LAND USE CHANGES AND THEIR IMPACTS ON WETLANDS IN LOBOI PLAINS BARINGO COUNTY, KENYA.

BY

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DECLARATION

Declaration by the Candidate

This thesis is my original work and has not been presented for a degree in other University. No part of this thesis may be reproduced without the prior written permission of the author and/or Moi University.

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DEDICATION

his thesis is dedicated to: My late father, Gibson Kareri Waithanji and my mother, Martha Wanjira Kinyeru whose contribution to my life is immeasurable; My family (Eve, Ken, Gibson, Martha, Peninah and Willie) for their love and prayers as they looked forward to the end of this work and; The late Emeritus Professor of Geography Reuben Benjamin Ogendo (PhD) who shaped my understanding of the discipline of Geography

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ABSTRACT

Encroachments of land use systems into traditional forests and wetland areas are contributing to degradation of these ecosystems leading to unsustainable development. Whereas such land developments could be contributing to short term socio-economic welfare of the people, they, in the long-run cause degradation and thus threaten the very livelihoods of the local people they were meant to sustain. Generally, this study examined and analyzed land use changes and their impacts on wetlands in the semi-arid lowlands of Baringo County. In particular, the study sought to: analyze the nature of land use changes in the study sites and assess the impacts of the land use changes on the Loboi plains' wetlands; assess the traditional values and uses of wetlands and the impacts of loss of these ecosystems on people's livelihoods; and finally, suggest possible culture-based and/or policy interventions to stem wetlands loss and degradation. The study was guided by a broad spectrum of theories including; political economy, political ecology and "the tragedy of the commons". Secondary data were obtained and maps digitized from the resource inventory in the Survey of Kenya. Landsat Thematic Mapper and Enhance Thematic Mapper plus from 1986 to 2006 were analyzed in Geographical information system to establish the extent of land use/land cover change. Reference data obtained through GPS and photographic loggings of the landscapes guided the interpretation of the images in order to obtain details about the various features of land use changes and the manifestations of their impacts. Content analysis of relevant literature was done. Primary data was obtained through administration of questionnaires to a random sample of 132 household heads. In-depth interviews and discussions were conducted with 10 key informants. The collected data were synthesized, treated and analyzed for necessary generalization using SPSS computer package. Digital image processing indicated loss of 4,248 acres (or 2.23% of total land area) and 8,789 acres (or 4.61% of the total land area) in wetlands and forests respectively, within 20 years. These findings were corroborated by the socio-economic survey results where forests and wetlands were perceived to have declined by 35.1% and 23.4% respectively. Increased crop-cultivation was viewed as a more prominent cause of land use/land cover change (28.8%) compared to others such as population increase at 25.8%. Crop-cultivation was prioritized by most of the respondents (71.3%) because of the expected high returns accruing to irrigation farming. Thus, water withdrawal from river Waseges and the lowland wetlands increased as the influent reduced. Furthermore, upstream deforestation increased sediment load that suffocated wetlands plants. Together these factors led to the degradation of wetlands. In conclusion, attempts at replacing pastoralism as a livelihood strategy with sedentary agriculture have not only been disruptive to the traditional way of life but have exacerbated the prevailing environmental destruction. An integrated watershed management that incorporates payment for ecosystem services is recommended in order to balance ecological gains with livelihood needs within the study area. Further, researches for planning and academic purposes should be carried out to investigate the best ways of managing the watershed areas so as to minimize sedimentation and fluctuations in seasonal river discharge. Research should also be carried out to seek and recommend alternative forms of livelihoods that are compatible with the semi-arid environments.

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ACRONYMS AND ABBREVIATIONS

ALRMP	Arid Lands Resource Management Project
ASAL	Arid and Semi-Arid Lands
CARE	Co-operative of American Relief Everywhere (1945)
KNBS	Kenya National Bureau of Statistics
GIS	Geographic Information System
GLCF	Global Land Cover Facility
GOK	Government of Kenya
IDS	Institute of Development Studies, Nairobi
IMF	International Monetary Fund
IUCN	International Union for Conservation of Nature and Natural Resources
JICA	Japanese International Co-operation Assistance
KNBS	Kenya national Bureau of Statistics
KENGEN	Kenya Energy Generating Company
KFS	Kenya Forest Service
KREMU	Kenya Rangelands Ecological Monitoring Unit {currently Department of Resource Surveys and Remote Sensing (DRSRS)}
LBNR	Lake Bogoria Nature Reserve
KWS	Kenya Wildlife Services (Nairobi, Kenya)
MDGs	United Nations Millennium Development Goal (2015 Changed to Sustainable Development Goals (SDGs)
MOALD	Ministry of Agriculture and land Development
NFA	National Forestry Authority-Uganda

NWCM	National Wetlands Conservation and Management
NEAP	National Environmental action Plan
NGO	Non-governmental Organization
NPSDASAL	National Policy for the Sustainable Development of Arid and Semi-Arid Lands
OECD	Organization for Economic Co-operation and Development
PES	Payment for Ecosystem Services
PRSP	Poverty Reduction Strategy Papers
REGLAP	Regional Learning and Advocacy Programme for Vulnerable Dry land Communities
SAP	World Bank's Structural Adjustment Programme
UNEP	United Nations Environment Programme (Nairobi, Kenya).
UNESCO	United Nations Education, Scientific and Cultural Organization
USEPA	United States Environmental Protection Agency (2000)
RAE	Rehabilitation of Arid Environment
WRMA	Water Resources Management Authority
WRUA	Water Resource Users Association
WECD	World Commission on Environment and Development.
WWF	World Wide Fund for Nature.

DEFINITION OF OPERATIONAL TERMS

Nature of land use change: this phrase interrogates the form of land use change and the factors driving the change. For example, the transition of land use from pastureland into cultivated land, is the culmination of many forces within and outside the community coming together to influence changes in the livelihood and other socio-economic preferences of production.

Pastoralism: the term is used here to describe an economic activity, which for long was the only known form of livelihood among the Tugen and IIchamus peoples of Baringo County. Pastoralism is also an embodiment of culture and hence describes the way of life of the people. Livestock in these communities is the measure of wealth, social status and a store of value. Therefore, every aspect of these people's lives rotates around livestock and pasture.

Wetland loss wetland degradation: The two terms are used together in the thesis to describe not only the spatial change, in the area of a wetland but also change in the ecological attributes that give character to a wetland. Wetland loss in the study area has been caused by encroachment onto these ecosystems by people for crop-cultivation and/or animal grazing. Wetland degradation is caused by the loss of ecological functions as a result of the disturbances and reduction of the biodiversity.

Land use/land cover change: the distinction between the two provided by Kiage, et al (2000) best describe the usage of these two terms in the thesis. They say land cover measures the physical attributes or characteristics of the earth surface, while the land use describes how land cover is utilized. In this regard the use of Remote Sensing technique can only detect land cover and not land use: to remove confusion in the use of the two terms, they are used interchangeably in the current research.

Discharge: volume of water passing through a given gauging station denoted in the case of River Waseges by 2EB5, 2EB4, 2EB3 and 2EB1.

Socio-economic class: stratification of household based on the societal perception of wealth and status of the household head. This information was obtained from the key informants.

Upstream/downstream linkages: refers to the hydrological linkage offered by the river Waseges, from the wet highlands to the dry low lands. The water of this river is the lifeline of upstream farmers and lowland pastoralists. Unregulated use of water upstream denies life to people downstream; hence conflicts over this resource are common.

Watershed (or catchment): the geographical area drained by the river Waseges and its tributaries. It covers all that area that starts from the Bahati and Marmanet forests to the mouth of River Waseges at Lake Bogoria

Watershed management: is used to define the best practices applied to all that area of land, within the upper catchments of river Waseges to ensure a sustainable use of watershed resources. This may include reforestation and protection of the existing forest cover and application of suitable soil and water conservation techniques.

Rangelands: these refer to the Baringo County lowlands receiving less than 600 mm of annual rainfall and experiencing around 2,400mm of annual evapotranspiration. These lands are marginal for crop production but have supported livestock production over millennia. They are best used for nomadic pastoralism, with limited dry land cropping of drought resistant crops. Rangelands also provide suitable habitats for wildlife and hence are productively used for tourism related economic activities.

External Economy: Relates to any economic organization that is outside the one supporting livelihood among the inhabitants of these arid lands. It comes in the form of trade, involving export and import of consumer and /or investments goods. The external economy tends to be advanced in its marketing systems and hence has the capacity to influence production decision-making in the latter economy in its favour.

Households: The definition given by the KNBS (2009) has been adopted here with slight modification, that is; "a household consists of persons living under one roof or several roofs within the same compound sharing a community life by their dependence on a common holding as a source of food and income". Polygamous families are common among the Tugens. Household may be constituted of several homesteads under a patriarch, who owns family assets and is the key decision-maker.

Community institutions: Social-cultural and economic organization that directs use of local resources by invoking socially acknowledged rules and obligations, for example the Tugen or IIchamus council of elders which has been vested with regulating the seasonal use of wetlands and other commonly owned resources such as saltlicks.

Ecosystem services: These are direct and indirect products and /or services a community derives from an existing wetland or forest resource. For example drawing clean water from river Waseges is an indirect contribution of the well maintained Marmanet and Bahati forests, whereas extracting vegetables from the wetland is a direct product and hence a direct ecosystem service. A natural resource management approach, which is based on an adequate understanding of the role of ecosystem services in people's livelihoods, is most successful way to protect the wetlands from degradation.

Livelihood: is defined here to distinguish between different forms of social-economic activities upon which the people's survival is anchored. Traditionally nomadic pastoralism was the only known source of livelihood for the people living in the Baringo County lowlands. However, social-political-economic interactions of these people with the outside world, has introduced other forms of livelihoods; including agricultural crop-cultivation, trade and commerce.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Land is the most important natural resource that Kenya has for the generation of national income and employment. But, land is also a scarce resource: out of the total land area of 582,646 Km^2 only 17% is suitable for rain-fed agriculture. Apart from 2.3% (13,396Km^2) of the area that is covered by forests and woodlands, the rest of the land constituting about 79% of the total land area of Kenya falls under what is commonly referred to as the dry lands. The UN (2011) defines the dry lands as the arid, semi-arid, sub-humid and productive part of the hyper-arid climatic zones (ASALs), characterized by unreliable rainfall at its best standing at 600 mm per annum. The dry lands support 3 to 4 million people, which are about 15 - 20% of Kenya's population (JICA, 1992)

A large majority of the ASAL watercourses are ephemeral, existing only briefly after rainfall and do not provide a reliable source of water supply unless trapped in either natural or artificial pans or dams (MOA, 1992). Water security is therefore, a critical component in any attempt to improve the livelihoods and the economy of the ASALs regions of Kenya. During the wet season water and grass are readily available over wide areas of the rangelands, but absence or scarcity of both water and fodder characterizes the dry season.

In common with other ASAL regions of Kenya, the Baringo lowlands receive low annual rainfall, which comes in the form of localized storms that generate heavy runoffs and massive erosion. It is therefore, unpredictable and unreliable for crop-

cultivation. Consequently, nomadic pastoralism has always been the main economic activity and in fact the only way of life for the majority of the people in the ASAL regions. This naturally, has been the most suitable land use practice, in view of the ecological sensitivity and low carrying capacity of these Eco-zones. The inhabitants of the ASAL regions have lived in these apparently harsh and demanding environments over many years. Historical events in these areas are dotted with repeated cycles of drought and flash floods resulting in massive crop failures and soil erosion. Recurrent food shortages are therefore a common occurrence in these regions. This has literally pushed the ASALs inhabitants into positions of partial and sometimes total dependence on relief food supplies.

Scattered within these dry lands, are wetlands that provide vital dry season grazing areas for domestic animals and wildlife. The term wetlands covers a wide range of habitats which share common characteristics; the main categories include, estuaries open coasts, flood plains, freshwater marshes, lakes, peat lands and swamp forests (Gichuki,1992). These ecosystems are of great importance locally, nationally and globally for their capacity to hold critical biodiversity resources. Most wetlands have been internationally recognized as Wetlands of International Importance, especially as habitats for Waterfowls by the Ramsar Convention, signed at Ramsar in Iran in February 1971.

The Ramsar Convention defines wetlands as “areas of marsh, fen, peat land or water that is static or flowing, fresh, brackish or salt including areas of marine water, the depth of which at low tide does not exceed six metres. These areas may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six meters at low tide lying within the wetlands”. Abundant water

makes wetlands the most biologically diverse ecosystems on Earth, more productive than even the Tropical rainforests (Turner, 1997). But unlike rainforests they are scattered across the world, preventing regional flood and erosion, acting as natural water purification systems and helping in nutrient recycling (Jones, et al, 2006).

Kenya acceded to the Ramsar convention in 1990 and ever since designated Lakes Nakuru, Baringo, Elmentaita, Naivasha and Bogoria as Ramsar sites. In addition Lake Bogoria together with Lakes Nakuru and Elementaita were added to the UNESCO World Heritage List during in its 35th Session (2011) in Paris, France. The government of Kenya (2013) through a ministerial statement acknowledged that, "wetlands are key to socio-economic development of Kenya", but lamented that, "these ecosystems continue to be degraded and/or lost mainly due to unsustainable human practices such as intensive agricultural production, and industrial use, urbanization, infrastructure and industrial development and pollution".

During the dry-season most of the land in the ASALs is desiccated and bare. This may go on for a period of six to seven months and in the event of drought the situation may persist for months and years. The value of wetlands for livestock and crop farming is due to the fact that they remain wet far into and sometimes throughout the dry-season (Scoones, 1992). Thus, these dry season fallback areas form the core of the local grazing systems (Little, 1992). Without them, or with restricted access to them, the pastoralists are forced to remain in the wet season grazing areas for extended periods, which cause overgrazing and land degradation (JICA, 1992).

The Loboi plains have two distinct wetlands named Loboi and Kesubo swamps. The two wetlands give credence to Sketchley, et al (1978) assertion that the Loboi plains were in the past occupied by a water mass that has since shrunk. They argue that the

two lakes; Bogoria and Baringo stand out as the only visible remnants of the former massive water body. The process of losing the water body is slow but steady. For instance a study done by Onyando (2002) showed a continuous decrease in the surface area of Lake Baringo from 219 km^2 in 1976 to 108 km^2 in 2001. He predicted that if the same trend continued the surface area of the lake will have been reduced by 50% by 2025. Available data also show that the lake depths are rendered shallower by the increased sedimentation (Kiage, 2009, Onyando, 2002 and Odada et al, 2004).

The combined effects of low precipitation and very high evaporation within the range of 450-900mm and 1,650-2,300mm respectively, are to blame for the continued dryness. The situation is made worse by clearance of forest cover in the watershed areas of the Bahati and Marmanet forests, giving rise to the seasonal variations in the rivers' discharges. A scenario whereby the wet season is characterized by increased river discharge and flash floods alternating with a dry season (that is notorious for shortage of water supply and animal feed), prepares a good recipe for land degradation.

The Loboi and Kesubo swamps have been shown by different studies (Renaut, 1993, Owen, 2004, Driese, 2004 and Ashley, 2004), to have changed spatially over time. The permanent wetlands have been reduced systematically over time but the seasonal wetlands appear to fluctuate with seasonal changes. These changes have been attributed to effects of climate change that has been reinforced by anthropogenic factors.

Wetlands have from time immemorial been used to provide different services to the local communities, including food, medicinal plants, and cultural benefits such as secluded sacred places of worship and as critical sources of raw materials for cottage

industries (Kareri, 1992). The traditional users of wetlands in the ASALs applied rules that were embedded in local social institutions to minimize overgrazing and over-exploitation of wetland plants, soil and water (Campbell, 1978, Little, 1992, Anderson, 2002). Often a council of elders was vested with the responsibility of deciding when to start and when to cease grazing in the wetlands depending on the season and availability of pasture in the adjacent highlands (Mr. kangogo- Group Ranch elder, per. comm. 2010).

Today we have witnessed the collapse of traditional institutions and emergence of modern capitalist oriented formal institutions which have weakened traditional practices such as transhumance. We have hence lost the rationale upon which the traditional resource management systems were built. Modern institutions have failed to offer effective resource-use regulation and control because they operate with minimal involvement of the people. Hence, the impacts on the wetland ecosystems that we see today are unprecedented. Therefore, a new management approach, to ameliorate the detrimental effects of the market forces, must be found.

The advent of colonialism in Kenya appears to have accelerated events that led to the demise of 'the wise use' of our natural resources based on traditional practices. Documented works of the history of colonial settlement in Kenya (Anderson, 2002, Little, 1992) has it that white settlement in Kenya claimed pastoralists' grazing land on the Laikipia escarpment. The colonial settlement was justified on the receipt of 'consent' for occupation of all that part of the Rift Valley that the Maasai people traversed with their animals (Okoth-Ogendo, 1991). The Tugen and IIchamus in common with the Maasai were using the highland as part of their annual nomadic grazing cycle. The settler occupation, therefore denied them a critical resource, which

destabilized their regular grazing patterns, leading to overgrazing in the non-occupied pockets of land, particularly the swamps (JICA, 2002).

The momentum for reclaiming what was erroneously viewed as 'no man's land' continued far into the post-colonial era, as sedentary agriculturalists under the aegis of the resettlement program vigorously entered and converted much of the forests and woodlands into crop and grazing lands. Together with the official excision of forest land, informal arrangement that included what was locally called the "shamba system" enabled people to encroach deeper into the forest land. The situation would have been ameliorated if only the government interventionist policies factored in the mobile way of living and economy into programs aimed at improving the dry land environments. This failure is best shown in the GOK (1979) Arid and Semi-Arid lands Development strategies and programs, which underlined the government's commitment, to total transformation of the ASAL economy.

Nomadic economic lifestyle was variously described as "backward", "not in-keeping with modernity" and in the minimum an "anti-thesis of development" (Awuondo, 1989). It was generally argued that the nomadic lifestyle, which for millennia supported the ASAL people, could no longer meet the changing world's lifestyle needs. Therefore, the ASAL development programs of 1979 cited above, viewed these regions as areas that were in great need for structural change. Hence, an important component of this development strategy was sedentarization of pastoralists into agricultural cultivation. Therefore, the government embarked on promotion of irrigation schemes where they existed and initiation of new ones where there were none.

The potential for irrigation farming was said to be high and was to be the answer to the persistent cycle of food deficiency in the ASALs. To ensure the success irrigation farming in these dry lands, the Government invested significant resources in water supply development and conservation. Among other allied activities, the government embarked on construction of sub-surface earth dams, weirs, pans, spring protection, and sinking of shallow wells and bore-holes. These efforts were superimposed and strengthened by various development and relief packages from national and international donor community covering substantive development concerns (Scholz, 2000).

Unfortunately, the community water drawing points became centres of population concentration, exerting pressure on the immediate ecosystems, causing enormous degradation of both vegetation and soils (Lamprey, 1978). Ironically, studies carried out later to determine the feasibility of crop-cultivation in the ASALs were quick to blame degraded land on nomadic pastoralism. The degradation of the land was then used to demonstrate the superiority of cultivation over nomadic pastoral way of life and to justify the sedentarization and domestication of the pastoral people (JICA, 1992).

Sedentary lifestyle, led to the reduction of the former space of action, including the necessary movement and therefore the basic subsistence conditions for the nomadic population. A new and previously unknown land tenure system was slowly creeping in, accompanied by privatization of land. Communal land tenure system slowly acquired pseudo-statutory rights in the form of group ranches and individualized parcels of land. Consequently, the size of the free pastoral grazing land declined, forcing an even greater number of the people to adopt settled lifestyles.

Contrary to the commonly held view, nomadic pastoralism has always been the most sustainable grazing system in these hostile climatic zones. But the government planners and policy makers tend to see things differently. Settled lifestyle is favored because a concentrated settlement generates higher economies of scale in the delivery of education, health and other government services. These efforts, it is argued will not only raise the people's standards of living but will also encourage diversification of the pastoral economy, allowing pastoralists to engage in less precarious forms of livelihood such as agricultural crop-cultivation(GOK, 1979 and GOK 2005).

The above arguments are however, not supported by the emerging views on the potentialities of the global dry land resources. The more current view is that the ASALs promise to offer new frontiers of development-a development that maximizes on the regions' comparative advantage. For instance, a World Bank (2001) report was optimistic that the livestock was to make a significantly sizable contribution to the national economies in the new millennium. It was reported that the sector's output will constitute about 30% of global agricultural produce. It will also be the single largest user of land taking up about 80% of the world's agricultural land surface within the first two decades of the twenty first Century. This will make it the most important sub-sector in terms of agricultural land use.

The World Bank report (2001) concurs with what has always been advocated by economists with respect to the need for regions to specialize in those economic activities that they have the greatest comparative advantage. The dry lands of Kenya have over millennia proved to be best suited to range management and pastoralism. It was mainly for that reason that the Kenya Meat Commission was formed to handle all

aspects of meat processing and marketing on behalf of the cattle owners, while ensuring that wildlife sanctuaries were protected.

In a similar vein the Baringo County vision and strategy document (2005) has extensively described the County's rich landscape that is well- endowed with a wide variety of natural and human resources. Notable resources are; natural capital including; geological and geomorphic landforms (associated with the formation of the Rift Valley), fauna and flora resident in the various eco-zones and the scenic beauty of the two lakes Baringo and Bogoria. This rich natural capital offers opportunities for a very profitable tourist trade. The County too, enjoys a unique economy based on traditional livestock grazing that is expanding in number and variety to include small livestock rearing (poultry, snakes, crocodiles, chameleons etc.). Umpteen opportunities for livelihood diversification that include irrigation agriculture, bee-keeping, commercial production of medicinal plants such as the Aloe Vera, have been strengthened by a rich indigenous knowledge of traditional medicine and surgery.

Full realization of this potential, however, depends on enhanced investments on infrastructure such as roads and irrigation canals to promote agricultural production and marketing. Equally important is formation of appropriate policies to address endemic poverty that is reinforced by a fast growing population. Besides, successful implementation of water-based projects depends on a continuous supply of water from the adjacent highlands. Therefore, maintenance of a healthy vegetation cover at the headwaters of the many rivers that drain the lowlands must be assured. This underscores our reason for expanding our study sites from the lowlands along the River Waseges up to the adjacent highlands.

1.2 The Statement of the Problem

Encroachments of land use systems into traditional forests and wetlands are contributing to degradation of these ecosystems leading to unsustainable development. Whereas such land developments could be contributing to short term socio-economic welfare of the people, they in the long-run cause degradation and thus threaten the very livelihoods of the local people they were meant to sustain. History has it that, these lowlands were once occupied by a massive lake that has since receded, leaving behind lakes Bogoria and Baringo as its remnants. This shrinkage has been blamed on varied causes including climate change and anthropogenic factors. If this trend continues, the remaining aquatic and semi-aquatic ecosystems may eventually be transformed into terrestrial landforms, losing a lot of their ecological and economic importance.

In the past, and in common with other parts of Kenya's arid and semi-arid areas, the Loboi plains were less populated. Nomadic pastoralism together with hunting, collecting and gathering constituted the main source of livelihood. Today, however, due to increased population and penetration of forces and influences of modernization, herding systems are experiencing enormous competition from alternative land uses namely; permanent human settlements, cultivation agriculture and commerce. Therefore, household welfare that was previously assured by a relatively stable pastoral economy is in dire need for compensation through government food relief supplies.

A sedentary lifestyle based on crop-cultivation is seen as the panacea to land and food production problems in the ASALs. Unfortunately, crop-cultivation in the dry lands is encumbered by shortage of water. The lowland wetlands have become the source of

hope and dependable grounds for all-year round crop-cultivation, besides supplying water for both people and their animals. Yet no detailed studies or analysis have been carried out to assess the potential impacts of the changing land use activities on these fragile dry land ecosystems.

Many communities in Kenya use wetlands for economic, social cultural and aesthetic functions. However, studies of wetlands have long been the domain of ecologists. Few studies focus on human activities with respect to wetlands. Consequently, anthropogenic factors and their influence on wetlands have been less understood. Hence, appropriate recommendations on how best to incorporate man in the efforts of wetlands conservation are lacking. As a result, wetland resources are continuously encroached, over-exploited and depleted by man.

The current study has attempted to document and analyze land use changes within the Loboi plains and the adjacent highlands, with a view to determining the subtle factors that directly or indirectly affect the ecology of the dry land wetlands in Kenya.

1.3 Research Objectives

The general objective of this study is to examine and analyze the nature of land use changes and their impacts on wetlands and people's livelihoods, in the semi-arid lowlands of Baringo County. The specific objectives are:

(1). Examine the nature and magnitude of land use/land cover changes, their related causal factors and consequent impacts on the lowland wetlands;

(2). Assess the traditional values and uses of wetlands and the impacts of loss and degradation of these ecosystems on people's livelihoods;

(3). Suggest possible culture-based and/or policy interventions to stem wetlands loss and degradation.

1.4 Research Questions

1. What is the nature and magnitude of land use/land cover changes in the study area and their related causal factors?
2. What is the impact of land use changes in the upper catchments on lowland dry lands wetlands?
3. What are the consequences of wetlands loss and degradation on people's livelihoods in the Semi-Arid Baringo County lowlands?
4. What community attributes can be harnessed in support of wetland conservation efforts?

1.5 Scope and Limitations of the Study

Initially the study was to limit itself to an investigation of land use changes in the geo-ecological land units confined within the lakes Bogoria-Baringo lowlands, covering the Loboi plains. However, in the course of the study vital information emerged revealing critical hydrological linkages between the upper catchments of River Waseges and the Loboi Plains.

Consequently, the study considered and analyzed the causes of wetland loss and degradation at two levels namely; (1) the direct loss and degradation that occurs due encroachment onto the wetland itself and (2) the indirect loss and degradation that occurs in the wetland due to human activities taking place in the upper catchments of River Waseges.

GIS and RS have been applied in the current study to establish the spatial-temporal land use change. An integrated approach which views the natural and the social factors, interdependently has given us a better understanding of the linkages between land use change and man's activities within the framework of the man-environmental

interface. These factors have been brought together comprehensively to inform policy so as to contribute to sustainable management of wetlands in the dry lands of Kenya.

Since the initial interest of the study was focused on land use change within the Baringo County lowlands, the extension of the study to River Waseges catchment areas meant picking a separate sample to investigate land use practices among the registered members of the WRUA and non-registered farmers. The socio-economic data was augmented by the spatial analysis of land use/cover change using Earth observatory technology, coupled with analysis of hydrological data. Together this data was found sufficient in informing the study on the intensity of land use land cover change on a wider scale.

Finally, the study focused on deepening our understanding of people's dependence on wetlands and the critical role that these ecosystems play in local, national and regional economies. However, information on strategies adopted by households, in their attempts to balance conservation and subsistence needs was blurred by rigid traditional resource management decision-making, in these patriarchal societies.

1.6 Importance and Usefulness of the Study

The study was carried out in response to many global concerns on conservation of natural resources including forests, wetlands and the associated genetic wealth. Although much of the loss in natural resources has been blamed on the rapidly growing population, there has been a notable failure in formulating suitable policies to balance conservation with utilization of these natural resources.

The UN MDG7 (changed to SDGs in 2015) underscores the fact that many people in the developing world have a high dependence on biological resources. Therefore, deprivation of access and use of these environmental services would adversely affect

the community's welfare. However, an open access regime to wetlands may also result in undesirable destruction of these fragile ecological resources. Therefore, the question on how best to align poverty reduction strategies with conservation needs remains unanswered.

To contribute towards the realization of the MDG7, Kenya raised a poverty reduction strategy paper (2001-2004) that outlined priorities and measures necessary for poverty reduction and economic growth; that underscored critical need for sustainable management of natural resources such as wetlands. Promotion and attainment of food security is recognized as the initial step towards poverty reduction. It is imperative therefore, that the potential of wetlands in the dry lands is assessed from the view point of their ability to support food production on a sustainable basis- that is, without adversely affecting the delicate balance between production and conservation.

Furthermore, Baringo County is one of the eleven major regions selected for the Arid Lands Resource Management Project (ALRMP, 2001). The project contains a number of activities whose implementation calls for a coordinated plan of action to make the most beneficial and sustainable use of soils, landscape, water, vegetation, livestock, agriculture, and wildlife. A human resource management sub-component is also incorporated to strengthen initiatives that may minimize vulnerability of communities to the effects of drought. It is important to highlight these physical and human engagements, so as to contribute to a better understanding of environment.

In addition the Kenya National Policy for the Sustainable Development of Arid and Semi-Arid Lands (GOK, 2003) expressed the need to provide an enabling environment through which synergies between the ASAL economies and the rest of the country could effectively be strengthened. The policy framework is based on a

vision that seeks to address conditions that have undermined the long-term development of these areas. The policy document emphasized the government's commitment to apply its national planning instruments and funding mechanisms to make sure that, the socio-economic and environmental causes of poverty in the ASALs were clearly understood and dealt with in a manner that would reduce and minimize them.

Realization of the Kenya's vision 2030 inevitably means higher consumption of energy and allied natural resources, thereby generating massive loads of carbon dioxide (CO^2). CO^2 is one of the green house gases associated with global warming and climate change. Forests and wetlands are the most potent carbon sinks and hence their joined protection goes a long way in ameliorating adverse climate change. The Vision 2030 document is emphatic that, "to address the population needs, we need to invest in and manage our natural heritage wisely to ensure that economic growth is sustained and poverty reduced".

The Loboi plains provided an excellent setting that allowed in-depth understanding of the relationship between the modernization of the pastoral economy, poverty alleviation and the consequential effects on wetlands. In this dry region wetlands have been the most reliable source of water for people and their animals. However, the changing population parameters, lifestyles, and societal value systems have had varying impacts on the use of wetlands that invites our attention and action.

Kenya acceded to the Convention of Wetlands of International Importance Especially as Waterfowl Habitat (1971), in 1990, and by virtual of this convention five Rift Valley lakes, Lake Baringo, Lake Nakuru, Lake Elemeintaita, Lake Naivasha, and Lake Bogoria were added to the list of Wetlands of International Importance, under

Article 2(1) of the Ramsar convention(Ogolla and Ojwang, 1996). This underscores the importance the government of Kenya and the international communities attach to wetlands, and hence the need to enlarge our data base, on the potential causes of loss and degradation of these ecosystems.

Lastly, this is one of the few studies that has comprehensively linked spatial-temporal land use change to the loss and degradation of wetlands in Kenya. The study, adds to the existing knowledge on the topic by focusing on the land users, soliciting their views on what they consider important for their livelihood. The study has led to suitable recommendations with regard to the natural and human innovation-based potential for the development of dry lands in Kenya.

1.7 Thesis Outline

The thesis is built into six chapters all focused on the issue of the relationship between the changing land use systems and their impacts on the wetlands and people's livelihoods. Chapter one introduces the study by giving the background to the study problem, the study problem itself, objectives, research questions, scope, limitation and importance of the study. Chapter two is detailed literature review of both theoretical and empirical nature. The research methods employed in this study including methods of data collection, data analysis data presentation and limitations of the research are the subject of chapter three. Chapter four lays the physical, historical and socio-economic setting of the land use/cover change in the study area. The biophysical aspects namely; geological formations, the land surface configurations, soils, drainage, climate, vegetation and geo-ecological land units are discussed. The human population totals, population growth trends and infrastructure facility and services and historical and future prospects for the region's economic development are highlighted.

Chapter five contains data analyses, results and discussions. The values and uses of wetlands are discussed and a detailed examination of land use change and causative factors and their direct and indirect impacts on wetlands examined. Land use/cover changes evidently illustrate the spatial-temporal land use/land cover change using satellite images taken in 1986 and 2006. The last chapter of this thesis provides the summary of the research findings and recommendations for further research for scholars, government planners and decision-makers in both public and private sectors. Thus, alternative strategies for sustainable natural resource management are explored.

CHAPTER TWO

LITERATURE REVIEW, THEORETICAL AND CONCEPTUAL FRAMEWORK

2.1 Introduction

This chapter has attempted to review different articles and publications with reference to the study question. It has underlined the fact that land use change has been occurring with time as people acquire more superior technology and as the population increases. However, the nature and extent of its occurrence varies from one eco-region to the next. Some land use changes have introduced positive aspects to the quality of land, but in most cases they are accompanied by loss and degradation of land.

Comprehensive literature review on land use in Baringo County-lowlands shows that, the region is one of the most severely degraded areas in Kenya (Anderson 2002, Little 1992, Mwasi 2004, Meyerhoff, 1998). It shares most of the land use problems characterizing the arid and semi-arid regions of Africa including, vulnerability to climate change and risk of desertification. The situation is exacerbated by the fact that it houses environmentally sensitive ecosystems such as the rangelands and dry land wetlands. These two ecosystems have been used for both animal grazing and crop-cultivation over millennia. Concern over degradation and loss of these natural resources, however, has been awakened by observable changes in the landscape as population growth rates and high socio-economic development rates are realized.

A number of theoretical and empirical studies have been done attempting to explain the significant contribution of different variables in the degradation of the arid lands. Some studies have emphasized the role of culture, population growth rates and technological advancement, and others have focused on the nature of the land in terms of the land surface configuration, soil types, climate and vegetation cover. The following sections contain a critical review of literature on land use changes, the causal factors and their impact on the natural resources and the land surface configurations.

2.2 Evolution of Land use Systems in the Rangelands

The earliest and most comprehensive literature on the classification of Kenya's rangelands was produced by Pratt and Gwynne (1977). In East Africa, rangeland is defined as "Land carrying natural or semi-natural vegetation which provides a habitat for herds of wild or domestic ungulates" (Pratt, Greenway and Gwynne, 1966). These ecosystems are only suitable for certain land use systems such as wildlife management and pastoralism involving light grazing, hence demanding extensive grazing areas. However, Kenya's rangelands consist of vast areas of land which were traditionally utilized for extensive livestock production, but are by no means identical or of similar ecological potential. Hence the concept of range units was developed to allow an easier and more realistic evaluation of the productive potential of rangelands. Range units are defined as areas of reasonably uniform ecological potential in relation to their use as pastures (Schwartz, 1994)

Pratt and Gwynne (1977) trace the stepwise evolution of land use from the hunter/food gatherer, pastoralist to agriculturalist. The first category of land users was directly dependent on the natural environment. In view of their small population size

they could hardly deplete the range resources available to them. Furthermore, the only technology at their disposal was fire, which they used to suppress woody species, to permit regeneration of perennial grasslands and to get rid of ticks and Tsetse fly. This regular grazing and pasture burning was therefore used as a means of preserving pasture in useful state (JICA, 2002). Today hunter/food gatherers are unimportant users of the rangelands. Pastoralists and agriculturalists have taken over. This explains the dramatic land use change from a relatively moderate use to an intensified land use type leading to over-exploitation of these fragile ecosystems.

The merits of traditional resource management systems is a subject that has attracted enormous literature (Scoones, 1982, Little 1992, Barrow 1989) Barrow, in his paper on the traditional knowledge of the Pokot and the Turkana, demonstrated the inherent conservation traits resident in the social cultural organizations of these communities. He, however, laments that education of the youth and the authority of the government official has gradually been vested with the responsibility of resource management. He argues that government supported development projects in the ASALs are to blame for compartmentalization of life that is otherwise closely interlinked and stable.

Scholars writing about the traditional resource management systems in the 1970s (Rappaport, 1971., Cruz de, Carvaho, 1974., Wilkes 1977., and Goldsmith, 1977) shared a common belief about the rationality of the traditional resource management systems. They objected to the then ruling paradigm of modernizing the African production systems. They saw stability in the diversity of African cultures and ecology. They asserted that modernization, had led to the breakdown of the ecological and social-economic balance of the traditional systems, disrupting the African family's cultural and economic bond with their environment. They observed that each

system has its inherent dynamics, and these systems have evolved as a result of adaptive interactions between the natural and cultural milieu. Rappaport (1971), in particular argued that, since there was a link between culture and forms of habitat on the one hand, and the forms of physical environment on the other, it is neither desirable nor inevitable to replace (in Africa) a rich variety of languages, world views, ways of life, family and social structures, forms of habitat and so on by Western European forms.

The transformation of the traditional resource management systems and the incorporation of the same into the modern markets-oriented systems were also viewed by Goldsmith (1977) as the basic cause of desertification in the ASALs. Goldsmith argued that the object of development is material consumption. Therefore, if people are to consume more, they also produce more and this, especially in the dry and arid tropics must have very serious consequences. It means for instance, that the pastoralists must increase the size of their herd, thus causing overgrazing and soil erosion. Eventually, they must settle and pursue an agricultural way of life, even if the land is not suitable for intensive agricultural activities. The author is totally silent on the factors driving the process of change. The movement from one form of livelihood to the next is viewed as a mechanical process which people have no control over. The author is recommending de-development which would be against the natural aspirations of people. A more desirable alternative approach must be sought.

The open gap in Goldsmith's argument is the failure to show the processes of change, that are skillfully captured by Frankie and Chasin (1980). The two explain how politico-economic variables affect pastoralism in Africa. In their famous article "Seeds of Famine and ecological Destruction" they argue that if African societies

remained closed to the influences of the outside World, they would have perpetually maintained working harmony with nature. But exposure to international capitalism through trade inevitably introduced farm production systems that served the outside market at the expense of the local physical environment and social welfare. Frankie and Chasin (1980) examined political and historical dimensions of the Sahel drought, which engulfed the region (1968-74), and traced hunger and starvation to the growing of soya beans for the export market instead of growing animal fodder. The two authors further argued that the problem of hunger in these regions came not from drought but from the general nature of the international relations and the production priorities deriving from those relations.

Frankie and Chasin's work agree with what George (1979), had forwarded earlier with regards to the causes of social inequalities, poverty and environmental destruction. George says that, in capitalist economies, income distribution determines not only consumption but production patterns as well. In other words, the system's priorities will encourage the production of foodstuffs and other goods which yield the highest profits and which are therefore geared to satisfying the needs of those who can pay. Such priorities will also, determine the use pattern of human and physical resources. It is therefore, a natural trend in all capitalist economies to have socio-economic inequalities and environmental decay. Therefore, strategies to mitigate the impacts of the capitalistic exploitative production systems must be suggested based on the understandings derived from specific geographic conditions.

The goals of production as understood from the free market economy perspective, dominate the perception of policy makers and planners. According to Odegi-Awuondo (1989), government policies, especially in the dry lands is one

characterized by total abhorrence of the traditional resources management strategies. The starting point has always been that pastoralists or nomadic way of life is outmoded and undesirable. In the extreme it is relegated to primitive cultures, an antithesis of civilization and a deterrent of modernization. Howell (1989) is more emphatic noting that migrating lifestyle are incompatible with the aspirations of modern state, because they are perceived as outmoded reservoirs of separatist tribal consciousness, which is an obstacle to national awakening. This perception informs government planning machinery; consequently public resources are marshaled to the ASALs with a bid to re-orient production systems away from traditional to modernized resource management strategies.

However, modernization of the pastoral economy has been blamed for resource over-exploitation and eventual degradation. For instance, Lamprey, (1978), reports that development activities in the ASALs involving sinking of boreholes to supply water to people and their animals created islands of degradation. Each borehole becomes a human/livestock concentration centre. Each of the concentration centers becomes a nucleus of denuded land which spread in widening circles as people move outward in search of fuel wood and pasture.

This confinement of people and their animals; in the absence of external avenues is to blame for overgrazing and land degradation. The situation is exacerbated by the low productivity of the arid ecosystems, with only 119 days of growing season per year (Schwartz, 1994). The resulting grazing pressures tend to change the grassland composition reducing the effect of fire on woody vegetation. Recker (1994) confirms that it is difficult to burn bushy areas; because of the lack of grass to spread the fire. Therefore, what the hunter/food gatherer was able to achieve by the use of fire is

reversed through overgrazing. Overgrazing successively reduces plant vigor and the carrying capacity of the land, leading ultimately to a depleted ground cover, which results in massive soil erosion and eventual land degradation (Pratt and Gwynne, 1977).

Ruthernberg (1980) joined the chorus of researchers who were of the opinion that Baringo district had reached an "overgrazing end point" in the 1980s. He observed that most of the grass and the topsoil had already gone and the ground was blanketed with thorn bush largely useless to man and beasts alike. He added that Baringo was a case where the large human population in an attempt to maintain enough stock for it, ended up undermining its life-support system. Ruthernberg appears to be blaming high population growth rate and the culture of maintaining large stocks of cattle for land degradation. He fails to extend his arguments to the question of grazing land availability and the resource management systems in place.

Hardin's (1968) was more specific in his theory of the "tragedy of the commons." The theory describes an open access property regime characterized by communally owned grazing land. Each cattle owner seeks to maximize returns from the commonly owned resource by increasing the stock size. But none of the stock owners have the responsibility to care for the land. Communal property regimes are therefore characterized by over-exploitation of resources and land degradation. However, these early thoughts were describing an open access system, which was not regulated by the traditional institutions. In the case of the Baringo lowlands grazing systems were regulated by a council of elders. Therefore, what is of concern is not the absence of a regulating body but its efficiency. What are the factors that rendered it dysfunctional? The answer is partly found in replacement of traditional institutions with formal institutions of government.

It is also a widely documented fact that cattle and small stock utilize different species of grass and bushes available in the rangelands. Thus, an area may be overgrazed with respect to the needs for cattle, but still has ample browse for small stock such as sheep and goats. Schwartz, (1994) has offered an explanation to the effect that, the quality of pasture deteriorates most rapidly after the end of the rainy season, but unlike cattle, an increasing proportion of browse in the diet of sheep, goat and camels increases the number of grazing days because the woody vegetation retains higher forage quality levels for longer periods. Overgrazing could, therefore be minimized by simply re-arranging the use of pastureland in such a manner that it serves different livestock species at different seasons of the year. This observation alone underscores the rationale behind traditional transhumant grazing systems.

Furthermore, Schwartz (1994) adds that a pastoralist's family (of average 8 members), needs at least 20 units-cattle, sheep and goats to survive from year to year. If 20 units are needed for a family and if the carrying capacity of the range is one unit per 5 hectares, each family must have 100 hectares of useable land. It is only when this figure is exceeded that overgrazing results; a fact that was corroborated by Pratt and Gwynne (1977). In the absence of external factors, the grazing systems are patterned in such a rhythmic arrangement that ensures adequacy of pasture and minimal overgrazing.

Swift, Coughenour and Atsedu (2002) dispute the common claim that overgrazing is the sole cause of land degradation in the ASAL. Giving examples from East Africa they argue that for a long time, periodic droughts and other disasters have tended to reduce herds below the long-term support capacity of the range. They argue that in all cases of pastoralism in East Africa, degradation has usually followed some sort of

disruptive change that has modified the traditional patterns of land use. Anderson, (2002) traces the history of land degradation in Baringo, noting that much of the degradation of the rangelands occurred as the pastoralists lost their traditional grazing areas to the colonial settlement. Colonial settlement disrupted the traditional movement of people and their animals, forcing the pastoralists to operate on a limited space.

Janzen (1990) underlines the fundamental importance of the "mobile livestock economy" in its dual role for safeguarding the future existence of families dependent on livestock rearing and also in preserving the economic potential and ecological balance of the grazing grounds themselves. But he laments the fact that nomadic pastoralism in Africa is on the decline, due to scarcity of free grazing land previously availed within the commons. Scholz (1997) proposes a strong case for enhancing the traditional transhumant systems if all potential pockets pasture is optimally grazed. Janzen (1990) supports Scholz on the aspect of ensuring livestock rearing remains as mobile as possible, because the more mobility there is, the more the long-term preservation and renewal of resources is guaranteed. As many different kinds of livestock as possible must be kept, so that the maximum use is made of the available biomass and the overgrazing of selected areas prevented (Schwartz, 1994). Unfortunately, this can no longer hold because of the pressure exerted by other forms of land uses in the ASALs.

The World Bank (2008) report summarizes the discussion, underlining the fact that the practice of mobile pastoralism has been hindered by development policies which have undermined its basic foundation. The report notes that there has been no serious commitment from the government to support; in terms of development planning, the

nomadic way of life and economy. Contrary to the widely held view, that pastoralists operate independently, untouched by the state bureaucracies and commerce, Little (1992) says that recent studies of pastoral area demonstrate that pastoralists were clearly affected by state policies and commodity markets that inter alia, differentiate pastoral households, and increase pressures to enter wage-labor markets which create contradictory and sometimes destructive land use systems.

2.3 Transition from Pastoralism to Crop-cultivation

It is becoming clear that nomadic pastoralism does not cause overgrazing and the associated land degradation (Lamprey, 1978, Little, 1992, Scholz, 1997, Janzen, 1990). It is the forced sedentarization of stock as pastoralists embark on crop-cultivation that causes localized pressures on the available vegetation cover and soils. A review of literature gives a number of reasons for conversion of pure pastoralists to agro-pastoralists. Olson, et al (2004) underlines governmental policies, economic factors, population, land tenure and environmental conditions as some of the key factors that are associated with the transition from nomadic pastoralism to crop-cultivation agriculture.

The ASAL development programme (GOK 1979, 2003) was formulated within a premise that supported settled lifestyles; claiming that concentrated settlements generates higher economies of scale in the delivery of education, health and other public services. Secondly, the government's policies sought to support diversification of the pastoral economy, so that the pastoralists could engage in a less precarious form of livelihood such as agricultural crop-cultivation.

This development strategy failed to recognize that pastoralists are by inclination livestock keepers. Their wealth is stored in animals and they cannot seek alternative

form of livelihood unless the livestock sub-system fails to meet the family's subsistence requirements (Schwartz, 1994). Without cattle the basic social institutions of families, households and kin-groups could not and cannot be formed. Every family obtains cattle in order to build new households and to establish networks of kinships and affinity (Harkinson and Widgren, 2007). In spite of the good intentions of the government, the unintended result occurred. Land degradation was escalated as more land was converted into agricultural crop-cultivation.

Darkoh (1990) argues that, there is no economic rationality of converting the ASAL from range management activities to settled cultivation agriculture, given the fact that the number of cultivating farmers these ecosystems can support is doubtlessly significantly smaller than the number of pastoralists. He adds that, introduction of crop cultivation in a state of diminishing land size only adds to increasing competition which aggravates land degradation. Consequently, government policies that have gone into the creation of development of alternatives to pastoralism such as sedentarization, have consequently received little success.

Janzen (1990) argues that, it is the shortage of water supplies that had actually encouraged livestock mobility, in the past. Therefore, it is the failure to adequately involve the pastoralists in the planning and implementation of these projects that has contributed to low success levels. The author argues that the commonly held view, that nomadic pastoralism is basically responsible for permanent destruction of both the vegetation and soil is simply not correct. He supports his case by quoting political events taking place in Somalia during the Ogaden war. Irrigation activities that were introduced along River Jubba cut off pastoralists from their dry season grazing areas within the riparian wetlands. This confined pastoralist to specific watering points.

Area of bushy vegetation also increased due to the removal of certain species of acacia trees for the charcoal trade, culminating in further reduction of the area under grass. Together, these caused increased instances of desertification. It is a futile exercise to attempt to blame environmental degradation to a single cause.

The livestock economy is an adaptive form of livelihood that constitutes the pastoralists' way of life. It is questionable whether irrigation or non-pastoral programs are the appropriate vehicles for herders, who eventually will have to return to pastoralism. Horowitz and Little (1998) say that impoverished pastoralists move to irrigation schemes with a hope that once drought ceases they would return to pastoralism. But low returns from these schemes result in a more permanent form of pauperization. The herders who are engaged in low-return agriculture and wage activities have little chance to rebuild their herds, and are increasingly vulnerable to drought (Hogg, 1984).

Mace (1993) developed a model in an attempt to explain transition from pastoralism to settled agriculture. She postulates that a decision to cultivate means pursuance of an agro-pastoralist's lifestyle, suffering a lower per animal productivity but having the chances of a grain harvest- and possibility of keeping part of its wealth as stored grain. In her model the choice between the two production systems will be determined by the household wealth. Risk aversion is more associated with the poor household than the rich ones. Taking account of the effects of wealth differences is crucial to understanding transition from pastoralism and cultivation, she concludes. Unfortunately, in a globalizing world societal goals and aspirations tend to gravitate towards commonly shared values. Capitalistic values will tend to encourage wealth accumulation. Although household wealth may influence decision to either go

agriculture or remain pastoralist, the tendency will always be that the more lucrative of the two will receive more attention. Information is today more available than in any other time in human history to allow producers to make the most desirable choices.

2.4 Capitalism and sustainable use of Natural Resources

Anderson and Grove (1989) are of the opinion that, much of the conservation thinking in Africa, as defined and exercised by Europeans has been directed to sustaining an image of Africa which form a part of European mythology. They say that the symbol of Africa as a yet un-spoilt "Eden" continues to stimulate many of those who wish to intervene in the way the environment is managed in Africa. It remains true, therefore, that European and their ideas exert an undiminished, even increasing influence over the African environment today (Mazrui 1980). Many proponents of environmental conservation in Africa would prefer to view it as an entirely apolitical affair; a global value that no prejudice could undermine. Vance (2001) emphatically underlines the need for survival of life on this planet, whose foundation stands on preservation of large areas of wilderness. A goal that should never be a subject of politics, but one that is beyond politics, sociology and material ideals.

Anderson and Grove (1989) capture the naivety of this idealized picture of apolitical conservation in Africa, noting that it fails to appreciate that in the rural societies in Africa, conservation is a very political issue. Any attempt to manage the African landscape for conservation or development invariably involves direct interventions in the relationship between man and his environment (i.e. man and his means of production).

Obi (2000), blames the deepening environmental crisis in Africa on the World Bank/IMF Structural Adjustment programme. He argues that the pattern of resource

extraction promoted by the Structural Adjustment programme feed into authoritarianism the acceleration of environmental degradation; since African states have lost their capacity to protect their environment in the face of economic liberalization. He argues that African states have failed to address ecological concerns of the people. Consequently, they resort into the use of brute force and repression to subdue those forces that seek to protect their environment from further pillage. As such, the state in Africa is a principal actor in the economy-ecology nexus under the SAP. Therefore, he adds that the ongoing environment conflicts are not only contestations for political space, access to, and control over resources, but also a form of resistance to authoritarian forms of state rule, and the expropriation of surplus from Africa. Obi (2000) extends his argument noting that environmental scarcities or resource wars are the outcome of the unbridled exploitation of the Third World's ecosystems through the instrumentality of the globalized capitalist structure of production, distribution and consumption.

Saurin (1996) sees the incorporation of many third World nations to the international capitalist system, to have contributed to over-mining of these countries' natural resources. This has a lot to do with the capitalist production goals that pay maximum attention to profit enhancement as environmental costs are externalized. Redcliff, (1987) summarizes the argument by noting that, the social ecology of SAP ignores not only the ecological considerations, but also the local basic needs for subsistence in preference for local production for global markets. As such, it spawns social relations that are exploitative, inequitable and disruptive underlines Saurin (1996).

Umpteen research findings (Chavangi, 1985; Chitere, 1994; Chambers, 1979; Agrawal and Clark, 1999) have shown that conservation projects that have high

probabilities of success have a high component of local participation and material input. Therefore wetland conservation efforts that fail to take cognizance of the local users' values and attitude towards the resource may never meet the envisioned goals. As evidenced by an environmental rehabilitation program in Pakistan where women planted tree seedlings supplied to them upside down the results may worsen the situation. This is arguably because wetland use under these circumstances does not build upon, develop, or incorporate indigenous practices and local knowledge (Wood 2000, Dixon, 1989).

It has been further noted that wetland degradation will always occur where there are strong economic or political pressures which lead to the complete drainage of wetland and sometimes also the adoption of double cropping. This is often associated with the development of market opportunities or with enforced cultivation of wetlands in response to government food security drive (Wood, 2000). The presence of maize seed companies in the study area has offered open market opportunities to local cultivators, which may explain the high demand for all-season crop-growing land.

Besides, available literature (Egziabher, 2005; Mwakalila and Madulu, 2009) show that lack of institutional capacity is a regular problem in any attempt at controlling the use of wetlands. Hence where communities have little experience of wetland agriculture, or when conditions change and local knowledge and management practices have not adapted, wetland degradation may occur very rapidly (Wood, 2005).

George (1979) says that the food problem is not a problem of production or distribution, but rather one of resource allocation, which occurs through the market. She says, the power of the market systems influences production systems away from

goals to satisfy local consumption and local sale to production goals to meet demand prevailing in the wider national and international market.

2.5 Global Wetlands Loss

Documented literature on Wetlands has shown that, the World has over the years lost large areas of wetlands to human development activities (Turner 1997, Taylor and Mafabi 1991). In the past there were no planned efforts to protect these ecosystems, mainly because they were least understood and hence were relegated to wastelands (Williams, 1990). The perception by then was that they hindered economic development (Dahl, 1990). Dahl (ibid) summarizes his discussion by noting that the recent increases in flood damages, drought damages, and the declining bird populations are, in part, the result of wetlands degradation and destruction. Unfortunately, Dahl's scientific understanding is not shared by majority of the land users who still view wetlands as "wastelands".

According to OECD (1993) some estimates show that the world may have lost 50% of the wetlands that existed since 1900, whilst much of this occurred in the Northern hemisphere countries during the first 50 years of the century, increasing pressure for conversion to alternative land users has been observed on tropical and sub-tropical wetlands. Myers (1980) in his book, "The Sinking Ark" sees the real causes of wetland drainage to be linked to the wider global economic system that is dependent on market forces of demand and supply. To meet the market demand for grain, beef, timber and wetlands products 'in both the advanced and developing regions wetlands are being drained, dug up, paved over, so that they can be converted from their present 'useless' state into something more profitable for man".

According to Myers, it appears there is lack of a comprehensive policy that protects wetlands from drainage in America. But the law prohibits Americans from shooting snowy egret, which nests on the marshes. Therefore, Myers says an action that encourages wetland drainage eliminate the food supply for a whole colony of egrets. Hence the need to underscore the importance of addressing causes other than symptoms of disappearing species.

GOK (2013) is in support of wetlands protection and conservation because their naturalness and serenity makes them important ecotourism and recreation centers. But all these beneficial functions of wetlands are threatened by drainage for agricultural activities. While many cultures have lived among and even depended upon wetlands for centuries, the modern wetland management systems are driven by the erroneous understanding that wetlands are wastelands that at best should be avoided, or if possible drained and filled (Mitsch 1994).

Kenya's National Food Policy (GOK, 1981) while recognizing the need to accelerate food production in the country, encourages landowners to reclaim all the wetlands that may be adjacent to their land. Tree species such as *Eucalyptus grandis* have been planted in wetland areas to accelerate water withdrawal through evapotranspiration. This view has in many instances contributed to wetland loss and degradation in Kenya.

2.6 Community Involvement in Wetland Conservation Efforts

Taylor and Mafabi (1991) have argued that 'wetlands" are not synonymous to Wastelands". In their view wetlands hold multiple values and attributes including stabilization of water supply and the conservation of soils and nutrients. Taylor and Mafabi (ibid) argue that, "If people were taught the values of wetlands and

encouraged to use the resources wisely, then they will recognize the sense of conserving that resource for future use" They add that conservation through exclusion will only work if there is a consensus among the population that the resource is already under threat. But, for the population to appreciate the need to conserve a threatened 'resource' their definition of what constitutes a resource must be known. According to Burton and Kates, (1965) understanding the people's perception and attitude is therefore, critical in developing sound management programmes.

Another area of concern in reference to wetlands conservation is land tenure system. Land rights in Africa for example were radically modified with the introduction of the freehold and leasehold concepts from Europe (Taylor and Mafabi, 1991). The present situation is that in many areas, there is confusion as to who holds the right and entitlement to a resource (Lwanga, 1990). The situation has been compounded by presence of such resources on private land, where the short-term economic gains surpasses the long-term requirements of sustainable production.

Unlike other resources such as forests and mineral resources, wetlands have mostly been ignored except in protected areas such as the well-documented case of Amboseli (Western, 1982). In Uganda although wetlands were mapped, their value was not appreciated and it is common to find that photo-interpreted maps of wetlands have significant errors of details (Taylor & Mafabi, 1991). This is explained by the fact that, wetlands for many years remained unattractive areas of concern to both cultivators and researchers, mainly because agricultural land was plentiful. However, according to Taylor and Mafabi (1991), there were indications from the National Forestry Authority of Uganda that significant reductions in wetland cover was occurring mostly due to conversion of wetlands to crop lands. One of the factors

driving these conversions was the immediate economic returns accruing to individuals involved in lucrative rice growing in the wetlands.

A More serious problem is that the function that wetlands perform, and indeed the factors that govern their very existence, were largely unknown or ignored until recently (Maltby, 1986). Consequently, land regulative bodies, while aware of the issues in forests were unable to attribute loss of wetlands to the same factors that led to deforestation. According to Mgaya, (1991) in Tanzania wetlands are poorly studied with only a few academic institutions having done some work. Therefore, policy makers and the local communities are generally not aware of the values and functions of wetlands. To aggravate the situation conservation of wetlands does not come under a single government ministry or department.

In Kenya, most of the research projects on wetlands are mainly a contribution of Biological Scientists interested with the technical aspect of wetlands not the people who draw benefits or suffer due to their presence (Kareri 1992). There are no contributions that incorporate land-users into the management and conservation of wetlands. The world conservation strategy (IUCN, 1980) sought to enlist the integration of development goals with conservation objectives and the participation of grass-root operators. However, Redcliff (1987) laments that the World conservation strategy has failed, because it has disregarded the social and political changes necessary to meet its goals. Anderson and Grove (1989) add that most government conservation and rural economic development programmes in Africa have been applied without an awareness of the broader social implications they embody. This has largely been due to the prominent role of specialists in designing these schemes.

2.7 The Ramsar Convention's Role in Sustainable Wetland management

For much of the 20th Century, wetlands were drained or otherwise degraded. However, growing understanding of the vital importance of wetlands led to the signing of the Ramsar Convention on Wetlands in 1971. Today more than 1,424 wetlands – a total area of 129 million hectares – have been designated as Wetlands of International Importance. The Ramsar Convention's 145 national signatories have committed to maintaining the ecological character and are obliged to report on the state of Ramsar designated wetlands under their jurisdiction (Globwetland, 2008). Finlayson and Moser (1991) reported significant progress in the identification of potential Ramsar sites globally. A number of national governments have also developed, or are in the process of formulating wetlands protection laws and relevant policies. The major constraint, however, is lack of political will to legislate against encroachments onto these fragile ecosystems. It appears many of the government's planners and policy-makers still hold a brief that the wetlands are fertile grounds that have the potent to solve food security problems.

2.8 Watershed management: The upstream downstream linkages

Whigham (1999) suggested that wetland ecology is best understood when viewed at the individual wetland level and how it relates with the surrounding upland forested areas. He adds that even where large areas of an ecosystem type have already been preserved in national parks (e.g. Lake Bogoria nation reserve) many wetland-dependent species remain threatened because wetlands are impacted by indirect human activities such as changes in water quality, invasion of alien species. The current study has employed this approach because we agree with Whigham that the micro and macro dimensions of a wetland in terms of spatial extent and the complex interplay of related factors are central to a fuller understanding of wetlands ecology.

The debate on the role of forest ecosystems on moisture availability at differing eco-zones takes divergent views. Haigh et al (2005) have examined the impact of human activities in headwater regions. They note that, when water qualities and yields change in headwaters the consequences affect the lands downstream. Hence, activities throughout the watershed can have adverse effects on the eco-hydrological characteristics of the wetlands (Dixon, 2000) and may equally affect people's livelihoods. By altering ecosystem services, changes in land use and cover affect the ability of biological systems to support human needs, and such changes also determine, in part, the vulnerability of places and people to climatic, economic or socio-political perturbations (de Sherbinin, 2002).

Calder, et al (2003) has, however, discredited the past assumption; "that under any hydrological and ecological circumstance, forest is the best land cover to maximize water yield and regulate seasonal flows". According to them, hydrological research suggests a rather different picture, in view of the fact that the forest ecosystem is in itself a major user of water. They however, note that forests make their most significant contribution to watershed ecosystems through minimization of soil erosion on site and reduction of sediment in water bodies (wetlands, ponds, lakes, streams and rivers).

Irrespective of the differing views forests are important ecosystems that act as the lungs of the earth, releasing oxygen as they act as carbon dioxide sinks. They also act as sponges, capturing the rain water during the wet season, reducing run-off and soil erosion. Blaikie and Brookfield (1987) show that river discharge increases more in cultivated land during the wet season than in forested land. Forests are therefore, said to have positive effect of regulating stream base flow as well as reducing suspended

load. Thus, the subsoil flow rates under forests are greater than under other types of vegetation (Palamuleni, 2011).

However, Lorup and Hansen (1997) say that the widespread belief that trees and tree planting will increase stream flow during and at the end of the dry season are in conflict with research findings. This opinion is supported by Hamilton and King (1983), who say that contrary to commonly shared view tree planting generally results in reduced total water yields from catchments. More research is needed on this aspect to bring clarity on the ecological role of trees in the watershed areas.

In Kenya studies by UNEP (2012) have clearly shown that deforestation of the water towers in 2000 to 2010 of 28,427 hectares resulted in a reduced water availability of approximately 62 million m^3 per year. Furthermore, Macdonald et al (2003) have highlighted the important role of forest litter in controlling splash-induced soil erosion as it encourages rainfall infiltration, contributing to ground water recharge that enhances dry season flow. Finally, the UNEP (2012) paper adds that in the case of Kenya's montane forests, it is most likely that the gains in water yield as a result of deforestation will be off-set by loss in cloud water interception in these forests, occurring at such high elevations.

2.9 Ecosystem Services, Market Forces and Household welfare

Egziabher (2005) says that rural people in Africa depend on the renewable natural resource (-biological ones-) that their immediate environment can provide to meet their needs. Egziabher asserts that, their impact on their immediate ecosystems is intense, and their knowledge of them intimate. This impact is however, being increasingly intensified by globalization. Consequently, local changes in land use are actually a response to the wider global economic lifestyles that have inevitably come

to be intertwined with the local economy through the globalization process whose main tenets is found in “free trade” as a panacea for underdevelopment.

Cavendish (1999) provides strong evidence to show that rural households depend quite heavily on freely-provided environmental goods and services to sustain the household welfare, through the provision of productive inputs and consumption goods. He however, laments that, in spite of available evidence environmental resources are classically omitted from household budget surveys. This failure to take into consideration environmental services leads to poor estimates and true account of the level of poverty. It is possible that if real contribution of ecosystem services were taken into account in the national accounting system, they would be integrated into the national planning as vital development assets. Hence, their protection and conservation would be prioritized.

Dimoso (2009) reports on a study based on environmental degradation and intra-household welfare in rural Tanzania underlining the fact that natural biotic resources provide notable benefits to households neighbouring the resource. However, as more of the resource is used without reciprocal gesture of replenishment it deteriorates and losses its essential biological characteristic. People are forced to travel far inland to avail themselves the ecosystem products and services. There is a high opportunity cost incurred as members of the family travel many kilometres away to collect the desired products or access the needed services. The author argues that labour time that would normally be used in agricultural activities is expended on searching for ecosystem goods and services that were hitherto freely available, but now lost to degradation. Hence he concludes that deteriorating environmental resources increase the costs of meeting the household welfare.

2.10 Wetlands of Kenya

According to the Kenya Environment Action Plan (GOK 1994), a substantial proportion of Kenya's water resources are found in wetlands, which cover 2% to 3% of the country's surface area. These wetlands are diverse in type and distribution. Some of the country's major wetlands are; the Shallow lakes of the Gregory Rift Valley that include; Nakuru, Naivasha, Magadi, Baringo, Bogoria, Ol'Bolossat, Amboseli, Kamnarok, Elementaita and Jipe. Other wetlands are to be found at the edges of Lake Victoria and mangrove forests of the coastal region. The list also includes various seasonal and temporary wetlands that occur where internal drainage allows water to collect in some seasons or in some years. Man-made wetlands include dams, primarily meant for hydropower and water supply, and wetlands created for purposes of wastewater treatment.

Krhoda (1992) says that wetlands may have high rates of evapotranspiration, due to the ratio of surface area to water depth. Consequently their surface area fluctuates from year to year and from season to season. There may be water throughout the year in the central core of the wetland, but as one moves to the periphery, seasonality becomes more obvious. He goes on to note that infiltration is one of the most important processes in wetland formation and sustainability. Local factors influencing infiltration include rock and soil types. Soil types in wetlands will generally be clay-loam to silt-loam in order to retain water. In the dry lands of Kenya the rate of evaporation causes losses of nearly 80-98% of water. Given the high rates of evapotranspiration one is left the urge to know what sustains these wetlands.

Nyamweru (1992) classifies Kenya's wetlands based on topographic criteria into five major categories: (1) marine, (2) deltaic, (3) riverine, (4) lacustrine and (5) plateau,

and into two minor classes (6) artificial wetlands and (7) montane peat bogs. She notes that Kenya has a variety of wetlands occurring mainly in the well-watered areas; the coastal belt, the highlands and the Lake Victoria basin. She points out that all wetlands are vulnerable to changes in the land use of their catchment areas; intensive farming practices that fail to incorporate adequate soil, and water conservation measures lead to increased silt that goes to the wetlands and create erratic, highly seasonal supply of water in place of the previous more regular one. We are therefore faced with an ecosystem that is under siege. How can we harmonize upper catchments land use practices with the need for wetland conservation?

2.11 Land use/cover Change and its Impact on Hydrological Regimes

Population and poverty have often been blamed for the rampant destruction of the forest ecosystems. The poor are said to be pushed by poverty to the forests where they engage in slush and burn cultivation. However, according to Lambin, et al (2001) this is just but a myth. Such myths are simplifications of cause–consequence relationships that are difficult to support empirically but have gained sufficient public currency to influence environment and development policies.

The source provides evidence to show that population growth is never the sole and often not even the major underlying cause of forest-cover change. The critical point, is that tropical deforestation is driven largely by changing economic opportunities which, are linked to yet other social, political, and infrastructural changes (Hecht, 1985). This argument is supported by deforestation in the Brazilian forests that has nothing to do with poverty or population growth, but insatiable demand for beef-burgers in the US (Myers, 1980). Demand for beef-burgers creates need for more cattle ranches. Therefore, more forest land is converted to pastureland.

2.12 Wetlands of the Semi-arid Lakes Bogoria-Baringo Lowlands

The lake Baringo-Bogoria-lowlands-wetlands have attracted a lot of interest from different disciplines. Studies of the origins, structure, functions and ecological dynamics of these wetlands have been viewed from a wide ranging approaches and data demands, covering such areas as Geology, Sedimentology, Palaeoclimate, Aqueous geochemistry, Lithology, Hydrology, Pedology, Biology and Anthropology.

Owen et al (2004) notes that the area around the lakes contains numerous wetland systems that have been formed: along lake shorelines; along faults where hot, warm and cold springs have developed; and along river systems that cross the Rift floor. Six major types of wetlands are recognized: Proximal Hot Springs; Hot Spring Marshes, Blister wetlands; Typha and Cyperus Papyrus Swamps; Floodplain Littoral marshes; Hypersaline lake littoral wetlands; and freshwater lake littoral wetlands. All these show significant variability in terms of geomorphic setting, water chemistry, temperature, plant communities and diatom floras. They are variously dominated by macrophytes, such as *Cyperus Laevigatus, Typha domingensis* and *Cyperus papyrus*. The authors found that in some cases such as in hot spring settings and in hypersaline lake littoral zones macrophytes are absent but bacterial mats are common.

Ashley et al (2004) carried out a study on two of the most expansive wetlands in the South Baringo lowlands namely; the Loboi Swamp and the Kesubo marsh. These two wetlands are found within the Loboi Plain, which is the main study site of the current study. The authors have employed sedimentological and palaeoclimatic evidence to trace the origin and temporal spatial change of these wetlands. Deeper examination of geological, environmental and palaeoclimatic records by the authors gave an alternative explanation for the existence of these wetlands.

Ashley et al (ibid) studies showed that a juxtaposition of surface drainage and wetlands adjacent to fault scarps is common throughout the Bogoria-Baringo region and elsewhere in the rift. According to these authors, the Loboi swamp was probably formed about 700BP. It lies on the northward extension of a narrow westerly dipping tilt block or small grabben-like structure at Maji Ndege. Differential subsidence of the buried tilt block may have occurred following movement along the fault(s) located directly west of the swamp. Westerly tilting and subsidence of the buried fault block could have lowered the land surface sufficiently to bring the water table at or close to the surface.

The swamp is fed by two large warm (Lake Bogoria Hotel and Chelaba) springs that lie on N-S faults. A smaller Turtle spring discharge to the west of the swamp, together with many small seeps. Unlike wetlands fed by surface waters, ground water recharge from fault-line springs may continue even during dry periods when the land surface undergoes aridification (Renaut and Jones, 1997).

Renaut (1993) noted that Kesubo marsh and the Sandai River lie adjacent to the Bechot-Siracho fault scarp. He also observed that the diversion of Sandai River towards L. Bogoria and the development of Kesubo Marsh may have resulted from differential subsidence of the southern part of the Sandai fan directly adjacent to the scarp.

Climate change has also been suggested as another possible origin of the wetlands. According to Driese et al (2004), wetland and flood plain soils in the East African Rift of Kenya provide a record of changing palaeoclimate and paleohydrology compatible with climate records for the mid-Holocene through the late Holocene Medieval warm period (AD 800-1270) and Little Ice Age (AD 1270-1850). They investigated soils

forming from volcaniclastic source materials in both Loboi Swamp and laterally adjacent Kesubo Marsh and found that wetland formation was abrupt and possibly related to climate shift from drier to wetter conditions. This finding is corroborated by an earlier study by Sketchley, et al (1978). The authors understood the presence of wetlands in the Baringo-Bogoria lowlands to have resulted from a reduction in the size of a massive lake that had once occupied the lowlands during the wetter times in the Quaternary geological period.

There is further evidence that the hot springs and fumaroles that feed Lake Bogoria draw their water from as far afield as the Malewa and Karati rivers via Lake Naivasha. According to Becht (2007) total available water supply is determined by the rainfall over the whole catchment. But the bulk of the water falls in the higher parts of the catchment. This water is used by vegetation (evapotranspiration) and the excess flows into Lake Naivasha. The lake water recharges the shallow aquifers around it and these shallow aquifers loose water (again) to the deep (geothermal) aquifer system. The water escapes from the deep aquifer in the form of steam (fumaroles) and recharges lakes Magadi, Elementeita and Bogoria.

Anderson and Grove (1990) report that since 1930, soil, water and vegetation degradation has been a major concern in Baringo district. The presence of sparse and short-lowed ground cover, dominated by unpalatable animal herbs is associated with overgrazing. Anderson and Grove have also argued that the highly productive *cynodon and Echinochloa* swamp grasslands associated with permanent rivers draining into Baringo lowlands are in imminent danger of destruction through grazing pressure.

2.13 Ecological Impacts on wetlands

A wetland is defined by the nature of its soil, water and plant communities. Alteration of any of these may change the characteristics of a wetland (Kipkemboi 2002). Since the lowland wetlands mostly depend on water flowing down from the uplands, it is important to understand not only the quality of the water but also the volume of the flow. Whigham (1999) has shown that even where large areas of an ecosystem such as the Lake Bogoria National Reserve that have already been preserved; many wetland-dependent species remain threatened by changes in water quality and invasion of alien species.

Hugh (2011) has shown that sediments suffocate native wetlands species, thus allowing invasive species such as Kenya's notorious *prosopis juliflora;* to come in and dominate the area. This has serious implications on the wetlands ecology. This tree has the potent ability to suppress the growth and survival of indigenous vegetation as it invades (Weber, 2003).

Hong-Ren Luo, et al (1997) studied the effects of sedimentation on playa wetland with a view to determining the rate of sediment generation associated with cultivated and non-cultivated rangelands. They observed that Playas with cropland watersheds contained more sediment than those with non-cultivated watersheds. They argued that accumulation of sediments decrease the duration that wetlands retain water and change plant community structure by burial of seed banks (Wang, et al 1994). These changes negatively affect the ecological functions of wetlands (Johnston et al 1984).

Demissie et al (1992) carried out a study that examined sedimentation in the Cache river wetlands. In their findings they noted variations in sediment yield arising from differences in watershed characteristics, land use, stream channel and flood plains.

Forested uplands areas, for example tend to trap sediments and reduce sediment yield downstream. The rates of sedimentation in the wetlands was investigated using radiometric dating technique and also by the measurement of influent and effluent volumes of sediments.

U.S.E.P.A (2002) has further underlined the role of land use in the surrounding areas in determining the potential threats to a given wetland. It emphasizes that land use, especially the percentage of the watershed that has been cleared of natural vegetation, can affect the amount of water, sediment, pesticide, and nutrients entering a wetland as well as the composition of its plant and animal communities. Therefore, characterization of land use around a wetland is essential for evaluating wetlands for water quality purpose. Several factors have been listed that determine the movement of sediments and nutrients including; vegetation cover, slope angle, soil type, slope length, and frequency and intensity of rainfall.

2.14 Summary of the Literature Review

The foregoing literature review has provided a detailed account of the direct and indirect drivers of land use change in the arid and semi-arid Loboi plain. Review of historical records, data and writings have given us the background events that gave rise to the progressive land use change through time. A greater part of the literature review dwelt on general theoretical readings and empirical works relating to natural resource use and over-exploitation in such magnitudes as to cause degradation of the same. A more carefully chosen set of literature focused on wetlands; a unique natural resource that has tremendous potential in the provision of material and immaterial items for use in supporting the pastoral economy in the dry lands. It has been shown that the dry land pastoralists have had a long historical association with wetlands,

being the most reliable source of dry season animal feed. Competition over the use of these natural resources has been underscored in literature, a fact that is blamed for their continued loss and degradation.

Another set of literature, examines the institutional and people's attitudes towards wetlands. It is noted that for far too long wetlands were ignored and relegated to "wastelands". Consequently, in many countries wetlands have no legal protection. But that view has gradually changed and today wetlands have attracted a lot of attention from both biological scientists and politicians. This has emanated from the knowledge that these ecosystems are among the most productive biological resources on Earth. Even the non-specialist land users' perception has changed from viewing wetlands as "wastelands" to important ecosystems that hold a promise for future food production. But recommendations on how wetlands could be utilized to enhance food production areas have failed to capture the "wise use" concept, to ensure their sustainability.

It is evident from the literature review that threats facing Loboi lowlands-wetlands emerge locally and from distant places. These threats are both geo-hydrological and socio-eco-political in nature. It has been shown that various land use activities in the catchments and the recipient lowlands reinforce each other, projecting their joint force to the wetlands: resulting in loss and degradation of these natural resources. But few studies explicitly examine the geo-hydrological relationships between highland catchment areas and the water recipient lowlands.

This study has attempted to bridge some of the above mentioned research gaps. In addition to examining land use practices in the upper catchment areas of River Waseges, the exercise was extended to the lowland margins of the wetlands. Furthermore, the underlying motivational factors for engaging in certain farm

enterprises were established. However, the study was subject to financial, time and manpower constraints. The recommendations provided for further research are a response to an appreciation of these limitations.

2.15 The Theoretical Framework of the Study

An analysis of man-environment-development triad in semi-arid pastoralists' environment poses serious challenges with respect to the choice of a suitable theoretical framework (Homewood, 2009). Homewood, proposes an integration of a range of theories including but not limited to; political economy, political ecology and the tragedy of the commons. Below we attempt to review each theory and examine its utility in deepening our understanding of the processes that have culminated in natural resource loss and degradation in the arid and semi-arid environments.

2.15.1 Political Economy Theory

The development paradigm viewed the traditional natural resource management systems as among the set of internal barriers to the process of modernizing these societies. As such the traditional institutions and economy had to be overcome. There is a familiar tendency to "blame the victim". For instance, land degradation in the ASAL is blamed on increased human and animal population together with the social/cultural orientation of pastoralists' inclination to overstocking. But as Horowitz and Little (1988) rightly argue "finding the 'cause' of environmental degradation in the attitudes of herders rather than in the condition under which pastoralists operates may be a temporary comfort. It is a false comfort since it cannot but lead to inappropriate action". In other words, these authors contend that environmental degradation in the ASALs is but a symptom of other factors that are political and economic in nature.

Political economy has been extensively used to analyze development approaches and impacts, highlighting the role of power within the context of any development. The approach holds that change always entails winners and losers, and that those who are well placed tend to capture the benefits and improve their own position further at the expense of the marginalized (Homewood, 2009). A political-economic analyses leads to a better understanding of the process that result in land degradation. It illuminates the twin processes of increasing marginalization and social differentiation that characterize societies dependent on pastoral production systems in Africa's arid and semi-arid rangelands (Horowitz and Little; 1988).

The term marginalization is used by the two authors (Horowitz and Little; 1988) to refer to the compaction of ruminant herding in areas of low biological productivity, usually areas not yet experiencing agriculture. Pastoralism retreats as agriculture and commercial ranching expand. This is nowhere better shown than in Baringo lowlands, where nomadic pastoralism has been restricted by expansion of group ranches and irrigation crop-cultivation. The former dry-season grazing areas are today only a figment of their past.

Noting that an appreciation of the processes of marginalization and social differentiation is essential to a fuller understanding of environmental degradation and famine, Horowitz and Little (1988) define social differentiation as the growing inequalities between pastoralists and other segments of regional and national economies and among pastoralists themselves. Subsequent sections of this study attempt to examine the processes, legitimate or otherwise that led to the current situation in the study area whereby the majority has limited access and control of local resources.

The political economy theory provides an illuminating analysis to the commonly encountered resource management issues in the study area. A pool of peasant workers gravitates around local market centres seeking wage employment within the establishments owned by local wealthy individuals or absentee pastoralists, group ranchers and irrigation entrepreneurs. The political economy approach to development has revealed significant and long-term challenges to the improvement of the living conditions in the arid and semi-arid areas of Kenya. These fragile ecosystems host a diverse concentration of wildlife, which incidentally constitute an important feature of the tourist trade. To ensure continued sustenance of wildlife, fences have been erected around major game reserve areas, which were hitherto important dry-season grazing areas and hence constituted an important resource that supported the mobile livestock economy.

Furthermore, government ASAL development programme has tended to encourage transformation of the pastoral economy from livestock-based livelihood to crop-cultivation. Promotion of the latter is dependent on irrigation farming involving growing of high-value crops for external markets. As detailed later in chapter five, this lucrative business has attracted investments from the local and national elites, triggering emergency of social stratification that was largely unknown in the pastoral economy. (GOK, 1993, 2003). Little (1992) clearly shows how state policies and commodity markets have together differentiated the pastoral households, creating contradictory and sometimes destructive land use systems.

Notable social and economic changes that threaten the pastoral economy today are grounded in the political processes. For instance, the losses of rangelands to agricultural encroachments and wildlife conservation have introduced long-lasting

changes in the land tenure systems. Little (1992) attributes loss of power and autonomy of local traditional institutions (that were vested with resource management) to the state policies and interventions. He argues that, once the state assumes the role of administration on how the local resources are to be allocated and utilized to meet government desired goals, non-herders gain increased control over local resources.

2.15.2 Political Ecology Theory

According to Blaikie and Brookfield (1987) the phrase "political ecology" combines the concerns of ecology and broadly defined political economy. Together, this encompasses shifting dialectic between society and land-based resources, and also within classes and groups within society itself. The theory provides an illuminating approach to the analysis of natural resource exploitation and degradation by linking theories of ecology and political economy. It proposes that, the causes of natural and human resource degradation consist not only of ecological factors and technological errors/problems, but most centrally, socio-economic and political factors that determine why/how people use land, resources and technology (Thrupp, 1993).

The common elements of the political ecology model as noted by Basset (1988) that we find relevant to the current study include;

(a) A historical approach emphasizing the transformation of indigenous systems of resource management in the process of incorporation into the global economy;

(b) An emphasis on the influence of state in rural land use;

(c) A focus on different responses to changing relations of production and exchange.

Olson et al (2004) adds that the application of a political ecology approach to identify the root causes of land use and land management change involves identification of key social, economic, political and environmental drivers at multiple scales, from the household to the international and interaction of those drivers over time.

The model therefore demands a holistic approach encompassing an analysis of historical and socio-economic (or structural) context in which the local problem is situated, and similarly, to trace the links of causation to factors in the wider political economy. This according to Thrupp (1993) requires the examination and documentation of historical and economic development processes, power relations, land tenure systems and institutions surrounding the use of resources and technology. In addition the same source notes that the analyst should elucidate the interplay of power among different social groups, the control of information and technology and the role of the state and interests of the private enterprise that influence agricultural development, land use, human and natural resources.

2.15.3 The Tragedy of the Commons

Hardin's (1968) theory describes a scenario in which a group of pastoralists grazed their animals on common grounds. There were no restrictions or regulations on how the grazing land should be used. It was an open access regime in which individuals sought to maximize private gains from the common property. To do so, every herder increased his stock, which was the only known measure for individual wealth, social prestige and hence a status symbol. The fact that his action could result in overexploitation of the grazing land and its eventual degradation did not enter the herder's balance sheet. After all, if he did not increase his stock other grazers would and hence be wealthier than him. Consequently, in this competitive situation all

grazers tended to add as many animals as they possibly could to the commons. The land carrying capacity, in terms of the number of animals it could be able to support was exceeded, resulting in the collapse of the pastoral economy and impairment of the productive ecosystems.

Although Hardin's theory is today highly discredited, since that tragedy had nothing to do with the intrinsic characteristics of the commons (Okoth-Ogendo, 1991), it captures a lot of elements that characterize a tragedy'. We possibly are in the midst of a tragedy today with respect to the use of wetlands. Documented information gives a story of the "wise use" of wetland resources practiced by the Tugen and the IIchamus before the advent of colonialism and adoption of English land law, which is no longer practiced.

The adoption of the English law and its application to natural resource management encouraged the erroneous view that the living generation had inherited the Earth. The dictum that "we hold the Earth in trust for the future generation" was lost. Traditional institutions that perpetuated sustainable use of our common heritage were slowly displaced by modern legally constituted institutions that emphasized individualism as opposed to commonality. Individual selfish gain pushed the use of natural resources to a situation, similar to what is captured in Hardin's theory-"The tragedy of the commons."

In summary, the theoretical basis presented in this study, operates on the premises that much of the ASALs are already modernizing and going through a phase of instability or transition. In this state the various subsistence systems are not in equilibrium with the environment (Dixon, 1989). This creates different types of insecurities epitomized in environmental degradation and acute food shortages. Two, it is based on the

understanding that the sustainability of resource use can only be realized through a governance system that ensures accessibility of productive resources to all. It is the desperate search for grazing land by members of the community with least access to productive land, water, and other outlets for income generation, that culminates in wetland degradation.

2. 16 Conceptual framework

The political economy and political ecology theories have brought to light the theoretical underpinnings of the main actors and driving forces behind land use change in the ASALs. It has become clear that a historical approach to the study of land use change is the most likely method that can give a fuller and comprehensive picture of the factors at play. The study therefore traces changes in land use from the onset of colonial occupation to contemporary government's efforts of "modernizing" the pastoral economy.

Central to this analysis is the emphasis on the role of the exogenous factors in introducing changes into the production systems. Hence, the conceptual framework of this study is informed mainly by the postulates in the George (1979) paper, which interrogates the authenticity of commercial relationships between traditional and modern economies. George (1979) postulated that, whenever, a traditional society interacts with a modern one, its production and consumption priorities are distorted in favour of economic systems prevailing in the dominant society. The dominant society tends to influence production systems away from goals to satisfy local consumption and local sale, to production goals that meet product demand existing in the wider national and international markets.

When discussing the food situation within the traditional society, George (1979) refers to an anonymous colonial administrator's report in the following words:

"*The colonial administrator says-that hunger was not caused by drought, hail or locusts- these were environmental hazards which peasants took into account and had learnt to cope with-the real cause of hunger was the enforced cash crop production for metropolitan countries. Just as the early Spanish colonizers in search of cash crop products pushed American Indians on to soil-poor and easily eroded hillsides where their descendants still live, so was much subsequent dislocation in previously efficient food systems directly induced by commercial interests backed by national ones."*

Once the society embraces values of a free market economy it transforms its institutions so as to effectively respond to international demand for various foodstuffs and raw materials. Consequently, production systems are transformed to match the new market demand. Thus, landscapes may remain in harmony with the local cultural patterns as long as external interactions are minimized. But once external interactions are established and prolonged, changes in the local economy are bound to occur with unforeseeable consequences that may include deforestation to serve the insatiable timber market or to create pasture for the dairy industry or simply to create croplands. This scenario is captured in Myers' (1980) "the hamburger connection". Myers was describing a situation whereby, the dominant US economy had an insatiable market demand for beef, which was to be imported from Central America. The latter had to increase the number of cattle ranches through excision of forest land, causing massive deforestation (Plumwood and Routley, 1982).

Franke and Chasin (1980), argue that the Sahel famine (1968-74) showed that ecological deterioration and food shortages are not only linked with each other, but

are also structurally related to international capitalism. They describe a scenario where livestock were dying due to lack of pasture and water. But as this was happening potential feed in the form of cotton grain and peanut cake was being exported, because these necessities for survival were priced beyond the means of the herds' people. In the meantime, the nomads cut down trees to feed the animals; compounding the problem of desertification.

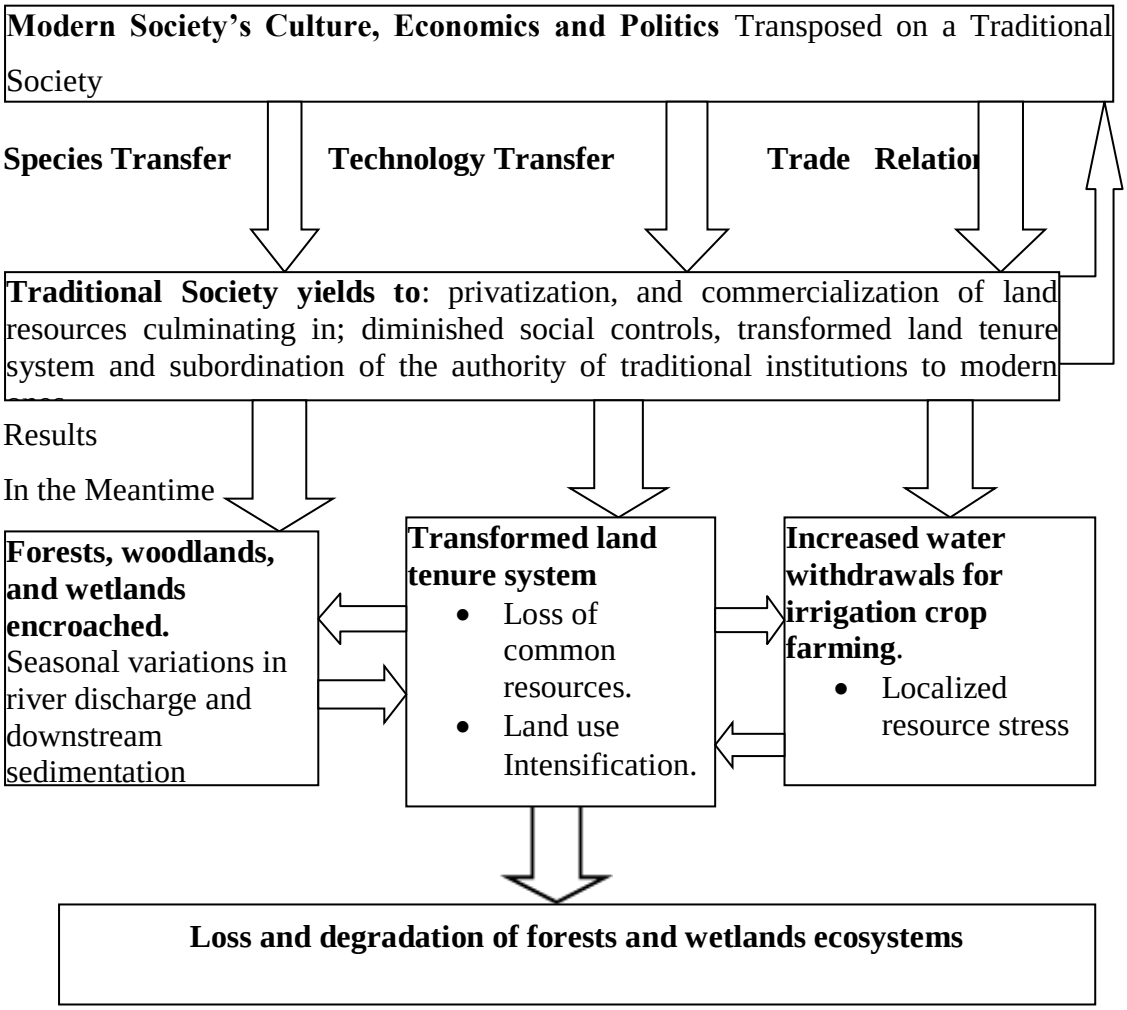


Figure 2.1. The Conceptual Framework (Modified from Susan George, 1979)

The conceptual framework, figure 2.1 above demonstrates possible changes that may be experienced in a relatively closed society once it gets into contact with a more technologically advanced society. The coming in of a modern society into a

traditional introduces radical changes in the management of the human and natural resources. There is an introduction of new animal and plant species on farms, technology and eventually trade arrangements that favour the modern society. The authority hitherto vested in the traditional institutions is replaced by modern administrative and management authority, subordinating the former.

The second stage in analysis as illustrated in figure 2.1 above, involves an examination of land cover/land use change. The initial land cover/land use was possibly covered by forests, woodlands, wetlands, bush lands, grasslands or a myriad combination of these different land cover types. However, as demographic variables changed, reinforced by forces of modernization and development; the initial land use pattern is disturbed, transformed and changed into other forms that were unknown in the society.

The traditional society is faced with new land use pressures that were never experienced before. Deforestation in the upper river catchment areas is associated with fluctuations in the river discharge and soil erosion, whereas introduction of new forms of land use in the lowlands causes encroachment into the wetlands. Eventually, there is loss and degradation of both forests and wetlands.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Methodological Considerations

Initially, the study intended to examine land use changes within the Loboi plains and their impacts on the wetlands. During the reconnaissance survey, however, it was realized that a hydro-ecological linkage exists between the lowland-wetlands and the watershed areas. A catchment approach was therefore adopted, and River Waseges was purposely chosen as the focal feature of the study. Similarly, the objectives of the study were slightly modified to direct the study focus to the core sites in the lowlands and peripheral sites along river Waseges. This re-orientation of the study introduced changes to the way the research design was formulated.

This re-orientation of the study was in consonant with recommendations to wetland managers based on Ramsar Convention (1971) document. According to the Ramsar document, "it is important to assess the cumulative effect of land cover and use in the supporting catchment. Thus, one should obtain not only low resolution information about the land cover and changes across the catchments, but also high resolution data about the surrounding local landscape, contours, flood level envelope and land use change". Whigham (1999) adds that, since the lowland wetlands mostly depend on water flowing down from the uplands, it is important to understand not only the quality of the water but also the volume of the flow. Finally the Ramsar document recommends that, the land owners' responses to these changes must be known in order to engage them in negotiations about the changes.

3.2 Research Design

Baker (1982) observed that, in presenting results researchers have devoted little space to justifying the approaches they followed in collecting and analyzing survey data. In this study elements of historical and descriptive research designs were used in conjunction with Earth observatory technology to describe and measure the spatial magnitude of land use/cover change. The following data collection methods were used; (1) Evaluation of historical socio-economic and policy documents pertaining to factors that led to the land use change and eventual integration of the study area into the wider national, regional and global economy. (2) Field study visits within and outside the boundaries of the study area in order to assess the magnitude of the problem from a wider spatial perspective. (3) In-depth interviews were conducted during these visits on a selected group of well-informed individuals including the game wardens, agricultural officers, and foresters, members of NGO's working in the area of study and village/group ranch elders. (4) Administration of sets of questionnaires seeking information on various aspects of lowlands and highlands land use systems and perception of wetlands as an environmental good. (5) These were augmented by detailed ground observations and photography of the physical conditions and practices of the people at the local level. (6) Satellite imageries taken for 1986 and 2006 were used to show the spatial change in vegetation cover, both in the study sites within the Loboi plains and the adjacent highlands that constitute the main watershed areas of the River Waseges. (6) Secondary data sources included; Review of documented historical records and books in libraries and national archives, district specific farm management handbooks, annual development plans and District annual reports of various Ministries. All the information gathered was recorded and later analyzed and incorporated into the general discussion on research findings.

3.3 Sample Frame

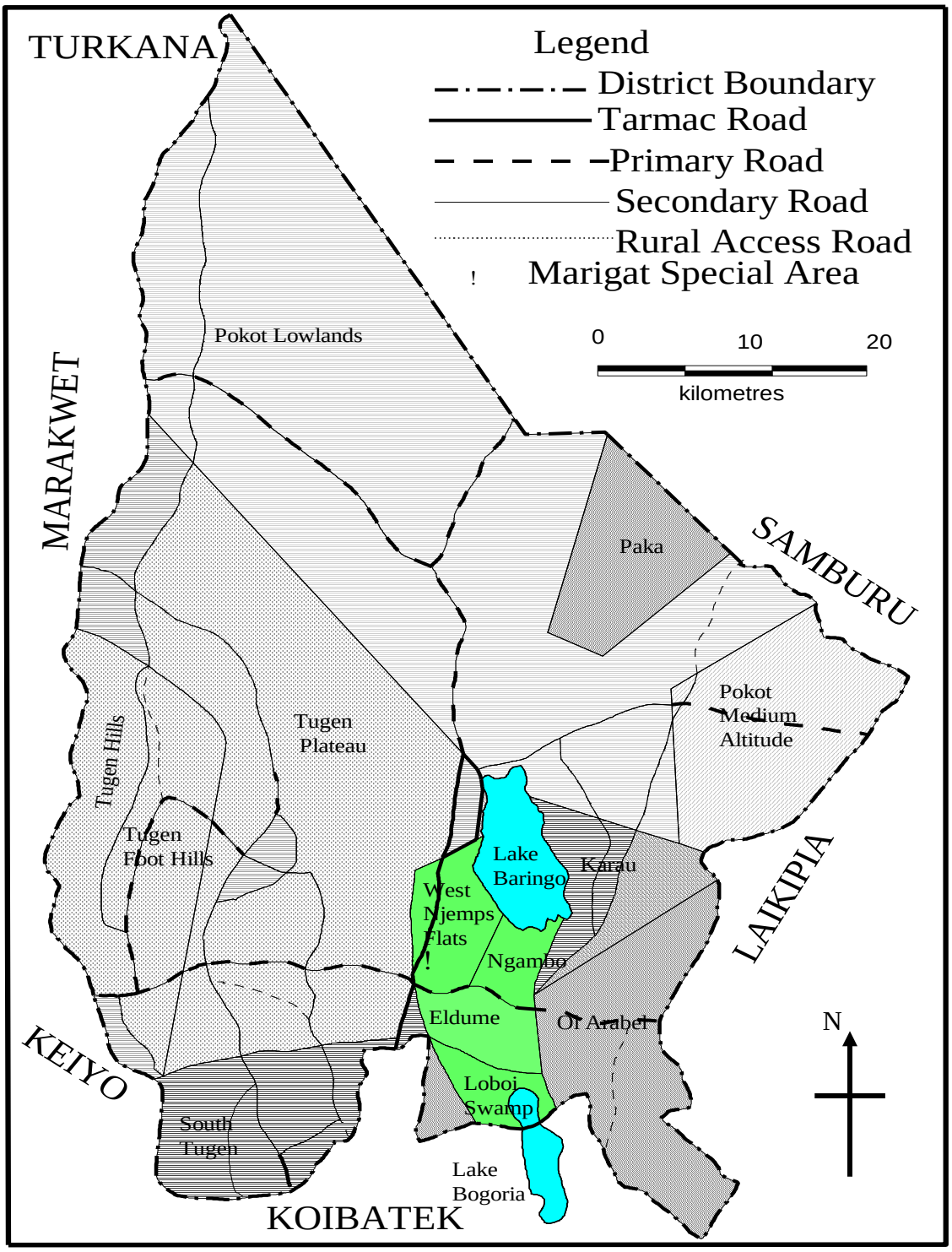
The Baringo County, the Core Research Area (CRA) is broadly subdivided into twelve geo-ecological land units based on such things as the geo-factors as climate, relief, and soil and plant life (GOK, 1984 and Herlocker, 1994). Ecological land units are areas of reasonably uniform ecological potential in relation to their use as pastures. They are not administrative boundary areas, and their utility remains that one of denoting ecological units to be used for land evaluation and resource management (Herlocker, 1994). Multi-stage area sampling was used to purposefully select four land units namely; Njemps Flats, Eldume, Ngambo and Loboi swamp plains. These were the land units that possessed most of the characteristics sought in the current study that is:

(i) Presence of wetlands, whose ecological stability was threatened by the emergent socio-economic developments.

(ii) Modern and traditional irrigation schemes

(iii) A protected national game reserve housing a major wetland

(iv) All weather road link to urban centers and other indicators of a modernizing pastoral economy.

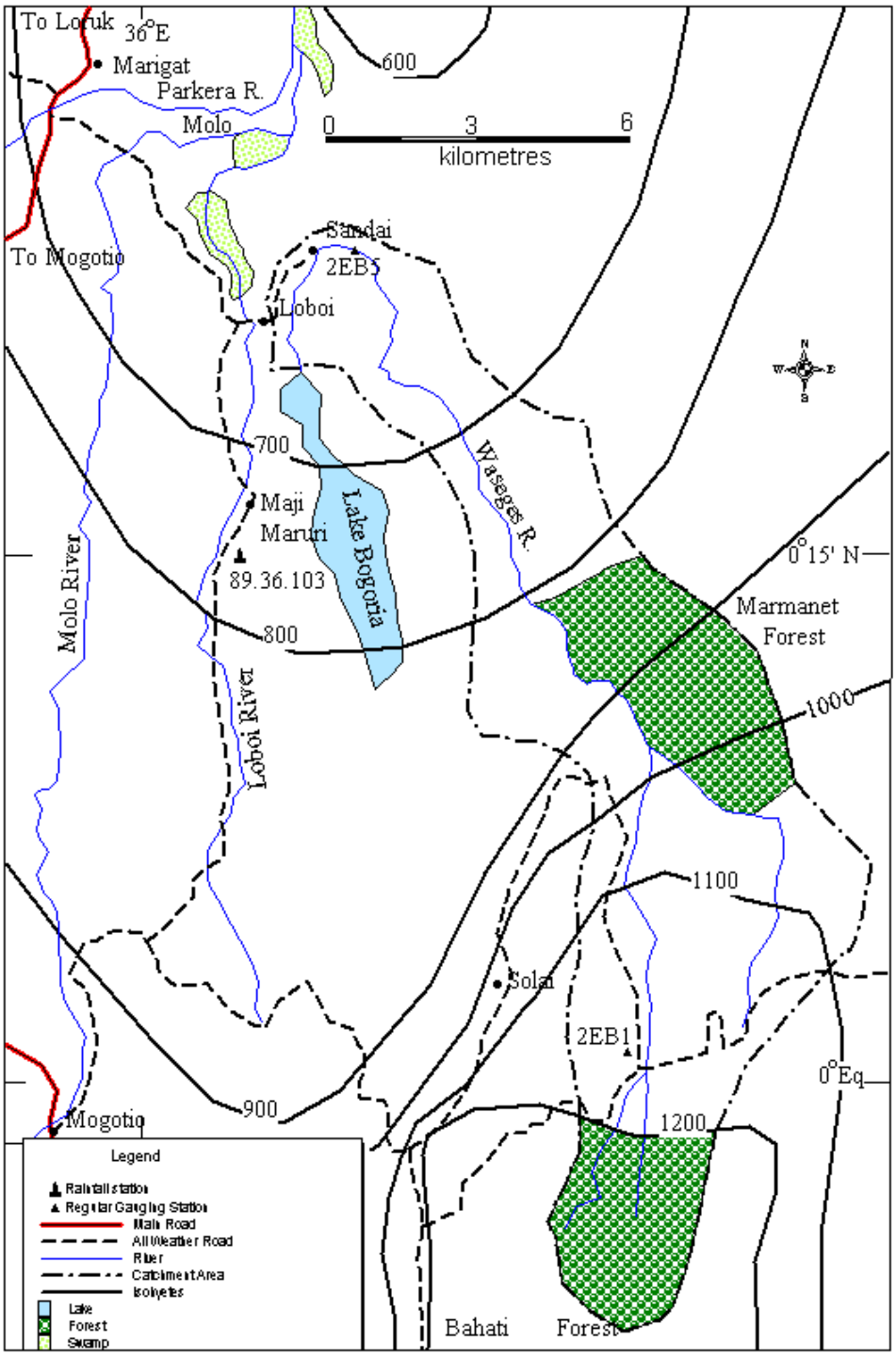


Map 3.1 Baringo District Geo-ecological Land Units Map (Modified from GOK 1984 and Herlocker; 1994)

In the second multi-stage area sampling, Loboi swamp plain was purposefully selected out of the four geo-ecological land units that had been selected at the first stage of multi-stage area sampling. This land unit was found to be the most representative and most ideal choice for current study. It holds the three of the most prominent wetlands in the study area namely; The Loboi swamp, Kesubo marsh and the lake Bogoria wetlands.

The three wetlands provide different facets of interest to this study. Lake Bogoria is considered a global heritage site, a wetland of international importance under the Ramsar Convention (1971). The Loboi swamp and Kesubo marsh are two wetlands that could provide a deeper understanding of the anthropogenic impact on a natural ecosystem. Both wetlands are threatened by encroachment of grazing and crop-cultivation.

Land use activities in the lowlands of Baringo County, however, are partly influenced and constrained by land use activities in the catchments of rivers draining the lowlands. Economic activities that lead to degradation of the catchments affect the lowlands through quantitative and qualitative supply of water. This aspect has been shown to not only affect people and their animals but also the lake Bogoria ecosystem (Onywere, 2005, Hickey et al., 2006, Ashley, 2004). Consequently, we adjusted the scope of the study area to cover the catchments of the River Waseges. Map 3.2 covers the research sites from the Baringo County lowlands represented by the Loboi Plains to the upper River Waseges catchments.



Map 3.2 Catchments areas of Waseges River and Isohyets of mean annual Rainfall

Source: Modified from GOK (1981)

3.4 Target Population

The target population was coined out of the study objectives. As noted earlier, fuller understanding of the impacts visiting the lowland wetlands could only emerge after viewing land use activities within the broader River Waseges watershed. Therefore, the target population was drawn from two geographical units that we referred to as Core Research Area (CRA) that fell in the lowlands and a Peripheral Research Area (PRA) within the upper River Waseges catchments.

The CRA target population was defined by all persons who usually reside in a small region that falls within the administrative boundaries of the present day Marigat district with a population of about 6,000 people (KNBS, 2009). The region is commonly referred to as the Loboi plain encompassing Loboi, Sandai and Kapkuikui locations. The three locations are occupied mainly by the Tugen ethnic community, which has adopted sedentary lifestyles. Their livelihoods range from livestock husbandry (cattle, goats and donkeys) to irrigated crop-cultivation. Transition from nomadic pastoralism to sedentary agriculture is elaborately visible.

3.4.1 Sample Size

The sample size was scientifically derived using Yamane (1967) formula below:

$n= N/1+Ne^2$ Where; n= Sample size

N= Population size

e=Desired margin of error (a percent allowance for non-precision because of the use of the sample instead of the population). A desired level of precision of 8% was fixed. The choice was informed by the knowledge that the sample size is normally dictated by the precision required, purpose of the survey and a compromise between what is desirable from a statistical point of view and what is

feasible from financial and manpower point of view (Ondora, 1983). The total population of the three locations (based on 2009 population census) was 5,167 socially united into 849 households. Applying Yamane (1967) formula to 849 households, a sample of 132 households was statistically determined as shown below:

$n=N/1+Ne^2$

$n=849/1+849(0.08)^2$

=131.963 approximately=132

The total figure of 132 was proportionately distributed into the six sub-locations based on the weight given by the number of households; (Table 3.1).

Table 3.1 Sample Size Drawn from the Loboi Plains land units

Location	Sub-Location	Land (km^2)	Population (2009)	Percentage of total Population	No. of H/H	Sampled H/Holds (No.)	Percent. of the total No. of H/H
Loboi	Maji/Ndege	14.6	989	0.19%	161	25	16%
	Chelaba	17.1	679	0.13%	110	17	15%
Sandai	Sandai	5.9	1,217	0.24%	204	32	16%
	Mbechut	12.4	1,048	0.20%	170	26	15%
Kapkuikui	Kapkuikui	40.7	739	0.14%	119	19	16%
	Kaptombes	5.5	495	0.10%	85	13	15%
Totals		96.2	5,167	100%	849	132	16%

Source: Data drawn from KNBS (2009)

Since the basic management unit was the household, a structured questionnaire was administered on the sample of 132 household heads covering all the six sub-locations. Household heads in each of the selected households were interviewed on specific areas concerning land use, the rationale for their decisions, and their perception and values attached to wetlands. Data collection was carried out by three research assistants from January to April of 2014. All the returned questionnaire schedules

were scrutinized for missing information and inaccurate and/or falsified data. Only 108 questionnaires were found to be complete and legible, and thus eligible for further processing.

The corresponding PRA sample was drawn from the list of all registered members of River Waseges Water Resource User Association (WRUA). In order to provide a comprehensive coverage of all land users within the riparian region of River Waseges, we obtained the list of 570 registered abstractors from WRMA Regional offices in Nakuru. Using the Table of Random Numbers a sample of 57 (or 10%) of the total number of 570 abstractors was selected for a face to face interview. The questionnaire sought to find out how the land users perceived the land use changing dynamics, their impacts and causal factors, and how the current land use practices were ameliorating or deepening the crisis.

3.5 Sources of Secondary Data

Different types of secondary data were utilized in this study. Hence several sources were consulted. We needed data ranging from archival records to remotely acquired satellite imageries. Historical data and information from different sources (National Archives (Nairobi), Ministries' H/Qs (Kabarnet) FMHB, 2002), documented literature (Anderson, 2000, JICA, 2002, Little, 1998 Bryan 1994, Hobley, 1906) and historical narratives from elderly members of the tribe, has been comprehensively pieced together to provide a logical exposition of the region's land use history. Drawing insights from those sources we have attempted to succinctly isolate direct and indirect factors that initiated long and lasting changes in the use and entitlement of land resources in the vicinity of Lake Bogoria and the catchment areas.

There are at least three sites where one can obtain Landsat satellite imagery namely; GLOVIS and Earth Explorer by USGS, and the Global Land Cover Facility (GLCF) at the University of Maryland. Landsat Satellite images covering the period 1986, and 2006 for the current study were obtained from the GLCF (http://glcf.umiacs.umd.edu/index.shtml). This is a source of free high-quality "Geo-Cover" images that have been selected for minimal cloud cover, during peak greenness and have been precisely ortho-geo-referenced (GLCF, 2010). The geo-reference formats employed by the GLCF for Landsat imagery include a UTM projection and a WGS84 datum and ellipsoid. Thus geometric correction was unnecessary (Sallaba, 2009).

Our premise was that, the changes in land use /land cover, particularly in the upper catchment areas, affect the river discharge; a fact that determines the amount and quality of water reaching the wetlands. Therefore, we obtained rainfall and river discharge data, from Kenya Meteorological station and WRMA Nakuru offices respectively. From the WRMA, we obtained data on river discharge at four gauging stations along River Waseges. Meteorological data was obtained for two rainfall stations within the PRA zone and from three rainfall stations in CRA zone.

Social and economic development data such as population size, distribution and mobility were gathered from documented information especially by the Kenya National Bureau of Statistics and District's Annual Reports from various Ministries of Government. Information on the current legislative and institutional status on the management of wetlands was sought from varied sources of government and NGOs.

3.5.1 Pilot Survey

The data collection exercise was preceded by a pilot survey carried out in January-

February 2008, in the Loboi Plains. It was during this exercise that it became clear, that a fuller understanding of the causes of loss and degradation of wetlands could only be reached by examining land use practices in the upper catchments of the River Waseges. The scope of the research problem was therefore expanded.

The data collection instruments were tested by administering 10 and 5 questionnaires at the CRAs and PRAs research sites respectively. The exercise helped to refine the instrument for language and cultural conformity. Three research assistants were also inducted to the fieldwork. They were trained on how to administer the questionnaires, which had now been fine-tuned with their participation. The exercise that was expected to last three days took seven days to accomplish.

3.6 Data analysis

Quantitative and qualitative data analysis techniques were singly and/or together used to attempt to give a fuller and more comprehensive answer to the study question. However, before embarking on the formal data analysis, a preliminary review and interpretation of historical data was attempted. This involved collation of all archival materials and historical data into a comprehensive account of the events that triggered the early land use change in the study area. Tables and maps were the main techniques used to capture and illustrate the impacts of historical events on land use/land cover change.

The most objective of this approach was the use of Earth Observation Technology. It provided time series images of different land use/land covers which were subjected to Digital Image Processing (DIP) tools, resulting in historical maps showing the status of LULCC over a twenty year period as described below.

The GLCF technical guide (2010) has given guidelines on how to download Landsat scenes of a researcher's interest. Two Landsat images, within the worldwide path 169 and 60 row, were downloaded from the free GLCF. The two satellite images were thereafter imported into the IDRISI and ArcGIS 9.3 software for processing. Next the 1986 image was clipped using bands 4, 3, and 2. The 1986 clip was used to clip the 2006 satellite image for consistency and congruence in analysis.

From the Shuttle Radar Topographic Mission (SRTM) a Digital Elevation Model (DEM) was also downloaded to delineate the catchment area of the sub-basin. Through a careful process the flow and accumulation direction were determined. The specific study sites were carefully clipped out by marking the areal extent with a rectangular polygon. ArcGIS was used to process the data obtained from DEM as IDRISI was employed in the analysis of land use/land cover change.

From the ensuing analysis, we were able to show the magnitude of spatial change from one LULC type to another. This was an important exercise, because it revealed the LULC type that had been most affected by human and non-human activities and processes over time.

Lastly, Statistical Package for Social Sciences (SPSS), an integrated system of computer programs designed for the analysis of social sciences, data was used to generate simple statistical analysis, tabulations, maps, graphs, bar-charts and frequency distributions. These illustrations covered various aspects of respondents' characteristics. It was virtually possible to show the relationships between the respondents' characteristics and land use changes through time.

3.7 Ethical Considerations

Ethical considerations included seeking appropriate authorities and consent of the interviewees representing governmental and non-governmental agencies at the national and local levels. The researcher ensured good working relationships between himself and the research assistants, the research team and the community.

The purpose of the study and methods of gathering information and expected final product were clearly explained to the respondents. It was made clear that the principal researcher was a University lecturer and that the exercise was needed to expand existing knowledge on land use; for teaching purposes and to inform policy and planning in this sector of the economy. Thus, the benefits to the respondents were neither to be immediate nor direct. Respondents were assured of confidentiality and anonymity if they agreed to participate in the study. After this explanation each respondent's informed consent was sought. Only those respondents who expressed free and voluntary participation after full comprehension of the study's purpose were interviewed. Cultural etiquettes were strictly observed at all times during the survey. The identification of the key informant took into consideration his knowledge of the local culture as well as his social standing. This was of critical importance.

Lastly, all the work that had been consulted in the process of writing this thesis was properly cited in the text and the titles appended in the reference list. Research work done by departmental colleagues in related fields was not included in the literature review, because it was felt that the same could not be judged impartially.

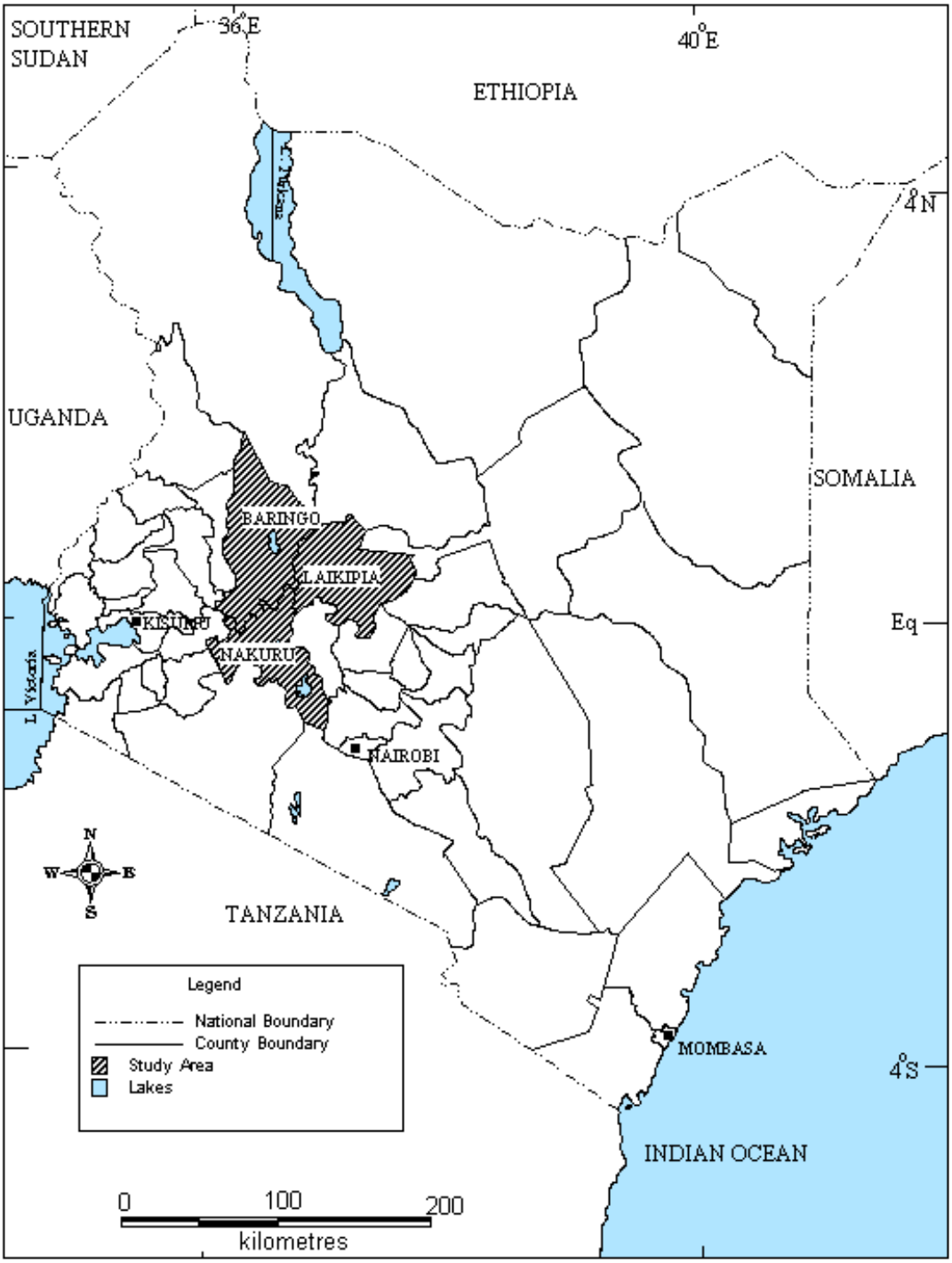
CHAPTER FOUR

PHYSICAL, HISTORICAL AND SOCIO-ECONOMIC SETTING OF LAND USE/LAND COVER CHANGE IN THE LOBOI PLAINS AND ADJACENT HIGHLANDS

4.1 Introduction

The core study area covers the region that lies between Lake Baringo in the north and Lake Bogoria to the south. It is defined by the geo-ecological land unit commonly referred to as the Loboi Plains. Hydrological links with the adjacent highlands meant that the study sites were to include Lake Bogoria catchments defined by the river Waseges and its tributaries. Therefore, the study area covers a substantial area of Laikipia and Nakuru Counties. The longitude 36^{o} 00'E roughly delineates the western extent of the study sites and the eastern extent is marked by approximately 36^{o} 26' E longitude. It is approximately bounded by the parallels 0^{o} 20'S and 0^{o} 55'N.

Initially, the study interest was focused on the impact of land use on wetlands confined within the Lakes Baringo-Bogoria lowlands. However, during the reconnaissance survey and the questionnaire pre-testing period it became apparent that the lowland-wetlands had notable hydrological links with the ecology of the adjacent highlands. Consequently, a decision to examine land use changes in the Lake Bogoria catchments was made. River Waseges which is the main source of fresh water entering Lake Bogoria became the main reference feature. The decision was prudent because land use changes in the catchments, will always impinge on the quantity of the river discharge, inevitably altering some hydrologic aspects in the lowlands.



Map 4.1 Location of Study sites In Baringo, Laikipia and Nakuru Counties

Source: Modified from Survey of Kenya at the Moi University GIS-Lab (2010)

The 2010 Kenya's constitution introduced a number of changes in the country's administrative boundaries, consequently the core research sites fell in Baringo County whereas the peripheral study sites are located within Laikipia escarpment in

Laikipia County and parts of Nakuru County. This demarcation means that three county authorities have vested interests in the management of the river Waseges catchments. Incidentally both the lowland and highland farmers have fully embraced commercial irrigation-based agriculture. Therefore, water resource use conflicts have been frequent.

However, thanks to the presence of the Water Resource Management Authority (WRMA), these conflicts have been minimized. WRMA is credited with the formation of Water Resource User Associations (WRUAs) along River Waseges. This people's institution has been mandated with responsibility of managing the water resolution in a manner that minimizes conflicts as discussed latter in chapter five of this thesis.

4.2 Geology and topography of the Lakes Baringo-Bogoria lowlands

The geology and physiography of the Lakes Baringo-Bogoria lowlands is closely related to the forming of the East African Rift Valley system, which in the study area is bounded to the west by Elgeyo Escarpment (over 3000m a.s.l) and to the East by the Laikipia escarpment (Over 2000m a.s.l).This is a volcanic-structural feature that extends from the Gulf of Aden in the north to Beira in Mozambique in the south (Karingithi, 2005). The area between Lake Baringo and Lake Bogoria which lies within asymmetric half-grabben in the East African Rift Valley was during a wetter period of the quaternary covered by a vast lake. However, due to climate change, the lake contracted, leaving behind a wide expanse of silt laid down in the original lake (Sketchley, et al 1978).

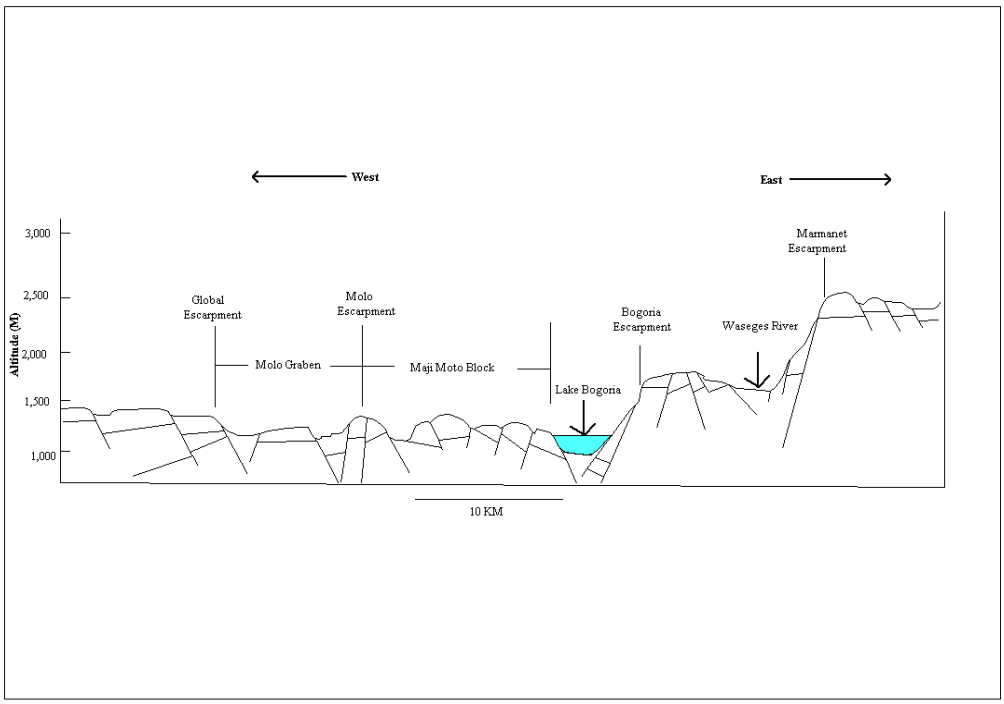
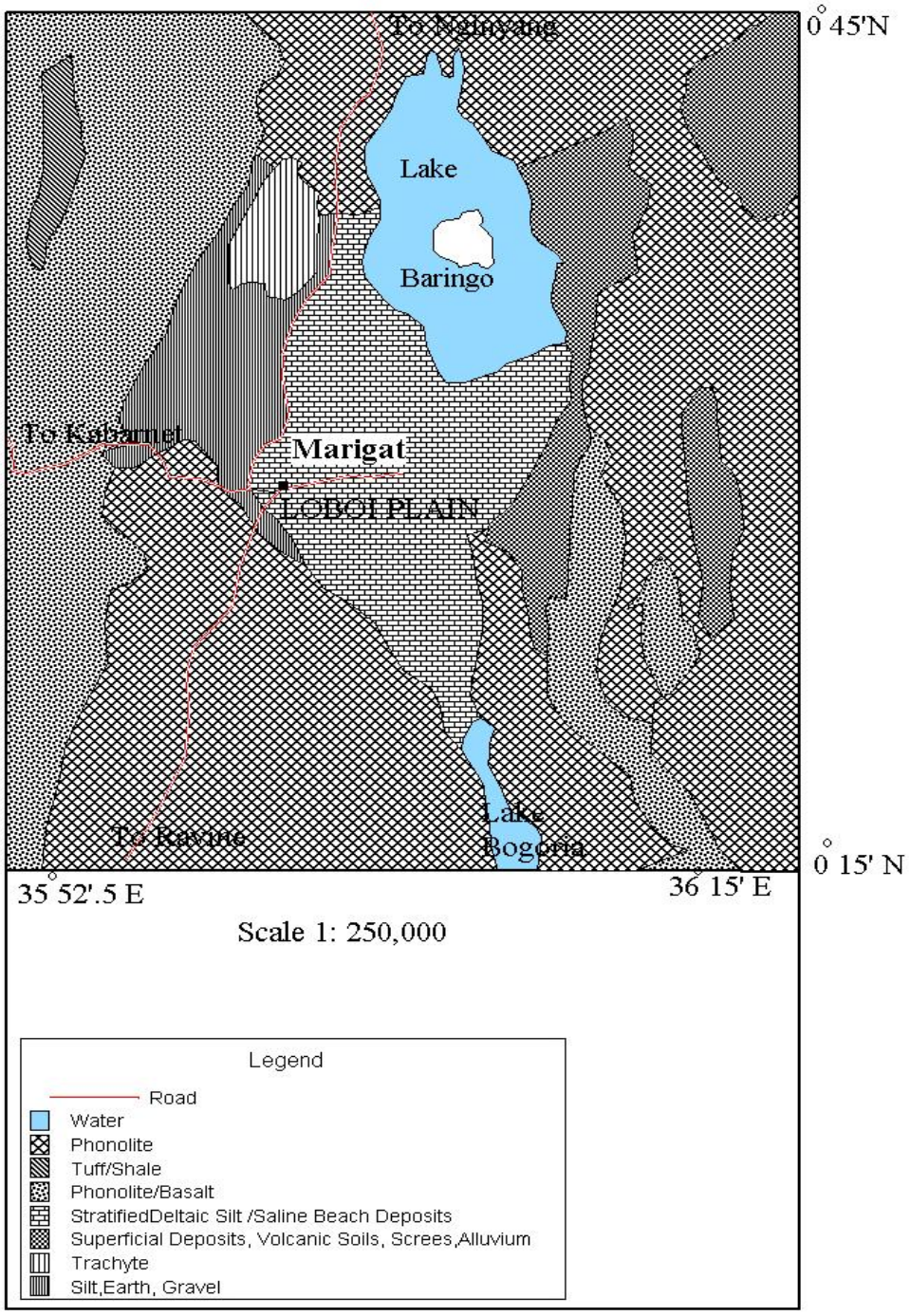


Figure 4.1 A Cross section of the Lake Baringo-Bogoria half-Graben (After Renaut and Tiercelin, 1994)

The Loboi plain is a locally swampy, subsiding alluvial fill of inter-bedded colluvial, fluvial, deltaic and lacustrine sediments that are Pleistocene to Holocene in age (Driese, et al., 2004). East and west of the Loboi plain, the land surface rises abruptly as a series of fault-steps to form the Laikipia escarpment and Tugen hills respectively (Ashley et al., 2004). Generally, the study area is a piedmont plain with a gradient of 1% tending towards the shorelines of lakes Baringo and Bogoria.



Map 4.2 Geology of Lakes Baringo-Bogoria Lowlands (Sketchley, et al. 1978)

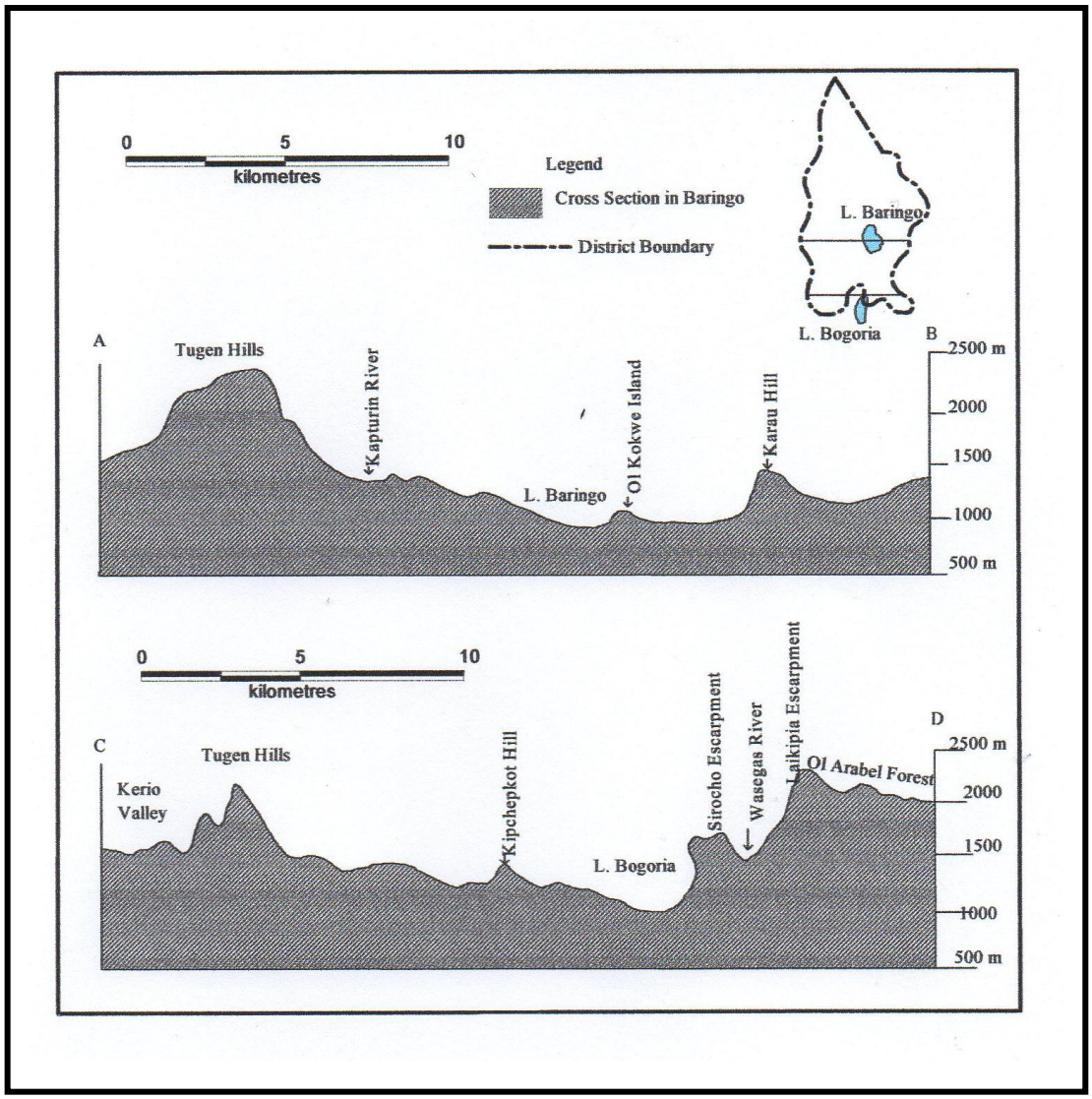


Figure 4.2 Relief Sections across Lakes Baringo and Bogoria

(Modified from GOK, 1984)

4.3 Geology and Topography of the Adjacent Highlands

In a very detailed treatise McCall (1967) shows that the geology of the area relates well with the physiographic features. For instance, the Laikipia escarpment is said to be more dissected to the north and is composed of three or four distinct escarpments. The Lake Bogoria Escarpment, the Solai Escarpment and the Lolderodo-Maryland-Chui Escarpment are to be seen South-eastern of Lake Bogoria. These three tiers step up the land surface from Lake Bogoria to an altitude of 2,870 metres at Lolderodo, the highest point in the area, and the summit of the Bahati Forest uplands. It is noted that the three escarpments are due to major fault displacements. Lake Solai is found at the foot of the Solai escarpment.

4.4 Soils of the lakes Baringo-Bogoria lowland

According to Sombroek et al (1982), the Lakes Baringo-Bogoria lowland is part of the piedmont plains which have soils developed on alluvium derived from various tertiary/quaternary volcanic rocks (mainly basalts). The soils consists of moderately well drained, very deep, dark brown to grayish brown firm, strongly calcareous, moderately to strongly saline and sodic, fine sandy loam to clay loam with a stone surface (orthic solonchaks, stone-mantle phase).

The Sombroek survey findings show that all the soils of the Lakes Baringo-Bogoria lowland are characteristically youthful. The organic carbon content of the topsoil is very low with values varying between 0.15% and 0.45%. This is mainly due to the low biomass production of the sparse vegetation, coupled with a high mineralization in this warm climate. These soils are classified by the Ministry of Agriculture (GOK, 1979) as Eutric Fluvisol and Calcaria Fluvisols with locally occurring saline and sodic phase. Texture is variable, but most are in the range silt loam-to-silty clay, with silt

contents of up to 50%. High silt, low organic matter and occasionally rather high sodium content cause the soil to cap very easily. They are slightly hard when they are dry, but become sticky and plastic when they are wet. This, coupled with erratic regime of the rivers and the high susceptibility to erosion of the unconsolidated volcanic deposits in the catchments areas, creates high sediment loads of the rivers (Okeya, 1985). It is common therefore, to find gully erosion occurring despite the low gradient. De-vegetation can therefore result in severe land degradation. However, these soils offer strong promise for horticultural farming.

4.5 Soils of Adjacent Highlands to Lakes Baringo-Bogoria Lowland

A very comprehensive description of the highlands soils was provided by Nyandat (1976). He wrote that Nitosols and Rhodic Ferralsols are the commonly found soils within the western highlands of Laikipia district. The physiography of the main areas of the Nitosols is rolling uplands whereas that of the Rhodic Ferralsols is undulating upland. Volcanic rocks (mainly basalt, phonolite and trachyte) underlie the main areas of Nitosols and metamorphic (Basement system) rocks underlie the main areas of Rhodic Ferralsols. Nitosols are predominant in the Marmanet Forests, the area around Nyahururu and the upper fringes of the Laikipia Escarpment. The altitudinal range of their occurrence is 1,500 to 3,000 metres above sea level. Rhodic Ferralsols are commonly found in areas of lower altitude ranging from 1,000 to 2,000 meters above sea level. The latter are most prevalent in the Laikipia Escarpment and the underlying areas.

Nyandat (1976) says that Nitosols and Rhodic Ferralsols can support a wide range of both annual and perennial crops. However, sheet erosion can occur when the soils are not properly managed. The cultivation of the land on slopes between 10-25%,

although agriculturally productive can be have sustained yields only by putting adequate soil conservation measure in place. This is important background information, because cultivation in the highland areas without application of proper soil conservation methods affects the high lands by loss of nutrients and the lowlands by increased siltation.

4.6 Climatic conditions and vegetation types in the Study area

The Bahati and Marmanet forests form the upper catchment areas of the Waseges River. The region has an altitudinal range of 1,500-2,700 metres above the sea level. Annual precipitation varies from 1,000mm to 2,000mm per annum. Due to this high and reliable rainfall, the region supported diversified plant and animal communities, characteristics of high altitude tropical forests (Odingo, 1978). The region, however, did not retain this biodiversity for long due to human encroachment that was set of by the advent of colonial occupation and later the independent government's resettlement scheme program.

Descending from the Marmanet hills at an altitude of 2,624metres above sea level down the course of River Waseges to Mbechot village at an altitude of 1,312metres above sea level, a distance of about 58 km, one can identify a number eco-climatic zones ranging from the upper sub-humid to the lower semi-arid zones. Onywere (2005) notes that, climatic parameters tend to change with altitude. As one descends from the highlands westwards, notable reduction in rainfall is recorded as temperature increase. He noted a general decrease in precipitation from the rift shoulders into the rift floor. This is best illustrated on the map below. The highest isohyet of 1200 mm is found on the upper catchment areas of Waseges River, whereas the Loboi plains are delimited by the 600mm and 700mm isohyets. The lowlands experience high annual potential evapotranspiration (E_T) of about 2,044mm (MOA, 1985). This gives a ratio

of r/E_0 of 32%, placing the area in the agro climatic zone V-2 (Sombriek et al 1982) that has a marginal to low potential for rain-fed agriculture. Rainstorms are sporadic, localized and some high intensity storms occur in most years (Bryan, 1994). Massive gulley erosion results and are known to cause serious damage to road constructions and diversion of rivers.

The upper zone is predominantly covered with a combination of exotic and indigenous forest trees, bushes and grasses. This zone forms the head waters of the many tributaries of the river Waseges. The lower zone is characterized by scanty vegetation composed mainly of drought resistant woody vegetation such as *Acacia brevispica, Acacia reficiens, Acacia mellifera, Acacia Senegal* and *Acacia tortilis* and a combination of tall stands of sedge *cyperus papyrus* with much shorter stands of perennial grasses dominated by *Eichinochloa haploclada* and *Brachiiaria* sp. (Herlocker et al 1994).

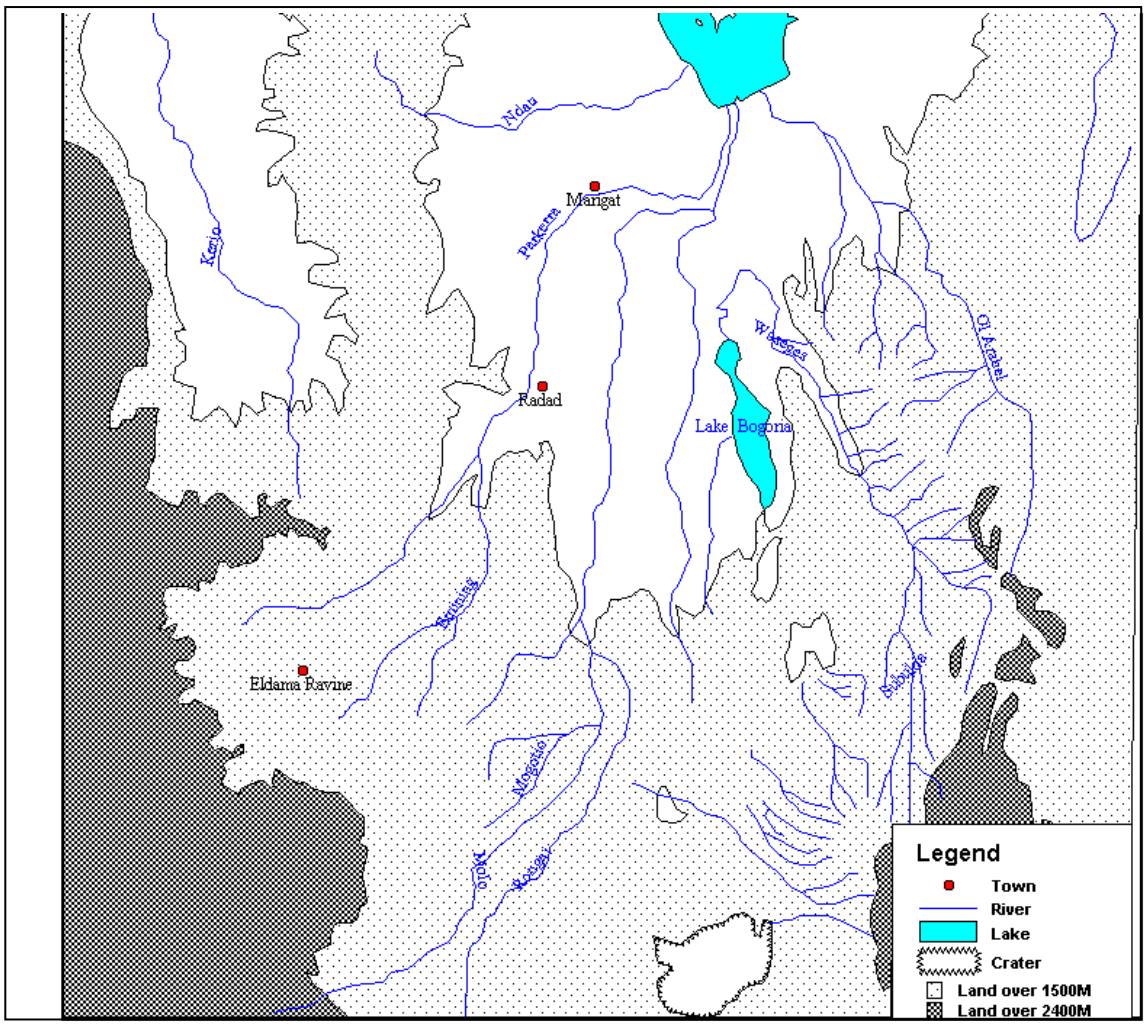
Grasses could be categorized as ephemerals and are available for livestock foraging within about eight weeks after rains. However, there are perennial grasses in the wetlands along Perkerra and Molo rivers, and around the swamps. The swamps are almost completely covered by perennial grasses such as *Cynodon dactylon, Cynodon plectostachyus* and *Echinocloa haplocada* (JICA, 2002).

The study of vegetation types and their utilization is important because the animal-based traditional form of livelihood is dependent on the natural vegetation. For instance, lopping of leaves and twigs to provide dry season fodder for the animals is common in the months of December to March. *Balanites aegyptiaca* and *ficus sycomorus* are utilized for their leafy parts whereas *Acacia tortilis* pods are fed to weak animals left mostly around the homesteads (Bundotich per.comm. 2010).

It is during the dry season (over nine months) that the wetlands, woody perennials and shrubs provide the much needed fodder for the livestock until the next rainy season. Shortage of alternative dry season animal feed such as hay deepens the pastoralists' reliance on wetlands, fodder trees and shrubs. Consequently, these resources have been jealously managed as to constitute a central position in the culture of the people. However, the traditional knowledge of tree fodder management has slowly been eroded by the incorporation of modern crop-irrigation form of practices. Overuse of the vegetation by grazing animals and down cutting of the woody vegetation for house construction and for firewood has led to severe degradation of the plant cover (Biwott, per comm.2010).

4.7 Drainage Systems

Many seasonal and permanent rivers drain into the study area, originating mainly from the upper agro-ecological zones, which receive high rainfall such as the Ol Arabel forest to the east, Bahati and Marmanet forests to the southeast and Mau forest to the south. Therefore, the catchment area covers some parts of Nakuru District. According to Onyando (2002) the catchment of Lake Bogoria is about 1,120km^2. The Lake surface is about 33km^2. It is a saline lake that is fed chiefly by the Weseges River that becomes seasonal as it approaches the lake. The river flows reliably and significantly from July till November but dries up in 20% of the years from December till April.



Map 4.3 Southern Baringo County-Relief and Drainage (adapted -Anderson, 2002)

4.8 Population and Livelihood Zones

It is important to note at the outset that Kenya's administrative boundaries have over the years been adjusted in response to political and economic needs of the country. The population data available covered the administrative divisions before the promulgation of the new constitution in 2010. According to the 2009 population census the combined population of Makutani and Marigat divisions was 54,000 people. It was also estimated that there were 52,000 cows, 194,000 goats and 55,000 sheep (KNBS, 2009).

The newly created administrative boundaries have placed the current study sites in the Lakes Baringo-Bogoria lowland in the new administrative district of Marigat, which is divided into 18 administrative locations. Two main communities inhibit the district, the Tugen who are mixed farmers and the IIchamus who practice pastoralism and some agro-pastoralism.

Wasonga and Otieno (1983) had classified the geo-ecological land units around Marigat among the least nutritionally risk areas. Incidentally these are the land units that have the largest concentration of small scale irrigation projects namely; Loboi, Kapkuikui, Kamaskoi, Sandai, kamaech and kailer. Table 4.1 below notes each project's source of water, flow rates, area under irrigation and the rate of water abstraction.

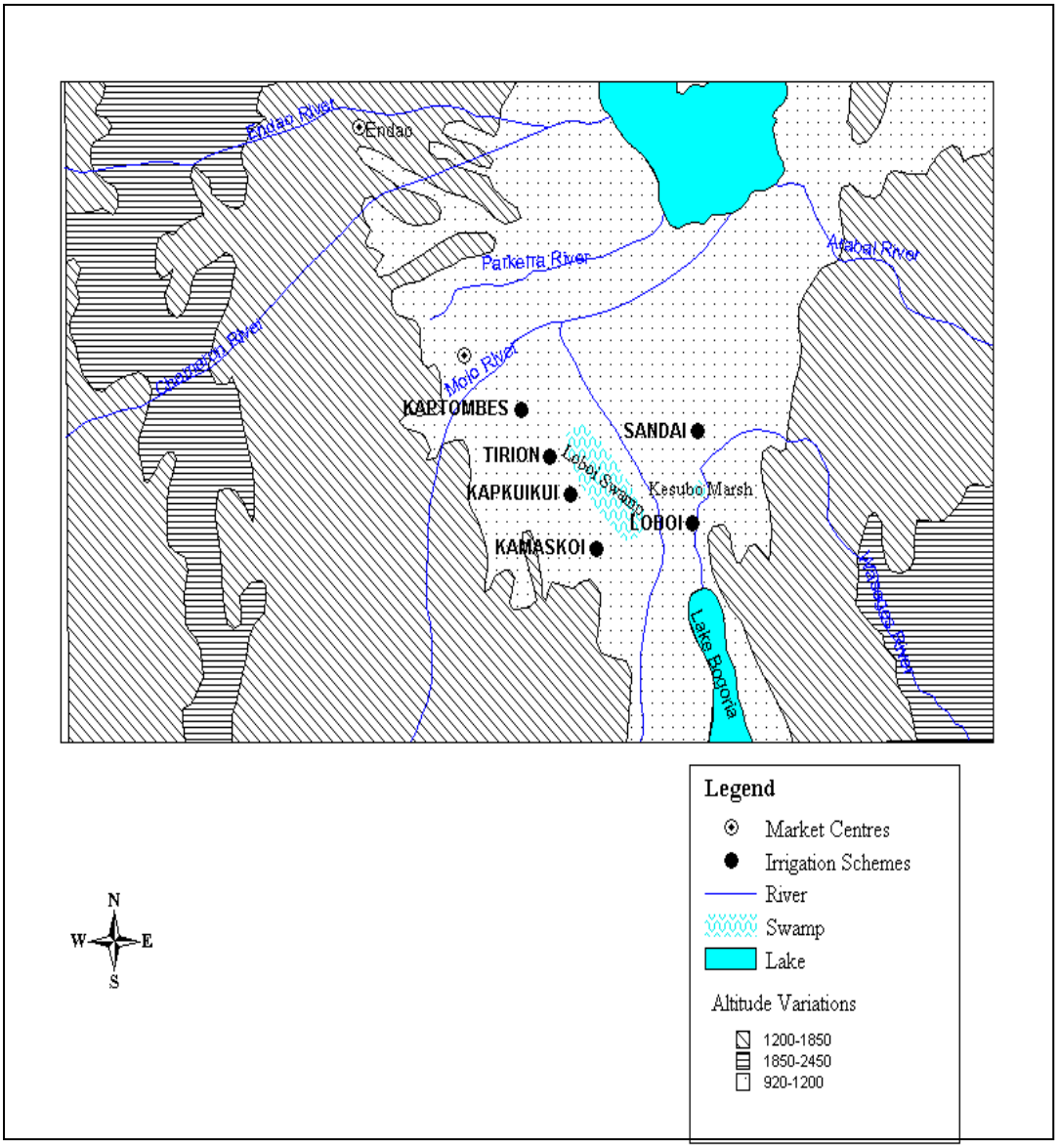
Table 4.1 Water demand levels in the major irrigation schemes in Marigat div.

Irrigation scheme.	Source water.	Flow m^3/day.	Area under irrigation.(Ha)	Abstraction Rate m^3/day
Kapkuikui	Loboi swamp	Swamp water	180	454.50
Sandai	Waseges river	15,075.30	300 ha.	2,726.00
Kamaskoi	Lorwai Spring	Swamp water	76 ha.	20,045
Kailer	Waseges River	258.20	48 ha	159.60
Kamaech	Waseges River	15,984.10	62 ha.	908.70

Source: JICA (2002).

Loboi swamp is the main source of irrigation water that serves Kamoskoi and Kapkuikui irrigation schemes (JICA, 2002). The plan to draw water from this wetland was initiated way back in the 1970s. Besides, the two irrigation schemes the government had also financed the construction of a water ditch to connect

Kaptombes, and Torion and Kamaskoi to Loboi swamp (Ashley 2004). Map 4.6 below shows the location of individual irrigation scheme relative to the wetland.



Map 4.4 Irrigation Schemes in the Loboi Plains in 2010 (field data)

4.9 Brief History of Land Use Change, Loss and Degradation of Wetlands

Available historical records describe Baringo lowlands as a onetime fertile crescent in Africa. The caravan trade engaged in by the Arabs and inland people stretching from the Kenya coast to Mumias is reported to have benefited from bountiful harvests of grains sold to the trade merchants by IIcahmus community. In exchange of sorghum

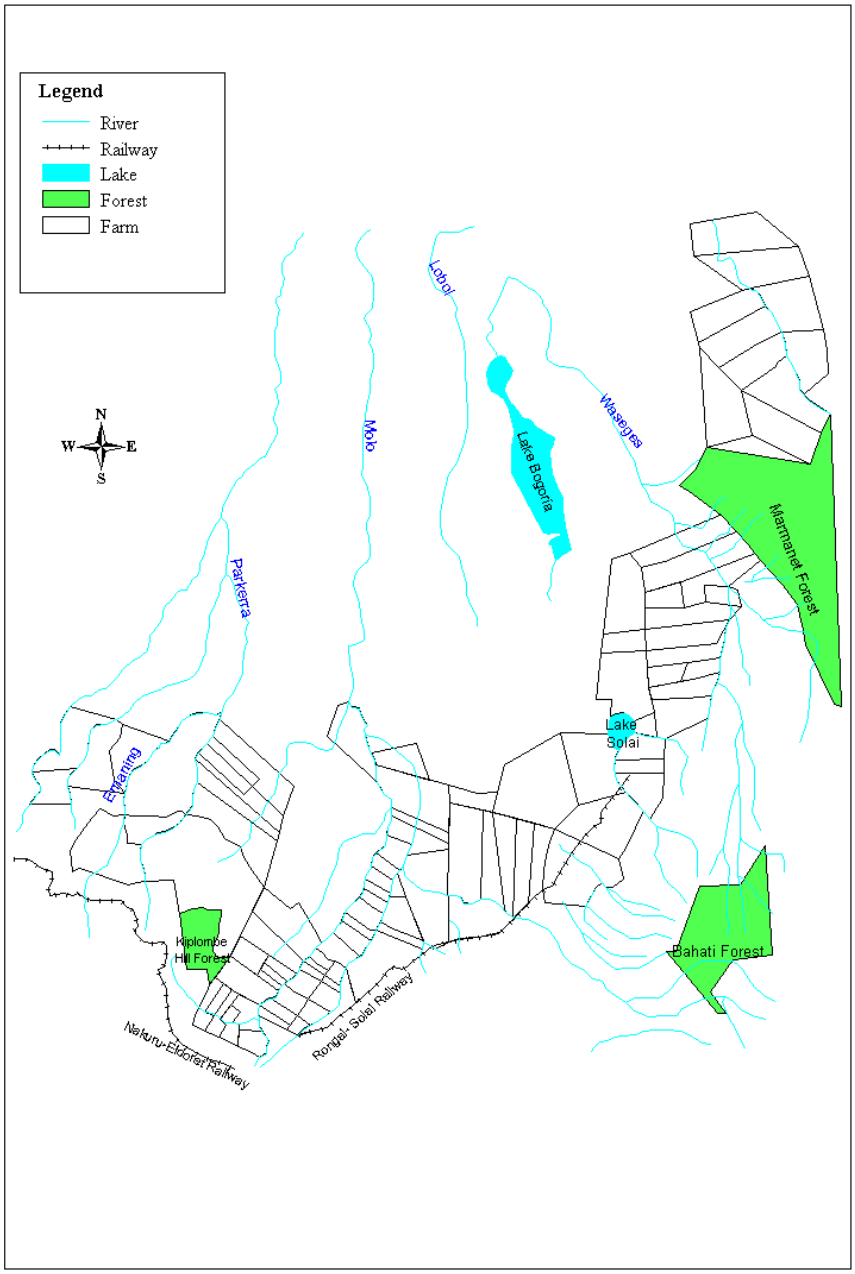
and other grains grown under traditional irrigation systems, the IIchamus received glass beads, cloth, metal wires etc. (JICA, 2002). Arab Geographers reported events of pastoral migrants from far afield who were attracted by green pastures in the Baringo lowlands. (Little, 1992 Anderson, 2002). These sources indicate that not only were the southern hills full of green meadows, but also along river valleys and extensive swampy grounds were to be found year-long pastures and water for the animals. A major question that immediately comes to mind is, what factors reduced the Baringo lowlands from a high food producing and grazing land to a land of food scarcity? Peter D. Little in his book "The Elusive Granary" has traced the history of deterioration of the Baringo lowlands in the face of changing political economic dynamics foreshadowed by the advent of colonial settlement in Kenya from the 1890s.

4.9.1 The Colonial Interval

The settler community was keen to embark on commercial exploitation of land in order to defray and justify the high costs incurred during the construction of the Kenya-Uganda railway. The higher and wetter margins of Baringo to the east and south were considered suitable for commercial farming and hence white settlement. Consequently, all energies were marshaled to ensure the removal of indigenous pastoralists from this expansive area of land in order to realize the set goals. However, care was taken not to appear to making forceful ejection of a people from their land. Hence, the Europeans entered into 'formal' agreements with the Maasai people, who according to Anderson (2002) occupied extensive areas of Baringo lowlands and the Laikipia plateau. Through agreements whose authenticity was highly contested the Maasai signed away their rights to land use and ownership throughout the Rift Valley to the British government (Okoth-Ogendo, 1991).

Anderson reports that by 1911, the Maasai had been effectively removed from Laikipia plateau to Southern Reserve and within a few years of their removal, opportunities for animal grazing were sealed. This led to the closure of the previously open dry season grazing land in the highlands. The Tugen and the Njemps pastoralists who were always welcomed by the Maasai to graze their animals here, particularly during the dry seasons had now to re-orient their grazing patterns (Little, 1992, JICA, 2002). This action, as noted in our discussions later had the undesired effect of disrupting the traditional transhumance system of grazing, that was most suited to this harsh environment. Animals were now to be confined to lesser space in the lowlands; causing overgrazing and eventual degradation of land (Meyerhoff, 1991; Little1992).

The new settlers appropriated land for cattle ranches and plantation farms. Map 4.5 shows the pattern of colonial farms in the 1930s within the upper catchments of the Waseges River. To create way for these large scale farms massive areas of forest land in the eastern and southern highlands had to be clear-felled. The E.A. Forestry Regulation enacted in 1902, had given the British settlers the sole right of clear felling of indigenous forests to supply raw materials to the British industries (Honore,' 1969; Abell, 1986).



Map 4.5 European Farmlands in 1930s (Modified from Anderson, 2002)

4.9.2 The Post- Colonial Development Interventions

The independent government of Kenya inherited an economy that was highly skewed in favor of the development of the former white highlands. The development axil stretched linearly from the port of Mombasa to the lakeside city of Kisumu. The rest of the country and particularly the ASAL regions lagged behind in development. The colonial administration had perceived the arid land's people as hostile to it, apparently because these people resisted attempts aimed at changing their traditional lifestyles (Mr. Matetai Per. comm. Marigat, 2010). The problem was exacerbated by unfavorable environmental conditions of this region, which made it unattractive to investors. The colonial interval therefore, did little to improve human and physical capital development of the region. According to the residents of the area the momentum set in motion by the colonial bias continued to be felt many years after independence.

It was imperative to redress this inequality through government policy actions that aimed at transformation of the ASAL economy. Thus, the arid and semi-arid lands (ASALs) strategy formulated under the Ministry of Finance and Economic Planning (GOK, 1979), focused attention on activities that would help diversify the pastoral economy and thereby reduce the risks associated with over-dependence on livestock as the only means of survival.

Similarly, the introduction of the District Focus for Rural Development in the 1980s brought in, tangible activities to the grassroots that manifestly integrated the pastoral people into the national development agenda. Although the early government's efforts at transforming the ASAL regions may have been criticized for ignoring the traditional resource management systems, it is the impetus set in motion by these

early efforts that highlighted the tragedy of the ASAL areas. Hence, considerable physical and human resources for infrastructural development flowed into Baringo County.

The success and the drive of these development efforts rotated around the government. It truly was a government driven socio-economic change. This can be attributed to the then president of Kenya who could easily trace his ancestry to Baringo County and the greater Rift Valley development region. He marshaled together government resources and people to rehabilitate the now highly degraded dry land environment. Gabions were erected to control soil erosion induced by flash floods and storms that characterized the Baringo lowlands. Thanks to this calculated political interests several governmental and non-governmental agencies found reason to invest physical and financial resources in programs that would later translate into environmental conservation and livelihood securities. These efforts brought in tremendous development dimensions in the arid and semi-arid Baringo County, which together helped to change the lifestyles of the ASAL inhabitants.

The predominant strategy on the development of the ASALs was focused mainly on the need to encourage nomadic pastoralists to adopt a settled way of life. It was believed that the traditional animal husbandry practices were the main causes of environmental degradation and development inertia in the ASAL regions. The perception then was that, "nomadic way of life is outmoded and undesirable. It is relegated to primitive cultures, an antithesis of civilization and a deterrent of modernization" (Awuondo, 1989).

It was therefore, the desire of the post-colonial government to transform all aspects of nomadic pastoralism, to make it more accommodative to the modern economy. Thus,

the official position was and continued to be for a long time to encourage sedentarization of pastoralists (Oba, 1988, 1992); so as to, among other development objectives minimize the costs of providing basic services such as health, education and water supply.

Between 1979 and 1980 the World Bank under the auspices of the Baringo Pilot Semi-Arid and Arid Lands Programme (BPSAAP) and in concert with the Ministry of agriculture and Livestock Development funded a number of development projects aimed at raising the standard of life for the ASAL people. Earth dams were constructed to harvest the seasonal rainfall run-offs and where boreholes were sunken diesel pumps were installed (GOK, 1984). These efforts ensured adequate availability of water supply for the domestic livestock and the people. The quality of the water was not viewed as important as its quantity. At least the availability of water helps to reduce many health problems facing the people irrespective of the quality (District Public Health Officer, Personal communication, 2010).

Although, this approach appeared to realize the set objectives, it was later blamed for creating dependency. It failed to capture the people's innovativeness and creativity because of adopting a transformation approach to the traditional resource management systems. It was also criticized for introducing new technologies of water harvesting and development but failed to empower the people in terms of relevant training to ensure sustainability of the technical equipment (CARE Field officer, per. comm., 2010).

4.9.3 Group Ranches Triggers Change in Land Tenure System

As early as 1945 the colonial government laid down an institutional framework under which the African grazing land would be managed, in order to reduce overgrazing

and allow pastoralists to embrace advanced husbandry practices. Accordingly, the African Land Development Board (ALDEV) was established to develop sound techniques to replace nomadic pastoralism with a more sedentary life style and economy (Veit, 2011). The ALDEV's main aim was to search for possible land use systems that were compatible with the rangelands environment (IDS, 1975). Group ranches were mooted. The attractiveness of group ranches was that they were to embrace management and organizational skills based on the western cattle ranches. This was not only going to improve the lowland habitats, but it was also going to minimize transhumant tendencies and encourage de-stocking. The boundaries were therefore drawn, and grazing blocks curved out (Lusenaka, 2002).

In 1965, the government commissioned an inquiry into "Land Consolidation and Registration in Kenya, 1965-1966." Known as the "Lawrence Report", it concluded that group registration of land, rather than individual registration (which the government was pursuing across Kenya), had greater relevance to range areas (Veit, 2011). The Land (Group Representatives) Act 1968, which vests title to land in group representatives, was therefore passed to provide a legal foundation for the establishment of group ranches in these areas (Coldham, 1982). However, the group ranch concept faced several problems that disabled full realization of its intended goals. For example, as the process of registering group ranches gained momentum, attributes such as equitable distribution of key pastoral resources were not observed (IDS, 1975).

Furthermore, many of the more productive areas within the ASAL, such as upland peripheries and wetland niches, fell under individual group ranch and/or private control. In other words, many group ranch committees failed to fully represent the

collective interest of the community. Hence, some ranch members with seniority, influence, business acumen and education were able to gain title deeds to individual ranches from the group domain-often taking the most productive land (Grandin, 1991). Consequently, critical natural resources that formerly provided common dry-season pasture and browse were no longer accessible to all pastoralists creating fertile grounds for resource use conflicts.

Furthermore, non-availability of free grazing land restricted free movement of animals causing overgrazing. The situation was exacerbated by the fact that the number of stock continued to increase as outlets for external grazing areas declined. The expected management process of de-stocking (Akiilu and Wekesa 2002) that was to accompany group ranch formation did not augur well with the traditional values attached to animal keeping in the pastoral communities. The planners imported an idea that was successful in North America but failed to seek the rationale of the traditional pastoralist systems. For instance, importance attached to livestock as a store of value, wealth and social status was not incorporated in the whole process of planning and implementation of the program (Roba and Witsenberg 2004).

That notwithstanding, the subsequent periods witnessed formation of more and more group ranches not only in Baringo but also in other areas where nomadic pastoralism was a predominant land use system. This so to speak, created and widened the socio-economic gaps among pastoralists. Groups that gained ownership of land that was better endowed with the natural biotic resources raised healthy and productive animals, and members who found themselves in environments lacking in most of the natural resources needed for the good management of livestock remained poor.

The emergence of the group ranches, therefore, marked the beginning of a revolution

in the social cultural and political organization of the pastoral people. The hitherto sense of oneness and common ownership of land resources slowly gave way to group goals and eventually to individualized desire to own land. A strong class society was in the making whose manifestation was visible in the way individuals responded to shortage of pasture as alienation of the common land was taking place. Each social class did not only respond differently to occurrences such as drought but its perception of livestock as a form of livelihood and as an item of trade also differed. For instance, it was revealed that during the dry season the rich pastoralists, given their strong financial base would hire herdsmen to move their animals across the landscape to distant lands in search of pasture. The poorer pastoralists who have low financial ability to hire herdsmen were forced to utilize the same grazing areas irrespective of the season (Little, 1992 Lamprey 1978 Anderson, 2002, Veit, 2011).

The idea of group ranches triggered and stimulated the concept of individualization of land in the ASALs more and more people sought individual entitlements to land, as the authority of traditional institutions diminished in the face of modern institutions of government. It is quite common today, to encounter people together or singly seeking demarcation of their jointly owned land to individual-owned smaller plots of land (Marigat, ASAL Dev. officer, 2010). He further added that aggressive individuals gained land through informal claim to land ownership, demarcation and fencing of a plot of land.

Although officially unrecognized, this people driven 'private' ownership system continues to gain momentum, especially in the dry land areas of Baringo where Group Ranches are dysfunctional and administrative and ethnic boundaries remain ill-defined (Kareri, 2007). The process of privatization of land appears to succeed more

where permanent crop-cultivation, under irrigation has become a norm. In the long run the land tenure system may acquire a double identity; whereby Trust land go hand in hand with free hold private land under animal grazing and crop-cultivation respectively.

Innovative methods of rehabilitating the dry lands by providing more water through various water harvesting methods such as rock and roof catchments, are allowing farmers to adopt animal husbandry practices that are commonly found in the high land wetter areas. The Ministry of Water and Irrigation has taken up the challenge by training members of the local women groups on how to construct water harvesting structures, to tap flash floods common in the area for cultivation of short season crops and grass (Marigat agri. officer-Mr. Matetai per. comm. 2010). Mr. Matetai added that the availability of reliable source of water coupled with adoption of a new system of growing fodder crops including *Cenchrus ciliaris* (African Foxtail) and vetiver grass has revolutionized animal husbandry in these semi-arid lands.

The most notable change is adoption of zero-grazing, in areas where free grazing was a common practice. These changes have been attributed to the women's groups' participation in livestock keeping, an activity that was hitherto a preserve of the male gender. Mr. Matetai explained the steps followed by the women groups to achieve their goals. "First a single women group would fence out 6 acres of grass land to protect it from unplanned grazing. During the dry season they would buy small bulls and fatten them by feeding them on the protected grassland. On maturity, in about six months the animals would be sold to meat merchants, at prices that economically justify their efforts. Alternatively the protected grassland would be processed into grass bales for sale during the dry season".

4.9.4 Lake Bogoria Nature Reserve and Wetlands Protection

Another important land mark in this development effort was the creation of the Lake Bogoria Game Reserve in 1970 (LBNR, 2007). The nature reserve was to serve the twin purpose of nature conservation and tourist destination. Tourism promotion was to attract financial capital to develop infrastructural facilities and hence create employment, outside the traditional pastoralist economy. Unfortunately, the creation of the Lake Bogoria Nature Reserve meant displacement of the Endorois community from their ancestral land (Keter, et al 2012).

The lake Bogoria and the surrounding areas were special sacred places for traditional worship, rituals and other cultural activities conducted by the Endorois community. Local myths have it that, the lake came about when the original inhabitants of the place (Bogorians) were swallowed into the ground, because of their failure to sacrifice to the gods. The hollow that was created filled with water to form the lake (Komen, Lake Bogoria Education Centre, 2010). It is not surprising that the demise of so many people at this spot qualified it to sacredness. Hence, the creation of the Game Reserve denied the Endorois access to their sacred place of worship. It was also a loss of indigenous nature conservation practices of the Endorois people who had protected the fauna and flora of the lake from time immemorial for posterity.

In 1981 the management of the lake Bogoria Game Reserve was taken over by KWS, and in 1989 the Baringo county council was vested with the responsibility to care and maintain it. But in 1996 Baringo district was divided into Baringo and Koibatek districts. Thus two county councils, with the support of KWS, NMK, jointly carried out the management of the reserve. WWF was also incorporated in the management team at an advisory level. In 2001 the wetland was declared a Ramsar site. That is a

wetland of international importance. A number of factors qualified it including, an extensive swamp home to 210 plant species dominated by acacia sp., wintering site for over 50 migratory birds-making it a world heritage. It has over 30 resident bird species (Senior Warden, Lake Bogoria Game Reserve, 2010).

The Act under which the game reserve was established outlawed its other uses different from wildlife conservation. The pastoralists were hence denied access to yet another dry season grazing land, thus progressively restricting their mobility. Ecosystems Ltd (1982) in a similar study noted that, "whenever the land users are denied the use of what is purportedly their land; they look upon it covetously and are unhappy with such conservation laws" (The colonial conservation law that was coercive and hence highly resented by people). It is not surprising that local people still regard this zone as one of their rightful grazing land (Mr. Biwott, Personal Communication, 2010). This provides a classic case of conflict between man and wildlife. Centered on the one hand the need for more productive grazing land and on the other the need to protect and conserve the habitat requirements of wild animals.

The conflict was accentuated by the fact that whereas the pastoralists were denied access to dry season grazing areas in the national reserve, the wildlife were free to disperse over and graze out of the reserve particularly during the wet seasons. Thus, the pastoralists' herd and wildlife shared wet season grazing land, but were denied access to areas reserved for wildlife (Campbell, 1978). The unprotected wetlands outside the national reserve, therefore, continued to sustain pressure from dry season grazers whose alternative sources of dry season forage were limited. The pastoralists, unable to reconcile the apparent discrepancy between their concept of communal land and the new concepts of private property and reserved wildlife sanctuaries sometimes

became hostile and forcibly grazed into the reserved areas (Mr. Bundotich, Per.Communication, 2010).

It is due to such reactions that some form of agreement was entered between the KWS and the local County Councils, whereby, some percentage of the gate collections could be ploughed-back to support local development initiatives. These include cattle dips, schools and dispensaries. This was to act as one way of compensating the pastoralists for the loss of their dry season grazing area. The pastoralists were also to be allocated some carefully selected parts of the national reserve for dry season grazing where they would also obtain salt licks (Mr. Komen, LBNR Education officer, per. comm. 2010). Grazing is done under strict regulation to ensure minimal contacts between wildlife and the domestic animals in order to control the spread of ticks and other animal diseases. The Worldwide Fund for Nature contributes by paying for acaricides to be used for spraying the pastoralist's livestock as they graze in the game reserve (Mr. Koros, WWF 2010).

4.9.5 Chapter Summary

This chapter has laid down background information on the characteristics of the study area, covering such aspects as the physical, historical and socio-economic attributes. The human population totals, population growth trends and infrastructure facility and services and historical and future prospects for the region’s economic development have reflected a picture of a modernizing economy. Consequently, the economy of the region is shifting away from dependence on pastoralism to irrigation crop-farming. The government has been in the forefront in driving these changes, through the instruments of policies; aimed at affecting and influencing the livelihoods of the ASAL inhabitants.

CHAPTER FIVE

DATA ANALYSIS, RESULTS AND DISCUSSIONS

5.1 Introduction

This chapter forms the bedrock of the study. It is an answer to our research objectives and the corresponding research questions. It starts with a historical exposition of the nature and causes of land use/land cover change. Hence a historical approach has been adopted at the outset to provide essential information on factors that together or singly contributed significantly to the land use/land cover changes. Krupnik and Jenkins (2006) argue that, any responsible study of human systems must start with a historical and political understanding of the forces that have shaped the physical and socio-economic environment. However, in order to enhance our understanding of the nature and causes of land use change investigations have been carried further by interrogating the land users' perception and practices of land use.

It is with that understanding that this chapter was written with a view to offering a deeper and detailed analysis of the evolution of the current land use systems in both the Baringo lowlands and the upper river Waseges catchments. The chapter combines historical data with current understanding in an attempt to show how these phenomenal changes have ultimately affected the health and stability of the wetlands in the study area. To confirm and quantify the spatial temporal land use/land cover changes, satellite imageries covering over a period of twenty years from 1986 to 2006 were analyzed in ArcGIS 9.3 and the resulting LULLC patterns mapped. For reasons of convenience, the study has been divided in two major sub-sections, one examining land use practices in the upper River Waseges catchment and the other devoted to analysis of land use practices in the Loboi Plains.

5.2 Socio-economics Characteristics of Respondents in the Upper River Waseges

The field survey was done following research protocols outlined in chapter three. The main outputs of the research including; age, gender, level of education, occupation, and place of birth and other traits of the household head were displayed in tables, bar-charts and graphs. These variables together with site specific conditions, according to Briassoulis (2002) influence the choice of land use and decisions to change it.

5.2.1 Gender, Age and Education Level of the Respondents

The gender coverage was skewed towards the male at 34 males against 23 females interviewed. This partly explains the dominance of male gender on important farm management decisions. Table 5.1 below explains the distribution of respondents according to their age groups and education levels. Both age and education levels have been known to have a strong correlation with labor productivity (Gobel and Zwick 2011, Chevalier et al 2004).

The respondents were classified into five groups of age: 20-34 years old; between 35-49 years old; between 50- 64 years old; between 65-79 years old; 80 years old and above. There were no respondents under the age of 20 years old. All the respondents were officially classified as adults. Majority of the respondents numbering 51(or 89%) were within the active age bracket between 20-49 years of age. Only one respondent was over 80 years old and was the only one who claimed to have been born in the region.

Similarly education was classified into Primary, Secondary, Tertiary and University. All the respondents had at least primary level education. According to Becker (1994) literacy brings a positive impact on people, in the sense that it helps to increase their productivity, income and awareness of benefits of a healthy environment. A literate

people, therefore, have the ideal qualities that provide a strong basis for economic development of a region. Unfortunately, literacy levels in Kenya's rural areas are low, particularly among female farm managers. This adversely affects not only farm productivity but also care and maintenance of environmental goods.

Table 5.1 Age and Level of Education of the Respondent

Age Group	Level of education				Total
	Primary	Secondary	Tertiary	Varsity	
20-34	5	12	13	7	37
35-49	3	3	6	2	14
50-64	0	0	1	1	2
64-79	3	0	0	0	3
over 80	1	0	0	0	1
Total	**12**	**15**	**20**	**10**	**57**

Source*:* Author's field data (2014)

5.3 Nature of Land Use/Cover Changes

5.3.1 Introduction

The first objective of the study was to examine the nature and magnitude of land use/land cover changes, their related causal factors and consequent impacts on the lowland wetlands. Land use change is hereby viewed as the transformation of land use/cover from one form to another. A number of factors may be associated with land use change. We have isolated population growth and movement, governmental land use and development policies and market forces as the main land use change driving factors.

To have a fuller understanding of the land use changes in Loboi Plains and the adjacent highlands, it was imperative to view these changes from a historical

perspective. Two historical approaches employed here include; a review of data and related information on the evolution of land use changes supported by an analysis of digital images taken in 1986 and 2006. It is instructive to note that the study area in common with other regions of Kenya has had a history characterized by a socio-politico-economic system closely tied up with external influences; including colonialism and the global capitalist economy; hence no study of this country would be complete without gaining insights of these two realities.

The colonial occupation and settlement in the study area greatly modified the ecology of the land as well as the pattern of human settlement. The colonial government policies were formulated in response to the need of the European settlers, as demonstrated by the 1939 Act of Parliament which created exclusive areas of white settlement (Okoth-Ogendo, 1991). The Kenya (Highlands) order-in-council and the Kenya (Native Areas) order-in-council were enacted clearly defining those areas that were to be reserved and utilized solely for the benefits of people of European descent, and those areas that were to be reserved and utilized for the benefit of the indigenous people (Odingo, 1978). This led to massive displacement of the indigenous people and confinement of others into what were referred to as “native reserves”

At independence Kenya inherited a skewed economy characterized by unequal ownership of the means of production including land. It was therefore, inevitable to redress these inequalities; through a two-prong land reform policy. The idea was to transform customary rights and interests in land to statutory rights and interests in land in the former “native reserves” and simultaneously transfer land from foreign to indigenous ownership, through the resettlement programme in the highlands (Maina 1969, Okoth-Ogendo 1991, Kariuki 2009, Ghai, 1979).

Although the implementation of land reform policy was a noble idea, it turned out to be an outlet through which people acquired the hitherto unoccupied forest land. The forest areas including the critical water spots of the Bahati and Marmanet were slowly opened up for human settlement under pressure to fulfill political promises (KFWG, 2001). Thanks to a political system that has used land to build alliances and loyalties in advancing its patrimonial interests (Kariuki, 2009), massive excision of the forest land took place in the 1990s, as population pressure added another dimension to the political demands. The government began to allocate forested land to the landless, culminating in the decision to de-gazette significant portions of Kenya's forest land (Wanyeki, 1981).

5.3.2 Respondents' Perception of Land Use and Land Cover Changes

This section of the study confines itself to people's perception of the land use changes in the Upper River Waseges catchments, in the pre-independent and post-independent periods. The former is represented by observations of inhabitants who were already settled or were settled in the region at independence. Table 5.2 and the corresponding figure 5.1 show the number of respondents who were either born or not born in the region but were finally settled in what was either forest land or former white settlers' farms. It is important to note that there were two groups of post-independent settlers, previous farm workers-turned squatters, left behind by white settlers and a new group settled here from other places.

Table 5.2 Place of Birth and Date of Settlement in the Location

		Year Settled				Total
		1960's	1980's	1990's	2000's	
Born in this area	Yes	1	12	7	4	24
	No	2	7	13	11	33
Total		3	19	20	15	57

Source: Author's field data (2014)

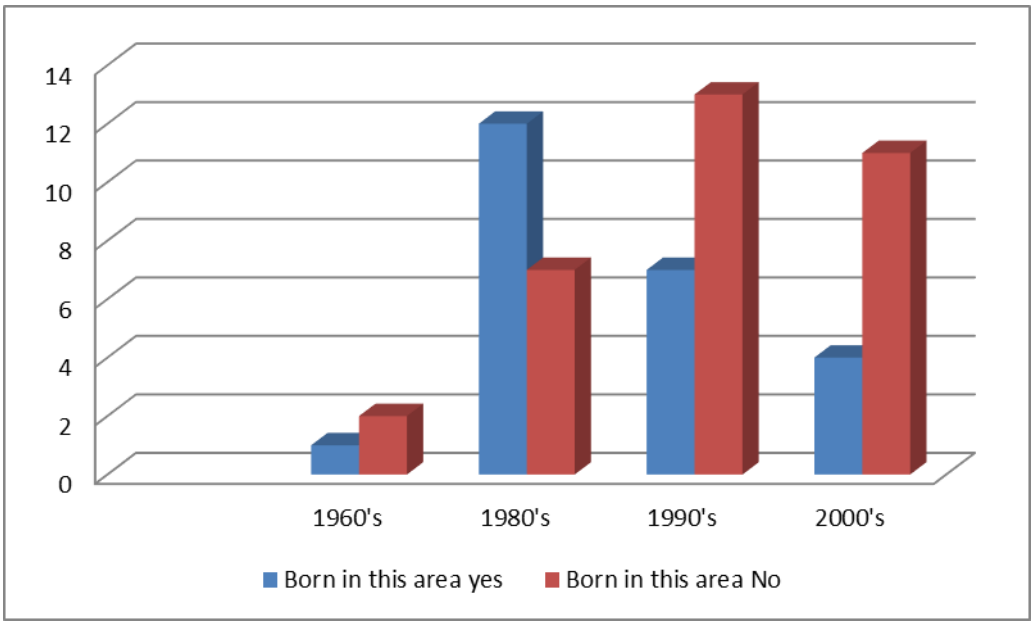


Figure 5.1 Year of Settlement for Indigenous and Immigrants

Source: Author's field data (2014)

Land ownership in the region was almost fully owned by colonial white settlers during the pre-independence period. Only three of the respondents claimed to have been settled here as way back as the 1960s. Further probe revealed that they were squatters on a large farm that was owned by a colonial settler. They were allocated the plots of land by their former employer as a token of appreciation. Later the independent government registered the plots of land, giving the land users, the legal statutory rights of ownership.

According to our survey, the period before 1980 experienced only a moderate rate of emigration, but between 1980 and 2000, 54.4% of all the people interviewed came into the region. This was a massive influx that inevitably had to have notable environmental impacts, as evidenced by people's perception of changes in land cover, tracing it back to the days of their early settlement. Table 5.3 and the accompanying figure 5.2 indicate the number and percentages of responses on the type of land cover respondents perceived to have been more prevalent at the time of their first settlement in the 1960s, 1980s, 1990s and 2000s

Table 5.3 Perceptions of land cover types at the onset of Settlement

		State of land at the time of settling					
		Woodland	Forest land	Bushed grassland	Grasslands	Bare land	Total
Year Settled	1960's	0	3	0	0	0	3
	1980's	2	10	3	4	0	19
	1990's	2	6	6	4	1	19
	2000's	0	1	4	10	0	15
Total		4	20	13	18	1	56

Source: Author's field data (2014)

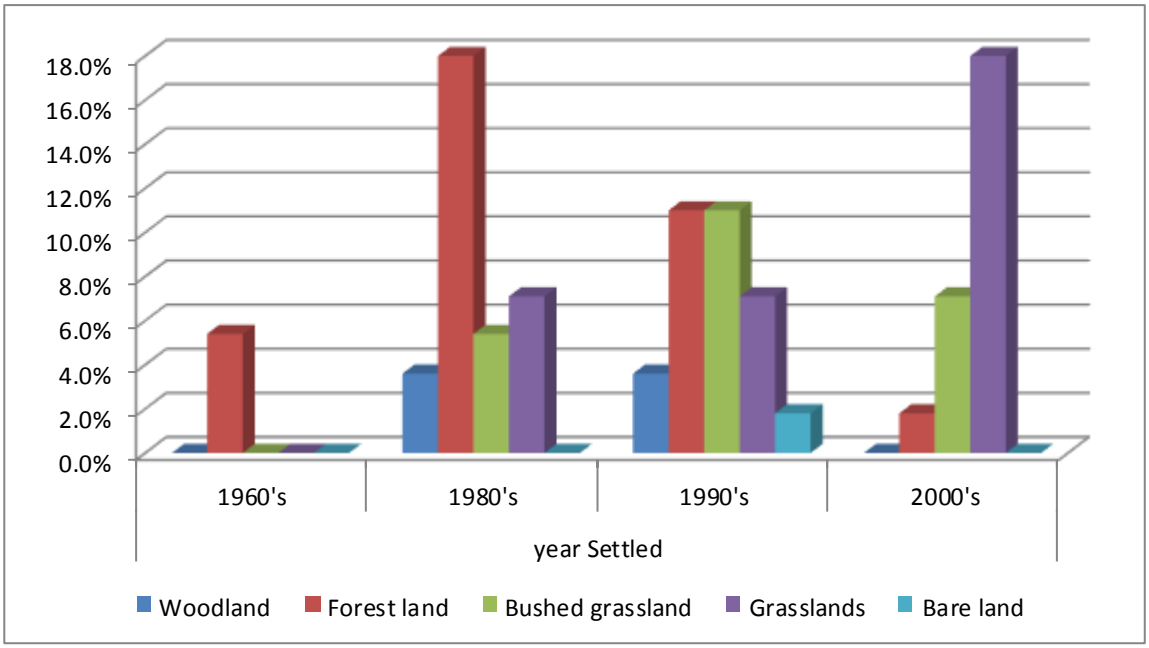


Figure 5.2 Perceptions of Land Cover Types at the onset of Settlement

Source: Author's field data (2014)

In the 1960s the few people who were settled then, saw a landscape dominated by thick forests. This perception was shared by the people who were settled in the 1980s also. The only difference is that some people in the 1980s identified other land covers, besides forests as having had an equal dominance. Observations from subsequent settlers in 1990s and 2000s were that the forests had declined, giving way to other land cover types, such as woodlands and bushes. In a very big contrast to the perceptions of the 1960s settlers, the people who were settled in 2000s saw more grasslands than forests.

As population grew demand for subsistence rose as well. This resulted in land pressure and a desperate search for more land. Even the government-supported "shamba system" could not ameliorate the situation, because of its heavy toll on the forest ecology. The period after political independence witnessed massive settlement

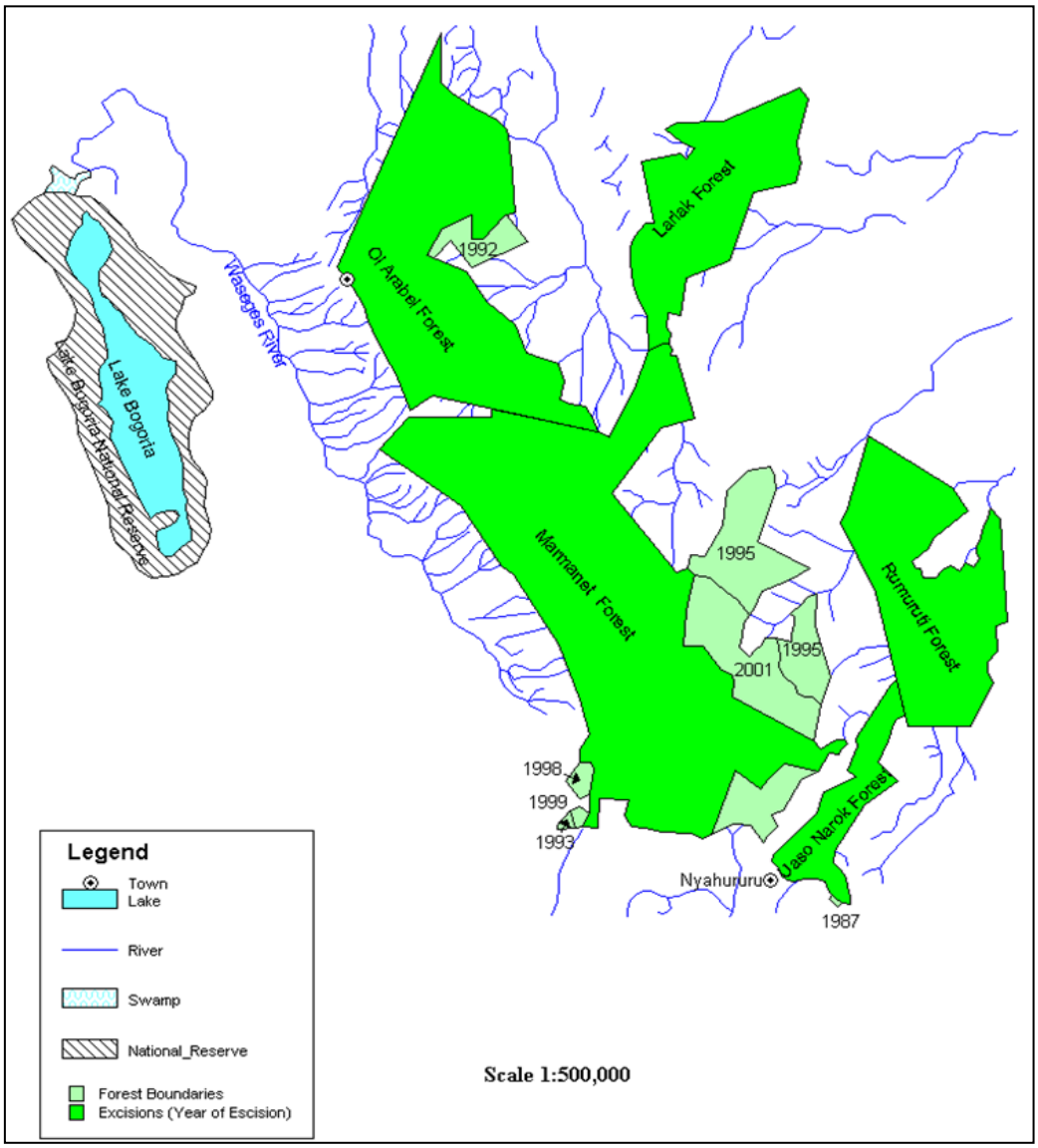
of people on unprotected forest land coupled with encroachment on protected forests under the guise of the "shamba" system culminating in land use/land cover types as seen in plate 5.1

Plate 5.1 Land use in the Subukia Valley: The "white" appearing surface in the background is an expansive green house and the foreground shows well-parceled crop- land co-existing with pockets of forests (15/05/2006, photo).

Excision of forest land and resettlement of people for various reasons including politics continued into 2000s. The Kenya Land Alliance (KLA, 2007) corroborates this by noting that "between 1990 and 1995, forest cover changed by about 17% with an average loss of 3% per year largely because of settling the landless people. KLA confirmed, also that some of the forest blocks were acquired illegally by politically influential persons who already owned land". It had become a norm for the political establishment at the time to facilitate the rich and the politically well-connected to acquire public land at the expense of the landless. In Figure 5.3 we note that a high percentage of the re-settled people were neither born in the region nor did they ever live there.

World Resource Institute (2007) Analysis of satellite images show that Marmanet forest had a gazetted area of 20,446 hectares, by 1990, however due to forest excisions and other illegal encroachments the forest had lost 7,052 (34%) hectares of land to other land use types by the year 2000. Map 5.2 below shows the progressive excision of various forest blocks in the 1990s as the government implemented the re-settlement programme, in response to the growing demographic and political pressures.

The same source shows that between 1963 and 1969, only 0.91 hectare of Marmanet forest land was excised. However, the 1990s witnessed massive excisions. In ascending order, Marmanet lost 45.60ha, 1,773.5ha, 213.56ha of forest land in 1993, 1995 and 1998 respectively. The excisions of the 1990s were done under the pretext of boundary alterations (Matiru, 1999), but we believe the more pressing reason was the need to fulfill political promises of resettlement made during political campaigns. It is instructive to note that two major national elections of the period were held in 1992 and 1997; a time that witnessed massive excisions of Kenya's forest land.



Map 5.2 Forest Excisions 1987-2001(Modified from GOK, 2002)

Besides, the losses of forest cover through excision, forests were further degraded by the implementation of the "shamba"system. The introduction of the "shamba" system in Bahati forest was viewed as a symbiotic approach to forest management whereby people were allowed to use forest land for crop-cultivation as they tended the tree saplings (Sinange, 2010). This form of forest management traces its origin to the Southern American Taungya system. The Forest Department introduced it in Kenya in 1943 to minimize costs of re-establishing plantation forests (Wanyeki, 1981). However, their costs on the forest ecology were found to be too high. According to

Kagombe and Gitonga (2005), the system had initially shown signs of success but due to mismanagement it failed to establish new plantations and, instead encouraged destruction of natural forests.

The researcher encountered clusters of human settlements at the edge of the forests at the time of this research in 2014. These people, besides utilizing forest products for their livelihoods are to blame for much of the illegal deforestation activities. Their proximity location to the forest acts as suitable conduit for enabling extraction of forest wood to be used either directly in its raw form, or to be processed into charcoal.

5.3.4 Growth of cultivation Agriculture in the River Waseges' Catchments

The region under study has a history characterized by different periods of land occupation and use. A casual observation over the landscape reveals a zone typical of old and permanent settlements co-existing with relatively newly-ploughed small scale farms. Twenty five (or 44%) of all the sampled farms were less than 2 acres and only eight (or14%) of the sampled farms were over 5 acres.

The smallness of the pieces of land may be explained by the initial allocation which did not exceed five acres. But through time, population growth rate coupled with commercialization of land has also led to sub-divisions of land into smaller land holdings. The diminishing farm sizes have serious implications on food security and environmental sustainability. Table 5.4 below shows that slightly more half (50.9%) of all farming activities reported by the respondents of upper River Waseges region were cash crop production. Horticultural crop-cultivation constitutes the major farm activity. A number of factors including availability of irrigation water and a large market have contributed to the success of commercial farming in the region.

Table 5.4 Agricultural Activities in the Upper River Waseges

Agricultural Activities	Frequency	Percent	Cumulative Percent
Subsistence crop cultivation	11	19.3	19.3
Cash crop cultivation	29	50.9	70.2
Livestock keeping and crop cultivation	17	29.8	100.0
Total	57	100.0	

Source: Author's field data (2014)

River Waseges and its tributaries is main source of irrigation water. The river traverses through high-density population zones before it drains into the lake Bogoria via Kesubo swamps. All along its course individual landowners have abstracted its water for small and medium scale irrigation activities. It was reported that there were 3,000 generators in 2010 pumping water out of the river Waseges, at the rate of $5m^3$/sec.(Kimei per comm., District Agricultural Extension Officer, 2010).

There are two categories of abstractors; the registered and non-registered. All Water abstractors are expected to be members of the local Water Resource User Association (WRUA). However some farmers choose not to join the WRUA, mainly because they would wish to use the river Waseges waters without any control or regulations. Therefore, one group is regulated by the by-laws of the WRUA, but the other is not. The latter operates as a sub-cultural group that applies unorthodox methods to withdraw water from the river. There are a number of techniques this sub-group uses to withdraw water including two that stand out; portable diesel pumps and erection of simple barriers, mostly made of stuffed sisal bags, stones and twigs to divert water to their farms.

Unfortunately, this high withdrawal of the river waters in the middle and upper catchment areas of River Waseges creates water shortage to the downstream users, who are also engaged in irrigation crop production besides animal husbandry. Furthermore, the river is the main source of fresh water supply for the Kesubo swamp and wildlife in the riparian forests. Therefore, reduced water flow adversely affects the ecology of the swamp and biodiversity of the riparian forests (Kimaru, Pers., communication 2010).

The Regional Manager of WRMA in charge of the South Rift Valley, Eng. Omuya (2010) gave us an account of the challenges involved in attempting to ensure water is available to all farmers within his jurisdiction. He noted that, during the dry season (January-March) land users downstream suffer serious cases of water shortage, triggering conflicts between the lowland pastoralists-cum farmers and upstream land users. The lowland pastoralists-cum farmers often seek to restore the water flow by forcefully removing water barriers erected by the upstream land users. These actions of the pastoralists-cum-farmers are misread as acts of aggression by the upstream farmers. This confrontation often erupts into physical confrontations that may invite external intervention noted Eng. Omuya.

5.3.5 Section Summary

In summary, the land use changes that occurred in the upper River Waseges catchment areas trace their causes to the colonial occupation of the land of Kenya. This foreign administration not only disturbed the settlement patterns but it also changed the meaning previously attached to land resources. Commercialization and commodification of land, culminated into population displacements, creation of land hunger and over-intensification of land use leading to land degradation. The post-

colonial government pursued development from a stand point that was not radically different from what was inherited from the Queen's government. Forests and rangelands were opened up for human settlement as was done by the colonialists, the difference being that this time it was in response to population and political pressures. But the result was the same: land degradation. Unfortunately, the settlement of people on the former forest land disturbed the known protective functions of forests. Reduced vegetation cover, not only undermined the capacity of water to infiltrate into underground aquifer but it also opened the land to erosive agents of wind and water.

5.4 Deforestation, Soil Erosion and Wetlands Loss

As deforestation in the upper catchments of River Waseges intensified, it was expected that this would have visible impacts on the lowlands wetlands. The guiding question was; what is the impact of land use changes in the upper catchments on lowland dry lands wetlands?

Land use changes in the upper river Waseges catchments involved mainly opening up of forest areas for permanent use in crop-cultivation and animal husbandry; leading to massive deforestation. Deforestation and other land use changes tend to raise the proportion of the land surface that becomes vulnerable to erosion and therefore, it indirectly contributes to siltation of water reservoirs, dams, rivers and lakes. Hence, land use activities in the upper catchments of the River Waseges that may encroach onto the forests are likely to disturb the hydrological balance between the highlands and the lowlands (McDonald, et al 2002 and McDonald, et al 2003).

A UNEP (2012) report provided a wider picture on how deforestation affects water yield levels during and after the rain seasons in Kenya's water towers. According to the report: as a result of Kenya's "long rains" (March to May) and "short rains"

(November), dry or low flow seasons occur in January-February and June –October. Therefore, increased runoff in a deforested land occurs in March to May, and November. Heavy flooding often occurs during these wet seasons. However, the period between June and October, experience low flows as shown in figure 5.8 below, and hence water shortage becomes a major constraint to irrigation farming.

During the wet season (March to May) cleared forest lands have higher water yield than an equivalent piece of land that has an undisturbed forest. In the subsequent period (June to October) very low stream flows are observed in the cleared forest, whereas the intact forest retains a moderate stream flow. Brujnzeel (1989) corroborates this finding and underlines the fact that clearance of tropical forest land and conversion to other types of land use, leads to an increase in total (annual) stream flow, whereas maintaining an undisturbed forest cover moderates peak flow rates. Consequently, ground water recharge has decreased, with streams drying up more often during the dry seasons, while they cause flash floods during the rainy season (Odada, Onyango and Obudho, 2004).

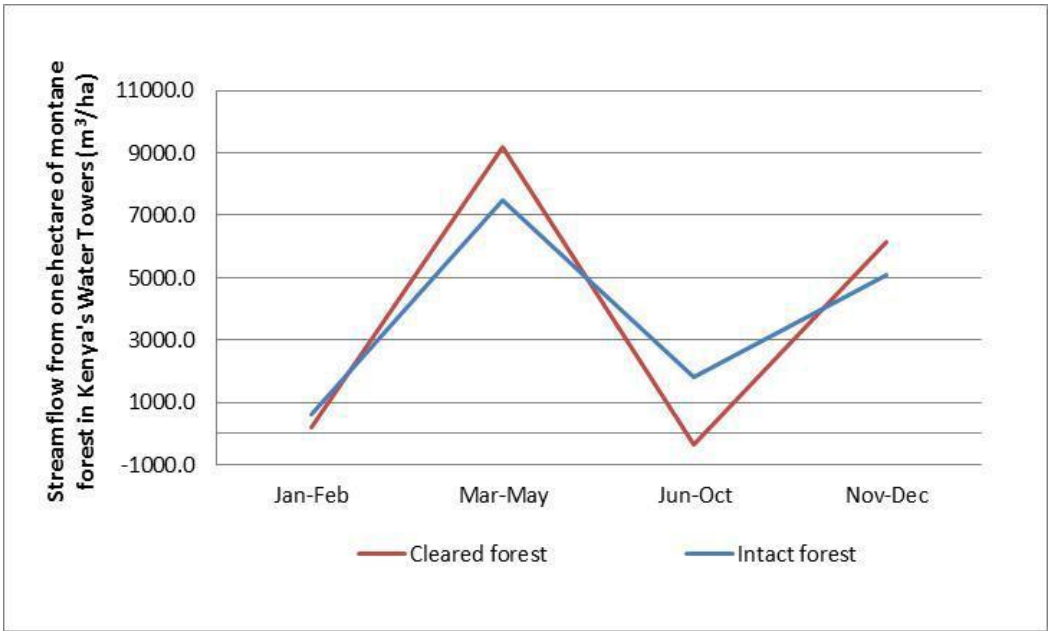


Figure 5.3 Changes in long term seasonal flow distribution off one hectare of intact and cleared Montane forest areas in Kenya's Water Towers (adapted from UNEP, 2012)

This phenomenon is best illustrated in plate 5.2, taken at gauging station 2EB05 on river Waseges, whereby water flow is shown to be high during the wet season but diminishes to zero flow during the dry season. The plate on the left shows River Waseges during the Wet Season flowing with water, whereas the plate on the right shows the same river during a dry season having turned into a dry river bed.

Plate 1 wet season **Plate 2** dry season

Plate 5.2 Flow of the river Waseges during the Wet and Dry Seasons. (Photo courtesy of WWF, 2007)

The seasonal fluctuations of River Waseges downstream can partly be attributed to deforestation in the upper catchment areas and partly due to abstraction for irrigation purposes. Once deforestation takes place the land losses the protection against surface runoff that forests provide. Macdonald, et al (2004) have highlighted the important role of forest litter in controlling splash-induced soil erosion, as it encourages rainfall infiltration, contributing to ground water recharge, that enhances dry season flow. However, after forest clearance more water is available both due to less interception but also due to a reduced evapotranspiration surface (Johansson and Svensson, 2002).

5.4.1 River Discharge in 1963 compared to River Discharge in 2006

Before Kenya's political independence (1963) the upper River Waseges catchment areas were said to have a healthy forest vegetation cover. But, by 2006 the study sites had lost about 8,789 acres (4.61%) of forest vegetation to other land cover types. Since forest cover has the capacity to regulate river flow, an attempt was made to

illustrate how discharge at 2EB04 River Waseges gauging station, varied in the two periods of 1960 (undisturbed forest) and 2006 (disturbed forest). Table 5.5 shows that the monthly river flow was moderate at 11.45m3/sec. in 1960 but was very high at 25.73m3/sec. in 2006. In 1960 much of the land was covered by forests, whereas deforestation was prevalent in most of the land in 2006. Consequently, during the dry season (January to March) the river flow totals of 5.77 m^3/sec and 0.89m^3/sec were recorded for 1960 and 2006 respectively. Note that the month of August is the peak of the rainy season, as represented in figure 5.6.

Table 5.5 Monthly Discharges of Weseges River at 2EBO4 in m^3 per second

Year	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1960	1.73	1.52	2.52	1.83	1.80	1.81	2.42	11.45	7.11	3.41	3.00	2.11
2006	0.70	0.11	0.08	11.6	10.18	4.43	10.47	25.73	16.69	13.44	5.82	2.54

Source: WRMA Records of Discharge of River Waseges in 1960 and 2006: Nakuru

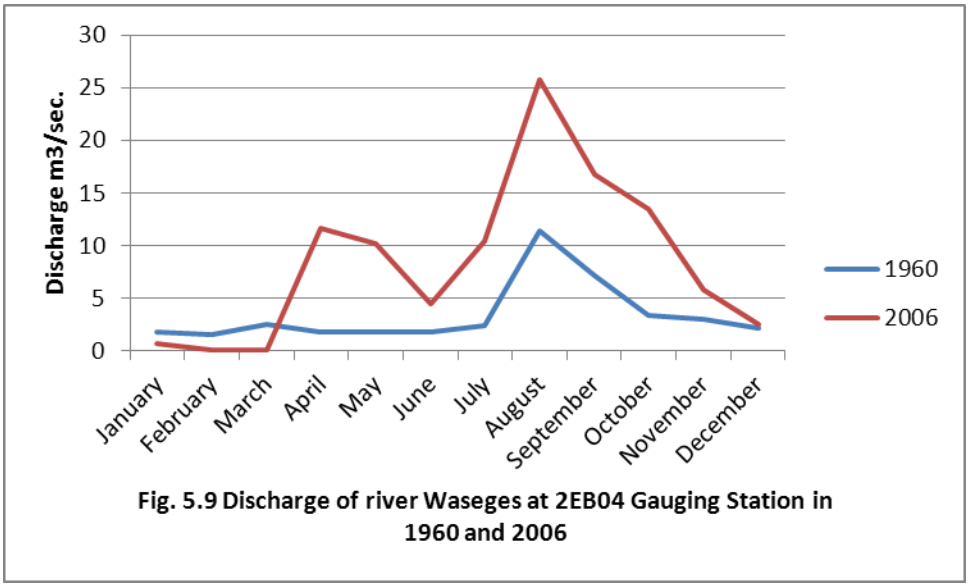


Figure 5.4 Discharge of River Waseges at 2EBO4

Source: WRMA Records of Discharge of River Waseges in 1960 and 2006: Nakuru

5.4.2 Soil Erosion and Downstream Sedimentation

In spite, of these known ecological benefits of trees, the natural and man-made forests are threatened by among other activities, wood harvesting for cooking and house warming. Data analysis showed that 87.5% of all the households in the study sites used firewood as their main source of energy for cooking, space heating and other household functions. Figure 5.12 below gives a representation of the various sources of wood fuel for the households.

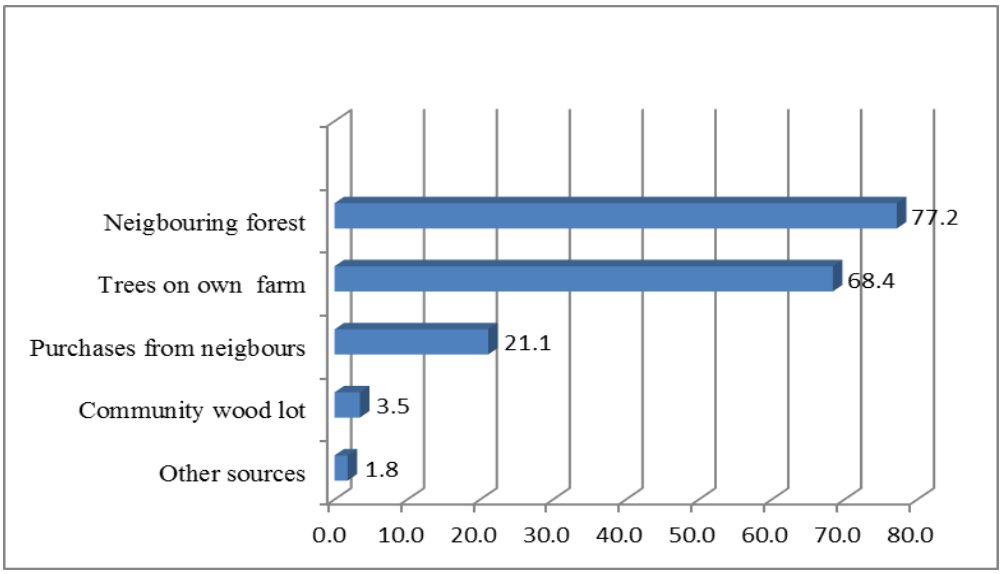


Figure 5.5 Sources of fuel wood for households

Source: Author's field data

It is evident that forests remain the major sources of wood fuel. Majority of the respondents (77.2%) were harvesting wood from the neighboring forest, whereas 68.4% had their own farm grown woodlots. The use of fuel wood and competition for agricultural land are; according to De la Paix, et al (2011), the main causes of deforestation, which leads to increased soil erosion and floods. McDonald, Healey and Steven (2002) added that, soil erosion results in gully development and shallow landslides that increase the sediment load in rivers and ultimately contributed to the formation of new sedimentary structures, including alluvial fans and deltas.

This severity of soil erosion has deepened through time in response to the destruction of vegetation cover in the upper catchments of river Waseges. The respondents were unanimous that soil erosion was very light ten years before the date of the interview. At least 76.8% of respondents recalled that soil erosion was light ten years before the date of the interview, but 47.3% of the respondents were of the view that it had become very severe and only 14.5% were of the view that it was still light at the time of the interview. It appears therefore, that as more people settled, land use intensity rose, reducing periods of fallow and possibly withdrawing attention from non-food production activities such as tree planting and other soil conservation efforts.

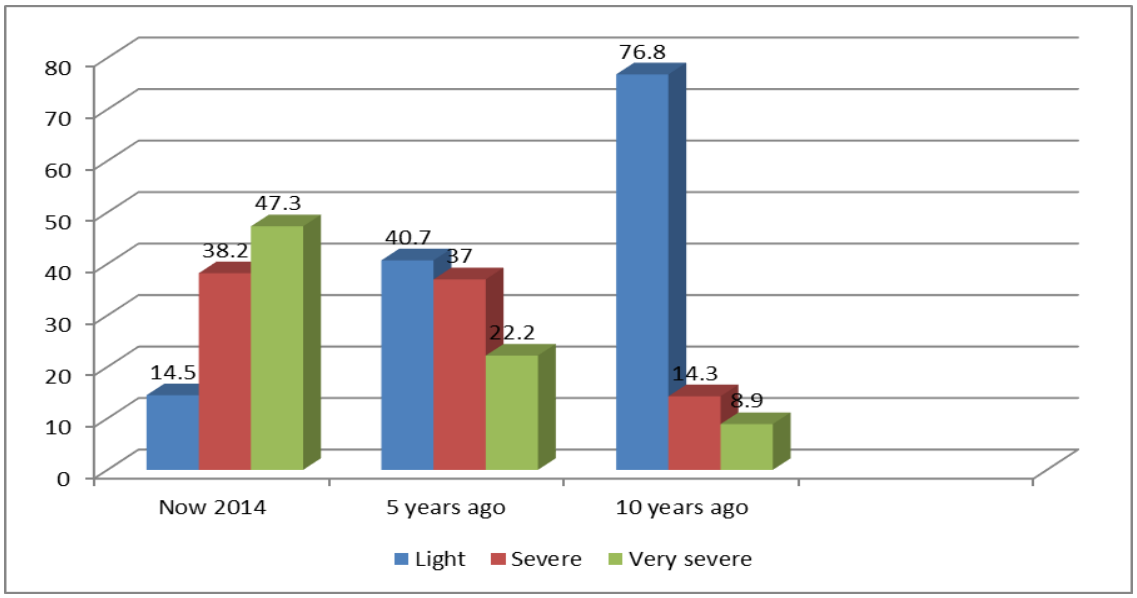


Figure 5.6 Perception of intensity of Soil erosion over time

Source: Author's field data

Soil erosion has the potency of reducing a one time productive land into a wasteland. The land users have both the responsibility and ability to control it. Therefore, the farmers' understanding of what causes soil erosion and what mitigating actions they would wish to implement is critically important. Thirty five percent (35.0%) of the

respondents blamed deforestation for the increased soil erosion and another set of 27.5% of the respondents blamed the rapidly growing population. Only 1.3% of the farmers blamed irrigation cultivation for soil erosion. Overgrazing (16.3%) and over-cultivation (20%) were other factors that were reported to have significant contribution to increased soil erosion.

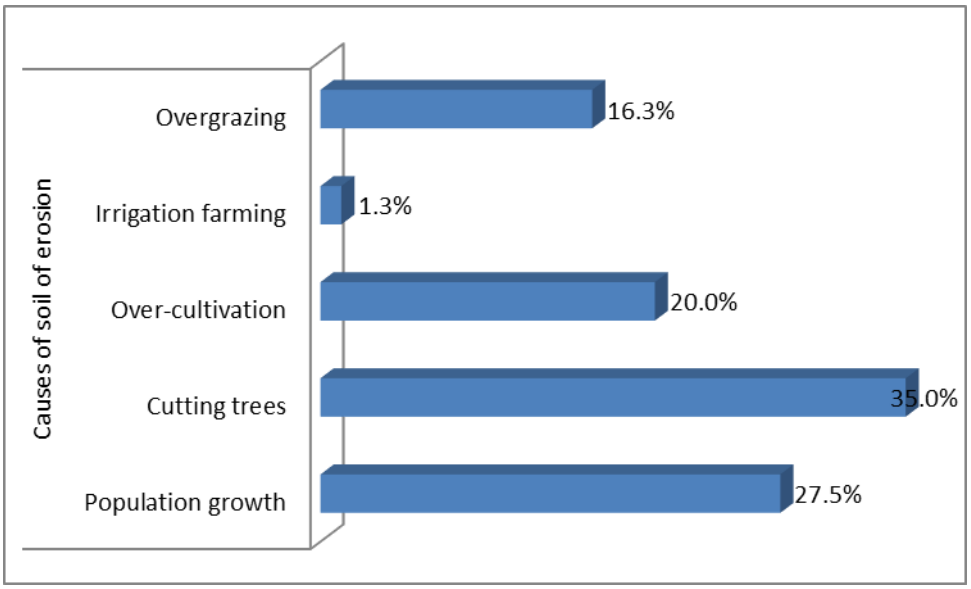


Figure 5.7 Perceived Causes of Soil Erosion

Source: Author's field data

Deforestation, in absence of other vegetation covers makes the ground more susceptible to erosive agents of water and wind. On the other hand a high population growth rate increases on land use pressure. Combined the two create far reaching and maybe irreversible environmental damage, in the absence mediating institutions and/or agencies.

Plate 5.3 below shows very precarious farming on steep slopes with scanty vegetation cover that is highly susceptible to erosion. The deep soils characteristic of the volcanic highlands are easily eroded in absence of protective measures. The fine silt is eventually carried downhill to river Waseges onto the Sandai fan.

Plate 5.3 Farming on steep slopes with scanty vegetation.

The loss of this valuable ecosystem is not only a local loss of wood supply but a global loss of services accrueing to forests. Deforestation induced by demand for human settlement and agricultural production has had its contribution to the change in the landscape. Not only has it led to the loss of biodiversity, but its contribution to soil erosion and siltation has added to the degradation of the lowland wetlands through suffocation of the wetland plants.

5.4.3 Summary of the Section

Land use/land cover change has altered the ecological character of the River Waseges catchment areas. Loss of vegetation cover in the upper catchment areas of river Waseges has been associated with seasonal fluxes in river discharge. Seasonal river flows is characterized by extreme variations; flooding in wet seasons and drying up in

dry seasons. The situation is exacerbated by raised levels of water abstraction for irrigation farming particularly during the dry season. Together these factors further reduce the dry season downstream river flow and increases the amount of silt deposited onto the wetlands during the wet season. Silt has ability to suffocate some wetland plants, hence ultimately contributing to their degradation.

5.5 Socio-economic Characteristics of the Respondents in Loboi Plains.

5.5.1 Introduction

The previous section examined the history of land use, land settlement and land cover change in the upper catchments of the Waseges River; covering Nyamamithi and Subukia locations. This section turns attention to land use and land cover change in South Baringo County dry land lowlands. River Waseges that flows from the adjacent highlands of Bahati and Marmanet forests provides critical source of water to this region. Availability of river waters has over millennia been associated with irrigation crop cultivation. Through time and under different influences many pastoralists have converted to sedentary agricultural crop production and animal husbandry.

The uniqueness of South Baringo lowlands is marked by the presence of an expansive swamp, which is centrally located in the plains called the Loboi swamp plains. Adjacent to Loboi swamp is the Kesubo swamp. A question of how the changing land use may have affected their ecological integrity is a central concern of this study. The following sections bring together analysis of land users' responses (enriched by secondary data) on various aspects of history of land occupation, dynamics of land use change and its consequential effects on the peoples' livelihoods and wetlands

5.5.2 Sampling Frame in the South Baringo County Lowlands

Since the research question sought to provide a fuller understanding of how the changing land use practices were affecting the ecology of the wetlands, it was important to interrogate all the land users engaged in crop-cultivation and animal husbandry. The study sites in South Baringo lowlands fell under Marigat administrative district covering Sandai, Kapkuikui and Loboi locations. The people in these localities have fully embraced sedentary lifestyles. Communal ownership and management of land resources is limited to grazing areas, especially around the two major wetlands of Loboi and Kesubo. Cultivated fields are privately owned (not necessarily registered) but have clearly marked boundaries.

5.5.3 The Main Attributes of the Respondents

From time immemorial the inhabitants of the Baringo lowlands practiced traditional fallow irrigation systems alongside rain-fed dry land farming. But nomadic pastoralism had remained for many centuries the main land use activities, because of its adaptability to prevailing arid lands environmental conditions and the importance of animals in the cultural milieu of the people. Agro-pastoralism is therefore not a new form of livelihood. The issue of concern here is the new trend whereby production systems appear to be responding to the needs of external market rather than to subsistence needs. We have tried to capture this transition from nomadic pastoralism to sedentary agriculture, paying special attention to the main drivers of this change.

According to our survey in Loboi plains pure pastoralism was no longer a dominant land use activity. Whereas only 0.9% of the land users classified themselves as pure pastoralists eighty eight percent (88%) of the respondents claimed to be agro-

pastoralists. This clearly shows that pure pastoralism is almost non-existent in Loboi Plains. At least 4.6% of the respondents were wholly occupied in farming activities, contrary to common expectations. The fact that another 6.5% of the respondents combined agro-pastoralism with some form of businesses is clear sign that this society that was for long been viewed as a conservative people (who were engaged in rudimentary economic activities) is rapidly modernizing and getting integrated into the market economy. Table 5.6 shows that out of the 108 land users that were interviewed 95 of them were agro-pastoralists.

Table 5.6 Occupations of the Respondents

	Frequency	Percent	Cumulative Percent
Farmer	5	4.6	4.6
Pastoralist	1	.9	5.6
Agro-pastoralist	95	88.0	93.5
Agro-pastoral-business	7	6.5	100.0
Total	**108**	**100.0**	

Source: Author's field data (2014)

5.5.4 Respondents' Age and Education Levels

Another critical aspect of social change is the growing levels of literacy in the region. According to Koissaba (2013) participation of pastoralists in formal education in Kenya's dry regions had remained for many years at very low levels, thanks to incompatibility of pastoralism as away of life and the ultimate effects of formal education on social, cultural and economic structure of the communities. However, attitudes towards education in pastoralist areas are changing very fast (Izzy, et al 2010).

Table 5.7 compares the levels of education with the age of the respondents. 33(31%) out of a total of 108 respondents between 20-34 years had attained primary level education. Eleven (11) others had attained secondary level of education and one had even graduated into a tertiary institution. In contrast only five respondents over the age of 50 years had attained primary level education.

Table 5.7 Age of respondent and Level of education

Age of respondent	Level of education				Totals
	None	Primary	Secondary	Tertiary	
20-34	3	33	11	1	48
35-49	12	26	7	0	45
50-64	9	5	0	0	14
65-79	1	0	0	0	1

Source: Author's field data (2014)

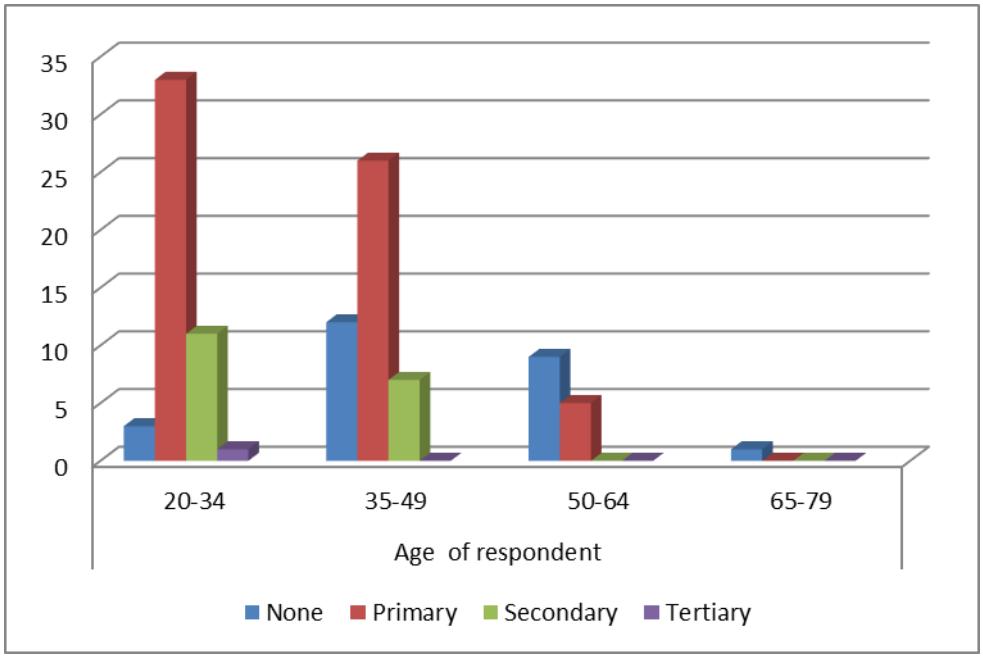


Figure 5.8 Age and Level of Education of the Respondent

Source: Author's field data (2014)

At this rate of empowerment of people through education, the traditional institutions may no longer execute the same level of authority as in previous traditional

arrangements. Hence, pastoralism as a way of life may no longer be tenable. This possibility is already understood by the pastoralist elders, and has been seen as the key reason for their objection to formal education as observed by Villiers, et al (2015), that in the opinion of elders, the school does not teach pastoralist skills or culture, and therefore, if all children were required to attend formal schools, the result would be to ruin the pastoral production system.

5.5.5 Family Structure and Dependence

The Tugen people constitute the main ethnic community involved in this study. It is a patriarchal society. Consequently, the man is entrusted with family property ownership making all critical decisions pertaining to land use and resource allocation. It is not a surprise that more than twice the number of respondents were men.

Table 5.8 Gender of respondent

Gender	Frequency	Percent	Cumulative %
Male	74	68.5	68.5
Female	34	31.5	100.0
Total	108	100.0	

Source: Author's field data (2014)

Polygamous families are the most prevalent, and therefore, number of dependents per household tends to be high. Majority of the families (46.3%) had a household membership greater than six but less than eleven. High dependence rate is detrimental

to wealth creation, since much of the household earnings goes to consumption. This tends to deter the ability of the households' heads to accumulate wealth or afford education for the children.

Table 5.9 Number of dependents

No. of Dependents	Frequency	Percent	Cumulative Percent
0-5	42	38.9	38.9
6-10	50	46.3	85.2
11-15	10	9.3	94.4
Over 15	6	5.6	100.0
Total	108	100.0	

Source: Author's field data (2014)

The KNBS (2008) reported that 52.3% of poor households in Baringo County had more than 7 dependents, but only 44.9% of the rich households had an equivalent number of dependents. It was also shown that, there was a close relationship between poverty and education levels. In terms of academic qualifications, the non-poor families (24.3%) had family members who had attained secondary school education. In contrast only 6.9% of the poor family members had attained such levels of qualifications.

5.5.6 Nature of Land Use Change

The nature of the land surface configurations and associated vegetation and climatic conditions distinguishes the Loboi plains from adjacent highlands described above. Aridity and acute shortage of water restricted land use to nomadic pastoralism with minimal settlement. People lived harmoniously with nature, with minimal environmental impacts for centuries. But the onset of colonialism introduced barriers and restricted free movements of people and their animals. This interruption tilted the

existing balance in favor of environmental destruction. It was also the beginning of the government's desire to convert pastoralists to sedentary agriculturalists: a policy decision that was to have irreversible consequences on the arid lands environment.

The Baringo lowlands have been described as an ecosystem and economy in transition or in a mixed state; characterized by duality of modern and traditional forms of human organizations and landscape management (Anderson, 2002, Little, 1992, Campbell, 1978, Meyerhoff, 1991). It has been observed so far that a number of factors have come together to alter the land use systems in the Loboi plains. Central to these factors is the changing demographic variables in number and attributes. The population increased by 74.3% between 2000 and 2010. Similarly, the traditional occupations have changed in a manner that has had noticeable impacts on the environment as indicated in Table 5.10 below. The changes are reinforced by visible displacement of pastoralism by agricultural crop cultivation (Kratli and Swift, 1999).

The arid and semi-arid Baringo lowlands were always classified under Kenya's low population growth areas (Wasonga, 1983), however, according to a REGLAP (2012) report Kenya's pastoral districts had an average population growth rate of 6.7% compared to a 5% national average growth rate between 1995 and 2000. This fast population growth rate was due to the combined effects of natural population growth rates and immigration. Increased population of both people and their animals tends exert a lot of pressure on the available natural resources including water, pastureland, natural forests and soils, as can be inferred from the resource assessment Table 5.10

Table 5.10 Population Projections and Related Resource Assessment indicators

Year	2000	2005	2010	2020
Population	54,000	71,412	94,132	163,323
Livestock units	68,545	87,175	100,700	116,195
Irrigated Area (Ha.)	1,904	2,311	2,845	4,447
Water Use (m^3)	2.8	33.5	47.5	88.9
Cereal-self-sufficiency (%).	43	48	52	56
Forage-self-sufficiency (%)	76	60	52	45
Fuel-wood self-sufficiency	98	75	57	33
Water depth of L. Baringo (m).	8.5	7.3	6.5	4.6

Source: J.I.C.A (2002) A Study in Marigat and Makutani Divisions

Table 5.10 above clearly shows the potential impacts of a rapidly rising population on the fragile dry land resources. The livestock units are projected to increase in response to population increase. This is because livestock remains the most acceptable yardstick for wealth measurement and accreditation to social status. The land area under crop irrigation is shown to expand steadily in pace with population increase. Water demand was also projected to double from 47.5 m^3 in 2010 to 88.9m^3 by 2020. This was to happen as more land was put under irrigation crop cultivation. Although cereal self-sufficiency was projected to grow, forage-self-sufficiency was projected to decline. Forage availability is critical in a livestock dependent economy: supply of forage is projected to decline from a 76% level in 2000 to a 45% level in 2020

Increasing human population under a modernized pastoral economy involved opening up of more land for human settlements and crop-cultivation. We sought, first to find out people's perceptions of how land use/cover appeared to them at the time they settled in the region followed by a subsequent question on what land use/covers changed and the possible causes of such changes.

Table 5.11 below shows the different categories of land covers that the respondents recall to have seen at the time they were settling for crop-cultivation under a more sedentary lifestyle. Forest cover and wooded grasslands were reported to have been prevalent by 42.6% and 33.3% of the respondents respectively. Both bushed grasslands and marshlands were reported to have been more prevalent by an equal number of respondents at 12%.

Table 5.11 Reported Land Cover Types before the onset of cultivation

Land cover Types	Frequency	Percent	Cumulative %
Forested grassland	46	42.6	42.6
Wooded grassland	36	33.3	75.9
Bushed grassland	13	12.0	88.0
marshland	13	12.0	100.0
Total	108	100.0	

Source: Author's field data (2014)

The respondents were unanimous that different land cover types had declined in different magnitudes since people settled on crop-cultivation. Figure 5.11 below shows that forests and marshlands were viewed to have declined by 35.1% and 23.4% respectively. Wooded and bushy areas also declined by 22.1% and 19.5% respectively. This finding was corroborated by satellite image analysis (reported in the last section of this chapter) that revealed forests and wetlands to have diminished by 8,789 acres (or 4.61%) and 4,248 (or 2.23%) acres respectively over a period of 20 years.

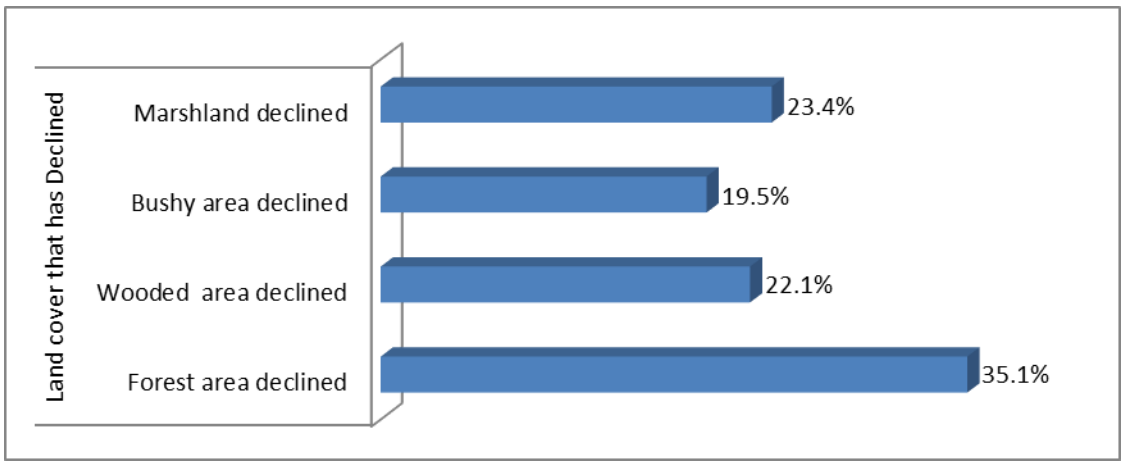


Figure 5.9 Land cover that has declined

Source: Author's field data (2014)

5.5.7 Transition from Nomadic Pastoralism to Sedentary Agriculture

The decision to move away from nomadic pastoralism to sedentary crop-cultivation is informed by several factors, including governmental development policies and the household characteristics. Mace (1993) suggested that household wealth is a key determinant. Poor households cannot afford to take risk, they are risk-averters. But a wealthy household can afford to experiment with new ideas.

Table 5.12 and the corresponding Figure 5.9 probed whether the respondents were born in that place or had immigrated; with a view to determining which group was more involved in the land use change. The earliest converters to sedentary agriculture in the 1960s were respondents born within the localities of the Loboi Plains, whereas immigrants came in from the 1970s to 2000s. An interesting observation is that the number of converters grew exponentially from the 1980s to 2000s. This corresponds with the implementation of the government's 1979 strategic plan for arid and semi-arid lands of Kenya. Government had to inject capital for infrastructural development so as to popularize the idea of sedentarization.

Table 5.12 Place of Birth and Year Respondent Settled on Cultivation

		Year respondent settled on cultivation					
		1960s	1970s	1980s	1990s	2000s	Total
Born here?	No	0	2	5	5	7	19
	Yes	2	8	18	20	41	89
Total		2	10	23	25	48	108

Source: Author's field data (2014)

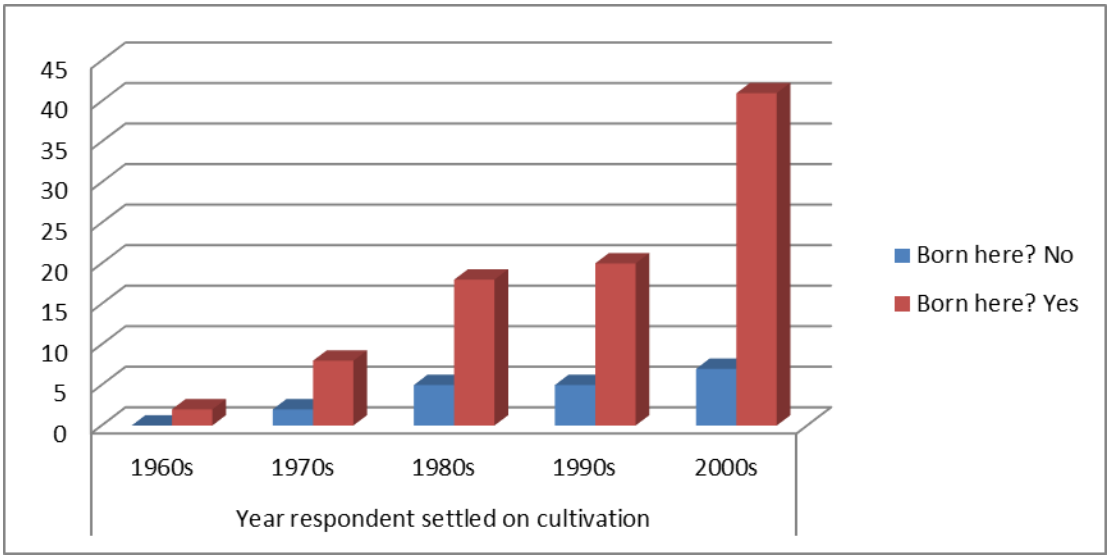


Figure 5.10 Year Respondents Settled on Cultivation

Source: Author's field data (2014)

Literature on the subject of land use/cover change has tended to apportion blame for LUCC on the growing population. The respondents expressed their opinions about causes of LULCC as scored in figure 5.10

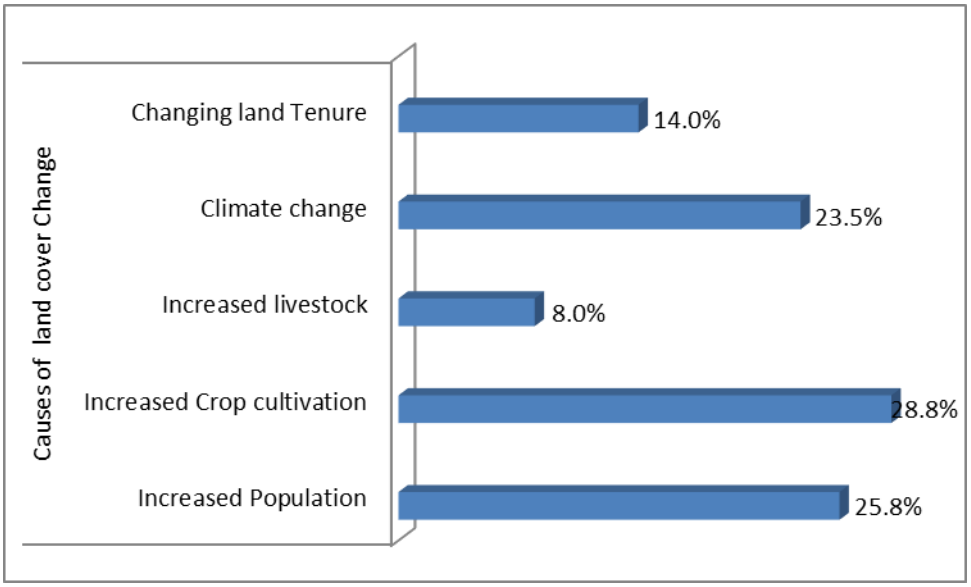


Figure 5.11 Causes of Land Cover Change.

Source: Author's field data 2014

Increased crop-cultivation was rated highest at 28.8%, followed closely by high population growth rate at 25.8%, Climate change was also mentioned by a sizable number of people at 23.5%. Others included changing land tenure at 14% and increased livestock at 8%. These results somehow tend to support Lambin (2002) who has often argued that population and poverty is erroneously blamed for the rampant destruction of biotic natural resources. He says that LULCC are caused by people's responses to economic opportunities, as mediated by institutional factors. However, it is now an acknowledged fact that LULCC has multiple causes; natural and anthropogenic. The respondents' opinions zeroed down more on climate change and increased population as the most important factors attributed to LULCC.

According to Bardecki (1984), the opportunity costs associated with conversion to agricultural or other use would have to provide a reasonable incentive for converting the wetland area. It is therefore, the potentiality of economic opportunities and expected returns that motivates the land user to clear more of the wetland areas.

Eventually the profitability of the venture attracts high population settlement and growth. Combined the expansion of population and commodity markets cause the conversion of areas of natural vegetation into farmlands, and its intensifying use, which in turn renders habitats for wild flora and fauna smaller and more fragmented (Bolwis, et al 2006).

5.8 Land Tenure and some Aspects of the Present Land Use

The Tugen people did not have a system of land inheritance, as land was communally owned. Members of a clan or sub-tribe were responsible for controlling grazing, and the sons of a household were, by customary right entitled to their father's herd (Vedeld, 1990). Today, only limited space especially, in the wetland that is not demarcated for individualized use and ownership. The process of land reform is picking momentum very fast. Hence, the traditional livestock inheritance right has been replaced by land inheritance right (Kandagor, 1993). The change in land tenure system has led to individualization and commodification of land. This is the mark of a modernized economy, which shifts care and maintenance of land from competition that culminates in Hardin's (1968) "tragedy of the commons" to individually managed land, and whose use is determined most often by its economic rent.

Figure 5.11 shows majority of the land owners (62%) inherited land from their immediate families or clans. A growing number of land owners (21.3%), however, bought their land in the open market. Some of the buyers of land were actually not born in the region, but had immigrated from elsewhere as Table 5.12 above shows. The extremities of a free market system with respect to land however, are not strictly observed, there are still welfare considerations exercised by close relatives and the wider society on the have-nots. It was revealed that 15.7% of land ownership was

obtained through gifts or traditional use rights that are accorded a member of a clan or family. In some rare cases (0.9%) people obtained land ownership rights using their labour contribution, which is translated into share-capital. This positive aspect reduces social economic inequalities which are deterrent to regional economic development (World Bank, 1993).

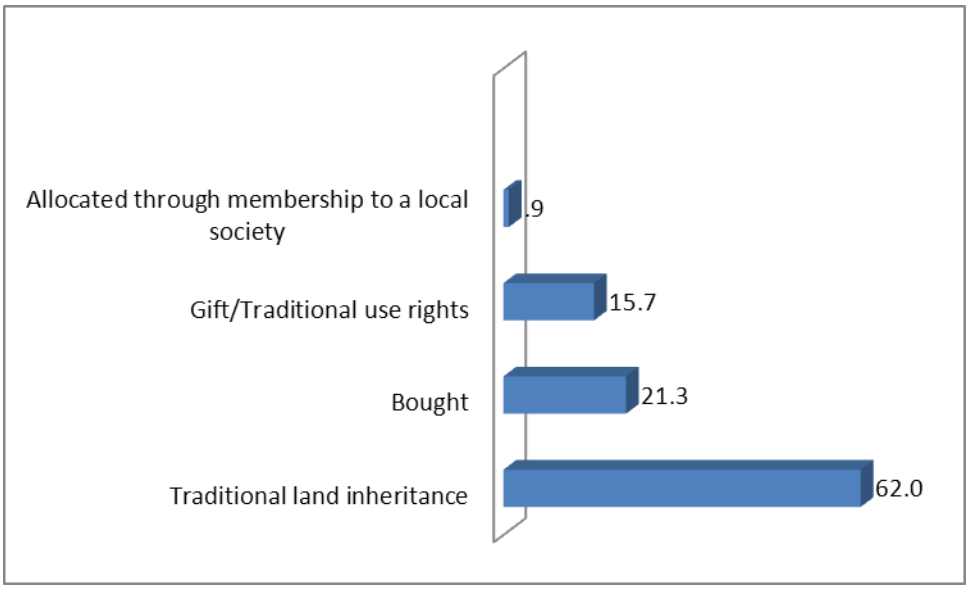


Figure 5.12 Methods of land Acquisition

Source: Field data (2014)

5.5.9 Farm Size and the Farming Systems

The Baringo lowlands fall under Jatzold (1982) agro-climatic zone 4, which is arid and semi-arid and hence only marginally suitable for rain-fed arable farming. Irrigation crop-cultivation is the only method that assures the farmer of a harvest, hence, it is widely adopted, but its success depends on the availability of water. Six small scale irrigation projects; namely, Loboi, Kapkuikui, Sandai, Kamaskoi, Kailer and kamaech exist within these lowlands drawing water either from River Waseges or the Loboi swamp. Eighty eight (88%) of all the respondents had indicated that they were agro-pastoralists, either engaged in rain-fed or irrigation agriculture. The former

was however; very erratic, taking the form of shifting cultivation given the vagaries of the weather, but the latter was more permanent and regular. It is not an accident that most of the permanent homesteads encountered during the survey were on irrigated crop lands.

The farm Size groups ranged from 0-3 acres to 8-10 acres of which 75.9% of the respondents owned cultivation land that was less than 3 acres. Only 3.7% of the farmers owned more than 8 acres of land for crop-cultivation.

Table 5.13 Land size under cultivation

Land Size Groups	Frequency	Valid Percent
0-3 Acres	82	75.9
4-7 Acres	22	20.4
8-10 Acres	4	3.7
Total	108	100.0

Source: Author's field data (2014)

The respondents were asked to express their opinion with regard to whether the number of cultivators was increasing or declining with time. Table 5.14 shows that 58.3% were of the opinion that the number of cultivators was increasing and only 0.9% of the respondents were of the view that the number of cultivators was on the decline. The main reason for the number cultivators to increase has a lot to do with the lure of irrigation farming. Table 5.15 shows that irrigation cultivation has been adopted by an overwhelming 71.3% of the farmers.

Table 5.14 Growth in the Number of Crop-Cultivators

	Frequency	Percent	Cumulative%
Increased	63	58.3	58.3
Decreased	1	.9	59.3
Not change	18	16.7	75.9
Do not know	26	24.1	100.0
Totals	108	100.0	

Source: Author's field data (2014)

Table 5.15 Practice Irrigation Farming

Practice irrigation or not	Frequency	Percent
No	31	28.7%
Yes	77	71.3%
Totals	108	100%

Source: Author's field data (2014)

It is evident that the former nomadic pastoral economy predominant in the Baringo County lowlands in the past has gradually and increasingly been replaced by crop-cultivation as a land use system. It is expected that there are trade-offs between crop-cultivation and animal keeping as far as land and labour resources are concerned. The balance would normally be determined by what people consider to be their priorities in the use of their resources. Therefore, an additional question was raised with respect to animal husbandry. We wanted to find out if the number of cattle, goats, sheep and chicken was increasing. Popular scholarly arguments tend to accord more credits to cattle in the way of life of a pastoralist. Some authors (Campbell 1981, Oba and Lusigi 1987, Barrow 1989) have argued that, because of their traditional inclination to pastoralism any additional income earned in any other economic activity will always be expended on buying more cattle.

However, the reality on the ground is that the pastoral economy is on the edge of decline as shown by the responses in Figure 5.21. Only 7.6% of the respondents thought cattle were increasing compared to 49%, 22.1% and 21.4% who thought there was an increase in the number of goats, sheep and chicken respectively. This is an inevitable change that goes against the known tendencies of the pastoral people, of accumulating large stocks of cattle; a phenomenon called "the cattle complex" (Herkovits, 1926). It may reflect two things: One, the pastoralists have found themselves in an inevitable position in which competition over resources has dictated against large stocks of cattle. Two, the wind of modernization has introduced different but more preferred store of wealth and measure of social status, for example setting up of business units or engaging in irrigation farming.

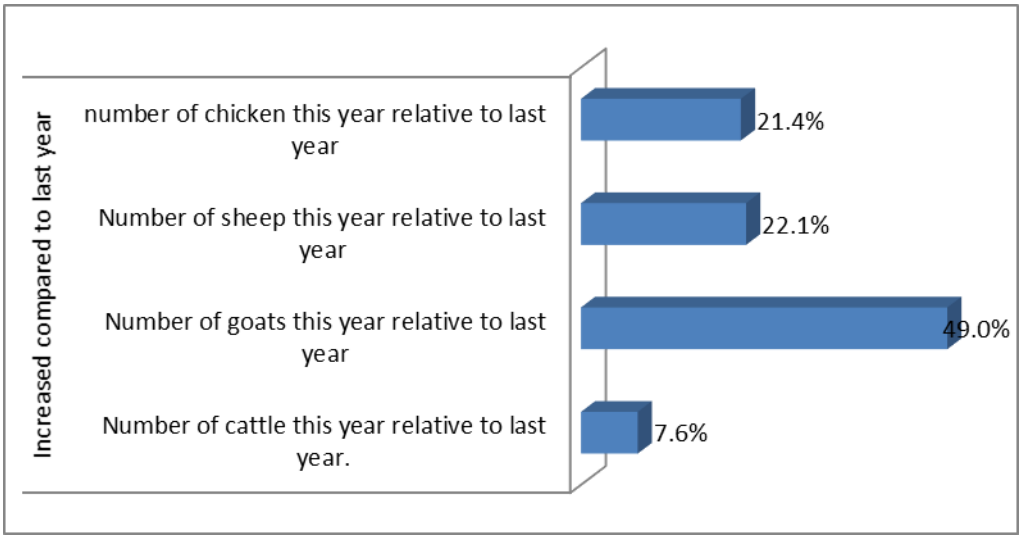


Figure 5.13 Number Increased this Year compared to Last Year

Source: Author's field data (2014)

Previous studies done in this region have shown that people's preference has shifted from cattle rearing to rearing of small stock such as goats, sheep and chicken (JICA, 2002, Schwartz, 1994). According to Schwartz cattle feed on the herb layer whose quality deteriorates fast after the rains. Conversion of former grazing land to crop-

cultivation has taken up what was the cattle's grazing herb, leaving trees and bushes for browsers. Therefore, in the face of land use competition cattle will run out of their feed before that of goats, which are basically browsers.

But the unasked question is; 'what would make a people to move away from their traditional livelihood to a new form of livelihood that may possibly not meet all their social, cultural and economic needs?' There are both natural and economic reasons for such a high level of adoption of crop-irrigation farming among a people who are essentially pastoralists. First and most important is because of the availability of water in rivers, springs and the swamps. Table 5.16 below shows rivers at 49.1% followed by swamps at 31.5% are the most important sources of irrigation water supply. Other sources of water include springs, boreholes, wells, roof, and rock catchments.

Table 5.16 Source of Irrigation Water Supply

	Frequency	Percent	Valid Percent	Cumulative Percent
River source	53	49.1	49.1	49.1
Swamp/dam	34	31.5	31.5	80.6
Other sources	21	19.4	19.4	100.0
Total	108	100.0	100.0	

Source: Author's field data (2014)

This source of water frees crop-production from dependence on seasonal rainfall. History has it that the Tugen community around Sandai was practicing irrigation farming along River Waseges as a counter measure against frequent drought and crop failure before 1932 (JICA, 2002). Ever since, Loboi plains have continued to be an active irrigation farming zone. Hence in the case of the Tugen people irrigation cultivation is not a new form of land use, what is possibly new is the mode of

production that encourages crop growing for sale and not for food.

The second reason for predominance of irrigation-crop farming is basically economic and external. External interest emanates from the region's comparative advantage in irrigation farming. An all-year round ability to support different crop production has attracted several agro-businesses to the region; including maize/sunflower seed producing companies and other agricultural food/non-food mercantile firms. Table 5.17 shows maize seed production takes fourth position with 16.9% of the respondents engaged in its production. Regular maize, the staple food for the local people is only grown by 8.7% of the respondents.

Table 5.17 Frequency of Crops Grown under Irrigation

Crops Grown under Irrigation	Frequency	Percentage
Maize seed	69	16.7%
Regular Maize	36	8.7%
Beans	104	25.1%
Millet/Sorghum	70	16.9%
Watermelons	57	13.8%
Kales	78	18.8%
Total	414	100%

Source: Author's field data (2014)

Kenya seed companies contract farmers to grow maize seed at a price often determined by the companies. The seed companies may also supply technical support to the farmer in terms of advice and the best way to improve the quality of the seeds. The seeds are collected at specified locations to reduce transportation costs that a farmer would normally incur. This becomes a major incentive that encourages the continued production of the crop, often at the expense of other farm enterprises.

Maize seed production under irrigation is preferred because of giving a high per unit area production (Manager, Perkerra Irrigation scheme 2010). The Seed Companies would normally buy all the seeds that the farmers offer for sale. Mr. Philip Matetai (Sub-County Agricultural Officer) informed this researcher that one acre of maize seed yields 40 bags of maize, of which 35-39 bags goes to Kenya seed. The surplus goes to feed the farmer's family. The price paid for one kilogram of seed maize in 2010 was kshs.50/kg, which was far much higher than kshs.30/kg offered for regular maize in the market then. According to Mr. Matetai growing other crops such as the water melons under irrigation is also profitable. For instance, one acre of land planted with watermelon at the 2010 market prices would have earned a farmer about Kshs.100, 000/=. However, the farmers preferred contract farming because of the certainty associated with marketing of the produce. This has had the positive effect of encouraging farmers to put more of their energy and resources into increasing the acreage under irrigated crops. More land is therefore allocated to the production of these high value crops. The seed companies therefore, opened a new phase of intensified commercial crop farming.

This is further illustrated by the fact that according to the district agricultural reports, acreage under maize production rose from 800 in 1995 to 1,816 in 1998 (Table 5.18) a difference of 1, 016 hectares or 127% increases in acreage under maize production. Although Table 5.20 below does not distinguish between the acreage under seed maize and regular maize, agricultural officer accorded seed maize the production a higher contributory factor to the increased acreage under maize production.

Table 5.18 Crop production in Marigat and Mukutan Divisions 1995-1998 (Ha)

Crop	1995(Number of Hectares)	1996(Number of Hectares)	1997(Number of Hectares	1998(Number of Hectares
Maize	800	1,378	1,350	1,816
F.millet	140	85	65	140
Sorghum	40	25	27	40
Cowpeas	5	8	5	15
Cassava	3	3	2	3

Source: GOK (1999) Baringo District Department of Agriculture Annual Report.

According to the local agricultural officer, the expansion in hectares under maize has tended to increase steadily over the years, except in 1997 when El Nino floods caused the yields to decrease slightly. The growing of the high value seed maize has been enabled by the easy accessibility of water, from the wetlands and rivers draining into the region.

Plate 5.4 An intensive utilization of irrigation waters, (31/3/2016, Photo). Different plots of land are holding maize crops at different stages of maturity. The background is a mature maize crop, middle ground is a maize crop about 30cm in height and the foreground is a newly cultivated land waiting to be planted.

Irrigation crop-cultivation is a lucrative business which has not only empowered the ASAL people but has also transformed their lifestyles and aspirations for higher standards of living. Contrary to the long held view that pastoralists are herders by inclination and farmers out of necessity (Oba, 1988, Little, 1992 Anderson, 2002), the conversion of the former pastoralists to crop-cultivators has proved that pastoralists were never opposed to crop-cultivation, it is the environment they were living in that was hostile for crop-cultivation.

Observations across the landscape reveal a changing society in terms of what used to be considered the most important form of capital-livestock. The distinction between the traditional preoccupation with animal husbandry and present engagement in crop-cultivation is that, the pastoral production process earns its income in the form of capital gain, whereas in crop-cultivation, a growth strategy necessitates increasing integration into a system of exchange relationships (Bierschenk and Forster, 1990).

The modern farmer, who has fully embraced the monetary economy, considers money a better store of wealth and measure of social status than the livestock. Many farmers were found to no longer considering animal keeping a suitable fall-back economic activity. For instance, the agricultural officer reported a case where farmers contracted by Kenya seed maize, were disillusioned by poor payments and decided to withdraw from the contracts. To ensure their financial stability they decided to diversify into production of other cash crops; including tomatoes, watermelons and mangoes (Mr. Matetai Per, comm.2010).

The fact that farmers opted for other cash crop production and not food crops or livestock is a clear prove that the money making has dominated farm decision-making. The agricultural officer justified this farmer behaviour by emphasizing the

fact that “in the modern society, the need for cash supersedes the need for subsistence. This is because the needs of the family go beyond the village. Families need to pay for education, health, transport and other consumer and investment goods”.

The third and final reason for ease in adoption and growth of cultivation agriculture is the geographical coverage of logistical services such as transportation and marketing of farm produce. Respondents were asked to identify their main channels of marketing their farm produce including; whether or not they operated through local cooperative marketing societies or sold directly to middle men and other agencies. 34.9% had access to a local market and 26% were on contract farming. Sale through co-operative marketing societies was least at 15.9% as middlemen took their share at 23.3%. Much of the produce sold at the local market was mainly targeting businessmen who have permanent business premises at Marigat, but who were also engaged in the sale of the same goods to distant markets in Nakuru and Nairobi. In other words farm production is determined by the availability of the market for the produce.

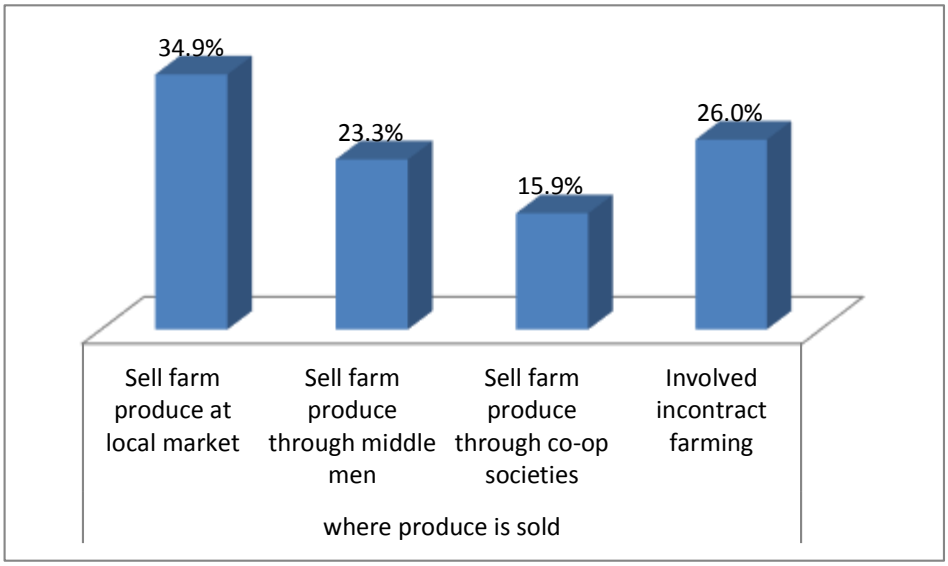


Figure 5.14 Marketing Channels used

Source: Author’s field data (2014)

The transition to agricultural crop cultivation has been fueled by the expansion in the irrigation schemes. Table 5.19 below shows that an increase not only in the acreage under irrigation but also the number of households engaged in the activity. For instance, in 1982 only 83 hectares of irrigable land in Sandai were fully established out of a potential of 300 hectares. In the same year only 150 households (HH) were engaged in irrigation farming. The situation dramatically changed in 2010 whereby 150 hectares had been established and 300 households were engaging in irrigation farming. The figures for other irrigation schemes too show an upward growth in both acreage and number of households participating in the enterprises as shown in the Table 5.19 below.

Table 5.19 Expansion of irrigation Farming in selected Schemes from 1982 to 2010

Irrigation scheme	Potential (Ha)	Established (Ha**)** 1982	Established (Ha**)** 2010	No. of (H/H) 1982	No. of (H/H) **2010**	Change (H/H) 1982-2010
Perkerra	2,400	87	480	73	780	707
Sandai	300	83	150	100	300	200
Kamoskoi	180	24	50	53	100	47
Loboi	310	30.6	78	72	250	178
Total	2,880	194	680	226	1,180	1,132

Source: GOK (2010). 1984 and District Annual Reports (2010)

Other things being equal irrigation farming earns the farmer higher per unit area gross margin than an equivalent area would do without irrigation as Table 5.20 shows:

Table 5.20 Crop Production Earnings with and without Irrigation in Sandai Scheme

Crop Type	Earnings without Irrigation		Earnings with Irrigation	
	Hectares(Ha)	Kshs/Ha	Hectares(Ha)	Kshs/Ha
Maize	0.31	22,213	0.31	25,433
Beans	0.06	15,430	0.06	38,206
Watermelon	0.01	96,588	0.02	123,572
Kales	0.01	64,742	0.02	90,378

Source: JICA (2002)

Table 5.20 compares two scenarios of crop production earnings with irrigation and the other without irrigation. Looking at the table 5.20 one can tell that farmers stand better chances of realizing higher returns from crop production under irrigation as opposed to a situation where the farmer depends on natural rainfall. This underscores the critical role of irrigated agriculture in contributing to the farmers' households' food security and welfare.

5.5.10 Summary of the Section

The first objective of the study was to examine the nature and magnitude of land use/land cover changes, their related causal factors and consequent impacts on the lowland wetlands. In summary it has been demonstrated that the former pastoral economy has been transformed over the years in response to the endogenous and exogenous change agents; including; societal change dynamics, business operators and government and non-governmental organizations. It has also been shown that the lure of the money economy have led farm production to focus more on goods for sale and less on goods for domestic consumption. Though this tendency may be viewed negatively with respect to food security in this semi-arid zone, it has created deeper interactions with other regions through trade; allowing the region to specialize in the production of goods that it has the greatest comparative advantage.

In common with the Upper River Waseges catchment areas, the perception of the people is that land use/cover has changed through time as population grew and as the society embraced market oriented agricultural production. Unlike the highlands, where crop-cultivation encroached onto the forests, the lowland wetlands were the main target for drainage. Wetlands provided a unique dry land ecosystem that allowed growth of a variety of crops throughout the year, thanks to perennial availability of water. Continued encroachment onto the wetlands has not only reduced the spatial size of these ecosystems, but has partially contributed to their degradation.

It is notable also that land use changes in both regions were a result of the expansion in commercial food production. Whereas, maize seed production constituted a major reason for wetland drainage in the lowlands, horticultural produce has been the main reason forest encroachment. To paraphrase George (1979) that, it is the intensification of the policy giving priority to export market production that has created "inauthentic" system- that is a system that is directed by outside hands; which according to George(1979) cannot satisfactorily feed its own people (though it may be efficient at feeding outsiders). Hence, important farm production decisions are arrived at on the basis of what is happening in the wider national and global market and not either in response to domestic cultural food preferences or the local environmental considerations.

5.6 Land Use/Cover Change Analysis using Remote Sensing and GIS

This last section of the chapter aimed at identifying and mapping different land use/land cover types in the study sites, with a view to determine the magnitude of land use changes in terms of gains and losses between and among various land use/land cover types. The guiding research question was: What are the magnitudes of

loss and/or gain between and among various land use/land cover types? This analysis brings in a timely understanding of the major land use economic activities that have been detrimental to the forest and wetland ecosystems. As Briassoulis (2002) rightly states, that changes in the uses of land occurring at various spatial levels and within various time periods are the material expressions, among others, of environmental and human dynamics, and of their interactions which are mediated by land.

5.6.1 Data Acquisition and Change Detection Techniques

The land use/cover change was determined by comparing environmental changes between two satellite images taken in 1986 and 2006. The images were downloaded from the University of Maryland Global land cover facility, and as noted in chapter three this is a source of free high-quality "Geo-Cover" images that have been selected for minimal cloud cover, during peak greenness and have been precisely ortho-geo-referenced (GLCF, 2004). The geo-reference formats employed by the GLCF for Landsat imagery include a UTM projection and a WGS84 datum and ellipsoid. Thus geometric correction was unnecessary (Sallaba, 2009). The study sites were fully captured on the Landsat Worldwide Reference system Path 169 and Row 60.

According to Kiage (2009) a crucial requirement for change detection is availability of relatively cloud-free satellite image at each date. He recommends that one should take advantage of cloud-free window, common during the dry season. Such choice of anniversary dates of satellite images minimizes discrepancies in reflectance, caused by seasonal vegetation fluxes and Sun angle differences (Sallaba, 2009). It is important also to ensure that data used for spatial-temporal image analysis matched as close as possible in terms of seasonality (Jones, et al 2006).

Two anniversary satellite images (Table 5.21 below), one of 1986 and the other of 2006; a twenty year difference between them, were acquired using Landsat TM5 and Landsat 7 ETM+ sensors. The two images were taken in the months of January 1986 and 2006 as shown in the table below. The region experiences one dry season starting in September ending in May, therefore, January is one of hottest months, characterized by very clear skies (Rowntree, 1988)

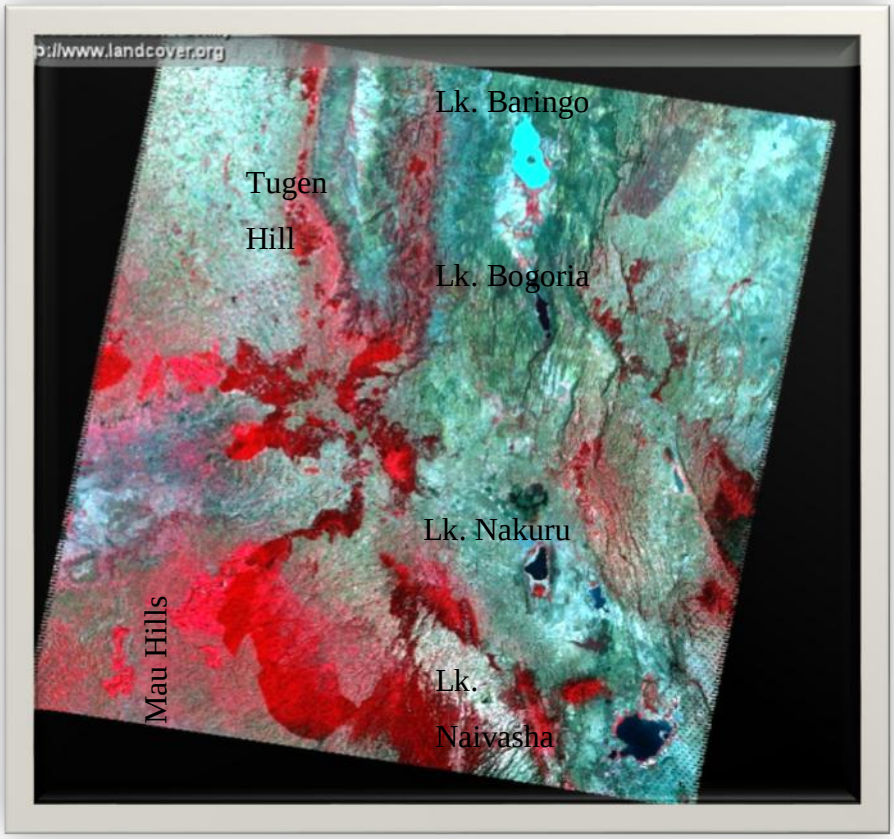


Figure 5.15 Five Rift Valley Lakes designated as Ramsar sites shown within the Landsat Enhanced Thematic Mapper Plus image of 27th January 2006.

Table 5.21 Attributes of the Landsat TM and +ETM imagery used in the Study

DATE ACQUIRED	SENSOR	PRODUCER	TYPE	ATTRIBUTES
1986-01-28	TM5	EarthSat	GeoTiFF	OrthoGeoCover
2006-01-27	7ETM+	GLCF	GeoTiFF	Surface Reflectance

Source: GLCF (2011)

According to Kasischke, et al (2004) radiometric preprocessing for change detection can either be relative or absolute. The former is similar to choosing anniversary images (as described above). In the latter, however, the original brightness values in the images are converted into surface reflectance using a number of atmospheric correction and calibration equations (Lillesand and Kiefer, 2004). Kiage (2009) says that, although the anniversary images enables the analyst to sidestep the effects of sun angle and phenology, there is need to perform radiometric calibrations, by converting the original brightness values into surface reflectance, thereby allowing comparison between the TM and ETM+ images. Hall, et al (1991), recommends use of relative radiometric normalization method. This is a method of correction that applies one image as a reference and adjusts the radiometric properties of subject image to match the reference (Biday and Bhosle, 2010). Thus, normalized image appear to have been acquired with the reference image sensor, under atmospheric and illumination conditions equal to those in the reference scene (Hall,et al, 1991). The 2006 image became the reference and the 1986 image the subject.

5.6.2 Image Classification

The image classification process involves conversion of multi-band raster imagery into a single-band raster with a number of categorical classes that relate to different types of land cover (Nagi, 2011). There are two primary ways to classify a multi-band

raster image; supervised and unsupervised classification. In the former an image is classified using spectral signatures obtained from training samples that are picked by the analyst. In the latter classification method, the software finds the spectral class in the multi-band image without the analyst intervention (Lillesand and Kiefer, 2004).

Unsupervised classification was employed to classify the image first into 30 land use/cover categories and subsequently reclassify the image into fewer LULC classes as desired by the analyst. This exercise gave way to an analyst-based supervised classification using training samples. In Arc Map as many training samples were created for each identified LULC type. Applying the merger function in ArcGIS a single class for each of the identified categories was made. A minimum and distance to means (MINDST), classifier was then used to create four land use/land cover classes namely; 1.Forest vegetation, 2. Swamp Vegetation, 3. Bushed/Woodlands and 4.Farms/Grasslands/Bare lands (Figure 5.15 and Figure 5.16).

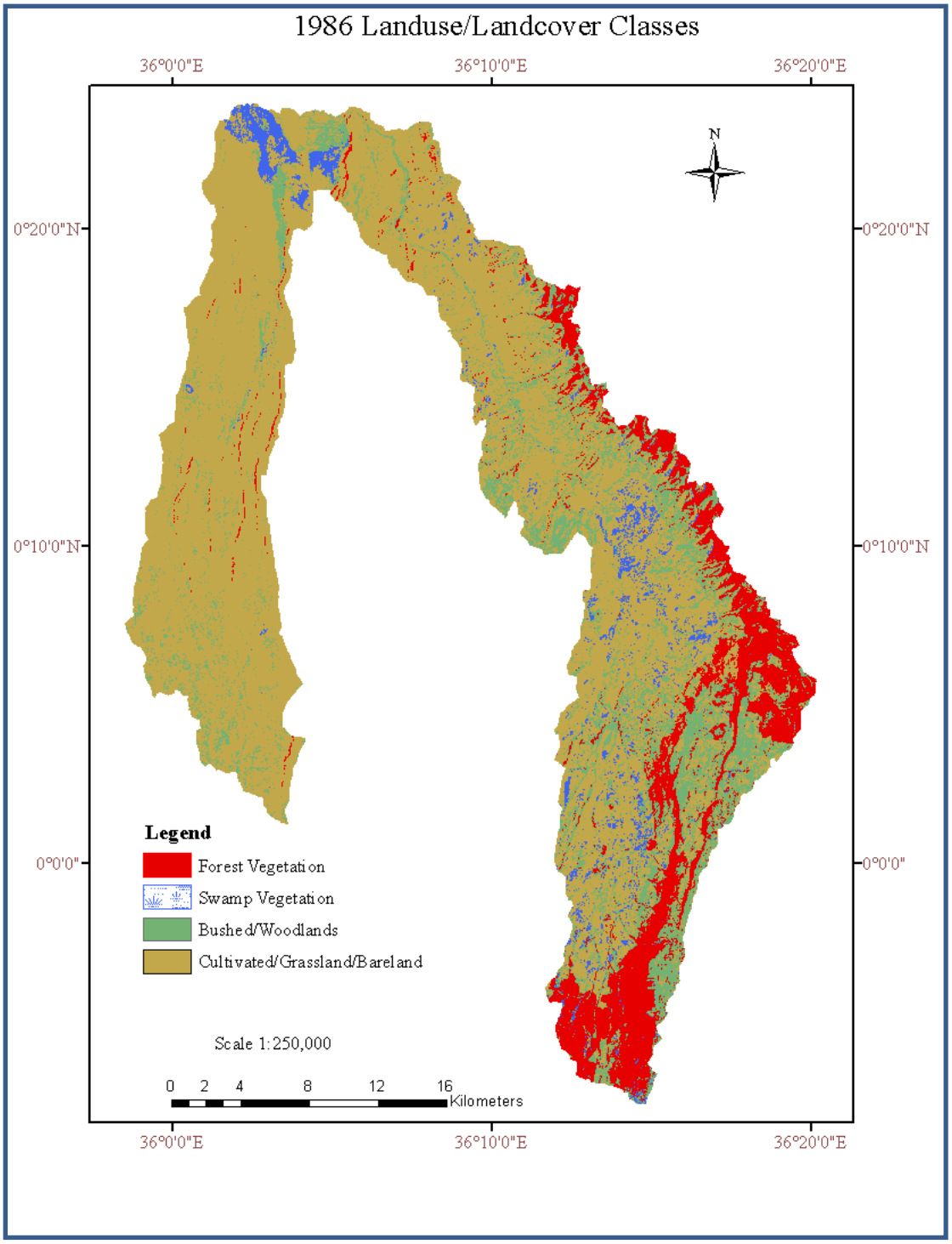


Figure 5.16 Land use/land cover classes identified, mapped and measured at the base period 1986. The blue coloration at the north top most part of the figure covers the Loboi and Kesubo swamps. These are the largest parcels of wetlands that continue to attract attention of ecologists and other interests in this area.

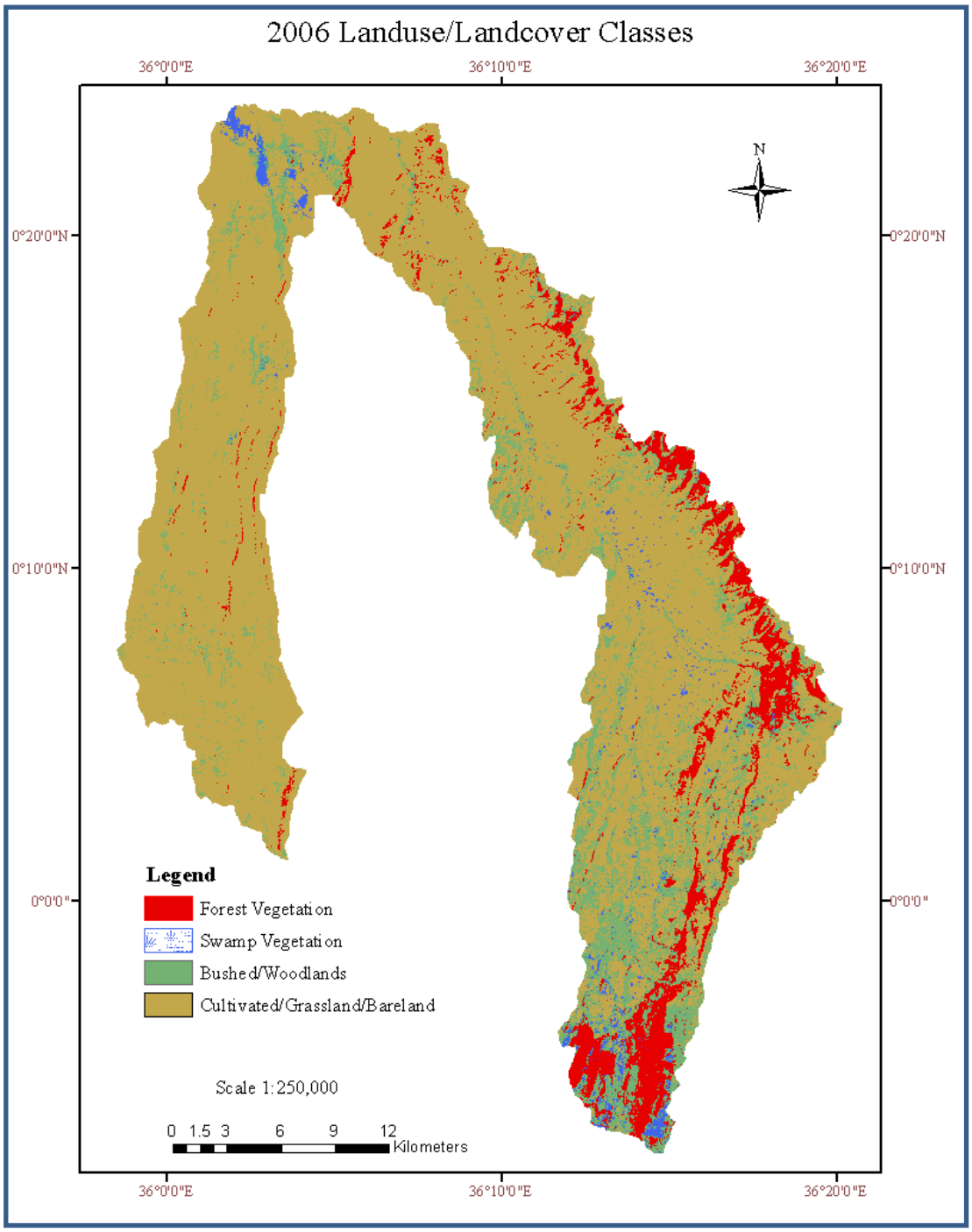


Figure 5.17 Land use/land cover classes identified, mapped and measured as at 2006. Wetlands and forests are shown to have decreased in this figure compared to the previous figure of 1986.

5.6.3 Ground Truthing

Lillesand and Kiefer (2004) have underlined the importance of obtaining reference data to aid interpretation, analysis and validation of the remotely sensed data. Reference data is interchangeably used with the term ground truth. But according to Lillesand and Kiefer (ibid), although this has had a wide acceptance, many forms of reference data are not collected on the ground and can only approximate the truth of actual ground conditions. Several instruments were used in this exercise to ensure accuracy of the land use/cover classifications. The Google earth images of high resolution were used to help in the initial identification of the land cover type in the research area. This was closely followed by several site visits to confirm the presence and type of the land use/cover. Several photographs and corresponding GPS points were taken during field visits for later use in the analysis of the satellite imageries. 1:50,000 UTM topographic maps were also used in identifying locations of features of interest to the study including wetlands and forests. The exercise was conducted intermittently as and when desired, throughout the research period.

5.6.4 Cross Tabulation

Cross-tabulation is used solely for image comparison (Nagi, 2011).Using the CROSSTAB module in IDRISI software, the two multi-band raster images were cross-tabulated to show what land cover has changed to what other land cover, over the twenty year period; 1986-2006. The 1986 image was therefore, cross-tabulated against the 2006 image. We wanted to compare land usage in 1986 and 2006 so as to determine the land use /cover changes that may have occurred within the 20 year period that separate the two images. Did forests or wetlands change? Did they grow or has their area decreased? and so on. Figure 5.17 shows how the land cover classes

changed from 1986 to 2006 and the corresponding Table 5.25 (See Area Table 5.25 in Appendix v) quantitatively indicates the acreage changes of each land cover type withi the two years 1986 and 2006.

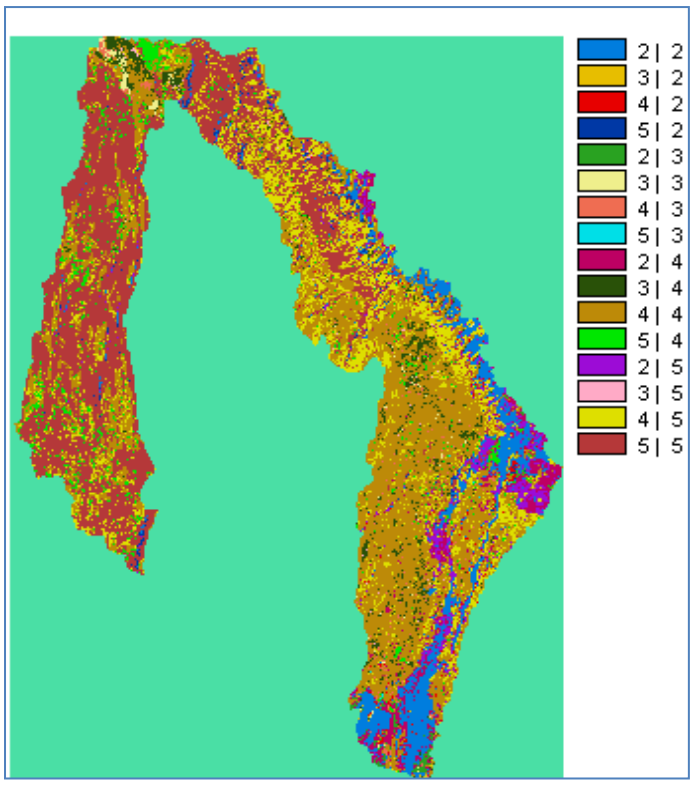


Figure 5.18 Cross-tabulations between the two classified images. The image shows how the land cover types changed over time.e.g 2/2 means what was forest in 1986 that remained forest in 2006.

5.6.5 Analysis of Land Use and Cover Change between 1986 and 2006

The following section examines land use land cover change between 1986 and 2006. The period after 1986 is critical because it was a period marked by enthusiastic excision of major forests in Kenya in response to political pressures; seeking amendments of the skewed land ownership patterns that were left behind by the colonialists. It was also a time when the government of Kenya turned its policy attention to the plight of the people living in the arid and semi-arid lands of Kenya, as

evidenced by two policy documents namely; Arid and Semi-Arid lands Development in Kenya (1979) and NPSDASAL (2003).

In our analysis we assumed the land use/land cover status in 1986 as the base period. Four land use/land cover classes under investigation occupied a total area of 190,594 acres. Farms/grasslands/bareland occupied 67% of the total land area under consideration. Forests, bushes and woodlands combined occupied about 30% of the same land surface. Swamp vegetation occupied the least land surface area at 4%. However, twenty years after, all land cover types but farms/grass/barelands had declined in different magnitudes as shown in Table 5.22.

Table 5.22 Land Cover classes and their areas in 1986 and 2006

Landcover classes	Area (acres) 1986	Percent	Area (acres) 2006	Percent	Change in Areas (acres) 1986-2006	Relative Percentage change
Forest Vegetation	25,730	14%	16,941	8.90%	-8,789	4.61% (Reduction)
Swamp vegetation	7,107	4%	2,859	1.50%	-4,248	2.23% (Reduction)
Bushes/ Woodlands	29,481	15%	25,417	13.3%	-4,064	2.13% (Reduction)
Farms/ Grass/Bare	128,276	67%	145,377	76.3%	+17,101	8.97% (Increase)
Total	**190,594**	**100%**	**190,594**	**100%**		

Source: Author's 1986 and 2006 image analysis

5.6.6 Forest Vegetation

Analysis of the 1986 satellite image classified 25,729 acres under forest vegetation. Twenty years later in 2006, the area under forest decreased from 25,729 acres to 16, 940 acres; that is a difference of 8,789acres or a 4.61% decline with respect to the total land cover. This decline was mainly attributed to encroachment of crop-

cultivation and animal grazing, besides clearfelling of forest trees by timber merchants. Charcoal burners and wood cutters were observed to be have sigificantly led to destruction of forest trees. Specifc analysis of land use land cover change within the forests is as shown in Table 5.23 below.

Table 5.23 Forest cover converted to and/or recovered from other Land Covers

Area of Forests converted to:	Swamp Vegetation	Bushes/ woodlands	Farms/Grasslands Bareland	Forests area converted
	712Acres	6,087Acres	4,675Acres	11,474Acres
Area of Forest gained from:	Swamp Vegetation	Bushes/ woodlands	Farms/Grasslands Bareland	Forest area gained
	145 Acres	1,032	1,507Acres	2,684 Acres
Forest land lost				-8,790 Acres

Source: Author's 1986 and 2006 image analysis

The conversion of 6,087 acres of forest land into bushes and/or woodlands may have resulted from a combined tree harvesting methods applied by both commercial and peasant wood harvesters. The harvesters often choose trees that have well-formed boles and avoid those with kinks. As the harvesting intensfies, only poorly formed trees are left standing in the forest. Consequently, much of what remains of the former thick forest are scatterd woods, thickets and bushes. The degraded forest becomes more vulnerable to encroachment by grazers and cultivators. A sizeable area of forest land measuring upto 4,675 acres also converted to farms/grasslands/barelands.

The loss of forest land to human encroachments is the result of official forest excisions of 1990s. Only an imperceptible 2, 684 acres of land was reclaimed 'back to forests'. There are a number of ways in which this could have happened including replanting through the "shamba system" and farm forestry ("taking the forests to the farms") and through K.F.S refforestation programmes. But in spite of these new plantations the forest area lost over 8, 790 acres of forest land cover to other uses.

Figure A Figure B

Figure 5.19 False color images of 1986 0n the left and 2006 **on the right**

Figure A and B were taken in 1986 and 2006 respectively. They show the status of forest cover in the two periods separated by 20 years. The loss of forests in Laikipia escarpment is noticeable when we compare the 1986 image (left-Figure A) with the 2006 image (right-Figure B). The dark red colouration on the left hand side of each image represents forests, whereas the lighter red at the northern tip of Lake Bogoria represents the marshlands. The dark red colouration (forest cover) is thick in the 1986 image but thins away in the 2006 image. This is a massive loss of forest cover.

Plate 5.5 Shows massive deforestation of the Laikipia escarpment. Dense human settlements can be seen in the foreground. Deforested areas become very vulnerable to erosive agents such as rain water and wind. The silt ends up in river Waseges to be deposited either in the swamps or in Lake Bogoria.

5.6.7 Wetland Vegetation

Wetland areas that include the two large swamps of Loboi and Kesubo were, as at 1986 image analysis covering an area of 7,107acres. But in the 2006 image analysis only 2,859 acres of land was classified as wetlands. A decrease of 4,248 acres or a 2.23% reduction relative to the total land cover in the study area. Table 5.28 shows the acreage conversion of wetlands to other land cover types and vice-versa. Only 817 acres of land remained classified as unaltered wetland area. A massive 5,889 acres of what was in 1986 classified as wetlands had been converted to bushes and/or woodlands and only 253 acres of what was classified as wetlands in 1986 had been

classified as farms/grass/bare land. Table 5.24 Wetlands cover converted to and/or recovered from other land cover types.

Table 5.24 Wetlands converted to and/or recovered from other Land Covers

Area of wetlands converted to:	Forest vegetation	Bushes/ woodlands	Farms/Grasslands Bareland	Total area converted
	145Acres	5,889Acres	253Acres	6,287Acres
Area of wetlands gained from:	Forest Vegetation	Bushes/ woodlands	Farms/Grasslands Bareland	Total area gained
	712 Acres	1,273Acres	55 Acres	2,040 Acres
Net wetland loss				-4,247 Acres

Source: Author's 1986 and 2006 image analysis

It should be noted that the satellite image was taken during the hottest month in the region. At this time the rivers draining into the wetlands had dried up. River Waseges for example, was no longer flowing into the Kesubo swamp, and the Papyrus vegetation had been fed on and trampled upon by animals, hence drying up. In many parts of the wetland, original vegetation, such as the Cattails (Typha) and the reeds (Phragmites) had been degraded and replaced by bushes/grasses and isolated trees. According to Goudie, (1988) when relieved of competition from palatable plants or plants liable to trampling, resistant and usually unpalatable species expand their cover**.** This alters the diversity and species composition of the wetlands.

Low or no waterflow to the wetlands, allows grazers and crop-cultivators to make easy inroads into the swamp. They clear native vegetation and introduce or allow exotic species to be established. Together grazing and crop-cultivation add competition over the use of water. that previously flowed uninterupted into the wetlands. In the process the wetland ecosystems lose valuable fauna and flora due to altered ecological conditions. The wetlands ecological integrity is undermined as the wetlands lose their basic characteristics. Eventually the wetland dries up and turns

into pasturelands or crop farms as shown in Plate 5.9. In other words wetland vegetation conversion into cultivable land undergoes through the transition of bushes, wooded grasslands and grasslands then opens up for crop cultivation or pastureland.

Plate 5.6 Livestock grazing at the edge of Loboi swamp

(Photo by the author, 1/05/2015).

Plate 5.6 shows a piece of grazing land in the foreground that according the Chairman of Lake Bogoria WRUA (2015) was at one time part of the Loboi swamp, but as the swamp receded under grazing pressure degradation resulted. During the wet season the moisture level rises, allowing good growth of pasture. The land is therefore, only suitable for grazing during the wet seasons. The drying up of swamps and the associated reduction of the biodiversity has diminished the availability of food and nesting places for migratory birds, which are major tourist attractions. It was reported that many migrant birds were seeking wintering sites in other wetlands as a result (Kimaru Park ecologist, 2010). Such trends have significant and lasting impact on the

regional and national economy in view of the fact that tourism is the major foreign exchange earner for Kenya.

The above discussion becomes clearer as one looks at the satellite images for 1986 and 2003 below; reproduced here under the courtesy of Global wetland images (2008). The images show, in true color (superimposed on false color composite) the spatial spread of both Loboi on the left and Kesubo swamps on the right. The green colouration represents the wetlands. The 1986 image on the left shows both the Loboi and Kesubo swamps, spread out over a wide spatial area. In contrast the 2003 image shows the two swamps having diminished in size over the 17 years period, between 1986 and 2003.

The 1986 image shows river Waseges descending the cliff at Mbechot. After the cliff, the river enters a low gradient plain, thus reducing its velocity. Consequently, heavy sediment loads from the higher grounds are deposited to form an extensive alluvial fan called Sandai fan. During the rainy season rivulets are cut through the Sandai fan, eventually forming a delta-like structure. It is important to note extensive deposition of silts forced River Waseges to change direction. In the past, the river flowed northwards into Lake Baringo (Owen, et al, 2004), but increased sedimentation caused it to change its course in 2008 to drain into Lake Bogoria (Kiptek, 2015)

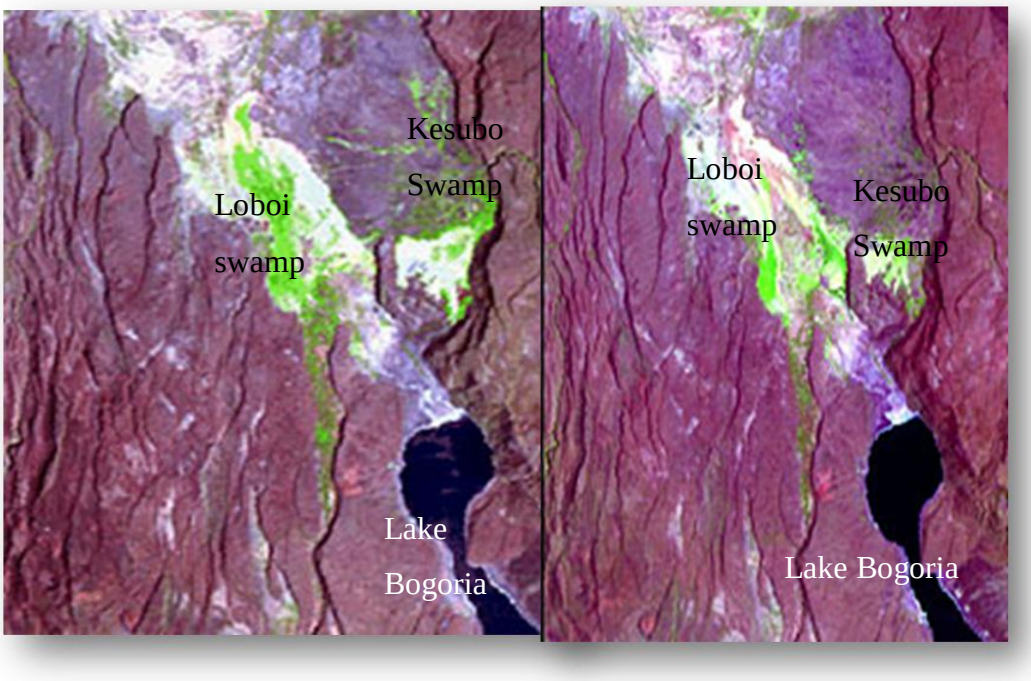


Figure 5.20 False colour images of 1986 left and 2008 right

(Reproduced from Global Wetlands: 2008).

This act had three immediate effects: (i) It reduced the volume of water hitherto flowing into Kesubo swamp; the swamp became more open to grazers and cultivators, (ii) allowed easy invasion of plant species that could not have survived under the previously water-logged conditions and (iii) it made it far much quicker for potential farmers to clear areas that were hitherto occupied by swamps. According to the Marigat agricultural officer, Kesubo swamp has been fully been converted from a swamp to irrigation farms.

5.6.8 Summary of the Section

The satellite image analysis has shown that not only did the area under wetlands and forests decline over the 20 year period, but other land cover types were also affected by encroachment of human activities. Degradation and loss of forest land was triggered by political decisions to solve problem of landlessness.

Crop cultivation, however, was extended beyond the legally excised forest land to the protected forest land. The situation was compounded by the presence of commercial timber merchants and a government policy that allowed the local people to intercrop trees with food crops in the protected forests; encumbering institutionalized control and regulation measures. Together all these activities led to forest destruction with serious implications on water catchments.

Deforestation of the upper catchment areas led to seasonal fluctuations in the river discharge adversely affecting irrigation agriculture, as it added more silt to the water pans, water dams and the wetlands. The seasonal variations in stream flow were critical because they affected the farmer economy and were a source of water resource use conflicts.

The related lowland wetland ecosystems were also degraded by a combination of factors, all emanating from human economic activities of animal grazing and crop-cultivation. Although these economic activities were not new to the people, it has been shown that the dynamics of the wider national and global economic environment have introduced a new mode of operation that tilts the balance in the man-environmental relationship towards more environmental destruction. For instance, degradation of wetlands ecosystems arose mainly from reduced water supply and encroachment by grazers and cultivators in response to prevailing external market opportunities for seed maize and horticultural produce. Eventually natural ecological succession adversely altered the ecology of the wetlands.

5. 7 Dry Land-Wetlands Ecosystem Services

The second objective was to assess the traditional values and uses of wetlands and the impacts of loss and degradation of these ecosystems on people's livelihoods. The

guiding research question was: What is the future implication for wetlands-dependent livelihoods? It is important to note at the outset that there is a close historical association between the inhabitants of Baringo County dry low lands and the wetland ecosystems. At whichever stage of cultural and economic development, from hunter-gathering to modern scientific intensive farming communities, there was and has always been useful resources drawn from the wetlands, to satisfy certain ceremonial requirements, medicinal products (herbs), cottage industrial raw materials, water and food (Kareri, 2007). These direct and indirect benefits society receives from the landscape are collectively termed ecosystem services (Chan, 2013). The concept of ecosystem services is emerging as a strategic framework within environmental governance, which seeks to place values on ecosystems on which humanity depends (Moore, 2010). The following sections detail some of the known wetland ecosystems services that the people living in South Baringo County lowlands obtain from the wetlands to enhance their socio-economic well-being.

Aridity characterizes the South Baringo lowlands therefore; wetlands play a critical role in the provision of direct and indirect means of livelihood. People draw water and extract vegetables and fruits directly from the wetlands. A number of livelihood activities such as crop-cultivation, animal grazing and production of raw materials are also based on the wetlands. Thus, the people's livelihoods tend to oscillate around these ecosystems. Understanding the benefits drawn or costs incurred by the people living around the wetlands, is therefore, important as governments and other agencies embark on development of interventions to secure the wetlands. This is because successful interventions should balance conservation needs and people's livelihoods.

Table 5.25, below contains a list of a few important ecosystem services that people draw from the wetlands. Some of these services such as water are directly consumed whereas others such as pasture and fuel wood are consumed indirectly via products that they assist in production.

Table 5.25 Wetland Ecosystem Services from Loboi and Kesubo Swamps

Wetland ecosystem services	Responses (Dependences)	
	Number of Respondents	Percent of the Respondents
Firewood/Herbs	75	15.7%
Industrial Raw Materials	13	2.7%
Water	39	8.2%
Vegetables/Fruits	94	20.0%
House thatch	77	16.1%
Animal feed/Pasture	103	22%
Posts/twigs/ropes	77	16.1%
Totals	**478**	**100%**

Source: Author's field data (2014)

5.7.1 Provisioning of Animal Feed/Pasture during the Dry Season

The livestock economy is very central in the cultural and economic aspects of people's lives in these arid and semi-arid lands. In the communal setting transhumance was ubiquitous, today animal grazing is confined in few places, where pasture and water are available. The wetlands are therefore, depended upon to support this sector in terms of feed and water. They provide valuable sources of animal feed grazed in situ or cut and carry for stall-feeding. The latter system is commonly used to deliver fodder to sick or very weak animals or calves that are normally left behind at the homestead; as healthy and mature animals are driven out to graze. Table 5.24 shows that 22% of the respondents use wetlands to either harvest animal feed or graze their animals in situ.

Figure 5.22 below further underscores the importance of wetlands during the dry season. It shows that 41.9% of respondents graze their animals in the swamps, while 36.2% of the respondents also find pasture in the river valleys. The river valleys hold water in depressions even when the river bed is dry. These water drainage channels support green vegetation that is palatable to animals. Only 9.3% of the respondents move their animals to graze in distant places, while 12.6% also graze on their own land. As discussed elsewhere in this chapter**,** only the rich and land propertied people are privileged to either graze on their expansive land or hire labor to drive their animals to greener pasture outside their immediate communities.

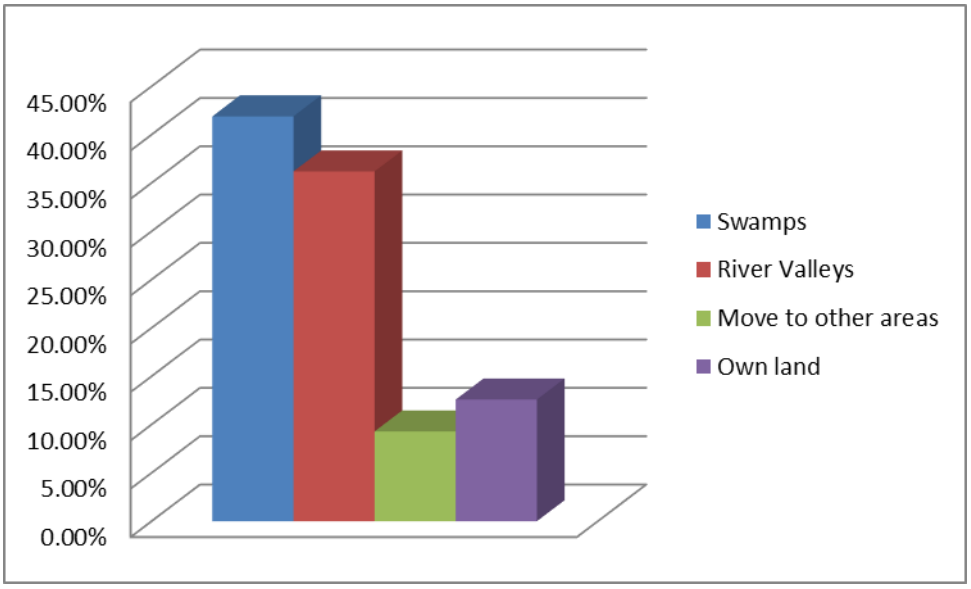


Figure 5.21 Animal grazing areas during the dry season.

Source: Author's field data (2014)

5.7.2 Water Supply and Local Food Security

Kesubo and Loboi are the two prominent swamps in South Baringo County lowlands. The latter is described as a large "sponge" that retains water and moderates its flow throughout the seasons (Ashley, et al 2004). Loboi swamp for instance, serves as a permanent fresh water source for people, animals and for maintaining biodiversity in

the region (Homewood and Lewis, 1987). Besides drawing water for domestic consumption from the Lobi swamp 8.2% of the respondents were also using the same source of water for irrigation farming. Water is the single-most important resource in these semi-arid regions of Baringo County. It has in the past sustained the pastoral economy and has today catapulted the economy to modernity through irrigated crop-cultivation.

Plate 5.7 River water flowing through the Loboi Swamp (15/05/2006, Photo).

5.7.3 Traditional Fruits and Vegetables

Traditionally, wetlands have provided the only source of indigenous vegetables such as the water cabbage (*narok*) that was considered a dry season delicacy among the Tugen and the Njemps people. At least 20% of the respondents named natural fruits and wild vegetables as some of the products harvested directly from the wetlands. Besides those wetlands products that have direct consumption utility, there are other wetlands products such as traditional herbal medicine extracted from hydrophytes found in wetlands. Firewood and medicinal products were other substances harvested from the wetlands by about 15.7% of the study population. According to Moore

(2011, p.180) “manufactured drugs are also widely available but medicinal plants and trees are an important resource as manufactured drugs are expensive and nearly all adults have some knowledge of herbal remedies, with a few more knowledgeable medicine women and men still within the community”.

5.7.4 House construction and Raw materials for handcraft cottage industries

The wetlands have over millennia served the local people with valuable sources of house construction materials. The traditional dwellings structures, however, were simply built and never posed any serious threat to the locally available raw materials. Today, not only have the traditional stores been enlarged but the houses have also been modernized acquiring rectangular shapes with many rooms. This escalates the demand for thatching and wall construction materials. The wetlands provide house construction materials including building posts, twigs, and thatch and tying strings for 16.1 % of the study population.

Plate 5.8 A Traditional house thatched with wetland materials

(Photo courtesy of Moore, 2010)

The diverse plant species in these ecosystems provide raw material for cottage

industries. Papyrus (Cyperus papyrus) is the commonly harvested raw material for handcrafts-making such as mats, carpets and baskets. Although this art is not widely practiced in the region, a sub-group of the Tugen people called the Endorois has perfected the art and has popularized it as a viable income-generating activity. Only 2.7% of the respondents were engaged in this art. The art continues to gather importance as efforts are made to promote its products among tourists. (County, Tourist Officer, 2010). For instance, the Endorois people are today making decorative mats, carpets, and other highly valued items for external sale and not for local consumption. A study by Terer, et al (2012) focusing mainly on the utilization of Cyperus papyrus L. (papyrus) captured people's fears that, diversion of water from the swamp, and frequent droughts may undermine future supply of the papyrus products, in spite of the instituted traditional management strategies.

5.7.5 Earnings from Nature-based Tourism

The Loboi plains wetlands provide vital habitats for aquatic and terrestrial plant and animal species including birds. Hence, they act as tourist attraction sites being the home and nesting places for migratory birds. The Lake Bogoria national park education officer gave an approximate figure 310 and 50 migratory bird species that are were counted in 2010. Tourism is an important foreign exchange earner at the national level and source of livelihood for local communities (GOK, 2003). Bird watchers from many parts of the World visit the wetlands in the Lake Bogoria Game reserve annually. Besides the rich wetland biodiversity, the local vegetation of not less than 210 plant species dominated by the acacia variety, provide spectacular beauty to the plains (Mr. Komen, personal communication, 2010). The gate fee is shared in an agreed proportion between the government and support to local community development projects.

Plate 5.9 Showing birds and birds' nests in and around the wetlands in the dry lands

5.7.6 Section Summary

In summary it has been shown that the wetlands support diverse forms of economic activities and livelihoods; including provision of food, water, and animal fodder, building and construction materials, aesthetic beauty and sacred places for social-cultural activities. However, wetlands continue to be a threatened ecosystem because of the perceived benefits that accrue to their unique biophysical nature. Encroachments into these ecosystems introduce dangers of degradation of these valuable resources. Without decisive actions to protect these valuable ecosystems they are soon to be annihilated, at a great cost in terms of the loss of products and other ecosystem services.

5.8 Possibilities for Protection and Conservation of dry land wetlands

The last objective of the study was to suggest possible culture--based and/or policy interventions to stem wetland loss and degradation. The guiding research question was: What attributes; endogenous to the community that can be harnessed in support of wetland conservation efforts? This objective therefore, is a summation of observations made so far, on how people perceive the wetlands and how their perception could provide an opportunity for wetlands protection and conservation.

The results of the image analysis exercise reported in chapter revealed that the wetlands in the study sites had spatially decreased by about 4, 247 acres (or 2.23%) over the period 1986-2006. This finding confirms that the wetlands are a threatened ecosystem, and unless appropriate decisions are made and wisely implemented, this century might be the unfortunate witness of the demise of Loboi plains wetlands. The demise or survival of wetlands is in the hands of the people, who draw benefit or suffer due to the presence of these ecosystems (Kareri, 1992). In this regard a question was raised seeking to find out whether wetlands should be protected or not. The question was extended to capture the reasons for protecting or not protecting.

Table 5.26 shows that 27.4% of the respondents were willing to conserve the wetlands for wildlife protection so as to promote tourism. Next highest score of 24% was to protect wetlands as a source of food/raw materials. The least score of 12.3% was to protect wetlands as a source of water, whereas 14% viewed these ecosystems as important sites for social-cultural activities. In total 78% of the respondents expressed a willingness to protect/conserve the wetlands, and only 22% found no good reason for protecting/conserving the wetlands.

Table 5.26 People's reasons for conservation of wetlands

Reasons for conservation of wetlands	Responses		Percent of Cases
	N	Percent	
Wildlife/ tourism	49	27.4%	45.4%
Source of water	22	12.3%	20.4%
Social-cultural	25	14.0%	23.1%
Food/ raw-materials	43	24.0%	39.8%
None of above	40	22.3%	37.0%
Total	179	100.0%	165.7%

Source: Author's field data (2014)

High scores are on wildlife/tourism (27.4%) and food/raw-materials (24%). The latter are products such as food and construction materials directly consumed by households and the former are indirect benefits derived from the tourism trade which occurs due to the presence of wetlands. Therefore, wetlands conservation is viewed as an economically beneficial activity that supports people's livelihood requirements. But often than not, the livelihood question rarely comes into the purview of the researchers and/or the decision makers, as rightly pointed out by Fisher, R.J et al (2005). Fisher argued that in the process of promoting conservation, conservationists have, to a considerable extent, ignored its costs to poor peoples' livelihoods, and the inequitable distribution of these costs. Therefore, success in wetlands conservation programmes must prioritize initiation of projects that would empower people to meet their livelihood requirements.

Social/cultural reason for conservation of wetlands also scored highly at 14%. This underlines the importance of these activities among the local communities. It has been shown, for instance, that among the Tugen, Endorois and Njemps wetlands have a cultural importance that dates back to the mythology of their origin, hence they are

accorded status of "sacredness". On an equal measure also, wetlands constitute a very strong component of the pastoral economy in these semi-arid lands. Without them, pastoralism as a livelihood and a way of life would not have maintained the traditional form and practice that is known today. These attributes provide reason for the people to protect the wetlands; hence they provide an important entry point for wetland conservation projects.

The Endorois, are a people who are said to have very deep ecological knowledge of wetlands. Using this local ecological knowledge they have managed to strike a balance between the rate of harvesting of the papyrus and its regeneration (Terer, et al. 2012). In other words, the wider goals of wetlands conservation can be realized by ensuring Loboi and Kesubo swamps are managed by the people, borrowing heavily from their traditional social structures, so as to effectively control and regulate the use of these fragile ecosystems in harmony with their culture.

Wetlands the World over have also been associated with negative attributes that may deter the communities' desire to protect them. In Table 5.27 below there three main reasons that discouraged people from protecting wetlands namely; (1) that they hamper tsetse flies/mosquitos (28.2%); (2) they provide suitable habitats for wild animals, that destroy their crops (25.5%) and (3) that they take up grazing land (19.5%). These are important factors to consider when implementing wetland conservation projects.

Table 5.27 people's Reasons for not willing to Conserve Wetlands

why not conserve wetlands	Responses N	Responses Percent	Percent of Cases
Tsetse flies	42	28.2%	77.8%
Wildlife destroy crops	38	25.5%	70.4%
Takes up grazing land	29	19.5%	53.7%
None of the above	40	26.8%	74.1%
Total	149	100.0%	275.9%

Source: Author's field data (2014)

The perception that wetlands provide habitat to wildlife that destroy crops (25.5%) and also hamper tsetse flies (28.2%) which infect man and animals with Trypanosomiasis were the strongest reasons given, that would deter people from engaging in efforts that would appear to protect or conserve wetlands. Human African Trypanosomiasis and African Animal Trypanosomaisis, are highly prevalent parasitic vector-borne diseases in sub-Saharan Africa (Grady, Messina and McCord, 2011). Wetlands were also perceived to take up animal grazing land (19.5%). These are parts of the wetlands that are inaccessible to animal grazing, since they are waterlogged.

5.8.1 Section Summary

In summary it has been shown that wetlands ecosystem services have contributed enormously to social economic well-being of the Loboi plains inhabitants. Not only do people directly obtain goods and services from the wetlands but there are innumerable indirect benefits that accrue to the people due to the presence of wetlands. These positive attributes give support and justify in people's minds the reasons for protecting and conserving wetlands.

However, there are also nuisances associated with the wetlands. The most undesirable

being their capacity to hamper wild animals and umpteen insects that infect man and his animals with deadly diseases. The willingness to accommodate the negative externalities arising from the presence of wetlands will be determined by the balance of benefits over costs. The government can intervene in form of compensation, to minimize the negative externalities so as, to realize the intended objective of sustainable use of wetlands.

5.9 Chapter Summary

The study's central concern has been the broken balance, between utilization and conservation of wetlands, as the pastoral economy modernizes. A suitable theory to guide the analysis was found in Susan George's (1979) postulates, that the interaction between the modern and traditional economies always distorts production goals of the latter in favour of consumption priorities in the dominant society. A historical exposition to the research question helped us to trace land use changes in the pre-colonial, colonial and post-colonial periods. The inhabitants of the present day Baringo County lowlands were shown to have lived harmoniously with nature. Existing cultural institutions ensured sustainable use of natural resources, particularly, the grazing land. On the other hand the region covering the upper catchments of the River Waseges had very low population densities so that the impact on the natural biophysical resources was insignificant.

For instance, the coming of colonial authority in Kenya affected the way traditional institutions managed local natural resources such as land, forests and wetlands. The colonialists introduced English-styled land tenure system, which gave land, new meaning and significance. Prior to introduction of the new land tenure system, land was viewed as a common resource for societal use. This old perception of land

changed as land became a commercial asset, which could be sold and mortgaged for commercial loans. Land consolidation, adjudication and registration not only displaced people but it instrumentally interrupted the traditionally known resource management systems, which were sustainable and productive.

Social classes emerged based on unequal accessibility and entitlement to the land resources. The poor were marginalized, relegating their land occupations to the peripheral areas that were less productive. In the meantime productive land was carefully apportioned to lucrative enterprises. For instance, the fertile soils in the upper high rainfall Lake Bogoria catchments were transformed from pastoral grazing areas into small, medium and large scale cash crop production farms.

Theoretically, it is possible to have an all–year round crop production that is sustained by continuous water supply from the river Waseges, its tributaries and lowland wetlands, but in practice the emerging pressure occasioned by land use intensification only ends in land degradation and loss of biodiversity. The Wetlands within the Loboi plain have over millennia provided ideal dry season grazing grounds, but due to encroachment of crop-cultivation , grazing land has become restricted, a fact that has been widely acclaimed to be the cause of wetland loss and degradation.

The initial land cover/land use was possibly covered by forests, woodlands, wetlands, bush lands, grasslands or a myriad combination of these different land cover types. However, as demographic variables changed, reinforced by forces of modernization and development; the initial land use pattern is disturbed, transformed and changed into other forms that were unknown in the society. Encroachment of cultivation agriculture onto the wetlands replaced the wetlands natural vegetation with domesticated plants such as high value grain-crops, fruits and vegetables.

In the meantime deforested upper catchment areas become invaluable source of sediment load, carried down by the rivers to be deposited in the wetlands. The sediment so deposited suffocate wetland plants, by reducing the duration that wetlands retain water, which Wang (1994) argue change plant community structure. Thus, invasive plants such as *prosopis juliflora*, *Acacia reficiens and Dodoaea viscosa* (Herlocker, 1994) find an easy entry into the wetland ecosystem. Furthermore, animal grazing in wetlands reinforces the damage caused through stampeding which hardens the soil surface reducing root penetration of some plants and hence stunting their growth. The situation is exacerbated by seasonal flooding; which claim massive areas of pastureland. Eventually, the ecosystem loses it basic characteristics and degrades with time.

CHAPTER SIX

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

The current study has focused on a number of aspects relating to land use/cover changes and conservation of dry lands wetlands. The hydrological relationship between the humid highlands and the dry lowlands has been discussed with respect to deforestation and its impact on the river discharge. The question of the traditional values and uses of these wetlands has been addressed, by referring to the place of wetlands in the traditional pastoral economy and the locally emerging market economy.

The Baringo lowlands were traditionally occupied by nomadic pastoralists who practiced transhumance, to minimize overgrazing. Furthermore, impacts of environmental hazards such as droughts were mitigated through kinship networks of animal lending and borrowing. The frequent food shortage that was later to characterize the semi-arid Baringo County lowlands was unknown. But over the years, the pastoral community changed its social organization, in response to population pressures, societal values, government development policies and other forces of modernization and development. These internal and external forces have in turn dictated the use and methods of management of the locally available natural resources.

Although change was inevitable, it had and continues to have the consequences of destabilizing the traditional harmony between man and the environment. For example, introduction of modern systems of governance of natural resources diminished the traditional authority vested in the council of elders “Okeri”, with dire consequences

on the wetlands. Thus, the seasonal grazing systems, in and out of the wetlands gave way to “open access regime” culminating in competition over the use of wetland resources. Hence, wetlands were encroached by cultivators and grazers in a manner that caused irreversible degradation. Furthermore, the colonial and post-colonial governments initiated social and economic changes, aimed at transforming the pastoral economy, by encouraging sedentary lifestyles based on crop-farming. These changes adversely affected the dry land wetlands, since they had to be drained to give way to crop-cultivation.

Moreover, the volume of river water draining into the wetlands was highly reduced by the need for irrigation waters. The situation was aggrieved by extreme seasonal variations in river flow. The rainy seasons became characterized by high river regimes, often accompanied by floods, erosion and heavy suspended loads. The silt that is deposited into the wetlands suffocates some wetland plants, thus diminishing their number. On the other hand the dry season is characterized by prolonged aridity, and hence low moisture availability for plant growth. Combined the two phenomena adversely affect the quality of wetlands.

This chapter contains a summary of the main aspects of the study pertaining to land use changes and their impacts on wetlands and people’s livelihoods. The chapter is divided into four main sub-sections namely; this introductory section is followed immediately by the main research findings, conclusion, and then recommendations of the study to the government planners and other stakeholders, and finally an outline of further lines of research for scholars and other researchers.

6.2 Summary of the Main research Findings and Conclusion

On the basis of the available evidence assembled and discussed in the preceding

chapters, the following aspects were noted in relations to land use/cover changes, the drivers of land use changes and eventual impacts on wetlands and people's livelihoods. In the upper catchments of the River Waseges, a humid to sub-humid climatic condition prevails, which is very ideal for forestry and other forms of land uses including highlands crop cultivation and dairy animal husbandry. On the other hand the Baringo lowlands are characterized by aridity. Therefore, the presence of wetlands in the dry lands of Baringo County raises many questions with regard to their origin, ecology and ability to sustain continued onslaught by man and animals in these semi-arid lands.

The first specific objective examines the nature and magnitude of land use/land cover changes, their related causal factors and consequent impacts on the lowland wetlands. The aim was not only to focus on the land use/over changes, but also to isolate for discussion the main drivers of land use change. Hence, a historical approach was adopted to investigate the pattern of land use change and the causal factors. This is also in line with our conceptual framework that underlines employment of a historical approach to understand the temporal dimensions of interactions between society and environment.

Documented literature and oral accounts from various sources were consulted to provide the basis for the historical analysis. It became clear that the advent of colonialism set the stage for forests and wetland degradation. In the upper catchment areas of the River Waseges, large tracks of forest land were clear-felled; initially to allow colonial land settlements and later on, in the post-colonial period to settle people who had either been displaced from their ancestral land and/or for political expedience. Satellite images showed that Marmanet forest alone lost 7,052 hectares

of forest land between 1990 and 2000 through forest excisions and illegal encroachments (WRI, 2000). These forests were the traditional highlands free grazing zones of the Tugen and the Njemps. Therefore, the decision by the two administrations denied the two communities their dry season fall-back grazing land, confining the herding communities around the wetlands. Furthermore, deforestation in the upper catchment areas increased soil erosion and deposition of silt in rivers, water dams, pans and eventually to the lowland wetlands.

The post-colonial period, particularly in the 1980s and 1990s witnessed greater influx of people into the Bahati and Marmanet forests. Land use intensification increased as high value horticultural crops were grown under irrigation in green houses, alongside small scale labour intensive irrigation farming. The two systems contributed to withdrawal of large volumes of water from river Waseges and its tributaries; minimizing the flow of water downstream. Reduced river discharge affected the ecology of the wetlands and biodiversity of the riparian forests.

In the meantime, the government's policy of modernizing the lowlands pastoral economy led to more and more people into sedentary agricultural production. The transition from nomadic pastoralism to sedentary agriculture had progressed very well by the time of the study in 2014. Eighty eight (88%) of the respondents were classified as agro-pastoralists and only 0.9% of the respondents claimed to be pure pastoralists. At least 4.6% of the respondents were wholly occupied in farming activities, another 6.5% of the respondents combined agro-pastoralism with some form of businesses.

The immediate impact of highlands' settlements and embracement of sedentary agriculture among the lowland pastoralists was a change in the landscape. The

lowlands respondents were unanimous that land cover, since their settlement on crop-cultivation had changed in different magnitudes. Forests and wetlands were seen to have declined by 35.1% and 23.4% respectively. Woodlands and bush-lands also declined by 22.1% and 19.5% respectively. These observations by the respondents were corroborated by satellite image analysis, that revealed forests and wetlands had diminished by 8,789 acres and 4,248 acres respectively over a period of 20 years. The wetlands lost a total of 6,287 acres, of which 5,889 acres of the land was converted to bushes/woodlands and 253 acres was converted farms/grasslands/bare land. Forest on the other hand lost a total of 11,474 acres of which 6,087 acres were converted to bushes/woodlands and a further 4,675 acres were converted to farms/grasslands/bare lands.

The Baringo lowlands respondents were of the opinion that the loss of forests and wetlands was due to; increased crop-cultivation (28.8%), high population growth rate (25.8%) and Climate change at 23.5%. Other minor factors identified were, changing land tenure system (14%) and increased livestock (8%). These findings were critical because they showed the close association between expansion of crop-cultivation, reinforced by high population growth rates and the observed land use changes.

Modernization of the pastoral economy changed the pastoral economy through increased interactions with other societies. In the process, exchange of merchandise between the Baringo lowlands land users and distant traders increased. External trade interests emanated from fact that the region had a natural advantage in irrigation farming. Consequently, several agro-business firms were set up in the region; including maize /sunflower seed producing companies. These companies (mainly the ‘Kenya Seed’) would contract farmers to grow maize seed, assuring them of technical

support, including a ready market. The price paid for one kilogram of seed maize in 2010 was kshs.50/kg, which was far much higher than kshs.30/kg offered for regular maize in the market then.

The growth and expansion of commercial farming in the Baringo lowlands meant that the government had to invest more on improvement of road transportation so as to achieve wider marketing opportunities for the farm produce. About 35% of the farmers had access to a local market and 26% were on contract farming. Sale through co-operative marketing societies was least at 15.9%, as middlemen took their share at 23.3%. As a result more land was allocated to commercial seed and horticultural production; serving more the needs of the external market rather than for local sale and subsistence.

Consequently, irrigation agriculture was adopted by an overwhelming 71.3% of the respondents and 58.3% of the respondents were of the opinion that the number of cultivators was increasing, because crop-cultivation had become a lucrative business activity. As more land was turned offer to commercial crop production, less land became available for animal grazing; the grazers were condemned to the peripherals of the quality land. Animal grazing had to give way to crop farming. It is therefore, evident that the pastoral economy in its traditional form and practice was no longer tenable.

Finally, promotion of school and vocational training were identified as potent forces in land use change. At least 31% of the 108 respondents aged between 20-34 years had attained primary level education, 10.2% had attained secondary level of education and 0.93% had graduated into a tertiary institution. It is in this group of young and educated people that the dynamism of change lies. As more young people join the

farm production sector, the traditional institutions may no longer execute the same level of authority as in previous traditional arrangements. Farming may no longer be viewed as a way life but a business to be managed within the acceptable business standards. A new economy, then emerges, an economy that is firmly linked to the national and international free market system.

6.3 Impacts of land use Changes on the lowland wetlands

The hydrological link between the Loboi Plains and the humid highlands to the South is the River Waseges that originates from the Bahati and Marmanet forests. The status of these watershed areas is critical for the ecological stability of the lowland wetlands, because it determines the regularity of the river flow.

The changing land use systems have had lasting impacts on the wetlands. For instance, Kesubo swamp had been so deeply encroached by both grazers and crop-cultivators that it had lost most of the ecological characteristics of a wetland. Together, grazing and crop-cultivation add competition over water supply, that previously flowed uninterupted into the wetlands. Deliberate efforts are made to divert the river waters through dug canals, away from the swamp to the crop lands. In the process the wetland ecosystems lose valuable fauna and flora due to altered ecological conditions. The wetlands ecological integrity is further undermined by siltation which suffocates some endemic wetland species. Eventually the wetland dries up and turns into pasturelands or crop farms. The farmers clear the endemic wetland vegetation and introduce or allow exotic species to be established. It is therefore, clear that the changing land uses in the upper catchment areas of river Waseges have had direct and indirect effects on the ecology of wetlands and land use practices in Loboi plains.

The second objective sought to assess the traditional values and uses of wetlands and the impacts of loss and degradation of these ecosystems on people's livelihoods of the ASAL people. Because of the aridity that characterizes the lowlands, wetlands have played a critical role in the provision of direct and indirect means of livelihoods. Several products listed from the questionnaire enquiry were said to have had enormous contribution to the household economies. Some of the products such as water and wild vegetables and fruits had direct consumption utility whereas others, such as pasture and crop lands were indirectly consumed. The local communities also harvested house construction materials from the wetlands. Besides, wetlands are critical sources of raw materials for the local cottage industries such as basketry.

Besides, the wetlands provide breeding sites for rare bird and animal species that add another aspect to the scenic beauty that attracts tourists to the region. The tourist trade is both a direct and indirect source of people's income. Tourism creates direct employment in the hospitality industry and indirectly encourages development of infrastructure that enhances efficiency in other sectors of the local economy. This underscores the need to ensure that the ecological integrity of wetlands is maintained for the betterment of economic well-being of the ASAL people.

There are, however, some negative externalities associated with the presence of wetlands; such as provision of suitable habitats for harmful insects and wild animals. Government intervention is therefore, invited to minimize these negative externalities through compensation.

The third and last objective was to suggest possible culture-based and/or policy interventions to stem wetland loss and degradation. It is instructive to note that the willingness to conserve wetlands in a today's modernized economy is determined

more by the economic returns accruing to conservation efforts vis-à-vis alternative uses of the same piece of land. Therefore, individuals left on their own volition may not find it lucrative enough to justify their use of time and/or money on such efforts. A multiple approach that including; creation of awareness of the direct and indirect benefits of wetlands to other life forms, compensation for maintaining wetlands on private land, legal protection, possibly fencing out wetland areas, and where applicable incorporate traditional institutions that were vested with the management of local natural resources.

It has been shown, for instance, that among the Tugen, Endorois and Njemps wetlands have a cultural importance that dates back to the mythology of their origin. On an equal measure also, wetlands constitute a very strong component of the pastoral economy in these semi-arid lands. Without them, pastoralism as a livelihood and a way of life would not have maintained the traditional form and practice that is known today. Directly wetlands have provided food and medicinal products and other useful materials that have ceaselessly supported the pastoral economy. Culturally wetlands have been viewed as sacred places of worship. These attributes provide reason for the people to protect the wetlands; hence they provide an important entry point for wetland conservation projects.

Successful wetlands conservation strategies must therefore, be based on the traditional values and uses of these ecosystems. In some communities social-cultural activities rotate around the wetlands, hence people have intimate knowledge and understanding of the physiological requirements of wetland plants. The Endorois, for example are a people who are said to have very deep ecological knowledge of wetlands. Using this local ecological knowledge they have managed to strike a balance between the rate of

harvesting of the papyrus and its regeneration (Terer, et al. 2012). In conclusion therefore, the wider goals of wetlands conservation maybe realized by ensuring Loboi and Kesubo swamps are managed by the people, borrowing heavily from their traditional social structures, so as to effectively control and regulate the use of these fragile ecosystems in harmony with their culture.

Furthermore, these people have had traditional institutions ("Olkeri") that regulated use of the community's natural resources. These institutions inculcated values that advocated collective management and collective responsibility over local natural resources. Punitive measures were taken against deviants. Although it has been observed that these traditional institutions had lost much of their authority to formal government institutions, there still exists a hierarchical structure of authority based on age-sets, which can be captured and promoted to bridge the gap in decision making between the people and the government agencies. This action adds credence to decisions taken over the management of natural resources, by government agencies, since people's input is seen to have been incorporated in the process of arriving at the final decision.

Greater success may be achieved if the proposed action to protect or conserve the wetlands is synchronized with activities that address people's livelihoods. This is because people's pursuit for livelihoods tends to undermine environmental conservation. Therefore, any program on wetland conservation must seek ways of empowering the people to meet their livelihood requirements.

Acknowledging the fact the wetlands are continually encroached to provide products that serve the outside market, the pressure on the use of these resources will definitely escalate with time. To ease the pressure, the pastoral economy maybe diversified

through value-addition of the locally produced goods such as honey and medicinal plants (*Aloe Vera*) and promotion of markets for such products to minimize overdependence on wetlands.

6.4 Conclusion and Recommendations to Planners

Modernization of the pastoral economy has been shown to have disruptive effects on the traditional wetlands management systems. This is because the strategies adopted to introduce changes among the pastoralists were based on the premises of transformation. There was failure to incorporate ideas and traditions of the ASAL people. Thus the traditional methods of resource management had to be transformed in order to accommodate the production of crop plants that yield saleable goods for the external markets. Food crops were produced for sale not for domestic consumption. Hence, crop-cultivation was not the panacea to persistent food insecurity in the ASALs.

Although the government policies with respect to the ASALs have tended to emphasize sedentary lifestyles as opposed to nomadism, it must be appreciated that pastoralism is a way of life for the most people, and that it is the most sustainable system of utilization of the rangelands. Commercial agriculture that has come to dominate crop-farming in the Baringo County lowlands faces challenges of ecological sustainability. Salinization and sodification are often associated with irrigated areas in semi-arid lands or soil textural types impede the washing of salts out of the soil, which subsequently build up in the surface layers. Salinization greatly reduces soil quality and vegetation cover. Due to the destruction of the soil structure, saline and sodic soils are more easily eroded by water and wind. When land degradation occurs in arid, semi-arid and sub-humid areas it is known as desertification (EC, 2009).

It is suggested that planning and development of the ASAL regions should be based on an intimate understanding of these fragile ecosystems, and the culture of the inhabitants; and how this is reflected in their resource management techniques that have enabled these people to live harmoniously with nature through millennia. An approach that enables the ASAL people to identify their problems and seek desirable solutions that are acceptable and appropriate to their cultural setting is therefore needed. This is just about the only way to ensure the future sustainability of wetlands. Certain aspects of the people's culture carrying conservation traits should be incorporated into institutions, vested with making critical decisions on natural resource management.

It is instructive to note that the pastoral community has changed its social organization, in response to population pressures, societal values, and government development policies. These internal and external forces have in turn dictated the way the local resources are used and the methods of management applied. The monetary economy, for example has transformed the pastoral economy by changing the way people perceive land. Land that hitherto was satisfactorily used for animal pasture has been put into production of commercial crops that are seen to yield comparatively higher economic returns. The answer to commercialized agriculture is, therefore, focused on total drainage and full utilization of wetlands. Consequently, concerted efforts that may include legal protection are needed to ensure sustainable utilization of these resources.

Perhaps the non-existence of a government policy until 2013, to specifically address the plight of the wetlands, deepened both the direct and indirect onslaughts on these ecosystems. For instance, whereas the law was explicit on the use of forests and water

resources, it was silent on wetlands. The national environment policy of 2013 has captured the weaknesses of past sectoral policies and laws, that failed to see the 'forest for the tree.' It concludes that, "the sectoral rather than integrated and ecosystem approach to management of natural resources has proved inadequate in addressing environmental challenges." The devolved system of governance, based at the County level can take advantage of the small spatial geographical coverage to embrace an integrated development strategy.

Dickens, et al (2003) wondering why there are no procedures in place to protect wetlands in South Africa, say that the problem lies with the fact that, "Protection of wetlands requires protection of both the land uses around and within wetlands, as well as the water which feeds them and maintains their essential characteristics" In this regard protection of the Baringo lowland wetlands, must address the wanton destruction of forests in the catchment areas of the river Waseges. Deforestation has been shown to affect the river discharge causing seasonal floods and drought. Both phenomena have been shown to have adverse effects on the health of the wetland vegetation. Hence, there is an urgent need to stem deforestation and restore regular river flow in order to save the wetlands.

But restoration of the lost forest cover cannot be realized, without a simultaneous harmonization of sectoral policies and laws concerning agriculture, land, water, forests, trade and industry which have significant implications on the environment (GOK, 2013). The relevant County government agencies should be able to work in collaboration with the farmers, who suffer or gain from the ecosystem services endemic in forests. The research findings have made it clear that the local community harvest forest trees to serve domestic need for fuel wood, therefore, promotion of

farm forestry would reduce such destruction by making it easier for the farm families to obtain fuel wood from their farms. That is why the County agencies concerned with forests; water and agriculture must collaborate to decide on the best way to raise the percentage of forest cover, not only in the protected forests but also on the farms.

6.5 The way forward

Traditional approaches to watershed management were largely the subject of forestry and related hydrology. Watershed management was therefore viewed as a purely technical issue and all that was required was to ensure technical feasibility. The concern then was on ecological gains alone. People's participation and their livelihood considerations were missing. Hence, people looked covetously upon forests as resources denied them of their use by conservation laws. Attempts at encouraging farm forestry were also seen as coercive and therefore contested. The destruction of the watershed areas continued unabated with negative livelihood consequences on the lowland wetlands.

It has been established that pursuit for economic gains has been the greatest motivator for land use change in both the River Waseges catchments and the lowlands. The lowlands suffer water shortages, because the upstream farmers abstract rivers and divert water into their irrigation farms. A way must be found to ensure that both groups of land users benefit from the waters of river Waseges and other rivers flowing down from the highlands.

Regmi, et al (2009) have suggested an innovative approach to integrated watershed management in Rupa Lake Area of Nepal, which can be adopted with appropriate modifications to management of the River Waseges Watershed areas. Their decision was motivated by the past failure of the conventional approaches to watershed

management, to incorporate livelihood components in their structure. There was a tendency to over-emphasize potential ecological gains, in the absence of the people's livelihoods.

Regmi's et al (ibid) asserted the view that, concern for livelihood alone leads to over-exploitation of the resource and its eventual degradation. They took cognizance of the fact that communities living within the watershed areas have no motivation to invest on conservation that will benefit the downstream water users. At the same time, people downstream may not be willing to compensate upstream land users for the actual and opportunity costs incurred in the process of managing the watersheds. Therefore, they proposed application of the concept of payment for ecosystem services (PES), which they argued would be the best form of transaction between downstream water users and upstream land owners. It is assumed that the ecosystem service has been generated by the land owner, and therefore, it should be bought from him/her to secure the water-related benefits of a sustainably managed watershed (Machui and Otuki, 2015).

According to Bardecki (1984), it would be difficult to create a convincing economic argument for the preservation of wetlands, based on their return to the land owner, because many of the wetlands benefits are intangible public goods (i.e. a good which if available for one is available for everyone). In that light there is a clear case for government intervention, through a financing mechanism that compensates land owners for the opportunity costs incurred by maintaining the wetlands.

6.6 Further lines of Research for Scholars and other Researchers

This study had the immediate aim of analyzing land use/cover change and its impacts on dry land wetlands. It has been shown, however, that the study met both theoretical

and practical constraints. These short comings have created knowledge gaps that need to be bridged by conducting further research along similar or different lines.

We examined a wide spatial area, so as to bring a better understanding of the relationship between the lowland wetlands and the upper catchment areas of rivers flowing to the lowlands. It is recommended that specific studies be carried out on the two ecosystems separately, with a view to producing a detailed study focusing on management issues pertaining to each ecosystem.

Literature search and informed people's account have revealed the need to carry out further research on the effects of seed maize/sunflower production on family labour allocation and its relationship to other forms of livelihood. For instance, how is the family labour shared between the traditional livelihoods such as cattle grazing and the emergent commercial farm enterprises?

The study employed descriptive research, because of the merits of utilizing elements of qualitative and quantitative together within the same study. However, Borg and Gall (1989), have noted that, although the method is valid for researching specific subjects, it cannot identify causes. It therefore, calls for more quantitative studies. It is important therefore, that further studies with higher quantitative inclination be carried out in future to deepen our scientific understanding of the degree and magnitude of contribution of various variables to land use/land cover change.

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APPENDIX A1

Socio-Economic Questionnaire 1

Land use Practices in the Upper River Waseges Catchment.

This is an academic research being conducted by Raphael Wamithi Kareri of Moi University that is aimed at helping us to understand and learn your land use practices and their direct/indirect impacts on soil and water conservation. We also want to find out the challenges that you face as you attempt to conserve the environment through different methods that are applicable here. All the information that you give will be kept strictly confidential.

Location…….

Name of village/settlement**…….**

Gender of the respondent

i) male
ii) female

(1) Which of the following best describes your occupation?

i) Subsistence farmer

ii) agro-pastoralists

iii) Farmer cum business person

iv) Others (specify) ----------

(2) Were you born in this area?

(i) Yes

(i) No

(3) Which year did you settle here for agricultural activities?

(a)1970s (b)1980s (c)1990s (d) 2000s

(4) Which of the following best describe how your piece of land looked like at the time you settled here? (a) Thickly forested (b) Moderately forested (c) Slightly forested (d) Other (specify)

(5) What is the size of your land? (a) 0-2 acres (b) 2-3 acres (c) 3-4 acres (d) 4-5 acres (e) Over 5 acres

6) What agricultural activities do you engage in? (a) Livestock keeping (b) Subsistence crop-cultivation (c) cash crop-cultivation (d) Livestock keeping and crop cultivation (e) Others (specify) ----------

7) Would you considered soil erosion a problem in this area

(i) Yes (ii) No

8. How do you evaluate the trend of soil erosion problem in this area over time?

Now/2014	5years ago	10 years ago
Light	Light	Light
severe	severe	severe
Very severe	Very severe	Very severe

(9) If soil erosion is a big problem what do you see as the main cause of soil erosion in your area?

(a) Population growth (b) Cutting tress (c) Over cultivation (d) Irrigation farming

(e) Overgrazing (f) River stream discharge (g) Others (specify) -----

(10) To mitigate soil erosion, would you be willing make some of the following changes?

Changes willing to adopt	Strongly agree	agree	Not sure	Disagree	Strongly disagree
Prevent cutting of trees					
Decrease livestock					
Practice crop rotation					
Plant grass					
Practice terrace farming					
Build cut-off drains.					
Others(specify)					

11). What do you see as the main future threats to livelihood in this area?

(1) Food shortage
(2) Water shortage
(3) Firewood, Timber ,Poles and charcoal scarcity
(4) Population growth
(5) Overgrazing
(6) Shortage of animal feed
(7) Others (specify)----------

12). What is the source of water used often in the household for various uses?

(1) Nearby river
(2) Ponds
(3) Dams
(4) Piped water supply
(5) Boreholes
(6) Springs /streams
(7) Others(specify)----------

13). If you answer to 12 is river or stream, is the water used for irrigation farming?

(1)Yes (2) No

14). Does the household own a water pump to draw water from the river?

(1) Yes (2) No

15). W hat changes have you observed on the river discharge?

(1) Increased in quantity

(2) Decreased in quantity

(3) Increased in quality

(4) Decreased in quality

(5) Others (specify) ----------

16). What do you think has contributed to the change in the river discharge?

1) Deforestation up stream

2) River banks cultivation

3) River abstraction

4) Siltation

5) Waste water from irrigation farms

6) Others (specify) ----------

17). What is the main source of energy this household uses for different purposes like cooking, space heating, and others?

(a)Fire wood (b) Charcoal (c) Plant residues (d) Kerosene (e) Gas (f) Electricity (g) Solar panel (h) Others (specify) ------

18). If fuel wood and /or charcoal is the main source of energy which is the source of fuel wood this household depends most on?

1. Neighboring forest
2. community wood lot
3. trees on the farm
4. purchases from neighbors
5. others (specify)----------

19). Do you maintain or plant trees on your farm?

1) Yes. 2) No

20). If yes, what tree planting practices do you prefer?

1. Boundary planting
2. Hedgerows planting
3. Farm woodlots
4. Tress on pasture land
5. Shelter belts around home stead
6. Trees scattered on farm
7. Others (specify)----------

21). What in your opinion is the major problem encountered by farmers who wish to plant trees on their farm?

1. Lack of seedlings
2. Lack of water
3. Lack of knowledge of suitable trees /shrub species
4. Seedling are too expensive
5. Trees nursery are too far from the farm
6. Other (specify)----------

22) What are other benefits do you get from growing trees?

1. Sale (cash) of trees
2. Aesthetic beauty
3. Compensated for maintaining trees on the farm
4. Improves local climate
5. 5. Others (specify)----------

23) What is happening to the tree cover in this area?

1. Increasing
2. Decreasing
3. Remained the same
4. Other (specify)----------

24) On average how many hours in a day do you spend in colleting fuel wood outside the farm? 0-1hour (2) 1-2hours (3) 2-3hours More than 4 hours

25) Do you keep animals like cows, goats and sheep?

1) Yes. 2) No

26) How do you address the problem of animal feed shortage?

1) Graze outside traditional area

2) Supplement grazing with purchased feed

3) Use more of the fodder grown on the farm

4) Purchase fodder from neighbors

5) Loop branches of trees grown on the farm

6) Others (specify) ----------

27) Which trees /shrubs are commonly used to feed animal particularly during the dry period? ----------

28). Do you intend to plant more fodder trees on your farm?

1. Yes 2. No

29). If yes, what challenges do you anticipate in doing so?

1. Lack of seedlings for fodder tree species.

2. Lack of technical guidance

3. Lack of knowledge on the suitability of the tree species use as fodder.

4. Others (specify) ----------

30).Are you a member of Farm Forestry Small Producer Association?

1. Yes 2.No.

31). If yes, what benefits do you draw from the membership in terms of tree growing?

1. Source of information on tree planting: types, suitability and source of seedlings

2. Together we are able to solicit government and non-government support.

3. Sharing ideas on how trees could support the people's livelihood, through commercialization of the tree.

4. Others (specify) ----------

Finally, I would like to ask you some questions about your background.

- How old are you? ----------
- What is the level of your education? ----------
- How many people live in this household? ----------
- How many of your children live outside this homestead? ----------
- Do you also have off-farm employment?----------

Thank you for answering my questions. I wish you well in your work. Your information will be treated with all the confidentiality it deserves. I hope the information you have given me goes round and gets back to you in support of your work.

APPENDIX A2

The Loboi Plain Land Use Practices Survey Questionnaire 2

This is an academic research being conducted by Raphael Wamithi Kareri of Moi University that is aimed at helping us to understand and learn your land use practices and their direct/indirect impacts on soil and water conservation. We also want to find out the challenges that you face as you attempt to conserve the environment through different methods that are applicable here. All the information that you give will be kept strictly confidential.

A. RESPONDENT AND SITE IDENTIFICATION

(NB. Some of the following information was observed or obtained in the course of the interview or got straight from the key informant)

- Name of respondent (optional) ----------
- Location: ----------
- Sub-location: ----------
- Name of village/settlement----------
- Respondent's educational level (a) Primary (b) Secondary (c) Tertiary
- Age of respondent (a) 20-34, (b) 35-49, (c) 50-64 (d) 65-79
- Gender of the respondent ---------- (1) Male (2) female
- Number of dependents (a) 0-5 (b) 6-10 (c) 11-15 (d) over 15
- Ethnic group------ (Tugen, Endorois, Pokot or IIchamus and any others)
- House roofing materials (a) Traditional thatch (b) Papyrus (c) Iron sheets (d) others---specify
- Are the farm boundaries marked? (i) Yes (ii) No
- Socio-economic category of the respondent (as indicated by the local informant) (a) Rich (b) Middle (c) Poor

(1) Which of the following best describes your situation? (a) Farmer (b) Pastoralist (c) Agro-pastoralist (d) Agro-pastoralist-cum-Business person (e) Farmer-cum-business person (f) Pastoralist-cum–business person

(2) Were you born in this area? (a) Yes (b) No

(3) Which year did you settle on your farm to carry out crop-cultivation?

(a) Before 1950 (b) 1950s (c) 1960s (d) 1970s (e) 1980s (f) 1990s (g) 2000s

B. NATURE OF LAND USE CHANGE

(4) Which of the following best describes how your piece of land was like at the time of your first settlement on it?

(a)Forested grass land. (b) Wooded grassland. (c) Bushed grassland.

(d) Marshy land. (e) Bare land. (f) Others (specify) ----------

(5) Which of the following has changed since you settled here?

(a) Forest area declined (i) Yes (ii) No

(b) Wooded grass land declined (i) Yes (ii) No

(c) Bushed grass land declined (i) Yes (ii) No

(d) Marsh land declined (i) Yes (ii) No

(e) Bare land declined (i) Yes (ii) No

(f) Others (specify) ----------

(6) Which of the following species that you used to see, have since disappeared or decreased in number?

(a) Variety of bird species/ Insects (i) Yes (ii) No

(b) Big mammals (e.g. lions) (i) Yes (ii) No

(c) Others including reptiles and amphibians (i) Yes (ii) No

C. CAUSES OF LAND USE CHANGE

(7) What in your opinion can be attributed to these changes?

(a) Increased population (i) Yes (ii) No

(b) Crop-cultivation (i) Yes (ii) No

(c) Increased livestock (i) Yes (ii) No

(d) Climate change (i) Yes (ii) No

(e) Change in land tenure (i) Yes (ii) No

(f) Others (specify) ----------

(8) What is the size of your land under crop-cultivation?

(a) 0-3 acre

(b) 4-7 acres

(c) 8-10 acres

(d) More than 10 acres (specify) ----------

(9) How did you acquire this land?

(a) Inherited

(b) Bought

(c) Gift/traditional user rights

(d) Earned through association membership

(e) Others (specify) ----------

(10) Do you practice irrigation farming?

(a) Yes (b) No

(11) If yes, what is the source of irrigation water?

(a) River (b) Swamp

(c) Dam (d) Rain water catchment

(e) Others (specify) ----------

(12) Which of the following crops do you grow under irrigation?

(a) Maize seed (i) Yes (ii) No

(b) Maize (i) Yes (ii) No

(c) Beans (i) Yes (ii) No

(d) Millet/Sorghum (i) Yes (ii) No

(e) Watermelon (i) Yes (ii) No

(f) Others (specify) ----------

(13) What is the main advantage of farming in the swamps?

(a) Can grow crops throughout the year

(b) Swamps hold fertile soils

(c)Different varieties of food crops can be grown

(d) Others (specify) ----------

(14) What is the main disadvantage of farming in the swamps?

(a) Costly in terms of time and money to prepare the land

(b) Must protect crops against domestic and wild animals

(c) Others (specify) ----------

(15) What are the other products that you harvest from the wetland?

Environmental product	Yes	No
Firewood		
Raw materials for basketry/handcrafts		
water		
Vegetables		
Thatch grass		
Animal fodder		
Building poles		
Others(specify)----------		

(16) Where do you normally sell your farm produce?

(a) Local market (i) Yes (ii) No

(b) To middlemen who collect from the farm (i) Yes (ii) No

(c) Through the co-operative society (i) Yes (ii) No

(d) Directly to contracting companies (i) Yes (ii) No

(e) Others (specify) ----------

(17) How much is your return fare to the nearest market from your farm?

(a) Kshs.20-10 (b) Kshs. 101-200. (c) Kshs. 201-300 (d) Kshs. 301-400 (e) >kshs. 400

(18) What percentage of your last year's farm earnings could you attach to farming in the wetlands? (a) 0-25% (b) 26-50-% (c) 51-75% (d) 76-100%

(19) In your opinion, how has the number of people engaged in crop-cultivation changed in the last ten years? (a) Increased, (b) Decreased (c) Stayed the same (d) Can't tell

(20) If the number of crop-cultivators has increased what do you think is the main reason? (a) The government has encouraged people to grow crops

(b) Companies contract farmers to do so

(c) Crop-cultivation is a lucrative farm activity

(d) None of above----------

LIVESTOCK FARMING

(21) Do you keep livestock? (i) Yes (ii) No

(22) If yes, indicate the type and whether the number has increased this year over last year.

Animal type	Number this year	Number increased this year over last year?
Cattle		Yes No
Sheep		Yes No
Goats		Yes No
chicken		Yes No
Others ------		

(23) Where do you normally graze your animals during the dry season?

(a) Nearest Swamps (i) Yes (ii) No

(b) Along river valleys (i) Yes (ii) No

(c) Move them to other areas (i) Yes (ii) No

(d) Own land (i) Yes (ii) No

(e) Others (specify) ----------

(24) Where do you normally graze your animals during the wet season?

(a) Swamps (i) Yes (ii) No

(b) Along river valleys (i) Yes (ii) No

(c) Move them to other areas (i) Yes (ii) No

(d) Own land (i) Yes (ii) No

(e) Others (specify) ----------

(25) In terms of importance (less important to very important), how would you classify the various uses of wetlands.

Uses of wetland	Very Important	Important	Less important
Crop-cultivation			
Grazing			
Source of water			
Wild life conservation			
Socio-Cultural activities			
Raw materials-for artwork/building			
Others (specify)----------			

D. IMPACTS OF LAND USE CHANGE ON WATER RESOURCES AND THE WETLANDS

(26) What are the commonly encountered conflicts over the use of water resources in this region?

(a) Grazers and agriculturalists (i) Yes (ii) No

(b) Wild animals and agriculturalists (i) Yes (ii) No

(c) Upstream and lowland water users (i) Yes (ii) No

(d) Others (specify) ----------

(27) What changes in the size of the wetland have you noticed in the last 10 years?

(a)Decreased in size (i) Yes (ii) No

(b) Remained the same (i) Yes (ii) No

(c)Expanded in size (i) Yes (ii) No

(d) None of the above (i) Yes (ii) No

(28) If the wetland has decreased, what in your opinion could have contributed to it?

(a) Increased human population (i) Yes (ii) No

(b) Decreased River discharge (i) Yes (ii) No

(c) Climate change (i) Yes (ii) No

(d) Expanded crop production (i) Yes (ii) No

(e) Overgrazing (i) Yes (ii) No

(f) None of the above (i) Yes (ii) No

E. SUGGESTIONS ON THE FUTURE OF WETLANDS

(29) In your opinion, do you think this wetland ought to be protected?

(i) Yes (ii) No

(30) If yes, why are wetlands to be protected?

(a) Wildlife and Tourism (i) Yes (ii) No

(b) For water supply (i) Yes (ii) No

(c) Socio-Cultural activities (i) Yes (ii) No

(d) Source of food and other natural products (i) yes (ii) No

(e) None of the above

(31) If no, why would you not want to protect it?

(a) Hampers insects and tsetse flies that infect humans and animals with disease (i) Yes (ii) No

(b) Home to animals such as baboons that destroy crops (i) Yes (ii) No

(c) Takes up grazing land (i) Yes (ii) No

(d) None of the above------

Finally, I want to thank you for your contribution to this work. Your information will be treated with all the confidentiality it deserves. Good bye. I wish you well in your endeavors.

Extra comments and/or observations----------

APPENDIX A3

Guide to in-Depth Survey in Loboi Plain

This interview is being conducted for purposes of research by Raphael Wamithi Kareri of Moi University. The information needed will be used to examine land use changes and their impacts on wetlands. It will not be used for any other purpose and all the information that you give to the researcher will be kept strictly confidential. Your assistance in this exercise is highly valued.

History of Land Use and Tenure

1. Please give me a brief history of the change in the land tenure system in this area --
---

2. How do people get access to pasture land in this community today?

3. What is the nature of land tenure in the following land use types;

   a. Grazing areas----------
   b. Dry land farming areas----------
   c. Wetland areas for: Grazing----------Crop-cultivation----------

Crop and Livestock Farming

(a)What has been the main economic activity of the inhabitants of this area? ---

(b) People in this area appear to have settled down on crop-cultivation, how is crop cultivation relating with the traditional livestock grazing? ----------

(c) What are the main problems facing land users today?

(d) What in your opinion is the future of the pastoral economy?

(e) How has land transactions changed during the last ten years? i.e

   (i). Are land sales and sub-division increasing, decreasing, or staying the same as in the past? ----------

   (ii). Are people from outside seeking to buy land here and if so what do you think have attracted them? ----------

Water

What are your comments on the following aspects?

1. Factors contributing to lack of water for irrigation----------

2. Drying up of watering points or streams ----------

3. Conflicts over use of water among herders and agriculturalists----------

Communal Resources

1. How does one get to own a piece of land in the wetlands today?
2. Besides grazing and crop-cultivation are there other benefits that people get from these wetlands? .
3. Wetlands remain the most popular communal natural resources for grazers and cultivators, what do you think will eventually happen to these swamps? --------
4. Do you think the land users have any reason to protect the wetlands?--------

Non-Agricultural and off-farm Income Earning

1. What are the types of non-agricultural/off-farming earnings for households in community? ----------

2. What in your opinion is driving people out of the land to engage in other types of non-agricultural/non-pastoral/off-farming earnings activities?

Marketing

1. Please describe for me the most commonly used channels for marketing of both livestock and farm produce? ----------
2. What livestock and agricultural commodities are imported from other areas? (Name of commodity and place of origin). ----------
3. Which are the most marketable farm produce that grow under irrigation cultivation?
4. Where are these produce normally sold?----------
5. What are the major marketing problems faced by most households?----------

Other observations and /or extra comments of the respondent----------

Thank you for your responses. Your information will be treated with all the confidentiality it deserves. Good bye. I wish you well in your endeavors.

APPENDIX A4

Table 4.1 Ecological Land Units, Baringo District (2006)

Land unit	Main ethnic group	Area (km^2)	Main Economic Activities	Dominant Vegetation
MarigatArea	Tugen	20	Trading	-
Lakes	-	170	Fishing and Tourism	-
Loboi Plain	Tugen	80	Livestock/ Irrigation	Swamp/Acacia tortilis
Tugen/Foothill	Tugen	230	Goats, Finger millet	Terminalia/Combretum
Tugen Plateau	Tugen	620	Livestock	Acacia thicket
Ol Arabal	Tugen/Ilchamus	280	Highland livestock	Acacia bush/ grass
South Tugen	Tugen	290	Mixed Farming	Mixed Acacia
Eldume	IIchamus	50	Livestock/irrigation	Swamp/acacia
Ngambo	IIchamus	40	Livestock/Irrigation	Swamp/Acacia tortilis
Njemps Flats	IIchamus	70	Lowland Livestock	Acacia tortilis, swamp
Karau	IIchamus	270	Livestock/ Irrigation	MixedAcacia Bushland
Pokot Medium	Pokot	330	Livestock/ crops	Terminalia/spinosa
Pokot Lowland	Pokot	1,700	Livestock	Mixed Acacia Grass
Paka	Pokot	450	Livestock	Mixed Acacia Grass

Source: Modified from Ministry of Finance and Planning (1984) and Herlocker, (1994)

APPENDIX A5

Population Estimates for Marigat Division 2007-2009

Division	Location	Sub-Location	Livelihood zones	2007	2008	2009
Marigat	Eldume	Eldume	Irrigated Cropping	2,582	2,621	2,659
Marigat	Eldume	Ilngarua	Irrigated Cropping	1,526	1,549	1,572
Marigat	Kapkuikui	Kapkuikui	Irrigated Cropping	525	533	541
Marigat	Kapkuikui	Kaptombes	Irrigated Cropping	518	526	533
Marigat	Kimalel	Kimalel	Pastoral all species	740	751	762
Marigat	Kimalel	Koriema	Agro Pastoral	1,739	1,764	1,790
Marigat	Kimalel	Sabor	Agro Pastoral	1,413	1,434	1,455
Marigat	Loboi	Chelaba	Agro Pastoral	982	997	1,012
Marigat	Loboi	Maji Ndege	Agro Pastoral	569	577	586
Marigat	Marigat	Endao	Pastoral all species	1,058	1,074	1,090
Marigat	Marigat	Perkerra	Irrigated Cropping	5,844	5,931	6,018
Marigat	Marigat	Yatoi	Agro Pastoral	3,103	3,149	3,195
Marigat	Ngambo	Ngambo	Irrigated Cropping	3,111	3,157	3,204
Marigat	Ngambo	Sintaan	Irrigated Cropping	1,685	1,710	1,735
Marigat	Salaban	Meisori	Pastoral all species	2,844	2,887	2,929
Marigat	Salaban	Salaban	Pastoral all species	1,562	1,585	1,609
Marigat	Sandai	Mbechot	Pastoral all species	1,097	1,114	1,130
Marigat	Sandai	Sandai	Irrigated Cropping	1,009	1,024	1,039
sub total				31,908	32,383	32,858

Source: Kenya National Bureau of Statistics (2010)

Area on File: Crosstab 1986 versus 2006.rst

Category	Acres	Legend	
1	399506.16.3236	0	0
2	14255.0510157	2	2
3	145.6707555	3	2
4	1032.3719802	4	2
5	1507.8591180	5	2
6	712.1187162	2	3
7	817.7578137	3	3
8	1273.4515206	4	3
9	55.3771269	5	3
10	6087.2583951	2	4
11	5889.3240861	3	4
12	62434.2634092	4	4
13	6749.1151407	5	4
14	4675.2528582	2	5
15	253.9786302	3	5
16	27966.3386769	4	5
17	56737.9808739	5	5

Source: Author's field data