), 80-90% or more of the land is always under cultivation. Simiyu (1978) further says that around 1978 - 1980, nearly 90% of the cultivated land was under maize while the rest was under sorghum, vegetables and beans.

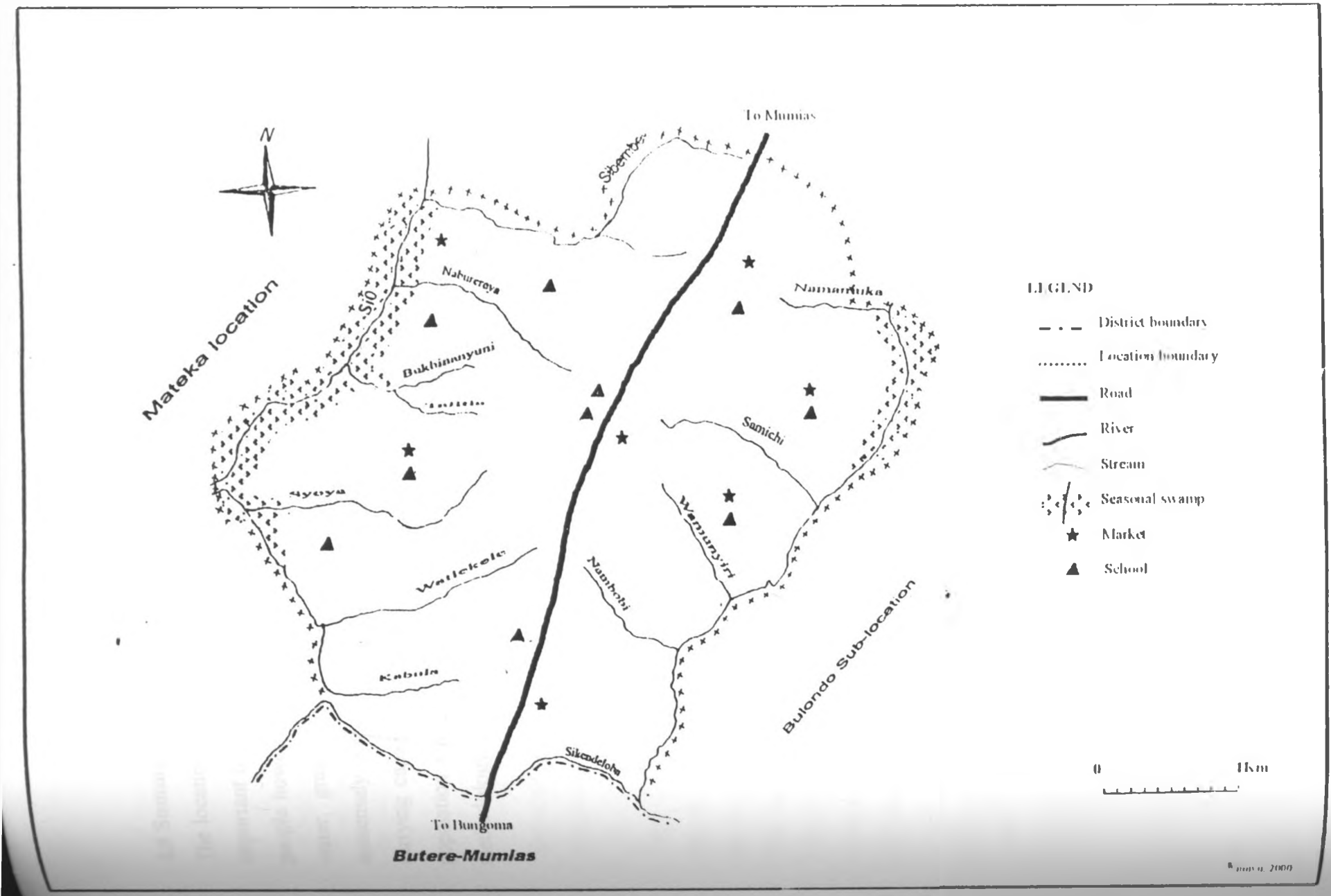
On introduction of sugar cane farming in 1979, most of the cultivated land was put under this crop. Sugar cane farming has drastically reduced land under food crops and animal husbandry. Since most of the dry land is under sugar cane, food crops production and animal husbandry has been mainly pushed to wetland areas, which over time is putting pressure on the ecosystem.

The employment levels in Kabula Location are low. Apart from farming, other income generating activities include small-scale businesses like shops, trading and bicycle transport.

The location being near urban centers presents a good environment for business. Most of the farm products such as maize, milk and vegetables find ready market. The Bungoma-Kakamega-Kisumu road presents a good linkage of the location to main urban centers.

Infrastructure also determines the land use patterns. Most settlements in the location are along the roads. Infrastructure influences land prices that further influence the value of the wetland resources. Households that have their farms from the roads to the rivers have a greater opportunity of using the wetlands more due to their accessibility.

Map 4.14: Markets in Kabula Location



4.8 Summary

The location presents a diverse character of land resources. Wetlands in particular are an important resource that the location abundantly has. Their existence and importance to the people however shall rely on how they are managed. The wetland resources in terms of water, grass, reeds, trees, wildlife and others have diverse utility values that could immensely attract human use. The human activities have to keep within the wetland carrying capacities. Therefore, basing on the natural conditions and resources, and the population characteristics in the location, the next chapter presents a suiting research methodology.

CHAPTER FIVE

RESEARCH METHODOLOGY

5.0 Introduction

This chapter presents the research design. It discusses how the research was organised including the types of data and methods of collection as well as the analysis

5.1 Research Design Process

Formulation of the study problem as discussed in chapters one, two, three, and four preceded the field data collection. The process of data collection followed these. Data analysis and presentation followed data collection.

Data collection began by a reconnaissance survey of the study area. This assisted the shaping of the problem and the research objectives. Of more importance was its role in guiding the formulation of the research tools and designing the sampling procedure and field survey. Data was collected from both primary and secondary sources. Primary sources consisted of the people in Kabula Location and relevant officers such as Government and Company Officers. Secondary data was sourced from library materials such as government reports and plans.

Data analysis was aided by the computer process especially SPSS and Excel packages. General thinking process to present the facts on the ground combined statistical tools of analysis. These were presented in various forms such as tables, bar graphs and qualitative discussions.

5.2 The True Population

The whole of Kabula Location formed the total spatial frame of the study. The total number of households was 1796 (Chief's office and District Commissioner's office, 2000). Given that the research was dealing with wetlands, it considered all wetlands in Kabula Location along the rivers. In total, there were eleven wetlands. Each

administrative village had a single wetland utilized by he people in the area. The research covered all the eleven wetlands in its sample frame.

5.2.1 Sample Frame

The unit of analysis was the household. The total sample was 110 households. Sampling was done along the existing local administrative villages (headed by village elders). The location has a total of 11 villages. In each village, 10 households were sampled. Out of the 10 households, 6 were from areas fronting wetlands, while 4 were selected from areas not directly fronting wetlands. Therefore, 66 households were sampled from areas fronting wetlands and 44 from areas not fronting wetlands. In each administrative area, 2 key informants were selected to give specific information such as use of wetlands for circumcision and to tress the historical context of wetland management. Therefore, 22 key informants were interviewed in total.

Stratified random sampling was applied to select specific households. Purposive sampling was applied in selecting specific individuals such as the key informants and government officials.

Villages were used as the spatial sample frame because as shown in map 4.6. Each area is fronted by a river that posses a wetland. Therefore, each area interacts with a specific wetland. Further, village administrative boundaries facilitated easy and un-biased spatial coverage of the location. The village elders were also an essential institution in facilitating the research through identification of wetlands and identification of key informants.

5.3 Methods of Data Collection

Both secondary and primary data was collected. Administered questionnaires collected information on household characteristics, land tenure and land uses, wetland ownership and uses, technology used in the production and land management process, perception and attitudes, policy issues and conflicts.

Oral interviews were used to collect information from the key informants. These included people with specific functions in the wetlands. Old people were also important in tracing the historical changes in wetland use and management. The information collected mainly concentrated on the traditional values of the society as concerns the use and management of wetlands, historical changes, and conflicts and future trends. As earlier stated, in each administrative area, 2 key informants were selected. Therefore in total, 22 key informants were sampled.

Observation verified the physical state of wetlands, sizes of wetlands, vegetation on the wetlands, uses, erosion, developments, infrastructure, and wildlife. Photography captured the relevant issues of interest to the research.

Survey was applied on 11 household cases that did not know acreage of their wetlands. It was also applied to determine the sizes of riparian reserves along rivers. Issues measured included sizes of wetlands, distance from rivers, area under forests, areas cultivated, areas under grazing and in estimating amounts of reeds and grass in an area. Mapping was done before the fieldwork, in the field and after the field. This mainly covered features such as rivers, existing wetlands, infrastructure, and relief.

The tools for data collection included questionnaires, a camera, maps, and a tape measure.

5.4 Types of Information Collected

Both secondary and primary information was collected. A sustainable management strategy for wetlands requires an integrated approach both in terms of the stakeholder's knowledge and in terms of different factors that affect wetlands. Desegregation of such knowledge has first to be done and latter followed by the integration and merging of the issues. The research therefore collected information on the following main factors:

5.4.1 Activities on the Wetlands

This encompassed information on crop agriculture, livestock production, socio-cultural activities, and other economic activities in the location. Activities on the wetlands signify the values people attach on the wetlands. They also influence the physical and ecological state of the wetlands. This was done with a special emphasis on those that go on in wetlands. However, land use activities were considered in both the dry lands and the wetlands. Dry land activities were considered as a control factor for the wetland utilization.

5.4.2 Technology Used in Carrying Out the Activities

Technology was viewed in terms of physical inputs such as fertilizers and chemicals, aids to carry out the activities and the non-physical technology such as management skills. Information collected under this included mechanization on farms, chemicals and fertilizers applied on land, physical developments on the farms and application of indigenous knowledge.

5.4.3 Land Tenure Systems

Land tenure is land ownership, use, and management. Land tenure systems impact on the management and utilization of resources. The manner in which a private wetland is utilized and managed will most likely differ with that which is communally owned. Sizes of wetlands for example could determine what they are used for. Resources that were common to all in the community could probably cease to be communal and turn private with the changing land ownership systems.

Information collected under this included ownership of both the wetlands and the dry lands, and accessibility to common resources. Other information included ways of management of the private and communal resources, historical changes that have taken place, resource use conflicts arising from the tenure systems, opinions of the people and future trends.

5.4.4 Perception and Attitudes

Intrinsic feelings of the people about the resources around them determine what they do with the resources. On the other hand, feelings of the people indicate the long time utility values and management aspects of the resource.

Opinions and values about resources are determined by other factors. Education levels, age, and land ownership influence values for wetland resources.

Data was therefore collected on value systems of the society, cultural systems that control wetland use, and common activities taking place in wetlands. Further, data was collected on knowledge of people about wetlands, feelings about the role of different agencies in wetland management and wishes of the people on which direction wetland management should move.

5.4.5 Policies, Laws and Institutions Governing Wetlands

These include formal and indigenous institutional systems that govern the wetlands. Acts applying to resource management such as the Survey Act Chapter 299, the Agriculture Act Chapter 318, the Water Act Chapter 372, the Physical Planning Act 1996, and the Environmental Management and Co-ordination Act, 2000. Informal category considered the indigenous tools used to control wetland use such as customs, beliefs and taboos.

5.5 Categories of the Target Population

The research categorised different target groups as the sources of information. Each category had special information to offer.

5.5.1 Farmers

Farmers are indeed the people that interact with the resources. They therefore are the users and managers of the wetlands. The research recognised the fact that there are those that own the wetlands and those that do not. In total, 110 households were sampled and they all practised farming. The data collected from the farmers include land tenure system, uses of the dry lands and the wetlands, technology applied in both the wetlands and the dry lands. Other information include perceptions and the values of wetlands, historical changes in the use and management of wetlands, socio-cultural values of the

wetlands, trends in management of the wetlands, wildlife species, plant species, and land use conflicts.

5.5.2 Resource Technicians

Experts were expected to be guiding the community on the management of the wetlands. These experts encompassed Agriculture Extension Officers (both from the government and private sugar companies) and Livestock Extension Officers. In total, 5 technicians were interviewed. The data collected from the Resource Technicians included technology used by farmers, problems of the technology the farmers use, and appropriate technology applied. Other data included changes in the physical status of the wetlands, policies on the wetlands, and opinions on the future of the wetlands.

5.5.3 Government Ministry Officers

The government officers at the district level were expected to be in charge of implementing government policy at the local level. Such policies determine the state of the wetland resources. The officers targeted by the study included the District Agriculture Officer, the District Environment Protection Officer, the District Surveyor, the District Physical Planner and the District Tourism and Trade Officer. In total 6 government officers were interviewed. The data collected from this category included policies, projects, survey and mapping activities, plans, status of the wetlands, conflicts, and community awareness and attitudes and future trends.

5.5.4 Administrators

The Kenyan governing system lays a great emphasis on administrators as the implementers and enforcers of the government policies and laws at the local level. The administrators targeted by the research included Village Elders, Sub-chiefs, Chief, District officer, and the District commissioner. In total, 11 village elders, 2 sub-chiefs 1 chief and 1 district officer were interviewed. Therefore 15 administrators were interviewed. The information collected from this category included the utilization of wetlands, administration of laws and policies, societal organization, socio-cultural values, historical changes in wetlands, physical state of wetlands, conflicts, projects in wetlands and future trends.

5.5.5 Community Based Organizations and Institutions With Special Interests in Wetlands

Organizations were perceived to have a potential of playing a significant role in wetland utilization and management. Such groups include youth groups, women groups, male groups, and NGOs. In total 3 groups were sampled. The information collected from this category included projects on wetlands, technology applied, perception on values of wetlands, policy, support from stakeholders and trends.

5.5.6 Special Groups Performing Specific Functions in Wetlands

Special groups were perceived to have special interests in the wetlands and therefore posses immense information on the wetlands. Such groups were also perceived to be more vulnerable from the degradation of wetlands. Such groups included Ritual Elders, Circumcisers, Medicine men and women, Handicraft Undertakers, Hunters, Fishermen and old people. In total 7 respondents were interviewed from this group. The information collected from this category included perceptions, values on wetlands, changes in wetlands, traditional uses, specialised uses, conflicts and future trends.

5.6 Methods of Data Analysis

Both quantitative and qualitative data analysis techniques were applied. Quantitative techniques include the Chi square, the Spearman's rank correlation, and the Pearson's product moment correlation. These were mainly for interpreting relationships between factors affecting wetlands. The Chi-Square for example analysed relationships between factors such as education and age on the perception and values for the wetlands. The Spearman's rank correlation was for example used to test the association between wetland and dry land sub-divisions. The Pearson's product moment correlation was for example used to test the relationship between wetland and dry land crop production. The Likert scale of rating was applied in appraising values the people attach to wetlands. Other quantitative methods include means, totals, percentages, and variance. For example, means of land under different uses were analysed, variations in opinions over

ages and education on the use and management of wetlands were analysed. Verbatim reporting of the opinions of the respondents was used.

5.7 Methods of Data Presentation

The data was presented in the formats of tables, bar graphs, pie charts, calculations, photographs, maps, and discussions.

5.8 Summary

This chapter has discussed the research design. Existing administrative villages were based on as the spatial frame in sampling households and key informants. In total 110 households and 22 key informants were selected in the location. Random and purposive sampling methods were applied. Data collection methods used included administering questionnaires, interviews, observation, photography, survey and mapping. Data analysis was done both quantitatively and qualitatively, and presented in various forms as in the next chapter.

CHAPTER SIX

RESULTS OF DATA ANALYSIS AND DISCUSSION

6.0 Introduction

This chapter presents data analysis and findings. It begins with the extractive functions of the wetlands, direct utility functions, socio-cultural functions, values people attach to wetlands, physical state of wetlands and ends with institutions.

6.1 Main Functions of Wetlands

Wetlands are subject to ownership and utilization by the people. By understanding how wetlands are utilized and managed, patterns of their main functions are derived. Many aspects of basic needs such as water, energy and shelter are met from wetlands in the location.

6.1.1 Extractive Functions

Extraction means drawing from or taking away. Extractive functions include drawing water, harvesting fuel wood, and obtaining building and handicraft materials.

6.1.1.1 Domestic Water Supply

Wetlands are sources of water to 67% of the households in Kabula location. This implies the majority of the households depend on wetlands for domestic water needs. Springs require to be protected by maintaining of natural vegetation above them that limits pollution and conserves the water.

Out of the 67% households that source their water from the wetlands 39% have no other alternative sources while 61% have alternatives. Degrading the wetlands would therefore deny water completely to 39% of the households, and partially to 61% households in the location.

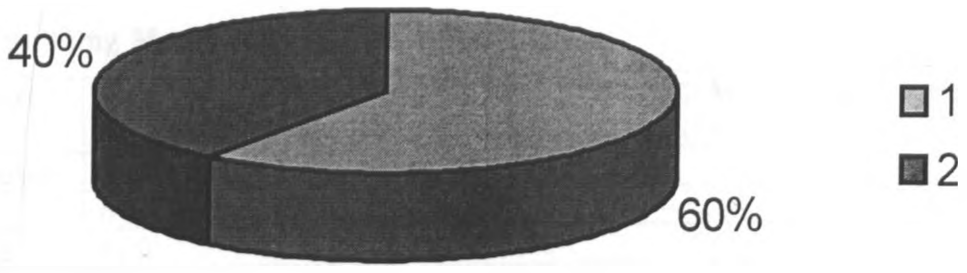
The respondents who reside at the markets and Bungoma town get domestic water from wetlands when reticulated water sources dry up. One - 20 liter container costs Ksh 5. Each day, a household buys on average 100 litters and spends Ksh.25 per day and Ksh. 750 per month on water. This is therefore the wetland spring water value. Bungoma town has 5,000 households, then wetland water value for domestic use is Ksh. 45,000,000 per year (Appendix V).

6.1.1.2 Energy Supply

Fuelwood is another resource gotten in wetlands. In Kabula 72 % of the households get their fuelwood from the wetlands while 28% do not. Fuelwood harvesting is extraction of vegetation especially indigenous trees. Vegetation is key in the protection of the very wetlands. Clearing of the vegetation therefore has a capacity of degrading the wetlands. Clearing of vegetation conflicts with the need to retain it as part of conservation of spring water.

Turning to energy, out of the 72% of the households that source energy from wetlands, 41% are fully depended on wetlands, as they have no alternative energy. The other 59% have alternatives. Total dependency implies ever-clearing vegetation. total dependency on wetlands for livelihood in terms of water and fuelwood stand at 40% of the households, while the proportion with alternatives stand at 60%. Figure 6.1 illustrates this scenario.

Figure: 6.1 Dependency on wetlands for water and fuelwood



Pie chart legend: 1= Households fully dependent on wetlands for water and fuelwood.

2= Source water and fuelwood from wetlands with alternatives.

Figure 6.1 shows that the majority (60%) of the households depend on wetlands for water and fuel wood. On average families in Kabula Location that use electricity instead of fuelwood spent Ksh. 2500 per month. Therefore, this being an opportunity cost for not using wetland fuelwood, then wetlands are valued at this cost for energy per household. Total value of wetlands for fuelwood therefore, is Ksh. 53,580,000 in a year. This figure excludes the environmental damages of removal of fuelwood. This valuation demonstrates that the community gets a lot from wetlands. Any activity that leads to the loss of wetlands through degradation will definitely affect many livelihoods (Appendix Vi).

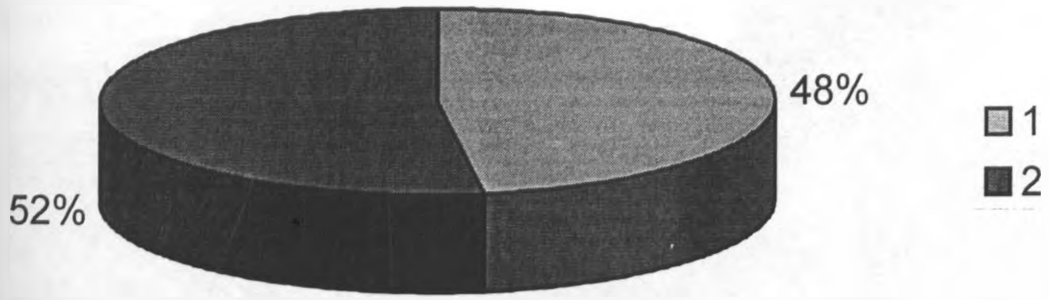
6.1.1.3 Building Materials

Kabula community sources building materials for housing, stores and toilets in forms of poles, sticks, thatch grass and reeds. According to the respondents, this has been going on since time immemorial. Levels of dependency are as shown in figure 6.2.

Table 6.1: Building Materials from Wetlands

BUILDING TYPE	GET MATERIAL FROM WETLANDS (%))	DO NOT GET MATERIALS FROM WETLANDS (%)
Living houses	51.3	48.7
Stores	64.1	35.9
Pit latrines	41.0	59.0
Total	**52**	**48**

Figure 6.2: Utilization of building materials from wetlands



Fie chart legend: 1= Those household that do not get materials from wetlands.

2= Those households that do get materials from wetlands.

From table 6.1 and figure 6.2 52% of the population get building materials from wetlands from wetlands, while 48% do not.

Plate 6.1: People get water from a protected wetland spring

Plate 6.2: A field of wetland grass material

In plate 6.1, note the maize plantation in the background and in plate 6.2, note the sugarcane plantation in the background. This indicates heavy agriculture production in the wetlands.

The materials gotten from the wetlands include tree poles, sticks, thatch grass, soils, bricks and sand. The method of getting the materials is extractive apart from bricks that require processing. Poles, sticks and thatch grass are vegetation cover that plays a key role in water storage and habitat for wildlife. Extraction reduces their functions. 98% of the respondents indicate that overtime reduction in vegetative cover due to harvesting has contributed to reduction of water in wetlands, wildlife number and reduction of water in springs. Extraction of soils, bricks and sand also mean interference with habitats of wildlife. Brick industry extracts soils and vegetation. These impacts worsen with increasing population and consequent increase in activities such as crop agriculture and livestock production. However, 100% of the respondents argue that traditional technologies of extraction based on hand tools are not disastrous.

In an isolated sample worthy noting, a farmer has kept 2 acres of grass thatch for sell. In one acre, the farmer earns Ksh. 33, 750 per year and Ksh. 67, 500 in two years. It has to be noted that Ksh. 67,500 has very limited environmental costs. The grass is natural vegetation that continues to play its natural ecological importance (Appendix Vii). The income from the grass if compared to 1 acre of sugar cane, that according to Mumias Sugar Company gives on average Ksh. 30, 000 after two and half years is quite competitive. The sugar cane income comes at a higher environmental cost in terms of drainage, heavy fertilizer and chemical input. Further the sugar cane income comes ones after two and a half years, which is not as sustainable (continuously) as the grass thatch material income.

In another isolated sample, which was also important to note, a respondent planted reeds along the riverbanks. The farmer makes Ksh. 25,000 in a year. Approximate full value of the reeds was Ksh. 500,000 (appendix Viii). It has to be noted that the farmer has not incurred any input cost apart from land. Further, the ecological advantages of the reeds have not been valued. These natural material value figures in the two case studies when

compared to sugarcane value indicate a potential in wetlands through natural material harvesting.

6.1.1.3.1 Factors Determining Dependency on Wetlands for Water and Fuelwood

The manner in which people respond to the management of the wetland resources relates with their capacity to access alternatives in resource use. Having alternatives is influenced by other factors such as occupation of the people (and therefore income) and differs with ages. Tables 6.2 and 6.3 show an auto-correlation of age and dependency on water and energy respectively.

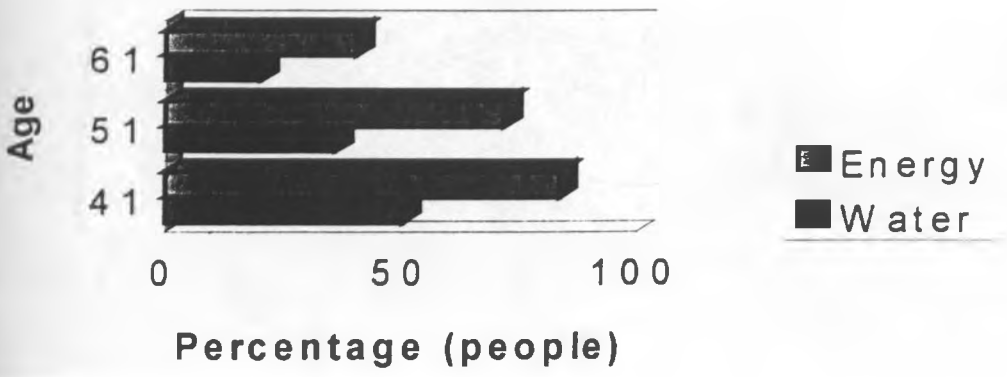
Table 6.2: Relationship of Age and Full Dependency on Wetland Water

AGE (YEARS)	FULLY DEPENDENT ON WETLANDS WATER (%)	THOSE WITH OTHER WATER SOURCES (%)
41-50	50	50
51-60	35.7	64.3
Above 60	20	80

Table 6.3: Relationship of age and full dependency on wetland energy

AGE (YEAR)	FULLY DEPENDENT (%)	THOSE WITH ALTERNATIVES (%)
41-50	83.3	16.7
51-60	71.4	28.6
Above 60	40	60

Figure 6.3: Wetland Dependency By age



Tables 6.2 and 6.3 reveal that as the age increases, full dependency on wetlands for both water and fuelwood drastically reduces. Further, when a Chi square is run between age and dependency on wetlands, given that the chi square (8.821) is greater than the p value (7.78), with a degree of freedom of 4, it is highly probable that such a large difference can occur with chance. It therefore holds that the increase of age has an effect on reduction of full dependency on wetlands for water.

6.1.1.4 Handicraft Materials Supply

Wetlands do provide handicraft materials. The materials are mainly utilized for weaving baskets, chicken rackets (locally called *Kamatabuku*), rabbit rackets, bird rackets and fishing traps. The people who undertake the weaving business are selective in raw materials. Though this weaving is done on a limited scale the undertakers earn an income from them. The research for example established that one chicken racket (*litabuku*) go at Ksh. 120-250. Undertakers sell between 20-25 chicken rackets in a month. On average, this earns them Ksh. 2,947.5 in a month and Ksh. 35,370 in a year. The input is labor and time. Harvesting of the materials from the wetlands is sustainable. However materials are reducing which therefore could lead to a decline of handicraft industry.

Plate 6.3: A man weaving chicken rackets *(Kamatabuku)*

In plate 6.3 note the amount of sticks required to make one chicken racket. One racket takes a lot of sticks hence heavy wetland vegetation clearance.

6.2 Direct Utility of Wetlands

Direct utility of wetlands encompasses the production activities. These are the in-situ activities including crop and livestock production, and fish farming.

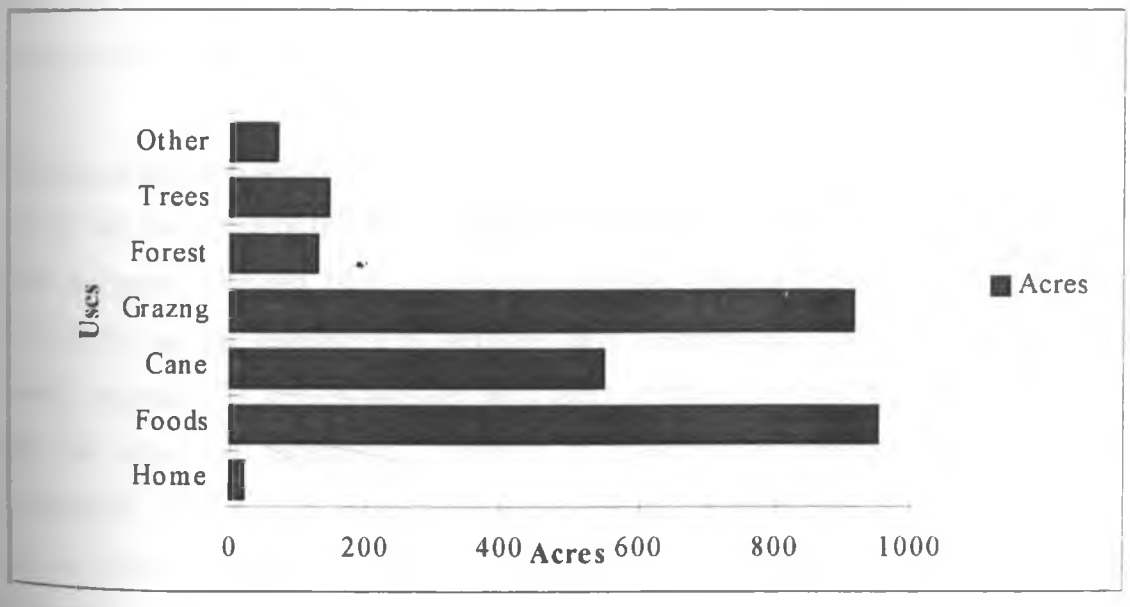
6.2.1 Subdivision of Wetlands

Utilization of the wetlands by the community for different purposes was also captured through the acreage under different uses. Individuals subdivide their wetlands for specific purpose. Once a large part of a wetland under a specific crop, then this is a strong indicator of the value the individual attaches on that use for the wetland. Table 6.4 presents subdivision of wetlands in the location.

Table 6.4: Subdivision of wetlands for specific uses

USE	TOTAL AGREGATE (acres)		% OF TOTAL WETLANDS
	Sample	Whole location	
Homestead	1.0	19.3	0.7
Food crops	48.85	950.9	34.5
Cash crops	28.25	551.25	20.0
Grazing Livestock	47.05	917.83	33.3
Natural forest	6.45	126.78	4.6
Planted trees	7.35	143.32	5.2
Other uses	2.5	66.87	1.7
Total	**141.45**	**2,756.25**	**100%**

Figure6.4: Sub-division of wetlands



From table 6.4 and figure 6.4 food crops take the highest sub-division of the land with 950.9 acres. It is closely followed by land under grazing of livestock. Food crops and livestock grazing together take 68% of the total wetland area. The two are classified as economic activities. Most of the households utilize the wetlands for economic purposes.

However, food crops and livestock culturally are looked at as livelihood activities for sustenance of the household rather than monetary. The wetlands in this case are considered as still providing basic survival needs of the people. This if seen in combination of the earlier discussion of wetlands providing water, energy and building materials put a strong emphasis on importance of wetlands for basic human survival in Kabula location.

As an economic resource, we see the land under cash crops being 351.25 acres taking 20% of the total wetland area. This if combined with food crops and livestock production, as economic activities form 88% of the total wetland area. Wetlands therefore are mainly being utilized for production of economic goods.

Settlement in wetlands (homestead) takes a 1% of the total wetland area. This implies that settlement in wetlands is still low. However, given that population is increasing and more sub-divisions of land are to follow, this percentage is bound to rise. This is further being accelerated by the drainage of wetlands through farming and planting of water ~~absorption~~ absorbing trees such as eucalyptus that make wetlands more suitable for human settlement. With the drying up of wetlands, people stop seeing them as marginal areas.

The natural forest coverage is only 5% of the total wetland area. This implies that human activity has had a heavy toll on the natural conditions of the wetland resources. Around 1979 wetlands exhibited 100% vegetative coverage. Within a period of 20 years, over 95% of the natural vegetation in wetlands have disappeared. Therefore, at least 5% of natural vegetation is lost on average each year. At this rate we only require one year to clear the remaining vegetation. Therefore, if conservation measures are not instituted immediately, then it is projected that by the end of the year 2001 Kabula Location will have no wetland vegetation coverage. This has serious ecological implications not just in the location but the wider region. The most obvious one being the drying up of rivers. Given that people depend on fuelwood, an energy crisis is also bound to arise.

Artificial vegetation cover 6% of the total wetland area compared to the 5% natural vegetation. It is important to note that most of the respondents cleared the natural vegetation to plant eucalyptus trees. Eucalyptus trees were mainly planted for money values and for construction. They were preferred because they mature fast. With the reduction in fuelwood they are also being utilized for fuelwood. Unfortunately Eucalyptus trees are heavily unfriendly to the wetland ecology. IUCN (1992) describes Eucalyptus as the quickest agent of wetlands drying up and one of the greatest simplifiers of wetland species diversity. These impacts are even more serious in wetlands of small sizes as those in Kabula location. Natural wetland conditions are bound to be completely lost in the near future. Some respondents strongly complained of the drastic reduction of stream water volumes in areas with heavy eucalyptus growth.

The utilization of the dry lands has a great control effect on how the wetlands are utilized. Sugar cane growing for example was noted by 100% of the respondents to have pushed other activities to wetlands. The future utilization of wetlands would also influence the manner in which the wetlands shall be utilized. Population increase and subsequent reduction in farm holdings for example mean that alternative space for both settlement and other human activities shall be sought. Given that wetlands have been looked at as less suitable for human activities, with the pressure on land, people will have no alternative but to move on them. This trend has already been explained by the people to be happening. In the late 1980s, the wetlands had no settlements. But with time, settlements on wetlands have emerged. It is important therefore to look at dry land sub-divisions in relation to wetlands. Table 6.5 shows subdivision of wetlands and dry lands.

Table 6.5: Subdivision of dry lands Vis a Vis wetlands (sample area)

LAND USE	SUB-DIVISION		SUB-DIVISION	
	Dry land		Wetland	
	Acres	%	Acres	%
Homestead	23.9	5.9	1.0	0.70
Food crops	105	26.0	48.25	34.5
Cash crops	198	49.0	28.25	20.0
Grazing	52.6	13.0	47.05	33.3
Natural forest	6.25	1.5	6.45	4.6
Planted trees	11.55	2.9	7.35	5.2
Other uses	6.2	1.7	2.5	1.7
Total	**403.5**	**100**	**141.45**	**100**

Table 6.5 show that crops take highest acreage in wetlands followed by land under livestock grazing and then cash crops. All the top uses are agricultural production. Table 6 6 below presents ranking of land under different uses.

Table 6.6: Ranking of land holding under different uses in Kabula Location

LAND USE	RANKING	
	Wetland	Dry land
Settlement	7	4
Food crops	1	2
Cash crops	3	1
Livestock grazing	2	3
Natural forest	5	7
Planted trees	4	5
Other uses	6	6

To test if there is any degree of association between the manner in which wetlands and dry lands have been sub-divided, the spearman's rank correlation was applied basing on table 6 6. The value of the spearman's rank correlation was 0.64 denoting a positive association between the dry lands and the wetland sub-division. It therefore confirms that the utilization of the dry lands impact on how the wetlands are utilized. Positivity in association is in terms of the more the pressure on the dry lands in terms of sub-divisions, the more the utilization of wetlands (Appendix ix).

Cash crops in dry lands take a powerful rank 1 with 49.0% of the total dry land acreage. This agree with the statements given by 100% of the respondents to the effect that cash crops, especially sugar cane have consumed most of the dry lands hence they turn to wetlands for food crops and livestock production. This is further confirmed by the fact that food crops and livestock production in wetlands takes ranks 1 and 2 respectively. Food crops and livestock production in dry lands takes ranks 2 and 3 respectively. The two combined form 39% of the dry land space, falling 10% less than cash crop production alone. In both cases (in dry lands and wetlands), planted forests (trees) are above the natural forest. This implies that people have already realized the crisis facing them in fuelwood and other tree products hence are planting more trees.

Given that cash crops occupy a strong rank 1 in dry lands and a fair rank 3 in wetlands, it pose a great threat to wetlands sustainability in future. There are great potentials of the cash crops acreage increasing tremendously in future in wetlands. Given that the productivity of dry lands for cash crops is reducing and population is increasing, people would turn to wetlands for cash crop production. Cash crops require extensive mechanization and technology hence would completely wipe out wetlands.

6.2.2 Crop Agriculture Production in Wetlands

It is important to consider in specific terms which crops are produced in wetlands. It is only through such knowledge that one can determine specific values of wetlands and the technology applied and therefore the threats to the wetlands. People give more land to a specific crop if it produces more yield and hence income.

The crops produced in wetlands should be equated to the production in dry lands to measure the potential of wetlands. This help in predicting trends in future. Table 6.7 presents crop production.

Table 6.7: Crop production in Kabula Location (sample area)

CROP	ACREAGE			
	Wetlands		Dry lands	
	Acres	%	Acres	%
Sugar cane	37.0	31.8	200.45	52.5
Coffee	0.0	0.0	2.1	0.6
Maize	45.6	39.2	77.15	20.2
Beans	6.0	5.2	32.35	8.5
Bananas	0.5	0.4	11.4	3.0
Vegetables	5.7	4.9	4.15	1.1
Tomatoes	1.1	1.0	1.45	0.4
Millet	2.0	1.7	2.7	0.7
Sorghum	2.0	1.7	1.75	0.5
Potatoes	2.75	2.4	4.3	1.1
Cassava	1.35	1.2	2.45	0.6
Arrow roots	2.4	2.1	0.6	0.2
Nappier grass	8.2	7.1	14.9	3.9
Other crops	1.6	1.3	25.6	6.7
Total	**116.2**	**100**	**381.5**	**100**

Figure 6.5: Crop production

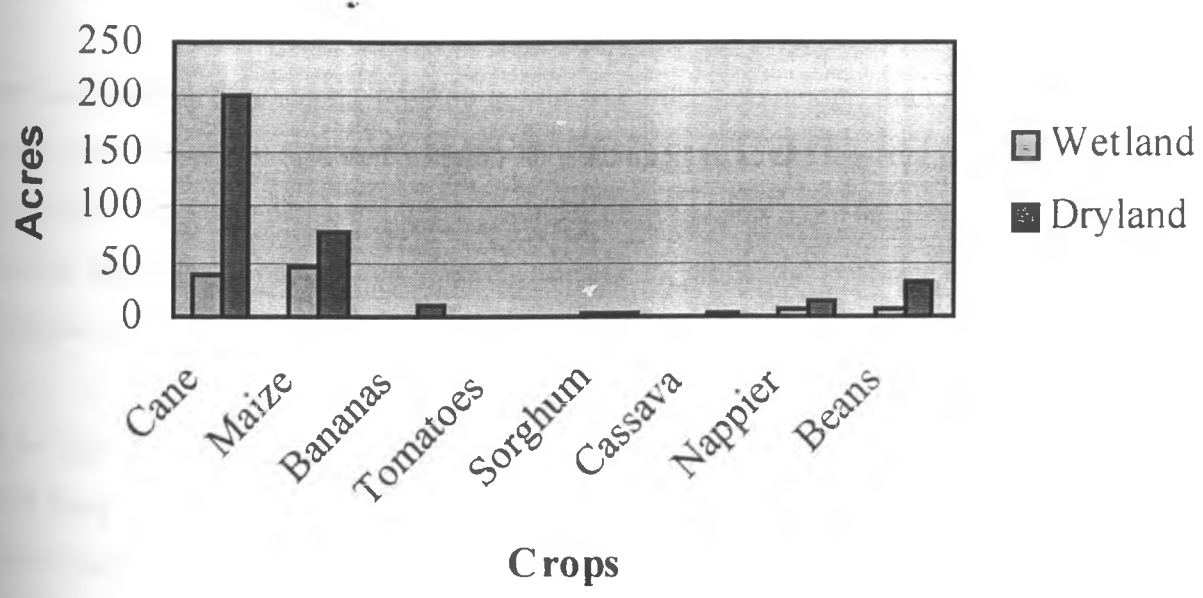


Table 6.7 and figure 6.5 show that maize covers the largest acreage of wetlands (45.6), followed by sugarcane (37). These two crops together cover 71% of the wetland area. Other crops together cover 29% of the wetland area.

It becomes important to test the association between sub-division of crops in the wetlands and the dry lands (Appendix x). The value of r_s being 0.61 therefore implies that there is a positive association between the crop production patterns in the wetlands and the dry lands. In this case, wetlands as a resource respond to the crop production acres in the dry lands. More food requirements for example out do the acreage in the dry land thus people open more wetlands for food production. The wetlands therefore are not independent variables, but they are dependent on utility values of the people and other land uses.

Maize takes the highest rank in wetlands acreage. Maize is the staple food of the Kabula community. In this case therefore, wetlands are being utilized for basic needs provision. Other food crops produced include Beans, Bananas and Vegetables.

Vegetables and tomatoes fall under the category of horticulture. They are not basically being produced for food purposes only but are also for sell. Therefore in this case the wetlands are still an economic resource. Horticulture production has a characteristic of requiring heavy chemical and fertilizer inputs. These have impacts on the ecology.

Sugar cane takes a firm second position in wetland utilization among the crops. It takes 32% of the total wetland area under crops. This if compared to the dry land percentage of 52% implies that wetlands have a great potential of producing more sugar cane. This on the other hand poses one of the greatest threats to wetlands existence. Sugar cane production requires heavy drainage and heavy input of fertilizers.

It is not just sugar cane that has a great potential to take up most of the wetland area. People being economically rational go for more productive areas to invest in. As earlier noted in chapter three, wetlands have fertile soils due to erosion deposits from the higher

dry areas. Wetlands produce a total food yield of 36,000 kgs per year as compared to dry lands that produce 88, 250kgs per year. Dry lands produce more food. When productivity is looked at per unit area, we still find dry lands producing more food. Wetland food productivity per unit area is 736.95kg per acre, while dry lands produce 840.5kg per acre (See appendix xi).

Therefore dry lands still have a potential for food production. This is further seen in terms of the initial investment and inputs required. Higher potentials in food production in the dry lands offer a great opportunity for the sustainable use of wetlands. People are encouraged to put more food in the dry lands.

Production in a particular area requires inputs in land in terms of fertilizer, manure and chemicals. Productivity of an area is also influenced by how much quantity of inputs is required to produce. The less the inputs the more cost effective and lucrative the area is for production. Table 6.8 present land inputs in Kabula Location.

Table 6.8: Inputs for production (sample area)

INPUT	DRYLAND		WETLAND	
	Units	**Area (Acres)**	**Units**	**Area (Acres)**
Fertilizer	34,600 kgs	303	12000kgs	76.5
Manure	32,350kgs	303	8963kgs	76.5
Chemicals	216 litters	105	8963 litters	48.25

Figure 6.6: Land inputs

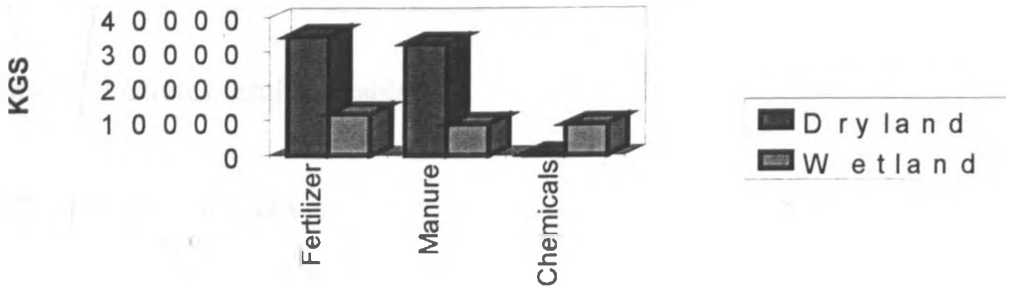


Table 6.8 and figure 6.6 show that wetlands receive 8963 liters of chemicals in an area of 48.25 acres as compared to dry lands area of 105 acres that receive 216 liters of chemicals.

Therefore wetlands do receive a heavy amount of chemicals as compared to the dry lands. This is from the fact that for crop survival in wetlands heavy protection against pests and diseases is required. Wetlands have a lot of species diversity in terms of insects and plants, which balance themselves naturally. Disturbance of the ecosystem simplifies the biodiversity, hence emergence of much pests and diseases. The heavy input of chemicals as in Kabula location further spells doom to the ecology. Pesticides and herbicides kill many soil and water insects and plants. These chemicals also find their way into the water, which people drink.

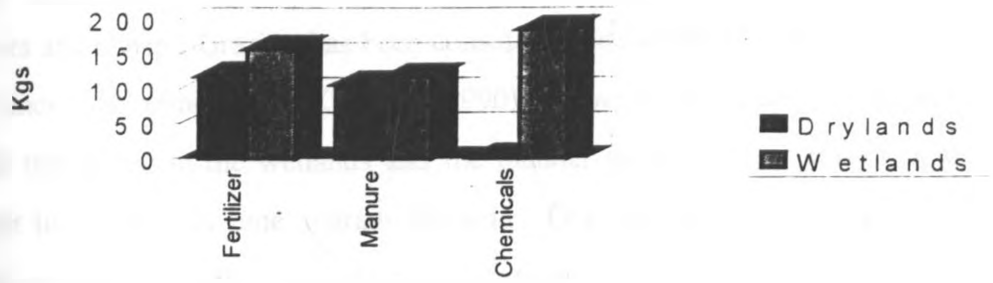
The situation becomes worse when one looks at the inputs in wetlands per unit area as compared to the dry lands. In general analysis, it is seen that it is only chemicals that wetlands receive more than dry lands. Dry lands would seem to receive more fertilizer and manures. However, if one considers inputs per unit area, wetlands receive much higher inputs as compared to drylands (Appendix xii). Table 6.9 shows inputs per unit area.

Table 6.9: Inputs per unit area

INPUT	DRYLANDS	WETLANDS
Fertilizer	36,000 (kgs) 303 (Acres = 118.3	12,000 (kgs) 76.5 (Acre) = 156.9
Manure	32350 (kgs) 303 (Acres) = 106.7	8963 (kgs) 76.5 (Acres = 117.2
Chemicals	216 (Litters) 105 (Acres) = 2.1	8963 (kgs) 48.25 (Acres) = 185.8

Figure 6.7 below illustrates results in table 6.9.

Figure 6.7: Inputs per unit area



From table 6.9 wetlands receive a much higher input per unit area as compared to dry lands. Wetlands receive 156.9 kgs of fertilizer per acre compared to 118.8 kgs per acre received by dry lands (forming a 32% unit higher). The situation is even more critical in chemicals where wetlands receive 185.8 liters per acre as compared to dry lands receiving only 2.1 liters per acre (forming a massive 8,747% unit higher).

Wetlands therefore are receiving a very high percentage of inorganic fertilizer and chemicals that are detrimental to the ecology and human beings. It is however encouraging to note that even in organic farming (manure), wetlands still receive higher amounts per unit area. Wetlands receive 117.2 kgs per acre as compared to dry lands that receive 186.7 kg per acre (forming a 10% unit higher). Organic manure is a friendly ways of utilizing wetlands without altering them. When one considers units between wetlands

and dry lands of chemicals, fertilizers and manures (8,747%, 32% and 10% respectively), manure is the lowest yet the most appropriate.

Wetlands support production through out the year (whether in wet or dry seasons). They attract tillage through out without any allowance for re-generating. In Kabula location, 10% of the households till wetlands 12 months in a year, while only 3% of the households till dry lands 12 months in a year. Excessive tillage leads to a complete lose of the wetland character.

6.2.3 Livestock Production

Wetlands in Kabula location are also being utilized for livestock production. Livestock commonly kept by the Kabula community and have implications on wetlands include cattle, goats and sheep. Grazing has been considered one of the friendly ways of utilizing wetlands since time immemorial (Kimosop, 1990). However, this depends on the number of animals that graze in the wetlands and the manner in which they graze. Too many animals per unit area over time degrade the land. Grazing on the same site through out even if the animals are within the land carrying capacity also simplify the ecology. Table 6 10 presents livestock numbers in Kabula Location.

Table 6.10: Livestock Numbers

LIVESTOCK	NUMBER		AVERAGE PER HOUSEHOLD
	Sample	Location	
Cattle	203	9296	5
Goats	56	2564	1
Sheep	44	2014	1
Total	**303**	**13874**	**8**

Table 6.10 show that on average households in Kabula location keep 5 cattle, 1 goat and 1 sheep. Cattle are heavy in weight hence require a larger biomass amount to be supported.

Total grazing land in the dry lands is 552.5 acres (40%) while in the wetlands it is 365.3 acres (60%). The Kabula community thus grazes their animals in the wetlands more than the dry lands. Wetlands provide 60% of the grazing land while dry lands produce 40% of the grazing land in the location. On average, each household has 1 acre for grazing in the dry lands and 1.5 acres in the wetlands. This scenario is explained by various reasons. One, the dry lands are more valuable for the production of crops as compared to the wetlands hence people take grazing to wetlands. Secondly, grazing does not require heavy capital input in terms of preparing the land. Animals in most cases will graze on the natural grass and vegetation. As Kimosop, (1990), states, livestock grazing is a more sustainable use of wetlands than crop production. Livestock if kept within the carrying capacity of the wetland and grazing rotation is practiced sustainably utilize the wetland. But if livestock numbers go beyond the carrying capacity, then degradation in form of clearing of vegetation, hardening of soil and erosion occur. Table 6.11 presents land grazing per livestock unit.

Table 6.11: Livestock unit wetland grazing area (sample area)

LIVESTOCK	NUMBER	TOTAL GRAZING AREA-sample area (acres)		UNIT GRAZING AREA (acres per livestock)	
		Wetland	Dry land	Wetland	Dry land
Cattle	203	47.05	38.8	0.23	0.2
Goats	56	47.05	38.8	0.83	0.7
Sheep	44	47.05	38.8	1.06	0.9

Table 6.11 show that 1 cow has an average grazing land of 0.23 acres in wetlands. This if compared to the sustainable grazing unit area as given by FAO (1990), to be 2 acres is inadequate. It falls less by 1.77 acres therefore posing a threat to wetlands survival. This situation is made worse from the fact that households graze livestock together. Going by the FAO (1990), guidelines, 1 cow of about 300-350 kgs equivalent 5 goats or sheep. Therefore the 56 goats and 44 sheep in the location are equivalent to 20 livestock units (cows). In total therefore, the sample area has 223 livestock units. Each livestock unit therefore ends up having an average of 0.2 1 acres grazing land in wetlands and 0.17 acres

grazing land in dry lands. This means that the wetland carrying capacity for grazing has already been surpassed. Degradation conditions are to worsen. The 51% respondents who say that grazing has tremendously led to wetland degradation confirm this.

The importance of wetlands for grazing is emphasized by the fact that 74% of the households graze in wetlands but do not own them. That means they graze on wetlands owned by other people, government or the community. A shadow price put on wetlands to estimate the wetland grazing value indicate wetland grazing value in the location to be Ksh. 82,243,300, while dry lands grazing value was Ksh. 54,830,200. The average wetland livestock value per household is Ksh. 46,050 while for dry lands is Ksh. 30,700. The wetland grazing value is therefore much higher (see appendix xiii).

Grazing in wetlands still takes the traditional approach where wetlands used to be open to communal use. Currently grazing in other people's wetlands therefore has a big potential of resource use conflicts. Privatization of wetlands leads to denial of these resources from the use by some households. This is emphasized by the 26% of the households who indicated quarrels with their neighbors when they attempt to graze on the neighbor's wetland. The respondents indicate the conflicts to include animals destroying crops in wetlands and the difficulty in moving with animals along rivers since the riparian reserves have been encroached on. Further wetlands that culturally have been believed to be communal have been sub-divided with no proper information to the community. Conflicts of awareness of whether specific wetlands are under community or are privately owned exist.

The high privatization of wetlands is exemplified by 63% households that graze on their wetlands alone. Out of this, 98% strongly say that they cannot accept to share grazing with their neighbors. The remaining 2% agree to share grazing with the neighbors but under strict permission and control. However, the location still has some wetlands that are open for grazing to the community. 44% of the households are aware of existence of a

communal grazing site that they graze on. The open grazing site falls under different categories of ownership. This is presented in table 6.12.

Table 6.12: Ownership and sizes of open grazing sites in the location

OWNER	ACRAEGE (acres)	PERCENTAGE
Government	290.03	32
Private individual who has not used wetland	531.42	58
Community	96.38	10
Total	**917.83**	**100**

Table 6.12 show that the majority of the open grazing sites are under ownership of private individuals (58%) who have not used them. This is a temporal situation since soon or later; the owners will find use for them. The households that graze in these privately owned open sites therefore face great danger of losing wetland-grazing opportunity. Livestock production among them is therefore threatened if alternatives are not found.

However, there is still an opportunity to grazing in government and community owned wetlands covering 356.41 acres. These wetlands require protection from encroachment. The largest government owned wetland (*Bullcome*) is suffering from encroachment by settlement and agriculture.

A characteristic of the open grazing sites is that intense utilization both for grazing and getting materials such as fuelwood, grass thatch and tree poles. Large numbers of livestock graze on these sites leading to degradation. Fodder and vegetation have been cleared, the ground is bare and soil erosion is evident. Of the households that depend on these sites for grazing, 68.8% indicate that they provide inadequate fodder. Further, 100% of all the households agree that grazing is the main cause of the degrading conditions of the open wetlands.

Plate 6.4: Livestock on a private farm

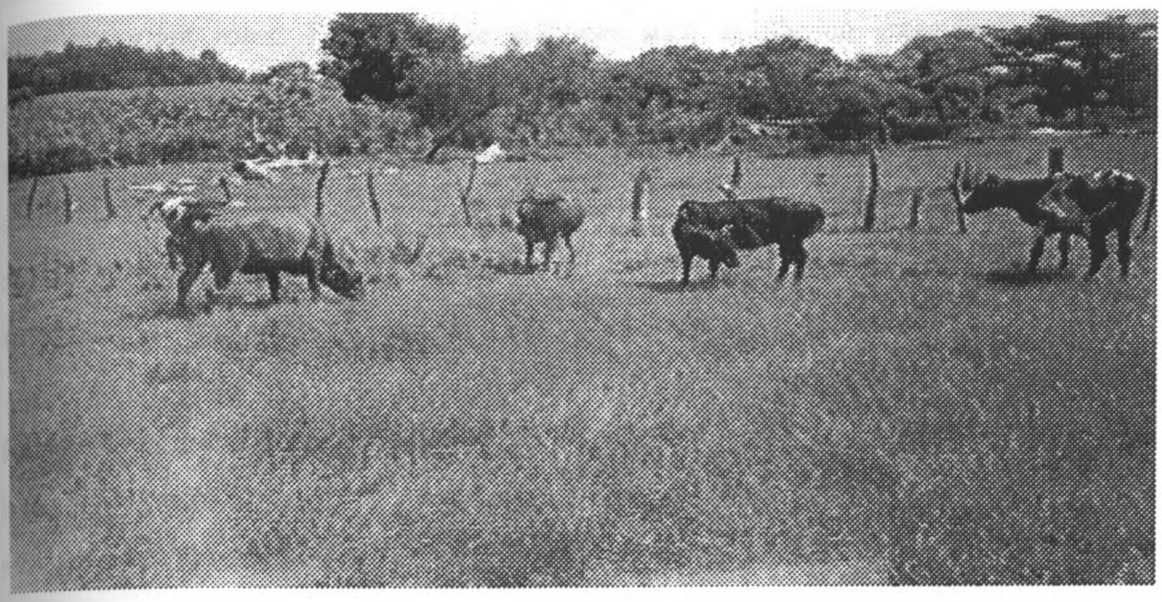
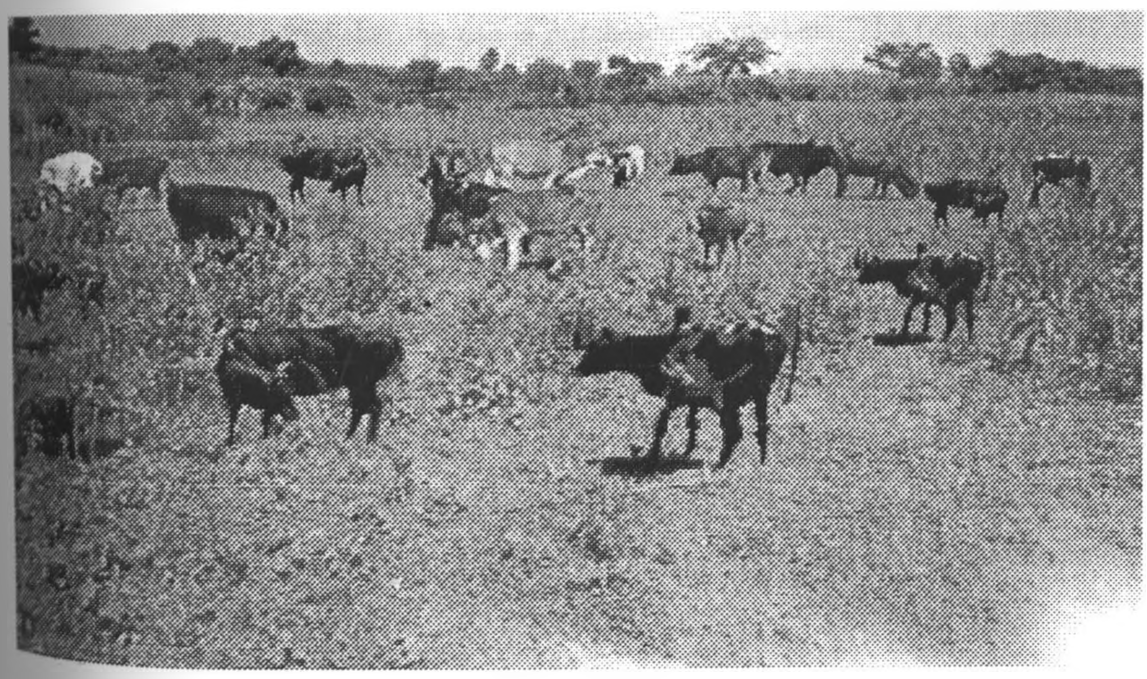


Plate 6.5: Livestock in a common grazing wetland



In plates 6.4 and 6.5 note the differences in ground foliage coverage and general ground condition. Private grazing site has better conditions.

Wetlands are also utilized for treatment of foot disease in animals. Of the households, 20% use wetlands for animal foot diseases. The open sites that are utilized for grazing also play other important roles. These include activities such as playing grounds for children (recreation). The children meet in large numbers and form football teams. As the animals graze, the boys play football. According to one responded, the wetlands have significantly contributed to producing of tough football players from that region. Other sports that children engage in wetlands include swimming, athletics, "hide and seek", fishing and hunting.

6.2.4 Fishing and Fish Farming

Fishing is considered as a recreational activity rather than an economic activity. The research established existence of only five fishponds in the wetlands. The fish farmers mainly use the fish for household proteins rather than selling. Women and boys mainly do fishing in wetlands and in rivers. The respondents noted that there exists many fish in the wetlands and streams. Further, on establishing fish eating habits 100% households consume fish. It is noted that the fish is purchased on markets. The fish originates from Sio Port in Busia and from Lake Victoria. Nearby urban centers and market centers also provide heavy potentials for fish demand. There thus exists a heavy potential for fish farming in Kabula location.

Fishing would be one of the most sustainable uses of wetlands. Small family fishponds would take a small portion of the land, yet produce protein yields that could easily out do livestock farming. Fish is heavily consumed in the households. A small fishpond would therefore feed the family and facilitate an extra income through selling of fish. The constraint therefore exists in lack of technological know-how and inadequate awareness of the potential in fish farming.

6.3 Socio-Cultural Functions of Wetlands (Service Functions)

Socio-cultural uses of wetlands are non-consumptive. They are mainly service oriented and include circumcision ceremonies, and bathing and washing. Collection of vegetables and medicines is also classified as service since the community considers them cultural and medicine is sacred.

6.3.1 Circumcision

Circumcision is considered an important cultural rite among the Kabula community. The location has 12 circumcision sites locally called *bitabicha* (Map 6.1). The sites serve different clans. Culturally the clans move westwards and down the slope to the circumcision sites during the circumcision festive (Map 6.2).

Circumcision sites in Kabula Location are considered sacred. Of the households, 71.8% attach value to these sites since they utilize them. Culturally, these sites are not supposed to be interfered with. It is only harvesting of materials such as grass, sticks or soil for plastering houses that is allowed. These materials can only be harvested during the year when circumcision is not on. The sites are kept intact to make them pure and clean. Activities that are totally discouraged from these sites include grazing and agriculture. According to several respondents, these sites have to be respected whether they fall on private farms. Cultural penalties are executed if one destroys sacred sites. The penalties include being bewitched, cursed or practical expulsion from the society. The field survey confirmed several farmers who have extensively utilized their wetlands but have strategically left intact such sites. Other farmers have fenced the rest of the wetland but left such sites open. However several respondents especially the old say that the sacred sites have drastically reduced in numbers and even those that exist are quickly degrading. This has contributed to the loss of culture.

According to 90% of the respondents, the future generation is bound to know nothing of the present culture. Conservation endeavors are not just for the benefit of the current

generations but also for the future generations. Sacred sites if conserved could pass on community history and legend to the future generations.

6.3.2 Bathing and Washing

People also use wetlands for bathing and washing. Of the households in the location, 65% wash clothes and bath in the wetlands. People who have other alternatives for water still depend on wetlands for washing. Culturally, the bathing sites for men are located away from those of women. Places where people bath and wash have to be neat and protected from interference of other activities such as watering of animals.

Plate 6.6: A female washing hands in a wetland

In plate 6.6 note the neatness of the spot where the lady is washing he hands. Strict traditional laws control the use of such sites.

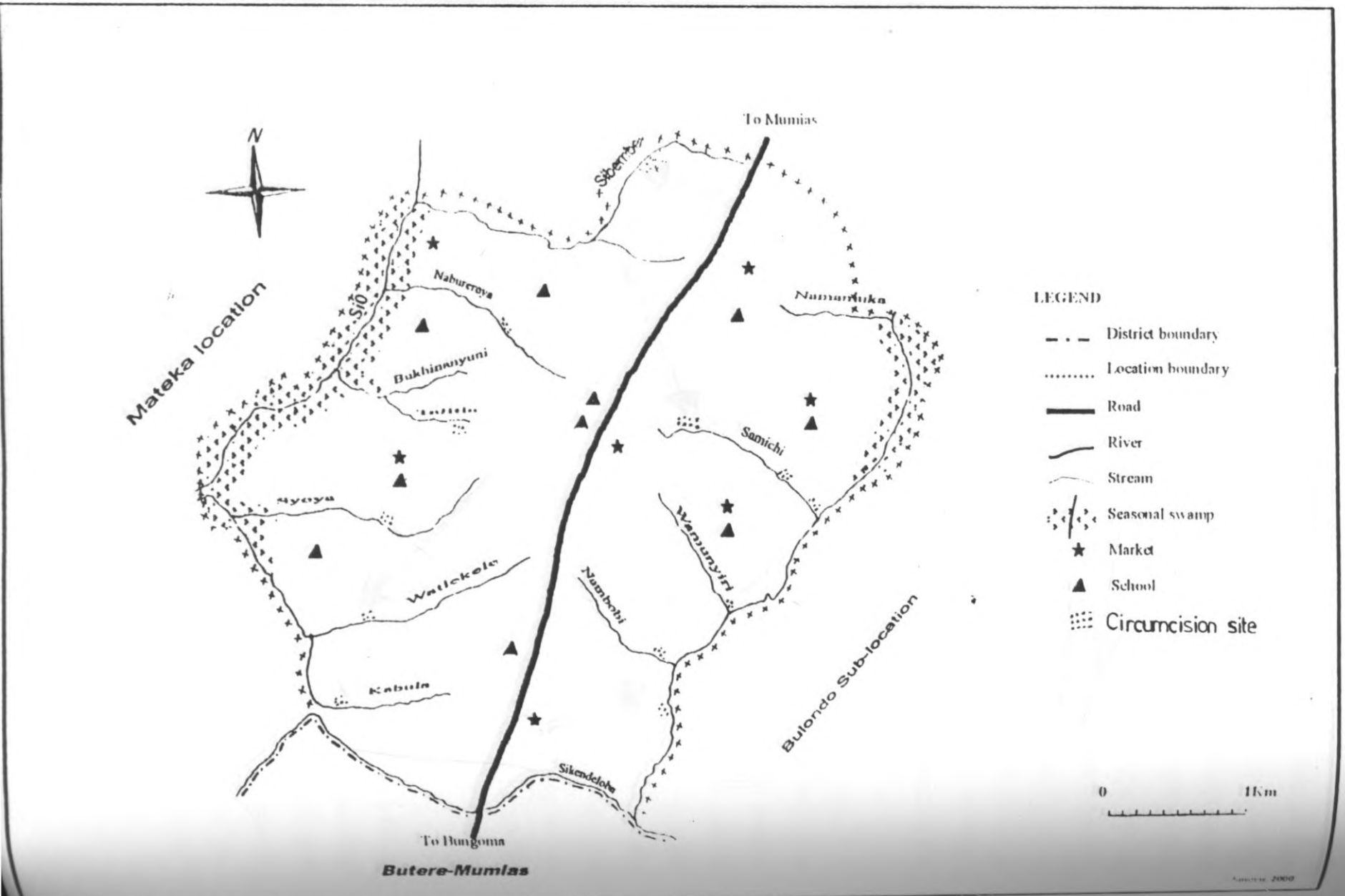
6.3.3 Collection of Traditional Medicines and Vegetables

Traditional medicines and vegetables are collected from wetlands. The community (especially old people) have a strong feeling that it is only in wetlands that currently one can get medicines and vegetables. Traditional medicine men/women make a living from these medicines. According to an isolated case of a medicine lady, she receives about 10 patients in a week that earns her on average Ksh. 1, 000 per week. Given she emphasizes that all the medicine is gotten from wetlands, therefore wetland medicinal value per each medicine person is Ksh. 4, 000 (1000x4) per month and ksh. 48, 000 in a year. The loss of wetlands would not only lead to losing of this important medicinal species but would lead to loss of medicinal services to the society and loss of income to the medicine people.

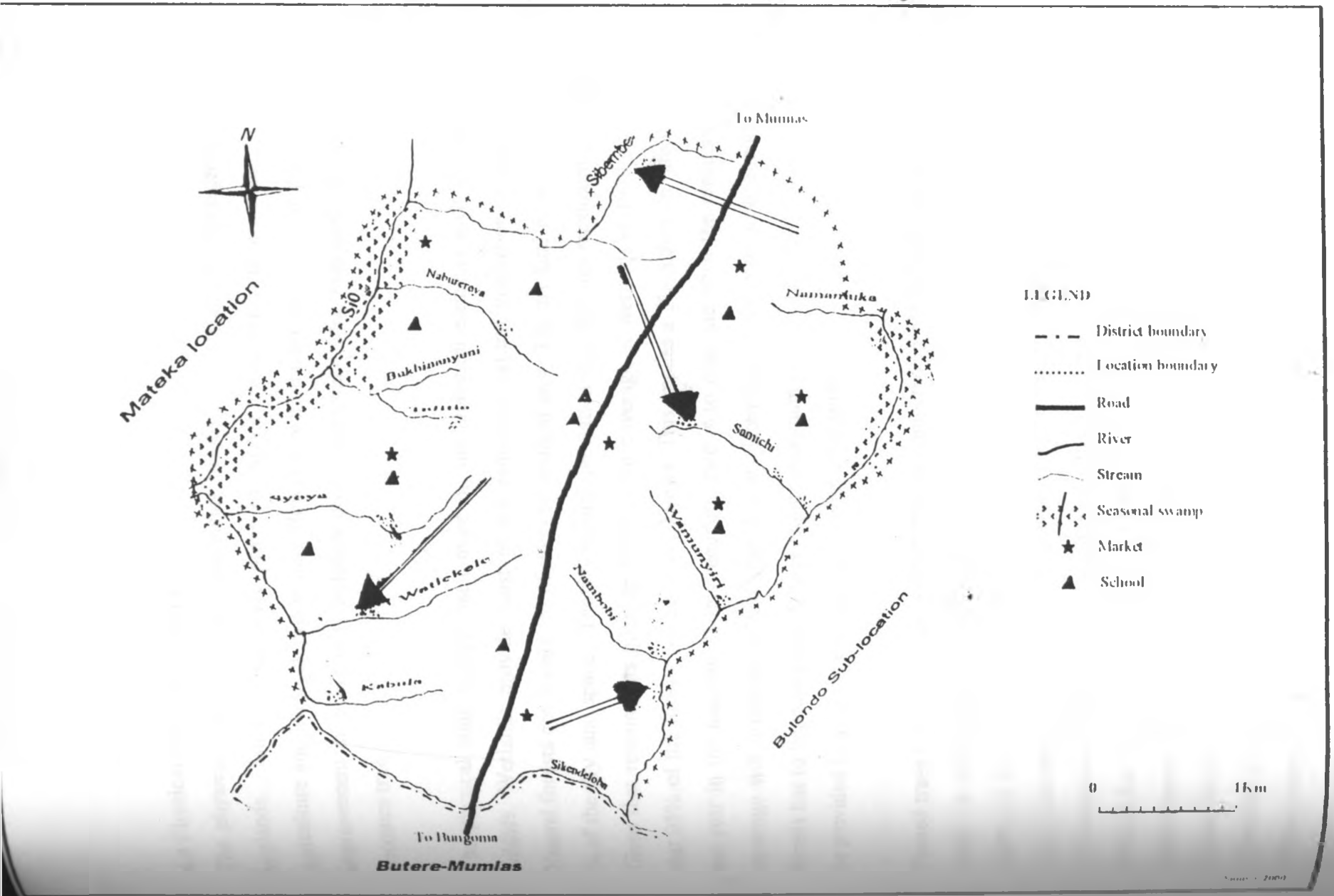
There is a potential in medicines healing the people. Research is therefore required on these species to formalize the use of the medicines. In addition, if the researches establish validity in the medicine, possible methodologies to undertake traditional medicinal species agriculture in wetlands could be researched into. Sites with such species could be specifically preserved for such research purposes. The traditional medicine people need to be integrated in such programs.

The old generation of people harvest traditional vegetables from the wetlands such as *enderema*, *lubiliabilia*, and *khafulululu*. Potentials lie in the natural herbs that require being researched into. Overtime the traditional feeding habits are changing drastically. The young generations do not attach much value to such herbs and therefore their use is being lost. This implies that the herbs will get extinct without notice. Research to establish the food value of such herbs and possibilities to develop more palatable species from them through biological engineering is required. Possibilities of such species being produced in wetlands for a more friendly economic and ecological use of the wetlands require research. The traditional food values need to be passed on to the future generations through such research programs. For such programs to run, traditional infrastructure is required to be in place.

Map 6.1: Circumcision sites in Kabula Location



Map 6.2: Flows of Clans to Wetland Circumcision sites.



6.4 Physical State of Wetlands

The physical state originally determines the use, ownership and management of the wetlands. Small wetlands are prone to private ownership, and are mainly used for agriculture and livestock production. However, with the growth of human population and improvement in technology, wetlands do not determine what man does. The vice versa becomes true.

The physical state focuses itself more on the biological elements such as forests and wildlife. Wetlands provide most of the remaining natural vegetation in the location. Natural forests cover only 5% of the total wetland area. The dry land forest cover only 1 % of the dry land space. The 5% natural vegetation thus requires maximum protection. Given that respondents point to 100% forest coverage of wetlands in 1979, this means that 95% of the forests were lost in 20 years. This implies a 5% reduction rate in forests per year in the location. If this reduction rate is to continue, then the remaining forest coverage will disappear in less than 1 year. Therefore, if the ecological importance of forests has to be maintained, forests require maximum conservation. Other alternatives can be provided to save the existing endangered vegetation.

Planted trees take 6% of the wetland area as compared to 5% natural vegetation. People prefer to clear natural vegetation for artificial trees (especially eucalyptus). They are driven by the economic value in Eucalyptus as more costly building material and fuel wood. Eucalyptus is one of the most non-recommended tree species for wetland ecology. They completely drain off the wetland. Given there is reduction in natural vegetation while demand for fuelwood and building materials raises, eucalyptus trees are bound to be planted more. This will effectively wipe out the wetlands. Eucalyptus trees also reduce the species diversity in both flora and fauna. Insects and animals that hide under natural vegetation do not survive in the open eucalyptus ecology. Therefore the eucalyptuses have a higher economic return to the people, but indirectly have a very high ecological cost that is detrimental on the very people and completely negate the economic benefits.

Indigenous vegetation covered the riparian reserves of rivers. Over time crops and eucalyptus trees are taking over. Eucalyptus trees dry off a stream and reduce volume flow of a river. This lead to general reduced water flow. Rivers and lakes that depend on such streams as catchments suffer heavy loss in volume flow. This combined with heavy erosion would lead to reduced rainfall trends hence desertification. Consequently, agriculture production goes down.

Clearing of vegetation and reduction in wetland waters reduces the suitable habitats for wildlife. The respondents fully agree that wildlife in the location have drastically reduced. Given that wildlife has very limited habitation in dry lands, wetlands were the alternatives. Lacking habitation and food means that the wildlife has to migrate, invade crop farms for food and be killed. The respondents point specifically at the monkeys and baboons invasion of maize crops while guinea fowls and squirrels invade the beans and vegetable farms. The most affected crops are those in the wetlands. The people kill the animals by either poisoning them or hunting. Continued clearance of the vegetation mean escalation of the conflicts and extinction of wildlife.

6.5 Institutions Governing Wetlands

Sustainable utilization and management of natural resource can be achieved with a clear, well-coordinated and enforced institutional framework. Different stakeholders have to play clearly defined responsibilities under a supportive legal system. The community as a stakeholder has to be capacitated to appreciate and manage the resources because it is they who are directly affected by the resource. The Ugandan approach to wetland management emphasized the development of management strategies that maximize the local and national benefits. The government as an agent of resource management and facilitator of development also becomes very essential in resource management

The government owns 32% of the open grazing wetlands in Kabula Location This means that the inventory, survey and mapping of these resources have to be up-to date The study established that the survey office, the Physical Planning office nor the Environmental

office has an inventory of these resources. The Bungoma District maps do not indicate the wetlands either. Therefore, the government simply owns the wetlands but is not aware of their existence. There is a gap on exactly who is responsible for the management of the wetlands.

Section 16 of the Physical Planning Act, 1996, provides for the preparation of regional physical plans that should indicate key government resources. The wetland resources have not been planned for. The District Development Plans beginning 1964-2001 have never indicated existence of wetlands in the district.

The Survey Act provides for the non-subdivision of wetlands with width of 150 meters. Three wetlands in Kabula Location namely "Bullcome", Khalaba and Sio qualify under this Act to be public resources yet they are privately owned with legal title deeds. This implies the Act has not been enforced.

The Survey Act, the Agriculture Act and the Water Act provide for the provision of riparian reserves of 30 meters width along rivers. Kabula Location has a scenario of these laws having been totally flawed. People are aware of these requirements but argue that economic pressure cannot allow them to comply. Measures should be evoked to enforce the laws.

Section 37 of the Water Act provides for no interference in wetlands. Farmers in Kabula Location have done extensive farming in the wetlands. They did not seek permits. None of them has permission. They are not even aware that permission is a requirement. The law does remain in books but has no impact on the ground. Therefore, approaches that can make such laws more effective in managing wetlands need to be developed.

Section 42 (1) d of the Environmental Management and Coordination Act 2000 require an environmental impact assessment in relation to a wetland in Kenya to introduce or plant any plant specimen whether alien or indigenous dead or alive. This provides for a strict

control of wetland crop planting including crop agriculture and trees. Many local farmers may not be in position to seek for an environmental impact assessment before farming. Institutions to monitor and enforce the law need developing. In Kabula Location, 100% of the farmers acknowledge having never considered an EIA before planting trees in wetlands.

The community rejected the ownership and management of wetlands by the government. This is rational from the fact that the government agents at the district level are not even aware of the existence of these wetlands. Therefore, alternative management institutions need to be developed that appeal to the people to effectively manage the wetlands

The community has powerful traditional approaches for wetland management. However the changing population needs and values are quickly rendering these approaches useless. Opportunities that such approaches offer to the formal approaches in wetland management need to be integrated in management strategies.

6.6 Values the Community Attaches to Wetlands

Values and attitudes of a people towards a resource are derived from the use patterns of the resources, the historical context in which the resources have been developed, and the socio-cultural milieu in which the resources exist. People attach values to resources that they benefit directly from. Recent trends in natural resource management indicate that the more people benefit from resources and the more they are made aware of the diverse importance of the resource, the more they will readily conserve them.

Wetlands are valued diversely as per each culture. For effective wetland conservation, the intrinsic values and attitudes of the adjacent community have to be appraised. It is after the values of the people have been taken care of that they will see the importance of the natural resource. Approaches of curving out wetlands and putting s legal "wall" around them without incorporating the values of the people lead to greater wetland encroachment. When the people were asked of the wish to have a wetland, 100% strongly

wished to own a wetland. Table 6.13 presents reasons as to why people wish to own wetlands.

Table 6.13: Why people wish to own a wetland

REASON	PERCENTAGE
To do crop agriculture	38.5
For livestock production	5.1
For livestock and crop agriculture	23.1
Social functions	5.1
Livestock. crops and social functions	12.8
Livestock and social functions	7.7
Crops and social functions	5.1
Trees planting and social functions	2.6
TOTAL	100

From table 6.13 most of the households would therefore wish to own a wetland to put it under crop agriculture. The society thus values wetlands most for crop agriculture This implies that if a household purchases a wetland it would most likely put it under crop agriculture. Crop agriculture is closely followed by crop agriculture and livestock production together that score 23%. The two can be classified as economic functions. Therefore people value wetlands much economic functions. People however do not value wetlands much for livestock production alone (that scores 5%). People prefer to utilize the wetland for crops done rather than have crops and livestock.

It is possible that the few remaining natural wetlands will be converted to economic production. Agriculture and livestock production dries up wetlands. On the opportunity side, if appropriate technology is applied in crop and livestock production, people could see the value to conserve the wetlands. Economic benefits make people to easily see reason to conserve a resource.

Cultural functions of wetlands alone score 5.1%. Economic and social functions together score 12.8%. This means that an integration of economic and social values of wetlands achieve better results in management of the wetlands. However, the integration still scores

far much less than economic values alone. It therefore may require that management strategies of wetlands have to strongly base on economic productivity of wetlands

Sacred sites in Kabula wetlands retain natural state of wetlands. They are termed the preserved sites. They therefore serve important socio-cultural and ecological functions. Table 6.14 presents actions people would take if a sacred site falls on their private farm

Table 6.14: Use for wetland sacred sites

ACTION	LIKERT MEASURE	
	Score strongly (%)	Score nothing (%)
Drain for crop agriculture	69.2	2.6
Drain for livestock production	35.9	5.1
Partly drain and partly conserve	15.4	7.7
Seal off access by anyone else	17.9	7.7
Leave site open for community	20.5	61.5
Preserve the site as it is	5.1	35.9
Only harvest natural products	15.4	17.9

From table 6.14 most of the people still see wetlands in terms of crop agriculture production. Of the households in the location, 69% would drain a preserved sacred site for crop agriculture. Only 3% of the households completely disagree with the draining of the wetland site for crop agriculture. On the extreme end, people who would completely disagree with complete preservation are 40%. Partly draining and partly conserving scores 15%. Therefore, conservation approach is more acceptable than the preservation approach. It may therefore be more appropriate to approach wetland management through conservation basing on appropriate technology in crop and livestock production Table 6 15 presents results of the feeling of the people on the view that wetlands are not useful in their natural state.

Table 6.15: Feeling of people on view that wetlands are useless

SCORE	PERCENTAGE
Zero score	51.3
Very poor	5.1
Poor	12.8
Average	5.1
Strongly	10.3
Very strongly	7.7

From table 6.15 the households that completely disagree with the view that wetlands are useless in their natural state form 51.3% of the population. This implies that many people are aware of the importance of wetlands in their natural state. Further, when we combine the households that completely disagree with those that still give a very poor and poor score to the statement, they add up to 69.2% of the households in the location. The population feels wetlands are important even if they are not under economic utility. This therefore is an opportunity for conservation. However, people who fully agree that wetlands are useless in their natural state are 7.7% of the households. This together with those who agree strongly form 18% of the population, which is a high value. This percentage could actually transform wetland state.

Factors that influence the feelings on natural status of wetlands include age and education. To test the validity of the above feelings, the respondents were tested on the other extreme end of preserving wetlands (wetlands to be all put under agriculture). Table 6.16 presents the results of the influence of education on view that wetlands are useless

Table 6.16: Education effect on feeling of uselessness of wetlands

EDUCATION	FULLY DISAGREES (Zero score)	FULLY AGREES (High score)
No education	100.0	0.0
Primary	83.3	16.7
Secondary	44.8	10.3
Total mark	**228.1**	**27**

Figure 6.8: Education effect on feeling of uselessness of wetlands

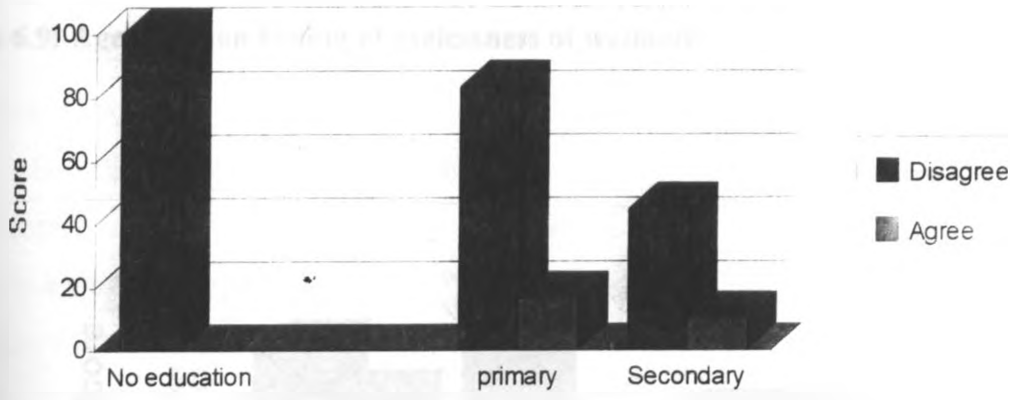


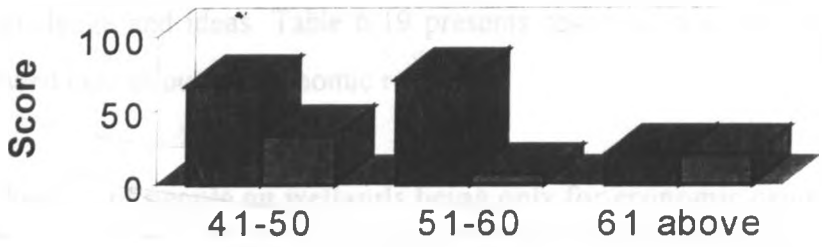
Figure 6.8 shows that the less the education the more people disagrees with the view that wetlands are useless in their natural state. Therefore, less educated people find more value in natural wetlands. This is so because they fully depend on wetlands for water, energy and other needs. Secondly more aged people find more value in natural state of wetlands. They have grown up having a more interaction with wetlands. More educated people end up valuing wetlands as economic resources (for agriculture). However, on overall the society disagrees with the view that wetlands are useless in the natural state. Fully disagreeing

scores a heavy total point of 228.1 as compared to fully agreeing that scores a mere 27. Therefore, there exists a general understanding in the community that wetlands are important in their natural state. This therefore offers an opportunity for conservation. Table 6.17 presents the results of a cross-tabulation of age and the value that people attach to wetlands in their natural state.

Table 6.17: Age effect on feeling of uselessness of wetlands

AGE	FULLY DISAGREES (Zero score)	FULLY AGREES (high score)
41-50	66.7	33.3
51.60	71.4	7.1
Above 60	20.0	20.0
Total	**158.1**	**60.4**

Figure 6.9: Age effect on feeling of uselessness of wetlands



From table 6.17 and figure 6.9 on overall the society fully disagrees with the view that wetlands are useless in their natural state. This agrees with the former test by education. There is a general feeling that wetlands are useful.

Table 6.18: View of people on usability of wetlands only for agriculture and livestock

SCORE	PERCENTAGE
No score	20.5%
Very poor	7.7%
Poor	5.1%
Average	28.2%
High	20.5%
Very High	12.8%

From table 6.18 the people who completely feel that wetlands should not just be agriculture are 20.5% of the population. The total number of people who closely agree that wetlands are not just for agriculture are 33.3%. Therefore a good percentage of the people still feel that wetlands have other uses. This is further confirmed by the fact that people who fully agree that wetlands should be for agriculture only from 12.8% of the population. Given that agriculture production has previously been seen to be a high valued activity in wetlands, people are however aware that wetlands have other important uses This is an opportunity for the sustainable utilization of wetlands since people's awareness already exists.

The value of wetlands for economic productivity is not an independent factor. Factors such as education and age determine these values. Education is essential in conservation in two aspects, one it determines employment and therefore income, and secondly, it exposes people to knowledge and ideas. Table 6.19 presents results of a cross-tabulation of age and value of wetlands as purely economic resources

Table 6.19: Feeling of people on wetlands being only for economic production

Education	Disagrees (Zero score)	Agrees (High score)
No education	100	0
Primary	50	0
Secondary	10.3	13.7
Total	**160.3**	**13.7**

From table 6.19 the less educated people more fully disagree with the statement that wetlands are only useful for economic productivity. This is so because they more fully depend on wetlands. Conservation efforts could more easily succeed since the less educated would be seen to be the problem in getting the message. But given they already have natural intrinsic values to wetlands, they would quickly accept to conserve them

The ownership of wetlands determines how the wetlands are utilized. Table 6.20 presents results of the opinion of the people on who should own wetlands.

Table 6.20: Feeling of people on ownership of wetlands

AGENT	NO SCORE	VERY HIGH SCORE
Individual	5.1	61.5
Community	17.9	15.4
Government	43.6	2.6

From table 6.20 the majority of the people feel the wetlands should be owned by private individuals (61.5%), followed by the community (15.4%) and then the government (2.6%). Most people feel that wetlands under private ownership are put under more productive economic benefits and they exhibit better conditions.

Of the households, 100% supported the feeling that private individuals should own wetlands but allow communal access to essential functions such as spring water, riverbanks and ceremony sites. Further, 100% of the respondents feel that wetlands that are still large enough should be under public ownership (community or the government).

Ownership of resources is driven by other factors. It is expected that people who depend on open wetland grazing sites could not support individual ownership. On the other hand, it is expected that people who own private wetlands would not support communal ownership. Table 6.21 presents results of a cross tabulation of people that graze on private wetlands with wetlands being owned by various agents.

Table 6.21: Private wetland owner's opinions on mode of wetland ownership

AGENT	NO SCORE	HIGH SCORE
Individual	6.25	93.25
Community	75	25
Government	100	0
Individual (allow communal uses)	12.5	87.5

Table 6.21 shows that the individuals who already own wetlands privately support private wetland ownership. This is seen from the fact that they already enjoy private wetland resources. When tested on private ownership with allowance of communal functions they still agree to it strongly by scoring 87.5 points. However, this is still lower than total private use mark of 93.25 points. Public ownership in terms of government and community ownership receive rejection (100 and 75 respectively). Most respondents feel the government is inadequate in management of resources. Communal ownership though rejected scores higher than the government. Wetlands are therefore seen more of communal resources than government. Table 6.22 presents results of a cross tabulation of people that graze on public wetlands and ownership of wetlands.

Table 6.22: Open land grazer's opinion on ownership of wetlands

AGENT	NO SCORE (%)	HIGH SCORE (%)
Individual	100	0
Community	0	100
Government	100	0
Individual (allow communal use)	100	0

Table 6.22 show that the people that depend on other people's wetlands and public wetlands fully (100%) do not support private ownership of wetlands. They feel private ownership of wetlands lead to misuse of resources. This group further rejects the idea that

wetlands should be privately owned but allow communal uses. The respondents feel that this is simply no different with putting wetlands totally under private control.

Therefore, there exists a powerful conflict of interests between the group of people who already own wetlands privately that want this promoted, and those that do not own wetlands that support communal ownership. The former group view private ownership as an opportunity to utilize wetlands for economic production and better management. The latter group views private ownership as a means of destroying wetlands and denying the community diverse functions of the wetlands.

In both cases, government ownership of wetlands is rejected. The respondents feel wetlands are resources owned by the people and therefore the people living by should own, use and manage them. The government is seen as a non-entity.

Resource ownership and management have an impact on the management of the resources. Management is in terms of control of behavior of the people and instituting of disciplinary actions on those who destroy wetlands. Given that most of the wetlands in the study area are already under private freehold, the research established what the community feels on who should directly manage the wetlands.

Table 6.23: Community opinion on ownership of wetlands

AGENT	REJECT (zero score)	SUPPORT (high score)	MEASURE INDEX
Individual	2.9	97.1	94.2
Community	71.3	28.7	-42.1
Chiefs, Elders	95	5	-90
Government	90.5	9.5	-85.5
Old men committee	94	6	-88
Women groups	93.2	6.8	-86.4

Table 6.23 show that the community feels the individuals should be directly responsible for the management of wetlands. This gives an opportunity for sustainable management of wetlands since the individual is seen as the target agent in wetlands. Given the Kabula

scenario where most of the wetlands are already privately owned, individual commitment to wetland conservation is key to sustainability.

The community as an agent in wetland conservation comes second after the individual. Though very weak when compared to individual management, but there is an indication that the community as a whole could be mobilized for conservation. The government is still heavily rejected as an agent of wetland management. The chiefs and village elders are also rejected. People view them as government machinery.

6.6 Summary

Wetlands in Kabula Location are being relied on for basic survival requirements, economic, and socio-cultural functions. Economic activities include crop agriculture and livestock production. Socio-cultural activities range from harvesting of materials such as grass thatch, soils and cultural activities. However, their existence is threatened by the very activities. Approaches to planning for sustainability of wetland resources in the location are pertinent. This is the essence of chapter seven.

CHAPTER SEVEN

APPROACHES TO PLANNING FOR SUSTAINABLE USE OF WETLANDS IN KABULA

7.0 Introduction

The goal of the study was to propose approaches to planning for sustainable management of wetland resources in Kabula Location. An analysis of the issues that arose from the functions of wetlands and the values the Kabula society attaches to wetlands has been done. This chapter presents the output of the study.

The chapter begins by consolidating main findings of the study. The main findings are discussed in terms of opportunities and constraints. These are discussed before a conceptual model to guide wetland planning is presented. The conceptual model in conjunction with policy goals and specific planning objectives link the findings to the strategies proposed. The strategies comprehensively present programs, actions and institutions that can manage wetlands in Kabula Location.

7.1 Main Findings

The main findings are presented in terms of a consolidated list of opportunities and constraints per each objective. Opportunities are defined in the light of their strengths or advantages as established from the study. They therefore act as the available entry points in sustaining the management of the Kabula Location wetlands Constraints are seen in light of their being the challenges or deficiencies that could curtail the sustainable management of the wetlands in Kabula Location. These constraints require being offset

7.2 Opportunities in Extractive Functions of Wetlands in Kabula Location

Wetlands provide safe spring water that flows year in year out. The water has for a long time been consumed by the society. This is further enhanced by the cultural approach of considering springs important communal resources even when they exist on private farms.

There is existence of natural (indigenous) vegetation that is used in many ways by the society and plays an important ecological role. Wetlands are the main areas that contain the indigenous vegetation.

Local skills and technology in harvesting and utilizing the natural resources in wetlands exist. The Kabula community has developed a management system based on local skills to prudently harvest the wetland resources. The Kabula community has attached important values for wetland resources both in economic and socio-cultural ways.

7.2.1 Challenges in the Extractive Functions of Wetlands in Kabula Location

There exists heavy dependency on wetlands for fuelwood. This poses threats of extinguishing the wetland vegetation especially indigenous tree species. The less the income the more the people depend on wetlands for fuelwood thus destroy them, yet they are more vulnerable to consequences.

Population growth at rate of 1.9% per annum in Kabula Location will continue putting pressure on land (wetland) resources. The fast reducing wetland capacity stands a risk of completely being out done. Wetland sizes per household for example are set to reduce to unsustainable levels.

Conflicts in resource utilization in Kabula Location exist. These arise from the fact that the society heavily relies on the wetlands yet they are going beyond the wetland carrying capacity that would boomerang on them. Further, conflicts arise from the different wetland tenure systems.

Inadequate marketing structures for natural materials and products from natural materials lowers the ecological value of wetlands. This situation could make the wetland values that would be more sustainable to be abandoned by the Kabula community and go for the less sustainable wetland uses.

The changing societal values, cultures and needs may render ecological friendly uses of wetlands redundant. The current young generation and possibly the future generations

could have less value for the wetland natural conditions. This has the capacity to make people practice less sustainable activities in the wetlands.

7.3.1 Opportunities in Crop Agriculture Production

The wetlands in Kabula Location have the capacity to be used as an alternative source of food and income. They are already being utilized as key producers of food for the people in Kabula Location. This is very important from the fact that sugar cane production in the dry lands has significantly reduced food production.

There exist appropriate crops for the wetland ecology. This means that agriculture could go on in the wetlands without dire consequences to the wetland ecology. Such crops include arrowroots, millet, sorghum, vegetables and rice. Potentials exist for many other crops.

There exist appropriate technology for production in the wetlands. The community in Kabula Location has indigenous technology that is already being applied for production in the wetlands. This includes organic farming, shallow irrigation and growing of indigenous crops such as Traditional Vegetables, Millet and Sorghum.

7.3.2 Challenges in Crop Agriculture Production

Lucrativeness of wetlands for crop agriculture has a danger for food crops wiping out wetlands. This arises from the fact that increased crop production has the capacity to outdo the wetland crop carrying capacity.

Population increase in the location has subsequent increase in demands for more food and income. This, coupled with the fact that sugar cane has eaten up most of the dry lands means that wetlands will be turned to for more food production. Pressure on wetlands will continue increasing.

Increasing human settlement directly on wetlands has a great capacity to compete crop agriculture requirements. This is feasible from the fact that the location exhibits a 1.1%

land subdivision rate. Direct settlement on wetlands would effectively wipe out the wetlands.

Fast reducing dry land capacity to produce food and cash crops puts more pressure on wetlands for food production. The reduction emanates from the increasing population, land subdivisions and competing land uses such as housing, nucleated settlements and infrastructure development. People will thus turn more to wetlands for food hence degrades them.

There is inadequate technological know how and capacity to produce in wetlands This is exhibited in terms of inappropriate technology application in wetlands, inappropriate crops, and heavy fertilizer and chemical input in wetlands. This does not only pose threat to the wetland ecology but reduces the lifespan of the wetlands for crop production

There is a great threat of sugar cane plantations wiping out wetlands. Sugar cane farming exhibits technology that is unfriendly to the wetland ecology. This is seen in terms of deep drainage tunnels, monoculture and heavy fertilizer and chemical inputs.

Crop agriculture extensively reduces riparian reserves. Lands fronting the rivers and the wetlands practice agriculture right into the reserves. This lead to resource use conflicts. Communal resources such as indigenous vegetation is threatened, river volumes reduce and there is an escalation of wildlife and crop conflicts.

7.4.1 Opportunities in Livestock Production

Livestock husbandry has the capacity to be friendlier to wetlands if kept within the land carrying capacity. This is from the fact that livestock grazing requires a less alteration of the wetland ecology.

Wetlands in Kabula Location are already playing a main role in livestock production. This implies that they are contributing to the economic status of the people. The wetland economic value thus goes high and people value them more.

It is easier to begin livestock production in wetlands when compared to crops. This is from the fact that livestock mainly depend on the natural vegetation in the wetlands. Wetland ecology if utilized in its natural form enables the wetlands to play a role in natural functions.

The location exhibits different forms of grazing. This includes private and communal grazing. Private grazing has advantages such as improved livestock breeds, yield, and a better livestock-land carrying capacity ratio. Communal grazing has advantages such as the maintenance of the wetlands as communal and therefore open to all, conservation of riparian reserves and maintenance of the traditional resource use patterns. The existing riparian reserves play a critical role in livestock production.

The Kabula community has developed traditional environmental easements These facilitate resource accessibility by the society when the resources fall in private ownership. This is further enhanced by traditional knowledge and technology in harvesting wetland resources for livestock.

7.4.2 Challenges in Livestock Production

Population increase leads to reduction in dry land grazing that means more livestock pressure on wetlands. This means that the wetland livestock carrying capacity is surpassed. This situation is set to become worse with the reduced wetland sizes.

The wetlands are already degraded due to overgrazing. This is mainly exhibited in the communal grazing wetlands. There is thus a possibility of setting in of the law of diminishing returns in the livestock economy.

Conflicts of resource use emanate from the private ownership of wetlands. This is mainly witnessed in terms of quarrels among neighbors, denial of grazing accessibility to a majority of the people, and loss of traditional salt licks and indigenous livestock treatment sites.

7.5.1 Opportunities in Socio-Cultural Functions of Wetlands

There exist preserved cultural sites especially those for circumcision. These sites play a critical role in conserving the typical wetland character, and also preserve and enhance the Kabula community traditions.

Traditional management systems have been neatly developed by the Kabula community that integrates material harvesting and strict ceremonial activities. There is also traditional purposive planning in terms of a traditional calendar of activities in wetlands. Strict traditional mechanisms of allowing compatible uses on sites and restricting incompatible wetland activities conserve the wetlands. Further, there exist traditional environmental easements that allows communal uses on private wetlands. There is immense knowledge of traditional uses of vegetables, herbs and medicines.

The Environment Management and Coordination Act, 1999, provides for environmental easements. The Act further provides for protection of the interests of the local communities in the existing wetland resources. This therefore provides for institutional base on which the traditional sites could be protected. This could be integrated with the already existing traditional institutions.

Existence of abundant fish in wetlands in Kabula Location presents an opportunity for proteins and income to the families. The Kabula community consumes fish and the nearby urban centers create a lot of market for the fish. Fish production has limited impacts on the wetlands.

7.5.2 Challenges in Socio-Cultural Functions of Wetlands

Changing societal cultural systems that place less emphasis on wetland cultural functions imply that the Kabula community will not only lose the culture but also lose the value of wetlands as cultural sites.

Private ownership of wetlands threatens usability of wetlands for communal socio-cultural functions. This also leads to resource use conflicts. Cultural sites that fall on private farms are threatened by drainage for other uses especially for crop and livestock production.

Changing societal material needs that put less emphasis on wetland herbs, vegetables and medicines mean that these indigenous resources will not be used in future. This will reduce the wetland value for these products. This is coupled by lack of research to establish potentials in traditional herbs, vegetables and medicines

Attitudes of the Kabula society taking fishing as recreation rather than an economic endeavor has immensely curtailed the exploitation of the full potential of wetlands for fish production. Inadequate technical know how for fish farming also limits fish production

7.6.1 Opportunities in Values That Kabula Society Attach to Wetlands

The community values wetlands for social functions. Socio-cultural functions conserve the wetlands. The community is aware that wetlands are ecologically important. More so, the less educated people value wetlands in the natural state. This implies that wetland conservation programs could be easily accepted.

Awareness of the community that integration of economic uses and conservation needs is better than either of the two alone imply that integrated models of wetland conservation could be based on what already exists in the location

The Kabula society appreciates wetlands as communal resources rather than government resources. This is important in resource management since the community is critical in natural resource management.

7.6.2 Challenges in Values the Kabula Society Attach to Wetlands

Societal view of wetlands as economic resources implies that the future of wetlands is mainly seen as economic. Economic uses of wetlands if not well managed degrade the wetlands. More educated people view wetlands in economic terms and there is the heavy wish to drain cultural sites for agriculture. This implies that the future of wetlands is threatened.

Feeling that wetlands should be privately owned implies that the wetlands will continue being subdivided to private individuals. This exposes the wetlands to private misuse.

Heavy rejection of government role in wetland ownership and management further emphasize the fact that public wetlands could be encroached on further.

7.7.1 Opportunities in Physical Character of Wetlands

There exist in Kabula Location communal and private wetlands. This offers diversity in use and opportunity to all members of the Kabula community to access wetlands. Vegetation that exists in the wetlands plays a critical role in fuelwood supply, grazing, construction and handicraft art. Cultural preserved sites conserve the wetland ecology and plays a critical role in the Kabula community culture.

7.7.2 Challenges in the Physical Character of Wetlands

Vegetation in the wetlands has drastically reduced since 1979 and it is threatened. This has serious ecological consequences such as the drying of rivers and streams and increased erosion. Heavy demand for fuelwood, building materials and crop agriculture products imply that the wetland natural vegetation will further reduce.

Eucalyptus tree species have been increasing in wetlands replacing the indigenous vegetation. Eucalyptus trees dry up the wetlands and reduce the wetland species diversity.

Land subdivisions threaten to reduce wetland sizes hence reducing their carrying capacity for human activities such as crop agriculture and livestock production.

There is reduced species diversity both in wild animals and plants mainly emanating from reduced vegetation coverage and reduced wetland sizes. Human - wildlife conflicts have thus increased.

7.8.1 Opportunities in Institutional Framework

Traditional approaches to wetland management exist that are already controlling wetland use The community values of wetlands as communal resources rather than government resources provide a chance for easy community mobilization. There are special skilled people in wetland uses in Kabula community.

7.8.2 Challenges in Institutional Framework

No inventory of the wetland resources in formal offices exists. Therefore, there are no plans for wetland resources in the formal sector. This has led to inadequate enforcement of the laws. This has culminated into inadequate awareness of the people of the laws. There are thus no apparent institutions with specific liability to specific resources. This has led to low opinion of community over government. The Location has limited NGO programmes in wetland resource uses and conservation.

7.9 Ranking of the Challenges and Criteria Used in Ranking of the Challenges

For purposes of developing strategies to conserve the wetlands, the main findings were ranked using the following criteria:

There was an emphasis of issues that cuts across many other issues. Such issues were seen as a basis of tackling other issues. The integrated nature of the issue also determines its importance to success of the strategies. Other factors included existence of local resources and possibility in solving the challenge, potentials of heavy damage to the ecology and lives of people in future if the challenge is not addressed, opinion of the community on the challenge, size or spatial areas the challenge affect, groups of people affected with emphasis of weak groups such as women, the poor and children, and International and local policy focus on the issue.

Basing on the criteria discussed in section above, the following ranking of the main issues came up:

- Population growth and its chain effects **(1).**
- Economic drive in the society to achieve economic and social well being **(2).**
- Inappropriate technology and little know how in utilizing wetlands and putting value on natural wetland products **(3).**
- Changing societal values, traditions, cultures and needs that place less emphasis on natural wetland resources **(4).**
- Land tenure systems **(5).**
- Weak institutional framework **(6).**

7.10 Conceptual model for the sustainability of wetlands in future

Sustainability of wetlands in Kabula Location can be achieved through an integrated plan that responds to the economic and social needs of the people through the application of technology that fits in the ecology and cultural setting of the environment and is supported by a holistic institutional framework that lays emphasis on participation of all relevant stakeholders.

7.11 Policy goals

Basing on the opportunities and main challenges and with the guidance of the conceptual thought, the following were derived as the general policy goals:

- To promote the utilization of wetland resources for the provision of material and social needs of the Kabula community.
- To enhance the preservation and conservation of specific wetland resources in Kabula Location.
- To enhance the institutional functioning in wetland management in Kabula Location.

7.12 Specific Planning Objectives

Given that the policy goals are general and not specific, it was important to develop under each goal more specific objectives.

7.12.1 Objectives for the Goal of Promoting the Utilization of Wetland Resources for the Provision of Material and Social Needs of the Community

- To enhance the provision of food and income to the community.
- To enhance the value of natural products and materials in wetlands.
- To enhance the application of appropriate technology in production in wetlands
- To enhance the functioning of wetlands as socio-cultural resources.

7.12.2 Objectives for the Goal of Enhancing the Preservation and Conservation of Specific Wetland Resources

- To preserve important existing cultural sites

- To conserve and enhance the indigenous forests and vegetation.
- To resolve land use conflicts.

7.12.3 Objectives for the Goal of Enhancing Institutional Functioning

- To enhance the community capacity in utilization and management of wetland resources.
- To enhance the traditional management systems in wetland conservation
- To enhance legal enforcement.
- To promote stakeholder interaction and participation in management of wetlands.

7.13 Strategies

Each objective had strategies addressing it. It has to be noted that under this study, strategy implies any response mechanism that can enhance the utilization and management of wetlands. The strategies discuss several aspects including programs, actions where they are to be carried out, by which agent and possible time coverage.

7.13.1 Strategies to Enhance the Provision of Food and Income to the Kabula Community

Appropriate food crops exist that can be sustainably produced in wetlands. Such crops have the capacity to grow in wetlands without serious ecological implications. The society already tries to plant some. These include arrowroots, vegetables, sorghum and millet. Rice is also grown on a very small scale. Encouragement of people to grow such crops can be achieved through changing of feeding habits to get the society to feed more on them. Marketing strategies for these crops could be developed through the development of local cooperative societies. Heavy market potentials for example exist for sorghum in the wide Western region of Kenya. Vegetables are heavily required in the local markets and urban centers.

Advantages that underlie such crops include the little requirement for heavy technology and inputs such as fertilizers and chemicals. Sorghum and Millet are highly adaptable to natural soils and are resistant to pests and diseases. They require limited damage of

wetlands (if not zero) especially when timing of planting is done. Further, they could easily be inter-cropped with maize hence less requirements for opening up of virgin wetlands.

Rice as a crop could experimented on marshy lands without extensive drainage. The few farmers who plant rice do it using furrow irrigation with controlled water in-takes. However, this endeavor requires more impact studies.

Extensive appropriate crop farming could be achieved through the mobilization of abundant youth labor. Women groups exist that are already undertaking crop farming. Government agencies and relevant NGOs could encourage support of such groups. Private farms of willing farmers could be used as demonstration sites.

There exists a potential for dry season crop production. The dry season that begins in November to March, offers the greatest challenge to food availability. Wetlands at this time can be irrigated by shallow furrows that can uptake water from rivers. This implies that integrated methodologies of conserving river flows have to be developed. High market prices for agricultural products on local markets exist in such times which farmers can cash one.

Fish farming offers one of the greatest opportunities in wetland utilization that has not been tapped yet people heavily consume fish from markets. Fishponds are some of the friendliest uses in wetland ecology. A fishpond owned by a family will occupy less space than crops or livestock. Fishponds simply require excavation by use of the local labor. Local vegetation that abundantly exists in the wetlands can be used to feed the fish with little supplement from shops. This would go a long way in providing basic family proteins and income. Joint fish projects for example by youth groups or women groups could be carried out. The Ministry of Agriculture and Rural Development could be on the forefront in building local capacity through training. The local fish species that already exist in the wetlands and rivers could be developed in the fishponds.

Improvement of livestock breeds to crossbreeds or hybrids could go a long way in reducing the livestock numbers per household yet improve the yields. Instead of a

household keeping five local cattle, they could be converted to two crossbreeds Napier grass could be planted in smaller acreage. Napier grass can be grown on farm hedges, riverbanks, drainage tunnels and roadsides to feed the animals. This would make the households reduce the over-spill of livestock on the land carrying capacity.

The livestock land capacity in Kabula location was given to be 2 acres for 1 livestock (if grazing without improvement of the land). Given that the households on average have 1.5 acres for grazing in wetlands, the people have no choice but to improve the breeds and control grazing land. On average therefore, families can only afford to keep 1 livestock each if they have to continue gazing traditionally. But if they improve the breeds and practice zero grazing or semi-zero grazing then they can keep more livestock

For the people who depend on open sites for grazing, alternative livestock feeding has to be developed especially during the rain seasons. Fields that produces maize and beans could be used after harvest for grazing to give time to the open sites to rejuvenate. Open sites for grazing could thus be mainly for dry season grazing. Technologies of storing feeds such as maize stalks, maize cobs, sugar cane leaves, Napier grass and natural grass could be applied more. The Ministry of Agriculture and Rural Development and NGOs could be key agents in training farmers in such skills.

The wetland natural products (ecological) value could be boosted through the sell of products such as grass and minerals soils to hybrid and crossbreed animal farmers. Instead of farmers buying artificial grass and feeds, they would buy these products at cheaper prices yet produce same (or even) better yields. This would in itself go a long way in encouraging many wetland owners to conserve and maintain the natural materials. The wetland ecology would thus be conserved yet play great economic roles. The Lake Basin Development Authority, Ministry of Agriculture and Rural Development and NGOs such as ITDG would develop capacities in such intermediate technology.

Given the heavy threat posed by sugar cane production to wetlands, it is recommended that the initial policy that completely banned sugar cane growth in wetlands should be applied. This however requires effecting a thorough EIA of sugar cane to wetlands. The

Environmental Management and Coordination ACT, 1999, provides for EIA requirements to be applied to such heavy activities in wetlands. Given the great impact of sugar cane reducing food needs, completely simplifying the ecology of wetlands and the requirements of heavy fertilizers, chemicals, mechanization and drainage tunnels. it is tentatively recommended that sugar cane farming in wetlands should be banned.

To enhance the economic and functional value of sites that are of cultural importance, alternative further uses could be encouraged in them. Compatible economic uses could include tourism, research and education. Site owners for example could be paid to preserve such sites. The Ministry of Environment and Natural Resources, Bungoma County Council, Ministry of Home Affairs Culture and National Heritage, and interested NGOS could facilitate such economic funding. This would offset the feeling in private owners of such sites as having no economic value. Conservation is best achieved through integration of preservation and economic value of resources.

7.13.2 Strategies to Promote the Value of Natural Materials From the Wetlands

It was noted that there are heavy economic potentials in natural wetland products such as grass, reeds, sticks, soils, herbs, vegetables, medicines and water. Such materials would receive an improved community attitude in conservation if more economic value were attached on them.

In analysis stage, there were cases of heavy potential in grass products, reeds and medicines. The initial step in achieving such potentials is doing extensive research to establish the real value and uses of such materials. The wetland materials are utilized at two levels, one, the basic raw materials used in roofing houses, constructing stores, feeding animals, making pots, etc. Two, the value added level stage where technology in processing can be applied. To achieve an effective economic value of the wetland (ecology) products, the value-added stage should be enhanced. Processing and storage of natural grass for animal feeds for example offers a great potential for hybrid animal production in the location and the wider region. Soil value could be enhanced through improved skills in pot making that can fetch better market values. Reeds and sticks can

achieve a high economic value through improved skills in mat and chair making that can fetch more market value.

The products therefore require improved strategies of marketing. Currently, there exists no formalized marketing system for these products. Undertakers of these handicraft art markets the products at individual level hence are limited in the spatial coverage of market and are easily competed out of price by products from other regions. Joint production and market ventures could be achieved through formation of groups and cooperative societies. The existing handicraft undertakes could come together to strengthen their production skills, seek for training and funds assistance. Programs such as the Poverty eradication, Wetlands conservation and Intermediate technology could be relevant in assisting.

Big projects that can benefit the society from wetland products should be encouraged. The immediate example is the pumping of water from springs, rivers and wetlands. Such a project would not only make the community value the wetlands more, but promote social development. Such long-term projects could be inter-phased by short-term projects such as improving the natural springs by plastering and protecting them.

Wetland materials processing should be able to change with the changing socio- economic needs of the society. Raw soil extraction for plastering houses could be evolved into brick making. Specific wetland hills could for example be identified for brick making. The youthful abundant labor could be employed in such endeavors. This will not only earn more value for the soils, but also earn income to the undertakers.

Basing on the indigenous knowledge and technology, possibilities of very high value in traditional medicines and vegetables should be established. It is imperatively important to establish what diseases the medicines treat and how they are administered. Biological engineering studies are therefore required to see possibilities of domesticating such resources. Great potentials would lie in conserving wetlands by coming up with such high valued alternatives derived from the wetland ecology. The Ministry of Research and Technical Training, and multi-lateral bodies in genetic engineering are key in such developments.

7.13.3 Strategies to Enhance the Application of Appropriate Technology

Wetland sustainability indeed relies on the application of appropriate technology Production systems in themselves are not a problem. It is the kind of technology applied in production that matters. Application of appropriate technology can go a long way in facilitating the economic value of wetlands yet conserve the ecological functions. Appropriate technology is key in limiting the negative economic use impacts on the ecology.

Technology encompasses wide aspects including management systems, inorganic and chemical inputs, tools applied, machinery used, crops and livestock kept, and the physical infrastructure developed. It is through the prudent management of these factors to suit the ecological system of wetlands and the socio-cultural milieu of the people that makes them appropriate.

One of the greatest threats to wetland survival has been seen to be drainage. Deep and wide drains that sharply run along steep slopes quickly drain off wetlands. Farmers would be tempted to use such methods to produce crops such as sugar cane and maize especially during rain seasons. It has already been recommended that sugar cane should be banned from wetlands. Farmers should endeavor to use shallow drains that run along the contours and not along slopes. This will slacken the speed of water movement, limit soil and nutrient loss and conserve the water. Farmers would also limit need for deep-wide drains through the timing of crop planting. Households should do most of wetland agriculture in dry seasons rather than wet seasons. The Agriculture Extension Officers should more extensively guide the farmers on wetland management techniques.

Diverting of whole river courses for irrigation during dry seasons should be avoided through the excavation of shallow earth pans on farms. Such would not require water from rivers but source it from the wetland soils. The down stream population would be spared of reduced water flows in dry seasons. Shallow trenches that uptake water to these water pans should be utilized and limited in number.

Identification of appropriate crops that do not require heavy irrigation is important As earlier mentioned, crops such as arrowroots, millet, sorghum and traditional vegetables require limited amounts of water. Such crops also require limited chemical and fertilizer input and thus could significantly reduce inorganic inputs in farms.

Organic farming is key in sustainably producing crops in wetlands. Households have alternative means to organic farming. There is the livestock manure. This is limited given that households do not keep large herds of animals. However, this can be adequately supported by the vegetative organic manure that can be prepared from the abundant household sugar cane leaves. Farmers simply require training on how to prepare the manure. Organic manure will go a long way in preserving the chemical, physical and biotic state of the wetlands. This will have limited or no impact on water systems and general pollution. The Institute of Organic Farming could be handy in training the farmers in organic farming.

The killing of wild animals to reduce their effect on crops could be reduced through application of intermediate technology such as scarecrows and physical watching of the crops to scare off the animals. Further, buffer crops could be planted on the outside rows of farms to protect the main crops in the middle part of the farms. Millet for example has been locally applied by some farmers to effectively keep off monkeys from maize It has to be noted that the most effective way of limiting wildlife problems is conserving the wetlands and the little remaining vegetation.

Napier grass, reeds and bamboo can be planted along riverbanks, dug drainage tunnels and farm boundaries to act as soil and water conservation and yet they be utilized to feed animals, sold, construct houses, make mats, among other uses. The heavily eroded sites can be rehabilitated quickly by planting such vegetation.

It was earlier noted that improved livestock breeds would be kept on zero grazing or semi-zero grazing for reduction of land requirements for grazing. Animal feeds in this case will be provided by the above-discussed technique and by harvesting natural vegetation form wetlands. The improved breeds will give more yields

For the growing population to meet its growing energy requirements, alternative sources of energy need to see developed. Instead of people basically depending on firewood, other opportunities lie in harvested sugar cane remnants that rot in the farms and the maize stalks and cobs. Improved *jikos* can also be used to save energy used. Several households are utilizing solar energy and electricity and in the long term, these should be the ultimate energy sources. The government has to play a greater role in supply of rural electrification in the location. Due to sugar cane farming, most households can afford electricity. Reduction of family sizes from the current average of 8 would conserve energy.

Traditional technology that utilizes wetland mineral soils to feed animals and uses specific wetland sites for foot disease treatment should be integrated in modern management systems. For example, instead of the community traditionally taking the livestock to the sites to lick the soils hence over trading the area, people would dig out the soils and ferry them to homes. This would reduce diseases and improve the milk yield. Further, private site owners would realize less pressure on their land. Hybrid animals would get the advantage of feeding on such mineral soils instead of the bought-feeds.

7.13.4 Strategies to Enhance the Functioning of Wetlands as Socio-Cultural Resources

It has been noted in the study that the Kabula community has a strong traditional model of utilization and management of wetlands. However, with the changing societal culture and needs, the traditional approaches are losing grip and are bound to weaken further in future. For conservation of both the culture and the wetlands, the traditional systems have to be supported by formal organization.

The important cultural sites should be preserved. This can be achieved though various means. The application of the Environmental Management and Coordination Act, 1999, that allows for environmental easements. The government can facilitate the declaring of such sites as preserved sites for importance of the local community. The sites that exist on government or communal wetlands could easily be declared so. The government in conjunction with the community could

compensate the private farm owners to relinquish the sites for public purposes or the owners could be paid to allow communal access. Protection of the riparian reserves along the river would also go a long way in preserving several sites.

Given that the community already has an existing cultural control system, it is important that enforcement institutions mainly encompass local communities, especially of the old people, handicraft undertakers, circumcisers and the traditional medicine men. These groups have more specific interests in the wetlands and would more readily be on the forefront to conserve them. They also possess extra knowledge about wetlands that the rest of the people do not have. They need to receive a backing from the formal system such as the administration and private wetland owners.

Apart from the sites being utilized for cultural functions, secular functions would be integrated. Cultural sites that have been declared preserved and gazetted by law could be utilized for tourism purposes, research, education and recreation. This would add value to the sites and appeal more to the future generations. However, extensive education and mobilization of the people is required. The local administration with the help of the Ministry of Culture and National Heritage become handy in this process. Anthropologists could also aid in the techniques of achieving more appealing strategies for preservation.

The communal/government wetlands should be maintained as public resources. They should be protected from private encroachment of any form. They therefore require to be surveyed, beaconed and mapped. The local community should be sensitized of their rights. The community in conjunction with the local administration would effectively preserve these lands. Activities such as grazing, recreation, fishing should be allowed to go on. The community should be encouraged to continue utilizing soil mineral leakage and foot treatment sites. Livestock management related activities such as cattle dipping, immunization and branding should be held on these sites. Government/NGO demonstration projects could go in these wetlands.

7.13.5 Strategies to Preserve Important Cultural Sites

The Survey Department in the Ministry of Lands should take inventory of the sites, survey them, beacon them and map them. They could then be declared important traditional protected sites by law under the Environment, Act, 1999.

The sites that are very important and large but fall on private wetlands should be purchased back by the government or local authority (county council). The eminent domain law could be applied On softer terms, environmental easements under the environmental Act, 1999 could be applied to allow access to these sites. This would still maintain them as private owned but would allow communal access. The private landholders would be allowed only acceptable uses such as harvesting materials On the other hand, the sites would be put under communal management.

Location environmental committees would therefore become very necessary. This could monitor the resources and resolve any societal conflicts. The committees should integrate the special groups that depend on the sites, farm owners and formal administration Any major disputes should be forwarded to the District Environmental Tribunal as provided for in the Environmental Act, 1999.

Several sites fall within the riparian reserves of rivers and therefore enforcement of riparian reserves become very important. Degraded sites in the riparian reserves could be rehabilitated through planting of trees, reeds and bamboo.

The community in general should be discouraged from sub-dividing of wetlands. Families should be encouraged to have a common approach to ownership and management of wetlands. Through the common agenda then important sites would be spared degradation

7.13.6 Strategies to Conserve Indigenous Forests and Vegetation

Forests and vegetation are critical in conservation of wetlands. They maintain the water conditions, protect soils from erosion, filter dirty water and release clean water to rivers, maintain temperatures, attract rainfall and are habitats for wild animals and insects. It has also been noted that in the location they provide fuelwood and building materials

The riparian reserves contain indigenous forests and vegetation. Through their conservation, a good percentage of the vegetation will be conserved. The 30m-radius provision of riparian leave ways along rivers should be strongly enforced, despite the pressure on land expressed by the community. The local administration should be in charge. The people should be educated of the importance of these reserves. Uses that are compatible should be encouraged such as grazing and cultural uses.

As earlier discussed the cultural sites should be preserved. These sites compose of some of the most indigenous vegetation. If the sites are protected by law, a good percentage of vegetation will be preserved.

There should be an order of uprooting all the eucalyptus trees in wetlands. People should be encouraged to plant Eucalyptus in dry lands and especially within the home compounds. Further, agro-forestry practices should be encouraged to provide for fuelwood and construction materials. Energy conservation methodologies should be enhanced (through energy saving *jikos*) and alternatives to energy. This will reduce dependency on natural vegetation.

There should be efforts in developing indigenous forests through planting more. Indigenous tree nurseries should be established though research programs. The local administration could facilitate this. This should target farms fronting the wetlands. Degraded sites should be rehabilitated though planting vegetation such as reeds and bamboo that are indigenous.

7.13.7 Strategies to Resolve Land Use Conflicts

Various land use conflicts have been noted in the study. In essence, the whole study aims at resolving the economic and ecological conflicts of wetland importance Within this general conflict, some specific conflicts arose from the land tenure systems and population pressure over land.

All land under government communal tenure should be maintained public and be put under appropriate uses such as grazing and public functions. This would help give free access to the people who have to survive on common grazing grounds. This would maintain them in the livestock economy. The common lands would also allow for the easy access of wild animals hence reduces the stress in wild animals.

All the big wetlands that qualify under the Survey Act to be protected but are under private ownership should be bought back by the government. This includes the Sio wetland, Bullcome wetland and the Khalaba wetland. Such should then be gazetted as public resources to benefit the community. This may be the only way of ensuring that the big wetlands are rehabilitated and protected

People should be discouraged from the heavy fencing of private wetlands to allow easy access of the wild animals, especially the big ones. This would biologically reduce wild animal stress.

7.13.8 Strategies to Enhance Community Capacity in Utilization and Management of Wetlands

For the success of any conservation plan the community has to be at the center stage with enough capacity to initiate, implement and manage projects. The community should be educated on the ecological importance of wetlands. This would help them appreciate further the risks of degrading the wetlands. Public meetings (brazes) would be used Church meetings and group meetings could also be used. Local media e.g. newspapers and radio programs would run programs to educate the people. School curriculum could integrate environmental concerns that can use the wetlands as field laboratories.

Projects/ programs that would benefit the community should be funded by agencies such as the government, churches and NGOs. Such projects would target user-friendly techniques in wetlands such as fish farming and handicrafts. Farmers could be trained on appropriate technology. Specific farms (wetlands) would be used as field demonstration sites. The programs would encourage the individuals and groups that are already trying to

appropriately use wetlands. For example the grass and reed farmers (discussed in analysis) would be trained in marketing of their materials.

Indigenous knowledge should be promoted and applied where relevant. If farmers for example are growing traditional vegetables in wetlands, then they should be encouraged along same lines instead of introducing other vegetables. Environmental economic modeling should be carried out (by research) to exactly establish which uses of wetlands are more sustainable and more profitable than others.

7.13.9 Strategies to Enhance Wetland Traditional Management Systems

The traditional management systems should be integrated in the formal management systems. It has been severally mentioned for example that the traditional cultural access to sites could be formalized into environmental easements. The old people who understand the historical changes and dynamics of wetlands could be invited to give talks to school children and village barazas. Videos could be recorded on the cultural functions of wetlands and be publicity showed to people in schools and colleges.

Establish popular and functioning local wetlands management committees. Such committees would be in charge of issues such as resolving conflicts arising from wetlands, recommending any projects, establishing tree nurseries and planting trees. Such committees should be representative of the wishes of the people.

Research into the traditional institutions of resource management and how they have evolved over time should be carried out by planners, environmentalists and anthropologists. This should be accompanied by detailed notification of local uses of wetland resources that can be developed on.

7.13.10 Strategies to Promote Legal Enforcement

The people should be educated about the existing laws that affect wetlands such as the water Act, Environment Act, Survey Act and the Agriculture Act. The Ministry of Environment and Natural Resources in conjunction with the local administration should be the main agents.

After a thorough sensitization of the community then people who go against the law should be adequately punished by the law. Ordering of rehabilitation of wetlands should be an essential component in the legal system as provided for in the Environment Act.

It should be clearly defined which agent is responsible for doing what in wetlands. Responsibilities should be given to relevant stakeholders as the Ministry of Environment and Natural Resources, Ministry of Agriculture and Rural Development, Ministry of Lands and Human Settlement, community, local administration, the resource technicians, NGOs, churches and schools. The local people should be given a central role in monitoring resources.

7.13.11 Strategies to Promote Stakeholder Participation

It is important to identify who the most relevant stakeholders are. In this case they would include the community, local leaders, sugar companies (Nzoia and Mumias), relevant Government Ministries (Environment, Water, Agriculture, Lands, Culture, Physical Planning), parastatals (KWS, LBDA), NGOs (ITDG, KWWG) and multi-lateral donors, among others.

Each stakeholder should have a key focus on issues. A multi-management team should be established at local levels among the stakeholders and forward pertinent issues to District Committees. The government and the community should be at the forefront of encouraging the other stakeholders to play a role in the management of wetlands.

7.14 Conclusion

The study has confirmed that wetland resources have a diversity of functions. The functions can be classified in two two: ecological and socio-economic. In Kabula Location, these functions include: maintaining the flow of rivers, acting as habitats for wildlife, harboring indigenous vegetation, on one hand, and on the other hand include society dependency on them for water, fuelwood, building materials and handicraft materials. Further, direct utility functions include crop production, livestock production

and fishing. Socio-cultural uses include recreation, collection of vegetables and traditional medicines and act as circumcision sites.

The use of wetlands in Kabula Location however leads to a myriad of problems such as clearing of vegetation, drainage, reduction in wildlife and soil erosion. Other problems include private and communal use conflicts. The community values the wetlands both for socio-economic and ecological functions. However, economic values outweigh the other values. This therefore posits a worrying situation where the ecological values of the wetlands could degrade further.

However, the Kabula community has developed both indigenous and formal mechanisms of reducing degradation. Traditional norms and cultural practices such as circumcision conserve wetland resources. These efforts are however not efficient because they lack adequate support from the formal policy and legal institutions. The study therefore recommends development of formal wetland framework that heavily relies on traditional institutions.

7.15 Areas for Further Research

Further research should focus on legal enforcement for the conservation of small-scale wetlands.

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APPENDIX I: HOUSEHOLD QUESTIONNAIRE

Introduction: This questionnaire is purely an academic exercise meant to assist Mr. Robert Wabwile Simiyu to fulfil the requirements for attaining a Master of Arts (Planning) degree of the Faculty of Architecture, Design and Development (ADD); University of Nairobi. Mr. Simiyu is undertaking a thesis entitled –**Sustainable utilization of wetland resources in Kabula location, Bungoma district**. Your answering of the questions accurately will help produce an accurate plan. Your opinions will be treated with due respect and in confidentiality.
Thank you in advance.

PART A: HOUSEHOLD ISSUES.

1. Household heads details:

Individual	Age	Education Level	Occupation
Father			
Mother			

2 (a) Number of children _____

(b) Details of the children, fill in the table below:

Name	sex	Age	Occupation

3 Water Source:

Water source (Tick)	Distance from house (km)	Ownership of source	
		Private(Tick)	Communal
Natural spring			
Borehole			
Water tank			
River			
Piped			

4 Energy source:

Energy source (Tick)	Is it gotten from a wetland	
	Yes (Tick)	No (Tick)
Fuel wood		
Charcoal		
Maize stock remnants		
Sugar cane remnants		
Paraffin		
Electricity		
Others (specify)		

5 Housing building material:

Building type	Material used (Tick)	Is it from a wetland?	
		Yes (Tick)	No (Tick)
1 Living house			
• Wall	Mud		
	Brick		
	Stone		
• Roof	Grass thatch		
	Mabati		
	Tiles		
• Floor	Soil		
	Cement		
	Tiles		
2 Granary			
• Roof	Grass thatch		

	Mabati		
• Wall	Sticks		
	papyrus		
	Tree poles		
	Wire mesh		
	brick		
	stone		
• Floor	Tree poles		
	sticks		
	wood		
	cement		
3 Toilet			
• Roof	Grass thatch		
	mabati		
	tiles		
• Wall	mud		
	brick		
	stone		
	block		
	papyrus		
	Grass thatch		
• Floor	mud		
	cement		
	wood		

6 What is the distance to the following facilities:

Facility	Distance (Km)
Tarmac road	
Small earth road	
Closest primary school	
Closest secondary school	
Closest market	
Closest town	
Closest medical facility	
Chief's office	
Sub chief's office	
Church	

PART B (i): LAND OWNERSHIP ISSUES.

7 (a) Do you own land? (Yes) / (No)
(b) If yes, what is the acreage _____ (acres)
(c) If no, on whose land do you live? _____
(d) (i) Do you have a land title deed ? _____
(ii) If no, why? _____

8 How did you acquire the land? (Tick).
(a) Inherited
(b) Bought
(c) Rent
(d) Lease
(e) Other (specify)

9 (a) Do you own land anywhere else _____
(b) If yes, what is the acreage _____ (acres)
(c) (i) Does the piece have a wetland _____
(ii) If yes, fill, in the table below:

Area of dry part (acres)	Area of wetland part (acres)

10 (a) Does the parcel of land you stay on have a wetland?
(b) If yes, what is the acreage of the dry part and the wetland part:

Area of dry part (acres)	Area of wetland part (acres)

PART B (ii): LAND USE ISSUES.

(a) Crop Agriculture production issues.

11 Briefly categorize how you have sub-divided your land for different uses?
(a) Dry part of your land:

Use	Acreage (acres)
Homestead	
Food crops	
Cash crops	
Grazing land	
Business buildings	
Kept natural forest	
Planted trees	
Fallow land	

Others	
Total	

(b) Wetland part of your land:

Use	Acreage (Acres)
Homestead	
Food crops	
Cash crops	
Grazing land	
Kept natural forest	
Planted trees	
Fallow land	
Other	
Total	

12 What type of crops do you grow on your farm:

Crop type	Acres in dry part of farm	Acres in wetland part of the farm	Total
Sugar cane			
Coffee			
Maize			
Beans			
Bananas			
Vegetables			
Tomatoes			
Millet			
Sorghum			
Potatoes			
Cassava			
Arrow roots			
Nappier grass			
Any other			
Total			

13 Give an average range of the produce (income) you get from each crop in a year

Crop type	Yield in a year from the dry part of the farm (either in Ksh. or bags or tones or Kg)	Yield in a year from the wetland part of the farm (either in Ksh. Or bags or tones or Kg).
Sugar cane		
Coffee		

Maize		
Beans		
Bananas		
Vegetables		
Tomatoes		
Millet		
Sorghum		
Potatoes		
Cassava		
Arrow roots		
Nappier grass		
Any other		
Total		

14 Considering the climate and soils of your area, tick months of production (activity) on your farm, and in each month indicate which crop you grow:

Month	Tick	Crops grown in the dry parts of the farm	Crops grown in the wetland part of the farm
January			
February			
March			
April			
May			
June			
July			
August			
September			
October			
November			

December			

15 (a) In your own opinion, comparing the produce from the dry part of the land and that of the wetland part of the land which part of the land is more productive?

_____

(c) Why do you think the part you have chosen is more productive?

16 What are the farm inputs you put in your land:

Input type	Quantity in dry part of the farm (Bags or Kgs or Ksh per year)	Quantity in wetland part of the farm (Bags or Kgs or Ksh per year)
Fertilizers		
Manure		
Chemicals		
Others		

17(a) For you to be able to produce crops in the wetland part of your farm, what activities/work do you undertake on the farm. Tick the activities from the choices below:

Activity	Tick
Open drainage tunnels	
Chemical spraying	
Fertilizer application	
Cultivation/digging	
Apply manure	
Irrigate	
Plant water absorbing trees	
Plant water retention trees	
Fence the land	
Block the water from moving	
Any other (specify)	

(b)Among the activities you have ticked, which ones do you consider to be spoiling your wetland?

18 Have you planted any trees on your farm?

Tree name	Area planted		
	In home (acres)	Dry farmland (acres)	Wetland (acres)

19 (a) Do you receive extension services on how to use your farm? _____

(b) If yes, how many times per month? _____

(d) Does the advice ever touch on the use of wetlands? _____

PART B (iii): Animal husbandry issues.

20 Do you keep any livestock on your farm? _____

Animal type	Number	Grazing area (acres)	
		Dry part	Wetland
Cattle			
Goats			
Sheep			
Donkey			
Pigs			
Chicken			
Geese			
Others			
Total			

21 (a) Are you the only one who graze on your farm or other people do graze on it?

(b) If other people do graze on it, approximately how many homes do graze on it?

22 (a) Do you ever graze your animals in the wetlands?

(b) If yes, is the wetland yours or for another person?

(c) If it is for another person, does he or she quarrel you for grazing on it?

(e) Do you have to seek for permission to graze on it?

23 (a) Is there a wetland area you graze on that is open for grazing to anyone?

(b) If yes, how large is it? _____ (acres)

(c) Does it have enough fodder for the animals?

(d) Who owns this open site? (Tick)

- Government
- Community
- Individual who has not used it
- Not known who owns it
- Others (specify)

(f) Compared to the past, is the area having enough fodder?

(g) Is the site used for any other activities? List them.

24 (a) Are there any quarrels among the people arising from grazing in the wetlands?

(b) If yes, why?
(c) (a) Comparing the number of livestock grazing on the wetland to the wetland area, is the area big enough to support to support all the animals?

(d)If no, how do the people ensure the animals get enough fodder?

(e)Apart from vegetation such as grass and leaves, what other foods do wetlands provide for animals?

(f) (i) Do you think grazing has contributed to the destruction of wetlands?

(ii) If yes, how?

24 (a) Have you ever grown any nappier grass in the wetland for your livestock or for selling in the wetland area?

(b) What is the acreage?_____ (acres)

25 (a) On your farm, have you left a piece of wetland for grazing?

(b) If yes, what is the acreage?_____ (acres)

(c) Why did you choose to leave the grazing ground in the wetland site and not the dry part?

(d)What activities have you done on the grazing site? (Tick)

- Fenced
- Opened drainage tunnels
- Planted water absorption trees
- Cleared vegetation and only left grass
- Dug water drinking ponds
- Others (specify)

(e) How many other farmers do you know have developed a wetland for grazing? _____

26 (a) Comparing to the past (i.e. 10 years or 20 years), is grazing in the wetlands still free and open, or is more difficult?
(b) Why do you think the situation has changed?

27 (a) Is it easy/free to move with your livestock along the river?

(b) If no, why?

28 (a) Have you or your neighbors farmed crops up to the river waters?

(b) Are you aware that you are supposed to leave 15 meters on each side of the river free of farming?

(c) Could you accept to leave 15 meters land on each side of the river for forests and for passage of people?

(d) What do you think should be done by the whole community on this issue?

PART C: OTHER WETLAND ISSUES.

29 Apart from crop farming and animal husbandry, what other goods/products or materials do you get from wetlands?

Product/Good/Material	Use
Soil	

Water	
Papyrus	
Medicines	
Fish	
Trees	
Any other	

30 What other socio- cultural events/activities go on in wetlands?

31 Rank the importance of the following socio-cultural activities of the wetlands using the following scale:

5-Very important
4-Important
3-Fairly important
2-Not so important
1-Poorly important
0-Not important at all

Activity	Rank
Wetlands are for circumcision	
Wetlands are for funeral	
Wetlands provide pure water	
Wetlands are for grazing	
Wetlands provide building material	
Wetlands provide handicraft materials	
Wetlands are for witchcraft	

34 (a) Are there sites in wetlands that are sacred?

(b) If yes, what are they used for?

(c) Are people just allowed to go there?

(d) (i) Are there any laws controlling the use of these sites? _____ List them

(e) Who manages or controls the use of these sites?

(f) Who owns these sites?

(g) As compared to the past, have the sacred sites reduced?

(h) If yes, what are the reasons that have led to the reduction?

(i) Has the reduction of these sacred sites affected the culture of the people?

(j) If yes how?

35 (a) Please enumerate any myths or cultures on wetlands?

(b) (i) Are these cultures and myths still effective in controlling the use of wetlands?

(ii) If yes how?

(ii) If no, why?

36 (a) Are there any wild animals in Kabula location?

Wild animal name	Found in wetland area (tick)	Found in dry part of the farm (tick)

(b) In your own opinion, are wetlands important homes for wildlife?

37 Are the wild animals used in any way?

Wild animal	Use

38 (a) Comparing the present to the past, have the wild animals reduced?

(b) If yes, why?

PART D: PERCEPTION/ATTITUDE ISSUES.

39 (a) Would you wish to have a land with a wetland?

(b) If yes, why?

40 How would you use a wetland acre of land? Rank the opinions below using the following scale:

5- Scores very strongly
4- Scores strongly
3- Scores fairly
2- scores weak
1-Scores very weak
0- Score nothing

Use	Score
I would drain it for intensive farming	
I would drain it for livestock rearing	
I would partly drain it and partly leave it natural	
I would fence it so that no one accesses it	
I would leave it open for communal grazing	
I would completely preserve it	
I would preserve it for culture uses	
I would develop a fish pond	
Any other (specify)	

41 If you had a site of a wetland on your farm that is used for communal functions such as circumcision ceremonies (i.e. Sitabicha), what would you do with it? Rank the following opinions using the following scale:

5- Scores very strongly
4-Scores strong
3- Scores fairly
1- Scores very poor
0- Scores nothing

Comment	Rank
I would drain the site for my farming/livestock	
I would develop a fish pond	
I would fence the site for my use	
I would leave part of it for communal uses and use part of it myself	
I would completely leave the site for	

communal use	
I would only harvest natural products from the site and still allow the community to use it	
I would give the site to the community for them to manage it	
I would still own the site but manage it for communal use	
Ant other Comments	

42 Give a ranking score to the following statements, using the following scale:
5-Score very strongly
4- Scores strongly
3- Scores average
2-Scores poor
1-Scores very poor
0- No score

Statement	Score
Wetland are useless in their natural state	
Wetlands are very useful for water, soils fuel wood and other tangible benefits.	
Wetlands are more useful when they are used both for agriculture and for natural and cultural ceremonies.	
Wetlands are only useful when they are producing agriculture and livestock products.	

43 Give a ranking score about who should own wetlands, using the scale below:

5-Scores very highly.
4- Scores high.
3- Scores average.
1- Scores poor
2- Scores very poor
0- Score nothing

Owner of wetland	Score
Individual	
Community	
Wetlands which are still big in Kabula should be preserved and owned by the community	

Big wetlands should be owned by the government	

44 Score the following ideas on what should be done on wetlands, using the scale given below:

5- Very high score
4- High score
3- Average score
2- poor score
1- Very poor score
0- Scores nothing

Comment	Score
Wetlands should be drained for agriculture and livestock production	
Wetlands should be partially used for agriculture and livestock production, and partly be conserved	
Wetlands should not be farmed at all	

45 Rank the following groups on who should be responsible for managing wetlands, using the scale below:

5-very high
4-High
3-Average
2-Poor
1-Very poor
0-Zero

Group	Score
Individual who own the wetland	
The community	
The chief, Sub-chief and Village elders	
The Government	
The government, individuals and community	
Committee of elected old men	
Women groups	

46 What is the role played by women in management of wetlands?

47 Give any other comment you may want to say on wetlands.

48 What do you think of this research?

APPENDIX II: QUESTIONNAIRE FOR ADMINISTRATORS

Introduction: This questionnaire is purely an academic exercise meant to assist Mr Robert Wabwile Simiyu to fulfil the requirements for attaining a Master of Arts (Planning) degree of the Faculty of Architecture, Design and Development (ADD), of the University of Nairobi. Mr. Simiyu is undertaking a thesis entitled: **Sustainable utilisation of wetland resources in Kabula location, Bungoma District.** Your answering of the questions accurately will help produce an accurate plan. Your opinions will be treated with due respect and with confidentiality.
Thank you in advance.

1. Name of the administrator (Optional)----------
2. Position held----------
3. Total area under your Management---------- (Km^2 or acres).
4. Total population of people under your management----------
5. Are there any Wetlands in your area of jurisdiction ----------

b) If yes, how Many could they be in Number ----------

6) What are the main uses of these wetlands?

7) In your own opinion, are the wetlands being utilised well? ----------Yes/No

b) Give reasons for your answere in 7 (a) above.

8) a) Over time, have the Wetlands reduced – Yes/No

b) If yes, why?

9) a)Do you think the people in your area of Jurisdiction are aware of the importance of wetlands?

b) Give reasons to your answere in (a) above.

10) a) Are there any main projects going on in wetlands in your area of jurisdiction --- yes/No

b) List them.

11) Are there any regulations or laws governing the use of wetlands in your area of jurisdiction? yes/no.

b) list the laws:-

c) Who implements the laws?

d) How do the people respond to the laws?

12) a) Are there any sites in wetlands that are of very significant importance i.e. for circumcision ceremonies? – Yes/No.

b) If yes, how Many?

c) How are they Managed?

d) Do you think these sites will last for long without being destroyed?

e) Explain your answere in d above.

13 Who do you think should own wetlands?

a) Private individuals
b) Community
c) Government
d) Any other (Specify).
e)

14) In your own opinion, how should wetlands be used?

15) Any other comment.

APPENDIX III: QUESTIONAIRE FOR RESOURCE TECHNICIANS

Introduction: This questionnaire is purely an academic exercise meant to assist Mr Robert Wabwile Simiyu to fulfil the requirements for a Master of Arts (Planning) degree of the Faculty of Architecture, Design and Development (ADD) of the University of Nairobi. Mr. Simiyu is undertaking a thesis entitled: **Sustainable utilisation of wetland resources in Kabula location, Bungoma District.** Your answering of the questions accurately will help produce an accurate plan. Your opinions will be treated with due respect and with confidentiality.
Thank you in advance.

1- Name (optional) _____
2- Position held _____
3- Total area under your jurisdiction _____(km2)
4- What are your main duties?

5 Are there any Wetlands in Your area of Jurisdiction? Yes/No

b) If yes, roughly, how Many are they?

6 What are the main uses of these wetlands?

7a) In your opinion, are the wetlands being utilised well?

b) Give reasons to your answere.

8 What technical/advisory/Planning role do you play in wetlands management?

9) Are there any Main projects going on in wetlands in your area of jurisdiction?

b) Do the above projects have any impacts on the wetlands? List the impacts.

threats to wetland resources?

10 B) What could be the solutions to these threats?

11) In your own opinion, how should wetlands be utilised?

12) Any other comments.

APPENDIX IV: OBSERVATION SHEET

Wetland name	Area	Type of crop grown		Tree species		Animal (acres)	Condition	Cultural uses	Ownership	Distance from the river
		Crop	Acres	Tree	Acres					

APPENDIX V: CALCULATION FOR WETLAND DOMESTIC WATER VALUE

Total households in Bungoma town are 5000. Average amount of money spent per household on domestic water in a month is Ksh. 750. Therefore monthly domestic water value=5000 households x Ksh. 750 =Ksh. 3,750,000 per month, and 3,750,000 x 12 = Ksh. 45,000,000 per year.

APPENDIX VI: CALCULATION OF WETLAND FUELWOOD VALUE

Average electricity bills for households is Ksh.2500 per month. This is an opportunity cost for not using fuelwood. Total number of households in Kabula Location is 1786. Therefore fuelwood value:

=Opportunity cost value x total households in location

=2500 x 1786

= Ksh. 4,465,000 per month and

= Ksh. 4,465,000 x 12 = Ksh. 53,580,00 in a year. Therefore, wetlands are valued at Ksh 4,465,000 for fuelwood alone in a month and Ksh.53, 580,000 in a year.

APPENDIX VII: CASE STUDY OF A FARMER WHO HAS KEPT 2 ACRES OF THATCH GRASS

The farmer has kept 2 acres of thatch grass. He sells one bundle at Ksh. 75. In 1 acre, he can produce 150 bundles. Therefore each acre can produce 150x75 = Ksh.11, 250. The grass takes 3 months to mature for use after a harvest. Therefore he can harvest 3 times in a year. In one acre, the farmer therefore makes 11,250 x 3 = Ksh. 33,750. From the two acres the farmer makes 33,750 x 2 = Ksh.67, 500 in 1 year.

APPENDIX VIII: CASE STUDY OF REEDS FARMER

The farmer planted reeds along a riverbank. He sells one bundle of approximately 100 reeds at Ksh. 50. When a physical count was done on the farm, it was established that the 100 reeds cover approximately 1 square meter. Given that the reeds had spread to approximately 1 acre:

1 acre= 10,000 m^2

Number of m^2 in 10,000m^2 = 10,000

Value of reeds in 1 acre = 10,000 x Ksh. 50 = Ksh.500, 000.

According to the farmer due to low demand for the reeds, he makes only about Ksh 25,000 in a year. In as much as the full cost of the reeds (Ksh. 500,000) is not achieved, Ksh. 25,000 for a non-employed farmer is "high". He said, *"In the beginning I felt like uprooting the reeds because I thought they would spoil my farm. Nevertheless, I did not because people began buying them for building houses and stores. Further I realized the reeds were encouraging water storage in my farm".*

APPENDIX IX: SPEARMAN'S RANK CORRELATION OF WETLAND AND DRYLAND SUBDIVISION

Land use	Dryland	Wetland				
	Value (Acres)	Rank	Value (Acres)	Rank	Difference between rank(d)	d^2
Homestead	23.9	4	1.0	7	-3	9
Food crops	105	2	48.25	1	1	1
Cash crops	198	1	28.25	3	-2	4
Livestock	52.6	3	47.25	2	1	1
Forest	6.25	7	6.45	5	2	4
Plant trees	11.55	5	7.35	4	1	1
Other uses	6.2	6	2.5	6	0	0 $\sum d^2=20$

This furthered into a mathematical equation comes up as:

$$r_s = 1 - \frac{6\sum d^2}{n(n^2-1)}$$

Where n is the number of subjects (land uses).

$$R_s = 1 - \frac{6 \times 20}{7 \times (7^2-1)}$$

$= 1 - 0.36 = 0.64$

APPENDIX X: PEARSON'S PRODUCT MOMENT CORRELATION OF DRYLAND AND WETLAND CROPS

CROP	RANK	
	Wetland	Dryland
Sugar cane	2	1
Coffee	14	11
Maize	1	2
Beans	4	3
Bananas	13	6
Vegetables	5	8
Tomatoes	12	13
Millet	8	9
Sorghum	8	12
Potatoes	6	7
Cassava	11	10
Arrow roots	7	14
Nappier grass	3	5
Other crops	10	4

CROP	WETLAND		DRYLAND			
	Value (Acres)	Rank	Value (Acres)	Rank	Difference between ranks	Squared difference d^2
Sugar cane	37.0	2	200.45	1	1	1
Coffee	0.0	14	2.1	11	3	9
Maize	45.6	1	73.15	2	-1	1
Beans	6.0	4	32.35	3	1	1
Bananas	0.5	13	11.4	6	7	49
Vegetables	5.7	5	4.15	8	-3	9
Tomato	1.1	12	1.45	13	-1	1

es						
Millet	2.0	8	2.7	9	-1	1
Sorghum	2.0	8	1.75	12	-4	16
Potatoes	2.75	6	4.3	7	-1	1
Cassava	1.35	11	2.45	10	1	1
Arrow	2.40	7	0.6	14	-7	49
Nappier	8.20	3	14.9	5	-2	4
Others	1.6	10	25.6	4	6	36 $\sum d^2 = 177$

Spearman's product moment correlation:

$$r_s = \frac{1-6\sum d^2}{n(n^2-1)}$$

Where n is the number of subjects (land uses).

$$= 1 - \frac{6 \times 177}{14\,(14^2-1)}$$

$$= 1-0.39$$

$$= 0.61$$

APPENDIX XI: CALCULATION OF WETLAND AND DRYLAND FOOD PRODUCTIVITY PER UNIT AREA

Productivity per unit area = $\frac{\text{Total yield}}{\text{Total land under production}}$

Wetlands food productivity per unit area

$$= \frac{\text{Total wetland food yields (kgs)}}{\text{Total wetland acreage under food crops (Acres)}}$$

$$= \frac{36{,}000\text{kgs}}{48.85\text{ acres}}$$

While dryland food productivity per unit area

$$= \frac{\text{Total dryland food yields (kgs)}}{\text{Total dryland acreage under food crops (Acres)}}$$

$$= \frac{88\ 250 \text{ kgs}}{105 \text{ acres}}$$

= 840.5 kgs per acre.

APPENDIX XII: FORMULAE FOR CALCULATION OF INPUTS PER UNIT AREA

$$\frac{\text{Total input units (i.e. Kgs or Litters)}}{\text{Total cropland area}}$$

APPENDIX XIII: CALCULATION OF WETLAND GRAZING VALUE

From the Bungoma district livestock officer, prices of livestock go at,

- Cow of approximate weight 300kgs – maximum price Ksh.15, 000.
- Goat of approximate weight 50kgs – maximum price Ksh.1000.
- Sheep of approximate weight 150kgs – maximum price Ksh. 750.

Ratio of grazing land = 1:1.5 (dryland: wetland).

Therefore ratio of wetland: dryland animal weight

$$= 300 + 50+50x\frac{1.5}{2.5}: 300 +50+50x\frac{1}{2.5}$$

= (400x 0.6): (400x0.4)

=240: 160

=3:2

To convert weight ratios into money,

- Cattle = number of cattle per household x total households in location x price per cattle.
- Goats = number of goats per household x total household in location x price per goat.
- Sheep = number of sheep per household x total households in location x price per sheep. This comes to,

Cattle = 5 x 1786 x 15,000 = Ksh.133, 950,000

Goat = 1 x 1786 x 1000 = Ksh.1, 1786,000

Sheep = 1 x 1786 x 750 = Ksh.1, 339,500

Total earnings from livestock = Ksh.137, 075,500

Wetland value = 3/5 x 137,075,500= Ksh.82, 245,300

Therefore wetland grazing value = Ksh. 82,245,300 in the location, while the dryland grazing value = Ksh.54, 830,200. The average wetland livestock value per household is Ksh. 46,050 while for dry lands is Ksh.30700. The wetland grazing value is therefore very high.