INFLUENCE OF SOCIO-ECOLOGICAL FACTORS ON THE DISPERSAL OF GREATER KUDU *(Tragelaphus strepsiceros, Pallas, 1766)* IN THE LAKE BOGORIA LANDSCAPE, BARINGO COUNTY, KENYA

BY

CHEPKOECH BEATRICE CHESEREK

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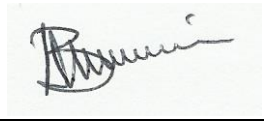
DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not been presented in this University or any other for the award of a degree.

Signature: 

Beatrice Chepkoech Cheserek

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Recommendation

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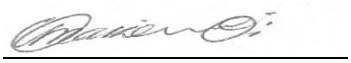
Signature:  3rd April, 2024

Prof. George M. Ogendi, PhD **Date**

Department of Environmental Science

Egerton University

Signature:  3rd April, 2024

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Department of Environmental Science

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DEDICATION

To my late father, Daudi and my beloved mother, Alice; my loving husband, Eng. Cheserek; and my lovely children, Purity, Abigail, Solomon, Phoebe and Angie.

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ABSTRACT

An average of 69% decline wildlife populations globally has been reported. Baringo County, Kenya has experienced up to 85% wildlife loss. The population of Greater Kudu *(Tragelaphus strepsiceros)* (GK), endemic to Lake Bogoria landscape in Baringo County has been declining over the years. The objective of this study was to examine the influence of socio-ecological factors on the dispersal of GK in Lake Bogoria landscape for enhanced adaptive management and improved livelihoods. A mixed methods research design was used. Secondary data and data collected in 2022 were used to assess the abundance, distribution and trends of Kudu population. Long-term (1981 to 2022) temperature and rainfall monthly data was obtained from Kenya Meteorological Department. Landsat 4-5 Thematic Mapper (TM) and Landsat 7 Enhanced Thematic Mapper Plus (ETM+) images were downloaded for the years 1980, 1990, 2000, 2010, and 2020. A cross-sectional survey was conducted to analyze knowledge, attitudes and practices (KAP) of locals towards the conservation of GK using a semi-structured pre-tested questionnaire administered to target populations (N = 137 households). Face-to-face interviews of key informants and focus group discussions were also carried out. Measures of dispersion and point pattern analysis were used to analyze dispersal of GK population in a GIS. Temperature and rainfall trends were analyzed in Excel and Pearson's correlation analysis between GK population and weather variables conducted. Land use/cover change (LULCC) over the period 1980 and 2020 was analyzed using descriptive and inferential statistics (Pearson's correlation). Thematic and content analyses were used to analyze the qualitative KAP survey data. Further, Chi-square test was used to measure the disagreement between observed and expected frequencies of KAP responses. From the results, it was evident that ecological needs of Greater Kudu influenced their dispersal in the study area. It was also noted that maximum and minimum temperature variability did not significantly affect GK ($r(1) = -0.42$, $p > 0.05$ and $r(1) = 0.45$, $p > 0.05$ respectively). Built-up and agricultural areas had significantly increased with a negative correlation to rangeland ($r = -0.935$, $df = 4$, $p = 0.019$) and ($r = -0.952$, $df = 4$, $p = 0.012$) respectively. It was noted that 73% of KAP respondents agreed that the extinction of Greater Kudu in the landscape may lead to poverty. It is concluded that the dispersal of the GK in the landscape is influenced by its ecological requirements, as well as the LULCC. It is recommended that adaptive GK management and conservation must embrace regular monitoring of population and dispersal as well as community involvement for improved livelihoods.

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LIST OF ABBREVIATIONS AND ACRONYMS

AoI	Area of Interest
CBD	Convention on Biological Diversity
CBNRM	Community Based Natural Resource Management
CCB	County Council of Baringo
CCC	Connectivity Conservation Management
CIDP	County Integrated Development Plan
DJF	December January February
DPSIR	Drivers, Pressures, State, Impacts and Responses
EEA	European Environment Agency
ENSO	El Nino-South Oscillation
ETM	Enhanced Thematic Mapper
FGD	Focus Group Discussion
FONB	Friends of Nature Bogoria
GDP	Gross Domestic Product
GIS	Geographic Information System
GK	Greater Kudu
GMST	Global Mean Surface Temperature
GPS	Global Positioning System
IBA	Important Bird Areas
IMP	Integrated Management Plan
IOD	Indian Ocean Dipole
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
JJASON	June July August September October November
KAP	Knowledge, Attitude and Practice
KI	Key Informant
KMD	Kenya Meteorological Department
KNBS	Kenya National Bureau of Statistics

KOAN	Kenya Organic Agricultural Network
KWS	Kenya Wildlife Service
LBL	Lake Bogoria Landscape
LULC	Land Use Land Cover
LULCC	Land Use Land Cover Change
MAM	March April May
$meql^{-1}$	Milliequivalent per litre
MoT&W	Ministry of Tourism & Wildlife
NbS	Nature based Solutions
NBSAPS	National Biodiversity Strategies & Action Plans
NDVI	Normalized Difference Vegetation Index
NERI	National Environmental Research Institute
NIR	Near Infrared
NRC	National Research Commission
SDG	Sustainable Development Goals
SGP	Small Grants Programme
SPSS	Statistical Package for Social Scientists
TM	Thematic Mapper
UN	United Nations
UNDESA	United Nations Department of Economic and Social Affairs
UNEP	United Nations Environment Programme
VIS	Visible
WCFSD	World Commission on Forests and Sustainable development
WRI	World Resource Institute
WRTI	Wildlife Research & Training Institute
WWF	World Wildlife Fund for Nature

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Prior to exponential increase in population of the 20th century, mankind's consumption was smaller than the earth's ability to regenerate natural resources and ecosystems (Grooten *et al.*, 2018). The globe population is anticipated to reach 9.7 billion by 2050, with a growth of more than 21% from the current 2022 population of 8 billion (Nations, 2022) hence exerting strain on the planet's resources. It is anticipated that the human population for countries of sub-Saharan Africa will continue to experience growth through 2100 which will account more than half of the world population increase through 2050 (Nations, 2022). Rapid population growth for countries with sustained high levels of birth rates present challenges to the achievement of Sustainable Development Goals (SDGs), especially those pertaining to health, education and gender (United Nations Department of Economic and Social Affairs (UN DESA), 2022).

In sub-Saharan Africa and Asia, there are significant number of countries which continue to experience exponential population growth and high birth rates, where the urgency to alleviate poverty while minimizing harm to the environment will be especially pronounced (National Research Council [NRC], 2019). Fulfilling even the fundamental necessities of a growing population means increased production and consumption of goods and services, increased demand for land, energy and materials, and intensified pressures on the environment and living resources (Council *et al.*, 1999). Consequently, the primary global factors driving changes in nature, listed by their impact, include: alterations in land and sea use; direct exploitation of organisms through activities such as hunting and poaching; climate change; pollution; and the invasion of alien species (Bull & Maron, 2016; Morris, 2010; Watson *et al.*, 2019).

Further, anthropogenic activities are triggering a change in global climate which has accelerated the rate at which species are getting extinct now at 100 to 1,000 times more than before pressure from human activities came into play (www.worldatlas.com; World Wildlife Fund [WWF], 2018). Consequently, an average of 69% decline in the relative abundance of observed wildlife populations around the world between 1970 and 2018 has been reported (Almond *et al.*, 2021). Kenya's biodiversity is facing significant threats from both natural and human-induced factors and without dedicated research and targeted conservation efforts, there is a high risk of

losing distinct species that are only found in Kenya (Convention on Biological Diversity [CBD] 2005). For instance, there was a 68% decline in wildlife populations between 1977 and 2016 in the country's rangelands. The worst possible losses (72 – 88%) were recorded among the warthog, lesser kudu, Thomson's gazelle, eland, oryx, topi, hartebeest, impala, Grevy's zebra and waterbuck (Ogutu *et al.,* 2016).

The wildlife decline in Baringo County has been estimated at 85% in the last four decades. Ecosystems are currently undergoing rapid depletion, with forests, coral reefs, wetlands, and mangroves all witnessing a significant decline (World Wildlife Fund, 2018). The decline in wildlife populations can be attributed to the rapid increase in the human population and the resulting pressures on resources such as changes in land use, infrastructure development, and poaching. Other factors include institutional and market failures, the impacts of climate change and variability, the lack of development in the rangelands, and ineffective wildlife conservation policies, strategies, and practices in Kenya (Ogutu *et al.,* 2016; Ojwang *et al.,* 2017).

The Greater Kudu dispersal areas are within the Lake Bogoria Landscape (LBL) that hosts Lake Bogoria National Reserve (LBNGR), a site recognize as World Heritage Site, a Ramsar Site and an Important Bird Area. LBNGR has gained recognition at national, regional, and local for significant wildlife species, such as the flamingo and the Greater Kudu. The Reserve possesses distinctive physiographic characteristics and geothermal phenomena as a result of its geological past (Kaibos, 2013). The combination of landforms, biodiversity content, availability of water and forage makes it a preferred Kudu habitat and an important site locally, nationally and international levels. According to Baringo County Government (2012) LBNGR was designated as a National Reserve in 1974. In 2002, the wetland was designated as a site of global significance under the Ramsar Convention (CCB *et al.,* 2007).

The Kudu with its magnificent spiraled horns is considered as one of Africa's most elegant and attractive antelope. Kudu were first described from a specimen from the Kammiesberg, southern Namaqualand in the Cape of Good Hope and were classified in the genus *Tragelaphus*. The origin of the name kudu was from the Hottentot or Khoi-khoi word "ku::du", Tragos the Greek for a he-goat and elaphos for a deer (Furstenburg, 2022). Furstenberg further states that: "the species name of the Greater Kudu (*Tragelaphus strepsiceros*) originates from strephis, the Greek word for twisting, and keras for animal horn. There are three sub-species of the Greater Kudu: *T.s.*

strepsiceros - the southern Greater Kudu, T.s. *bea* - the East African Greater Kudu and *T.s. cottoni* - the northern Greater Kudu" (Furstenburg, 2009).

Both Lesser Kudu *(Tragelaphus imberbis)* and Greater Kudus (*Tragelaphus strepsiceros*) have an overwhelming resemblance in physical appearance, but there are some typical distinct features that set them from each other (Tilahun, 2019). Filahum also notes that for instance, both sexes of the Greater Kudu have a mane that continues as a whitish dorsal crest while the Lesser Kudu does not have a mane. Lesser Kudus' body is smaller when compared with Greater Kudu. They are herbivorous animals; mainly described as browsers, and they reproduce by mating. Kudu are mostly active in the early morning and early evening. Greater Kudu do not have fixed breeding season since their breeding season is heavily influenced by environmental conditions including rainfall and temperature. Kudu are found in east, south, central and north-eastern Africa in bush land and woodland habitat types (Tilahun, 2019). In the northern parts of its range, key areas where some of the northern populations appear to have reasonable prospects for long-term survival include Zakouma National Park (Chad), Awash National Park (Ethiopia), Baringo, northern Laikipia and Tsavo (Kenya), and Tarangire (Tanzania) (East, 1999).

Greater Kudus are the most typically targeted species for hunting in southern Africa, contributing the largest share (13.2%) of income generated by hunting activities in South Africa (Patterson & Khosha, 2005). Due to its dual magnificent horns of bulls and more generally for their high-quality meat, Kudos are much sought after by hunters (Owen-Smith, 2013). Greater Kudus are also preferred game-ranching species, since as browsers they do not compete with domestic cattle (Owen-Smith, 2013).

Due to the growth in human population in the Lake Bogoria landscape coupled with increased number of livestock and heightened agricultural expansion explains the landscape transformation and to some extent, the observed deterioration of the quality and productivity of the land in the region. The step to excision and degazettement of forests to facilitate the establishment human settlement; inadequate funding for environmental conservation; lack of education to the residents on the importance of environmental conservation; policy, institutional and market failures have contributed to habitat loss and human-wildlife conflicts, hence impacting negatively on wildlife conservation.

In the year 2007, the Lake Bogoria Integrated Management Plan (LBIMP) approach to conservation was initiated and is currently in its second phase of implementation. The LBIMP

aimed to strike a balance between enhancing the quality of life for people, generating new economic prospects, and safeguarding the ecological assets of Lake Bogoria National Game Reserve and its environs (Mugo, 2007). Nevertheless, despite the introduction of the IMP for LBNGR, conflicts regarding revenue allocation and environmental deterioration persist at extents that have not been previously experienced (Kaibos, 2013). These may lead to depletion of natural resources, habitat destruction and even wildlife extinction in the Reserve. The Greater Kudu population will not be spared from the aforementioned anthropogenic pressures. This study was conceived in light of this background and carried out to understand the Greater Kudu population, and factors influencing their dispersal in the Lake Bogoria Landscape.

1.2 Statement of the Problem

Whereas Greater Kudu in IUCN Red List of 2020 is under the category of Least Concern species, it is at risk of extinction in Uganda and Somalia and is thought to be vulnerable in Chad and Kenya (IUCN, 2020). The status of the northern population is uncertain and perhaps unstable due to overexploitation and habitat loss (East, 1999). In fact, the Kudu is extinct in Djibouti and its presence is uncertain in Somalia, South Sudan, Sudan and Uganda (IUCN, 2020). It is also indicated that there is a continuing decline of Greater Kudu mature populations estimated at between 300,000 – 350,000 (over 71%) of the total population (IUCN, 2020).

Lake Bogoria National Reserve's Integrated Management Plan (IMP) listed Greater Kudu as threatened (County Council of Baringo [CCB] *et al.,* 2007). The Lake Bogoria's landscape ecological processes risk collapse as a result of catchment wide unsustainable natural resource exploitation, poor land utilization plans, keeping too many animals and unsustainable farming systems driving communities to abject poverty and wildlife towards extinction (Damania *et al.*, 2019). This poses threat to survival of species including Greater Kudu. It is against this background that this study sought to generate information on the influence of socio-ecological factors on the dispersal of Greater Kudu in Lake Bogoria landscape for enhanced adaptive management and improved livelihoods.

1.3 Objectives

1.3.1 Broad Objective

To examine the influence of socio-ecological factors on the dispersal of GK in Lake Bogoria landscape for enhanced adaptive management and improved livelihoods.

1.3.2 Specific Objectives

i. To assess spatio-temporal change of dispersal and population of Greater Kudu in Lake Bogoria landscape between years 2019 to 2022.
ii. To assess the impacts of temperature and rainfall variability on population of Greater Kudu within Lake Bogoria landscape between years 2019 to 2022.
iii. To relate land use/cover change to the population of Greater Kudu in Lake Bogoria landscape between years 2019 to 2022.
iv. To evaluate knowledge, attitudes and practices (KAP) of locals towards conservation of the Greater Kudu in Lake Bogoria landscape.

1.4 Hypotheses

i. H_0: Spatio-temporal distribution of dispersal areas and population of the Greater Kudu in Lake Bogoria landscape did not change between years 2019 - 2022.
ii. H_0: Temperature variability did not influence the population of Greater Kudu within Lake Bogoria landscape between years 2019 - 2022.
iii. H_0: Rainfall variability did not influence the population of the Greater Kudu within Lake Bogoria landscape between years 2019 - 2022.
iv. H_0: Land use/cover change did not influence population of Greater Kudu in the study between years 2019 - 2022.
v. H_0: Knowledge, attitude and practice did not influence the conservation of the Greater Kudu in Lake Bogoria landscape.

1.5 Justification of the Study

While reporting the progress of attaining Sustainable Development Goal (SDG) 15, the UN Secretary-General indicated that the 2020 targets were unlikely met because deterioration of land and loss of biodiversity is happening at a worrying proportion, issues of invasive species, poaching, and wildlife trafficking makes it difficult to safeguard and rehabilitate crucial ecosystems and species (UN, 2019). This study offers essential data and insights to evaluate Kenya's progress towards the following Sustainable Development Goals (SDGs): 1) Ending poverty in all its forms everywhere, 2) Ending hunger, achieving food security, improving nutrition, and promoting sustainable agriculture, 13) Taking urgent action to combat climate change and its impacts, and 15) Protecting and promoting the sustainable use of terrestrial ecosystems, including forests.

The AU Agenda 2063 Framework goal significant to the investigation is the one on environmentally sustainable and climate-resilient economies and communities, focusing on biodiversity conservation, genetic resources, and ecosystems, align with Aspiration 1: a prosperous Africa based on inclusive growth and sustainable development (Ezechukwunyere, 2018). East Africa Community (EAC) Vision 2050 Goal number 4 - effective and sustainable use of natural resources with enhanced value addition and management is relevant to the study as it relates to wildlife protection areas/rangelands and conservancies as well as environmental education and awareness (East African Community, 2016). Thus, findings from this study will be useful to biodiversity conservation in the African continent.

The study is also relevant to Kenya Vision 2030 Social Pillar that aims to enhancing the quality of life for all Kenyans by implementing a range of human and social welfare projects and programs aimed at transformation of sectors touching on environment conservation, gender, youth and culture of the Lake Bogoria landscape communities. The findings of the study will also contribute to Kenya Vision 2030 Economic and Macro Pillar priority sectors of tourism, agriculture and livestock that among other sectors promised to raise GDP growth rate to the region of 10 per cent according to a study conducted in 2006/2007 (GoK, 2008).

World Bank report of 2019 listed Baringo County among the few counties in Kenya that experienced 85% wildlife loss in the last four decades. Tourism is a crucial component of the County's economy and serves as a major driver for prospective economic expansion and job generation. Greater Kudu is endemic to LBNGR and is a major tourist attraction for Baringo County necessitating use of its photo on the County's logo and thus a flagship species. It is indicated that 92% of all tourists visited LBNGR in the year 2017 (Baringo County CIDP, 2018) making it an important landscape in the County's natural resource management and tourism development. However, Kudu survival will depend on effective protection and management of LBNGR landscape by maintaining existing wildlife dispersal areas and migration routes/corridors, and to restore areas that have been interfered with or lost (Ojwang *et al.,* 2017; Tilahum, 2019).

Hence the study seeks to contribute to Baringo County CIDP 2023-2027 Environmental protection, water and natural resources sector priorities namely: wildlife protection areas and conservancies and protection of plant and animal species through adoption and application of participatory rangeland management (PRM) as an integrated approach in rangelands restoration of

ecosystems in natural resource and protection of endangered wildlife and plant species (Baringo County CIDP, 2023).

From literature reviewed, it was evident that population trends and dispersal areas of Greater Kudu in the landscape has not been documented. Studies on impacts of temperature and rainfall variability, land use/cover changes on the population and distribution of Greater Kudu within the study area could hardly be found. Moreover, the influences of knowledge, attitude, and practices of local resource users towards conservation of Greater Kudu in the landscape have not been studied. Therefore, this study sought to generate scientific information on the influence of socio-ecological factors on population, dispersal areas and the existence of Greater Kudu in the Lake Bogoria landscape. This will facilitate both national and county decision makers in coming up with informed policy, legal and institutional frameworks for protection and management of the Greater Kudu in Lake Bogoria landscape for improved livelihoods.

1.6 Assumptions/Scope and Limitations

1.6.1 Assumptions

i. The political situation in the landscape was conducive for the researcher and team as they conducted the proposed study.
ii. That all the proposed sampling/geographical areas of the study area were accessible i.e. there were no adverse weather conditions that may interfere with data collection.
iii. That there were no major policy changes relating to land use/cover and wildlife management in the study area.
iv. That no catastrophic ecological and/or environmental event occurred before and during the study that may have affected the Greater Kudu population, behavior and/or ecology.

1.6.2 Scope

The study was done in Lake Bogoria landscape – the area of Lake Baringo National Reserve in Baringo South and Mogotio Sub-counties, Baringo County delineating a total area of 107km^2. The study primary data was collected within a period of one year covering the wet and dry seasons. The study focused on temporal and spatial distribution of Greater Kudu (4years), temperature and rainfall variability and land use/cover change detection over a period of 40 years and assessment of knowledge, attitude, and practice of locals towards conservation of the Greater Kudu in community conservancies at Lake Bogoria landscape.

1.6.3 Limitations of the Study

Field studies to assess spatio-temporal change of dispersal of biodiversity are expensive, time consuming and need to be carried out over many years. However, they have some limitations because of the complexity of interactions and difficulty of generalizing the results. For this study, secondary data for two years was used to supplement primary data collected during the study period and integrated in GIS of Greater Kudu dispersal in Lake Bogoria landscape.

To assess location specific temperature and rainfall variability requires acquisition of weather data from reputable sources in-situ. Not many people can recall accurately the changes in weather patterns especially over a long period of time. Collecting information from respondents on weather patterns was a limitation. For this study, monthly maximum and minimum temperatures and rainfall data for Lake Bogoria landscape was acquired from Kenya Meteorological Department.

High resolution multispectral satellite images have demonstrated potential to accurately detect, identify, and map land use/cover changes this is with cost implication. For this study, satellite images at 30m meters spatial resolution from Landsat 4-5 Thematic Mapper (TM) and Landsat 7 Enhanced Thematic Mapper Plus (ETM+) were downloaded for the years 1980, 1990, 2000, 2010, and 2020 for this research.

During KAP surveys, many interpretations for one simple question are likely to be received from the population making it difficult to conclude the findings. To address this, KAP survey on conservation of Greater Kudu in Lake Bogoria landscape for local resource users, was conducted using a semi-structured questionnaire and KAP questions were presented using Likert scale. Key Informant Interviews and Focus Group Discussions were also held for in-depth understanding of the participants' responses.

1.7 Definition of Terms

Agro-ecological zones: A land resource mapping unit constitutes a specified area that takes into account climate, landform, soils, and/or land cover. It is characterized by a specific range of potentials and restrictions for land use.

Anthropogenic: Arising from or generated by humans. The human or anthropogenic influence on the environment include effects on biophysical environments, biodiversity, and other resources.

Attitude: a way of thinking or feeling about Greater Kudu conservation. A psychological construct is a mental and emotional entity that is inherent to or characterizes a person.

Dispersal: The distribution of animal populations, specifically the Greater Kudu, exhibits a pattern where large mammals tend to have a wide range during the wet season and then concentrate in smaller core areas during the dry season.

Ecosystem approach: Integrated natural resource management strategic approach that aims to conserve and sustainably use land, water, and other natural resources. It acknowledges the importance of humans as a vital part of many ecosystems.

Geographic Information System (GIS): A computerized approach for arranging, examining, combining, manipulating, storing, retrieving, and modeling spatial or geographically situated phenomena or features.

Knowledge: Knowledge is the familiarity, awareness, or understanding of Greater Kudu, encompassing facts, information, descriptions, or skills gained through experience or education by perceiving, discovering, or learning. It pertains to both theoretical and practical comprehension of Greater Kudu.

Land use/cover: The utilization and administration of the landscape for social and economic purposes.

Landscape: The visible characteristics of a region's terrain, including its landforms and their integration with natural or man-made features.

Practice: the application or use of conservation ideas by the local resource users in the study area.

Social facilities: indicators of socioeconomic status of local resource users in the study area.

CHAPTER TWO

LITERATURE REVIEW

2.1 Biodiversity, Extinction and Conservation

Biodiversity encompasses the wide range of life on Earth; including all organisms, species, and populations. It also refers to the genetic variation among living things, species, and populations. Biodiversity has been described as the interconnectedness of genes, species, and ecosystems, along with their interactions with the environment. It is commonly categorized into three levels: genetic diversity, species diversity, and ecosystem diversity (CBD, 2005).

During the June 1992 United Nations Conference on Environment and Development, that is, "the Rio Earth Summit", Convention on Biological Diversity (CBD) ("the Convention") was adopted with the objectives of ensuring the preservation of biological diversity, the sustainable utilization of its components, and the fair and equitable distribution of the resulting benefits from the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by applicable funding (United Nations Environment Programme, 2018). Article 6 of the CBD suggests that the Convention can be implemented through the National Biodiversity Strategies and Action Plans (NBSAPs) (CBD, 2005).

Biodiversity exerts a direct impact on human development, but it is rarely associated with human population measurements. It supports around 40% of the worldwide market for products and services. The World Commission on Forests and Sustainable Development (WCFSD) considers biodiversity to be essential for human development, emphasizing the significance of long-term sustainability rather than short-term economic benefits (Ojwang *et al.,* 2017). This underscores the importance of biodiversity.

The rapid growth of the human population and the resulting increased demand for food, energy, and resources have led to resource overexploitation (Reid & Raudsepp-Hearne, 2005). The expansion of human populations has been shown to impact biodiversity through various means, including deforestation, pollution, soil erosion, hunting, excessive exploitation of certain species, the introduction of non-native species resulting in displacement of native ones (local extinctions), habitat fragmentation, loss of genetic diversity leading to inbreeding issues, and climate change effects such as ocean acidification and changes in atmospheric temperatures (Benn, 2010; Cafero

et al., 2022; Yang *et al.*, 2017). These factors primarily drive changes in land use, leading to habitat reduction for species, ecosystem degradation, loss of dispersal areas and migration routes, and heightened human-wildlife conflicts (CBD 2010; Reid & Raudsepp-Hearne, 2005). Consequently, ecosystem processes suffer, resulting in significant biodiversity loss (Ojwang *et al.,* 2017).

Throughout history, there have been approximately 784 documented extinctions from 1500 AD to the present. These include various categories such as mammals (79), birds (129), reptiles (21), amphibians (34), fish (81), invertebrates (359, with 291 being molluscs), plants (86), and Protista (1) (IUCN, 2015). Similarly, based on the global assessment report on biodiversity and ecosystem services by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), an estimated average of about 25 percent of species in evaluated animal and plant groups are threatened unless measures are taken to mitigate the drivers of biodiversity loss (Watson *et al.,* 2019). Moreover, the Red List Index, an indicator designed to monitor the likelihood of species extinction, has exhibited a decline globally from 0.82 in 1993 to 0.73 in 2019, where a value of 1 indicates no threat to any species and a value of 0 suggests the extinction of all species (UN, 2019).

The country's biological resources are critical to its prosperity as captured and emphasized in Kenya's Vision 2030 and Sustainable Development Goals (*Kenya Vision 2030 | Kenya Vision 2030,* n.d.) These resources serve as sources that provide the Kenyan population with food, healthcare, energy, housing, jobs, and foreign currency supply the Kenyan population with food, healthcare, energy, housing, jobs and earnings in foreign exchange. Additionally, they provide numerous opportunities for human prosperity. Kenya's development plan, Vision 2030, acknowledges the critical importance of sustainable resource use and development, particularly concerning land, biodiversity, and ecosystems. It aims to create strategies to restore habitat connectivity that has been disrupted by human activities. The Kenya's Vision 2030 envisaged flagship projects of which three are important to biodiversity conservation. They include:

i. Protecting wildlife corridors disrupted by human activities and restoring them to generate revenue through tourism;
ii. Land cover and land-use mapping, which entails producing precise and regularly updated land-use maps, as well as conducting censuses for both livestock and wildlife; and

iii. Rehabilitating five water towers as components of water catchment management, namely the Mau Escarpment, Mt. Kenya, the Aberdare Range, the Cherangani Hills, and Mt. Elgon.

2.2 Wildlife Conservation and Management

2.2.1 Wildlife Conservation

Wildlife conservation involves safeguarding and protecting animals, plants, and their natural habitats. The activity involves deliberate efforts by humans to protect plants, animal species, and their habitats (Robinson, 2010). An example of such successfully implemented conscious efforts is the case of Zakouma National Park, Chad (Profile, 2015). As detailed in the Zakouma case, whereby during the period from 2002 to 2010, approximately 4,000 elephants were killed. However, since African Parks took over management of Zakouma in 2010, poaching has been almost completely eradicated. In 2021, Chad celebrated five consecutive years without a single reported case of elephant poaching, with a population count of 636 elephants in the park, indicating a 17% rise since 2010. Zakouma hosts half of the world's kordofan giraffe population, and their numbers are increasing. In 1986, there were only about 220 buffalo in the park; today, there are over 15,000 of them.

Furthermore, the region's major employer, Zakouma National Park, also offers greater prospects for generating revenue locally by assisting with the local purchase of supplies for parks and tourist camps and creating business initiatives like the production of shea butter and honey. Following the restoration of law and security, tourists started coming to Zakouma to see its diverse fauna, which increased job and business opportunities in the area (Profile, 2015).

2.2.2 Wildlife Conservation in Kenya

Okello (2005) opined that conservation natural resources in Kenya has been largely based on the IUCN category II park model which necessitated: (1) identifying an area based on resource endowment or physical features, (2) displacing local people, (3) outlawing human settlement, and (4) designating the resource as protected. A protected area for the conservation of wildlife comprises approximately 8% of Kenya's total land area (*Overview | Kenya Wildlife Service*, n.d.).

According to Kenya Wildlife Services “protected areas are gazetted landscapes/seascapes that have been surveyed, demarcated and gazetted either as National Parks and/or National Reserves”. Kenya's protected areas encompass wetlands, forests, savannahs, marine regions, and arid and semi-arid environments. These include 23 terrestrial National Parks, 28 terrestrial

National Reserves, 4 maritime National Parks, 6 marine National Reserves, and 4 national sanctuaries (Mwangi, 2005).

In general terms and among other duties, Kenya Wildlife Service (KWS) is responsible for organizing the development and execution of national conservation and management plans unique to each species, particularly for endangered species, in order to sustain wildlife populations and their ecosystems (KWS, 2022). The Wildlife Conservation and Management Act, 2013's Part II, Section 7 describes KWS's duties as:

i. Maintain and oversee the national parks, wildlife conservation areas and sanctuaries under its jurisdiction purview;
ii. preserve and oversee national parks national parks, wildlife conservation areas and sanctuaries that fall within its purview; establish a county wildlife conservation committee in respect of each county; Ensure the safety of wildlife and tourists in sanctuaries, national parks, and wildlife conservation areas;
iii. Encourage or carry out business ventures and other initiatives aimed at attaining sustainable wildlife conservation; advice the Cabinet Secretary on issues concerning wildlife strategy, policy, and law.;
iv. Coordinate the development and execution of plans for ecosystems;
v. Develop and carry out management strategies for national parks;
vi. Support and provide guidance when creating management plans for public and private wildlife sanctuaries and conservancies;
vii. vii. Engage in and carry out enforcement actions, including wildlife protection, anti-poaching campaigns, intelligence collection, investigations, and other enforcement actions;
viii. Conduct and coordination of all research projects related to the management and conservation of wildlife, and make ensuring that research results are applied to conservation planning and decision-making;
ix. Provide guidance on the creation of national parks, wildlife conservancies, and sanctuaries to the Council, the Lands Cabinet Secretary, and the National Land Commission.;
x. Promote and carry out extension service initiatives aimed at improving training, education, and wildlife conservation;

xi. Establish the rights of users and advise the Cabinet Secretary of any changes;

xii. Grant permits;

xiii. Establish forensic laboratories; and

xiv. Monitor whether license terms and conditions are being followed.

KWS have developed a Strategic Plan (2019-2024) describing strategies employed to ensure the functions outline above are implemented. In the Plan, Strategic Objective number 1 is to stop and steady the decreasing trend throughout the wildlife populations and habitats. This will be achieved by: winning more space for wildlife; maintaining the ecological integrity of parks and reserves; improving research on wildlife, monitoring and science to guide management choices for the preservation, protection, and management of wildlife.

2.2.3 Migration and Dispersal Areas

Western (2007) distinguishes between three types of animal movement patterns: migration, residential movement, and dispersal, where dispersal refers to the wet season spread and dry season concentration within a range. In the field of ecology, migration refers to the extensive relocation of a species' individuals to an alternative habitat (Dingle & Drake, 2007). Although animal migration is the most well-known form, migration is a natural habit and an integral part of the life cycle of many other types of mobile organisms. Migration is generally cyclical, happening often during certain seasons and sometimes even every day. Species move in search of better environments, whether it is for mating opportunities, food availability, safety from predators, or other environmental considerations (Dingle & Drake, 2007).

In order for animal species to maintain healthy populations that are resilient to illness, predators, and unpredictable rainfall, migration is crucial. There are two primary impulses that cause animals to migrate from one area to another (Ojwang *et al.*, 2017). First, internal ones like breeding or avoiding inbreeding; second, external ones like wildfires, droughts, floods, competition for resources (like food and water), avoiding predators, and diseases (like parasitism and epidemics). The primary goal of wildlife migration and dispersal is to increase the chances of that species surviving (Ojwang *et al.,* 2017).

While certain species of wildlife that migrate exhibit significant movements, others exhibit substantial seasonal concentrations and resident movement within their home range (Ottichilo, 2000). Many wildlife populations today are isolated, and some have totally broken away from one another due to habitat loss, fragmentation, or degradation brought on by human activity. An

exemplary illustration of the Serengeti-Mara ecosystem, the seasonal dynamics of large herbivores and their habitat use in response to rainfall and food supplies are extensively documented (Ojwang *et al.,* 2017; Ottichilo, 2000).

Dispersal among large mammals results in populations being widely distributed. These animals might move daily within a local area or change habitats seasonally (migration and dispersal) because resources in their home ranges are unevenly distributed (Western, 2007). In a study that used long-term monitoring data on different components of the Serengeti-Mara Ecosystem to trace the effects of disturbances, Sinclair *et al.* (2007) found that abiotic events, such as droughts and floods, created disturbances that affected survivorship of ungulates and birds while anthropogenic disturbances had direct (hunting) and indirect (transfer of disease to wildlife) effects.

Naturally, interactions among species in their respective environments are influenced by climate and anthropogenic activities. It is now understood by scientists that plants and animals take their signals from the long-term weather patterns of their local climate (Beever *et al.,* 2016). Species rely on the yearly variations in the climate that are predictable to determine when they begin natural events such as breeding or migration. An ecosystem disturbance which can be naturally or humanly induced causes a disruption to the current state of an ecosystem hence disrupting species interactions. Human disturbances include clear-cutting, habitat fragmentation, wildlife poaching and pollution. Conservationists consider various spatial needs of wildlife when creating plans to safeguard animals, for instance, the territory size, different habitat types and migration routes that wildlife needs (Burton-Roberts *et al.*, 2022).

Water availability affects the survival of plants and animals in semi-arid and arid regions. Jörg *et al.* (2004) study revealed that changes in rainfall patterns will have a direct effect on the growth and death of trees, as well as the competition between herbaceous and woody plants, including trees seedlings. The finding agreed with Lamprey (1963) who noted that "access to water is the most important limiting factor to wildlife abundance and distribution on the East African savannahs, especially during the dry season. Most wildlife species concentrate around water sources in the dry season, and spread out during the wet season". Zhang et al. (2023) found that arid land biodiversity is extremely susceptible to some types of disturbance and recovers slowly. Furthermore, arid regions are susceptible to agricultural practices like cattle grazing and irrigation, which need communal best practice to reduce impact. This can be achieved through combined

efforts to embrace a socio-ecological paradigm by researchers, practitioners, policymakers, and local communities.

Further, according to Morrison *et al.* (1992), it has been observed that habitat loss is the leading cause of wildlife population declines, and for most species, habitat fragmentation poses the greatest threat to their survival. Natural ecosystems are being disrupted by human activity such as encroachment by cultivation and settlements resulting in reduced space for grazing (Ottichilo, 2000) and human-wildlife conflict.

Baringo's semi-arid plains are a biologically and environmentally diverse ecosystem that significantly contributes to the preservation of regional and global biodiversity. However, the area is under threat from a number of sources, including human settlements, infrastructure development projects, illicit logging, slushing, and burning for agricultural purposes (Ogendi & Ondieki, 2020). Human-wildlife conflict has increased in Lake Bogoria landscape because of livestock grazing within the reserve, habitation in areas designated for wildlife dispersal, and wildlife damage to crops and property. Poor management of natural resources outside of protected areas has led to an increase in conflicts throughout time, and this has a direct correlation with rising poverty (Mugo, 2007).

2.2.4 Wildlife Corridors

The best way to ensure habitat connectivity is through the creation of wildlife corridors, which act as vital links between formerly connected natural habitats and make it easier to migrate between now-isolated locations (McEuen, 1993). This reduces inbreeding; improves genetic viability and reduce overexploitation by predators (Ojwang *et al.,* 2017) by attaining metapopulation stability and sustainability (Hanski, 1998; Richmond-Coggan, 2006). The concept of metapopulation extinction serves as the theoretical foundation for habitat corridors (Hanski, 1998); in the theory of island biogeography (McArthur & Wilson, 1967), and in Leopold's law of interspersion proposed in the early 1930s.

The preservation of biodiversity in fragmented habitats has been demonstrated to be particularly effective when corridors are used in animal conservation and management. Additionally, crucial to the preservation of natural processes in areas altered by human activity are corridors (Ojwang *et al.,* 2017). The success of wildlife corridors is largely dependent on their planning and design; factors that must be considered include an understanding of the unique circumstances of each corridor, the ecological requirements of those corridors, and the movement

patterns of the species that are anticipated to use those corridors (Bennett, 2003). The ecological requirements of species (requirements for food and water, shelter, breeding behavior, and predation) and their movement patterns (dispersal, migration, or home range) will dictate the shape, length, and breadth of a given corridor, among other factors. Crucial factor to consider is the implementation of management measures that involve monitoring human activities within wildlife corridors (Bennett, 2003).

2.2.5 Principles of Wildlife Management

Wildlife refers to free-living, wild animals that hold significant importance to humans including associated plants and micro-organisms. Wildlife species and their habitat are interlocked and cannot be considered separately. In the USA and Canada, wildlife is classified as belonging to the public – a holistic view of wildlife triad of the animal, its habitat, and people, and the interactions between them is therefore considered (Giles Jr, 1978; Krausman & Cain, 2022). The human dimension is the most important aspect of the triad because human decisions dictate how species will be managed, what instructions into their habitat are acceptable, and how management will be funded. The human aspects include cultural systems, social structures and institutions. Wildlife management incorporates managing human behavior through human education through sensitizations and trainings, extension, law enforcement and administration (Krausman & Cain 2022). To manage wildlife population effectively requires a combination of biological, environmental and sociological strategies.

Habitat management: It is essential to understand which locations offer a species' ideal habitat conditions as well as the quantity and quality of habitat needed to reach a particular population size (Suchant *et al.,* 2003). Wildlife species habitat provides food, water, nesting areas, breeding ranges. It is important to have enough habitat space to avoid competition. Management of habitats is the development or conservation of the natural environment by a landowner to enhance wildlife habitat. While development that would take away the space necessary for wildlife threaten wildlife species, Activities that appropriately manage vegetation are generally beneficial for wildlife.

Balancing act: Habitat must be in harmony to sustain wildlife. To maintain the natural ecology within a range, it is necessary to create sizable, unaltered areas that allow species to travel among critical areas, such as breeding grounds, and are therefore essential for their existence (Yemshanov *et al.,* 2021). Indeed, most herbivores move over long distances as part of their

foraging and social conduct. Therefore, the range of the herbivores should be connected to reduce exposure to predators, be connected via unaltered corridors.

Carrying capacity: Only certain numbers of animals can be supported by the resources in any particular area. This is dependent on food and nutrient availability, habitat availability, climate, prey/predators availability, pollution, mortality, disease and water availability (Chapman & Byron, 2018).

Limiting factors: Diseases, hunger, predators, hunting, pollution, accidents, and aging affects wildlife populations. Restrictive conditions such as climate and drowning influenced the study moose population's demographics more than predation did (Crête & Courtois, 1997).

Hunting: Given that wildlife is a replenisheable resource, hunters contribute to keeping wildlife populations in a healthy balance for their habitat. Controlled hunting is not a threat to wildlife (Heffelfinger *et al.*, 2013).

2.2.6 Wildlife Management Practices

Monitoring wildlife population: Monitoring wildlife species' birth and mortality rates is crucial. This gives the information required to establish hunting laws and decide whether other wildlife management techniques are required to protect animal species.

Habitat improvement: As part of wildlife management, forested areas/woodlands are cut down or burnt to promote new growth and slow down succession. This will enable them to increase production of certain wildlife species by increasing their forage.

Hunting regulations: These regulations aim at protecting natural environment and preserving wildlife populations. The rules governing hunting include harvest restrictions based on age and sex, bag limits, species permits, daily and seasonal limits, and permissible ways to take wildlife.

2.2.7 Wildlife Management Tools

Legal and policy framework: Wildlife management laws and policies must be adaptable, anchored on biological realities, and utilized in conjunction with additional management techniques.

Habitat management: As part of wildlife management, vegetation/forage may be manipulated to meet necessities for life for variety of wildlife.

Stocking: Allowing wildlife species to live in places with enough habitat but no animal production.

Hunting and trapping: This is done to maintain/control population of wildlife species at or below the habitat's carrying capacity.

Public education: vital to the general public's comprehension of wildlife conservation and management programs. People are more likely to support conservation and management initiatives when they have a greater understanding of wildlife and its needs.

2.2.8 Public Land versus Private Land Wildlife Management

The future of wildlife management in the United States lies with private landowners, according to Aldo Leopold, who is regarded as the founder of modern wildlife management, who made this observation in the 1930s (Watson, 2012).

Approximately 20 million hectares of land in South Africa are dedicated to wildlife ranching, which is a type of private land business that adopts wildlife-based land utilization for commercial purposes– contributing towards wildlife conservation. An estimated population of 4.66–7.25 million herbivores exists on ranches across the country. This is a rare example of indigenous animal populations persisting and demonstrates how sustainable use can contribute to re-wilding (Taylor *et al.*, 2021).

2.2.9 Adaptive Wildlife Management

Large herbivore species, such as ungulates, have a significant role in shaping the structure, composition, and development of terrestrial ecosystems (Board, Ocean Studies and National Research Council, 2004).

The concept of adaptive management was initially introduced to explain the process of making flexible decisions in the field of fisheries management (Beverton & Holt, 1957).

2.3 The Greater Kudu

2.3.1 Greater Kudu Biology

Kudu is classified under the genus of *Tragelaphus*. There are two species of Kudu in Africa, which are Lesser Kudu *(Tragelaphus imberbis)* and Greater Kudu *(Tragelaphus strepsiceros)* - *Tragelaphus* (goat-like deer) *strepsiceros* (twisted horns) (Hosking, 2006). Both the Greater Kudu and Lesser Kudu exhibit patterns of stripes and spots on their bodies, with the majority also possessing a patch of white hair on their foreheads, situated between their eyes. The male Greater and Lesser Kudu possess elongated and helical horns. The horns serve as a means of defense against predators, yet they do not pose any hindrance in woodland areas. The Kudu

elevates its chin and positions its horns against its back, effortlessly maneuvering through thick vegetation. Female Greater Kudus appear noticeably smaller than male Greater Kudus that do not have horns. Male Lesser Kudus possess horns of lesser size compared to Male Greater Kudus (Tilahun, 2019).

The Greater Kudu is widely regarded as the most attractive among the tragelaphine antelopes, a group that included the Bongo, Eland, Nyala, Bushbuck, and Sitatunga (Stuart, 2013). The Kudu is one of the tallest antelope, with the largest most spectacular horns in the animal kingdom of an average length of 120 cm - they can grow 100-140 cm long (Van Wijk *et al.*, 2015). The horns of a mature male form two complete spirals, each adorned with a prominent ridge encircling it (Plate 2.1). The age of a kudu can be determined by observing the orientation of the horn tips: If the tips of the horns are directed backwards and outwards, it indicates that the male is approximately three years old (Tilahun, 2019).

Plate 2. 1: An adult male Greater Kudu (Source: Wikipedia, 2023 June 29th)

The Greater Kudu are bluish-gray, grayish-brown, with lateral white stripes of any way between four and twelve stripes. The neck and shoulders of its body have a raised, erectile crest, and there is a mane that runs along the throat.

The weight of the Greater Kudu typically ranges from 120 kg to 315 kg. The average weight of male Greater Kudu ranges from 190 kg to 315 kg, while their shoulder height typically

measures around 160 cm. The female individuals have a weight range of 120 kg to 210 kg, and their shoulder height can reach up to 100 cm (Van Wijk *et al.*, 2015).

Plate 2. 2: Mature female and male Greater Kudu (Source: Wikipedia, 2023 June 29th)

2.3.2 Greater Kudu Social Organization and Structure

Tilahun (2019) states that the dominance order among male Kudu is primarily established based on their physical size and age. As a rare occurrence, cases have been found where unable to extricate themselves from each other's horns, resulted to death of both animals. Occasionally males form small bachelor groups that consisting of 4 to 8 calf males, but more frequently, they are solitary and widely isolated (Kingdon *et al.,* 2013).

Female Greater Kudus reside in social groups consisting of six to twenty individuals, which includes their calves. It is uncommon for a herd to consist of more than forty individuals, and it can be challenging for big groups to gather at times. The territory of a herd can cover an expanse of 6.1 square kilometers, and they typically allocate approximately 54% of their day to searching for food (Kingdon *et al.,* 2013). Females may occasionally repel males by biting them, as a result of their absence of horns (Kingdon *et al.,* 2013; Tilahun, 2019).

Kudus are protected by the use of their concealed pigmentation and patterns, which serve to camouflage them.

Greater Kudu herds split during the rainy season when there is an abundance of food, but they come together during the peak of the dry season, large herds are observed in areas with a higher concentration of feed and water resources. Maternal herds possess home ranges spanning around 4 square kilometers that intersect with the territories of other groups (Van Wijk *et al.*, 2015).

Greater Kudu tend to stay in their 'home' area of their birth if they do not translocate within 14 months of birth but after 14 months the birth environment becomes permanently imprinted on its brain and it will try to return at all costs. If disturbed, Kudu flee and either make their way immediately or setup a temporary extra 'home' area within a maximum distance of 11km away. They return to their original 'home' range within 3-90 days and will repeatedly return to the same temporary 'home' range each time they experience disruptions. During rutting season, the socially mature bulls may leave their home ranges and become nomadic in areas associated with female breeding groups of neighboring home ranges. After breeding season, they return to their home range. Kudu have daily movement of between 1.5 and 3km during wet summer and up to 8km in dry winter periods (Owen-Smith 2013).

Greater Kudu have a wide range of vocalizations, including barks, grunts, hooting bleats, and a strangulated whimper (Van Wijk *et al.*, 2015).

2.3.3 Reproduction and Breeding Habits of Greater Kudu

The socially mature Male kudus attain sexual maturity at 21–24 months, whereas female kudus reach sexual maturity at 1–3 years. The conclusion of the rainy season, which varies significantly depending on the temperature and region of habitation, marks the beginning of the mating season. They celebrate a courtship activity that involves the male standing in front of the female and frequently having a neck wrestling before mating. After that, the male kudu follows the female and calls in a low tone to get its consent to copulate. It takes about eight months to go through gestation (Stuart, 2013).

The pregnant female kudu separates from the group to give birth, leaving her calf hidden for safety. Greater kudus usually give birth to one calf, though twins are rare. Most births occur during the wet season, from January to March. In the first two weeks, the calf remains concealed from predators. For the next four to five weeks, it travels with the herd only during the day (Estes, 2004). While females reach self-sufficiency at one to two years of age, males do so at six months. Greater Kudus can live up to 23 years in age (Kingdon *et al.*, 2013).

2.3.4 Ecology: Distribution and Habitat of Greater Kudu

The Greater Kudu is found across the savannahs of eastern and southern Africa. From eastern Africa, Greater Kudu is widespread in Ethiopia, Sudan, Somalia, Eritrea, Tanzania and Kenya; and also is distributed across several countries in southern Africa, including Zambia, Angola, Namibia, Botswana, Zimbabwe, and South Africa. In addition, it is also found in Central Africa, specifically in Chad. Their habitat includes wooded areas, dense bushland, rocky hillsides, and dry riverbeds, as well as any location with a consistent water supply (Tilahun, 2019). The preferred habitat of this species consists of mixed scrub woodland, particularly in settled areas where it can thrive. It can also be found in acacia and mopane bush on lowlands, hills, and mountains up to an altitude of 2400 m in Ethiopia (Yalden *et al.,* 1996). In Kenya, Greater Kudus are endemic to Lake Bogoria landscape.

Greater Kudu habitat in LBNGR

In 2002, Lake Bogoria in Kenya was designated as a Ramsar site, indicating its status as a protected wetland region. Additionally, Lake Bogoria National Game Reserve, spanning an area of 107km2, has held the status as a protected National Game Reserve since 1973. The national game reserve's acacia forests provide habitat for a diverse range of wild species, including Greater Kudus, antelopes, zebras, leopards, cheetahs, hyenas, mongoose, monkeys, baboons, and jackals. Some of the dispersal areas for the Greater Kudu within the Lake Bogoria landscape are wildlife conservancies and private lands thus a threat to their existence (Baringo County CIDP, 2018).

2.3.5 Greater Kudu Feeding Habits

Greater Kudu is herbivorous animal that mostly consumes foliage and shoots from a diverse range of plant species. During arid periods, they consume untamed watermelons and various kind of fruit. Kudu are herbivores who primarily feed on vegetation. They have the ability to go without drinking water for extended periods of time, as they acquire enough moisture from their food. However, during seasons of extreme dryness when the vegetation is scarce, kudu become reliant on water to survive. This adaptation allows the species to thrive in arid and semi-arid regions (Owen-Smith 2013).

In time daytime, Greater Kudus retreats to look for cover under woodlands, especially in days that are hot– their feeding and drinking time is in the early morning and late in the evening. Although they stay in one area, Kudus may cover extensive distances in search of water in times of drought. Greater Kudus sometimes venture into nearby farmland during the night when it has

been established near their habitat, as reported by Tilahun (2019). Greater Kudus primarily consume forbs, particularly creepers, due to the higher nutrient content in their leaves and the less fibrous quality of their stem material compared to trees and bushes. Woody browse is highly desired during the initial stages of growth when their new shoots are at their most tender, particularly when forbs are scarce. Fruits and pods serve as a significant source of nutrients throughout specific seasons, with a particular preference for oranges and tangerines (Kingdon *et al.*, 2013; Oddie, 1994).

2.3.6 Greater Kudu Predators and Diseases

Predators for kudus are majorly lions, leopards, wild dogs, and spotted hyenas are predators, additionally young Kudu and vulnerable cows are preyed on by cheetahs, smaller cats, eagles and pythons (Tilahun, 2019). There have been multiple reported cases of Nile crocodiles preying on Greater Kudus (Cronje *et al.*, 2002). When predators threaten a herd, an adult, normally a female, will issue a hoarse alarm bark to signal danger to the rest of the herd – the Kudus depend on their ability to jump over shrubs and small trees in order to get away from their pursuers, the male laying back his horns to avoid obstructions (Oddie, 1994). Greater Kudus possess great hearing and vision abilities, enabling them to detect the presence of oncoming predators (Nersting & Arctander, 2001).

Kudus population has also decreased due to human poaching for their meat, hides, and horns. Hunters highly desire greater kudu, mostly for the impressive horns of bulls and also for their superior meat. They are a frequently targeted species in southern Africa and contribute the largest share (13.2%) of hunting revenue in South Africa. Kudus exhibit a preference for densely vegetated habitats and their timid behavior offers some level of protection from hunting attempts. Nevertheless, human activities such as agricultural development and charcoal burning lead to the destruction of Kudu's habitats. This adversely affects the Kudu's habitat as the species is unable to thrive in wide fields or farmland (Kingdon *et al.*, 2013).

Kudus are vulnerable to rinderpest, anthrax, coryne bacterium, foot and mouth disease, tuberculosis, pneumonia, cytauxzoonosis, mange, and rabies. A healthy Kudu can withstand up to 5000 ticks on them at a time. Tick loads may increase tenfold when the animal come under nutritional stress and stress can significantly impact bodily condition in a negative way (Du Toit *et al.*, 2002; Tilahun, 2019).

2.3.7 Greater Kudu Game Meat

Research has indicated that game meat contains higher levels of polyunsaturated fatty acid potassium, phosphorus as well as micro-minerals such as Zn and Fe, together with B-group vitamins and vitamin E than meat from domesticated animals (Soriano & Sánchez-García, 2021). Wild animal meat obtained in Europe is regarded as a substitute for other red meats due to its high nutritional value and sensory properties (Soriano & Sánchez-García, 2021). Game meat is perceived by consumers from European countries as a novel cuisine and are prepared to pay a higher cost for it. They are also inclined to consume more of it if it is of superior quality and more readily available in the market (Demartini *et al.,* 2018). The Greater Kudu is the second most popular animal for game meat in South Africa (Bothma *et al.,* 2002; Hoffman *et al.,* 2009). A study conducted in Limpopo Province, South Africa, aimed to compare the fatty acid profile, cholesterol content, and sensory characteristics of game meat from Kudu *(Tragelaphus strepciceros)* and Impala *(Aepyceros melampus).* The results revealed that the saturated fatty acid content in Impala meat was higher than that in Kudu meat. (Hoffman *et al.,* 2009). The difference in diets between Kudu and Impala can be linked to their feeding preferences. Kudu are non-selective browsers, mostly consuming grass and forbs (non-woody plants other than grasses). On the other hand, Impala are mixed feeders, and their diet varies according on the area or season (Furstenburg, 2009).

2.3.8 Greater Kudu Population Estimation in LBNGR

Wildlife population estimating methods can be categorized into two types: direct sampling, which entails counting individual animals, and indirect sampling, where animal indications, such as dung or tracks, can serve as indicators of animal presence or be utilized to determine animal density. Utilizing cull data is an alternative approach, but it is not viable in a game reserve where hunting is forbidden (Annighöfer & Schütz, 2011; Ellis, 2003).

Population census studies have utilized many direct methods that involve the enumeration of individual animals. The methods include drive counts, (Bothma *et al.,* 1990; Takeshita *et al.,* 2016) road and field strip counts (Underwood, 1982), aerial counts (Reilly, 2003), water hole counts (Bothma *et al.,* 1990) and line transects (Focardi *et al.,* 2002; Lannoy *et al.,* 2003). Each method possesses advantages and disadvantages when applied to various habitat types and animal species being studied (Ellis, 2003).

Indirect techniques, such as pellet (dung) counts, can be employed when the behavior and habitat preferences of some species make it impractical or unreliable to use direct sampling

methods (Bowland & Perrin, 1995). Methods for quantifying track counts (Mayle *et al.,* 2000), territorial marking counts (Mayle *et al.,* 1999), and levels of browsing and grazing impact (Mayle *et al.,* 1999) have been established. Each method has its own limitations depending on the species being studied and the habitat types where it will be applied.

Pellet or dung counts have been employed to determine the approximate population sizes of several animal species, such as lizards, rabbits, large and small ungulates, kangaroos, and elephants (Barnes, 2001). Various methods exist for measuring population size via tallying pellet groups, which also yield average abundance estimates over multiple months, as opposed to a single-day estimate obtained through direct counts (Ellis, 2003). There are two methods used to estimate animal population density. One technique is based on counting all pellet groups within sample plots, while the other method is based on counting the number of pellet groups deposited within sample plots that were initially cleansed of all pellets (Marques *et al.,* 2001). To determine the density based on the counts, it is necessary to have information about the animal's feces rate and the time it takes for the pellets to degrade (Ellis, 2003).

Earlier between 1991 and 1994, it was indicated that Baringo district (6,000 km^2) had an estimated Greater Kudu population of only forty-five (45), with a projected population trend that remains constant or decreasing, determined by an aerial survey. However, in 1995, the Greater Kudu's abundance was observed to be rare with population trend unknown as determined through field observations at the Lake Bogoria National Reserve (107 km^2) (East, 1999).

In the recent past, the Ministry of Tourism and Wildlife (MoT&W), Kenya Wildlife Service (KWS), and the Wildlife Research and Training Institute (WRTI) conducted a three-month nationwide wildlife census between April-July 2021 (Ministry of Tourism and Wildlife [Kenya], 2021). The aim of the national census was to create a baseline for wildlife species across the country. It was reported that 2,524 Kudus were counted during the census and was placed under vulnerable category (Waweru *et al.,* 2021). However, the data in the report did not differentiate Greater and Lesser Kudus. The Report also described wildlife status in some key Protected Areas in Kenya but status of wildlife in LBNGR landscape was not mentioned.

2.3.9 Greater Kudu Dispersal in LBNGR

In a report of a thorough analysis of wildlife dispersal areas and migratory corridors in Kenya's rangeland and coastal terrestrial ecosystems revealed that these areas are primarily located in landscapes dominated by humans and livestock (Ojwang *et al.,* 2017). According to these

authors, the majority of these habitat connections have been interrupted or lost due to human activities, and restoring them would significantly enhance the ability of the ecosystem to withstand disruptions and provide more room for wildlife. This restoration will also improve conservation efforts and decrease conflicts between humans and wildlife. There is scanty information on Greater Kudu population and dispersal areas in Lake Bogoria landscape and thus basis for this study.

2.4 Climate Change

2.4.1 Effects of Climate Change on Biodiversity

Significant risk to the biodiversity and ecological services in Africa is posed by climate change (Sintayehu, 2018). The challenge of climate change and biodiversity are intricately linked, not only due to the effects of climate change on biodiversity, but also because changes in biodiversity can influence climate change. According to the International Union for Conservation of Nature Red List of Threatened Species, climate change is posing a threat to 4,161 species. The International Union for Conservation of Nature (IUCN) in 2016, indicate that 33% of these species are vulnerable to habitat shifts and alterations caused by climate change, 29% are at danger owing to severe temperatures, and 28% are threatened by drought (IUCN, 2016).

Therefore, it is crucial to understand the impact of climate change and variability on wildlife species in the fields of conservation biology and wildlife management, particularly for proactive management and the development of conservation status choices (Zanamwe *et al.,* 2018). Climate change has a direct impact on terrestrial ecosystems by causing variations in rainfall and temperature patterns throughout the year. Additionally, it indirectly affects these ecosystems through other disturbances like fire and drought, as stated by the IPCC in 2007. By 2050, the East African region is projected to experience higher temperatures and changes in rainfall patterns. Specifically, there is expected to be a 5% - 20% increase in rainfall from December to February, and a 5% - 10% decrease in rainfall from June to August. These changes are attributed to the Indian Ocean Dipole (IOD), a pattern of warming in the Indian Ocean, which interacts with the El Niño-Southern Oscillation (ENSO) and leads to the occurrence of El Ninos (IPCC, 2013).

The direct effects of climate change encompass the consequences resulting from the rise in temperature and the increase in CO2 levels that are linked to global climate change. These factors can lead to significant indirect consequences, including alterations in hydrologic cycles (evaporation and precipitation) and an escalation in the intensity and scope of extreme weather events and frequent wildfires that devastate the environment. These changes can have various

impacts on biodiversity, such as modifying life cycles, shifting habitat ranges and species distribution, altering abundance, changing migration patterns, and affecting the occurrence and intensity of outbreaks and pest and disease (Sintayehu, 2018; Veldhuis *et al.,* 2019; Zanamwe *et al.,* 2018).

Oguto *et al.* (2016) found one of the reasons for the decline in wildlife populations is climate change and variability. This is seen through less rainfall and significant increases in both the lowest and highest temperatures. These changes, along with alterations in land use and cover, and other factors, have a combined impact on wildlife populations and their habitats. Similarly, Muposhi *et al.* (2016), noted that the influence of surface water availability, proximity to riverine ecosystems, and roads on the habitat suitability for large and medium-sized herbivores during the dry season was highly variable, potentially fluctuating from year to year. Possible impacts of climate change on ecosystem services encompass alterations in the delivery of services such as food, fiber, and timber, as well as modifications in carbon storage and sequestration, water regulation, and disease regulation. Climate change can also diminish the quantity and accessibility of suitable habitats and lead to the extinction of species that are crucial for the survival of other species (Philips *et al.,* 2008; Sintayehu, 2018).

Nevertheless, it is crucial to acknowledge that climate change can have both positive and negative effects on biodiversity and ecosystem services. Certain species may flourish or adjust to the changing conditions. In a research conducted by Woodward *et al.* (2010), species that inhabit lowland areas were found to be increasing their elevation distribution whereas high elevation species were adopting restructuring community relationships. Similarly, a field study carried out in Panama determined that ecosystems with high biodiversity are more likely to exhibit enhanced resilience in the face of a drying climate. This is because the existence of several species that can withstand drought acts as a form of "biological insurance" to mitigate the loss of other species (Bunker *et al.,* 2005).

2.4.2 Climate Change and Carbon Markets

Ecosystems have an impact on climate at both local and global scales. At a local stage alteration in land cover can impact both the temperature and the amount of precipitation. On a global scale, ecosystems have a significant impact on the climate by either storing or releasing greenhouse gases. It is evident that rising anthropogenic CO_2 emissions is the primary factor contributing to global warming (IPCC, 2007). Global initiatives including UN Framework

Convention on Climate Change (UNFCCC) have shaped development of Payment for Ecosystem Services (PES) through time. PES is a voluntary transaction for a well-defined ecosystem service, with at least one buyer, at least one seller (landholders, administrators of public land and individuals or groups in communal land), and based on the condition that the buyers only pays if the providers continue to deliver the defined ecosystem service over time (Wunder, 2005). The main PES programs negotiated under UNFCCC are the Clean Development Mechanism of the Kyoto Protocol and Reducing Emissions from Deforestation and forest Degradation (REDD).

Carbon markets refer to markets formed for buying and selling of carbon emission permits that are allocated by a regulatory body or are generated by a GHG emission reduction project (Hamilton *et al.,* 2007). Carbon sequestration and storage is one of the PES commonly implemented in Africa. Carbon PES can stabilize atmospheric CO2 concentrations by increasing the amount of carbon stored in vegetation and soils ensuring that carbon and other GHG are not released back to the atmosphere. Carbon markets hold the potential to revolutionize Africa's economic growth and development. However, one of the challenges facing scaling up of voluntary carbon markets is that the number of project developers working in Africa is limited, and the remaining developers have little capacity in terms of carbon market understanding, implementation capabilities, local expertise, and fundamental business capabilities.

The Government of Kenya is keen to position the country as a leading exporter of carbon credits in Africa. The Climate Change (Amendment) Act, 2023 is a commendable measure aimed at facilitating the establishment, engagement, and oversight of carbon markets in Kenya. The Act created the National Climate Change Council, which has the responsibility of providing guidance and policy direction on carbon markets to national and county governments, the public, and other stakeholders. These include regulatory bodies such as the Designated National Authority and National Environment Management Authority.

In between sellers and buyers in carbon markets are intermediaries who help set up PES programs (Greiber, 2009; Namirembe & Jindal, 2012). PES key areas of interest include:

1) **Renewable energy projects** for instance solar farms and wind energy. Estimated 50% of Africa's populace resides in urban areas and stands to gain from enhanced energy accessibility and enhanced air quality through the decommissioning of diesel and other fossil fuel alternatives.

2) **Forestry and land use (afforestation and reforestation):** Africa possesses a significant amount of biodiversity, making it one of the most diverse regions on the planet. It is

home to a quarter of the world's biodiversity, which may greatly benefit from enhanced preservation and heightened community awareness.

3) **Sustainable agriculture and soil sequestration:** Farmers across Africa, including those managing 33 million smallholder farms, could receive direct payments for enhancing soil and shade cover by planting trees and improving soil management practices.

4) **Livestock projects:** Africa's pastoralists, who occupy more than 40% of the continent's land area, have the potential to receive direct compensation for their efforts in controlling carbon sinks on their ranches.

5) **Employment opportunities:** By 2035, Africa's working-age population is projected to increase by 450 million people, potentially benefiting from new job opportunities within the voluntary carbon market ecosystem.

2.4.3 Interactions between Climate Change and Large Mammals

Human activity is causing a dramatic drop in the number of wild animals and the areas they inhabit (Almond *et al.,* 2021) hence decreased quantity and functional bio-diversity (Donoso *et al.,* 2020) Resulting in increased rates of extinction in other groups of species and impacting the overall functioning of entire ecosystems (Tella *et al.,* 2020). There is an increasing interest in exploring policy options that integrate biodiversity conservation and recovery with climate change mitigation and adaptation agendas (Rockström *et al.,* 2021).

One way to achieve this alignment is by implementing nature-based solutions (NbS) to address climate change. These solutions entail collaboration between humans and nature, with the aim of directly reducing the impact of climate change and supporting the ability of ecosystems and local populations to adapt to it (Seddon *et al.,* 2020). The conservation strategy and public awareness efforts have primarily emphasized large wild animals due to their charismatic nature and ability to attract financing (Macdonald *et al.,* 2017), additionally, they serve as umbrella and ambassador species, providing broader ecosystem protection benefits.

The appeal of species, as measured by their charisma, has an impact on the level of investment that partners are willing to make in seeing, researching, and conserving these species (Berti *et al.,* 2020). The emphasis has been placed on 'megafauna', which is typically characterized as animals whose adult size exceeds a specific threshold mass (ranging from 45 to 1000 kg for herbivores and 15 to 100 kg for carnivores) (Meleon *et al.,* 2020). These thresholds are determined by considering the fact that terrestrial herbivores of a certain size can have a significant impact on

the landscape by modifying the structure of ecosystems, disrupting the growth of woody plants, consuming large quantities of foliage, and affecting the flow of nutrients from plants to decomposers (Svenning *et al.,* 2016).

Research has highlighted that large land-dwelling animals, known as 'megafauna', have a significant impact on the climate by modifying the characteristics of surface vegetation and soils. They affect the mortality and species composition of plants, which in turn can influence the overall physical properties of ecosystems. Additionally, these animals can change the frequency and intensity of disturbances and modify soil properties and the cycling of biogeochemical elements through activities such as excretion, trampling, and digging. Additionally, methane emissions have a direct impact on the atmosphere (Malhi *et al.,* 2022).

2.4.4 Surface Temperature

The average land surface air temperature has significantly increased since the pre-industrial period (1850-1900) and is currently more than the global mean surface (land and ocean) temperature (GMST). It is indicated that from the years 1850–1900 to 2006–2015 mean land surface air temperature has increased by an average of 1.53°C (range from 1.38°C to 1.68°C) while GMST increased by 0.87°C during the same period (range from 0.75°C to 0.99°C) (Masson-Delmotte *et al.,* 2019).

The increase in Global Mean Surface Temperature (GMST) has caused climatic zones to shift in various regions worldwide, resulting in the expansion of dry climate zones and the reduction of polar climate zones. Consequently, many plant and animal species have undergone changes in their ranges, population sizes, and timing of their seasonal activities. Climate change can worsen land degradation processes by causing more intense rainfall, flooding, more frequent and severe droughts, heat stress, dry periods, strong winds, rising sea levels and wave activity, and thawing of permafrost. The effects of these processes are influenced by how the land is managed (Masson-Delmotte *et al.,* 2019).

Aduma *et al.* (2019) conducted a study that revealed the significant effects of high temperatures on wildlife. These effects are exacerbated by other factors such as competition with livestock, predation, and human activities like agriculture and settlements. These human activities obstruct the migration or dispersal routes of wildlife from hot areas to cooler and wetter regions. In addition, they observed that rising temperatures are causing the huge herbivores in the Kenyan Savanna to lose their habitats. Nevertheless, these reactions varied among various species.

According to Staudinger *et al.* (2013), gaining a better comprehension of the inherent ability of species to adapt - including their evolutionary potential, phenotypic flexibility, and dispersion skills - would assist in determining which species will be capable of adapting and keeping up with the speed and extent of climate change.

According to Simpson (1972), during the winter season in South Africa, Greater Kudu populations migrated to higher ground. Although the availability of food, cover, and water resources was reduced in these areas, the night temperatures were warmer and there was less variation in daily temperatures. This observation confirms that temperature plays a key role in restricting the distribution of kudus during the cold season. Additionally, it has been shown that in semiarid habitats, increases in the frequency and intensity of droughts due to climate change are expected to worsen the impact of drought on the availability of fodder. This, in turn, can have a regulating influence on the reproduction and recruitment of ungulates (Zanamwe *et al.*, 2018).

In South Africa, Greater Kudu's foraging patterns are only impacted by harsh temperatures approximately once every seven days. Extreme temperature in this scenario is defined as surpassing 36°C during the wet season and 30°C during the dry season (Owen-Smith 2002). Kudus can be killed by intense cold in late winter and early spring (Bothma *et al.*, 2002). The rise in temperature in Kenya's savannah led to a considerable decrease in the population of wildlife, and beyond certain limits, certain species disappeared from these areas. The limited availability of vital resources during these severe conditions may result in significant mortality rates among the impacted species (Aduma *et al.*, 2019).

2.4.5 Rainfall

Water is an essential resource that plays a crucial role in controlling the amount and quality of food available, which in turn affects the distribution and population of wildlife species. Less apparent, yet significantly more perilous than heat, are the repercussions of a warming globe on the water cycle, in which the oceans assume a pivotal function (IPCC, 2007). For every 1°C rise in temperature, the atmosphere can contain around 7% more moisture. This results in an increase in water vapor in the atmosphere, which has the greatest impact on precipitation (Trenberth, 2007). There is no disagreement that water vapor is a potent greenhouse gas, which significantly enhances the initial warming. Moreover, the oceans have experienced an increase in sea surface temperatures, resulting in a corresponding rise of 5 to 10% in atmospheric water vapor (Trenberth *et al.*, 2005). Storms, including thunderstorms, rain or snow storms, and tropical cyclones and

hurricanes, generate more intense precipitation episodes due to greater moisture, even in areas where overall precipitation is decreasing (Trenberth, 2007).

The variability of rainfall has significant implications for the biophysical environment, including alterations in the timing and duration of seasons, resulting in unpredictability. These changes have already had a noticeable effect on biodiversity at the species level, namely in terms of phenology (timing of occurrences), distribution, and populations. Additionally, these changes have impacted the ecosystem at the level of distribution, composition, and function (Both *et al.,* 2006).

Populations of large herbivores can fluctuate dynamically with changing rainfall patterns. High rainfall enhances range conditions by promoting rapid vegetation growth and ensuring easy access to surface water, which can lead to population increases. However, excessive water, such as flooding, may cause population declines, either directly or indirectly, through waterlogging and decreased food availability (Ojwang *et al.,* 2017). Vanacker *et al.* (2005) discovered that numerous ecosystems in sub-Saharan Africa have a strong susceptibility to fluctuations short-term rainfall.

The El Niño occurrence of 1998 in East Africa resulted in loss of life for both humans and animals due to the heavy rains and subsequent flooding. Droughts have a disruptive impact on vegetation, both directly by influencing the kind of species that survive, and indirectly by reducing the amount of primary forage that is produced. The growing frequency of droughts has significant ramifications for the movements of wildlife and the dynamics of on the populations (Ojwang *et al.,* 2017). The presence of water is a crucial factor for the survival of many animals in arid and semi-arid environments. Lamprey (1963) proposed that the availability of water is the primary factor that restricts the abundance and dispersion of wildlife in the East African savannahs, particularly in the dry season. During the dry season, the majority of wildlife species tend to gather around water sources, while they disperse more widely in the wet season.

Simpson (1972) discovered that Greater Kudus were widely scattered throughout their range during the rainy season. The extensive distribution suggests that the environmental circumstances during this particular time of year were most likely ideal for the species. Simpson additionally observed that the temperatures during the season were moderately elevated but not too hot. The area was rich in food, with ample flora providing full foliage for cover, and there were many water sources in the form of pans and ephemeral pools. However, in the dry season, water

seemed to play a more important role in animal distribution and the number of Kudu. This was evident from the overall movement of animals down the hill towards permanent water sources.

The Greater Kudu consumes approximately 7 to 9 liters of water daily during hot weather. Nevertheless, at typical yearly precipitation levels, Greater Kudu are able to sustain themselves by extracting moisture from their food. However, Greater Kudu are primarily located in woods that are next to watercourses (Skinner & Chimimba, 2005). While the Kudus are capable of surviving on vegetation alone and without water, there is a finite threshold to this endurance. During periods of extreme aridity, the Kudu will rely on water for survival (IUCN, 2008).

Based on the findings of the Heinz Centre (2012), there was a 30% rise in rainfall, which led to an increased population density of the Kudu. This suggests that the Kudu's reliance on available resources is mostly influenced by changes in rainfall patterns. Precipitation impacts the accessibility and nutritional value of fodder, which diminishes during periods of drought (Owen-Smith, 2002). Greater Kudu possess adaptations that enable them to consume a diverse range of vegetation. However, during periods of drought, the decreased nutritional value of the available browse necessitates an increased consumption rate (Dorgeloh, 2001; Owen-Smith, 2002). Males in poor condition at the end of the mating season may lack the ability to withstand the subsequent dry season (Skinner & Chimimba, 2005). Moreover, the arid season poses a significant threat to the Greater Kudu population due to increased predation. For example, in the Kruger National Park of South Africa, 40% of lion predations occurred specifically throughout the three-month period of the dry season (Owen-Smith, 2002).

2.5 Land Use/Cover Change

2.5.1 Effects of Agricultural land use change

The anthropogenic component significantly influences changes in land use and land cover. Rapid human population growth globally has caused agricultural land use to expand drastically due to increased food requirements. A study examining land-use intensity and its impact on biodiversity in agricultural landscapes revealed that the most degraded ecosystem quality was observed in heavily utilized agricultural areas (Reidsma *et al.,* 2006). This is attributed to the influence of agricultural activities on land use/cover, environment and ecosystems services. Agricultural related activities that put pressure on the environment and ecosystem services are fertilizer/manure and pesticides consumption and increased number of livestock which contribute

to release of the greenhouse gases and water abstraction. These make agriculture a top-priority sector a top-priority sector for both economic and environmental policy (Kanianska, 2016).

In a study to determine the influence of land use/cover change on soil erosion potential of a reservoir catchment, it was found that transition of other land use/cover categories to cropland or agricultural land use was the most detrimental to watershed in terms of soil loss while forest acted as the most effective barrier to soil loss (Sharma, 2011). Consequently, environmental or economic impacts of land use change on the ecosystems and ecosystem functioning and ultimately on human health and on the economic and social performance of society, have triggered response to wards optimization of production of agricultural land use to curb rapid expansion to forests and rangelands. One of such technologies is smart agriculture.

2.5.2 Climate-smart Agriculture

Since industrialization, traditional farming methods have placed greater demands on land to achieve higher yields per hectare. The use of agrochemicals, monoculture agricultural techniques, and extensive tillage has resulted in soil degradation, causing harm to the landscape. However, agriculture has the potential to contribute to the solution by aiding in the conversion of degraded landscapes into flourishing ecosystems. Regenerative agriculture aims to establish a symbiotic connection between farming and the environment by implementing methods that enhance soil health, biodiversity, and ecological equilibrium. This approach ultimately results in improved soil quality, consistent crop yields, and a more robust landscape.

Climate change adversely affects developing countries as a result of their greater reliance on agriculture at a percentage in their national gross domestic product. Furthermore, developing countries are often more susceptible to the impacts of climate change in comparison to developed nations (Long *et al.,* 2016). Conventional methods used by farmers are insufficient to meet the increasing demand. The incorrect utilization of nutrients, water, fertilizers, and pesticides disrupts agricultural development, resulting in infertile and unproductive land (Hassan *et al.,* 2021). Due to growing concerns about the impact of agriculture on the quality of surface and groundwater, as well as the rising costs of chemicals and the need to meet a projected 50-70% increase in food demand with limited resources, there is a need to transform agricultural systems into highly efficient and profitable systems (Zhang *et al.,* 2015).

Precision agriculture dates back to the middle of the 1980's. Precision agriculture (PA) is the scientific practice of enhancing crop yields and aiding management decisions through the

utilization of advanced sensor and analysis systems. Precision Agriculture (PA) is a globally embraced idea aimed at enhancing productivity, minimizing labor requirements, and optimizing the utilization of fertilizers and irrigation methods (Singh *et al.*, 2020). It utilizes a substantial quantity of data and information to enhance the utilization of agricultural resources, crop yields, and crop quality (Mulla, 2013).

The concept of 'regenerative agriculture' originated in the 1970s, when a collective of farmers and researchers started investigating alternate methods to traditional agriculture (Leu, 2020). Subsequently, the regenerative agriculture movement has expanded and developed. Lately, there has been a renewed interest in regenerative agriculture. Regenerative agriculture (RA) is suggested as a remedy for achieving sustainable food systems. RA focuses on achieving goals that pertain to improving the environment and emphasizes the significance of socio-economic factors that contribute to ensuring food security. Schreefel *et al.* (2020) introduced a definition of regenerative agriculture (RA) as a farming method that focuses on soil conservation to restore and enhance various ecosystem functions. In semi-arid environments, the occurrence of soil erosion poses a significant risk. Therefore, adopting measures to mitigate erosion, such as minimizing tilling and promoting ground cover, as well as enhancing the soil's ability to retain water, are appropriate strategies.

Climate-smart agriculture (CSA) is the use of evolving technologies and automation to optimize agricultural production for improved food security. The CSA offers a satisfactory solution by striving to achieve increased productivity in agricultural activities and sustainable income, resilience, as well as GHG emission reduction and enhances achievement of global nutrition and food security and development goals (Mizik, 2021). Environmental conditions are major factors to be monitored for improved crop yield. Such technologies are handy for monitoring environmental conditions (temperature, humidity, irrigation and water management (moisture), weeding, pests and diseases which may destroy the crops in agricultural field) through sensors with the aim of mitigating climate change impacts (Sushanth & Sujatha, 2018). Different control strategies are used automate CSA such as: Internet of Things (IoT), aerial imagery, multispectral, hyper spectral, NIR, thermal camera, RGB camera, machine learning, and artificial intelligence techniques (Hassan *et al.*, 2021).

Even though CSA has the ability to achieve sustainable agriculture, there aren't enough links between its field-level components. More importantly, different levels of stakeholders

occasionally have a poor understanding of the concept. It is essential to spread CSA approaches to the field level by incorporating them in research, academic syllabi, seminars, and symposiums in order to achieve a better future (Sarker *et al.,* 2019).

2.5.3 Effects of Land Use/Cover Change on Biodiversity

The regional surface temperature is directly impacted by changes in the forest cover, such as afforestation, reforestation, and deforestation, as a result of water and energy exchanges. (Masson-Delmotte *et al.,* 2019). Although inter-annual land cover change has a substantial impact on food security, ecosystem processes, and regional and global climate (Vanacker *et al.,* 2005), the natural vegetation of East Africa has been replaced by farmlands, grazing lands, urban centers, and human settlements due to changes in land use (Maitima, 2009). Livestock grazing can change the composition and structure of rangeland vegetation communities, often to the detriment of wildlife. Some plant species may decline with grazing, while others may thrive. (Ojwang *et al.,* 2017).

A study examining the connections between land use change, land degradation, and biodiversity in East Africa revealed that the loss of native vegetation results in the depletion of indigenous plant and animal variety, as well as plant cover (Maitima, 2009). Similarly, Kitina & Odiara (2014) discovered that land use changes in the Kimana Wetland Ecosystem in Kajiado had several significant impacts on wild ungulates. These included a decrease in the number of wild ungulates, destruction of their habitat, an increase in conflicts between humans and wildlife, degradation of the land, and the displacement of wild ungulates by livestock. The reduction of available spaces for wildlife dispersal in Amboseli is directly connected to recent alterations in land tenure and land usage within the Maasai group ranches, threatening wildlife dispersal (Okello & Kioko, 2010).

Another study conducted in Nech Sar National Park, Ethiopia examined the effects of human-caused changes to the landscape on the population and behavior of large mammals. The study found that these disturbances resulted in alterations to the size, quantity, distance, spatial arrangement, and structure of natural habitats between 1985 and 2013 (Fetene *et al.,* 2019). According to a study by Ogutu *et al.* (2016), there was an average reduction of 68% in wildlife numbers between 1977 and 2016. However, during the same period in Kenya, there was a noticeable increase in the numbers of sheep and goats (76.3%), camels (13.1%), and donkeys (6.7%).

Greater Kudu are known for their wide-ranging diet, consuming a greater variety of species than other bovids in the southern region (Skinner & Chimimba, 2005). They are able to adapt their diet during times of food scarcity in the dry season (Owen-Smith, 2002). Kudus are able to thrive in various habitats such as scrubland and abandoned fields (IUCN, 2008). Interestingly, they can coexist near human settlements as long as there is adequate cover (IUCN, 2008).

2.5.4 Land Use/Cover Change Detection

A comprehensive understanding of land use and land cover is essential in the planning process, as it can inform discussions about current arrangements and patterns, and highlight the need for changes in land use as part of a regional plan, resource development or management project, environmental planning effort, or preliminary regional study (Rogan & Chen, 2004). For instance, multi-temporal satellite imagery from the Landsat series was used to map land use and cover changes in the Wami River Basin over a 16-year period (Twisa & Buchroithner, 2019). Additionally, multispectral satellite data have shown potential for detecting, identifying, and mapping changes in forest cover (Coppin & Bauer, 1996).

According to Green *et al.* (1993), the main objectives of land use/cover change detection are twofold. Firstly, it aims to compare spatial representations of two different points in time while eliminating any variations caused by factors that are not relevant to the study (such as differences in orbital and platform altitudes). Secondly, it aims to quantify the changes that occur as a result of differences in the variables that are of interest. Land use/cover change detection, monitoring, and updating essentially depend on two types of techniques: comparing maps and comparing images.

Map-to-map comparisons are based on the detection of discrepancies between two maps that were created at separate times. This form of comparison necessitates the classification of images (either digital or analog) from two distinct dates by interpreters, followed by a subsequent comparison of the maps. Previously, the comparison was conducted on a light table and was the sole method of spatially referenced change detection available. GIS has enabled the digital performance of map-to-map comparisons, either by analyzing the area of each polygon type or by examining individual pixels. The effectiveness of comparing maps is limited by the assumptions and methodologies employed in creating maps of the same region at different points in time (Byrne *et al.,* 1990; Green *et al.,* 1993).

Remote sensing is a crucial tool for studying the complexity of land use and cover dynamics across various spatial and temporal scales. It has produced valuable indices for describing and quantifying both natural and human-induced land-cover changes, processes, and the provision of ecosystem services. Notably, the Normalized Difference Vegetation Index (NDVI) has been widely utilized.

The NDVI is a standardized metric that enables the creation of an image that depicts the relative biomass of vegetation. NDVI is calculated using the absorption of chlorophyll in the Red band and the high reflection of plants in the Near Infrared band (NIR). The index can be utilized to measure the annual net primary productivity (Young & Harris, 2005), which is influenced by temperature and water availability. NDVI is widely acknowledged as a reliable indicator that shows the geographical distribution of vegetation photosynthesis. It is closely linked to social-ecological processes such as habitat-land use conversion and crop rotation (Poveda & Salazar, 2004; Zurlini *et al.*, 2014).

In 2020, a study was conducted to examine the connections between hydrologic patterns in the basins of four Rift Valley lakes (Nakuru, Baringo, Bogoria, and Elementaita) and the recent changes in land use and cover. The findings indicated that between 1989 and 2019, there was a 27.5% increase in the proportion of agricultural land, a 0.8% increase in settlement areas, and a 0.4% increase in barren land. Conversely, there was a drop in natural vegetation (24.5%), wetland (1.6%), water bodies (0.5%), and grassland (2.1%) during the same period (Kiage & Douglas, 2020). Nevertheless, the study did not examine the correlation between changes in land use/cover and the dispersal areas of Greater Kudu in the Lake Bogoria setting.

2.6 Environmental Conservation Knowledge, Attitude and Practice among Local Resource Users

Nature's resources are the foundation upon which modern human society is built. Furthermore, the enormous value of the natural world to our safety, food production, economic prosperity, and general well-being is becoming increasingly clear to science. The exponential growth in human consumption is the primary catalyst for the extraordinary transformation of our planet, as it leads to a surge in the need for energy, land, and water. Although climate change poses an increasing danger, the primary factors contributing to the reduction in biodiversity remain the excessive exploitation of species, agricultural activities, and the conversion of land (WWF, 2018). The designated protected areas and biodiversity hotspots in Africa are facing a significant danger,

which emphasizes the need to involve the community in order to solve the increasing issues of poverty and malnutrition. Hanks (2021) has suggested innovative approaches to conserve Africa's mammals, which involve incorporating many species into the production environment, including the agricultural community.

Various strategies have been proposed to prevent and decrease the decline of wildlife. These include protecting areas where animals can disperse and migrate, supporting and investing in local communities and landowners to establish community and private wildlife conservancies, and promoting the diversification of rural livelihoods by taking advantage of ecosystem services, among other measures (Ojwang *et al.,* 2017). Local communities are increasingly acknowledged as custodians of their own environment, since there is growing acknowledgment of the area of Community Based Natural Resource Management (CBNRM). The efficacy of Community-Based Natural Resource Management (CBNRM) is contingent upon the specific local context in which it is implemented, specifically the governance capabilities, resource conditions, and local communities (Brunkhorst, 2010).

The act of displacing local residents and denying them access to protected resources can result in local animosity towards conservation efforts, particularly in relation to wildlife. Upon its establishment in 1990, the Kenya Wildlife Service (KWS) created a Community Wildlife Department with the explicit purpose of strengthening the involvement of local people in wildlife conservation. The primary objective was to enhance the degree of consciousness regarding the significance of wildlife preservation among rural populations through the implementation of a wildlife and environmental education initiative (Kioko & Kiringe, 2010).

Previous studies showed that wildlife on private and community sanctuaries were stable or increasing (Douglas-Hamilton & Hillman, 1976; East, 1999), unlike the decreases in protected areas and nationwide. Decades later, another study suggested that parks linked with community and private conservation endeavors have superior performance compared to parks lacking outreach programs (Western *et al.,* 2009). Such evidence indicates the necessity of implementing policies that integrate national, corporate, and community efforts to maintain substantial populations of free-ranging herbivores at both the ecosystem and landscape levels.

The Kenya Wildlife Service has implemented various strategies to actively involve local communities in wildlife conservation for their own benefit. These strategies include direct visits by community officers to specific individuals, conducting short training courses and workshops to

raise awareness and educate the local population, delivering wildlife-related messages at public meetings (Barazas), organizing exchange visits for targeted groups to different wildlife areas, utilizing mass media for community education and awareness programs, and enhancing the capacity of local institutions and communities to foster a sense of ownership and responsibility towards wildlife resources (Kenya Wildlife Service, 2015). Nevertheless, a significant obstacle in environmental conservation is achieving a harmonious equilibrium between human necessities and aspirations, and the requirements of the environment.

Environmental conservation projects aim to address the disconnection between humans and nature by influencing knowledge levels and attitudes. Respondents who are well informed on sustainability tend to have a positive attitude towards conservation. This was apparent in a study conducted in southern Ethiopia to examine the knowledge, attitudes, and practices (KAP) of local residents on the coexistence of carnivores and humans in a landscape predominantly inhabited by humans. The study revealed that those who possessed a higher level of knowledge about carnivores also exhibited a favorable attitude towards them (Gebo *et al.,* 2022). Moreover, research has confirmed that the perspective of a population might influence its inclination towards environmentally friendly actions and policies (Browne-Nuñez & Jonker, 2008).

The Knowledge, Attitudes, and Practice (KAP) survey is a structured approach used to carry out comprehensive investigations on certain populations. It aims to examine the understanding and beliefs of individuals regarding a particular subject, as well as their corresponding behaviors (Wood & Tsu, 2019). The KAP framework is highly relevant to conservation and management studies, as well as informing policy decisions, because it can be used to assess public knowledge and perception of threatened and exploited species, as well as the communities' current actions and willingness to take action in support of these outcomes (Ali *et al.,* 2020).

An excellent demonstration of the significance of Knowledge, Attitudes, and Practices (KAP) in conservation may be found in a research conducted on the Sekong, Sesan, and Srepok (3S) Rivers in South East Asia. The 3S Rivers, which serve as habitats for animals and sustain numerous endangered species, are facing significant risks due to hydropower construction, habitat degradation, economic land concessions, extractive industries, and illicit logging. To address these problems, a conservation program was established at the community level to protect water birds. This initiative involved providing direct financial incentives to communities in exchange for

safeguarding bird nests. Subsequently, a Knowledge, Attitudes, and Practices (KAP) survey was carried out in certain villages located along the 3S Rivers in order to get insight into the community's perspectives regarding the bird nest protection program. According to Sophat *et al.* (2019), the local community reported an increase in water bird populations and a decrease in threats as a direct outcome of the programme.

In Kenya, the community wildlife department of KWS has primarily prioritized community benefit and conflict resolution mechanisms, while placing less attention on knowledge and awareness building programs (Kioko *et al.,* 2010). The ongoing economic significance of the Greater Kudu in LBNGR serves as its strongest means of protection. Currently, the issue of overhunting and habitat loss of Kudus in northern Africa is being addressed by the management of the species in other regions (IUCN, 2008).

Greater Kudu at LBNGR landscape is vulnerable due to unsustainable exploitation and management of resources associated with issues as poverty, inefficient land utilization, excessive livestock numbers, and unsustainable farming practices. The Lake Bogoria Integrated Management Plan (IMP), Friends of Nature Bogoria (FONB) and the Small Grants Programme (SGP) through Global Environment Facility (GEF) in partnership with Kenya Organic Agricultural Network (KOAN) and Egerton University provided a thrust for conservation of Greater Kudu in the landscape by working with local community conservancies and financing establishment of Greater Kudu monitoring transect lines. This study seeks to assess the Knowledge, Attitudes, and Practice (KAP) of local resource users towards community conservancies, and more specifically, the conservation of the Greater Kudu in the landscape. KAP findings generated useful knowledge that contributes to Kudu conservation awareness Programmes and policy development for improved livelihoods.

2.7 Research Gaps

Table 2. 1: Research gaps

S/No.	Specific Objectives	Author(s)	Research Gaps
1.	To assess spatio-temporal change of dispersal of Greater Kudu in Lake Bogoria	-Ojwang *et al.* (2017) -East (1999)	Although comprehensive synthesis of the wildlife dispersal areas and migratory corridors in Kenya's rangeland and coastal

S/No.	Specific Objectives	Author(s)	Research Gaps
	landscape in the last four years.		terrestrial ecosystems was done in 2017, the scope did not include mapping of dispersal areas of the Greater Kudu.
2.	To assess the impacts of temperature and rainfall variability on population of Greater Kudu within Lake Bogoria landscape in the last four years	-Vanacker *et al.* (2005) -Ojwang *et al.* (2017)	It is indicated that populations of large herbivores may increase or decline dynamically with changing rainfall patterns. However, studies on impacts of temperature and rainfall variability on the distribution of the Greater Kudu within Lake Bogoria landscape have not been documented.
3.	To relate land use/cover change to the distribution of the Greater Kudu in Lake Bogoria landscape in the last four years.	-Kiage and Douglas (2020) -Okello and Kioko(2010)	While hydrologic dynamics in the basins of the four Rift Valley lakes (Nakuru, Baringo, Bogoria, and Elementaita) and the recent land use/cover changes were studied recently, the relationship between land use/cover changes and dispersal areas of Greater Kudu in Lake Bogoria landscape was not examined.
4.	To investigate the knowledge, attitude, and practice of locals towards conservation of the Greater Kudu in community	-Kioko *et al.* (2010) -Ali *et al.* (2020)	In Kenya, the community wildlife department of KWS has mostly focused on community benefit and conflict resolution mechanisms, with less emphasis on knowledge and awareness creation

S/No.	Specific Objectives	Author(s)	Research Gaps
	conservancies at Lake Bogoria landscape.		Programmes. This study aims at evaluating status of knowledge, attitudes and practices (KAP) of locals towards conservation of the Greater Kudu in in the Lake Bogoria landscape.

2.8 Theoretical and Conceptual Framework

2.8.1 Theoretical Framework

Connectivity Conservation Management Framework

The IUCN World Commission on Protected Areas has established a Connectivity Conservation Management (CCM) Framework to establish a structured and systematic method for managing connectivity areas. Connectivity conservation is a contemporary approach to managing land use on a large scale in order to preserve one or more types of connectivity. There are four types which include landscape, habitat, ecological, and evolutionary process connectivity. Each type may require different management strategies (Lindenmayer & Fischer, 2006; Worboys *et al.*, 2010).

The framework acknowledges the need to closely monitor the dynamic contexts of "nature," "people," and "management" because connectivity conservation areas are a part of the real world and are always changing. This information is continuously used in carrying out the four management functions (Figure 2). 1). The idea acknowledges the need of four management functions: leadership, planning, implementing conservation activities, and evaluating performance. These roles require a structured yet adaptable management strategy that takes into account the changing situation. The framework also acknowledges that management will vary depending on the situation. The suitability of local biodiversity protection measures may vary throughout different sections of the same corridor. Local planning is crucial in resolving this issue. However, it is the vision that offers comprehensive and overarching advice for the entire connectivity conservation area.

The preservation of connectivity plays a crucial role in conserving biodiversity. For instance, in 2011, connectivity conservation efforts linked protected areas, ensuring the

preservation of vast natural landscapes and ecosystem functions in Australia. These efforts were instrumental in supporting the National Reserve System's conservation goals. As a key strategy in combating climate change, connectivity conservation facilitates the movement, interaction, adaptation, and evolution of species in response to changing environmental conditions, such as rising temperatures and altered precipitation patterns leading to biome shifts on a large scale. The connectivity areas were initiated by grass root organizations; non-government conservation organizations; governments or by a combination of these organizations (Worboys *et al.*, 2011).

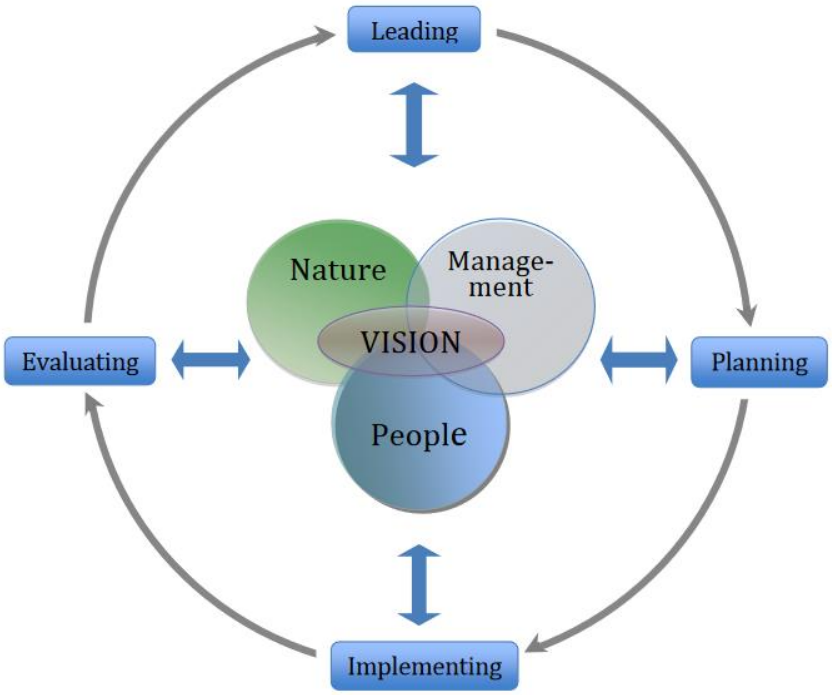

Figure 2. 1: IUCN WCPA Connectivity Conservation Management Framework. Source: Worboys et al. (2010)

Additionally, because connectivity conservation supports important ecological processes that deliver the vital ecosystem goods and services that environmental sustainability depends on, it has enormous social and economic benefits. It also helps to lessen conflicts between people and wildlife. For instance, pastoralist livestock production is permitted in areas designated for wildlife grazing, where compatible multiple land-use options are practiced (Ojwang *et al.*, 2017).

Connectivity at the landscape level refers to "the degree to which the landscape facilitates or curtails movement among resource patches" (Taylor *et al.*, 2021). Various species perceive a

landscape in distinct ways, resulting in differences in connectivity levels among species and communities. A high-connected landscape or local area is one where individuals of a given species can freely travel between suitable habitat areas with preferred plant types for foraging, or where different habitats are needed for shelter and forage. When people are severely restricted from relocating between specific habitats, the landscape is considered low connectedness (Bennett, 2003; *Ojwang et al.*, 2017).

In addition to the ecological justifications, it is crucial to build connectedness for social, economic, and political reasons. In Kenya, the government and other stakeholders have acknowledged the need of fostering ecological connections for the purposes of conservation and socio-economic advancement. The Vision 2030 national strategic plan (Ojwang *et al.*, 2017) underlined the need to protect wildlife dispersal regions and migratory routes/corridors.

This study sought to identify and map dispersal areas of the Greater Kudu within Lake Bogoria landscape which is a significant progress in the restoration and maintenance. The connectivity framework suggests progressively expanding the exercise to encompass a thorough evaluation of habitats and ecosystems which includes examining natural features that play a crucial role in facilitating movement, identifying key resource areas that provide essential minerals, water, dry season grazing, calving and breeding grounds, analyzing habitat mosaics and heterogeneity, and considering the impact of species movements on endangered habitats, among other factors. These and secondary data was considered to inform process of dispersal areas mapping.

The Driver-Pressure-State-Impact-Response (DPSIR) framework

While conducting wildlife research on wildlife migratory corridors and dispersal regions in Kenya's rangelands and coastal terrestrial ecosystems, Ojwang *et al.* (2017) applied a methodological approach. In the study, all the data pertaining to wildlife numbers, spatial distributions, and migratory patterns in Kenya were gathered and examined. A comprehensive examination of both published and unpublished literature, which involved conducting fieldwork and interviewing individuals with specialized knowledge, was also undertaken. The DPSIR analysis tool was modified to identify and prioritize the threats, opportunities, and actions required to restore wildlife dispersal areas and migratory corridors that have been compromised by human activities.

The National Institute of Public Health and Environment in Bilthoven, Netherlands suggested the adoption of the Driver-Pressure-State-Impact-Response (DPSIR) framework to the

European Environment Agency (EEA) as a guideline for developing an Integrated Environmental Assessment strategy. This framework identifies the driving forces, pressures, states, impacts, and responses related to environmental issues (Nelson, 1999).

The framework has been extensively embraced by the EEA, serving as a comprehensive method for reporting, as seen in the EEA's State of the Environment Reports (Kristensen, 2003). Kristensen, systematically described DPSIR by defining its components starting from driving forces to responses (Figure 2.2). He pointed out that a 'driving force' is required. Primary driving forces for an individual include the essential needs for shelter, food, and water. On the other hand, secondary driving forces encompass the desires for mobility, amusement, and culture. Driving forces, such as the need for transportation or food production, motivate human activity.

Human activities apply significant pressures on the environment through production and consumption processes. These pressures can be categorized into three primary types: (i) overexploitation of environmental resources, (ii) shifts in land use, and (iii) emissions of chemicals, waste, radiation, and noise into the air, water, and soil. Pressures exerted on the environment have a direct impact on its overall condition, specifically on the quality of different environmental components such as air, water, soil, etc., and their ability to perform their respective roles. The 'state of the environment' encompasses the collective physical, chemical, and biological factors, including ecosystems (biodiversity, plants, soil organisms, and water creatures), as well as human health.

The quality of ecosystems and the well-being of human beings are influenced by changes in the physical, chemical, or biological conditions of the environment. A "response" by society or policy makers occurs as a consequence of an undesirable effect and can influence any aspect of the sequence between driving factors and impacts (Figure 2.2). Put simply, alterations in the state can have environmental or economic consequences on the operation of ecosystems, their capacity to sustain life, and ultimately on human health and the economic and social performance of society.

It is important to note that developing a DPSIR framework for a specific context is a challenging endeavor, since it requires meticulous description of all the diverse cause-effect linkages and environmental changes that are seldom attributable to a single cause. Consequently, National Environmental Research Institute (NERI) suggested an approach that defines and organizes environmental issues in a manner that reveals a distinct correlation with external influences. The goal variable in this case is determined by physical or chemical state indicators,

while any changes in biological state variables are considered as derived effects (Figure 2.2). Although Binimelis *et al.* (2009), in a study to evaluate the use of DPSIR framework for biodiversity assessment concluded that it must be applied with care for analysis and not as a simple causal scheme, it was also concluded that consistent definitions of the elements in DPSIR, and the specification of the levels and spheres in which they operate, makes the framework useful for policy.

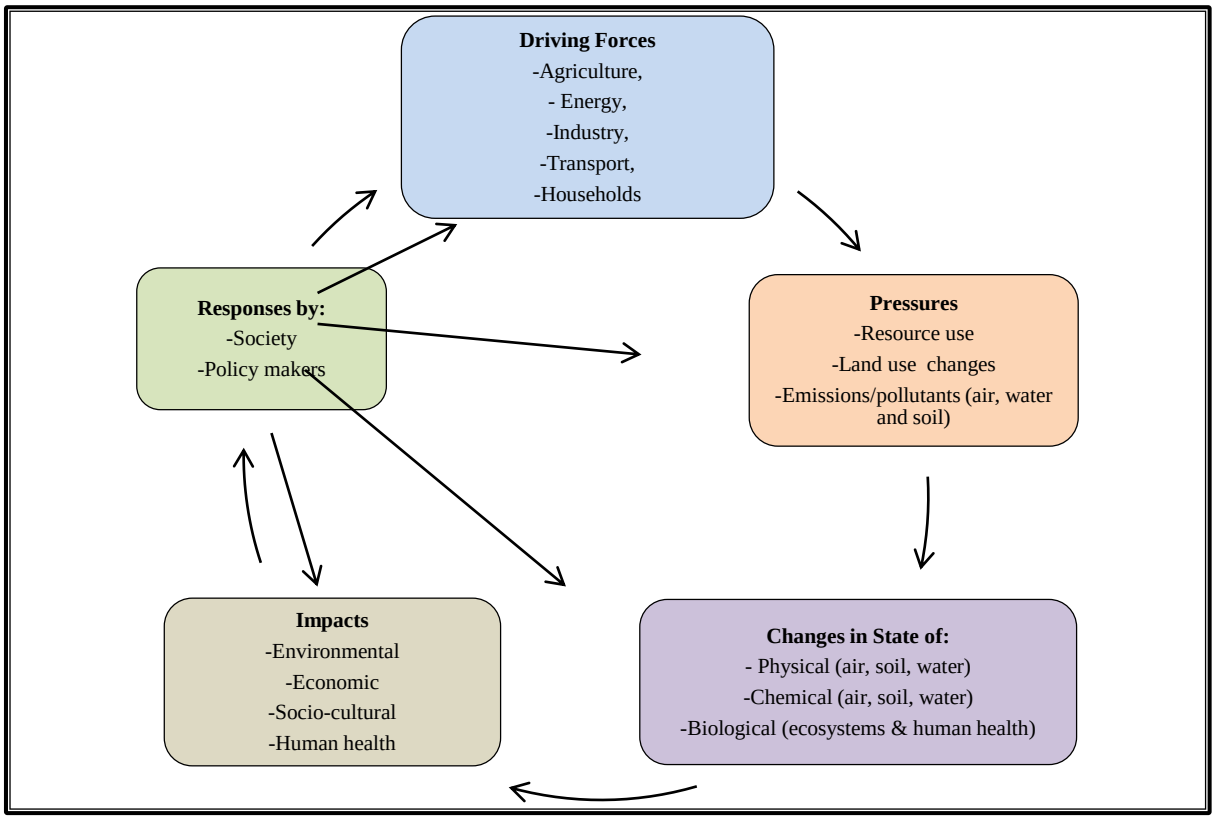

Figure 2. 2: DPSIR Assessment Framework. Source: Kristensen (2003)

Linking DPSIR Elements

The DPSIR framework is valuable for explaining the connections between the root causes and consequences of environmental issues. However, to comprehend their dynamics, it is also beneficial to concentrate on the interconnections among DPSIR parts (Figure 2.3). For instance, the relationship between the 'D' and the 'P' by economic activities is a function of the eco-efficiency of the technology and related systems in use, with less 'P' coming from more 'D' if eco-efficiency is improving. Therefore, the environmental impacts caused by human activities, such as emissions, resource consumption, and land use, depend on two factors: the extent of these

activities and the technology employed in carrying them out. Similarly, the correlation between the effects on individuals or ecosystems and the 'S' factor is contingent upon the carrying capacities and thresholds of these systems. The response of society to impacts is contingent upon the perception and evaluation of these affects. Furthermore, the effectiveness of the response determines the outcome of the subsequent development.

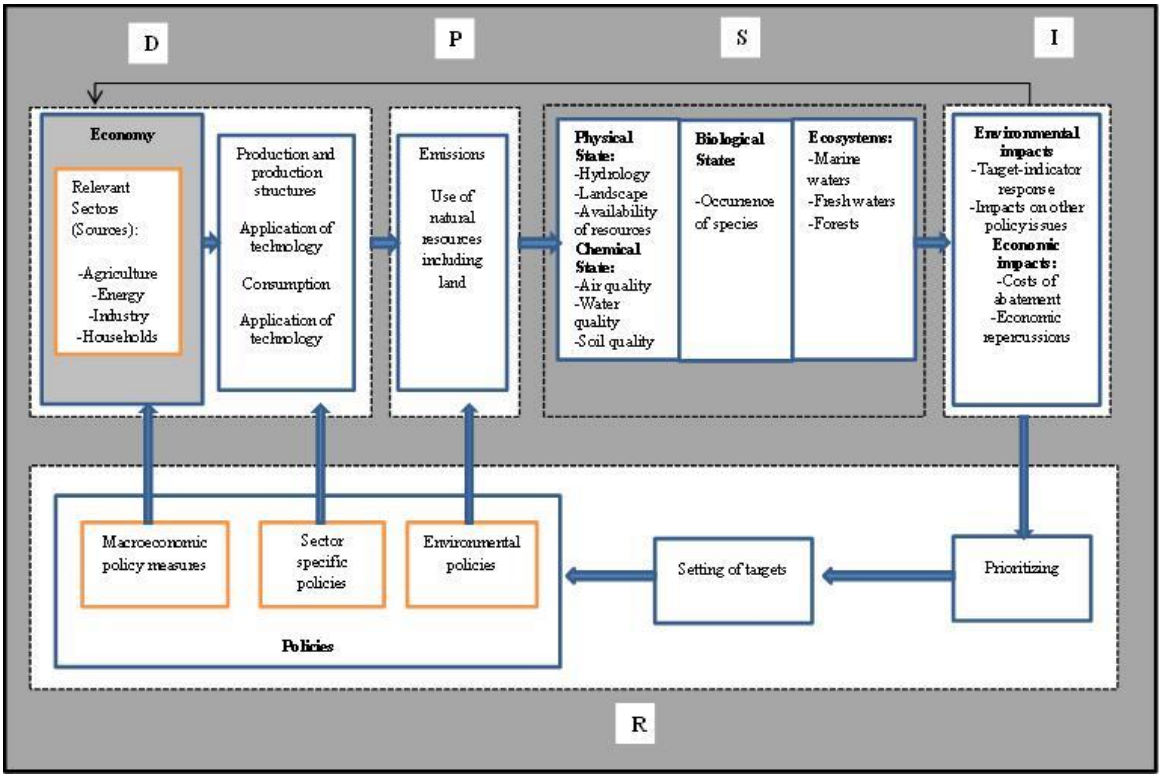

Figure 2. 3: Integrated Environmental Assessment in a DPSIR framework (Source: National Environmental Research Institute)

The framework above demonstrates that analysis of DPSIR is important in Greater Kudu conservation decision-making**.** The DPSIR framework offers a systematic approach for presenting indicators that can provide policy makers with feedback on environmental quality and the consequences of their policy decisions, both past and future.

2.8.2 Conceptual Framework

In this study, the CCM and DPSIR frameworks were integrated when evaluating impacts of the three independent variables i.e. climate (temperature, rainfall), land use/cover change and knowledge, attitude and practice (KAP) of local resource users on the dependent variables i.e. population and distribution of the Greater Kudu within Lake Bogoria landscape.

Description of how the independent and intervening variables affect the population and distribution of Greater Kudu and their interaction is summarized in Figure 2.4. From conceptual framework above, it is important to note that all the independent variables are interrelated. (KAP) apart from informing decisions on Greater Kudu poaching and or conservation, influences the extent to which temperature and rainfall variability and land use/cover change affect the population and distribution of Greater Kudu – the dependent variable. Land use/cover change variable also influences climate variability as well as directly affecting the population of Greater Kudu through effects on forage availability, habitat change/loss and exposure to predators.

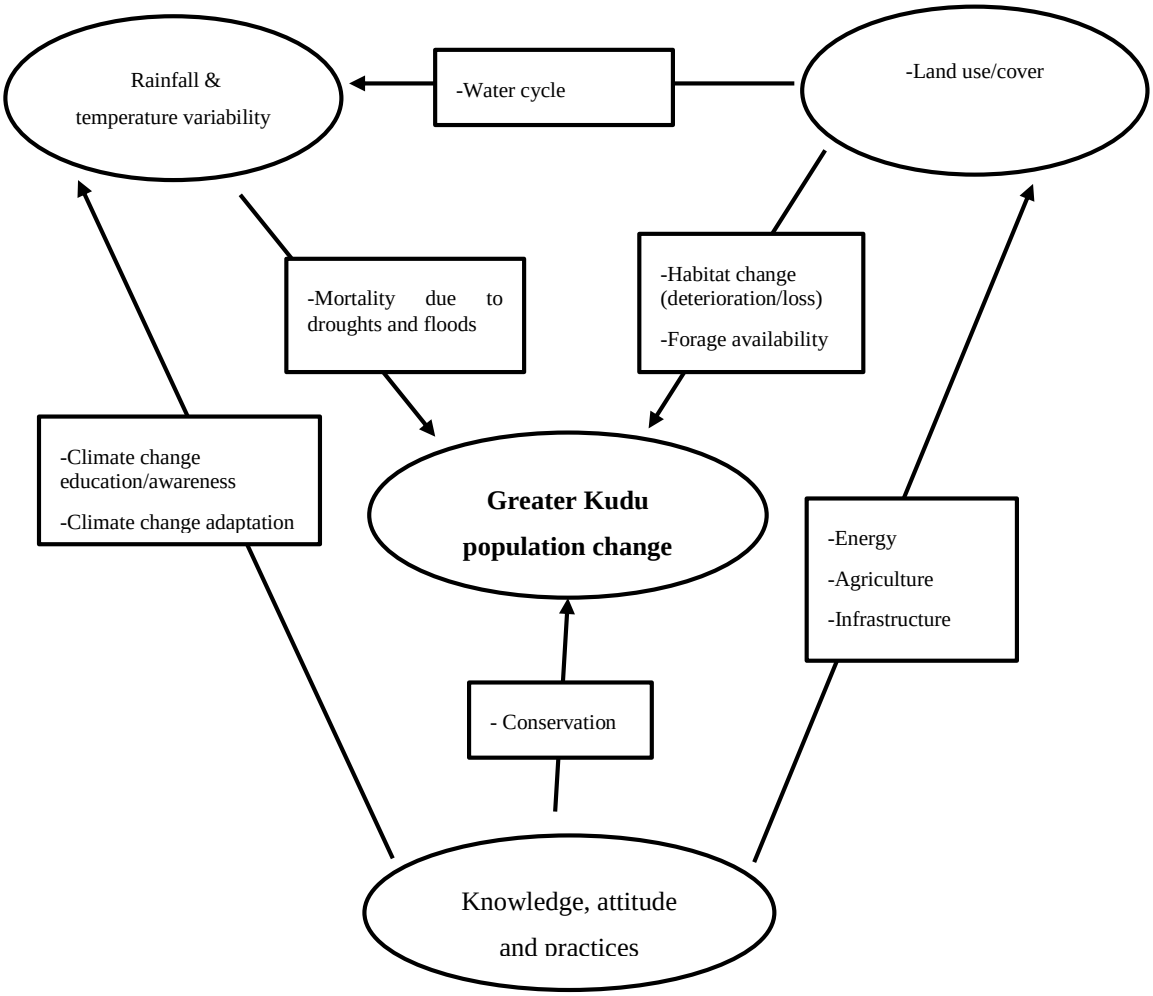

Figure 2. 4: An illustration of interaction of factors affecting Greater Kudu population

The intervening variables considered in this conceptual framework include local resource users' awareness and perception on climate change which affect how they will adapt to climate

variability (temperature and rainfall change) as an independent variable with a causal effect on Greater Kudu due drought, floods induced and/or extreme temperatures mortality.

Another intervening available is the personal misperception of production systems which will affect energy use, agricultural systems practiced, infrastructural and industrial activities embraced. All this will affect land use/cover change, an independent variable which in turn affects Greater Kudu's habitat change/loss, forage availability and exposure to predators.

Lastly, the other two intervening variables are stability of the water cycle in an ecosystem and greenhouse gas emissions or removal. Land use/cover change, an independent variable influences stability of water cycle and greenhouse gases emissions to the atmosphere or removal of the same gases from the atmosphere. The stability of water cycle and greenhouse gas emissions is responsible for climate variability which has a causal effect on Greater Kudu population and distribution.

The framework is relevant to the study as it integrates all the elements affecting the state of environment with the socioeconomic aspects when deriving relevant policies as a response to Greater Kudu conservation in the study area.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Description of the Study Area

3.1.1 General Information

Baringo is one of Kenya's 47 counties. The County is located in the Rift Valley region. It shares boundaries with Turkana and Samburu counties to the north, Laikipia to the east, Nakuru and Kericho to the south, Uasin-Gishu to the southwest, and Elgeyo-Marakwet and West Pokot to the west. The location is situated within the latitudinal range of 0° 10’ South to 1° 40’ South and the longitudinal range of 35° 30’ East to 36° 30’ East. The Equator intersects the County in its southern region. Baringo spans an expanse of 11,015.3 square kilometers, including 165 square kilometers consisting of “surface water from Lake Baringo, Lake Bogoria, and Lake Kamnarok” (Baringo County CIDP, 2018).

Lake Bogoria, located in Kenya, is the most profound alkaline lake in the country. It is characterized by a multitude of alkaline hot springs that provide substantial amounts of water to the lake. The Lake Bogoria National Reserve spans an area of 107 square kilometers and consists of both the lake and the surrounding land. The terrestrial section of the reserve contains several species of plants, which vary based on the soil types and geography. The national game reserve's acacia forests serve as the habitat for a diverse range of wild species, including uncommon greater kudus, antelopes, zebras, leopards, cheetahs, hyenas, mongoose, monkeys, baboons, and jackals. Furthermore, the shores of Lake Bogoria (Baringo County CIDP, 2018) are home to almost two million lesser flamingoes and 350 other bird species.

3.1.2 Location and Size of the Study Area

Lake Bogoria National Game Reserve lies about 10km North of the equator and 0° 20′ North and between 36° 4′ and 36° 7′ East in Baringo County (Figure 3.1). It has an altitude between 970m a.s.l at the lake to 1650m a.s.l on Siracho escarpment. The Reserve is located near the eastern edge of the Great Rift Valley, with its headquarters at Loboi Gate. Lake Bogoria National Reserve (Figure 3.2) was gazetted as wildlife protected area, via legal notice number 270 of 01/11/1970; and is included in boundary plan 216/26, outlining a total area of 107 km² (Mugo, 2007).

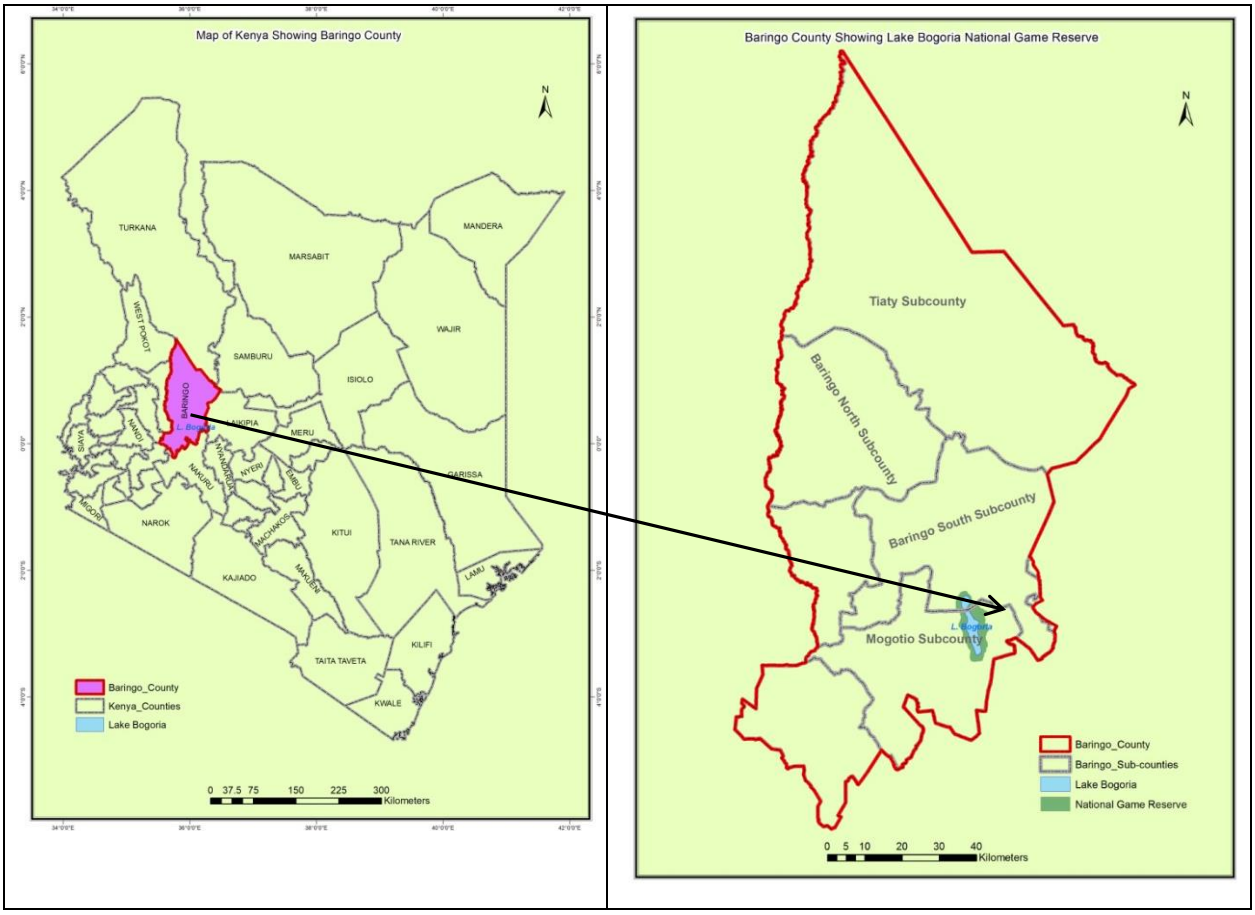

Figure 3. 1: The map of the study area in Kenya (Constructed by author, 2022)

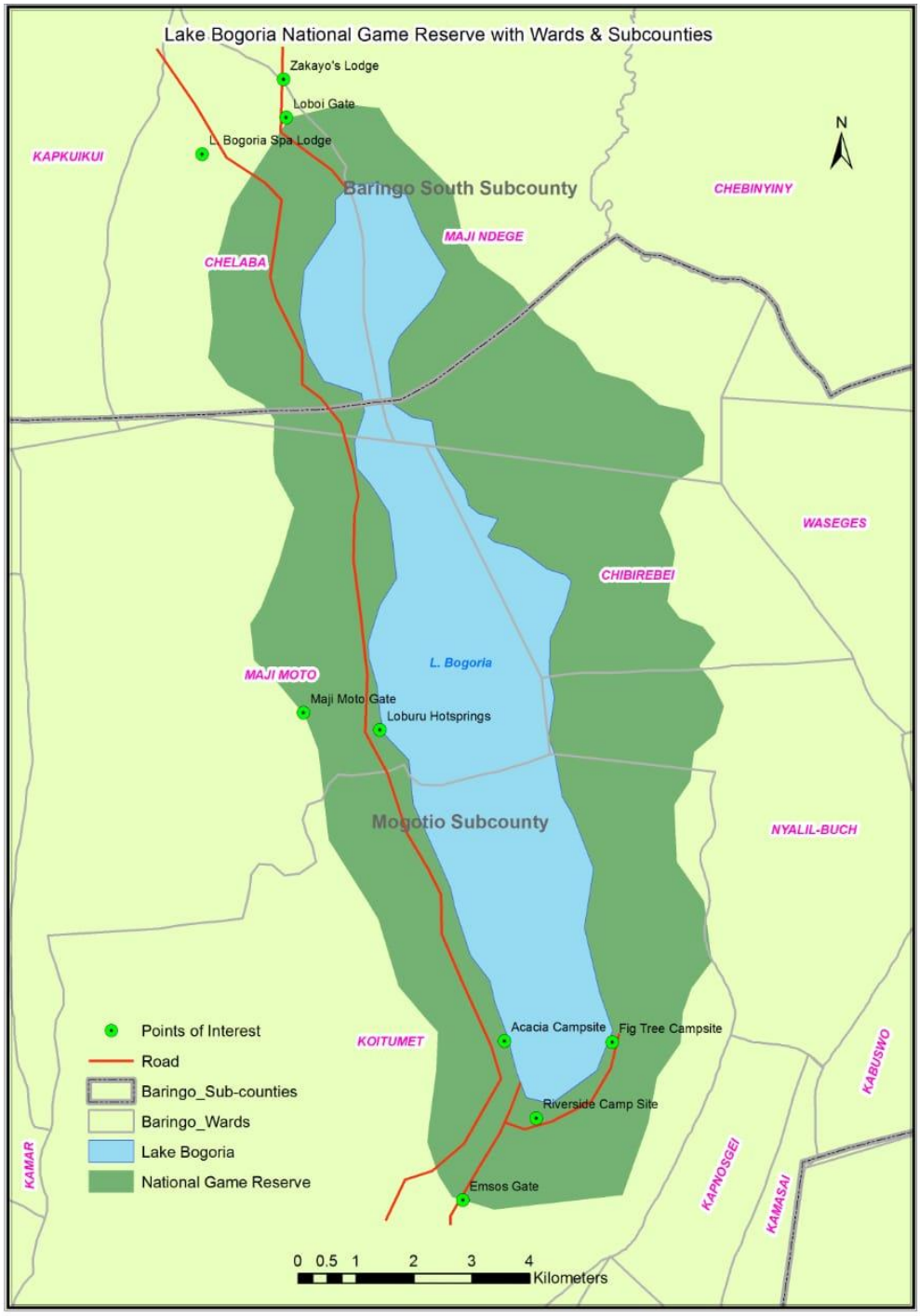

Figure 3. 2: The Lake Bogoria National Game Reserve (Constructed by author, 2022)

3.1.3 Geology and Soils

The genesis of Lake Bogoria and its surrounding area is a result of previous geological activities such as faulting, warping, and volcanic eruptions that occurred during the creation of the Rift Valley (Republic of Kenya, 2010). The region exhibits geological indications of continuous

volcanic activities, such as fumaroles, hot springs, and geysers found within the lake, along its shoreline, and at numerous locations in the surrounding areas. The region is distinguished by the presence of volcanic rocks and sediments that cover metamorphic substrata, dating back to the Pleistocene and Miocene geological periods.

The drainage basin of Lake Bogoria consists of three primary soil types: clay soil, clay loam, and silt loam. The soil texture is generally consistent, with the majority of soils classified as loamy. However, there are few deviations in riverine areas where clay loams are found. The riverine soils exhibit intricate characteristics with diverse textures, which are contingent upon the drainage conditions. These soils consist of eroded volcanic sediments and alluvial deposits. The composition of these formations includes various forms of granulomites, conglomerates, silts, and gravels. Clay soils are located in the higher regions of the basin, specifically in the lowlands. The central region is primarily characterized by clay loam, with a tiny area near the mouth of River Waseges leading to Lake Bogoria being identified as silt loam (Republic of Kenya, 2010). The soils around the lake have high a pH ranging from 6.8 to 9.0, with high sodium bicarbonate levels ranging from 0.5 to 9.92 $meql^{-1}$ (Baringo County CIDP, 2018; Mugo, 2007).

3.1.4 Climate

The climate in the plan area varies from arid to semi-arid, except for the moist highlands around Subukia. The climatic conditions are significantly impacted by the Inter Tropical Convergence Zone (ITCZ), resulting in the presence of two different seasons characterized by wet and dry periods. The climatic conditions within the reserve and surrounding areas are severe, with temperatures near the lake ranging from 18°C to 39°C, with a daily average of 25°C. Mean annual precipitation varies from 500-1000mm and falls in two seasons April- May and October-November. The reserve is situated in a physiographic region that is in the rain shadow of the nearby fault scarps and highlands. The lake basin exhibits a hot, semi-arid environment due to the interplay of weather elements and its physiographic location.

Lake Bogoria and its surrounding areas fall within agro-ecological climatic zone V. The area experiences an average of 10 hours of sunshine per day hence making the area hot for most of the year with a marked hot spell from January to March when temperatures in excess of 34^0C are experienced. Cold spells happen during July and August (Mugo, 2007).

3.1.5 Demography

Based on the 2019 population and housing census, the population of Baringo County was 666,763 (Figure 3.3). The Population in the county shows a constant positive trend.

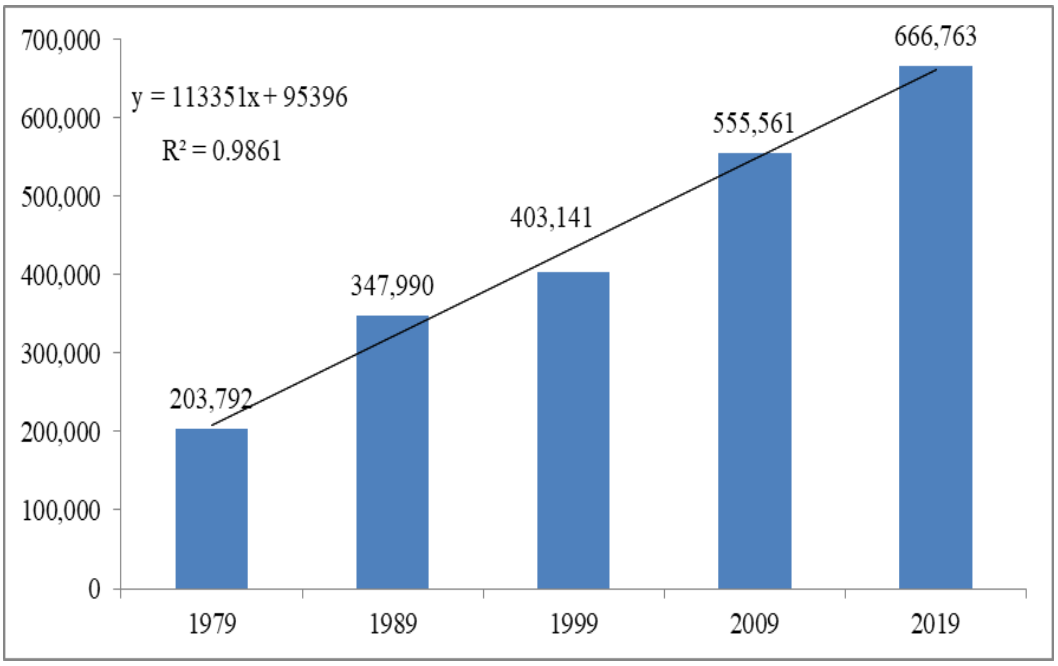

Figure 3. 3: Baringo County population trends (Source: Kenya National Bureau of Statistics 2019)

The landscape spreads to six locations in Baringo County - three in Mogotio Sub-county namely; Koibos, Sinende and Kamar and three in Marigat (Baringo South) Sub-county namely; Loboi, Kapkuikui and Sandai. The population in the study area according to the 2019 Census is indicated in Table 3.1 below.

Table 3. 1: Distribution of population in the study area (Source: Kenya National Bureau of Statistics (2019).

Sub-county	**Location**	**Sub-location**	**Population**	**Number of households**	**Land area in Km^2**
Mogotio	Koibos	Koitumet	2,058	391	40.2
		Majimoto	1,480	299	12.6
	Sinende	Chebirebei	391	63	16.6
		Nyalilbuch	933	154	17.3
		Waseges	982	162	16.2

Sub-county	Location	Sub-location	Population	Number of households	Land area in Km^2
	Kamar	Kamar	958	186	32.6
		Molos/Asenwei	656	132	19.3
Marigat	Loboi	Maji Ndege	1,582	254	40.2
(Baringo South)		Chelaba	1,413	418	12.6
	Kapkuikui	Kapkuikui	738	143	31.6
		Kaptombes	749	153	22.7
	Sandai	Sandai	1,877	369	29.5
		Mbechot	1,881	338	39.5

3.1.6 Ecology of Lake Bogoria Landscape

Flora

The Reserve encompasses six distinct vegetation categories. The six types of vegetation in this area include riverine woods, forested bush land, bushed thicket, bush land, bushed grassland, and swamps. The primary grass species present are Sporobolus ioclados, Dactyolectenium aegyptium, Chloris virgata, and Digitaria velutina. The shrubs in question are Grewia tenax, G. bicolor, Acalypha fruticosa, and Acacia mellifera. Acacia tortilis is the most prevalent tree species. Additional community types consist of combinations of Balanites aegyptica, Combretum spp., Ficus spp., and Terminalia spp. Extensive amounts of evergreen and semi-deciduous bushland are found in stream valleys and other unfavorable regions (Mugo, 2007).

The distribution of vegetation types is highly influenced by the interplay of terrain, soil types, elevation, drainage systems, and soil moisture content. Montane forests are present in the higher regions of the basin, including in Subukia, Olrara Bel, Mochongoi, and Marmanet areas. These places serve as the drainage basin for River Sandai/Waseges. There exist additional riverine forests that are located beside the courses of rivers, seasonal water flow channels, and freshwater springs.

The vegetation beyond the Reserve and forest regions consists of riverine forests, grasslands, bush lands, shrub lands, scrublands, and woodlands. These vegetation types are found in the arid regions of the plan area and are typically linked with loose soils, exposed rocks, and

river plains. The community areas indicated are tied to communal grazing, as stated by Mugo in 2007.

Fauna

The region is rich in wildlife species that exhibit a high diversity yet are found in low population densities. The wildlife that lives in the designated area encompasses several species like as the Greater Kudu, impala, vervet monkey, dikdik, warthog, and common jackal, among others. The area is home to several reptiles, including monitor lizards, other types of lizards, tortoises, crocodiles, and various species of snakes.

Over 373 bird species have been documented in the plan area, including over 50 migratory species, making it it one of Kenya's richest Important Birdlife Areas (IBA). The reserve's zoogeographical position between the Ethiopian and Masai zoo-regions contributes to its high species diversity. The lake hosts large gatherings of lesser flamingos, which feed on the abundant blue-green algae, primarily Spirulina platensis. The lake's shore configuration and freshwater points create a favorable environment for these assemblages, sometimes attracting over 300,000 flamingos. Lake Bogoria occasionally supports the highest population of greater flamingos among the Rift Valley's alkaline lakes (Mugo, 2007).

3.2 Research Design

A mixed methods design was used in the study. Spatial distribution and dispersal areas of the Kudu were assessed using primary data of Kudu population and Geographic Information System (GIS). The population counts of Greater Kudu were conducted by monitors based on line transects that had already been set up in the study areas. GIS was used to analyze spatial and temporal datasets obtained from distance sampling and secondary sources. Linear regression analysis was used to assess temperature and rainfall variability trends and to relate with Greater Kudu population trends for the 4 years (2019, 2020, 2021 and 2022). Rainfall and temperature data was sourced from Kenya Meteorological Department station at Marigat. Map layers of land use/cover change in multiple spatial and temporal scales was developed using satellite images and GIS. A cross-sectional survey on knowledge, attitudes and practices (KAPs) towards conservation of Greater Kudu was conducted using a semi-structured questionnaire.

3.2.1 Spatio-Temporal Dispersal of Greater Kudu Data Collection

The cost, size of the study area, type of habitat, Kudu behavior, manpower and the purpose of the study was considered when choosing the method to estimate population and distribution of Greater Kudu. The cost implication of aerial surveys and satellite imagery prohibits their use.

There are two methods of monitoring a wild animal, indirect and direct monitoring. The indirect monitoring involves checking of hooves on their tracks, droppings and any other features apart from viewing the animal physically. Direct monitoring involves direct observation and counting of objects in the study area. The direct method was adopted because it was possible to observe the Kudus along the transect lines. Through direct data collection, physical features and number of animals, their distribution and trends in some specific area were surveyed.

For this study, secondary data that had been collected by LBNGR since the year 2019 and data collected during the study period (2022) were used to assess the abundance, distribution and trends of Kudu population for the last four (4) years. The transect lines in the study area had been established in the year 2019 by Friends of Nature Bogoria with the aim to have Kudu trends across the year over different seasons. The area covered by the transect line survey is the same every year, making it possible to carry out spatial and temporal comparison of the distribution and population trends of Greater Kudu.

The distances of the identified Kudus from the already laid out transect lines were recorded and their geographic positions captured using GPS. During the study period, data was collected once during the dry (December to March) season in the study area mainly because of the cost implication of getting a set of such data. For temporal analysis, secondary data from LBNGR for years 2019 and 2020 for similar season (dry) were compared with the primary data. The data for the year 2021 was missing due to travel and activity restrictions associated with Covid-19 pandemic.

3.2.2 Spatio-Temporal Dispersal of Greater Kudu Data Analysis

The data collected were used to calculate population of Greater Kudu and estimate the average density of Greater Kudu within the landscape during the year 2022. This data was supplemented by historical Kudu population densities according to secondary data acquired from Lake Bogoria National Game Reserve for year 2019 and 2020.

The presence of Kudus in a location was digitized as points using GIS software. The measures of dispersion and densities were then applied to the distribution data. In addition, point

pattern analysis (PPA) was used to characterize spatio-temporal distribution of dispersal areas and population density of the Greater Kudu in Lake Bogoria landscape did not change between years 2019 - 2022.

3.2.3 Temperature and Rainfall Variability Data Collection

Long-term (>40 years) monthly temperature and rainfall public data available at Kenya Meteorological Department was analyzed to assess temperature and rainfall variability in the study area as indicators of natural-induced threats on temporal distribution of the Greater Kudu in Lake Bogoria landscape. Secondary data on monthly rainfall and temperature for the period 2019 to 2022 was used to derive rainfall and temperature annual variability for years under consideration. Monthly weather data was sorted using Excel to derive both maximum and minimum temperatures range and also precipitation range for Chebirebei sub-location and Maji Moto sub-location in the last forty years between 1981 and 2021.

3.2.4 Temperature and Rainfall Variability Data Analysis

The climate variables examined encompassed average seasonal temperature (both maximum and minimum) and precipitation, as well as temperature and precipitation ranges. Additionally, extreme values such as temperature during the hottest and coldest months, as well as precipitation during the wettest and driest months, were considered. Combinations of variables, such as precipitation during the hottest month and temperature during the driest month, were also taken into account. Pearson's regression analysis was employed to evaluate the impact of temperature and rainfall variability on the population and seasonal distribution of Greater Kudu within the Lake Bogoria landscape from 2019 to 2022.

3.2.5 Land Use/Cover Mapping Data Collection

GIS software and remotely sensed imagery was used to develop map layers of land use/cover in multiple spatial and temporal scales in the study area. Satellite images from Landsat 4-5 Thematic Mapper (TM) and Landsat 7 Enhanced Thematic Mapper Plus (ETM+) were downloaded for the years 1980, 1990, 2000, 2010, and 2020 for this research. For this study this data was analyzed at 10-year epochs.

Landsat 4-5 Thematic Mapper (TM) images comprise seven spectral bands with a spatial resolution of 30 meters for Bands 1 to 5 and 7. Band 6 (thermal infrared) has a spatial resolution of 120 meters but is resampled to 30-meter pixels. Each scene covers approximately 170 km from north to south and 183 km from east to west.

3.2.6 Land Use/Cover Mapping Data Analysis

Pre-Processing

After the selection and acquisition of the Landsat satellite imagery, layer stacking was done using ERDAS Imagine software based on the following bands Band 1 – blue, Band 2 – green, Band 3 – red and Band 4 - Near Infrared because of the nature of results needed for the study. Figure 3.4 displays full scene Landsat imagery showing location of Lake Bogoria.

After the layer stacking was done, the image is overlaid on the polygon of the area of interest (AoI) and the desirable resulting images covering only Lake Bogoria national reserve were extracted from the full scenes of the original Landsat images that measure 170 km north-south by 183 km east-west. After clipping, the resultant images fitted within the study area as outlined in Figures 3.5, 3.6, 3.7, 3.8 and 3.9.

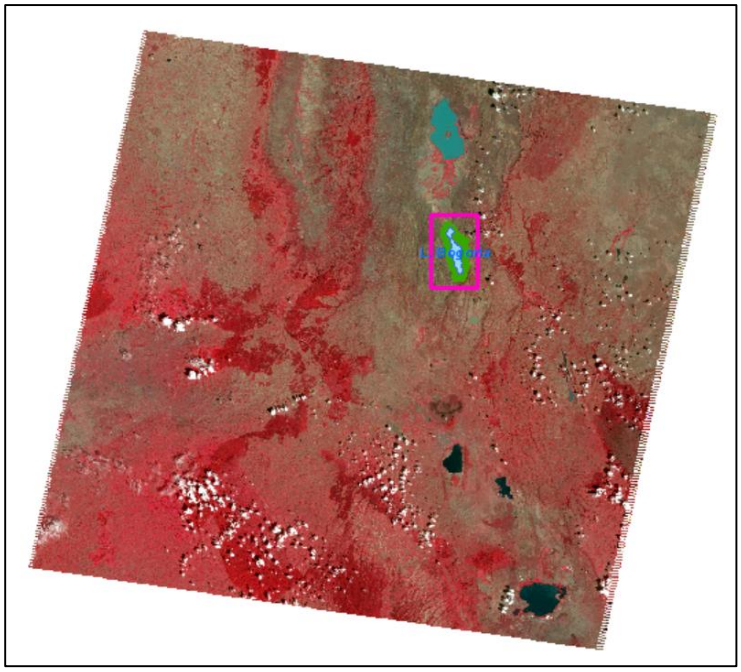

Figure 3. 4: Sample full scene Landsat Imagery showing location of Lake Bogoria

Figure 3. 6: 1990 Landsat Image

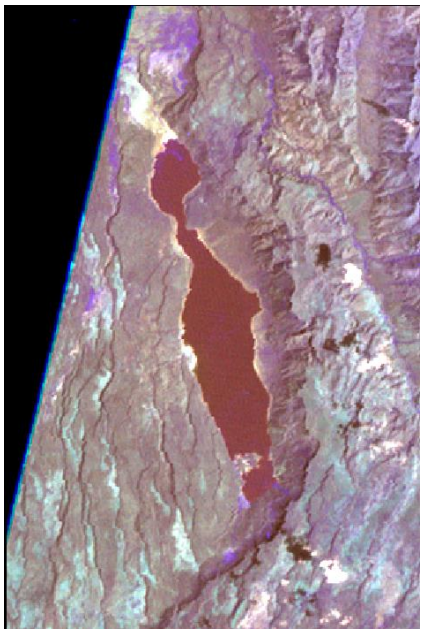

Figure 3. 5: 1980 Landsat Image

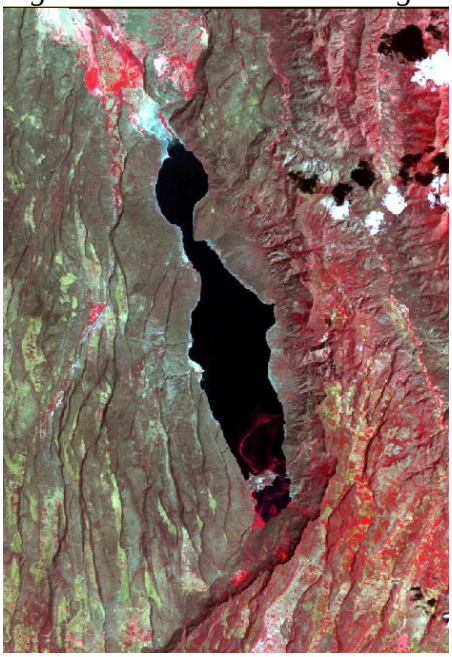

Figure 3. 7: 2000 Landsat Image

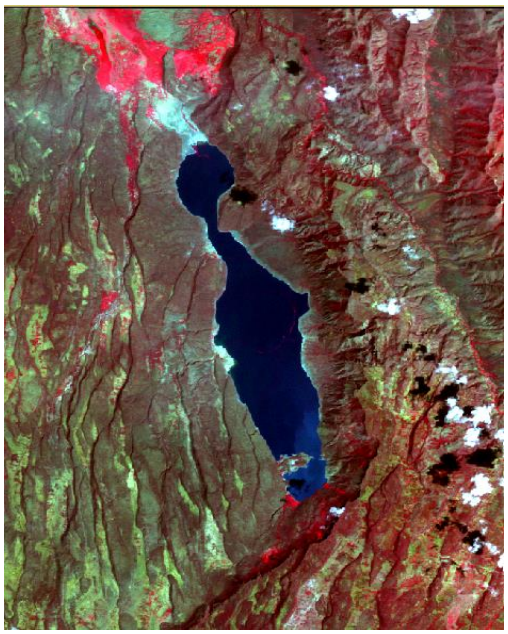

Figure 3. 8: 2010 Landsat Image

Figure 3. 9: 2020 False Color Clipped Landsat Image

Classification

Supervised classification was carried out and thematic maps of land cover including classes such savanna grassland, woodland, agricultural areas, settlements and so on clearly mapped out. Supervised categorization necessitates the utilization of "training sets," which consist of clusters of pixels with a predetermined kind or label. The training sets are utilized to statistically establish the known classes in terms of spectral characteristics.

Generation of training signatures based on the training sets was used to create class signatures. This helped in identifying pixels with similar spectral reflectance and assigned them appropriate information classes. The study employed the use of supervised classification to analyze the images obtained for the area of study. The following classes were used in this study:

1. Water (Blue)
2. Rangeland (Dark Brown)
3. Barren land (Light Grey)
4. Built-up (Red)

5. Agriculture (Bright Green)
6. Vegetation (Dark Green)

Accuracy analysis is a method used to measure the performance of grouping and evaluate the reliability of information obtained from remotely sensed data. The accuracy of topographical sheets from 1980 and Google Earth imagery from 2020 was assessed by comparing them to classified pictures. They served as reference for generating more data.

Land Use/Cover Change Detection

A spatio-temporal analysis was conducted to determine the rate and trend of land use and land cover change (LULCC). The data on changes in land use was evaluated using descriptive statistics to demonstrate the variation between 1980 and 2020. This entailed the computation of the area sizes for each land use category in the years 1980, 1990, 2000, 2010, and 2020, using a Geographic geographic information system (GIS) technology. The locations were subsequently inputted into Microsoft Excel for the calculation of land use changes over time. The land use change for a specific land use can be calculated by subtracting the total area in 1980 from the total area in 2020. The resulting figure is multiplied by 100 to calculate the rate of change, which can be either positive (indicating a rise) or negative (indicating a decline). A Pearson correlation coefficient statistical analysis was performed to evaluate the impact of land use/cover change on the population and dispersal of Greater Kudu throughout the period from 2019 to 2022.

The Normalized Difference Vegetation Index (NDVI) is a commonly employed quantitative measure that utilizes the visible (VIS) and near-infrared bands (NIR) of the electromagnetic spectrum. It is used to analyze remote sensing images and determine the presence of live green vegetation in the target area. Vegetated areas typically have high values for either index due to their relatively strong near-IR reflectance and low visible reflectance. Clouds, water, and snow exhibit higher visible reflectance compared to near-IR reflectance. Therefore, these characteristics result in negative index values. Rock and bare soil areas exhibit comparable reflectance in the two bands, leading to vegetation indices that are close to zero.

The Normalized Difference Vegetation Index (NDVI) was employed as a proxy to detect changes in land use and cover. The NDVI was calculated for the decades of the 1980s, 1990s, 2000s, 2010s, and 2020s in order to analyze and highlight the temporal and spatial variations of vegetation cover.

3.2.7 KAP Survey Sampling

The sampling unit was a household.

Sample size

The sample size for questionnaires was calculated according to Nassiuma, (2000) formula.

$$n = \frac{NC^2}{C^2 + (N-1)e^2}$$

Where:

N = Population size

n = Sample size

C = the coefficient of variation

e = the margin of error (5%)

In most social science experiments or surveys, coefficient of variation of between 30% - 70% is usually acceptable. Commonly, most social science researchers use 60% (Nassiuma, 2000). Because of the large target populations (households) per the seven Sub-locations, this study used the coefficient of variation of 60% to arrive at a manageable and cost effective sample size. A margin of error at 5% and a confidence level of 95% were used in the study. Margin of error of 10% was not used because the larger the margin of error lower the confidence level.

$$n = \frac{3062(0.6^2)}{0.6^2 + (3062-1)0.05^2} = 137$$

A representative sample size was proportionally assigned to each of the seven clusters using the following formula:

$$n_2 = \left[\frac{N_1 \, X \, n_1}{N_2}\right]$$

Where;

N_1 = Population size of a cluster

N_2 = Population size of all clusters

n_1 = Sample Size of all the clusters

n_2 = Sample Size of a clusters

Table 3. 2: Population and Sample Size

S/No.	Cluster (Location)	Number of Households (N_1)	Sample size (n_2)
1.	Koibos	690	31
2.	Sinende	379	17
3.	Kamar	318	14
4.	Loboi	672	30
5.	Kapkuikui	296	13
6.	Sandai	707	32
	Total	**3,062**	**137**

Multi-stage systematic sampling procedure was used for KAP survey. The clusters for the study area were the six locations (Koibos, Sinende, Kamar, Loboi, Kapkuikui and Sandai). At a given interval, the researcher selected every *nth* household after randomly selecting the first through *nth* element as the starting point. This depended on the sample size of a given cluster. The sampling interval was calculated by dividing the cluster population size by the desired sample size. That is:

$$K = \frac{N}{n}$$

Where:

K – Systematic sampling interval

N – Cluster population size

n – Sample size

Using a systematic sampling procedure was simpler to implement because the researcher didn't have to repeatedly navigate through the sampling frame to select the sampled households. The systematic sample also spread the respondents selected more evenly across the entire sampling frame for more representation of the population and more precise results (Groves & Heeringa, 2006).

KAP Survey Data Collection

Interviews comprised of a one-on-one, qualitative, and comprehensive discussion in which the researcher assumes the position of a "investigator." This indicates that the researcher posed inquiries, regulated the flow of the discussion, or interacted with a particular participant one-on-one. Conversely, during focus group talks, the researcher assumed the role of a "facilitator" or a

"moderator." In this context, the researcher served as a facilitator or moderator for a group discussion including participants, rather than engaging in a direct discussion with the participants themselves (Nyumba *et al.*, 2018). Conducting focus group discussions along with face-to-face interviews were used to assess participants' knowledge, attitudes, and practices (Abu-Taleb & Murad, 1999).

Questionnaires, especially directed towards bigger populations, offer broader insights into behaviors, including possibly associated environmental factors. Questionnaires, while useful, might be prone to misinterpretations and can be influenced by the subjective perspectives of participants, potentially impacting the accuracy of the results. Hence, it is imperative to provide careful consideration to the structure and format of the questionnaire in order to guarantee that it accurately assesses the intended variables. This was achieved by considering the questionnaire's reliability and validity (Tiira & Lohi, 2014).

A survey using pre-designed and pre-tested questionnaires (Appendix 7.1) were conducted to understand the knowledge, attitude and practice (KAP) local resource users have towards conservation of the Greater Kudu in Lake Bogoria landscape in the study. Face-to-face interviews of key informants (KI) guided by KI questionnaires (Appendix 7.2) and focus group discussions (FGDs) using FGD schedule (Appendix 7.3) also carried out.

The KAP survey questionnaires, FGD schedule and KI questionnaire were checked by the researcher and experts at the Department of Environmental Science and Faculty of Environment and Natural Resources. A pilot test and necessary adjustments was done before embarking on data collection activity. The pilot study was done in Kiborgoch Conservancy, Mochongoi Ward, an area with similar characteristics to the study area.

A pilot study was carried out in area with similar climatic and socioeconomic conditions where twenty KAP survey questionnaires were pre-tested for reliability. The respondents were purposively selected. One pilot FGD and three interviews to KIs were also carried out. An analysis of the pilot survey data was conducted and adjustments made in regard to the issues raised. The reliability coefficient, also known as Cronbach's alpha, is a measure that goes from 0 to 1. A value of 0 indicates that the instrument is very prone to error, while a value of 1 indicates that there is no error present in the instrument. An alpha coefficient of 0.7 or above was seen to have good reliability (Cho, 2016; Radhakrishna, 2007). For the pilot of this study, a reliability coefficient (alpha) of 0.76 was obtained.

The KAP questionnaires were administered to local community members to assess their knowledge, attitude and practices as far as Greater Kudu conservation in Lake Bogoria landscape is concerned. The KAP survey specifically targeted those who were the heads of households. Nevertheless, in the event of their absence, any individual over the age of 18 residing in the household was interviewed to ensure a comprehensive representation of perspectives across all age groups and genders. Both open-ended and close-ended questions were posed. Participants were prompted to provide further details on topics that were of particular interest and importance. Kiswahili and English Languages were used in administration of questionnaires. The questionnaires were divided into two main sections. Section one entailed personal details of respondents while section two contained questions on Greater Kudu management and conservation in Lake Bogoria landscape.

Focus Group Discussion Sampling and Data Collection

The participants for resource users FGD were selected through multistage cluster sampling where households were initially clustered based on their Locations/Wards then through simple random, 6 participants were sampled per cluster. A compilation of all household heads in the Locations (cluster) was entered into Ms-Excel spreadsheet and a random list of 6 household heads who were invited for FGD was generated automatically thus creating same probability of being selected for the sample (Friedrichs, 1989). Purposive sampling was used to identify FGD respondents for conservationists and LBNGR managers based on their expertise on management of Greater Kudu. Three FGDs were conducted.

As part of preparations, the participants were assured of confidentiality to make them feel comfortable enough to converse freely with others. They were also informed that they were not being coerced to answer the FGD questions. Using the FGD schedule (Appendix 7.3), questions were asked in an interactive group setting where participants were free to talk with other group members. Findings from the discussions were recorded during the FGD sessions.

Key Informants Interviews Sampling and Data Collection

The researcher purposively sampled key respondents in the study area. This was based on expertise knowledge on Greater Kudu management and conservation. The key respondents included KWS staff, National Environment Management Authority (NEMA) staff, conservancy staff (for conservancies that touch the road), County Government, Wildlife and Tourism Department and

Non-Governmental Organizations. The primary aim of purposive sampling was to obtain a sample that can effectively address the research objectives.

Informal, detailed interviews were conducted with specific individuals from the Kenya Wildlife Service (KWS), conservancy workers, administrative staff, and Non-Governmental Organizations (NGOs) to gather crucial insights on the economic development and wild conservation activities in the study area (Appendix 7.2). An interview schedule guided by open-ended questions produced quick and easy quantitative data. The results obtained were used to explain, reinforce and enrich data collected during the household survey.

3.2.8 Knowledge, Attitude and Practice (KAP) Data Analysis

Response Rate

Piloting is an important component of research survey. During piloting, questions which could be vague in the survey tools are fine-tuned until they convey the same meaning to all the subjects (Mugenda & Mugenda, 2003). Before commencing the actual study, study was undertaken to assess the accuracy and consistency of the research instruments at Koborgoch Conservancy, Mochongoi Ward, an area with similar characteristics with the study area. Mugenda and Mugenda (2003) suggest that the piloting sample ought to represent 10% of the population size based on the study sample size.

Therefore, twenty (20) Knowledge, attitude and practice (KAP) questionnaires were pre-tested for reliability where the respondents were purposively selected from the study area. Three (3) face-to-face interviews of key informants (KI) guided by KI questionnaire were also carried out. One Focus group discussion (FGD) using FGD schedule was conducted. The KAP questionnaire was later modified according to the pilot test responses.

Validity of Survey Tools

A survey tool has content validity if in the view of the experts; it covers all aspects of the areas being measured. Mwangi (2016) noted that validity is the degree to which the sample of the test item represent the content that is designed to measure. Throughout the development of survey tools for this study, consultations with my supervisors and environmental experts in the Department of Environmental Science and Faculty of Environment and Natural Resources of Egerton University were done. This was further enhanced by being consistent in administering the questionnaires and constant consultations with the supervisors. This was a progressive

development towards ensuring that the research tools represented the factors under study hence validating them.

Reliability of Research Tools

Testing for reliability crucial as it pertains to the uniformity and consistency among the components of a measuring research equipment (Huck, 2007). A scale is considered to have high internal consistency dependability when its items are coherent and effectively assess the same underlying concept (Huck, 2007; Robinson, 2010). In this study, the Cronbach's alpha (α) coefficient was utilized to assess the dependability. The use of Likert scales is considered the most suitable method for assessing reliability. The dependability coefficient, also known as Cronbach's alpha (α), is a measure that runs from 0 to 1. A value of 0 indicates a tool that is very prone to error, while a value of 1 indicates a tool that is completely free from error. In the study, a reliability coefficient (alpha) of 0.7 or above was deemed to be an acceptable level of dependability (Cho, 2016; Radhakrishna, 2007). The study's Cronbach's alpha (α) coefficient was 0.76.

Data obtained from respondents through questionnaires, interviews and FGDs was analyzed to assess the effect of knowledge, attitude and practice on the conservation of the Greater Kudu in Lake Bogoria landscape. The frequencies of the collected responses were computed, and if applicable, a chi-square test was employed to measure the discrepancy between the observed and expected frequencies.

A greater disparity between observed and predicted frequencies leads to a higher $\chi 2$ value. Furthermore, if the fit is extremely poor, a higher $\chi 2$ value will be achieved (Onchiri, 2013). This study employed a significance level of 0.05 to establish the association between data categories and draw conclusions. The findings were displayed in tables and figures, analyzed, and discussed. A summary of data analysis and independent and dependent variables are presented in Table 3.3 below.

Table 3. 3: Summary of data analysis and variables

Objectives	**Independent Variables**	**Dependent Variables**	**Statistical tool**	**Output**
To assess spatio-temporal change of dispersal of Greater Kudu in Lake Bogoria	Time (years)	Spatio-temporal dispersal of Greater Kudu	Point pattern analysis (GIS)	Population Graph and dispersal Maps

Objectives	Independent Variables	Dependent Variables	Statistical tool	Output
landscape in the last four years.				
To assess the impacts of temperature and rainfall variability on the distribution of the Greater Kudu within Lake Bogoria landscape in the last four years.	Climate variables (rainfall and temperature)	Greater Kudu population trends	Regression analysis	Regression graphs
To relate land use/cover change to the distribution of the Greater Kudu in Lake Bogoria landscape in the last years.	Land use/cover (in decades)	Spatio-temporal changes of dispersal of Greater Kudu	Pearson's correlation of land use/cover changes	Land use/cover maps and Pearson's correlation table
To investigate the knowledge, attitude, and practice of local resource users towards conservation of the Greater Kudu in Lake Bogoria landscape.	Knowledge, attitude, and practice of local resource users Knowledge, attitude, and practice of local resource users	Frequencies of responses Disagreement between observed and expected frequencies	Descriptive statistics Chi-square test	Frequency graphs, charts and tables Chi-square statistic

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Greater Kudu Population Distribution over the Period 2019 to 2022

Based on transect counts, the population of Greater Kudu improved slightly from 2019 to 2022 (Figure 4.1). The population increase is attributed to improved conservation campaigns and support by the conservation partners. There was a slight decrease in numbers in 2020 due to above normal rainfall received in the study area. This may have affected breeding cycle of the Kudus which usually begins at the end of a rainy season. From this study, the number of Greater Kudus females was significantly higher than that of the males, as well as that of the calves (Figure 4.1). The number of calves was lowest in the year 2020.

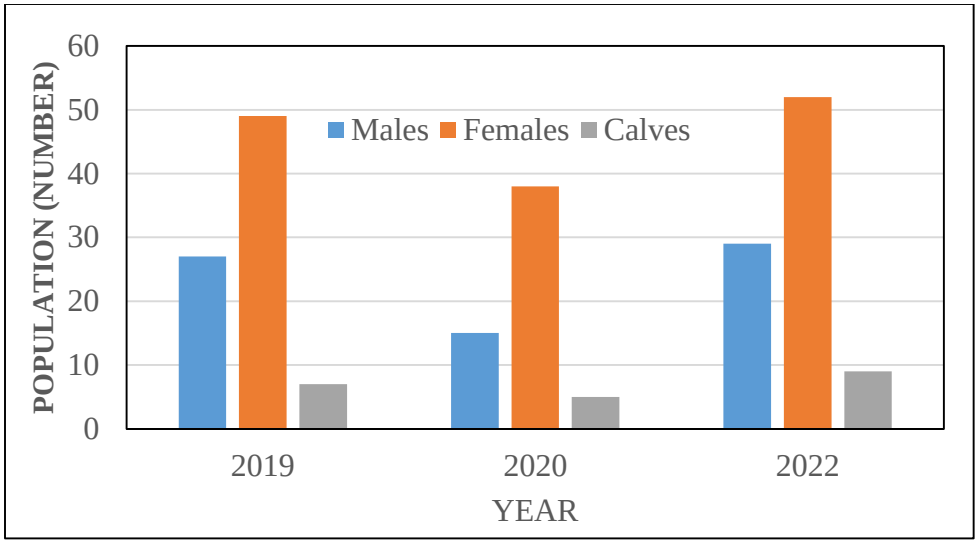

Figure 4. 1: Greater Kudu population (numbers) over the period 2019 to 2022 at Lake Bogoria National Reserve, Kenya

As indicated in Figure 4.1, females make the largest percentage of the total population with the year 2020 having the highest percentage at 66%. The males on the other hand showed minor changes across the years at 33%, 26% and 32% over the three years of 2019, 2020 and 2022. This affirmed the finding that male mortality rate was higher compared to that of females although this was not primarily explained by mate competition, increased hazards resulting from male dispersal, or the smaller group sizes typical of males (Owen-Smith, 1993). Conversely, Owen-Smith (2002) pointed out that male kudus were more susceptible to malnutrition and less agile than females due to their larger body sizes predisposing them to being caught easily by predators.

The percentage of the calves increased minimally by 9%, 8% and 10% for the years 2019, 2020 and 2022 respectively. The spatial distributions of sighted Kudus for the 3 years are presented in maps Figures 4.2, 4.3 and 4.4 showing age and sex structured Greater Kudu population for the three years. According to Kingdon *et al.* (2013), for the first two weeks after birth, Kudu calf hides where predators cannot find them. It was evident from this study that most the calves stayed away from the rest of the group since they were still young to move around with the mother (Figures 4.2, 4.3 and 4.4).

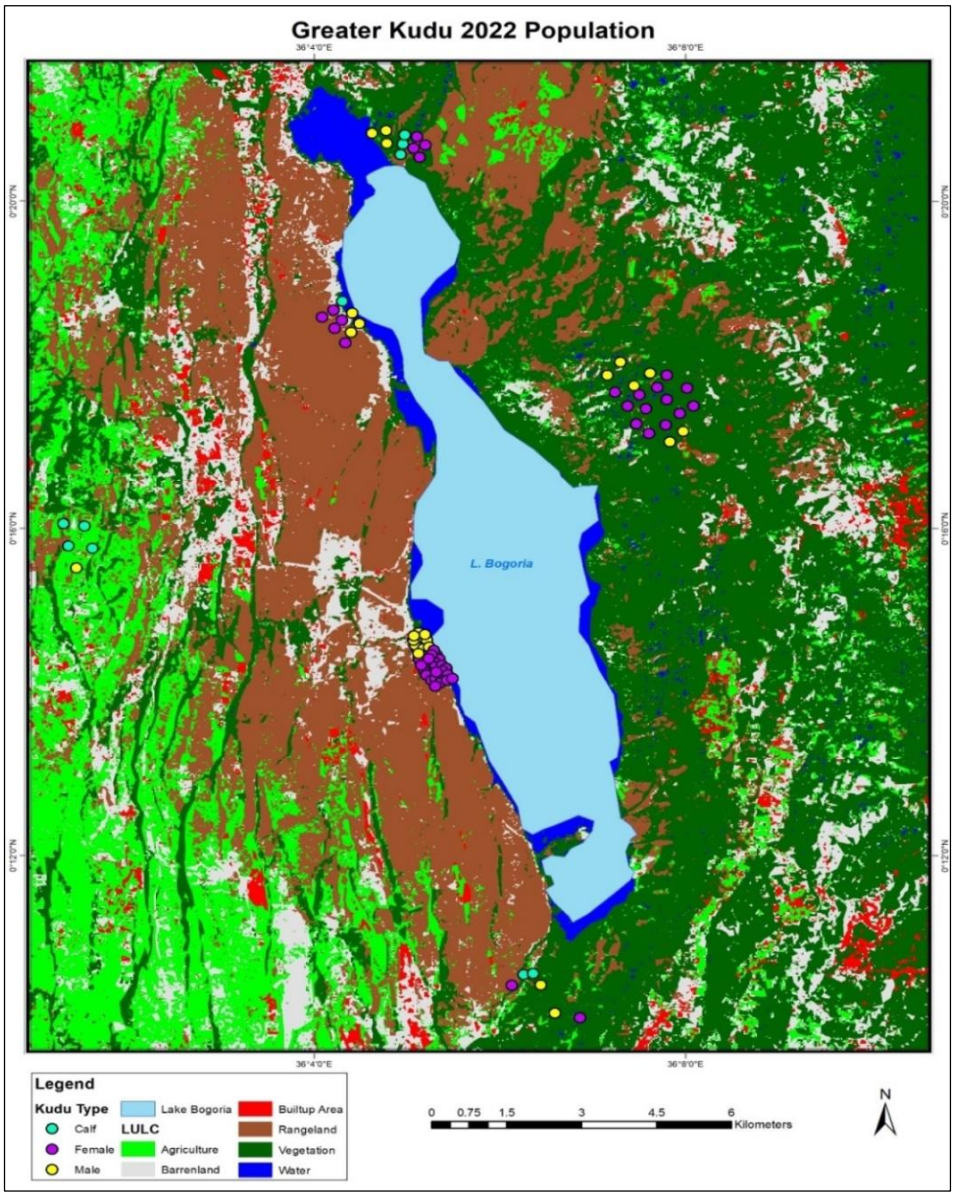

Figure 4. 2: Greater Kudu population (2022) at the LBNGR and its environs

It was also shown in Figures 4.2, 4.3 and 4.4 that Kudus were generally concentrated around the Lake. This agreed with the findings of Simpson, 1972 that Kudus concentrated around water points during annual dry season. Therefore, the sustainability of the Lake is critical for the survival of the Greater Kudu. It is also an indication that there could be limited availability watering points in the landscape.

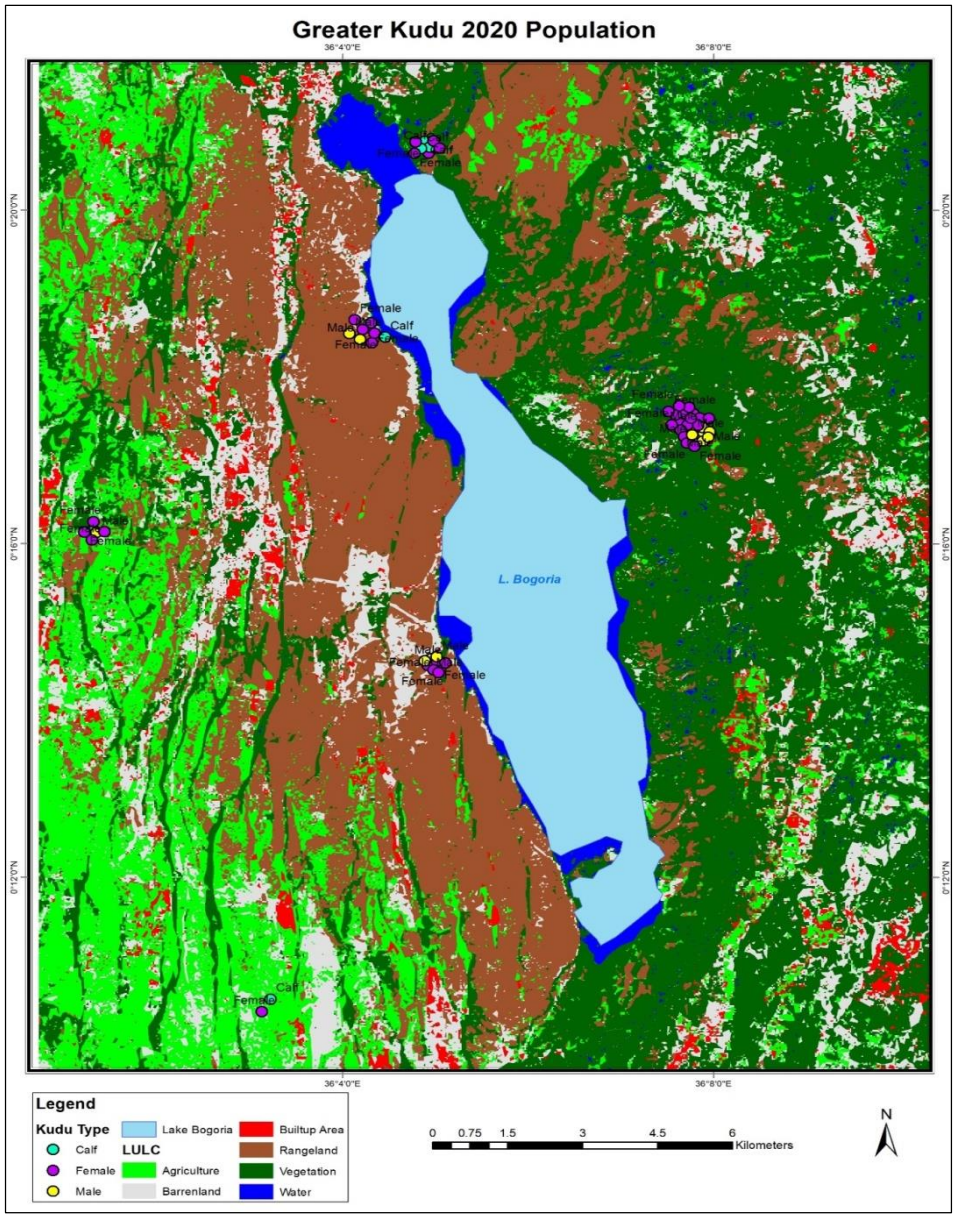

Figure 4. 3: Greater Kudu population (2020) at the LBNGR and its environs

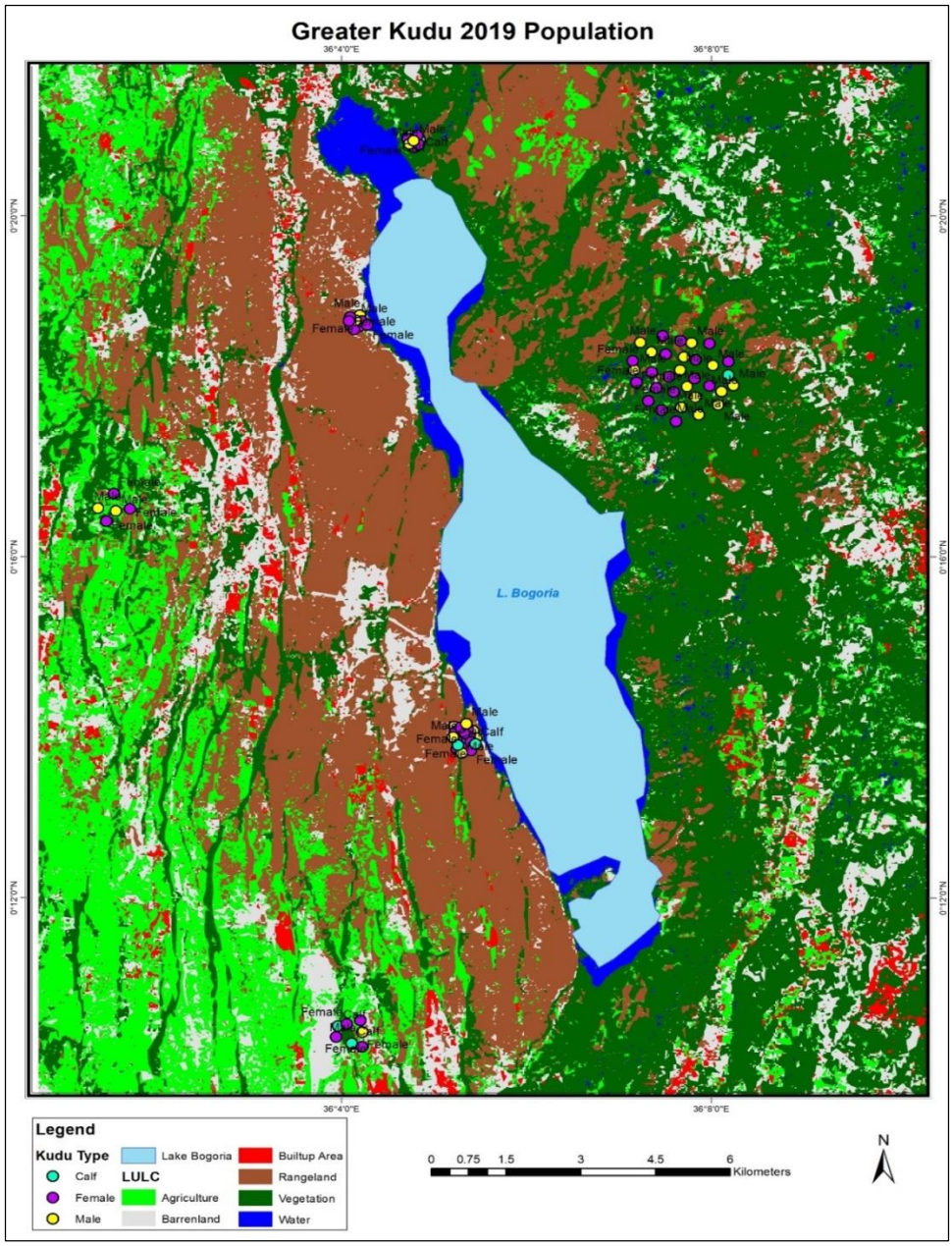

Figure 4. 4: Greater Kudu population (2019) at the LBNGR and its environs

Comparing the three years under consideration, most Kudus were counted in the dense vegetation located more that 5km away from the Lake in 2019 (Figure 4.4). This numbers appear to have decreased over the years such that by the year 2022 (Figure 4.2), most Kudus occupied areas not far from the lake. This implies that their terrestrial habitat could be facing disturbances from socio-economic activities as was also stated by Aduma *et al.* (2019) that human activities like agriculture and settlements interferes with migration or dispersal of wildlife.

4.1.1 Greater Kudu Dispersal

Dispersal is a dynamic process that varies among species and regions. It has been found that in a world with limited dispersal opportunities, the range size occupied by species is crucial for their survival and is responsible for their extinction that any other factor (Aduma *et al.*, 2018). Density-based point pattern analysis was used to analyze Kudu dispersal as shown in Figures 4.5, 4.6 and 4.7.

It was noted that for year 2019, Greater Kudu dispersal map shows a density of between 10 and 40 Kudus/km^2 on the rangelands around Maji Moto and Koitumet wards (Figure 4.5). It is likely that depressed rainfall for all the seasons in 2019 contributed to this population pattern. Being shy, the Kudus numbers ranging between 1 and 10 Kudus/km^2 were sparsely spread on the western side of the Lake in the agricultural lands of Molos and Kamar wards.

Greater Kudu dispersal map for the year 2020 (Figure 4.6) shows a density of between 10 and 40 Kudus/km^2 in the leafy vegetation located in Maji Ndege and Chibirebei wards. This could be due to above normal rainfall for all the three seasons of the year (2020) in the landscape; most Kudus met their water needs elsewhere other than the Lake. In fact, as shown in the map (Figure 4.6), the Kudus were densely populated in vegetated areas. Socio-economic activities tend to reduce the Kudu population as was evidenced by low numbers ranging between 1 and 10/km^2 on the western side of the Lake in the agricultural lands of Koitumet and Kamar wards.

The dispersal map for year 2022 shows dense population of Kudus (ranging between 40 and 50/km^2) near the shores of the Lake Bogoria in Koitumet sub-ward (Figure 4.7). More Kudus were also observed in Chibirebei and Maji Ndege wards in the highly vegetated areas around the Lake. Marginal numbers of Kudus ranging from 1 to 10/km^2 were seen in Tinosiek Olkokwe and Kamar wards respectively which further affirms the importance of water sources/watering on dispersal of Greater Kudus (Simpson, 1972).

From the findings above, it was evident that ecological needs of Greater Kudu affect their dispersal for instance; water requirements as was indicated by high concentration of Kudus around the Lake shores in year 2019 when rains were depressed; food as the case for high concentration of Kudus in Chebirebei ward in 2020; breeding behavior as is shown by dispersal of Kudu calves mostly away from the mature herds; and their seasonal movement patterns or home range. This agrees with what Bennett (2003) indicated as factors to be considered when establishing and managing wildlife corridors.

From the findings on Greater Kudu dispersal in the study area (Figures 4.5, 4.6 and 4.7), spatio-temporal changes of Greater Kudu population density were evident thus the null hypothesis that spatio-temporal distribution of dispersal areas of the Greater Kudu in Lake Bogoria landscape did not change in the last four years was rejected.

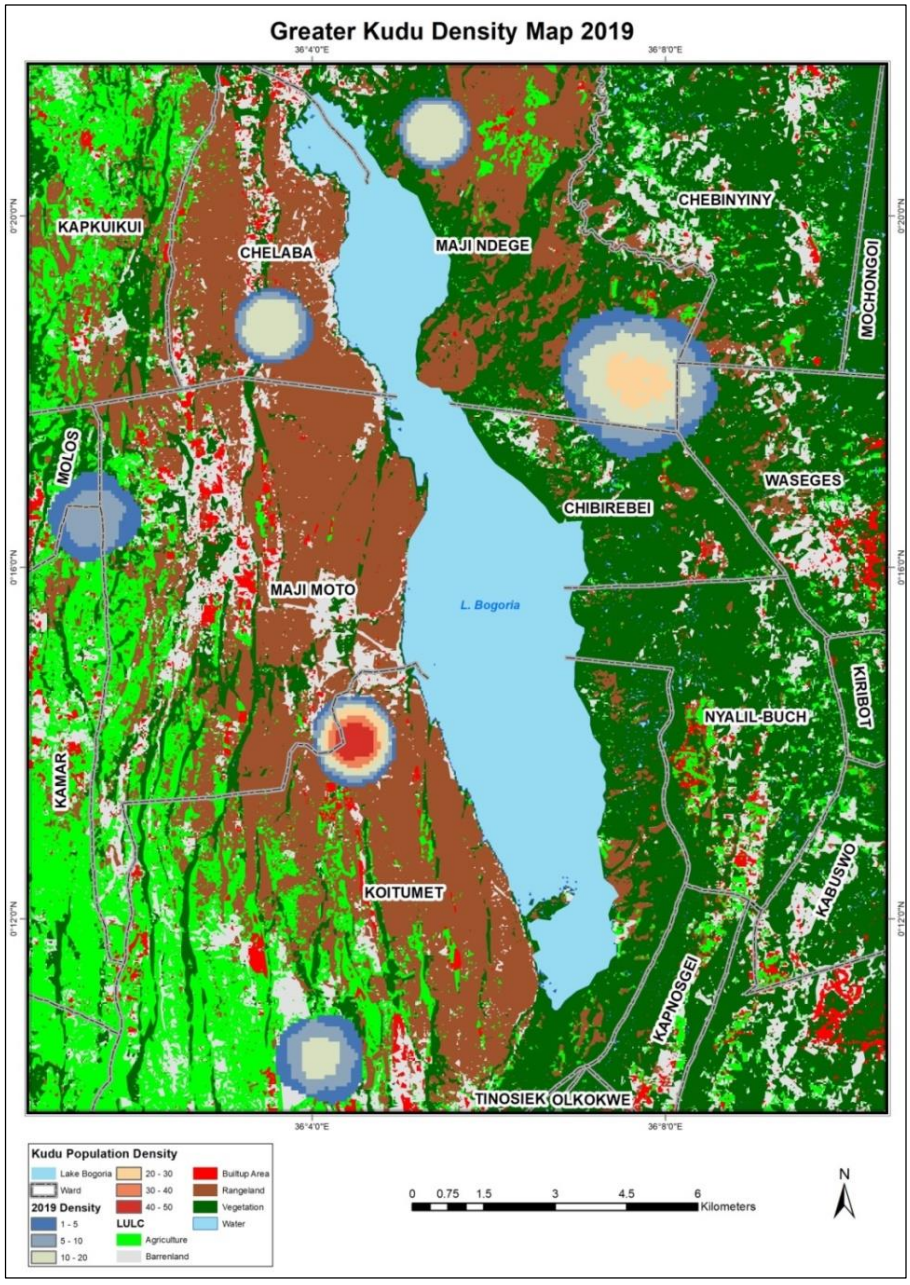

Figure 4. 5: Greater Kudu population density (numbers/km2) for Year 2019 at LBNGR

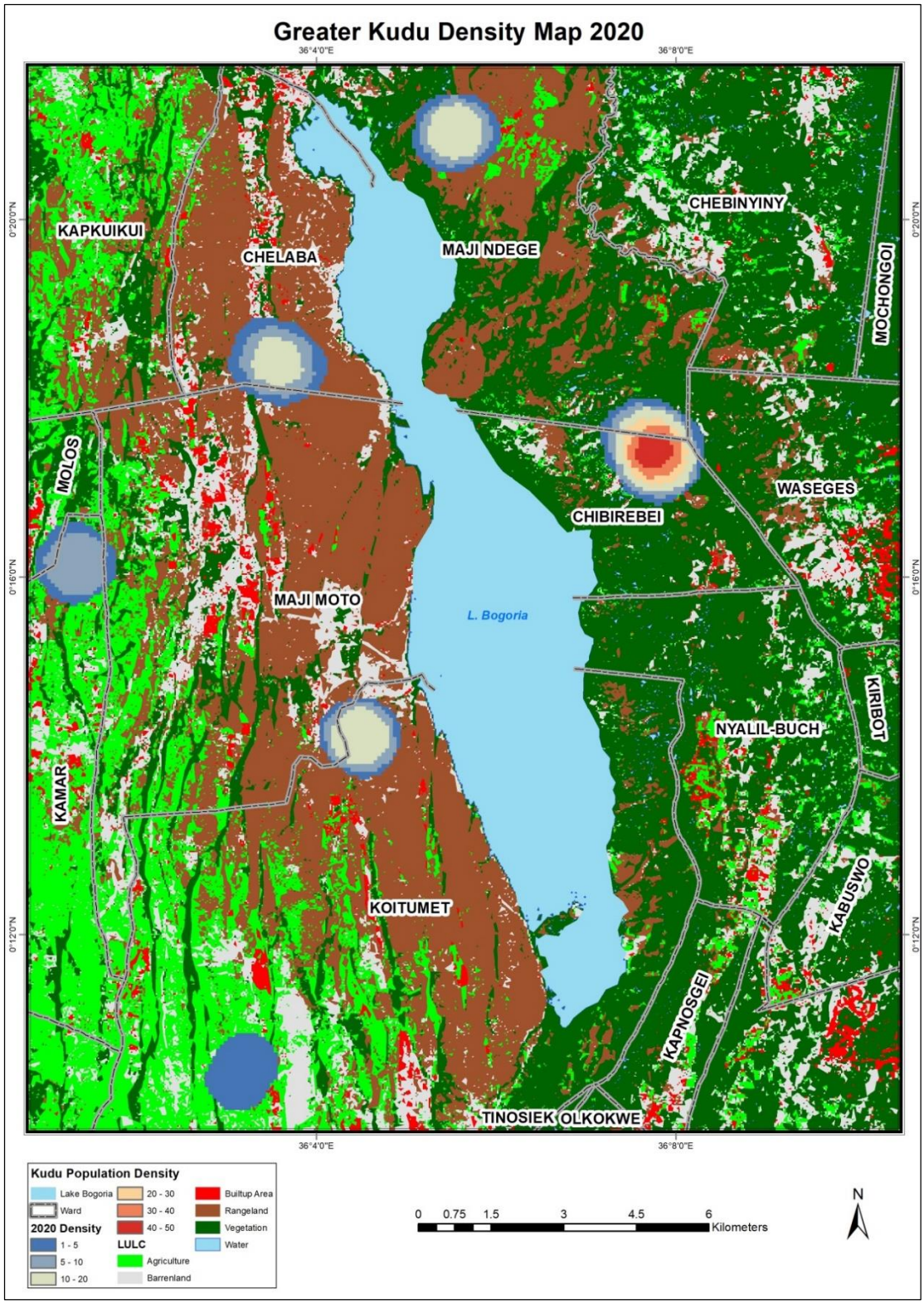

Figure 4. 6: Greater Kudu population density (numbers/km2) for Year 2020 at LBNGR

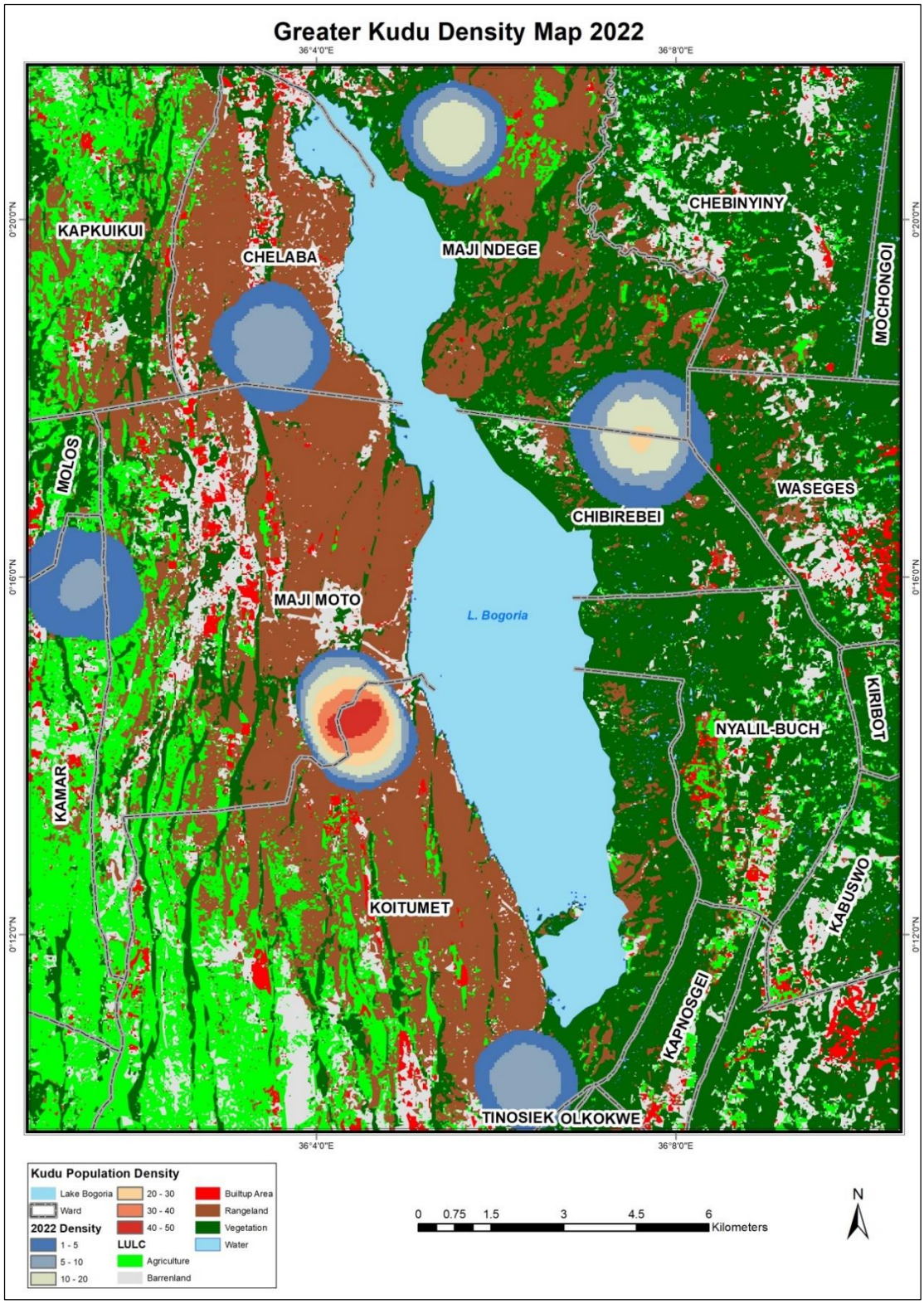

Figure 4. 7: Greater Kudu population density (numbers/km2) for Year 2022 at LBNGR

4.2 Temperature and Rainfall Variability

To understand climate change over the years and how it may affect ecosystem in the landscape requires a proper understanding of variability of weather parameters. For this study, monthly rainfall, maximum temperature and minimum temperature data was acquired from Kenya Meteorological for 40 years from 1981 to 2021 for two wards (sub-locations): Chebirebei to the east of Lake Bogoria and Maji Moto to the west as shown in Appendix A.

Temperature extremes can have profound effect on wild life population, metabolism, consumption, reproduction and livelihood. This hampers resilience in an ecosystem and creates complex feedback and ecosystem dynamics since it directly affects its physiological performance. Analysis for variability and trends of temperature and precipitation historical data is important in understanding ecosystem dynamics hence making informed recommendations on ecosystem conservation action plans and/or policies to improve resilience and reduce exposure to risks associated with harsh weather conditions. Additionally, changes in temperature conditions will affect population dynamics and distribution of wildlife including Greater Kudu due to its direct and indirect impacts on the ecosystem.

This study sought to establish relationship between Kudu population dispersal and changes in monthly maximum and minimum temperature and rainfall in the eastern side of the landscape (Chebirebei sub-location) and the western side of the landscape (Maji Moto sub-location).

The three seasons of a year in the study area include: dry season (December, January and February – DJF); long rainy season (March, April and May – MAM); and the short rainy season (June, July, August, September, October and November- JJASON). Seasonal variation of temperature and rainfall was also analyzed to demonstrate their effects on GK dispersal in the LBNGR.

4.2.1 Temperature Variability

Maximum and Minimum Temperature Range

Although the hot spell according to Mugo (2007) begin from January to March and the cold spells in the months of July and August, the findings from the study showed that the maximum temperature range in Chebirebei sub-location was between 25.9^0C in July 2018 and 39.2^0C in August 2019. However, mean monthly average was in agreement with Mugo (2007) where February and March recorded 32.5^0C and 32.6^0C respectively with July being the coldest month with an average 29.1^0C. A similar trend was recorded for Maji Moto sub-location with the lowest

maximum temperature of 25.9^{0}C in the months of July 2018 and 2020; and the highest of 38.5^{0}C in in the months of August 2019 and 2020. Mean monthly maximum temperatures in Maji Moto sub-location had the hottest months being February and March both recording 32.9^{0}C and the coldest month was July with 29.2^{0}C.

On the other hand, minimum monthly temperature range in Chebirebei sub-location was between 11.2^{0}C in January 2019 and 22.0^{0}C in February 2010 with long-term mean monthly temperature showing the highest in the months of March/April 19.4^{0}C and the lowest in the month of July 18.1^{0}C. The lowest minimum recorded in Maji Moto sub-location was 9.5^{0}C in September 2018 and the highest was 20.0^{0}C in January 1998 with long-term mean monthly temperature recording the lowest of 16.3^{0}C in the month of July and the highest 17.5^{0}C in the month of April.

From the results above, it was found that the long-term monthly temperature range for maximum temperature is from 25.9^{0}C to 39.2^{0}C and that for minimum temperature is 9.5^{0}C to 22.0^{0}C in the study area. It was observed that the ranges of lowest and highest maximum temperature in the recent past have been widening ranging from 9.5^{0}C to 39.2^{0}C as compared with 18^{0}C-39^{0}C as was reported by Mugo (2007). This indicates a likelihood of extreme temperature occurrences as a result of climate change in the study area.

Maximum and Minimum Temperature Seasonal Variability

From temperature data analyzed, it was found that long-term monthly maximum temperature in the study area appeared to have remained the same overtime in Chebirebei and Maji Moto sub-locations (Figures 4.8 and 4.9) with a marginal decrease of 0.01% and 0.04% respectively (R^2 = 0.001 and R^2 = 0.0038 respectively).

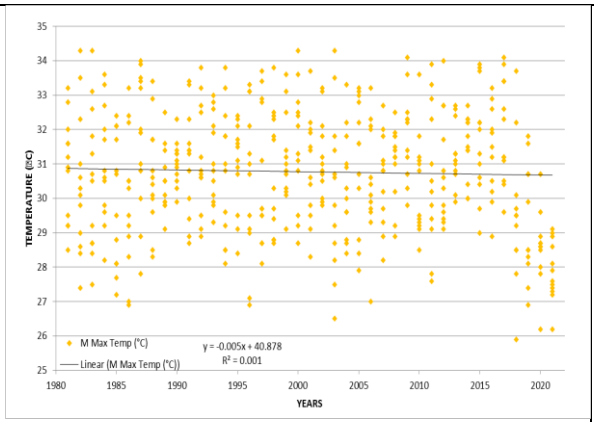

Figure 4. 8: Maximum temperature trends at Chebirebei Sub-location, Baringo County, Kenya

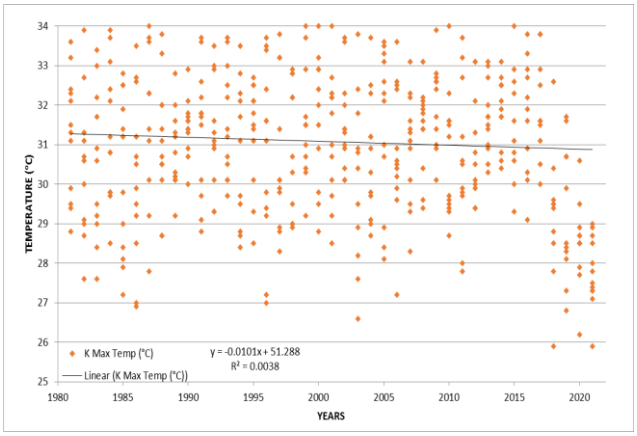

Figure 4. 9: Maximum temperature trends at Maji Moto Sub-location, Baringo County, Kenya

Similarly, it was found that long-term monthly minimum temperature decreased in the study area particularly in Chebirebei and Maji Moto sub-locations (Figures 4.10 and 4.11) recording percentage decrease of 7.49% and 5.0% respectively (R^2 = 0.0749 and R^2 = 0.0499 respectively).

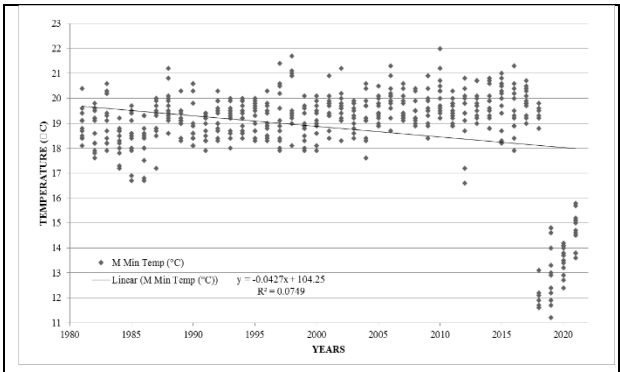

Figure 4. 10: Minimum temperature trends at Chebirebei Sub-location, Baringo County, Kenya

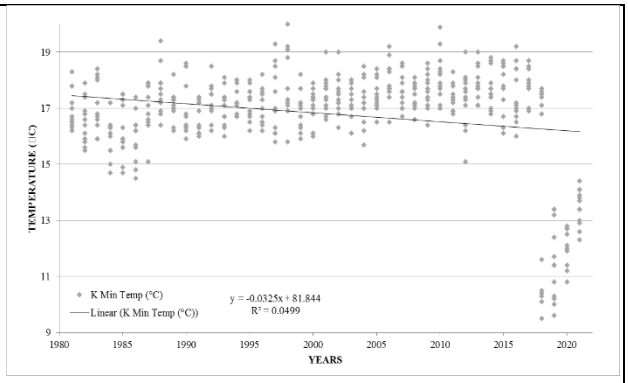

Figure 4. 11: Minimum temperature trends at Maji Moto Sub-location, Baringo County, Kenya

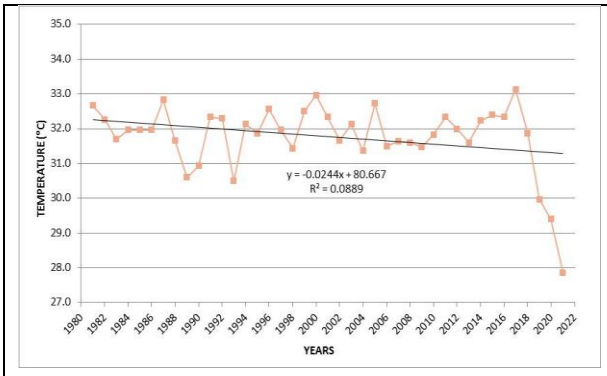

Figure 4. 12: DJF Maximum temperature at Chebirebei sub-location, Baringo County, Kenya

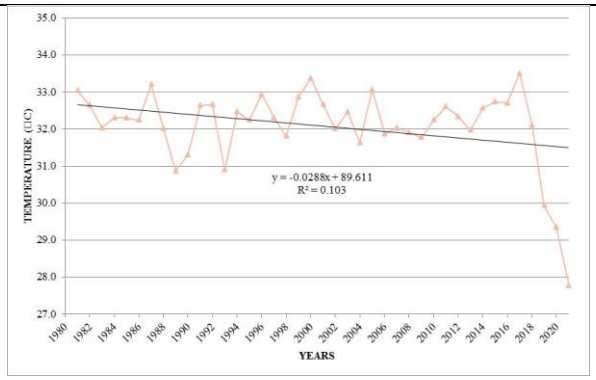

Figure 4. 13: DJF Maximum temperature at Maji Moto sub-location, Baringo County, Kenya

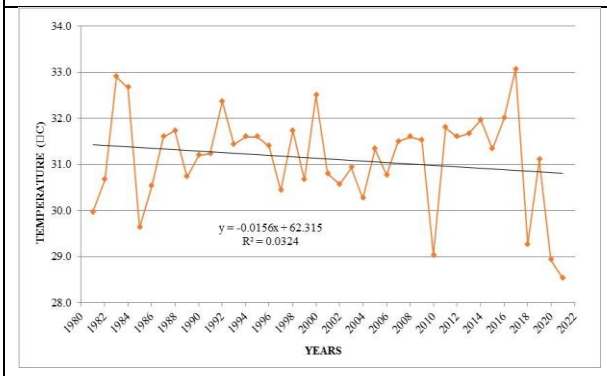

Figure 4. 14: MAM Maximum temperature at Chebirebei sub-location, Baringo County, Kenya

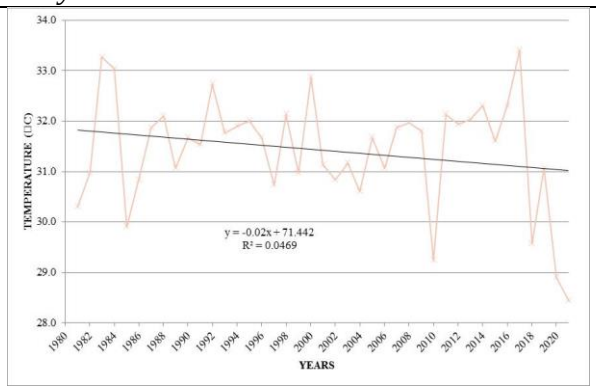

Figure 4. 15: MAM Maximum temperature at Maji Moto sub-location, Baringo County, Kenya

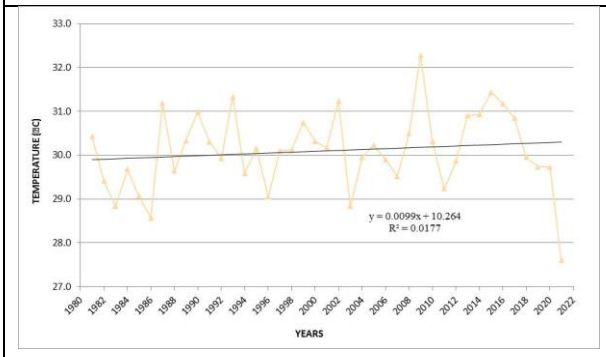

Figure 4. 16: JJASON Maximum temperature at Chebirebei sub-location, Baringo County, Kenya

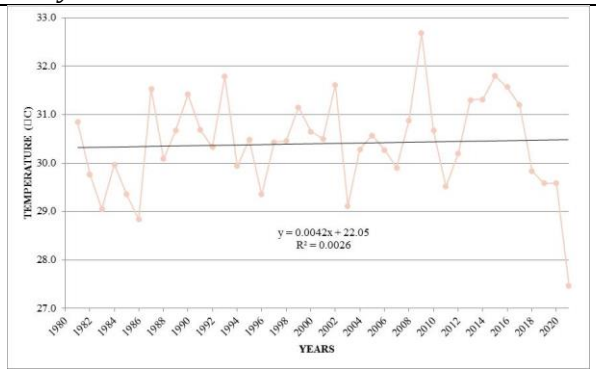

Figure 4. 17: JJASON Maximum temperature at Maji Moto sub-location, Baringo County, Kenya

Seasonal maximum temperature analysis showed that it has become low for all the three seasons (DJF, MAM and JJASON) in both Chebirebei and Maji Moto sub-locations with a percentage decrease of 9 and 10.3 respectively (R^2 = 0.0899 and R^2 = 0.103 respectively) for

season DJF; percentage decrease of 3.2 and 4.7 respectively (R^2 = 0.0324 and R^2 = 0.0469 respectively) in MAM season; and percentage decrease of 1.7 and 0.2 respectively (R^2 = 0.0177 and R^2 = 0.0026 respectively) in JJASON season as shown in the Figures 4.12, 4.13, 4.14, 4.15, 4.16 and 4.17 for seasonal maximum temperature.

A similar seasonal trend was observed for minimum temperature as shown in Figures 4.18, 4.19, 4.20, 4.21, 4.22 and 4.23 for the three seasons (DJF, MAM and JJASON) for both Chebirebei and Maji Moto sub-locations with a percentage decrease of 10 and 6.7 respectively (R^2 = 0.1002 and R^2 = 0.0675 respectively) in DJF season; percentage decrease of 11.3 and 8.9 respectively (R^2 = 0.1131 and R^2 = 0.0893 respectively) in MAM season; and percentage decrease of 7.7 and 4.9 respectively (R^2 = 0.0772 and R^2 = 0.0489 respectively) in JJASON season as shown in the Figures 4.18, 4.19, 4.20, 4.21, 4.22 and 4.23 for seasonal maximum temperature.

From temperature variability detected in the study area, there is likelihood of extreme temperature occurrences as a result of climate change. Consequently, climate change will impact on biodiversity including the Greater Kudu irectly and indirectly, through factors such as competition with livestock, predation, and human activities such as agriculture and settlements, migration or dispersal corridors of wildlife from hot to cooler and wet areas can be obstructed.

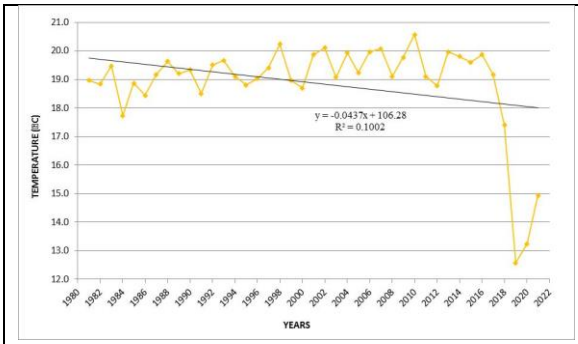

Figure 4. 18: DJF Minimum temperature at Chebirebei sub-location, Baringo County, Kenya

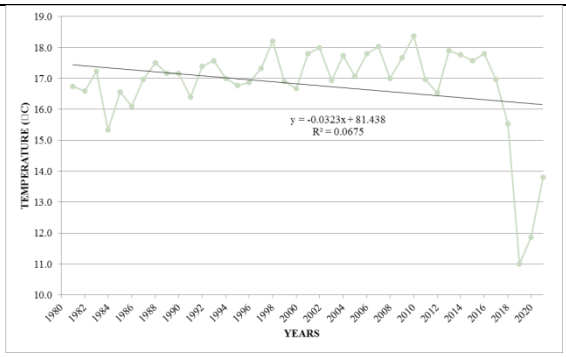

Figure 4. 19: DJF Minimum temperature at Maji Moto sub-location, Baringo County, Kenya

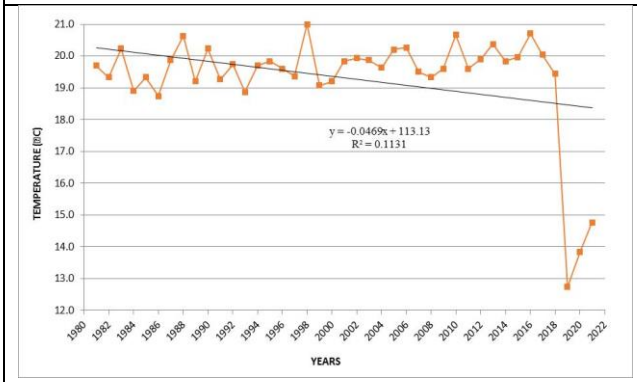

Figure 4. 20: MAM Minimum temperature at Chebirebei sub-location, Baringo County, Kenya

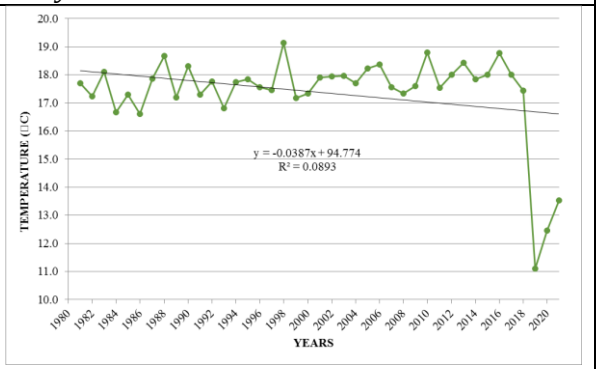

Figure 4. 21: MAM Minimum temperature at Maji Moto sub-location, Baringo County, Kenya

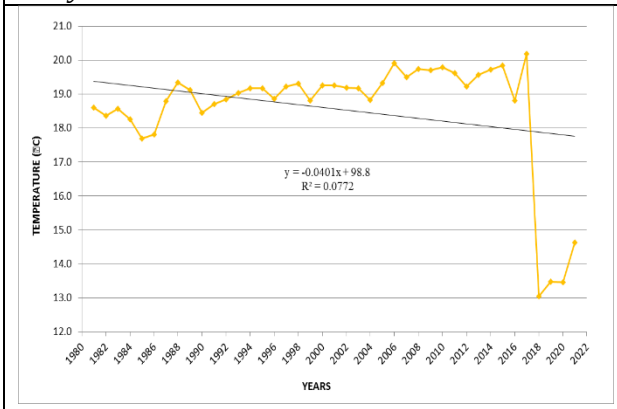

Figure 4. 22: JJASON Minimum temperature at Chebirebei sub-location, Baringo County, Kenya

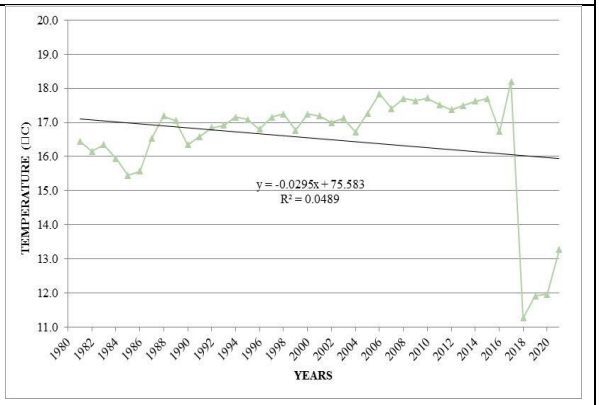

Figure 4. 23: JJASON Minimum temperature at Maji Moto sub-location, Baringo County, Kenya

4.2.2 Rainfall Variability

Rainfall Monthly and Annual Range

Further, it was found that the month of February was the driest in Chebirebei sub-location with no rainfall received for years 1986, 1997, 2000 and 2003. Similarly, the month of February for years 1981, 1986, 1997, 2000, 2003 and March 2000 were the driest months in Maji Moto sub-location. The wettest month for both Chebirebei sub-location (314.6mm) and Maji Moto sub-location (298.3mm) was June 2007. The long-term mean monthly rainfall put February the driest month both for Chebirebei and Maji Moto sub-locations with an average of 20.6mm and 18.8mm respectively. The month of April is the wettest month for both Chebirebei and Maji with an average of 115.2mm and 105.5mm respectively. However, annual rainfall totals varied from 304mm in 1984 to 1608mm in 2020 for Chebirebei sub-location with a long-term annual mean of 792mm. A similar variation was noted for Maji Moto sub-location recording annual rainfall range of 232mm in 1984 to 1514mm the year 2020 in with a with a long-term annual mean of 701mm.

Rainfall Seasonal Trends

From this study, it was found that rainfall (mm) amounts depicted an increasing trend (Figure 4.24 and 4.25) between 1981 and 2022 in both Chebirebei (by 2.6%) and Maji Moto (by 3.4%) sub-locations (R^2 = 0.0262 and R^2 = 0.0343 respectively).

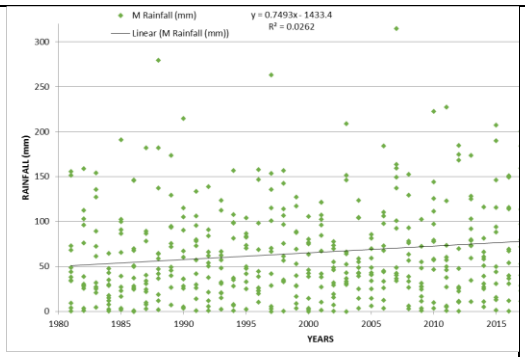

Figure 4. 24: Long-term rainfall trends at Chebirebei Sub-location, Baringo County, Kenya

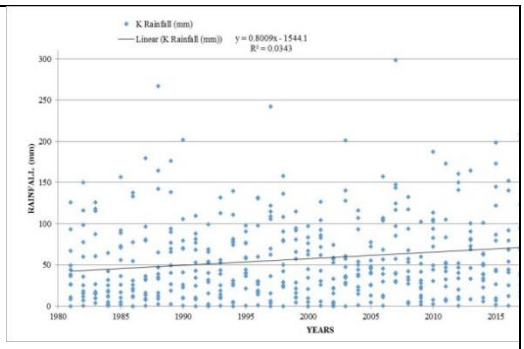

Figure 4. 25: Long-term rainfall trends at Maji Moto Sub-location, Baringo County, Kenya

Firstly, as indicated in Figures 4.26 and 4.27, the rainfall trend for DJF season in Chebirebei and Maji Moto sub-locations depicted an increase of 9.3% and 13.4% respectively (R^2 = 0.0929 and R^2 = 0.1344 respectively).

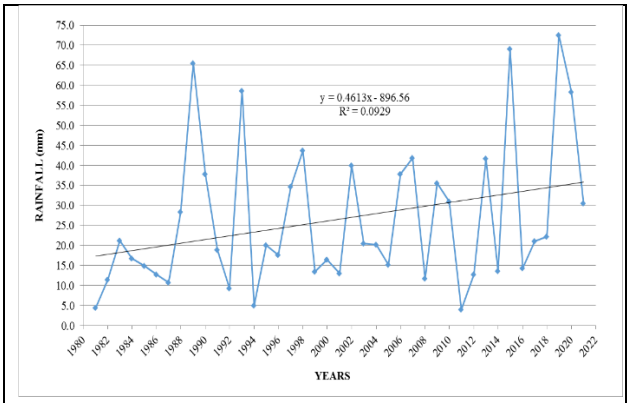

Figure 4. 26: DJF rainfall at Chebirebei sub-location, Baringo County, Kenya

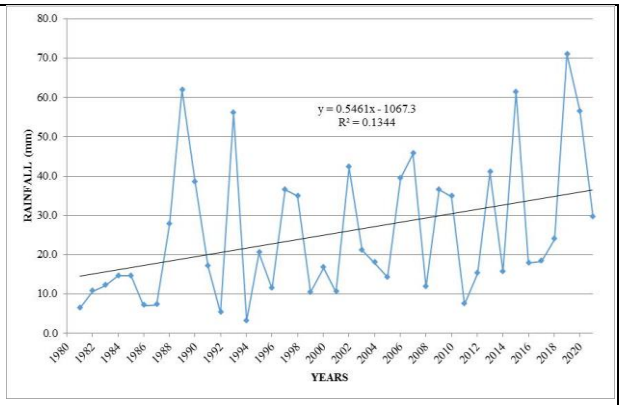

Figure 4. 27: DJF rainfall at Maji Moto sub-location, Baringo County, Kenya

Secondly, Figures 4.28 and 4.29 below also show an upward trend of rainfall for MAM season in Chebirebei and Maji Moto sub-locations with an increase of 4.3% and 4.3% respectively (R^2 = 0.0433 and R^2 = 0.0431 respectively). This increase is marginally lower than that of DJF.

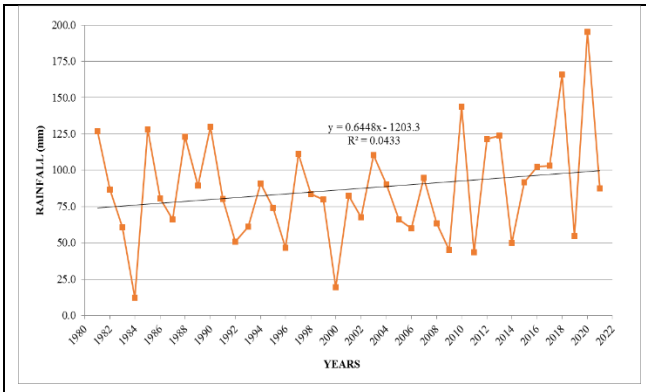

Figure 4. 28: MAM rainfall at Chebirebei sub-location, Baringo County, Kenya

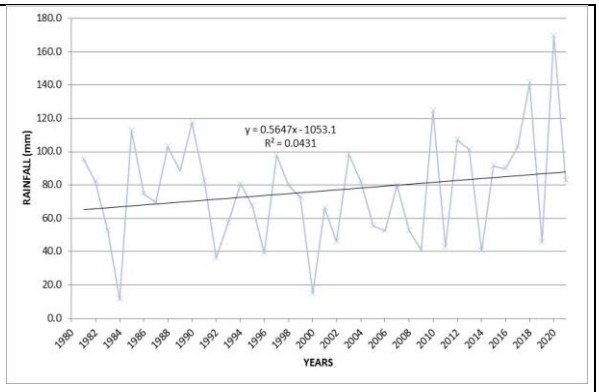

Figure 4. 29: MAM rainfall at Maji Moto sub-location, Baringo County, Kenya

Thirdly, Figures 4.30 and 4.31 below also indicated an upward rainfall trend for the short rainy season (JJASON) in the two sub-locations Chebirebei and Maji Moto. It is worth mentioning that the highest increase was recorded during this season compared to the other two seasons (DJF and MAM) with an increase of 18.4% and 22.8% respectively (R^2 = 0.1838 and R^2 = 0.2284 respectively).

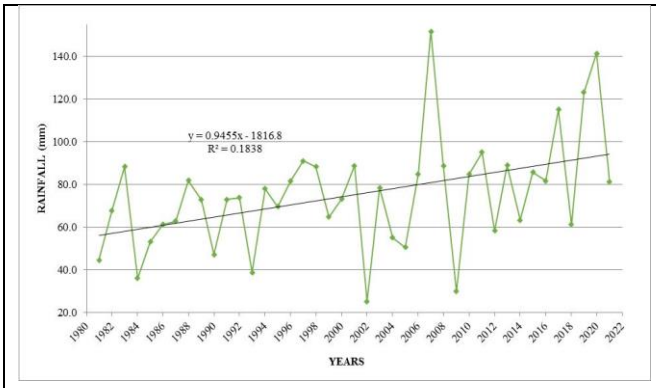

Figure 4. 30: JJASON rainfall at Chebirebei sub-location, Baringo County, Kenya

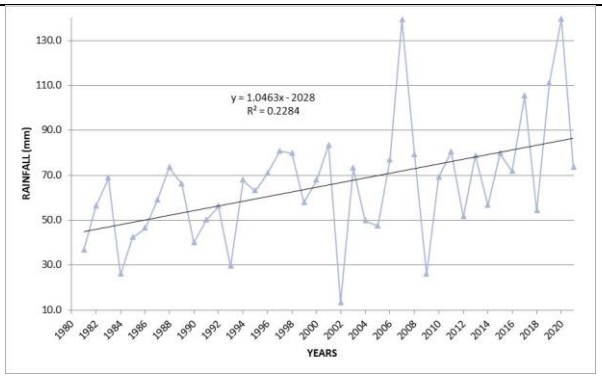

Figure 4. 31: JJASON rainfall at Maji Moto sub-location, Baringo County, Kenya

4.2.3 Impacts of Temperature and Rainfall Variability on Greater Kudu Population

Herbivores are dependent on food quality as well as food quantity. Greater Kudus are not an exception. They thrive well in productive ecosystem where water and food is adequately available. From the correlation Table 4.1, it was evident that maximum temperature had an inverse correlation with Greater Kudu population though not statistically significant $r(1) = -0.42$, $p > 0.05$. While minimum temperature had a positive relationship with Greater Kudu population but also not statistically significant $r(1) = 0.45$, $p > 0.05$. This confirms that Kudus thrive well in a warm environment – neither too hot nor too cold environment. Hence the null hypothesis that temperature variability did not affect the population of Greater Kudu within Lake Bogoria landscape in the last four years was rejected.

Table 4. 1: Correlation coefficients between Kudu population and weather parameters in LBNGR

		Maximum Temperature (^0C)	*Minimum Temperature (^0C)*	*Rainfall (mm)*
Greater Kudu Population	Pearson Correlation	-0.418	0.445	-0.991
	Sig. (2-tailed)	0.725	0.707	0.087
	N	3	3	3

*. Correlation is significant at the $p \leq 0.05$ level (2-tailed).

Climate change directly affects terrestrial ecosystems through seasonal changes in rainfall and temperature and indirectly through other disturbances such as fire and drought (IPCC, 2007). Contrary to our expectation, there was a drop of both maximum and minimum temperature in

LBNGR landscape. The drop in temperatures according to the local community would be ascribed to the introduction of *Prosopis juliflora* - a tree native to South America that was intentionally introduced for its adaptability to desert conditions, fast growth, and source of fuel wood, livestock fodder, human food and bee forage. The tree also provides shade, stabilizes soil through extensive root system hence controls soil erosion and increases soil fertility through litter and fixing of atmospheric nitrogen as it belongs to the legume family. It has progressively become a vibrant species, colonizing many parts of Kenya's arid and semi-arid areas (ASALs) (Choge *et al.*, 2022).

The widening temperature range in the recent past indicates a likelihood of extreme temperature occurrences as a result of climate change in the study area. The findings illustrate that Kudus thrive in warm temperatures – extremely hot or cold temperatures may not favour their survival. The findings agree with Simpson (1972) who noted that greater kudu in South Africa moved to higher ground in winter despite limited food and water resources there but because night temperatures were warmer there. A study by Bothma *et al.* (2002) indicated that extreme minimum temperatures in late winter and early spring were fatal to Kudus. Further, Aduma *et al.* (2018) indicated that extreme maximum temperatures (above 36°C in wet season and 30°C in the dry season) have great impacts on wildlife because it triggers complex ecosystem dynamics that lead to habitat loss among the large herbivores in the Kenyan Savanna and affected the foraging habits of greater kudu (Owen-Smith 2002).

It has been reported that rising temperatures are causing habitat decline in the population of the big herbivores in the Kenyan Savanna (Aduma *et al.*, 2018). Moreover, it has been reported that species have shown modification in their morphology, physiology, and behavior due to changes in climatic variables (Muluneh, 2021) -painted turtles grew larger in warmer years and reached sexual maturity faster during warm sets of years (Iverson & Smith, 1993). Similarly, juvenile red deer (Cervus elaphus) in Scotland grew faster in warmer springs resulting to growth in adult body size (Sheridan & Bickford, 2011).

Moreover, from Table 4.1 it was evident that rainfall (mm) has a negative effect on Greater Kudu population in the landscape though marginally significant $r(1) = -0.99$, $p > 0.05$ and 98% of the total variation in Kudu population related to rainfall variability. It was also noted that both seasonal and annual trends showed that rainfall has been rising over time in the study area. The results affirm what was expected to occur in the East African region; a 5% - 20% increase in rainfall from December-February and a 5% - 10% decrease in rainfall from June to August by

2050 due to the pattern of Indian Ocean warming – the Indian Ocean Dipole (IOD) which interacts with the El Niño-Southern Oscillation (ENSO) to generate El Ninos (IPCC, 2013).

The results, especially those of rainfall range, indicated that rainfall in the study area is largely erratic from months with no rainfall to months in some years with quite a substantive high rainfall. Such rainfall affects food security particularly in communities and locations that depend on rain-fed agriculture necessitating solutions like bringing extra land into agriculture (Muluneh, 2021) and this may compromise conservation of greater kudu and biodiversity in general.

A similar relationship was explained by Owen-Smith (1972) where he observed that although rainfall affects availability of food supply for the Kudus especially the nutrient rich forbs, it also inversely affects Kudus juvenile survival rate. Therefore, where there are plenty of food resources with minimum fluctuations between the years as is the case in the study area, the increase in rainfall may suppress greater kudu population growth. Whereas rainfall influences the growth and availability of feeding resources to the Kudus, Both *et al.* (2006), indicated that its distribution determines onset of seasons which in turn affect biodiversity at the species level on timing of events like migration, dispersal and breeding habits populations.

According to Owen-Smith (2013), both mature and juvenile Kudus are negatively affected by prolonged drought conditions leading to water and food scarcity and partly because it exposes them more to predators as they move for long distances in search of food and water. For instance, in Kruger National Park of South Africa, 40% of lion kills were during the three months of the dry season (Owen-Smith, 2002). High rainfall improves range conditions by enabling rapid vegetation growth and providing ready access to surface water which may lead to population increases. However, excess water in the form of floods may cause population declines, directly or indirectly, through waterlogging and reduced availability of food (Ojwang *et al.*, 2017). In fact, Vanacker *et al.* (2005) found that several ecosystems across sub-Saharan Africa are highly sensitive to short-term rainfall variability.

Rainfall affects availability of forage as well as its nutrition which decreases during drought (Owen-Smith, 2002Greater kudus are adapted to feed on various types of vegetation, but during a drought, the reduced nutritional value of their food increases the quantity they need to consume (Dorgeloh, 200; Owen-Smith, 2002). Males in poor state at the end of the mating season may lack ability to withstand the dry season (Skinner & Chimimba, 2005). Furthermore, the dry season is especially dangerous for predation of greater kudu. Hence, comprehending the impact of

temperature and variability on wildlife species is crucial in the field of conservation biology and wildlife management, particularly in proactive management and the development of judgments on conservation status (Zanamwe *et al.*, 2018).

4.3 Land Use/Cover Change

The results of the image classification identified six major land uses including water, built-up areas, rangeland (grasses, grass-like plants, grazing land), vegetation (forests), agriculture and barren land as shown in Table 4.1. Results from the classified images show that rangeland and barren land dominated the catchment with at 35% and 33% respectively while built-up areas, water and agriculture covered the least areas at 2%, 3% and 6% respectively in 1980. However, by the year 2020, rangeland and barren land decreased by 67% and 27% respectively while built-up areas, water and agriculture increased by 350%, 100%, 350% and 233% respectively. Farming activities and built-up areas which are evidently increasing corresponds to the increasing human population and subsequent economic activities in the area.

4.3.1 Effect of Swelling of Lake Bogoria on Greater Kudu Dispersal

Land use/cover change has been reported to impact on the hydrologic and ecological processes of an ecosystem because it influences runoff generation and flow patterns by altering hydrological factors such as interception, infiltration and evaporation, and thus causes changes in the frequency and intensity of flooding. At a catchment scale, such impacts on hydrological processes will, in turn, significantly influence ecosystem, environment and local economy (Ali *et al.*, 2011). It was evident from Pearson's correlation analysis that there is a significant positive correlation between water and built-up areas in LBNGR ($r = 0.926$, $df = 4$, $P = 0.024$) indicating that the more natural ecosystem is converted for human settlement, the more runoff and flooding is expected in the landscape.

Table 4. 2: Land use and land cover changes in Lake Bogoria Landscape, from 1980-2020

Year	**1980**		**1990**		**2000**		**2010**		**2020**		**Change**
LULC Type	***Area (ha)***	**%**	***Area (ha)***	**%**	***Area (ha)***	**%**	***Area (ha)***	**%**	***Area (ha)***	**%**	**%**
Water	750	3	814	3	910	4	993	4	1,575	6	**+100**
Rangeland	8,766	35	5,964	24	5,417	22	4,607	19	3,189	13	**-67**
Barren land	8,143	33	8,020	32	7,288	29	6,532	26	5,872	24	**-27**
Built-up	614	2	1,023	4	1,068	4	1,417	6	2,145	9	**+350**
Agriculture	1,537	6	4,989	20	5,633	23	6,326	25	6,509	26	**+233**
Vegetation	5,012	20	4,012	16	4,506	18	4,947	20	5,532	22	**+10**
Total	**24,822**	**100**	**24,822**	**100**	**24,822**	**100**	**24,822**	**100**	**24,822**	**100**	

The results indicate that the Lake Bogoria has been increasing in its capacity since the 1980 and a sharp increase is witnessed in the year 2020. This increase could be attributed to increased

precipitation in the Rift Valley by over 30% from 1980 to 2020. The expansion of Lake Bogoria has displaced both people and wildlife (including Greater Kudu) from their habitats, LBNGR Head Qaurters Offices, leaving behind submerged buildings and facilities, social amenities and rendering some of the public infrastructure like roads impassable.

This phenomena has significantly impacted the tourism industry, an important sector in the Baringo County's economy. Tourists have to use an alternative road that was constructed to access hot springs and gysers approximately 25km away from Loboi Gate where previuosly hot springs and gysers were within the proximity. Generally, construction of alternative all weather road and traffic has altered wildlife habitat, caused vehicle-related mortality, impede animal dispersal/ seasonal migration, and may disperse alien pests and diseases of plants and animals. Being a shy animal, Greater Kudus are currently rarely spotted by the tourists except when found drinking water.

The results also indicate a decline in the rangelands which could be due to increased economic activities around the Lake. This decrease implies reduction of forage for the Kudus. It can be seen that the vegetation cover was substantial in the 1980 but declined in 1990 before starting to increase in the year 2000. This can be attributed to the government intervention in the area and controlled human activities such as ban of charcoal burning, soil and water conservation measures, agroforestry, energy conservation technologies by introduction of improved jikos and use of solar energy around the Lake. The built-up areas are increasing steadily from 1980 due to increased human population and economic activities.

In a study to assess the linkages between land use change, land degradation and biodiversity across East Africa, it was found that as native vegetation is lost, indigenous plant and animal biodiversity and plant cover are lost (Maitima, 2009). A similar observation was noted in Kimana Wetland Ecosystem in Kenya where the main effects of land use changes on wild ungulates included a decline in wild ungulate numbers, habitat destruction, increased human-wildlife conflicts, land degradation, and displacement of wild ungulates by livestock (Kitina & Odiara, 2014). Lake Bogoria has also suffered siltation and erosions due to excessive human activity in the western part. Despite the government's efforts to conserve the area, human encroachments into the Lake Reserve still remain.

Consequently, the eastern part of the Lake is hilly with grass, shoots tubers and roots that grow along the rivers and these are very conducive environments for the Greater Kudu to thrive

in. On the other hand, the western part of Lake Bogoria National Reserve has a lot of human activities like farming/agriculture which have resulted in soil degradation resulting to bare lands and built-up areas which are not conducive for Greater Kudu existence. From the results (Figures 3, 4, 5, 6 and 7), it was also observed that the eastern part of the Lake depicted more densely Greater Kudu population than the western part of the Lake which is dominated with agricultural activities.

4.3.2 Impact of Agricultural Activities on Greater Kudu Dispersal

Agricultural activities were minimal in 1980 but rose in 1990 before starting to decline in the year 2000 while the built up centers were increasing implying expansion of human activities including settlements, town centers, tourist hotels, cutting of trees for charcoal burning and overgrazing around the study area. This could be due to government conservation efforts as well as displacement of settlers due to increasing water level of the Lake. Figures 4.32, 4.33, 4.34, 4.35 and 4.36 present the results of supervised classification carried out in the area of study for the 5 epochs.

Greater Kudus thrive in scrubland, shrub land, woodland and bush that grow in rangelands and grasslands. Clearing land for agricultural activities lead to destruction of the Kudus most preferred habitat – Kudus do not thrive in open areas. Therefore, it is important to consider smart agriculture for optimum land production as to limit the rate of land clearance for agricultural activities.

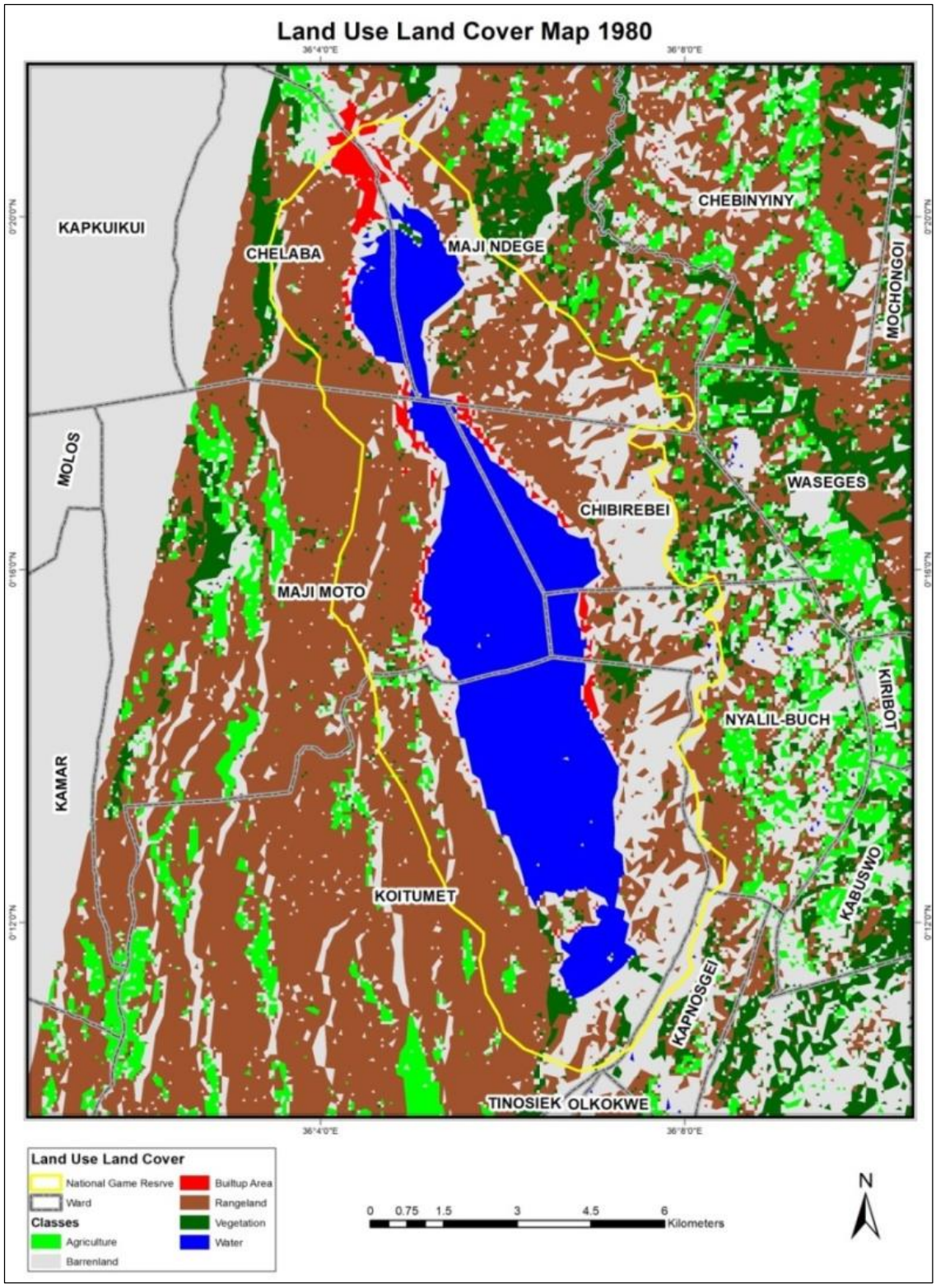

Figure 4. 32: Lake Bogoria landscape land use/cover map for 1980

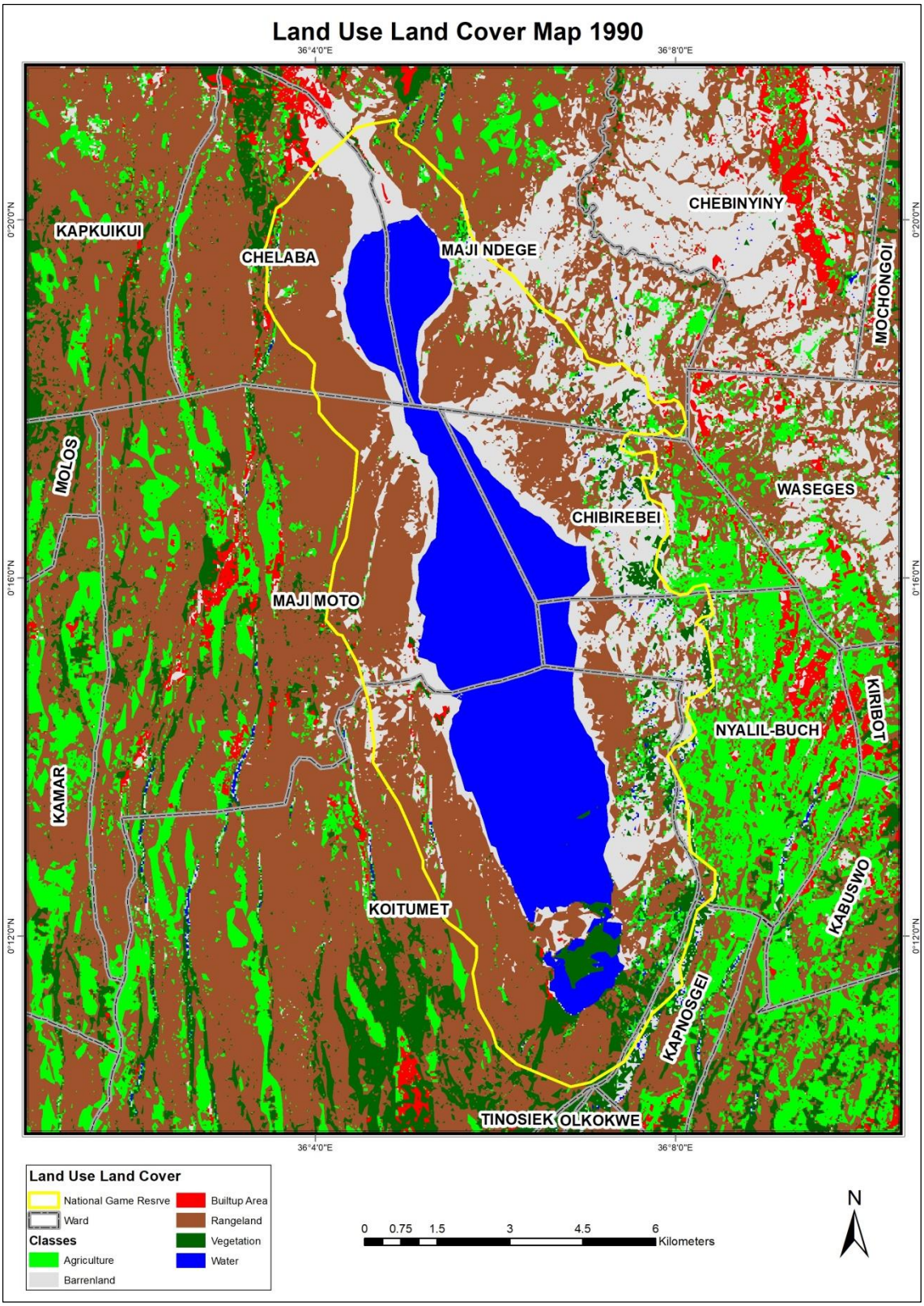

Figure 4. 33: Lake Bogoria landscape land use/cover map for 1990

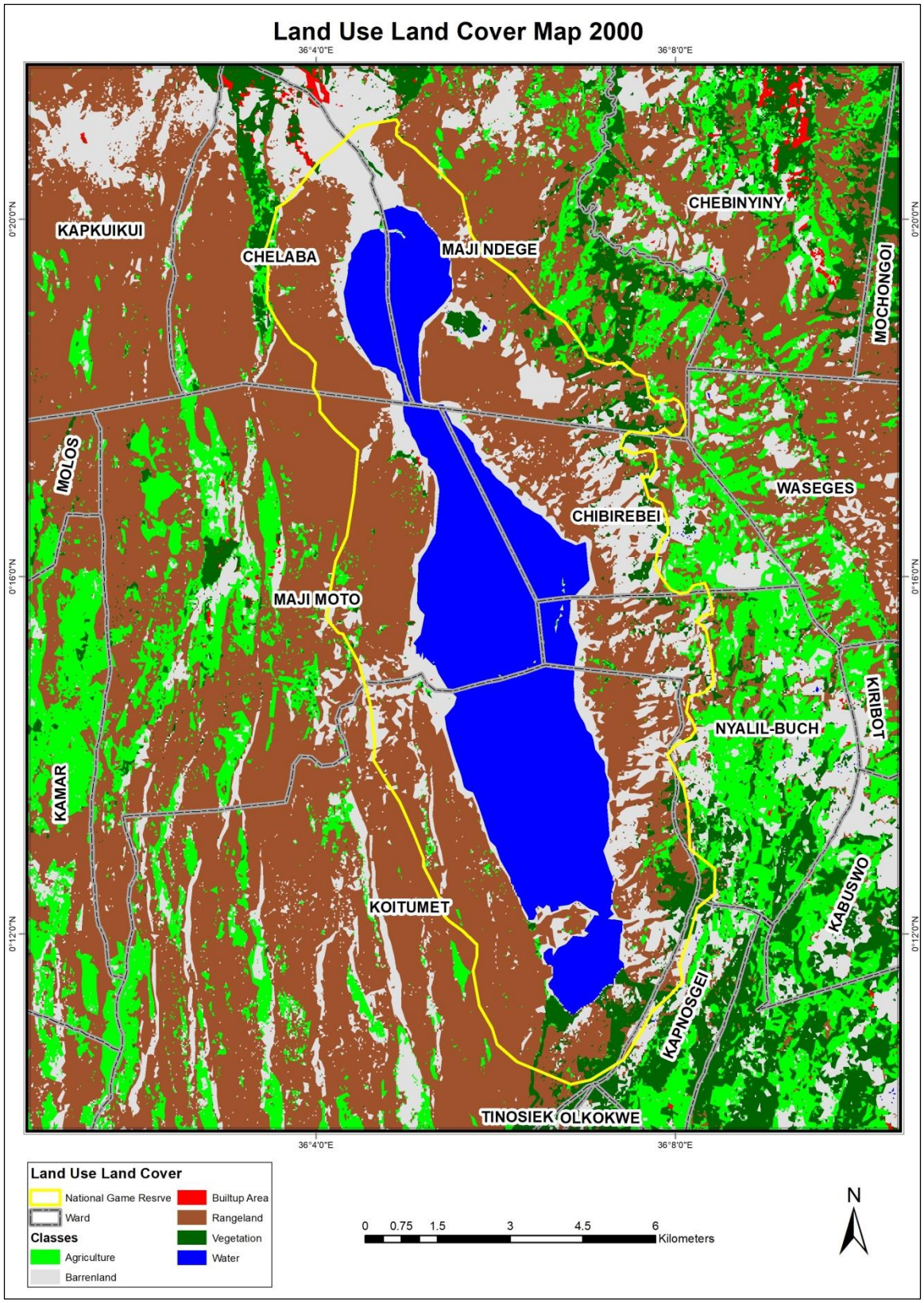

Figure 4. 34: Lake Bogoria landscape land use/cover map for 2000

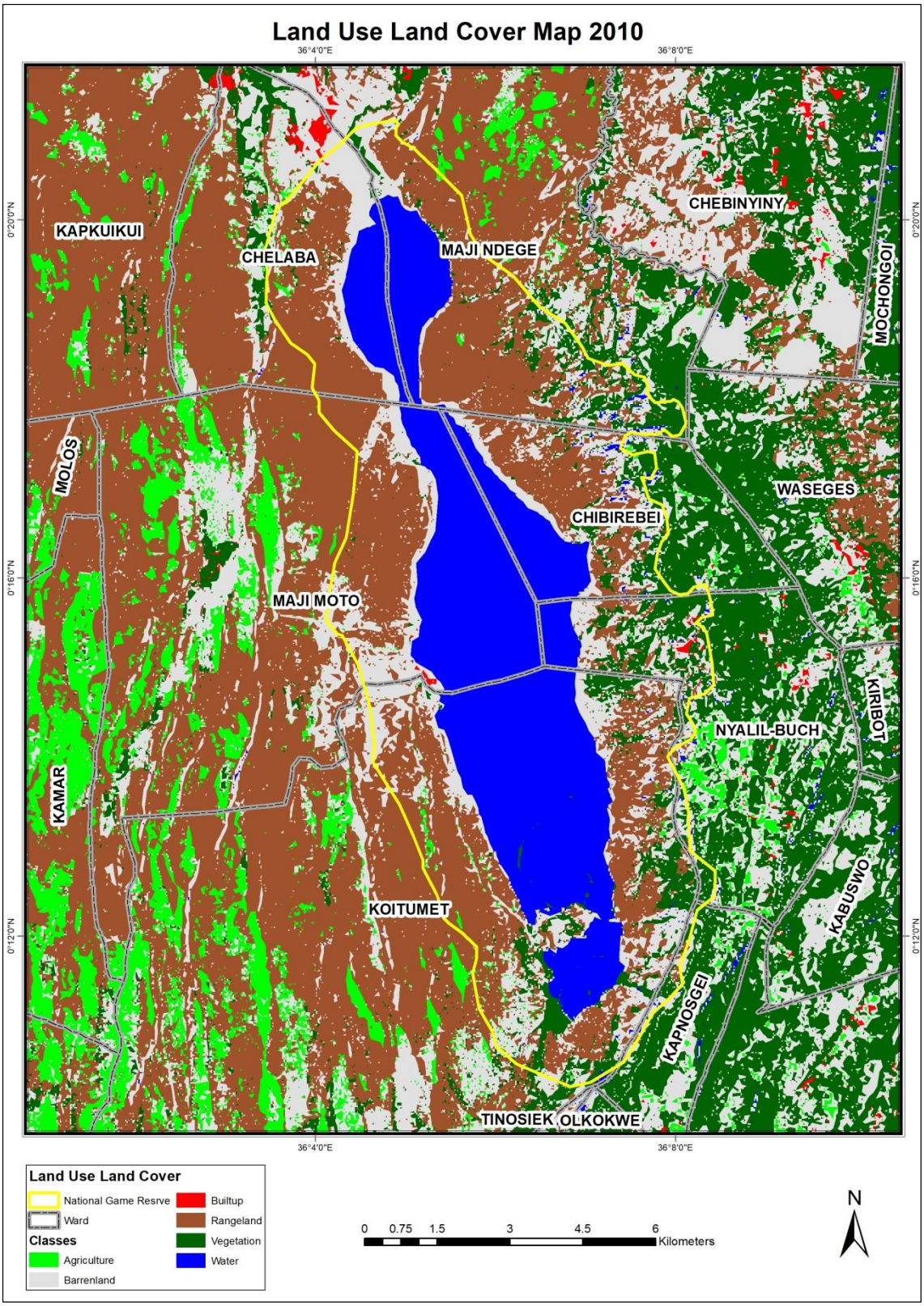

Figure 4. 35: Lake Bogoria landscape land use/cover map for 2010

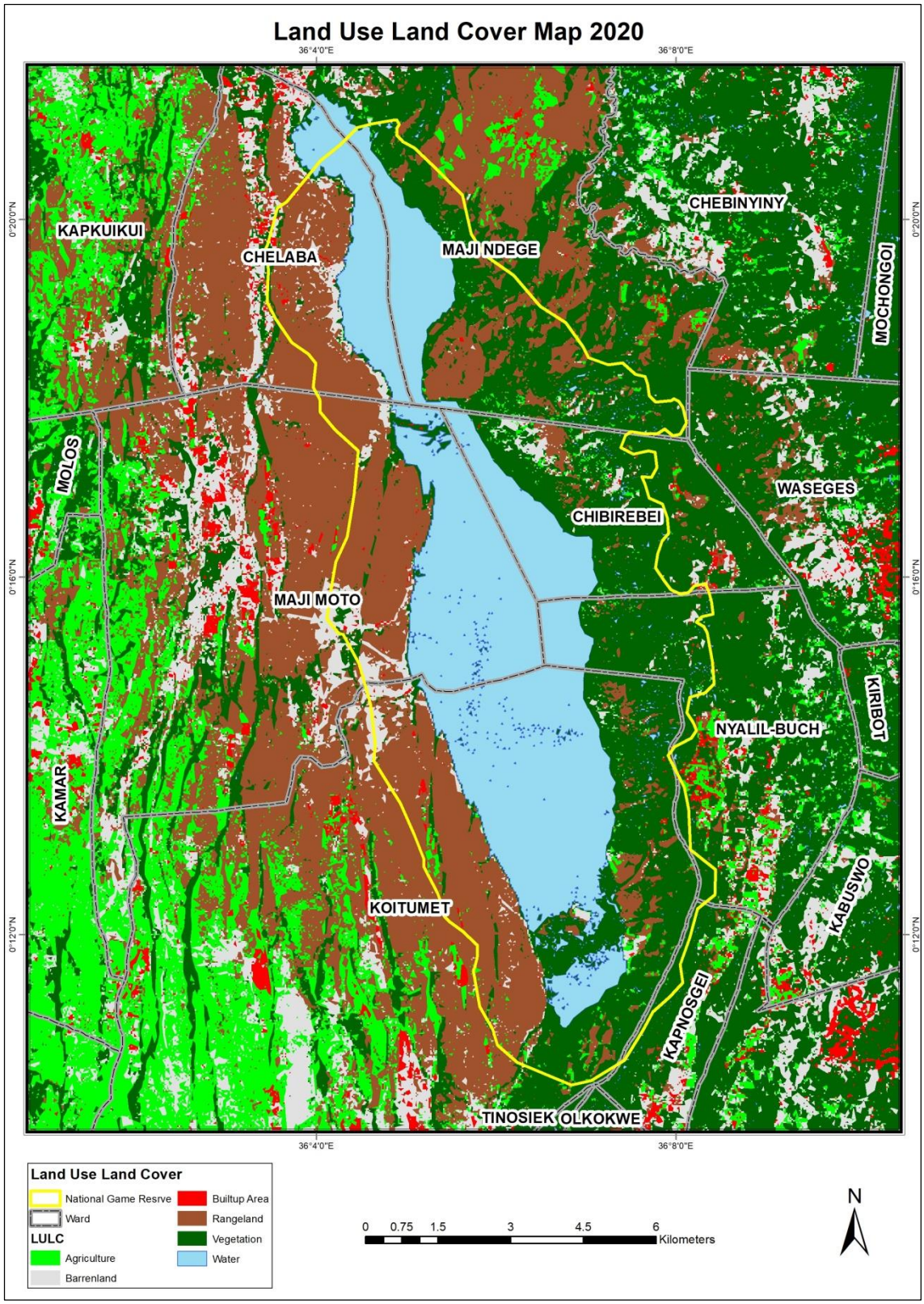

Figure 4. 36: Lake Bogoria landscape land use/cover map for 2020

Table 4. 3: Correlations between land use/land cover changes in LBNGR

		Water	*Rangeland*	*Barren land*	*Built-up Areas*	*Agricultural Land*	*Vegetation*
Water	Pearson Correlation	1	-.834	-.905*	.926*	.651	.716
	Sig. (2-tailed)		.079	.035	.024	.234	.174
	N	5	5	5	5	5	5
Rangeland	Pearson Correlation	-.834	1	.909*	-.935*	-.952*	-.320
	Sig. (2-tailed)	.079		.033	.019	.012	.599
	N	5	5	5	5	5	5
Barren land	Pearson Correlation	-.905*	.909*	1	-.937*	-.808	-.652
	Sig. (2-tailed)	.035	.033		.019	.098	.233
	N	5	5	5	5	5	5
Built-up Areas	Pearson Correlation	.926*	-.935*	-.937*	1	.788	.580
	Sig. (2-tailed)	.024	.019	.019		.113	.305
	N	5	5	5	5	5	5
Agricultural Land	Pearson Correlation	.651	-.952*	-.808	.788	1	.081
	Sig. (2-tailed)	.234	.012	.098	.113		.897
	N	5	5	5	5	5	5
Vegetation	Pearson Correlation	.716	-.320	-.652	.580	.081	1
	Sig. (2-tailed)	.174	.599	.233	.305	.897	
	N	5	5	5	5	5	5

*. Correlation is significant at the 0.05 level (2-tailed).

From the Pearson correlation analysis performed (Table 4.3), a positive significant correlation was noted between rangeland and barren land (r = 0.909, df = 4, P = 0.033) and water and built-up areas (r = 0.926, df = 4, P = 0.024). On the other hand, a negative significant

correlation was noted between water and barren land (r = -0.905, df = 4, P = 0.035) rangeland and built-up areas (r = -0.935, df = 4, P = 0.019) and rangeland and agricultural land (r = -0.952, df = 4, P = 0.012).

4.3.3 Normalized Difference Vegetation Index (NDVI)

The Normalized Difference Vegetation Index (NDVI) is a commonly utilized vegetation index among several others. The NDVI values go from -1.0 to +1.0. Barren areas consisting of rock, sand, or snow typically exhibit extremely low NDVI values, such as 0.1 or below. Scanty plant life, such as shrubs and grasslands, or aging crops can lead to moderate NDVI values, often ranging from 0.2 to 0.5. NDVI values ranging from around 0.6 to 0.9 indicate the presence of thick vegetation, such as that typically found in temperate and tropical woods, or crops during their peak development stage (*NDVI, the Foundation for Remote Sensing Phenology | U.S. Geological Survey*, 2018).

NDVI Results

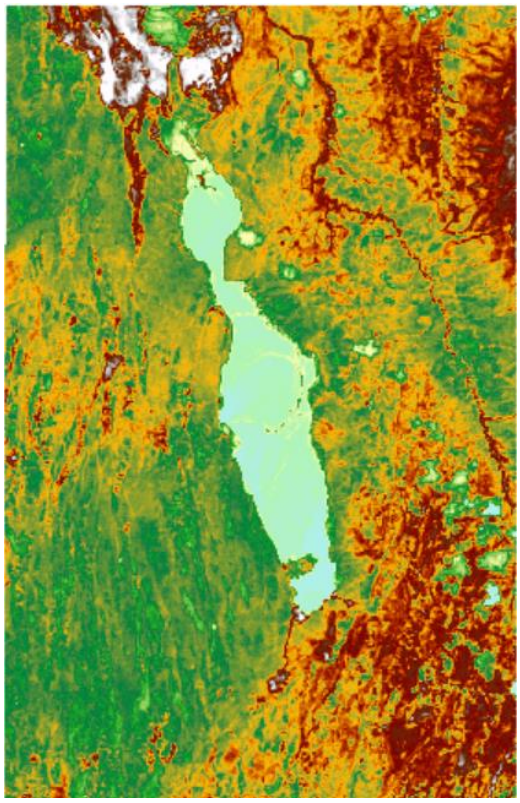

Figure 4. 38: Lake Bogoria Landscape 2000 NDVI (-0.46 to +0.45)

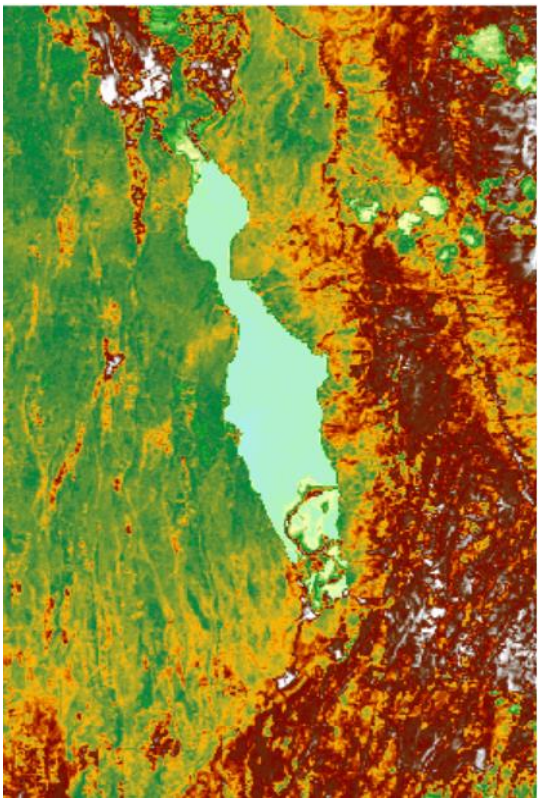

Figure 4. 37: Lake Bogoria Landscape 2010 NDVI (-0.31 to +0.46)

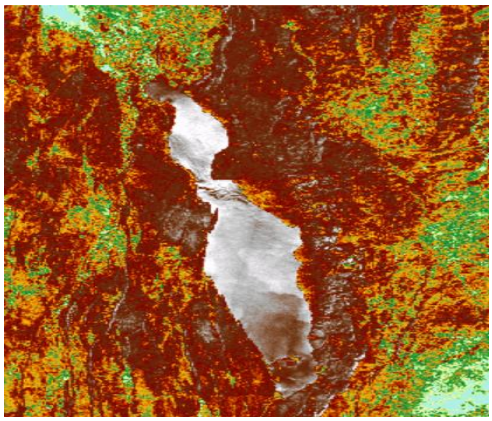

Figure 4. 39: Lake Bogoria Landscape 2020 NDVI (-0.12 to +0.96)

Results show NDVI of between -0.96 for bare surfaces to 0.98 for the most vegetative areas for year 1980 (Figure 4.37). This indicate an evenly distributed vegetation with moderate health in the 80s while the situation in 1990 show a shift of healthy vegetation in the north eastern side of the lake as well as areas along the shores of the lake (Figure 4.38). The results from 2000 (Figure 4.39) to 2010 (Figure 4.40) show an even distribution of healthy vegetation on both sides of the Lake. The 2020 results show that healthy vegetation is more dominant in the eastern part of the study area, an indication that deforestation may have occurred creating land for human settlement and farmlands (Figure 4.41).

The increase in healthy vegetation between 2000 and 2010 could also be related to the increase in the amount of rainfall in the study area and the introduction of the invasive tree, *Prosopis juliflora* in early 1980s as rehabilitation from over-grazing and over-exploitation of its woodlands (Mwangi & Swallow, 2008).

4.3.4 Influence of Land Use/Land Cover Change on Greater Kudu Population

The habitat of Greater Kudu includes mixed scrub woodlands (rangeland) The vegetation consists of bush and acacia trees, which can be found in abandoned fields, degraded pastures, lowlands, hills, and mountains. They sometimes wander into plains only when there is a substantial abundance of bushes, but often avoid such open regions to prevent themselves from becoming vulnerable to their predators. Their food primarily comprises of foliage, grass, and shoots, with occasional consumption of tubers, roots, and fruit. They occasionally venture onto plains only if there is a large abundance of bushes, but normally avoid such open areas to avoid becoming an easy target for their predators. Their diet consists of leaves, grass, shoots and occasionally tubers,

roots and fruit of Acacia species (*Acacia tortillis, Acacia mellifera, Acacia xanthophlea*), *Ficus Species,* grasses and forbs. Apart from over 373 birds' species of around the Lake, other wildlife species like impala, vervet monkey, dikdik, warthog, and common jackal and reptiles including monitor lizard, lizards, tortoise, crocodiles and various species of snakes are not spared either as the loss of rangeland displaces them to more conducive areas and this could lead to human-wildlife conflict within the area.

The globally, regional, and local decrease in wildlife populations has mostly been linked to alterations in land use, human intrusion into wildlife habitats, frequent droughts, illegal hunting, and other human-caused activities (Kitina & Odiara, 2014). From the results in Tables 4.2 and 4.3 both built-up areas and agricultural land in LBNGR have evidently increased with a significantly negative correlation with rangeland (r = -0.935, df = 4, P = 0.019) and (r = -0.952, df = 4, P = 0.012). This trend corresponds to rising human population and subsequent economic activities in the study area.

From a separate study investigating the effects of human-caused changes to the environment on the population and habitat preferences of large land-dwelling mammals in Nech Sar National Park, Ethiopia, it was indicated anthropogenic disturbances caused alterations in the dimensions, quantity, proximity, spatial arrangement, and structure of fragments within natural ecosystems from 1985 to 2013 (Fetene *et al.,* 2019). It has also been documented that there has been a decrease in the population of wildlife on average by 68% between 1977 and 2016 (Ogutu *et al.,* 2016) as the numbers of sheep and goats (76.3%), camels (13.1%) and donkeys (6.7%) evidently increased in the same period in Kenya. Therefore, the rising human population and subsequently settlement areas in the study area may negatively affect Greater Kudu population and distribution in LBNR.

It was noted that agricultural activities, built –up areas for settlement and deforestation due to charcoal burning have been expanding over time. The changes in natural land cover to various land uses like farmlands, livestock grazing lands, human settlements and urban centers is likely to destroy Greater Kudu habitat, breeding grounds and interfere with Kudu's dispersal corridors. It has been found that livestock grazing may alter the composition and the physiognomy of rangeland vegetation communities at the expense of wildlife. Some plants may decrease with grazing, while others may increase (Ojwang *et al.,* 2017). It was observed that LBNGR being a protected area

still suffers from human encroachment which may lead to Greater Kudu population instability and possibly local extinction due to increase in human-wildlife conflicts.

NDVI results (Figures 4. 37, 3.8, 3.9, 3.40 and 3.41) showed that the eastern part of the Lake has substantial natural vegetation and is covered in rangeland which is conducive for the Greater Kudu. The area is also hilly with grass, shoots tubers and roots that grow along the rivers and these are very conducive environments for the animal species to thrive in. On the other hand, the western part of Lake Bogoria National Reserve has a lot of human activities like farming/agriculture which have resulted in soil degradation resulting to bare lands and built-up areas which are not conducive for Greater Kudu existence. Lake Bogoria has also suffered siltation and erosions due to excessive human activity in the western part. Despite the government's efforts to conserve the area, human encroachments into the Lake Reserve still remain.

The NDVI results (Figures 4. 37, 3.8, 3.9, 3.40 and 3.41) in comparison to Kudu dispersal areas maps (Figures 4.2, 4.3 and 4.4) the western part of the Lake depicted more densely Greater Kudu population than Kudu population in the eastern part of the Lake which is dominated with agricultural activities. A similar observation was noted in Kimana Wetland Ecosystem in Kenya where the main effects of land use changes on wild ungulates included a decrease in wild ungulate populations, habitat destruction, heighten human-wildlife conflicts, land degradation, and displacement of wild ungulates by livestock (Kitina & Odiara, 2014).

Therefore, it was evident that LULC changes in the study area affect Greater Kudu existence which currently is threatened by the increase in encroachment to rangelands for human settlements and agricultural activities. Hence the null hypothesis that Land use/cover change did not influence population of Greater Kudu in the study area in the last four years was rejected.

4.4 KAP Data Analysis

In this section results and discussion on the knowledge, attitude, and practice (KAP) of local resource users towards conservation of the Greater Kudu in Lake Bogoria landscape are presented.

4.4.1 Frequency Analysis of Background Information of Respondents

The study analyzed the demographic information of the respondents pertaining gender, age, occupation, and education level. This information is important in evaluating whether the respondents are qualified to give reliable information in line with the objectives of this study.

Distribution of Respondents by Gender

To maximize positive impact in biodiversity conservation, multi-gender participation is essential. The respondents were asked to indicate their gender. From the findings, male respondents were 60% and female respondents were 40%. The results of the analysis are presented in Table 4.4.

Table 4. 4: Distribution of Respondents by Gender in Lake Bogoria Landscape

Gender	Frequency	Percentage
Male	82	60
Female	55	40
Total	**137**	**100**

Distribution of Respondents by Age

The respondents were asked to state their age brackets. From the findings, it was noted that majority of the respondents (65%) aged between 31 to 50 years. Respondents between the age of 20 and 30 years were (37%). Respondents of age below 20 years were the minority (3%) while 21% of the respondents were more than 50 years old. The results of analysis are shown in Table 4.5.

Table 4. 5: Distribution of Respondents by Age in Years in Lake Bogoria Landscape

Age Bracket	Frequency	Percentage
< 20	4	3
20 – 30	50	37
31 – 50	64	45
< 50	21	15
Total	**137**	**100**

Distribution of Respondents' Occupation

The nature of occupation amongst the respondents in the study area was assessed. Although all types of occupations were represented during the interview in the study area, majority (53%) of those interviewed was unemployed with only 7% in a formal employment (Figure 4.42). This implies that the unemployed respondents basically depend on the readily available local natural resources for their livelihoods which may lead to overexploitation.

Albu (2021) explains that unemployment rate, median wages, and wage inequality are all significant determinants of poverty which is manifested in manifestations include hunger and malnutrition, limited access to education and other basic services, social discrimination and exclusion as well as the lack of participation in decision-making. Therefore, the high rate of unemployment in an area is a risk to increased poverty levels. Therefore, promotion of Greater Kudu conservation for eco-tourism may be one way of improving their livelihoods through revenue generated.

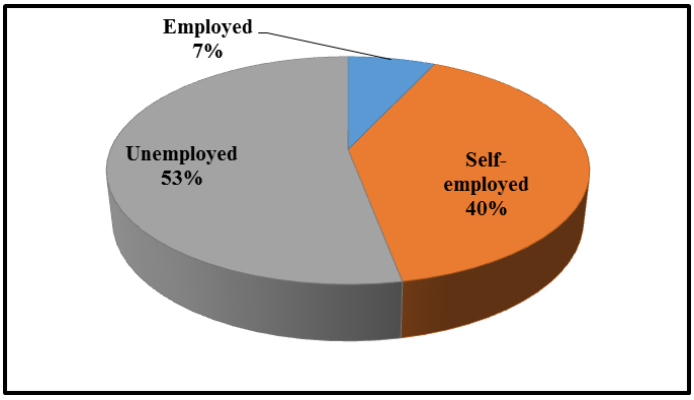

Figure 4. 40: Respondents occupation in Lake Bogoria Landscape

Distribution of Respondents by Education Level

The level of education amongst community members influences their knowledge and attitude towards conservation. The respondents were asked to indicate their highest level of education attained in terms of primary, secondary and tertiary levels. It is noteworthy that 12% of the respondents had not attained any of these levels of education. It was found that majority of the respondents 38% attained primary level of education, 33% of the respondents had secondary level while only 17% of the respondents had attained tertiary level of education (Figure 4.43).

From the findings, 50% of the respondents have secondary school level of education and thus the potential to be sensitized on wildlife conservation strategies. It has been found that conservation sensitizations enhance environmental knowledge, attitudes and practices, as well as builds skills that prepare individuals and communities to collaboratively undertake positive environmental actions ((Ardoin *et al.*, 2020).

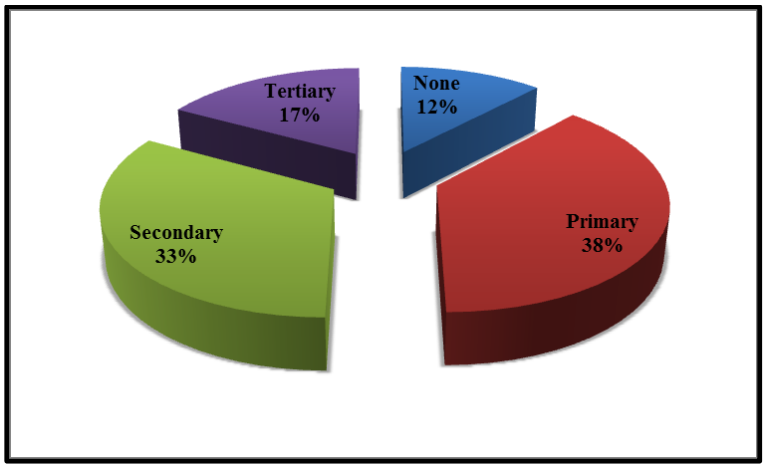

Figure 4. 41: Distribution of respondents by their level of education in Lake Bogoria Landscape

Distribution of Respondents by Nativity

The data of the respondents' nativity indicated that 98% those interviewed were born and grew up within the Lake Bogoria landscape with only 2% being immigrants as shown in Table 4.6.

Table 4. 6: Distribution of Respondents by Nativity in Lake Bogoria Landscape

Nativity	Frequency	Percentage
By Birth	134	98
Immigrant	3	2
Total	**137**	**100**

Distribution of Respondents by Amount of Monthly Income

In terms of monthly income, majority of the respondents (45%) earned an income of not more than KES 10,000 while only 5% were earning more than KES 20,000. The monthly income of respondents affects the willingness to pay for conservation of Greater Kudu. Findings are shown in Figure 4.44.

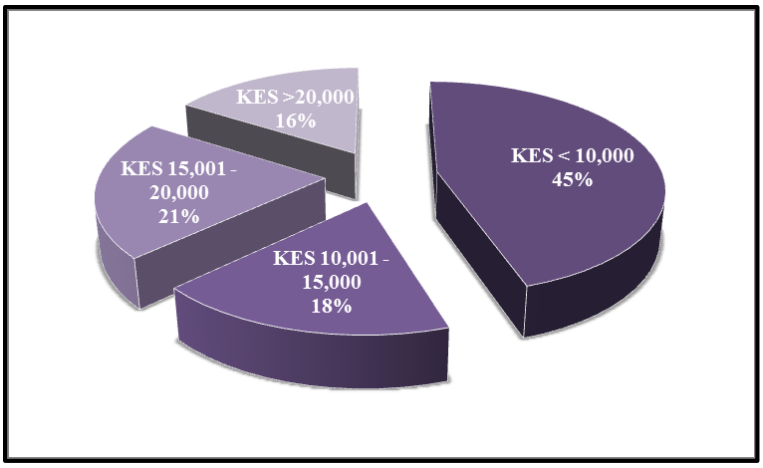

Figure 4. 42: Distribution of Respondents as per the amount of monthly income in Lake Bogoria Landscape

Distribution of Economic Activities for Respondents

The household sources of livelihoods in the landscape were assessed. It was noted that 47% of the respondents practiced crop farming as their main economic activity. The same proportion of respondents was keeping livestock while only 3(2%) of the respondents were bee keepers. The economic activity of the respondents is important is assessing the possible natural resource based conflicts within and around the landscape due to competition over scarce resources for particularly water and pasture on community farms. Findings are shown in Table 4.7.

Table 4. 7: Economic Activities for Respondents in Lake Bogoria Landscape

Economic Activity	Frequency	Percentage
Crop farming	64	47
Livestock keeping	65	47
Apiculture	5	4
Others	3	2
Total	**137**	**100**

Respondents' Size of Households

The household size of the respondents was assessed. It was noted that majority of the respondents (48%) came from households of between 5 and 10 as shown in Figure 4.45 while (8%) of the respondents were from household size of more than 10 members. Further, 92% of the households interviewed had school going children (Table 4.8). Smaller human populations are necessary to preserve biodiversity in both less developed and more developed parts of the world

(Cafaro *et al.*, 2022). Household size has been identified to directly relate with per capita environmental impacts, in particular with per capita direct/indirect energy consumption and carbon emissions (Underwood & Zahran, 2015). As per the findings in the study, 56% of the households have large families of more than 5 posing more environmental impacts on the landscape.

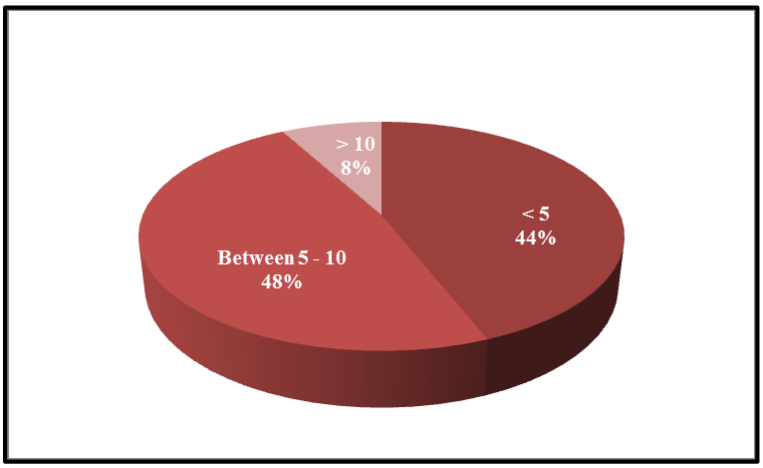

Figure 4. 43: Distribution of Respondents as per the size of household in Lake Bogoria Landscape

Table 4. 8: Household with Children in School in Lake Bogoria Landscape

Children in School	Frequency	Percentage
Yes	126	92
No	11	8
Total	**137**	**100**

Distribution of Respondents by Land Ownership and Size

Conservation interventions affect and are affected by land tenure security. Those with land ownership and work on the landscape are the ones making conservation decisions. The land tenure security in the study was assessed by asking the respondents if they legally owned the land they are occupying. It was found that majority of the respondents 92% were land owners (Table 4.9) hence could influence conservation decisions which is important for Greater Kudu sustainability in the study area. Although 52% of those owning land have no title deed (Table 4.10), it was found that 69% of the land owners have more than 1 acre of land with 27% owning more than 5 acres' piece of land (Figure 4.46). Such respondents' decisions influence development of Greater Kudu conservation policies and implementation of its activities.

Table 4. 9: Distribution of Respondents in terms of land ownership in Lake Bogoria Landscape

Land Ownership	Frequency	Percentage
Yes	126	92
No	11	8
Total	**137**	**100.0**

Table 4. 10: Distribution of Respondents in terms of Land Title in Lake Bogoria Landscape

Land Title	Frequency	Percentage
Yes	66	48
No	71	52
Total	**20**	**100**

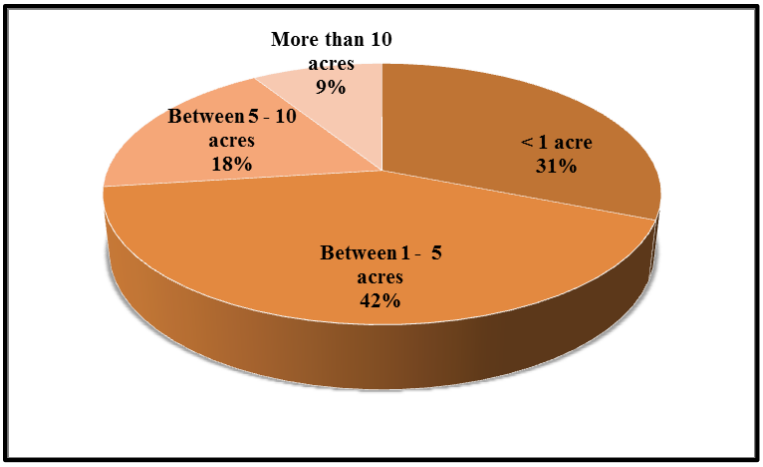

Figure 4. 44: Distribution of Respondents as per the size of land owned in Lake Bogoria Landscape

Respondents' Access to Social Facilities

It was observed that one main challenges of Greater Kudu conservation in the study area is revenue sharing. It is implied that those with more than two (2) social facilities were subjectively considered to have a better quality of life compared to those with less than 2 facilities and are more exposed to information related to basic social protections such as protection of human and civil rights, channels to participate meaningfully in decision making, and rights to land and benefits of resource conservation.

The social facilities considered in this study included those for recreation; social networking and cultural activities and were listed as: electricity, piped water, permanent house

structure, semi-permanent house structure, radio, mobile phone, credit (loan), car and computer/laptop. From the findings, 69% of the respondents accessed more than 2 social facilities (Figure 4.47) such as permanent/semi-permanent house, mobile phone, computer/laptop, credit (loan), electricity, radio, car and piped water. The results indicate that 31% of the local resource users are socially disadvantaged when it comes to making informed conservation decisions. This may negate development and implementation of all-inclusive Kudu conservations policies and frameworks.

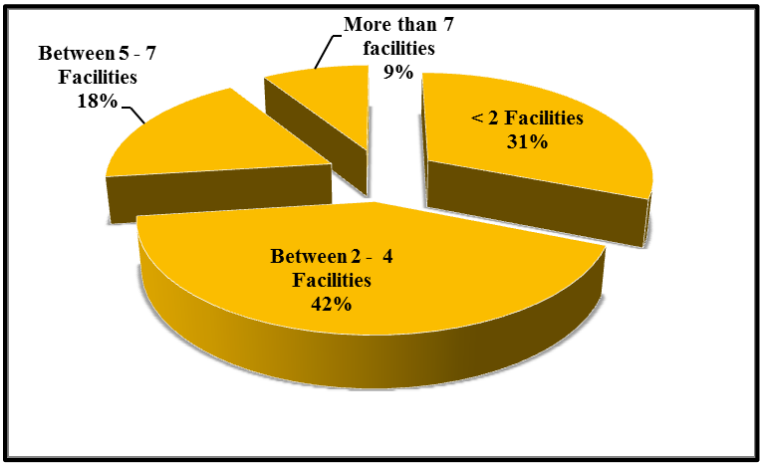

Figure 4. 45: Distribution of Respondents as per social facilities owned in Lake Bogoria Landscape

Membership in Conservancy Groups

The conservancy groups benefit from conservationist's technical support and training and incentives for conservation activities carried out. The conservancies apart from employment opportunities to the local resource users create awareness in the community and expose local resource users to sustainable ways of utilizing natural resources. These contribute to inclusivity in developing conservation policies and decision making. Sterling examples of successful conservancies are those of Living in a Finite Environment (LIFE) in Namibia and the Northern Rangelands Trust (NRT) in Kenya where the rights and responsibilities of managing wildlife and land onto local communities to improve on incentives for conservation.

A number of conservancies have been initiated in the study area and the respondents were assessed on their membership status to a conservation group. From the survey, it was found that 61% of the respondents (Table 4.11) belong to at least one conservation group; the conservancy groups in the study area included Pasture Production Establishment Groups (Lake Bogoria

Sossiche, Lokasacha, and Maji Moto Women Group), Smart Agriculture Groups (Sossion Women Group and Endorois Women Group) Wildlife Conservancies Irong Community Conservancy, Kiborgoch Conservancy, Chuine Wildlife Conservancy and Friends of Nature Bogoria. This show that a significant proportion of the population in the study area have limited access to matters Kudu conservation.

Table 4. 11: Respondents' Membership to Conservancy Group in Lake Bogoria Landscape

Conservation Group	Frequency	Percentage
Yes	84	61
No	53	39
Total	**137**	**100**

4.4.2 Descriptive KAP Findings

The study sought to find out the effect of knowledge, attitude and practices (KAP) of local resource users towards Greater Kudu conservation in the landscape and the responses are as detailed in Appendix 7.5. This section highlights some of the key KAP of respondents by use of descriptive statistics. Responses on the study variables were assessed using a 5 Likert scale coded as 1:(strongly agree), 2:(agree), 3:(undecided/neutral), 4:(disagree) and 5:(strongly disagree).

Knowledge Statements towards Conservation

Responses on knowledge statements towards conservation were assessed using a 5 Likert scale coded as 1: True (strongly agree), 2: True to some extent (agree), 3: Neutral/not sure whether True or False (undecided/neutral), 4: False to some extent (disagree) and 5: False (strongly disagree).

From the findings, 63% respondents strongly agreed and another 31% agreed that the natural environment of Lake Bogoria landscape has changed over time and 74% of them strongly agreed and 23% agreed that the amount of rainfall in Bogoria landscape has also changed over time. Further, 80% of the respondents strongly agreed and 15% agreed that air temperature has been on increase over the years. 84% of the respondents strongly agreed and 12% agreed that the landscape is a habitat for more than 8 wildlife species including 373 birds' species, Greater Kudu, impala, vervet monkey, dikdik, warthog, jackal and reptiles including monitor lizard, lizards, tortoise, crocodiles and various species of snakes. 23% strongly agreed and 20% agreed that the population of Greater Kudu has been reducing with time but 42% strongly agreed and 31% agreed

that extinction of Greater Kudu in Lake Bogoria landscape leads to poverty. It was noted that 39% of the respondents strongly agreed and 46% agreed that Greater Kudu conservation policies in the landscape are available. Lastly, 61% of the respondents also strongly agreed and 34% agreed that awareness creation and training of the local community is important for Greater Kudu conservation. Only 20% strongly agreed and 12% agreed that Kudu conservation is a preserve responsibility of the Government and not the local community.

The research findings showing percentages, resultant means and standard deviations of the knowledge statements are presented in Table 4.12. From the findings, the respondents largely demonstrated that they are knowledgeable on the importance of Greater Kudu to their livelihoods and that they have a role to play in its conservation as a community even as they wait on the government to do their part. However, the results also showed limited knowledge on Kudu population status with 43% of the respondents stating that Kudu population has been decreasing.

Table 4. 12: Descriptive statistics of knowledge statements towards Greater Kudu conservation in Lake Bogoria Landscape

Knowledge Statements	**Strongly Agree (%)**	**Agree (%)**	**Mean**	**Std. Deviation**	**N**
The natural environment of Lake Bogoria landscape has changed over time	63	31	1.47	0.718	137
The amount of rainfall pattern in Bogoria landscape has changed over time	74	23	1.31	0.615	137
Temperature in Bogoria landscape has been increasing over time	80	15	1.27	0.636	137
More than eight (8) wildlife species are found in the Lake Bogoria landscape	84	12	1.23	0.618	137
Population of Greater Kudu in Lake Bogoria landscape is decreasing	23	20	3.04	1.526	137
Human activities is threatening the existence of Greater Kudu in Lake Bogoria landscape	28	42	2.39	1.358	137
Extinction of Greater Kudu in Lake Bogoria landscape leads to poverty	42	31	2.23	1.467	137

Knowledge Statements	Strongly Agree (%)	Agree (%)	Mean	Std. Deviation	N
Greater Kudu conservation policies in Lake Bogoria landscape exists	39	46	1.98	1.303	137
Awareness creation and training of the local community is important in Greater Kudu conservation	61	34	1.47	0.687	137
Greater Kudu conservation is the responsibility of the Government not the local community	20	12	3.34	1.472	137

Attitude Statements towards Ecosystem Conservation

Responses on attitude statements towards conservation were assessed using a 5 Likert scale coded as 1: Highly positive attitude towards conservation (strongly agree), 2: Moderately positive attitude towards conservation (agree), 3: Neutral attitude towards conservation (undecided/neutral), 4: Moderately negative attitude towards conservation (disagree) and 5: Highly negative attitude towards conservation (strongly disagree).

The survey findings of the means and standard deviations of the attitude statements are presented in Table 4.13. It was found that some respondents demonstrated a positive attitude towards all conservation statements. Worth mentioning is that 77% of the respondents demonstrated a highly positive and 23% had a positive attitude towards both conservation of natural ecosystem as important in the community and 77% had a highly positive and 16% a positive attitude to dislike of people destroying the ecosystem. 74% of the respondents showed highly positive and 24% a positive attitude towards the ban of wildlife poaching in LBNGR. Additionally, 65% of the respondents had highly positive and 34% a positive attitude to support Greater Kudu protection and conservation activities while 66% of them demonstrated highly positive and 33% a positive attitude that everybody, young and old, should be engaged in Greater Kudu conservation practices. On the other hand, only 25% of the respondents had highly positive and 36 % a positive attitude in considering Greater Kudu population stable.

From the findings, the respondents largely demonstrated a positive attitude towards Kudu conservation statements. 99% of the respondents indicated that conservation of the natural ecosystem will contribute to Kudu sustainability and this was further emphasized by 93% of the

respondents disliking those destroying the natural ecosystem. It is also important to note that actual status of Kudu numbers in LBNGR is well known as only 61% of the respondents positively thought that its population is stable.

Table 4. 13: Descriptive statistics of attitude statements towards Greater Kudu conservation in Lake Bogoria Landscape

Attitude Statements	Strongly Agree (%)	Agree (%)	Mean	Std. Deviation	N
I consider conservation of natural ecosystem very important in our community at this time.	77	23	1.26	0.529	137
I believe in the LBNGR Integrated Management Plan (IMP).	45	29	1.96	1.070	137
I do not like people who destroy natural ecosystem	77	16	1.40	0.927	137
I think water pollution is a major concern in our community	59	29	1.63	0.970	137
I believe poaching of wildlife should be banned in LBNGR.	74	24	1.31	0.639	137
I consider Greater Kudu population stable	25	36	2.47	1.255	137
I support Greater Kudu protection and conservation activities.	65	34	1.37	0.542	137
I think everybody, young and old, should engage in Greater Kudu conservation practices.	66	33	1.35	0.523	137
Community taboos and culture have contributed greatly to the conservation of the Greater Kudu.	37	39	2.09	1.191	137
Baringo County Government is very supportive of Greater Kudu conservation	37	37	2.11	1.186	137

Practice Statements towards Ecosystem Conservation

Responses on practice statements towards conservation were assessed using a 5 Likert scale coded as 1: 100% of the time (always), 2: 71- 99% of the time (often), 3: 35 -70% of the time (sometimes), 4: 1 – 34% of the time (rarely) and 5: 0% of the time (never).

The research findings showing the resultant means and standard deviations of the practice statements towards ecosystem conservation are presented in Table 4.14.

Table 4. 14: Descriptive Statistics of Practice Statements towards Ecosystem Conservation in Lake Bogoria Landscape

Practice Statements	Always (%)	Often (%)	Mean	Std. Deviation	N
I use charcoal in my cooking at home.	10	10	3.74	1.291	137
I use firewood in my cooking at home	93	3	1.12	0.535	137
I practice apiculture (bee keeping for honey)	53	14	2.12	1.462	137
I promote Greater Kudu Conservation for tourism.	64	23	1.51	0.787	137
I practice soil conservation in my farm.	52	26	1.80	1.001	137
I carry out activities that help maintain natural ecosystem	48	34	1.78	0.929	137
I participate in climate change mitigation and adaptation activities.	47	34	1.85	1.056	137
I support environmental conservation guidelines (e.g. no poaching, no dumping, no littering etc.).	68	27	1.38	0.608	137
I participate in voluntary activities to protect or conserve our ecosystem (e.g. cleaning, tree planting, etc.).	41	31	2.12	1.251	137
I read materials on environmental conservation and protection.	22	32	2.62	1.324	137

From the findings, it was evident that only 10% of the respondents strongly always and another 10% often use charcoal for cooking in their homes while 93% of them always and 3% often use firewood for cooking. 64% of the respondents always and 23% often promoted Greater Kudu Conservation for tourism while 68% of them always and 27% often supported environmental conservation guidelines (e.g. no poaching, no dumping, no littering etc.). 53% of the respondents

always and 14 often practiced apiculture, 52% of the respondents always and 26% often carry out soil conservation activities in their farms like use of terraces, mulching and use of organic manure. It was also noted that 47% of the respondents always and 34% often participated in climate change mitigation and adaptation activities while 68% always and 27% often supported environmental conservation guidelines (e.g. no poaching, no dumping, no littering etc.). It was also noted that only 22% of the respondents always and 32% often read materials on ecosystem conservation.

Generally, the responses show that majority of local resource users are keen on practices they carry out with a view to promoting Kudu conservation. However, some respondents' practices did not promote sustainability. It is noteworthy that during the time of data collection, there was an ongoing campaign against charcoal burning in the study area hence the outcome of the use of charcoal may not depict the true picture. The number of respondents (54%) who read materials on ecosystem conservation implies that information on ecosystem conservation and protection is sometimes not easily accessible and/or retrievable.

4.4.3 Relationship between Background Information of Respondents and KAP

Local resource users play an important role in human-wildlife coexistence and biodiversity conservation. During the study, KAP survey of local resource users with varied background information in LBNGR was conducted to determine Human-Greater Kudu coexistence within and/or without the protected areas. A Chi-square test was conducted to evaluate independence of whether background information of respondents is related or not related to their respective KAP.

Association between Respondents' Geographical Location and KAP Statements

It was found that respondents' statement on whether the population of Greater Kudu had decreased in the landscape differed significantly (X^2 = 58.1, p = 0.000) depending on their geographical locations with 63% of those from Koibos sub-location (eastern side of the study area) accepting the null hypothesis that Greater Kudu population has not decreased over time compared to 40% of those from Sandai location (western side of the study area). Additionally, the respondents differed significantly on whether human activities posed a threat to the existence of Greater Kudu (X^2 = 33.7, p = 0.028) with 92% of the respondents from Kapkuikui sub-location (western side of the study area) agreeing that human activities posed a threat to the existence of Greater Kudu as compared to 54% of the respondents from Koibos sub-location (eastern side of the study area) having the same opinion.

Although it was generally agreed that extinction of Greater Kudu in the landscape could lead to poverty, the percentage of respondents who agreed varied significantly depending on their geographical locations ($X^2 = 41.9$, $p = 0.003$). 94% of the respondents from Sinende sub-location (eastern side of the study area) rejected the null hypothesis that Greater Kudu does not lead poverty as compared with only 60% of the respondents from Loboi sub-location (western side of the study area). Generally, the number of respondents who are aware that Greater Kudu conservation policies were significantly different ($X^2 = 50.5$, $p = 0.002$) as 93% of the respondents from Sandai sub-location (western side of the study area) were aware of the policies while 70% of respondents from Sinende sub-location (eastern side of the study area) agreed on the same.

In a study to investigate the local people's KAP towards carnivore coexistence with humans in a human-dominated landscape of southern Ethiopia, it was found that respondents who had better knowledge of carnivores also showed a positive attitude towards carnivore's conservation (Gebo *et al.*, 2022). Similarly, in LBNGR study, most of the residents from the eastern side of the study area, who are mainly pastoralists, demonstrated more knowledge and positive attitude towards Greater Kudu conservation matters than those from western side where crop cultivation dominates.

Further, according to Oremo *et al.* (2019), it is known that geographical experiences influenced knowledge, attitude and practices in relation to water resource management. This relates with the findings that depicted significant variations in KAP of respondents' in the LBNGR depending on their geographical location. This indicates that respondents' awareness towards Kudu conservation may also relate to economic activities prevalent in their geographic location as well as the level of awareness on Kudu conservation in their respective locations. It also illustrates the variation of spread of matters Kudu conservation in the LBNGR.

From the study, it was evident that KAP of local resource users were varied significantly hence affect Kudu conservation in the Lake Bogoria landscape. To reduce the knowledge gap and foster a positive attitude towards Kudu conservation, there is need for creating awareness on Kudu conservation to evenly cover the entire landscape.

Association between Respondents' Gender and KAP Statements

From the KAP survey, it was found that more male (52%) than female (29%) of female respondents significantly agreed that Greater Kudu population in the landscape is decreasing ($X^2 = 17.8$, $p = 0.001$) and also majority males (79%) compared to 56% of females agreed that human

activities threaten the existence of Greater Kudu in the study area (X^2 = 13.4, p = 0.009). It was significantly different (X^2 = 12.7, p = 0.013) that 82% of male respondents compared to 60% of female counterparts believed in the LBNGR Integrated Management Plan (IMP) and 76% of male vis-a-vis 57% of female respondents practice bee keeping (X^2 = 11.2, p = 0.024). Additionally, more males (87%) than females (72%) participated in climate change mitigation and adaptation activities (X^2 = 110.1, p = 0.039; $P \leq 0.05$) and more male (59%) than female (47%) read materials on environmental conservation and protection (X^2 = 13.7, p = 0.008).

Due to the foregoing, it is shown that males had better knowledge of Greater Kudu conservation than females and the illiterates. Culturally, females in the study area are responsible for indoor activities such as children up-bringing and cooking, while males are responsible for outdoor activities such as farming and livestock rearing. Women play important role in managing natural resources like food and animal fodder, water, fuel wood and forests, landscaping and soil conservation both at the family and community level. However, in case of biodiversity loss, women and girls are the ones burdened most by the increased time required to obtain necessary resources such as water, fuel wood and medicinal plants, which reduces the time they can spend on income generating activities and education.

In Rwanda, land tenure reforms that improved land access for legally married women led to a significant increase in soil conservation investment by female-headed households (Ali *et al.*, 2014). Results of the KAP statements responses varied significantly among the six sub-locations and also based on gender. This shows that awareness creation on Kudu conservation is not evenly spread in the LBNGR. Awareness about Kudu conservation should be purposely raised to reduce locational and gender knowledge gap and foster a positive attitude towards conservation. Particularly, women ought to be targeted because of their critical roles as primary land managers and resource users and are affected more by biodiversity loss and gender-biased conservation activities.

Association between Respondents' Age and KAP Statements

The knowledge on whether or not rainfall pattern in the landscape has changed over the years varied significantly depending on the age of respondents (X^2 = 30.1, p = 0.003 where). 25% of respondents below 20 years of age were not sure while 100% of those aged > 50 years agreed that rainfall pattern have changed over time. Similarly, it was observed that (X^2 = 24.0, p = 0.021) whereas 25% of those below 20 years were not aware that the landscape is a home to more than

(8) wildlife species, those aged >50 years affirmed awareness of wildlife abundance in LBNGR. It was also found that all respondents below 20 years of age are aware of existence of Kudu conservation policies compared to 74% of the age bracket of 31 – 50 years ($X^2 = 32.0$, $p = 0.006$).

It was also assessed whether the respondents believed that LBNGR Integrated Management Plan (IMP) developed in 2007 is an important guide on conservation activities in the landscape. All respondents below 20 years of age had a highly positive attitude towards the Plan compared to 40% of those aged between 20 and 30 years ($X^2 = 29.6$, $p = 0.003$). It was also found that 75% of the youngest respondents highly negative attitude towards people who destroy natural ecosystem as compared to 98% of the respondents aged between 31 and 50 years ($X^2 = 22.1$, $p = 0.037$). Furthermore, 75% of the respondents <20 years of age depicted a highly positive attitude that water pollution is a major concern compared to 91% of respondents aged >50 years of age ($X^2 = 25.9$, $p = 0.011$).

In addition, all the respondents of age below 20 years and those of age between 31 and 50 years of age a highly positive attitude that poaching should be banned from the landscape and that they are commitment to support Greater Kudu protection and conservation activities while 5% of those >50 years had negative attitude on the same ($X^2 = 17.3$, $p = 0.044$). It was further noted that 50% of those aged below 20 years disagreed that community taboos and culture have contributed to conservation of the Greater Kudu while 86% of respondents aged > 50 years affirmed that community taboos and culture have contributed to conservation of the Greater Kudu ($X^2 = 32.6$, $p = 0.001$). Baringo County Government was considered supportive of Greater Kudu conservation by 50% of the respondents aged below 20 years compared to 96% of respondents aged > 50 years ($X^2 = 21.5$, $p = 0.044$).

In a sharp contrast all the respondents aged below 20 years use charcoal for cooking while none of those aged > 50 years of age uses charcoal for cooking ($X^2 = 37.7$, $p = 0.000$). In addition, only 50% of respondents aged < 20 carryout economic activities that help maintain natural ecosystem as compared to 91% of those aged > 50 years ($X^2 = 37.7$, $p = 0.000$). Correspondingly, 75% of respondents aged below 20 years participate in climate change mitigation and adaptation activities while 95% of respondents with age of more than 50 years do the same ($X^2 = 26.2$, $p = 0.010$).

On the contrary, all the respondents below 20 years of age do support environmental conservation guidelines (e.g. no poaching, no dumping, no littering etc.) as compared to 85% of

those between the age of 31 to 50 years (X^2 = 30.1, p = 0.000). It was also found that 85% of respondents aged > 50 years participate in voluntary activities to protect or conserve our ecosystem (e.g. cleaning, tree planting, etc.) while only 50% of those below 20 participate in voluntary activities (X^2 = 28.7, p = 0.004). From the findings above, some of the preferred practices of the respondents aged less than 20 years did not promote conservation for example, only 50% of this group could choose economic activities that promote environmental conservation as compared to 91% of those aged > 50 years.

Changes in rainfall and temperature patterns have been used by communities to describe climate change in their local context. Climate change poses threat to livelihoods of people irrespective of their age but the impacts is more severe on vulnerable groups like youth, women and children. However, from the findings above, the description of change in rainfall pattern varied significantly among the respondents of different age groups with 25% the youngest respondents not able to give their views. The changes in rainfall patterns may include more than normal rainfall, unpredictable onset of rainy season and/or less rainfall/drought during periods when rainfall is expected. It was also found that age of the respondents positively related with knowledge of abundance of wildlife species in the study area.

The findings confirm that long-term rainfall changes and wildlife abundance has been reliably observed by older age-groups usually for more than 40 years but formal means of passing down this wealth of information is lacking in LBNGR. Such observations constitute indigenous ecological knowledge which is critical in identifying localized climate change and associated mitigation measures for ecosystem sustainability. Indigenous ecological knowledge provides the foundation for participatory approaches ecosystem conservation that is both cost-effective and sustainable. Leonard *et al.* (2013) argue that traditional ecological knowledge plays a significant role in shaping the process and outcomes of adaptation to climate change. This is because it is deeply embedded within social, economic, and cultural systems, and has a direct influence on individuals' preferences, beliefs, daily practices, perceptions, and responses to climate change.

However, in most cases, this indigenous ecological knowledge is hardly documented for reference and/or has been particularly ignored in the Africa. The study findings indicate that the youth are more knowledgeable on formally trending conservation affairs but have limited indigenous ecological knowledge on Kudu conservation. This implies that the indigenous

ecological knowledge though critical in sustainable conservation of Greater Kudu in LBNGR is at risk.

It is imperative that diversity, equity and inclusion (DEI) be roped in Kudu conservation strategies to facilitate indigenous ecological knowledge in the study area. Deliberate and tailor-made programmes for youths geared towards conservation ought to be developed and implemented to bring on board the youth in Kudu conservation matters. UNDP is already championing A systematic transformation aimed at promoting inter-generational unity, addressing and eliminating disparities, and overcoming structural obstacles to effective young involvement in environmental affairs (*Tapping into the Power of Young People for Climate Action*, n.d.).

Association between Respondents' Land Tenure and KAP Statements

In this study, KAP of native respondents and immigrant respondents were assessed and association between respondents' land tenure and KAP statements tested using Chi-square. It was found that only 33% of immigrant respondents were aware of the existence of Greater Kudu conservation policies in the study area which was significantly different from that of 86% of native respondents ($X^2 = 12.1$, $p = 0.033$). Considering that 67% of respondents' immigrants to the landscape were not aware of existence of Greater Kudu conservation policies indicate that capacity building and sensitization programmes on Kudu conservation in LBNGR are not sufficient. A vibrant eco-tourism marketing programme should be established and handy pamphlets to be developed and given to visitors to let them know the richness of the landscape at a glance. This will even assist in marketing the Kudu as a tourist attraction and increase the revenue collection for the County Government of Baringo.

It was also significantly different that none of the immigrant respondents knew whether Baringo County Government is supportive of Greater Kudu conservation compared to 75% of the native respondents ($X^2 = 20.4$, $p = 0.000$). Similarly, it varied significantly that 97% of the native respondents always used firewood for cooking in their homes, compared to 68% of the immigrant respondents ($X^2 = 45.1$, $p = 0.000$). It was also found that 89% of native respondents committed to promote conservation of Greater Kudu for tourism while only 33% of the immigrant respondents ($X^2 = 12.7$, $p = 0.005$).

It is believed that to effectively engage local resource users and address both community and biodiversity conservation needs, it is important to understand the local perceptions of such programmes. This is because indigenous ecological knowledge is usually passed down from

generation to generation. From the findings above, the native respondents are more knowledgeable and demonstrated a highly positive attitude towards Greater Kudu conservation than the immigrant respondents. This agreed with the findings of Ibrahim *et al.* (2021), who found that local community has a higher attitude towards biodiversity conservation than visitors.

However, to highlight its relevance on Kudu conservation in LBNGR, indigenous ecological knowledge should be interlinked with scientific knowledge and documented to improve accessibility of this place-based knowledge that makes contribution to understanding Greater Kudu ecology in the landscape for sustainability and improved livelihoods. It was also noted that indigenous knowledge promoted effective Greater Kudu conservation.

Additionally, it was found that land ownership status of respondents significantly affected knowledge on whether the natural environment of Lake Bogoria landscape has changed over time (X^2 = 12.2, p = 0.016) with 73% of respondents not owning land accepting that the natural environment of the landscape has changed compared to 95% of the respondents who owned land. Land ownership status of respondents also significantly affected their knowledge on whether the rainfall pattern in the study area has changed over time (X^2 = 11.9, p = 0.018) with 97% of the respondents who own land agreeing that rainfall pattern has changed over time compared to 91% of respondents not owning land. The responses varied significantly on knowledge about Kudu population trends (X^2 = 8.4, p = 0.015) where 60% of land owners agreed that Greater Kudu population has decreased while all the respondents without land were either not sure or disagreed on the decreased number of Kudus.

There was also a significant difference (X^2 = 11.8, p = 0.003) on whether the respondents considered conservation of natural ecosystem important in the community. All the respondents owning land in the landscape had a positive attitude that conservation of the natural ecosystem was important vis-a-vis 91% of the respondents without land ownership. Furthermore, a significant difference in attitude of respondents was noted where 58% of the respondents of the land owners considered Greater Kudu population stable compared with 91% of respondents without land (X^2 = 10.7, p = 0.030).

Notably, it was significantly different that all land owner respondents demonstrated a positive attitude that everybody, young and old, should engage in Greater Kudu conservation practices as compared to 91% of those not owning land (91%) (X^2 = 12.3, p = 0.002). It was noted that use of charcoal, though not popular was significantly different (X^2 = 19.4, p = 0.001) with

46% of respondents who are not land owners using charcoal for cooking compared to only 17% of land owner respondents.

Land tenure policies, ineffective land use policies, and the consequent establishment of settlements in the savannah of East Africa were found to be impacting wildlife (Aduma *et al.*, 2018). De Vos and Cumming (2019) indicated that community co-management of protected areas is on the rise, and privately owned protected areas are being considered to meet conservation goals in a challenging economic environment. They noted that possess the capacity to enhance the resilience of protected area networks. This observation resonated with findings in the study in that land owner respondents are more knowledgeable with a positive attitude towards Greater Kudu conservation.

This is usually the case in communities that r ely on natural resources for their means of subsistence – they are more attentive to conservation of such resources. In addition, pastoral areas which were privately owned became important for populations of wild herbivores during the growing season in Lake Mburo National Park, Uganda, even with a significant presence of livestock (Rannestad *et al.,* 2006). This shows that land ownership provides an avenue for synergistic implementation of Greater Kudu conservation policies in LBNGR.

Association between Respondent's Monthly Income and KAP Statements

Monthly income of respondents significantly affected their knowledge on whether or not the natural environment of the landscape has changed over time ($X^2 = 24.0$, $p = 0.020$). All the respondents earning between KShs. 15,001 to 20,000 agreed that the natural environment has changed overtime as compared to 83% of the respondents earning between KShs. 10,001 to 15,000. A similar trend was observed for knowledge on the number of species inhabiting the landscape where all respondents earning monthly income of between KShs. 15,0001 to 20,000 agreed that more than 8 wildlife species are found within the study area while 92% of the respondents earning between KShs. 10,001 to 15,000 affirmed the same ($X^2 = 31.7$, $p = 0.002$).

It was noted that 82% of the respondents earning between KShs. 15,001 to 20,000 demonstrated a positive attitude towards the importance of LBNGR IMP as compared to 53% of the respondents earning between KShs. 10,001 to 15,000 ($X^2 = 31.5$, $p = 0.002$). Consistently, 96% of the respondents earning between KShs. 10,001 to 15,000 significantly varied from the other respondents (100%) who thought that everybody, young and old, should engage in Greater Kudu conservation practices ($X^2 = 20.6$, $p = 0.002$).

Moreover, a significant variation was noted on the use of charcoal to cook where only 13% of the respondents earning less than KShs. 10,000 accepted the practice compared to 29% of those earning between KShs. 10,001 to 15,000 ($X^2 = 21.7$, $p = 0.041$). Similarly, 37% of those earning between KShs. 10,001 to 15,000 agreed to be reading materials on environmental conservation and protection as compared with 77% of those earning more than KShs. 20,000 ($X^2 = 25.5$, $p = 0.013$).

As defined by Jiao *et al.* (2019), environmental revenue include subsistence and money earnings derived from environmental commodities, wages earned from activities based on natural resources, and direct payments received for environmental services. For this study, the income that was assessed is the total income of the respondent. The total revenue consists of three distinct categories: environmental income, agricultural income (derived from crop and livestock production), and non-farm income (including wages, business profits, remittances, pensions, and other sources of income) (Jiao *et al.,* 2019).

An inverse relationship between KAP statements towards Greater Kudu conservation and household monthly total income was evident. The respondents, who earned more than KShs. 15,000 which is the minimum wage in Kenya constituted 37% of all respondents interviewed and were more knowledgeable in Kudu conservation information and demonstrated a positive attitude towards Kudu conservation than those earning less than KShs. 15,000. This was a contrast of Buncag *et al.* (2020) observation that household income had an inverse proportionality with the respondents' willingness to pay for conservation of Marine Protected Areas in Lemery, Batangas, Philippines. This shows that their livelihoods depend more on the sustainability of Greater Kudu for revenue generation.

A study conducted by PBL Netherlands Environmental Assessment Agency *et al.* (2009) aimed to establish a theory regarding the correlation between biodiversity and poverty. The study concluded that there is typically a simultaneous decline in both poverty and biodiversity, resulting in a 'win-lose' scenario. A second concern is that excessive exploitation might result in a system breakdown, exacerbating poverty and further contributing to biodiversity loss, creating a detrimental outcome for all parties involved. The third finding indicates that it is possible to both alleviate poverty and preserve biodiversity, resulting in a mutually beneficial outcome, at a local level. The relationship between biodiversity and poverty is influenced by various factors, including population density and growth, ecological vulnerability to degradation, governance, and policies

related to poverty reduction and biodiversity conservation. 73% of the respondents were earning less than 15,000, the minimum wage recommended in Kenya indicating that they are more vulnerable to fall below poverty line.

Association between Respondents' Economic Activity and KAP Statements

It is known conservation initiatives that offer both environmental and economic advantages can motivate commitment to conservation, regardless of the gender of the individuals leading them. From the study, knowledge of the respondents varied significantly based on their main economic activity with 26% of the crops famers agreeing that Greater Kudu's population in the landscape has decreased compared with 60% of the livestock famers ($X^2 = 24.0$, $p = 0.020$). Furthermore, 80% of the respondents practicing livestock keeping agreed that extinction of Greater Kudu in Lake Bogoria landscape leads to poverty as opposed to 67% of the respondents doing crop farming ($X^2 = 23.1$, $p = 0.027$). This indicates that Kudu conservation is more beneficial than any other economic activity in the study area. It was also found that 97% of respondents of crop farmers always used firewood for cooking compared to 80% of bee keeping respondents ($X^2 = 54.0$, $p = 0.000$).

The primary economic activity within the focus area are crop farming, rearing of animals, beekeeping, and the collection of forest products. Human population pressure, the urbanization of East African savannahs and the transition of semi-nomadic pastoralists to settled communities are having a negative influence on wildlife (Aduma *et al.*, 2018). It is understood that patterns of human activities influence the habitats that plants and animals need to survive. A wide range of human activities, including as altering land use, increasing vehicular traffic on roads, and extracting resources, have resulted in the relocation, reduced adaptability, and extinction of plant and animal species worldwide. These activities persistently endanger populations (Lewis *et al.*, 2021). Therefore, ecosystem management suggestions can be provided to improve the protection of habitats and ecosystems that support delicate and diverse forms of life, both in terms of space and time.

From the findings above, responses differed depending on which socio-economic activity the respondent is engaged in. Those practicing crop farming appear to show less concern on the status of Kudu conservation in LBNGR. This could be attributed negative attitude due to human-wildlife conflicts where Kudus sometimes stray and feed on their crops. According to Mekonen (2020), human–wildlife conflicts have negative impacts on both human and wildlife. It is therefore

important to create awareness and training of the local resource users on possible conservation measures to ensure peaceful co-existence between human and Greater Kudu and formulate rules and regulations to be implemented by the community including equal revenue sharing and reduction of human settlement encroachment into LBNGR.

Association between Respondents' Household Size and KAP Statements

The household size (i.e. the number of occupants of a household) of respondents significantly affected their attitude towards people who destroy natural ecosystem ($X^2 = 18.6$, $p = 0.017$). 73% of the respondents from households of more than 10 do not like people who destroys ecosystem compared to 95% of respondents from households of between 5 and 10 people. It was also noted that 91% of respondents from households of more than 10 people significantly differed ($X^2 = 15.0$, $p = 0.020$) in support of environmental conservation guidelines (e.g. no poaching, no dumping, no littering etc.) as compared to 98% of respondents from households of less than 5 people.

According to Liu *et al.* (2003), household dynamics influenced per capita consumption and thus biodiversity through, consumption of wood for fuel, habitat alteration for home building and associated economic activities and greenhouse gas emissions. Increase in household numbers resulted in higher per capita resource consumption. This will affect the attitude of respective local resource users. From the findings above, it evident that the larger the household sizes tend to have a negative attitude towards Kudu conservation. Such households in rural areas like LBNGR often have limited access to wide resource base rendering them more vulnerable to ecological impacts because of dire need for basic needs. To cushion them, it is important to suggest alternative resource base to avoid over reliance of the natural resources which may lead to overexploitation.

Association between Respondents' Membership to Conservation Group and KAP Statements

To understand the commitment and exposure of respondents to conservation practices, membership to a conservation group was assessed. The responses varied significantly with 4% of non-members to a conservation group being unaware of changes in rainfall pattern in the landscape while all respondents who are members of a conservation group knew that rainfall has changed over time ($X^2 = 10.2$, $p = 0.038$). Likewise, responses varied significantly ($X^2 = 11.9$, $p = 0.018$) on whether or not human activities threaten existence of Greater Kudu in LBNGR. 68% of respondents who are members to conservation group agreed that human activities do threaten

existence of Greater Kudu in the landscape as compared to 28% of non-members to a conservation group.

For the responses on the importance of LBNGR Integrated Management Plan, 79% of the respondents belonging to a conservation group believed in the Plan while 67% of non-members did not believe that the Plan is an important tool for conservation. These responses were significantly different ($X^2 = 10.3$, $p = 0.036$). A similar trend was observed on whether respondents believed that poaching of wildlife should be banned in LBNGR where all the respondents belonging to a conservation group significantly ($X^2 = 20.8$, $p = 0.000$) agreed that poaching should be banned while 6% of the respondents who do not belong to any conservation group disagreed. Additionally, it was found that 66% of respondents belonging to a conservation group considered Greater Kudu population to be stable in the study area as compared with 47% of respondents not belonging to any conservation group ($X^2 = 10.9$, $p = 0.028$).

Further, the attitude of respondents on whether community taboos and culture contributed to conservation of the Greater Kudu also varied significantly depending on whether the respondents belonged to a conservation group or not ($X^2 = 22.4$, $p = 0.000$). While 87% of respondents who were members of a conservation group demonstrated a positive attitude that community taboos and culture have contributed to the conservation of the Greater Kudu compared to 60% of respondents not belonging to any conservation group affirmed the statement.

The respondents' attitude towards Kudu conservation support received from the County Government was also assessed. It was found that responses differed significantly among the respondents ($X^2 = 18.7$, $p = 0.001$) with all the respondents demonstrated a negative attitude towards Baringo County Government support on Greater Kudu conservation where 60% of non-members to conservation group respondents disagreed as compared to 82% of respondents who are members to a conservation group.

It was also found that it varied significantly that 13% of the respondents belonging to a conservation group used charcoal for cooking as compared to 28% of the respondents who did not belong to a conservation group ($X^2 = 15.1$, $p = 0.005$). Soil conservation practices was also assessed and it was found that respondents who are members of conservation groups are keen on sustainable farming practices with only 13% of the respondents not practicing soil conservation on their farms compared to 33% of the respondents who did not belong to a conservation group ($X^2 = 13.1$, $p = 0.011$). Further, 77% of respondents who do not belong to a conservation group

carried out activities that help maintain natural ecosystem while 86% of the respondents who are members to conservation did the same, this variation was significant ($X^2 = 12.5$, $p = 0.014$).

Likewise, it was also significantly different that 74% of respondents who do not belong to conservation group participated in climate change mitigation and adaptation activities in the landscape as compared to 86% of respondents who are members to conservation group ($X^2 = 11.3$, $p = 0.023$). Although 82% of respondents who were members of conservation group participated in voluntary activities to conserve our ecosystem (e.g. cleaning, tree planting, etc.) it was significantly different that only 57% of the non- members of conservation group participated ($X^2 = 16.7$, $p = 0.002$).

Furthermore, 40% of non-members to conservation group disagreed that Baringo County Government is supportive to Greater Kudu conservation while 82% of members to a conservation group were of a contrary opinion. This indicates that the governance of conservation activities in the landscape is not clearly understood by the non-members to conservation group. More capacity building initiatives on existing conservancies should be regularly organized and a needs assessment be carried out in a view of establishing more conservancies, and mobilize the residents to join them.

It has been found that Community participation is important in effective biodiversity conservation (Seak *et al.,* 2019) and that conservancies provide a platform for collaborative ecosystem conservation among the stakeholders. From the study findings, it was evident that conservation groups do influence KAP of local resource users on Kudu conservation activities. It was found that respondents' KAP on Greater Kudu depended on whether the respondent belonged to a conservancy group or not. Generally, the respondents who are members of community conservancies were more knowledgeable with a positive attitude towards Kudu conservation that also influenced their conservation practices.

The critical role played by these conservancies cannot be over emphasized as it equips local resource users to become stewards of their own environment. The effectiveness of these conservancies greatly depends on the local context in which it operates, in particular, governance capacities; resource conditions; and local societies (Brunkhorst, 2010). Baringo County is responsible for revenue collection from tourism in the County including those from LBNGR and allocates for expenditure. The findings indicate that County Government is expected to up the game of leading in the forefront in Kudu conservation matters especially is evidence by KAP the

local resource users who are members to a conservancy group(s). The County Government should consider enhanced incentives for locals who strive to ensure ecosystem sustainability as a motivation for joining conservancies. In conclusion, the null hypothesis that knowledge, attitude and practice did not affect the conservation of the Greater Kudu in Lake Bogoria landscape is rejected.

4.4.4 Key Informants Report

This section summarizes key Greater Kudu conservation priorities as presented by purposively selected Key Informants considered knowledgeable by virtue of their position, responsibilities and experience in management and running of the landscape and conservation activities. Key Informant (KI) Survey Questionnaire was administered to each KI individually and they were made to understand that their participation was voluntary.

From the survey, key issues presented were ranked in order of frequency as mentioned by the respondents. The issues that were to be addressed included:

i. The importance of Greater Kudu in the study area
ii. The stability of the Kudu population
iii. The dominant land use/cover adjacent to Lake Bogoria landscape
iv. Activities that promote conservation of the Kudu
v. Activities that threatened the Kudu existence
vi. Impact of economic activities on the Kudu conservation
vii. Challenges to the Kudu conservation
viii. Solutions to challenges affecting the Kudu conservation.

Twenty-two (22) KIs were interviewed thirteen of which were coordinators of conservation activities in the study area while 4 of them were government administrators. The rest of the interviewees were technocrats in Greater Kudu conservation. 68% of the respondents had lived/worked in LBNGR landscape for >40 years and gained substantial experience in matters Kudu conservation. Plate 4.1 shows researchers posing with some of Key Informants during an interview session at Lake Bogoria Trading Centre.

Plate 4. 1: Researchers with some of the Key Informants during an interview session at Lake Bogoria Trading Centre (Photo Courtesy of Patrick Kurere, 2022)

From the KI survey (Figure 4.49) it was found that all informants affirmed that Greater Kudu is very important to livelihoods of the community in the study area. They also agreed that Greater Kudu population has been increasing in the recent past due to efforts put in place by the Government and conservation partners to ensure that community conservancies are operational and functional. This has been achieved partly by the establishment of conservancy croups in the landscape. These conservancy groups - herein referred to as conservancies creates an avenue of raising awareness in the community and exposing local resource users to sustainable ways of utilizing natural resources.

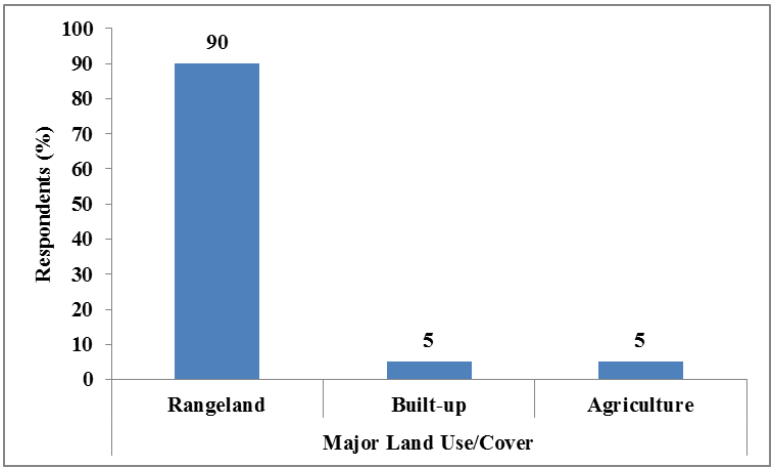

Figure 4. 46: Dominant land use/cover in Lake Bogoria Landscape

Rangelands type of land cover was prioritized as the most dominant in the landscape by 90% of the informants (Figure 4.48). The rangelands include grasslands, shrublands, woodlands, wetlands, and savannas that are suitable for Greater Kudu and the reason why Kudus are endemic

to LBNGR. However, based on LULC map of the year 2020 (Table 4.2), the rangelands have been decreasing while agricultural and built-up areas increased. This implies that the human economic activities continue to encroach on the Kudu preferred habitats.

Human activities cause environmental pressures in terms of pollution, overexploitation of natural resources and land use/cover changes. The environmental impacts resulting from such pressures is dependent on the level of such human activities and the technology applied during implementation of such activities. It is therefore important to be deliberate in ensuring that such human activities are implemented in a sustainable way to minimize land use/cover changes so that rangelands, the Kudu endemic ecosystem is prioritized in conservation as one way of reducing threats to Greater Kudu existence.

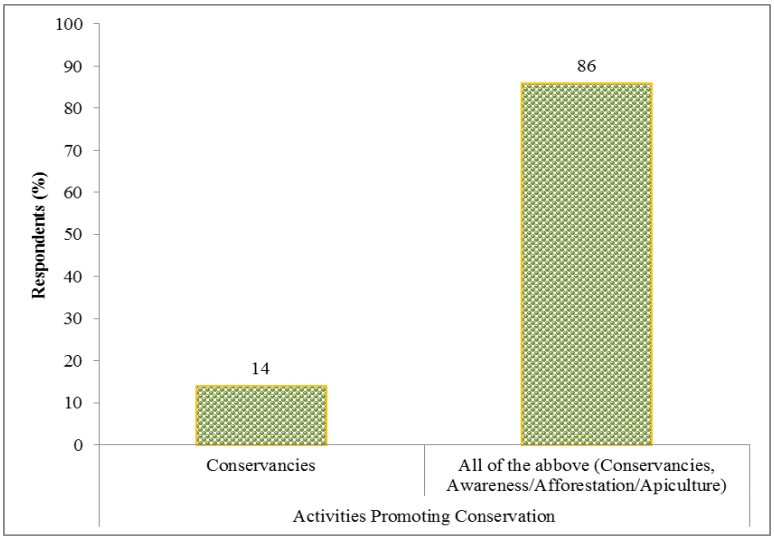

Figure 4. 47: Activities promoting conservation in Lake Bogoria Landscape

The Key Informants also gave their views on the existing conservation strategies in the LBNGR. As shown in Figure 4.49, 86% of the informants agreed that none of the conservation strategies is superior to the other instead they complement each other in ensuring sustainability is attained. This finding is in line with our conceptual framework which integrates all the elements affecting the state of environment with the socioeconomic aspects when deriving relevant policies as a response to Greater Kudu conservation in the study area.

This finding also supports development of all-inclusive rangeland management decisions/policies to address socio-ecological matters of Greater Kudu conservation in the landscape. These decisions/policies must have a more balanced socio-ecological perspective that ensure net gain in the interaction of natural resources use between humans and the Kudu. Such

decisions/policies should aim at supporting the functionality and productivity of LBNGR rangeland ecosystems and their ability to sustainably provide Kudu thriving environment as well as addressing needs of local resource users.

Furthermore, KI responses on threats to Greater Kudu existence in Lake Bogoria landscape were sought. From the findings, 77% of the Key Informants confirmed that human economic activities are the main threats to Greater Kudu existence with only 9% mentioning hunting (Figure 4.50). As mentioned earlier, main economic activities in the study area are crop farming, livestock keeping, beekeeping, and the collection of forest products. The major infrastructural development in the study area is an all-weather road mainly accessing the LBNGR. The agricultural related economic activities are important in addressing food security and nutrition for the livelihoods of local resource users.

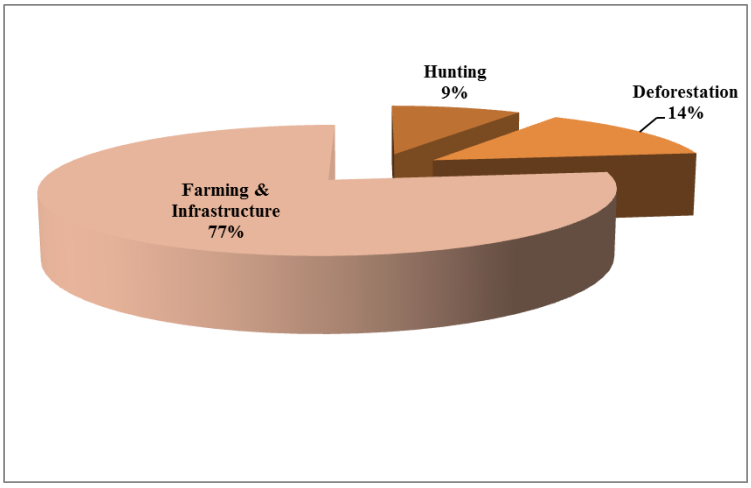

Figure 4. 48: KI responses on threats to existence of Greater Kudu in Lake Bogoria Landscape

It is therefore important to consider sustainability of the economic activities in the landscape to ensure conservation of the Kudu as well success of economic activities of the local resource users. To ensure sustainability of the LBNGR ecosystem practices such as agroforestry through the integration of indigenous trees producing marketable timber and non-timber forest products, soil conservation measures, water harvesting and water use efficiency techniques, controlled livestock grazing and improved land tenure systems. The Kudu dispersal corridors should also be mapped and conserved to ensure that their watering points and breeding areas are preserved. The County Government of Baringo should also enhance benefits paid to local resource users from revenue collected from Greater Kudu related tourism as an incentive for conservation.

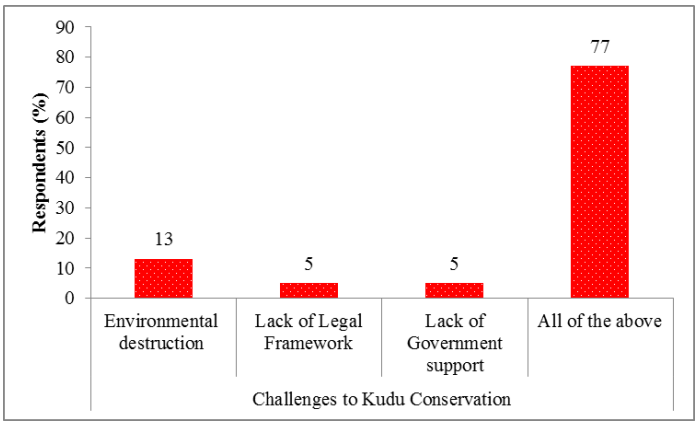

Figure 4. 49: Responses on Challenges to Kudu Conservation in Lake Bogoria Landscape

Although 13% of the respondents (believed that environmental destruction is the main challenge towards Kudu conservation, most of the Key Informants (77%) were of the opinion that the challenges are multipronged (Figure 4.51). A legal framework exists on wildlife conservation and related challenges under KWS, but it is not tailor-made to effectively carryout conservation activities specific to LBNGR.

This indicates that the lack of government support according to the respondents was that the government is only keen on revenue collection from tourism and that the 10% of the revenue collected received by the local resource users is not enough. The Greater Kudu conservation activities including compensation of crop farmers due to Kudu grazing on their crops or deliberate expansion of production of Kudu's forage and watering points is lacking yet this incentive will address environmental concerns due to economic activities. Establishing Greater Kudu conservation areas and continuous exposure of Kudu conservation information to the local resource users are key strategies that the respondents pointed out as important in overcoming the challenges above.

4.4.5 Focus Group Discussion Report

Three FGDs were conducted during the study period to assess their knowledge, attitude and practice towards Greater Kudu conservation. The participants were purposely selected based on knowledge by virtue of their positions, responsibilities and experience in the management and running of the landscape and conservation activities (Plate 4.2). The first FGD was attended by members from Chuine, Kiborgoch and Irong Conservancies. The second FGD was attended by members of Smart Agriculture and Irrigation women groups. The third FGD was attended by

members of pasture production groups. A total of 24 participants attended the discussions. The key findings are as outlined below:

Greater Kudu population has been increasing because of expansive awareness creation by conservation partners in the recent past. This has empowered the community to protect Kudus even when they stray to their farms because they know the benefit of its conservation.

Plate 4. 2: Photo taken during one of the FGDs meeting in Lake Bogoria (Photo Courtesy of Patrick Kurere, 2022)

Status of human wildlife conflicts in LBNGR landscape in relation to Greater Kudu: Greater Kudu is important to the livelihoods of communities in Lake Bogoria landscape. Occasionally, incidences of Kudus trespassing to feed on farmers' crops especially during dry seasons have been reported. However, the Government is not swift in compensating farmers who sometimes lose their crops when Kudus trespass.

Major land use types mentioned: farmlands, wetlands, rangelands, grasslands, acacia forest, water bodies, shrines, salt lick areas, conservancies, grazing areas, lodges and settlement areas.

Activities inside and outside the protected area that promote Greater Kudus conservation: Apiculture, taboos and culture where only the most mature horn of Kudu is used in sacred rituals, establishment of monitoring transect lines, revenue sharing for bursaries.

Threats of Greater Kudus: The threats outlined during FGDs included poaching, human population creates pressure on land, scarcity of potable water, Kudu habitat/corridors destruction, pests and diseases (ticks and related diseases), extreme weather conditions, culture/indigenous

knowledge erosion, encroachment to conservation areas and lack of awareness on Kudu conservation.

4.4.6 Strategies to reduce the impact of the activities that threaten Greater Kudu in the Lake Bogoria landscape:

Ensure Kudu corridors are identified and preserved to reduce human-wildlife conflicts: Ojwang et.al. (2017) noted that securing dispersal areas and migratory corridors is one of the effective interventions promoting wildlife conservation as it curbs human-wildlife conflicts. Mechanisms that provide measurable benefits to communities in Lake Bogoria landscape including wildlife-based enterprises and infrastructure development will promote wildlife user rights. Further, it is important to clarify compensation mechanisms for the management Greater Kudu of any designated critically endangered, endangered, vulnerable, or near threatened wildlife species or their habitats negatively impacts lives and livelihoods.

Need to increase Kudu watering points and introduce pasture production to substitute natural forage for Kudus: Provision of water and forage to Grevy zebras in northern Kenya saved them from massive die-off due to drought (Wildlife Research and Training Institute, 2022). FGD participants proposed that County government should consider increasing watering points and producing pasture for the Kudus in the landscape to minimize trespass to farms during dry spells in search of water and forage and reduce human wildlife conflicts.

Pest and disease management to be mainstreamed with Kudu conservation. Kudus are known to tolerate a tick load up to 5000 mature ticks per animal (Du Toit *et al.,* 2002; Tilahun, 2019). It has been noted that ticks are significant vectors that transmit bacterial, viral and protozoan pathogens to animals and humans (Ledwaba *et al.*, 2022). This becomes a risk to livestock farmers when Kudus mingle with their herds. It is proposed that pest and disease management subsidies to be readily availed to the communities in Lake Bogoria landscape to minimize losses due to ticks and related diseases.

Capacity building on participatory management: It has been noted that Baringo County's CIDP 2023-2027 emphasized on participatory rangeland management (PRM) as a strategy for rangeland conservation (Baringo County CIDP, 2023). In order to address challenges of gender, youth and people with disabilities, it is recommended that awareness creation mechanism for their inclusion in conservation be developed by the County Government of Baringo. This will encourage youth, women and people with disabilities to participate in

conservation of Greater Kudus and facilitate development of mechanisms for collaborative engagement between the County Governments and communities in Lake Bogoria landscape.

Periodic Kudu census/monitoring: Census establishes Kudu population sizes of the Kudu and ecological factors affecting the existence. Greater Kudu has been categorized vulnerable thus regular census/monitoring of the herbivore will facilitate proper planning, implementation and evaluation of conservation and management Programmes. It was recommended that the County Government of Baringo should have a budgetary allocation for Greater Kudu regular census for informed conservation and management policy decisions.

Revenue sharing policy to be reviewed to ensure more resources generated from Greater Kudu tourism is ploughed back for Kudu conservation: According to Kenya National Wildlife conservation and Management Policy of 2017, landowners/communities have the right to benefit from wildlife resources within their jurisdiction. FGD participants in Lake Bogoria landscape were of the opinion that the revenue received at community level was meager. Hence recommended that a strategy be developed by the County Government to tap benefits from the community professionals who benefited from Greater Kudu revenue bursaries. This can be achieved by organizing CSR activities towards Kudu conservation for them to participate and/or creating scholarship database.

The FGD findings reflected in-depth perceptions of local resource users' KAP towards Greater Kudu conservation as they were presented during KAP survey and KI interviews. The most important outcome of the FGDs was the strategies to reduce impacts of threats to Greater Kudu existence. The strategies proposed originated from the selected local resource users as ways of seeking local solutions using a participatory approach.

However, FGD findings due to limitation of the participants (there was no County representative in-attendance) were not able exhaustively give details on how revenue collected from tourism from LBNGR should be shared among relevant stakeholders because the policy documents on revenue sharing is domiciled in the County Government of Baringo in line with KWS regulations. Reforms on revenue sharing with a view of motivating local resource users to embrace sustainable use of natural resources are recommended.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of the Findings

This section summarizes all findings of the four objectives of the study. A general observation is that all null Hypotheses were rejected. It was evident that the integrated conceptual framework (Figure 2.4) of the study was relevant. As per the framework, all the factors affecting Greater Kudu were assessed and confirmed to be interrelated. The socioeconomic aspects which were evaluated using a cross-sectional survey were found to be affected by the physical environmental factors particularly temperature and rainfall. The socio-economic aspects on the other hand affected the land use/cover dynamics in the landscape consequently affecting Greater Kudu dispersal in the study area. Brief details are presented for each objective as indicated below.

5.1.1 Spatio-Temporal Change of Dispersal of Greater Kudu in Lake Bogoria Landscape

For year 2019, Greater Kudu dispersal map shows a density of between 10 and 40 Kudus/km^2 on the rangelands around Maji Moto and Koitumet wards. Greater Kudu dispersal map for the year 2020 shows a density of between 10 and 40 Kudus/km^2 in the leafy vegetation located in Maji Ndege and Chibirebei wards. The dispersal map for year 2022 shows dense population of Kudus (ranging between 40 and 50/km^2) near the shores of the Lake Bogoria in Koitumet sub-ward.

5.1.2 Impacts of Temperature and Rainfall Variability on Greater Kudu Population in Lake Bogoria Landscape

The findings indicate that Kudus thrive well in a warm environment – neither too hot nor too cold environment, and thus we conclude that temperature variability affects the population of greater kudu within Lake Bogoria landscape. Hence the null hypothesis that temperature variability did not affect the population of greater kudu within Lake Bogoria landscape in the last four years was rejected. Further, from this study, an increase of rainfall led to Kudu population decline thus the null hypothesis that rainfall variability did not affect the population of the greater kudu within Lake Bogoria landscape in the last four years was rejected.

5.1.3 Relationship between Land Use/Cover Change and Population of Greater Kudu in Lake Bogoria Landscape

The results of the image classification identified six major land use/cover including water, built-up areas, rangeland (grasses, grass-like plants, and grazing land), vegetation (forests), agriculture and barren land were presented. The results show that rangeland and barren land dominated the catchment with at 35% and 33% respectively while built-up areas, water and agriculture covered the least areas at 2%, 3% and 6% respectively in 1980. However, by the year 2020, rangeland and barren land decreased by 67% and 27% respectively while built-up areas, water and agriculture increased by 350%, 100%, 350% and 233% respectively.

Further, the results indicated that both built-up areas and agricultural land in LBNGR have evidently increased with a significantly negative correlation with rangeland (r = -0.935, df = 4, P = 0.019) and (r = -0.952, df = 4, P = 0.012). This trend corresponds to rising human population and subsequent economic activities in the study area.

5.1.4 Knowledge, Attitude and Practice of Local Resource Users towards Conservation of the Greater Kudu in Lake Bogoria Landscape

During the KAP survey, 60% respondents were male and female respondents were 40%, and majority of the respondents (65%) were aged between 31 to 50 years. In terms of their occupation, (7%) of the respondents were employed, while 53% were unemployed. It was also found that (12%) of the respondents were illiterate while 50% had attained secondary level of education and above. Only 2% of the respondents were immigrants to Lake Bogoria landscape. It was also found that 47% of the respondents were farming crops and a similar percentage of the respondents were keeping livestock as an economic activity. Only 4% of the respondents practiced apiculture.

From the knowledge statements towards Kudu conservation, 94% of the respondents agreed that the natural environment of Lake Bogoria landscape has changed over time while 43% agreed that the population of Greater Kudu decreased over the years. 70% of the respondents agreed that human activities threatened the existence of Greater Kudu in Lake Bogoria landscape while 73% agreed that extinction of Greater Kudu in Lake Bogoria landscape could lead to poverty. Lastly, 85% of the respondents agreed that Greater Kudu conservation policies exist in the landscape and 95% agreed that creating awareness and training of the local community is important in Greater Kudu conservation as an economic activity.

From the attitude statements towards Kudu conservation, it was found that 99% of the respondents demonstrated positive attitude towards conservation of the natural ecosystem with 72% believing that the LBNGR Integrated Management Plan (IMP) is an important conservation tool in the landscape. 99% of the respondents showed a positive attitude towards banning of wildlife poaching in LBNGR while 61% were positive in considering that Kudu population is stable in the landscape. It was also found that 99% showed a positive attitude towards Greater Kudu protection and conservation activities. Similarly, 99% of the respondents were positive that everybody, young and old, should engage in Greater Kudu conservation practices.

From the practice statements towards Kudu conservation, it was noted that 20% of the respondents use charcoal for cooking while 96% uses firewood. Although 67% of the respondents practice apiculture, 87% promote Greater Kudu Conservation for tourism. 78% of the respondents practice soil conservation in their farms while frequently carried out other 82% activities that enhance maintenance of natural ecosystem. It was also noted that 95% of the respondents support environmental conservation guidelines (e.g. no poaching, no dumping, no littering etc.).

Additionally, 90% of the KI respondents prioritized rangelands/natural ecosystem land cover as the most dominant in the landscape. It was noted that all respondents affirmed that Greater Kudu is key to livelihoods of the community in the study area and that Greater Kudu population has been increasing in the recent past due to efforts put in place by the Government and conservation partners to ensure that community conservancies are operational and functional.

During the FGDs, the activities identified inside and outside the LBNGR that promote Greater Kudus conservation include but not limited to: apiculture, taboos and culture where only the most mature horn of Kudu is used in sacred rituals, establishment of monitoring transect lines, revenue sharing for bursaries. On the other hand, activities identified inside and outside the protected areas that threaten Greater Kudus: poaching, human population creates pressure on land, scarcity of potable water, Kudu habitat/corridors destruction, pests and diseases, extreme weather conditions, culture erosion, encroachment to conservation areas and lack of awareness. The most important outcome of the FGDs was the strategies to reduce impacts of threats to Greater Kudu existence. The strategies proposed originated from the selected local resource users as ways of seeking local solutions using a participatory approach.

5.2 Conclusions

5.2.1 Spatio-Temporal Change of Dispersal of Greater Kudu in Lake Bogoria Landscape

From the findings, spatio-temporal changes of Greater Kudu population density dispersal were evident thus the null hypothesis that spatio-temporal distribution of dispersal areas of the Greater Kudu in Lake Bogoria landscape did not change in the last four years was rejected.

5.2.2 Impacts of Temperature and Rainfall Variability on Greater Kudu Population in Lake Bogoria Landscape

It was found that Kudus thrive well in a warm environment – neither too hot nor too cold environment. Hence the null hypothesis that temperature variability did not affect the population of Greater Kudu within Lake Bogoria landscape in the last four years was rejected.

It was also evident that rainfall (mm) has a negative effect on Greater Kudu population in the landscape though marginally significant. Thus the null hypothesis that rainfall variability did not affect the population of the Greater Kudu within Lake Bogoria landscape in the last four years was rejected.

5.2.3 Relationship between Land Use/Cover Change and Population of Greater Kudu in Lake Bogoria Landscape

LULC change in the study area was evidently characterized by the increase encroachment to rangelands for human settlements and agricultural activities thus reducing range size for Greater Kudu. Hence the null hypothesis that land use/cover change did not influence population of Greater Kudu in the study area in the last four years was rejected.

5.2.4 Knowledge, Attitude and Practice of Local Resource Users towards Conservation of Greater Kudu in Lake Bogoria Landscape

From the KAP survey, KI interviews and FGDS, it was evident that KAP of the local resource users affect sustainability of Greater Kudu. It was also noted that although conservation of the Kudu is more beneficial to majority of local resource users than any other economic activity in the landscape, regular census of Kudu population is not conducted. The null hypothesis that knowledge, attitude and practice did not affect the conservation of the Greater Kudu in Lake Bogoria landscape was rejected.

5.3 Recommendations

From the findings on spatio-temporal changes of Greater Kudu dispersal in LBNGR, it is recommended that Kudu corridors ought to be identified, mapped and preserved by monitoring of human activities within Greater Kudu dispersal corridors to curb encroachment. A consideration of having alternative corridors in strategic locations apart from the key dispersal corridors will promote connectivity in areas where human activities are practiced. This will ensure that human-wildlife co-existence is enhanced and human-wildlife conflicts controlled.

Owing to observed variability in temperature and rainfall, stakeholders involved in Kudu conservation are urged to embrace soil and water conservation measures geared towards enhancement of environmental security in the Lake Bogoria Landscape. It is also recommended that deliberate efforts by conservation agencies to create awareness on effects of climate change, and the necessary governance structures and financial support provided towards adoption of sustainable and affordable production technologies will improve livelihoods of the communities. Further, for purposes of enhanced conservation, continuous monitoring and awareness campaigns on the Greater Kudu and its dispersal in the landscape is recommended.

It was also observed that land use/cover change impacted on Greater Kudu dispersal mainly due to habitat alteration and destruction. It is recommended that biodiversity conservation policies on alteration and fragmentation LBNR be implemented as set out by the government legal framework on Protected Areas and where necessary review of such policies is necessary. This will curb future uncertainties on effects of land use/cover change on Greater Kudu dispersal and address human activities' encroachment to Kudu rangelands. Adaptive management and conservation of Greater Kudu should embrace continuous monitoring, and understanding its dispersal in LBNR and its environs. This will sustainably enhance livelihoods that directly and indirectly dependent on the Greater Kudu within Lake Bogoria Landscape.

From KAP survey findings, it is recommended that an all-inclusive adaptive management and conservation strategies should embrace continuous monitoring, and understanding dispersal of Greater Kudu to ensure its survival, in the lake Bogoria landscape and its environs. This will enhance and sustain livelihoods dependent on the existence of Greater Kudu in the study area.

Generally, extinction of Greater Kudu in the landscape can lead to poverty hence the local community are passionate in ensuring its sustainability for their improved livelihoods through

revenue generated from tourism. This will enhance and sustain livelihoods that are dependent on the GK within Lake Bogoria landscape.

5.4 Significance of the Study to Policy Actors and Scholarly Work

The research findings of the study are important to the State Department of Wildlife Research Training Institute, Kenya, County Government of Baringo, Kenya Wildlife Service, wildlife management professionals and ecologists, Universities, community (local resource users), Community Based Organizations (CBOs), conservancies' partners and all parties interested in wildlife conservation and management. The findings inform decision making and prioritization of Greater Kudu conservation strategies for all stakeholders for enhanced adaptive management in the study area.

5.5 Contribution to Scholarly Work in Comparison to Previous Studies

The influence of independent variables: climate (temperature, rainfall), land use/cover change and knowledge, attitude and practice (KAP) of local resource users on the dependent variables on the population and distribution of the Greater Kudu within Lake Bogoria landscape depicted an integrated wildlife management model which contribute knowledge that is important for adaptive wildlife management in Kenya.

The use of KAP analysis survey in the study was useful in integrating ecological and human dimensions of wildlife management in Kenya. KAP surveys are a focus of future wildlife adaptive management research and should be integrated into wildlife management programs. KAP findings affirm the stakeholder involvement in wildlife conservation is critical.

5.6 Recommendation for Further Research

Long-term regular monitoring of Greater Kudu population and dispersal dynamics is recommended for more precise spatio-temporal change analysis and informed decision making. It will also act as a precautionary measure to ensure Greater Kudu sustainability for posterity.

Payment for Ecosystem Services Programs (PES) in the Lake Bogoria National Game Reserve landscape have not been explored. Such PES may include ecotourism where local communities are paid not to hunt Kudus in rangelands where tourists go to view wildlife. Carbon credits under Clean Development Mechanisms (CDM) can also be considered to incentivize the local resource users to conserve wood/shrub lands constituting of Greater Kudu habitat. Research on carbon market opportunities is recommended.

Further research on sustainable energy systems in the landscape is also recommended. Local communities using charcoal for cooking fuel could see significant health benefits from switching to highly efficient coal stoves, natural gasified stoves, liquid petroleum gas stoves and renewables stoves such as solar.

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APPENDICES

Appendix A: Monthly weather data 1981-2021

		Maji Moto	Chebirebei	Maji Moto	Chebirebei	Maji Moto	Chebirebei
DATE	Month	Rainfall (mm)	Rainfall (mm)	Max Temp (°C)	Max Temp (°C)	Min Temp (°C)	Min Temp (°C)
1981	January	0	0.1	33.2	32.8	16.3	18.4
1981	February	11	9.1	33.6	33.2	17.2	19.4
1981	March	93.2	155.6	31.5	31.2	18.3	20.4
1981	April	125.7	151.5	29.5	29.2	17.8	19.6
1981	May	67	72.9	29.9	29.5	17	19.1
1981	June	26.4	34.5	31.1	30.9	16.5	18.5
1981	July	49.7	68.5	29.4	29.2	16.4	18.4
1981	August	44.1	43.9	28.8	28.5	16.2	18.1
1981	September	36.3	48.8	31.3	30.8	16.5	18.8
1981	October	38.5	38	32.4	31.6	16.6	19.1
1981	November	25.7	33.9	32.1	31.6	16.5	18.7
1981	December	8	4.1	32.3	32	16.7	19.1
1982	January	0.3	0.6	32.7	32.3	16.1	18.2
1982	February	6.7	3.4	33.9	33.5	16.9	19.1
1982	March	18.3	25.4	34.7	34.3	16.4	18.6
1982	April	150.2	158.8	30.6	30.3	17.9	19.8
1982	May	77.5	76	27.6	27.4	17.4	19.6
1982	June	35.5	38.8	29.1	29	15.6	17.8
1982	July	11.6	28.9	30	29.8	15.5	17.6
1982	August	116	112.3	28.7	28.4	15.9	17.9
1982	September	15.7	28.2	31.1	30.6	15.8	18.2
1982	October	98.7	96.4	30.7	30.1	16.6	19.2
1982	November	59.7	103.1	29	28.6	17.5	19.5

1982	December	25.1	30.2	31.3	31	16.8	19.2
1983	January	4	4.6	32.2	31.8	16.6	18.7
1983	February	17.6	31.7	33	32.6	18.4	20.6
1983	March	9.3	20.8	34.7	34.3	18.1	20.2
1983	April	87.4	89.2	33.4	33.1	18.2	20.2
1983	May	60.3	72.7	31.7	31.3	18	20.3
1983	June	9.9	25	30.6	30.5	17.2	19.3
1983	July	125.8	135.8	28.4	28.4	15.9	17.9
1983	August	115.7	154.1	27.6	27.5	16.4	18.4
1983	September	26.5	61.4	29	28.7	15.9	18.2
1983	October	118.2	127	29.2	28.7	16.8	19.4
1983	November	15.7	26.9	29.5	29.2	15.9	18.2
1983	December	14.8	27.1	30.9	30.7	16.7	19.1
1984	January	1.2	2.3	32.4	32	15	17.3
1984	February	0.3	0.4	33.7	33.3	14.7	17.2
1984	March	2.5	7.7	33.9	33.6	16.4	18.7
1984	April	18.7	17.7	33.1	32.7	17.2	19.2
1984	May	12.4	11.8	32.1	31.7	16.4	18.8
1984	June	31.6	35.3	29.8	29.8	15.5	17.8
1984	July	11.5	28.8	29.7	29.6	16.3	18.3
1984	August	5.3	15.3	30.8	30.5	16.1	18.2
1984	September	25	43.1	31.2	30.8	15.5	18
1984	October	17.4	29.6	29.8	29.2	16	18.7
1984	November	64.7	64.6	28.5	28.2	16.3	18.5
1984	December	42.2	47.7	30.8	30.6	16.3	18.7
1985	January	5.1	3.2	32.5	32.1	16.3	18.5
1985	February	36.6	39.5	32.5	32.1	17.5	19.7
1985	March	88.9	102.6	32.8	32.4	17.3	19.5
1985	April	156.4	191	29	28.8	17.5	19.4
1985	May	91.9	90.9	27.9	27.7	17.1	19.1

1985	June	73.2	86.5	28.1	28.1	15.8	17.9
1985	July	70.9	99.7	27.2	27.2	14.7	16.7
1985	August	56.2	65.8	28.4	28.1	14.9	16.9
1985	September	17.1	23	31.2	30.8	15.6	18
1985	October	10.2	16.7	31.4	30.7	15.9	18.6
1985	November	25.7	27.4	29.8	29.5	15.8	18
1985	December	2	2	31.9	31.7	15.9	18.4
1986	January	0.1	1	32.7	32.4	15.7	18
1986	February	0	0	33.5	33.2	15.6	18
1986	March	31	28.2	32.6	32.2	16.2	18.5
1986	April	138	145.9	30.7	30.5	17.4	19.3
1986	May	54.7	67.8	29.2	28.9	16.2	18.4
1986	June	133.3	146.4	27	27	16.4	18.6
1986	July	25.8	50	26.9	26.9	14.8	16.8
1986	August	77.5	70	28.5	28.3	14.5	16.7
1986	September	18.8	51	29.9	29.5	15.1	17.5
1986	October	12.1	24.3	31.2	30.5	16.2	18.8
1986	November	10.6	25.9	29.5	29.2	16.4	18.5
1986	December	21.1	37.1	30.5	30.3	17	19.3
1987	January	0.7	2.9	32.3	31.9	17.4	19.4
1987	February	13.4	21.8	33.7	33.4	17.1	19.3
1987	March	32.8	33.9	34.1	33.9	17.9	20
1987	April	96.3	86.5	32.3	32	17.8	19.7
1987	May	79.3	78.2	29.2	28.9	17.9	19.9
1987	June	179.7	182	27.8	27.8	16.6	18.7
1987	July	15.9	24.3	30.1	30	15.1	17.2
1987	August	36.1	40.3	31.1	30.8	16.5	18.5
1987	September	8.7	10	34	33.5	16.4	18.8
1987	October	31.5	30.9	34.8	34	16.8	19.5
1987	November	80.8	89.4	31.4	31	17.8	20

1987	December	7.6	7.6	33.6	33.2	16.4	18.8
1988	January	65.1	64	32	31.7	17.7	19.7
1988	February	2.2	2	33.3	32.9	17.9	20.1
1988	March	9.1	47.2	33.8	33.4	18.7	20.8
1988	April	266.9	279.6	32	31.7	19.4	21.2
1988	May	32.8	41.7	30.5	30.1	17.9	19.9
1988	June	39.3	36.7	31.1	30.8	17.2	19.3
1988	July	164.7	181.8	28.7	28.5	17.5	19.5
1988	August	142.5	137.5	28.7	28.3	17.3	19.2
1988	September	35.3	64.8	30.5	30	17.9	20
1988	October	46.6	58.7	31.4	30.6	16.8	19.4
1988	November	12.1	12	30.1	29.6	16.4	18.6
1988	December	16.1	18.9	30.7	30.4	16.9	19.1
1989	January	2.1	7.4	30.2	29.9	17.1	19
1989	February	93.8	94.5	30.8	30.5	16.2	18.3
1989	March	49.4	49.2	32.8	32.5	17	19.1
1989	April	176.1	173.8	30.1	29.8	17.3	19.1
1989	May	40.6	45.6	30.3	29.9	17.3	19.4
1989	June	26.6	26.7	30.2	30.1	16.3	18.4
1989	July	138.5	129.4	29.2	29.1	17.4	19.2
1989	August	18.9	39.9	30.1	29.8	17.3	19
1989	September	69.7	75.5	32	31.6	16.9	19.1
1989	October	66.1	72	31.2	30.5	17	19.5
1989	November	76.9	93.6	31.3	30.9	17.4	19.5
1989	December	89.7	94.6	31.6	31.4	18.2	20.3
1990	January	0.6	3.4	30.9	30.5	16.3	18.4
1990	February	105.7	104.9	31.4	31	18.5	20.6
1990	March	79.4	115	31.3	30.9	18.6	20.6
1990	April	202	214.7	31.6	31.1	18.5	20.3
1990	May	70.6	60.3	32.1	31.6	17.8	19.8

1990	June	25.7	36.3	31.7	31.4	16.4	18.4
1990	July	70.4	67	30	29.9	16.2	18.1
1990	August	10.5	28.2	30.7	30.3	16.8	18.6
1990	September	22.7	25.8	32.9	32.3	15.9	18.1
1990	October	69.6	90.4	31.4	30.7	16.4	18.9
1990	November	41	35.9	31.8	31.3	16.4	18.6
1990	December	9.3	5	31.6	31.3	16.7	19
1991	January	43	41.9	31.7	31.4	16	17.9
1991	February	0.1	0.8	33.6	33.3	16.3	18.3
1991	March	81.7	106	33.7	33.4	17.4	19.4
1991	April	76.8	57.1	31.8	31.4	17.3	19.2
1991	May	88.1	78	29.1	28.9	17.2	19.2
1991	June	109.7	133.8	30.1	30	17.4	19.4
1991	July	34.5	72.9	28.8	28.7	17.2	19
1991	August	52.8	95.7	29.7	29.4	16.4	18.3
1991	September	10.2	26.3	32.2	31.6	16.1	18.3
1991	October	24.8	29.6	31.5	30.8	16.1	18.7
1991	November	68.2	79.9	31.8	31.3	16.3	18.5
1991	December	8	13.9	32.6	32.3	16.9	19.3
1992	January	0.1	0.7	32.9	32.5	17	19
1992	February	0.4	5.8	33.5	33.2	17.5	19.6
1992	March	2.6	11.9	34.2	33.8	17.8	19.9
1992	April	66	90.9	33	32.7	18.5	20.3
1992	May	40.2	50.1	31	30.6	17	19
1992	June	69.3	84.3	30.9	30.7	17.5	19.5
1992	July	29.4	54.1	29.3	29.1	16.9	18.7
1992	August	99.4	138.6	29.3	28.9	17.1	18.8
1992	September	52.7	66.3	31.1	30.6	16.4	18.4
1992	October	54.3	62	30.1	29.5	17	19.4
1992	November	31.8	37.7	31.3	30.8	16.2	18.3

1992	December	15.3	21.4	31.6	31.2	17.7	19.9
1993	January	113.1	112.3	29.7	29.3	18.1	20
1993	February	43.9	48.1	30.5	30.1	17.3	19.4
1993	March	0.4	2.5	33	32.6	16.3	18.4
1993	April	38.7	57.2	32.2	31.9	16.7	18.7
1993	May	132.1	123.6	30.1	29.8	17.4	19.5
1993	June	55.9	66.6	30.7	30.5	17.9	19.9
1993	July	52.6	62.3	30.1	29.9	17.4	19.2
1993	August	14.1	20.8	31.4	31	16	18
1993	September	9.8	20.3	33.7	33	16.4	18.6
1993	October	25.4	30.7	33.6	32.8	16.7	19.3
1993	November	18.5	32.2	31.2	30.8	17.1	19.2
1993	December	11	15.3	32.5	32.1	17.3	19.6
1994	January	0.1	0.7	32.8	32.4	16.7	18.7
1994	February	5.3	6.7	33.5	33.2	17.1	19.2
1994	March	28	34.8	34.1	33.8	18	20
1994	April	139.6	156.8	32.1	31.8	18	19.9
1994	May	74	81.5	29.5	29.2	17.2	19.2
1994	June	81.6	98.9	29.7	29.6	17.6	19.5
1994	July	77.8	107.5	28.7	28.5	16.8	18.6
1994	August	111.2	98.9	28.4	28.1	16.7	18.4
1994	September	25.6	28	32.3	31.8	16.7	18.9
1994	October	31.1	37.3	31.7	31	17.2	19.7
1994	November	79.2	98.1	28.8	28.5	17.9	19.9
1994	December	4.2	7.6	31.1	30.8	17.2	19.4
1995	January	0.5	2.2	32.5	32.1	16.8	18.7
1995	February	21.2	25	32.7	32.4	17.3	19.3
1995	March	98.1	104.2	32.1	31.7	17.9	19.9
1995	April	59.5	70.1	31.8	31.5	17.6	19.6
1995	May	44.5	47.9	32.1	31.6	18	20

1995	June	58.2	73.6	32.5	32.3	17.6	19.7
1995	July	36.2	50	28.5	28.4	16.5	18.3
1995	August	40.3	41.8	31.1	30.7	16.7	18.7
1995	September	90.7	82.4	31.4	30.9	17.4	19.5
1995	October	76.2	83.5	30.1	29.5	17.4	19.8
1995	November	76.7	86.9	29.3	29.1	16.9	19
1995	December	39.7	33.1	31.5	31.1	16.2	18.4
1996	January	18.9	19.7	31.6	31.3	16.5	18.5
1996	February	14.2	22.8	33.5	33.1	17.6	19.8
1996	March	30.7	44.8	33.4	33.1	18.2	20.3
1996	April	26.9	25.9	32.4	32.1	17	19
1996	May	60.1	68.6	29.2	29	17.5	19.5
1996	June	131.8	146.7	27	26.9	17.7	19.7
1996	July	130.6	157.8	27.2	27.1	16.5	18.4
1996	August	98	98.1	29.4	29.1	16.7	18.5
1996	September	28.9	38.8	29.8	29.5	16.2	18.3
1996	October	18.5	23.1	31.6	31	16.4	18.9
1996	November	16.5	26.1	31.1	30.7	17.3	19.4
1996	December	1.2	10.2	33.7	33.3	16.5	18.8
1997	January	3.6	2.9	33.2	32.8	16.9	18.9
1997	February	0	0	33.8	33.4	15.8	17.9
1997	March	15.4	28.7	33.2	32.9	17.6	19.6
1997	April	242.3	263	28.9	28.7	18.5	20.2
1997	May	36.1	41.8	30.1	29.7	16.3	18.3
1997	June	62.3	66.5	31.4	31.1	17	19.1
1997	July	108.8	135.8	28.8	28.7	16.9	18.7
1997	August	69.7	70.2	29.8	29.5	16.1	18
1997	September	6.2	5.7	34.2	33.7	16.1	18.4
1997	October	114.7	115.2	30.1	29.5	18.1	20.5
1997	November	122.3	153.4	28.3	28.1	18.7	20.6

1997	December	106	101	29.9	29.7	19.3	21.4
1998	January	79.1	96.9	29	28.7	20	21.7
1998	February	25.5	33.6	32.2	31.8	18.8	20.9
1998	March	23	33	32.9	32.5	19.1	21.1
1998	April	80.5	75.8	32.8	32.4	19.2	21
1998	May	136.6	142.7	30.7	30.3	19.1	20.9
1998	June	42.4	56.7	29.5	29.4	17.3	19.3
1998	July	158.1	156.5	28.9	28.8	17.7	19.4
1998	August	90.7	114	29	28.8	17.3	19.2
1998	September	49.8	61.5	32.8	32.3	17.2	19.4
1998	October	108.5	106.6	30.3	29.7	17.1	19.5
1998	November	29.3	35.1	32.2	31.7	16.9	19
1998	December	0.1	0.4	34.2	33.8	15.8	18.1
1999	January	11.2	8.7	32.9	32.5	17.1	19
1999	February	4.1	3.3	34	33.6	16.4	18.5
1999	March	94.5	117.3	31.5	31.2	18.2	20.1
1999	April	65.6	69.2	31	30.7	17	18.8
1999	May	57.4	53.1	30.4	30.1	16.3	18.3
1999	June	21.3	28.5	30.3	30.2	15.9	18
1999	July	114.6	127.1	29.2	29.1	16.1	17.9
1999	August	91.8	88.9	30.7	30.3	17	18.8
1999	September	10.1	16.7	33.7	33.1	16.7	18.9
1999	October	80.7	87.7	31.5	30.8	17.2	19.7
1999	November	28.5	40	31.5	31	17.7	19.6
1999	December	16	28.4	31.7	31.4	17.2	19.4
2000	January	5	3.2	33.2	32.8	16	17.9
2000	February	0	0	34	33.6	16.1	18.1
2000	March	0	1.7	34.7	34.3	17.5	19.5
2000	April	9.6	14.4	32.4	32.1	17.4	19.1
2000	May	34.7	42.6	31.5	31.1	17.1	19

2000	June	76.3	76.5	30.9	30.8	17	18.9
2000	July	66.8	74.9	28.8	28.7	17.3	19
2000	August	97.4	105.7	29.5	29.2	16.8	18.6
2000	September	20.5	38.5	32.9	32.4	17.3	19.4
2000	October	83.3	80.6	32	31.3	17.4	19.9
2000	November	62.4	63.3	29.8	29.5	17.7	19.7
2000	December	45.1	46.3	32.9	32.5	17.9	20.1
2001	January	25.8	27.2	31.8	31.4	19	20.9
2001	February	5.5	10.4	34	33.7	17.3	19.4
2001	March	85.8	102.4	32.3	32	17.9	19.9
2001	April	82.6	107.2	30.1	29.8	18	19.8
2001	May	30.2	38.3	31	30.6	17.8	19.8
2001	June	61.6	67.3	29.2	29.1	16.7	18.7
2001	July	104.4	121.6	29.7	29.5	16.6	18.4
2001	August	126.7	121.4	30.7	30.4	17.4	19.3
2001	September	43.1	42	32.7	32.2	17	19.3
2001	October	92.4	96.4	32.2	31.5	17.7	20.1
2001	November	72	84.8	28.5	28.3	17.7	19.7
2001	December	0.3	1.6	32.2	31.9	17.1	19.3
2002	January	52.5	46	31.4	31	17.7	19.7
2002	February	0.1	0.2	33.6	33.2	17.3	19.4
2002	March	58.5	77.6	32	31.8	18.2	20.2
2002	April	57.5	69.9	30.1	29.9	18	20
2002	May	22	55.3	30.4	30	17.6	19.6
2002	June	3.5	19.5	31.4	31.2	17	19.1
2002	July	1.2	15.7	32.3	32.1	16.3	18.3
2002	August	21.3	29	30.9	30.5	17.2	19.2
2002	September	5.1	7.3	33.7	33.1	16.8	19.1
2002	October	15.5	31.7	31.3	30.7	17.2	19.8
2002	November	33.3	48.5	30.1	29.8	17.5	19.6

2002	December	74.1	73.6	31	30.8	19	21.2
2003	January	34.5	29.8	31.8	31.4	17	19
2003	February	0	0	34.7	34.3	17.7	19.8
2003	March	26.5	33.5	33.8	33.5	17.9	19.9
2003	April	128	146.2	30.8	30.6	18	19.8
2003	May	140.1	151.5	28.9	28.7	18	19.9
2003	June	57.2	64.2	28.2	28.2	17.3	19.3
2003	July	47.6	52.6	27.6	27.5	16.7	18.6
2003	August	201.4	208.7	26.6	26.5	17	18.8
2003	September	36.5	36.5	32.4	31.8	17.1	19.2
2003	October	35.8	42.7	30.4	29.8	17.1	19.5
2003	November	60.4	66.2	29.5	29.2	17.5	19.6
2003	December	28.8	31.6	30.9	30.7	16.1	18.4
2004	January	38.1	42.7	31.2	30.9	17.6	19.7
2004	February	0.8	3.2	32.5	32.2	18.2	20.4
2004	March	107.3	104.5	33.7	33.3	18.5	20.6
2004	April	116.1	123.6	29	28.7	18.1	19.9
2004	May	23.4	42.4	29.1	28.8	16.5	18.4
2004	June	36.4	39.4	29.8	29.6	16.2	18.3
2004	July	54.1	55.3	29.7	29.6	15.7	17.6
2004	August	44.2	48.9	30.3	30	17.2	19.1
2004	September	19.2	24.8	32.3	31.8	17	19.2
2004	October	50.2	58.5	30.9	30.3	17.2	19.7
2004	November	93.3	104	28.7	28.4	17	19.1
2004	December	14.9	14.6	31.2	31	17.4	19.7
2005	January	25.8	25	32.6	32.2	17.4	19.4
2005	February	12.6	14.5	33.5	33.2	17.3	19.4
2005	March	46.1	43.2	33.3	33	18.4	20.5
2005	April	72.3	85.6	33.6	33.1	18.2	20.1
2005	May	48.3	69.6	28.1	27.9	18.1	20

2005	June	40.9	40.6	28.4	28.4	17	19
2005	July	77.6	81.4	28.9	28.8	17.1	18.9
2005	August	39.7	40.7	31	30.7	17.5	19.3
2005	September	55.4	59.1	30.7	30.3	17.7	19.8
2005	October	25.6	34	32.3	31.6	17.2	19.7
2005	November	45.6	48.5	32.1	31.6	17.1	19.2
2005	December	4.4	5.9	33.1	32.8	16.5	18.9
2006	January	10.9	12.4	32.4	32	16.5	18.7
2006	February	0.4	3.4	33.6	33.2	17.7	19.9
2006	March	12.7	25.9	32.5	32.3	18.9	20.9
2006	April	106	110.2	30.2	29.9	18.4	20.1
2006	May	38.8	44	30.5	30.1	17.8	19.8
2006	June	45.3	45.3	30.6	30.4	17.6	19.6
2006	July	56.4	67.7	30.9	30.6	18.3	20.2
2006	August	68.3	73	29.9	29.6	17.4	19.2
2006	September	29.6	33.7	32.6	32.1	17.7	19.9
2006	October	103.6	106.3	30.4	29.7	17.6	20.1
2006	November	157.3	184	27.2	27	18.4	20.4
2006	December	106.9	97.5	29.6	29.3	19.2	21.3
2007	January	40.6	36.4	31.6	31.1	18.5	20.4
2007	February	57.4	49	32.2	31.8	18.6	20.6
2007	March	29.2	42.3	33.1	32.7	17.2	19.2
2007	April	124.5	149.2	31.1	30.8	17.6	19.4
2007	May	85.3	92.5	31.4	31	17.9	19.9
2007	June	298.3	314.6	28.3	28.2	18.1	20.1
2007	July	143.6	159.5	29.5	29.3	17.6	19.4
2007	August	147.5	163.6	29.3	28.9	17.4	19.3
2007	September	116.8	137.2	30.1	29.7	17.6	19.8
2007	October	97.4	101.1	30.9	30.2	16.7	19.3
2007	November	30.7	34.2	31.3	30.8	17	19.1

2007	December	39	40.3	32.3	32	17	19.2
2008	January	27.4	26.4	31.6	31.2	17.2	19.2
2008	February	5	6.2	32.1	31.8	17.2	19.2
2008	March	67.8	93.2	32.2	31.9	17.9	19.9
2008	April	57.6	63.3	31.9	31.5	17.1	19
2008	May	31.8	33.6	31.8	31.4	17	19.1
2008	June	42	56.7	31.4	31.2	17.5	19.5
2008	July	132.5	152.5	30.4	30.2	17.8	19.5
2008	August	94.1	78	31.4	31	17.7	19.5
2008	September	35.2	38.7	33.1	32.5	18.1	20.4
2008	October	117.5	129.4	29.4	28.9	17.9	20.3
2008	November	53.1	76.4	29.6	29.2	17.2	19.2
2008	December	2.8	2.8	32	31.8	16.6	18.9
2009	January	5.4	3.3	31.7	31.4	17	18.9
2009	February	1.6	1	32.6	32.3	17.4	19.5
2009	March	31.2	31.5	33.9	33.6	17.9	19.9
2009	April	41.6	48.4	31.4	31.2	17.3	19.3
2009	May	51.4	55	30.1	29.8	17.6	19.6
2009	June	21.3	24.4	32.4	32.3	16.4	18.4
2009	July	23.3	27.8	32.7	32.5	17.1	19
2009	August	10.1	11.2	32.6	32.2	17.7	19.5
2009	September	12.6	16.5	34.7	34.1	18.2	20.4
2009	October	59.9	72.6	30.9	30.3	18.4	20.9
2009	November	28	27.6	32.8	32.3	18	20
2009	December	102.5	102.4	31	30.7	18.6	20.9
2010	January	7.9	9.6	31.2	30.8	18.2	20.3
2010	February	93.7	79.5	31.5	31.1	19.9	22
2010	March	187.4	222.3	29.3	29.1	19.3	21.2
2010	April	82.5	97.3	29.7	29.5	18.7	20.5
2010	May	103.3	111.3	28.7	28.5	18.4	20.3

2010	June	49.3	57.2	29.4	29.3	17.5	19.5
2010	July	113.8	144.1	29.6	29.4	17.9	19.7
2010	August	104.7	125.5	29.5	29.2	17.7	19.6
2010	September	30.2	46.4	32.3	31.8	17.8	20
2010	October	72.2	77.8	31.6	31	18.3	20.7
2010	November	44.4	58.3	31.6	31.2	17.1	19.2
2010	December	2.7	3.6	34	33.6	17	19.4
2011	January	6.4	4.9	33.7	33.3	16.9	18.9
2011	February	8.1	6.3	34.2	33.9	16.8	19
2011	March	51.4	57.4	33.2	32.9	17.9	20
2011	April	23.8	27	32.7	32.3	17.3	19.3
2011	May	53	46.1	30.5	30.2	17.4	19.5
2011	June	32.3	37.5	30.6	30.5	17.8	19.8
2011	July	46.6	60.6	31.2	31	16.9	18.9
2011	August	83.7	73.6	27.8	27.6	17.3	19.2
2011	September	42.4	49.6	29.8	29.4	17.5	19.7
2011	October	104.8	122.8	29.7	29.1	17.3	19.8
2011	November	172.7	227.1	28	27.8	18.3	20.3
2011	December	7.7	0.7	29.9	29.8	17.2	19.4
2012	January	0.7	0.2	33.1	32.7	15.1	17.2
2012	February	10.9	10.6	33.1	32.7	16.4	18.7
2012	March	10.8	11.5	34.3	34	17.1	19.1
2012	April	160.3	184.9	32.1	31.7	19	20.8
2012	May	150.4	168.1	29.4	29.1	17.9	19.8
2012	June	140.8	174.8	30.5	30.3	18	20
2012	July	20.2	22.5	29.4	29.3	16.2	16.6
2012	August	40.4	25.4	30.1	29.8	17.4	19.4
2012	September	8.5	10.4	31.3	30.8	17.6	19.8
2012	October	52	69.7	30	29.4	17.7	20.1
2012	November	46.7	47.5	29.9	29.6	17.3	19.4

2012	December	34	27.3	30.8	30.6	18.1	20.4
2013	January	32.8	34.7	31.7	31.3	18.1	20
2013	February	8.5	10.8	32.7	32.4	17.1	19.2
2013	March	69.4	125	33	32.7	18.6	20.7
2013	April	164.6	173.4	31.4	31	19	20.7
2013	May	69.4	73.3	31.7	31.3	17.7	19.7
2013	June	90.6	91.8	31	30.8	17.7	19.5
2013	July	100.2	128.3	30.9	30.7	17.4	19.3
2013	August	80.3	78.8	30.5	30.1	17.1	19
2013	September	73.2	72.8	33.1	32.6	17.9	20.1
2013	October	46	59.1	32	31.3	17.1	19.7
2013	November	81.4	103.1	30.3	29.9	17.8	19.8
2013	December	81.7	79.6	31.5	31.1	18.5	20.7
2014	January	5.4	5.1	32.5	32.2	16.8	18.8
2014	February	10.1	10.6	33.1	32.7	18.8	20.7
2014	March	33.7	60.8	32.5	32.2	17.9	19.9
2014	April	38.1	39.1	31.7	31.4	16.9	18.8
2014	May	49.5	50.6	32.7	32.3	18.7	20.8
2014	June	63.6	81.4	32.5	32.3	18.6	20.6
2014	July	51.3	58.2	31.7	31.5	17.7	19.6
2014	August	62.8	66.2	30.8	30.4	17.4	19.3
2014	September	22.7	27.1	31.9	31.4	17	19.2
2014	October	100.8	116.4	30.6	30	17.5	20.1
2014	November	38.9	31.1	30.4	30	17.5	19.5
2014	December	31.4	25.3	32.1	31.8	17.7	19.9
2015	January	1.6	1.5	32.6	32.2	16.3	18.3
2015	February	9.6	15.5	34	33.7	17.7	19.7
2015	March	7.1	12.9	34.2	33.9	17.3	19.4
2015	April	145.1	146.2	30.6	30.4	18.5	20.3
2015	May	122.2	115.9	30	29.7	18.2	20.2

2015	June	79.7	88.4	30.8	30.6	18.6	20.6
2015	July	44.1	44	31.1	31	16.1	18.2
2015	August	26.5	31	32.3	32	16.7	18.7
2015	September	42.5	49.9	34.4	33.8	17.8	20
2015	October	86.5	93.9	32.9	32.2	18.5	21
2015	November	198.6	207.3	29.3	29	18.5	20.5
2015	December	172.9	190	31.6	31.3	18.7	20.8
2016	January	41	30.8	31.9	31.5	18.4	20.4
2016	February	12.1	12	33.3	32.9	18	20
2016	March	25.3	40	35.6	35.2	19.2	21.3
2016	April	91.8	115.8	32.2	31.9	18.7	20.6
2016	May	152.3	150.9	29.1	28.9	18.4	20.2
2016	June	68.5	67	30.1	29.9	16	17.9
2016	July	140.5	149.5	30.3	30.2	16.9	18.9
2016	August	44.3	36.7	31.6	31.2	17.1	18.9
2016	September	44.4	53.9	33.8	33.2	17.2	19.5
2016	October	53.9	69.5	32.7	32	16.7	19.3
2016	November	79.4	114.2	30.9	30.5	16.5	18.4
2016	December	0.4	0.3	32.9	32.6	17	19.2
2017	January	26	22.9	33.8	33.4	16.9	19
2017	February	17.3	28.9	33.8	33.4	17	19.2
2017	March	39.4	52.8	34.4	34.1	17.8	19.9
2017	April	68.7	72	34.2	33.9	17.8	19.8
2017	May	200.7	184.1	31.6	31.2	18.4	20.4
2017	June	37.3	40.1	32.5	32.3	18.7	20.7
2017	July	123.6	159.6	30.5	30.4	18.4	20.1
2017	August	96.4	97.4	31.5	31.2	18	19.8
2017	September	93.8	113.4	31.6	31.1	18.5	20.5
2017	October	209.1	200.6	31.1	30.5	17.9	20.3
2017	November	71.3	79.6	30	29.6	17.7	19.7

2017	December	11.6	11.2	32.9	32.6	17	19.3
2018	January	5.8	4.6	32.6	32.2	17.4	19.3
2018	February	4.4	5.3	34.1	33.7	17.6	19.8
2018	March	131.1	188.6	30.4	30.1	17.5	19.5
2018	April	158.2	178.2	29.5	29.2	17.7	19.6
2018	May	134.7	130.1	28.8	28.5	17.1	19.2
2018	June	122	141.2	27.8	27.8	16.8	18.8
2018	July	61.3	61	25.9	25.9	10.4	11.9
2018	August	46.2	50.9	37.9	38.5	10.1	11.7
2018	September	26.5	29.5	28.5	28.5	9.5	11.6
2018	October	39.9	51.5	29.4	29.5	10.3	12.1
2018	November	29.1	33.5	29.5	29.5	10.5	12.2
2018	December	61.5	56.9	29.6	29.7	11.6	13.1
2019	January	7.5	6.7	30.7	30.7	9.6	11.2
2019	February	9.1	8.2	30.7	30.7	10	11.7
2019	March	22.8	39.7	31.7	31.8	10.2	11.9
2019	April	71.8	84	31.6	31.6	11.7	13.3
2019	May	42.3	40.6	29.9	29.9	11.4	13
2019	June	74.8	80.5	27.3	27.4	13.4	14.8
2019	July	87.7	94.3	26.8	26.9	11.4	12.9
2019	August	78.9	83.9	38.5	39.2	10.8	12.4
2019	September	97.1	99.9	28.5	28.5	10.3	12.2
2019	October	224.5	271.9	28.1	28.1	12.4	14
2019	November	102.7	108.4	28.3	28.3	13.2	14.6
2019	December	196.3	202.8	28.4	28.5	13.4	14.8
2020	January	100.5	103.8	28.5	28.6	12.5	13.8
2020	February	42.4	47.7	28.9	28.9	11.9	13.2
2020	March	134.6	196.7	29.5	29.6	12.7	14
2020	April	240.3	248.9	28.5	28.5	12.7	14.1
2020	May	133.3	139.8	28.7	28.7	12	13.4

2020	June	133.7	129.3	27.7	27.8	12.8	14.1
2020	July	265.2	248.4	26.2	26.2	12	13.5
2020	August	139.5	130.4	38.5	39.1	11.4	12.9
2020	September	99.4	93.8	27.9	28	10.8	12.4
2020	October	132.5	176.5	28.7	28.7	12.1	13.7
2020	November	66.2	69.6	28.5	28.6	12.7	14.2
2020	December	26.4	23.4	30.6	30.7	11.2	12.7
2021	January	13.9	11.6	27.5	27.6	12.9	13.8
2021	February	61.1	68.1	28	28.1	14.1	15.2
2021	March	24.1	34.6	29	29.1	13.4	14.6
2021	April	60.9	64.9	28.9	29	13.4	14.7
2021	May	162.3	162.5	27.4	27.5	13.8	15
2021	June	17.2	20.3	28.7	28.9	12.3	13.6
2021	July	182.7	185.8	25.9	26.2	13.9	15.1
2021	August	58	57.3	27.1	27.3	12.6	13.8
2021	September	67.1	84.2	27.3	27.4	13.7	15.1
2021	October	88.7	107.9	27.3	27.2	14.1	15.7
2021	November	26.4	32.3	28.5	28.6	13	14.5
2021	December	13.5	11.9	27.8	27.9	14.4	15.8

Appendix B: Knowledge Attitude and Practice survey questionnaire

ASSESSMENT OF KNOWLEDGE ATTITUDE AND PRACTICE OF LOCAL RESOURCE USERS OF LAKE BOGORIA LANDSCAPE

Questionnaire No: ……

Sub-location: …….....

Date: .....

Introduction

Good morning/afternoon, (Name): _____. I am currently pursuing a doctorate at Egerton University, studying in the field of Environmental Science. I am currently engaged in a research project to assess the dispersal areas and threats of the Greater Kudu (*Tragelaphus strepsiceros*) in Lake Bogoria landscape. I am conducting a survey to gather information about participants' knowledge, attitudes, and habits related to Greater Kudu conservation, dispersal areas, and threats within the Lake Bogoria landscape. The duration of the interview will be approximately 20 minutes. All the information collected during this interview including the identity of the respondents will remain strictly confidential.

The objective of this study is to assess the impacts of temperature and rainfall variability and land use/cover change on the distribution of the Greater Kudu within Lake Bogoria landscape in the last four years. The purpose of this is not to assess or judge you, so please do not feel obligated to provide a certain response and do not hesitate if you are unsure of the answer to a question. You are welcome to respond to questions at your preferred speed.

Do you agree to participate in this interview?

☐ Yes ☐ No If yes, continue to the next question; if no, stop the interview.

Do you have any question before we start? *(Answer questions).*

May I start now?

Interview Schedule

The researcher will carefully read each of the following questions to the participant and fill in the appropriate response

A. Biodata

a) What is your gender: ☐ Male ☐ Female

b) Age bracket in years:

☐ (Below 20)

☐ (20 – 30),

☐ (31 – 50),

☐ (50 -75)

c) What is your occupation?

☐ Employed ☐ Self-employed ☐ Un-employed

d) Highest education level:

☐ None ☐ Primary ☐ Secondary ☐ Tertiary

e) Residence: ☐ Birth ☐ Immigrant

f) Kindly, approximate distance from an all-weather road (murram or tarmacked) to your home (km)?

☐ 0 to 1km ☐ 1km to 3km ☐ 3km to 5km ☐ > 5km

g) What is your family's total monthly income (in Kshs)?

☐ 0 – 10,000 ☐ 10,001 – 15,000 ☐ 15,001 –20,000 ☐ > 20,000

h) What is your leading economic activity? *Tick ONE*

- ☐ Crop farming
- ☐ Livestock farming
- ☐ Bee keeping (Apiculture)
- ☐ Others (Specify) _____

i) What is the size of your household?

- ☐ Less than 5
- ☐ Between 5 and 10
- ☐ More than 10

Do you have children in school? ☐ Yes ☐ No

(a) Do you own some land? ☐ Yes ☐ No

(b) If yes, what size of land do you own in acres? _____

- ☐ Less than 1 acre
- ☐ Between 1 and 5
- ☐ Between 6 and 10
- ☐ More than 10

(c) Do you have a title deed for your land? ☐ Yes ☐ No

j) Which of the following services do you have access? *Tick All*

- ☐ Electricity
- ☐ Piped water
- ☐ Permanent house structure
- ☐ Semi-permanent house structure
- ☐ Radio
- ☐ Mobile phone
- ☐ Credit (loan)
- ☐ Car
- ☐ Computer/Laptop

k) Do you belong to any conservation group? ☐ Yes ☐ No

If yes, which one_____

l) What is your source of environmental information (media)?

_____

Assessing KAP of local resource users towards conservation of Greater Kudu (*Tragelaphus strepsiceros*) in Lake Bogoria landscape:

I.Knowledge *(Tick appropriately)*

S/No.	Statement	Strongly Agree (1)	Agree (2)	Not Sure (3)	Disagree (4)	Strongly Disagree (5)
1.	The natural environment of Lake Bogoria landscape has changed over time					
2.	The rainfall pattern in Bogoria landscape has changed over time					
3.	Temperature in Bogoria landscape has been increasing over time					
4.	More than eight (8) wildlife species are found in the Lake Bogoria landscape					
5.	Population of Greater Kudu in Lake Bogoria landscape is decreasing					
6.	Human activities is threatening the existence of Greater Kudu in Lake Bogoria landscape					
7.	Extinction of Greater Kudu in Lake Bogoria landscape leads to poverty					
8.	Greater Kudu conservation policies in Lake Bogoria landscape exists					

S/No.	Statement	Strongly Agree (1)	Agree (2)	Not Sure (3)	Disagree (4)	Strongly Disagree (5)
9.	Awareness creation and training of the local community is important in Greater Kudu conservation					
10.	Greater Kudu conservation is the responsibility of the Government not the local community					

Legend for Mean Interpretation:

Rating Scale	Verbal Interpretation	Qualitative Description
1	Strongly Agree (SA)	True
2	Agree (A)	True to some extent
3	Undecided (U)	Neutral (not sure if it is true or false)
4	Disagree (D)	False to some extent
5	Strongly Disagree (SD)	False

II.<u>Attitude</u> *<u>(Tick appropriately)</u>*

S/No.	Statement	Strongly Agree (1)	Agree (2)	Not Sure (3)	Disagree (4)	Strongly Disagree (5)
1.	I consider conservation of natural ecosystem very important in our community at this time.					
2.	I believe in the LBNGR Integrated Management Plan (IMP).					
3.	I do not like people who destroy natural ecosystem.					
4.	I think water pollution is a major concern in our community.					
5.	I believe poaching of wildlife should be banned in LBNGR.					
6.	I consider Greater Kudu population stable.					
7.	I support Greater Kudu protection and conservation activities.					
8.	I think everybody, young and old, should engage in Greater Kudu conservation practices.					
9.	Community taboos and culture have contributed greatly to the conservation of the Greater Kudu.					

S/No.	Statement	Strongly Agree (1)	Agree (2)	Not Sure (3)	Disagree (4)	Strongly Disagree (5)
10.	Baringo County Government is very supportive of Greater Kudu conservation.					

Legend for Mean Interpretation:

Rating Scale	Verbal Interpretation	Qualitative Description
1	Strongly Agree (SA)	Highly positive attitude towards environment
2	Agree (A)	Moderately positive attitude
3	Undecided (U)	Neutral attitude
4	Disagree (D)	Moderately negative attitude
5	Strongly Disagree (SD)	Highly negative attitude towards environment

III.Practice *(Tick appropriately)*

S/No.	Statement	Always (1)	Often (2)	Sometimes (3)	Rarely (4)	Never (5)
1.	I use charcoal in my cooking at home.					
2.	I use firewood in my cooking at home.					
3.	I practice apiculture (bee keeping for honey)					
4.	I promote Greater Kudu Conservation for tourism.					
5.	I practice soil conservation in my farm.					
6.	I carry out activities that help maintain natural ecosystem.					
7.	I participate in climate change mitigation and adaptation activities.					
8.	I support environmental conservation guidelines (e.g. no poaching, no dumping, no littering etc.).					
9.	I participate in voluntary activities to protect or conserve our ecosystem (e.g. cleaning, tree planting, etc.).					
10	I read materials on environmental conservation and protection.					

Legend for Mean Interpretation:

Rating Scale	**Verbal Interpretation**	**Qualitative Description**
1	Always (A)	100% of the time
2	Often (O)	71-99% of the time
3	Sometimes (S)	35-70% of the time
4	Rarely (R)	1-34% of the time
5	Never (N)	0 % of the time

……. THANK YOU……..

Appendix C: Key Informant questionnaire

KEY INFORMANT QUESTIONNARE

Name of Key Informant: _____

Title / Position Held: _____

Physical Address: _____

Date: _____ Time: _____

Introduction:

I am currently pursuing a doctorate at Egerton University, studying in the field of Environmental Science. I am currently engaged in a research project to assess the dispersal areas and threats of the Greater Kudu (Tragelaphus strepsiceros) in Lake Bogoria landscape. I am conducting a survey to gather information about participants' knowledge, attitudes, and habits related to Greater Kudu conservation, dispersal areas, and threats within the Lake Bogoria landscape. The duration of the interview will be approximately 20 minutes. All the information collected during this interview including the identity of the respondents will remain strictly confidential.

The objective of this study is to assess the impacts of temperature and rainfall variability and land use/cover change on the distribution of the Greater Kudu within Lake Bogoria landscape in the last four years. The purpose of this is not to assess or judge you, so please do not feel obligated to provide a certain response and do not hesitate if you are unsure of the answer to a question. You are welcome to respond to questions at your preferred speed.

You are selected because you are considered knowledgeable by virtue of your roles, duties and experience in the administration and operation of the landscape and conservation activities.

1. For how long *(years)* have you worked/lived in Lake Bogoria landscape? _____

2. What Services do you provide?

_____

_____

_____

3. In your opinion, how important is the Greater Kudu in the Lake Bogoria landscape?

☐ Important ☐ Not important ☐ Not sure

4. Think back over the past years and now. What do you think of Greater Kudu's population in Lake Bogoria landscape?

☐ Increased ☐ Decreased ☐ Not sure

5. What are the **THREE MAJOR** land use/cover types adjacent to Lake Bogoria landscape? *Rank in order of dominance using numbers 1, 2, 3.* ***ONE*** *being the* ***most dominant****.*

☐ Rangeland

☐ Barren land

☐ Built-up/settlement

☐ Agriculture

6. What are the activities inside and outside the protected area that promote Greater Kudus conservation in Lake Bogoria landscape? ***TICK ALL YOU KNOW***

☐ Apiculture (bee keeping)

☐ Afforestation

☐ Community conservancies/associations

☐ Conservation awareness meetings/trainings

7. What are the activities inside and outside the protected area that threaten Greater Kudus in Lake Bogoria landscape? ***TICK ALL YOU KNOW***

☐ Hunting

☐ Farming

☐ Deforestation

☐ Infrastructure (roads/buildings)

8. In your general observation, how do the local community economic activities contribute to Greater Kudus conservation?

☐ Positively ☐ Negatively ☐ Not sure

9. What do you consider to be challenges to Greater Kudu conservation in the landscape? ***TICK ALL YOU KNOW***

☐ Lack of awareness on importance of Kudu conservation

☐ Environmental destructions/changes due to human activities

☐ Lack of legal framework to implement Kudu conservation laws and policies

☐ Lack of management support from the County Government

☐ Other *(State)*_____

10. What is/are your suggestion(s) in dealing with the challenges outlined above?

☐ Establishing Greater Kudu protected areas in the landscape

☐ Exposure to conservation information

☐ Promoting eco-tourism

☐ Promote personal benefits/dividends for conservation of greater Kudu

☐ Others (state) _____

……. THANK YOU……..

Appendix D: Focus Groups Discussion schedule

FOCUS GROUPS DISCUSSION SCHEDULE

I am currently pursuing a doctorate at Egerton University, studying in the field of Environmental Science. I am currently engaged in a research project to assess the dispersal areas and threats of the Greater Kudu *(Tragelaphus strepsiceros)* in Lake Bogoria landscape. I am conducting a survey to gather information about participants' knowledge, attitudes, and habits related to Greater Kudu conservation, dispersal areas, and threats within the Lake Bogoria landscape. The duration of the interview will be approximately 20 minutes. All the information collected during this interview including the identity of the respondents will remain strictly confidential.

The objective of this study is to assess the impacts of temperature and rainfall variability and land use/cover change on the distribution of the Greater Kudu within Lake Bogoria landscape in the last four years. The purpose of this is not to assess or judge you, so please do not feel obligated to provide a certain response and do not hesitate if you are unsure of the answer to a question. You are welcome to respond to questions at your preferred speed.

You are selected because you are considered knowledgeable by virtue of your roles, duties and experience in the administration and operation of the landscape and conservation activities.

1. Think back over the past 30 years and now. What do you think of Greater Kudu's population in Lake Bogoria landscape?
2. Is greater Kudu of any importance to the people of Lake Bogoria landscape?
3. What are the primary land use types that are located next to your neighborhood?
4. What activities, both within and outside the protected area, contribute to the conservation of Greater Kudus in the Lake Bogoria landscape?
5. What are the activities occurring both within and beyond the protected zones that pose a hazard to the Greater Kudus in the Lake Bogoria landscape?
6. What can be done to reduce the impact of the activities that threatens Greater Kudu in the Lake Bogoria landscape?

i. After summary – Is this an adequate summary?

ii. After reviewing the proposed of the FGD – Have we missed anything?

……. THANK YOU…….

Appendix E: KAP survey responses (N=137)

Knowledge Responses

The natural environment of Lake Bogoria landscape has changed over time					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	86	62.8	62.8	62.8
	Agree	42	30.7	30.7	93.4
	Undecided	6	4.4	4.4	97.8
	Disagree	2	1.5	1.5	99.3
	Strongly disagree	1	.7	.7	100.0
	Total	137	100.0	100.0	

The amount of rainfall pattern in Bogoria landscape has changed over time					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	101	73.7	73.7	73.7
	Agree	32	23.4	23.4	97.1
	Undecided	2	1.5	1.5	98.5
	Disagree	1	.7	.7	99.3
	Strongly disagree	1	.7	.7	100.0
	Total	137	100.0	100.0	

Temperature patterns in Bogoria landscape has been increasing over time					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	110	80.3	80.3	80.3
	Agree	20	14.6	14.6	94.9
	Undecided	5	3.6	3.6	98.5
	Disagree	1	.7	.7	99.3
	Strongly disagree	1	.7	.7	100.0
	Total	137	100.0	100.0	

More than eight (8) wildlife species are found in the Lake Bogoria landscape					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	115	83.9	83.9	83.9
	Agree	17	12.4	12.4	96.4
	Undecided	2	1.5	1.5	97.8
	Disagree	2	1.5	1.5	99.3
	Strongly disagree	1	.7	.7	100.0
	Total	137	100.0	100.0	

Population of Greater Kudu in Lake Bogoria landscape is decreasing					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	31	22.6	22.6	22.6
	Agree	28	20.4	20.4	43.1
	Undecided	18	13.1	13.1	56.2
	Disagree	25	18.2	18.2	74.5
	Strongly disagree	35	25.5	25.5	100.0
	Total	137	100.0	100.0	

Human activities is threatening the existence of Greater Kudu in Lake Bogoria landscape					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	38	27.7	27.7	27.7
	Agree	58	42.3	42.3	70.1
	Undecided	10	7.3	7.3	77.4
	Disagree	11	8.0	8.0	85.4
	Strongly disagree	20	14.6	14.6	100.0
	Total	137	100.0	100.0	
Extinction of Greater Kudu in Lake Bogoria landscape leads to poverty					

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	58	42.3	42.3	42.3
	Agree	42	30.7	30.7	73.0
	Undecided	7	5.1	5.1	78.1
	Disagree	7	5.1	5.1	83.2
	Strongly disagree	23	16.8	16.8	100.0
	Total	137	100.0	100.0	

Greater Kudu conservation policies in Lake Bogoria landscape exists

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	53	38.7	38.7	38.7
	Agree	63	46.0	46.0	84.7
	Undecided	6	4.4	4.4	89.1
	Disagree	7	5.1	5.1	94.2
	Strongly disagree	7	5.1	5.1	99.3
	11	1	.7	.7	100.0
	Total	137	100.0	100.0	

Awareness creation and training of the local community is important in Greater Kudu conservation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	83	60.6	60.6	60.6
	Agree	46	33.6	33.6	94.2
	Undecided	6	4.4	4.4	98.5
	Disagree	1	.7	.7	99.3
	Strongly disagree	1	.7	.7	100.0
	Total	137	100.0	100.0	

Greater Kudu conservation is the responsibility of the Government not the local community					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	27	19.7	19.7	19.7
	Agree	16	11.7	11.7	31.4
	Undecided	13	9.5	9.5	40.9
	Disagree	46	33.6	33.6	74.5
	Strongly disagree	35	25.5	25.5	100.0
	Total	137	100.0	100.0	

Attitude Responses

I consider conservation of natural ecosystem very important in our community at this time.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	105	76.6	76.6	76.6
	Agree	31	22.6	22.6	99.3
	Strongly disagree	1	.7	.7	100.0
	Total	137	100.0	100.0	

I believe in the LBNGR Integrated Management Plan (IMP).					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	61	44.5	44.5	44.5
	Agree	40	29.2	29.2	73.7
	Undecided	18	13.1	13.1	86.9
	Disagree	17	12.4	12.4	99.3
	Strongly disagree	1	.7	.7	100.0
	Total	137	100.0	100.0	

I do not like people who destroy natural ecosystem					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	105	76.6	76.6	76.6
	Agree	22	16.1	16.1	92.7
	Undecided	3	2.2	2.2	94.9
	Disagree	1	.7	.7	95.6
	Strongly disagree	6	4.4	4.4	100.0
	Total	137	100.0	100.0	

I think water pollution is a major concern in our community					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	81	59.1	59.1	59.1
	Agree	40	29.2	29.2	88.3
	Undecided	6	4.4	4.4	92.7
	Disagree	6	4.4	4.4	97.1
	Strongly disagree	4	2.9	2.9	100.0
	Total	137	100.0	100.0	

I believe poaching of wildlife should be banned in LBNGR.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	101	73.7	73.7	73.7
	Agree	33	24.1	24.1	97.8
	Undecided	1	.7	.7	98.5
	Strongly disagree	2	1.5	1.5	100.0
	Total	137	100.0	100.0	

I consider Greater Kudu population stable					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	34	24.8	24.8	24.8
	Agree	49	35.8	35.8	60.6
	Undecided	20	14.6	14.6	75.2
	Disagree	23	16.8	16.8	92.0
	Strongly disagree	11	8.0	8.0	100.0
	Total	137	100.0	100.0	

I support Greater Kudu protection and conservation activities.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	89	65.0	65.0	65.0
	Agree	46	33.6	33.6	98.5
	Undecided	1	.7	.7	99.3
	Disagree	1	.7	.7	100.0
	Total	137	100.0	100.0	

I think everybody, young and old, should engage in Greater Kudu conservation practices.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	91	66.4	66.4	66.4
	Agree	45	32.8	32.8	99.3
	Disagree	1	.7	.7	100.0
	Total	137	100.0	100.0	

Community taboos and culture have contributed greatly to the conservation of the Greater Kudu.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	51	37.2	37.2	37.2
	Agree	54	39.4	39.4	76.6
	Undecided	10	7.3	7.3	83.9
	Disagree	13	9.5	9.5	93.4
	Strongly disagree	9	6.6	6.6	100.0
	Total	137	100.0	100.0	

Baringo County Government is very supportive of Greater Kudu conservation					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	50	36.5	36.5	36.5
	Agree	51	37.2	37.2	73.7
	Undecided	17	12.4	12.4	86.1
	Disagree	9	6.6	6.6	92.7
	Strongly disagree	10	7.3	7.3	100.0
	Total	137	100.0	100.0	

Practice Statements

I use charcoal in my cooking at home.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	13	9.5	9.5	9.5
	Agree	13	9.5	9.5	19.0
	Undecided	19	13.9	13.9	32.8
	Disagree	44	32.1	32.1	65.0
	Strongly disagree	48	35.0	35.0	100.0
	Total	137	100.0	100.0	

I use firewood in my cooking at home					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	128	93.4	93.4	93.4
	Agree	4	2.9	2.9	96.4
	Undecided	3	2.2	2.2	98.5
	Disagree	1	.7	.7	99.3
	Strongly disagree	1	.7	.7	100.0
	Total	137	100.0	100.0	

I practice apiculture (bee keeping for honey)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	73	53.3	53.3	53.3
	Agree	19	13.9	13.9	67.2
	Undecided	20	14.6	14.6	81.8
	Disagree	5	3.6	3.6	85.4
	Strongly disagree	20	14.6	14.6	100.0
	Total	137	100.0	100.0	

I promote Greater Kudu Conservation for tourism.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	88	64.2	64.2	64.2
	Agree	32	23.4	23.4	87.6
	Undecided	13	9.5	9.5	97.1
	Disagree	4	2.9	2.9	100.0
	Total	137	100.0	100.0	

I practice soil conservation in my farm.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	71	51.8	51.8	51.8
	Agree	36	26.3	26.3	78.1
	Undecided	18	13.1	13.1	91.2
	Disagree	11	8.0	8.0	99.3
	Strongly disagree	1	.7	.7	100.0
	Total	137	100.0	100.0	

I carry out activities that help maintain natural ecosystem					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	65	47.4	47.4	47.4
	Agree	47	34.3	34.3	81.8
	Undecided	17	12.4	12.4	94.2
	Disagree	6	4.4	4.4	98.5
	Strongly disagree	2	1.5	1.5	100.0
	Total	137	100.0	100.0	

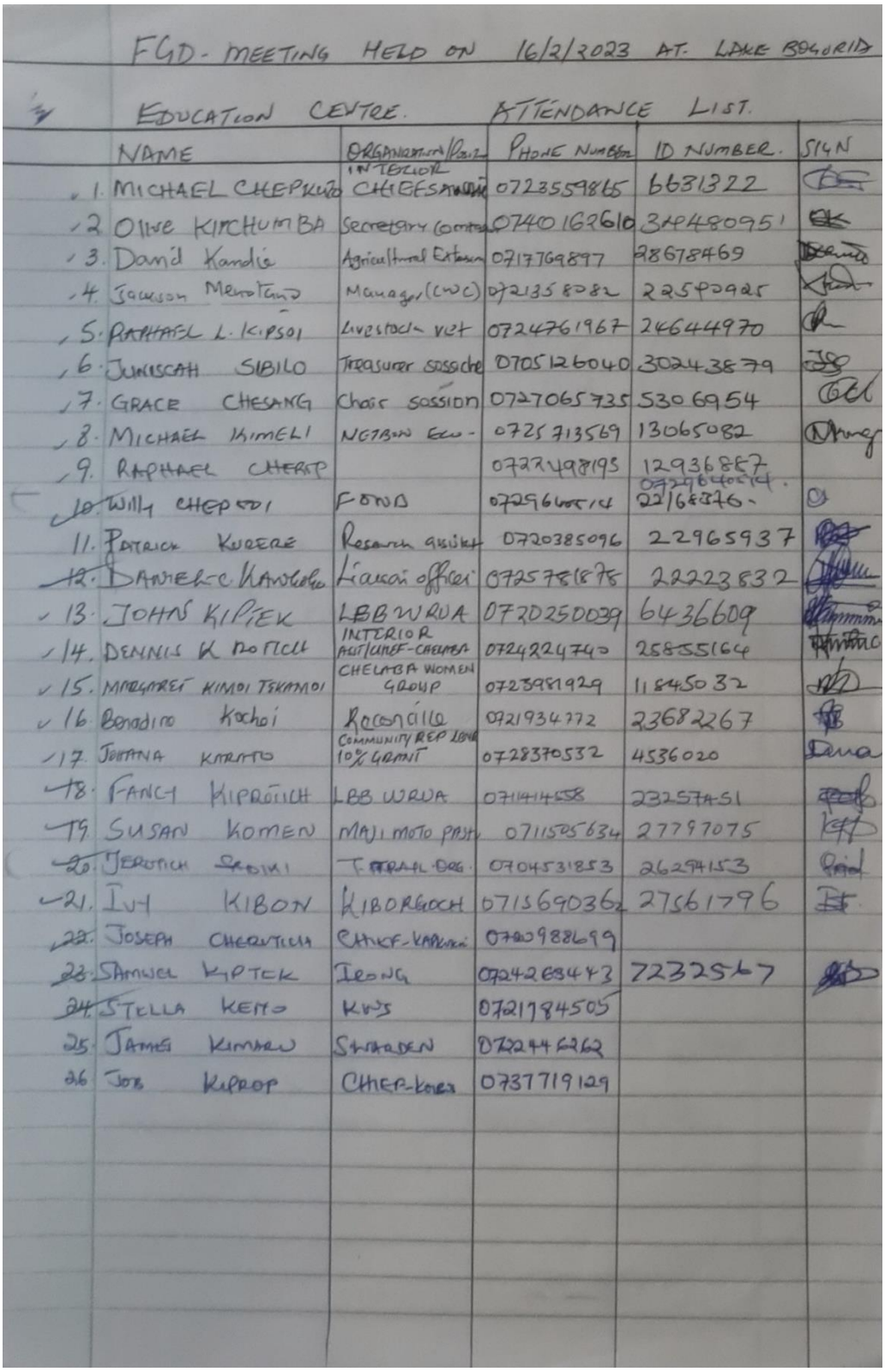
I participate in climate change mitigation and adaptation activities.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	65	47.4	47.4	47.4
	Agree	46	33.6	33.6	81.0
	Undecided	13	9.5	9.5	90.5
	Disagree	8	5.8	5.8	96.4
	Strongly disagree	5	3.6	3.6	100.0
	Total	137	100.0	100.0	

I support environmental conservation guidelines (e.g. no poaching, no dumping, no littering etc.)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	93	67.9	67.9	67.9
	Agree	37	27.0	27.0	94.9
	Undecided	6	4.4	4.4	99.3
	Disagree	1	.7	.7	100.0
	Total	137	100.0	100.0	

I participate voluntary activities to protect or conserve our ecosystem (e.g. cleaning, tree planting, etc.)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	56	40.9	40.9	40.9
	Agree	43	31.4	31.4	72.3
	Undecided	11	8.0	8.0	80.3
	Disagree	19	13.9	13.9	94.2
	Strongly disagree	8	5.8	5.8	100.0
	Total	137	100.0	100.0	

I read materials on environmental conservation and protection.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	30	21.9	21.9	21.9
	Agree	44	32.1	32.1	54.0
	Undecided	32	23.4	23.4	77.4
	Disagree	10	7.3	7.3	84.7
	Strongly disagree	21	15.3	15.3	100.0
	Total	137	100.0	100.0	

Appendix F: Focus groups discussion list of participants



FGD- MEETING HELD ON 16/2/2023 AT LAKE BOGORIA EDUCATION CENTRE. ATTENDANCE LIST.

	NAME	ORGANIZATION/POST	PHONE NUMBER	ID NUMBER	SIGN
1.	MICHAEL CHEPKWONY	INTERIOR CHIEFS ASSISTANT	0723559865	6631322	
2	OLIVE KIMCHUMBA	Secretary Committee	0740162610	34480951	
3.	David Kandie	Agricultural Extension	0717769897	28678469	
4.	JACKSON MEMOTANG	Manager (CWC)	0721358082	22590925	
5.	RAPHAEL L. KIPSOI	Livestock vet	0724761967	24644970	
6.	JUNIOSCAH SIBILO	Treasurer Sossiche	0705126040	30243879	
7.	GRACE CHESANG	Chair session	0727065735	5306954	
8.	MICHAEL KIMELI	NGTBON ECO-	0725713569	13065082	
9.	RAPHAEL CHERIP		0727498195	12936857	
10.	WILLY CHEPKOI	FOND	0729640614	22164776	
11.	PATRICK KURERE	Research assistant	0720385096	22965937	
12.	DANIEL C KANGOGO	Liaison officer	0725781878	22223832	
13.	JOHN KIPIEK	LBB WRUA	0720250039	6436609	
14.	DENNIS K ROTICH	INTERIOR ASST/CHIEF-CHEMPAS	0724224740	25855164	
15.	MARGARET KIMOI TSKAMOI	CHELABA WOMEN GROUP	0723951929	11845032	
16	Benadino Kochoi	Reconcilia	0721934772	23682267	
17.	JOHANA KARITO	COMMUNITY REP LOWER 10% GRANT	0728370532	4536020	
18.	FANCY KIPROTICH	LBB WRUA	0714414558	23257451	
19.	SUSAN KOMEN	MAJI MOTO PASTA	0711505634	27797075	
20.	JEROTICH SEROMI	T. TRIAL DRG.	0704531853	26294153	
21.	IVY KIBON	KIBORGOCH	0715690362	27561796	
22.	JOSEPH CHEBOTICH	CHIEF-KAPKOI	0720988699		
23.	SAMUEL KIPTEK	IRONG	0724263443	7232567	
24.	STELLA KENO	KWS	0721784505		
25.	JAMES KIMARU	STRADEN	0722446262		
26	JOB KIPROP	CHIEF-KONEI	0737719129		

Appendix G: NACOSTI Research License

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **302595**

Date of Issue: **07/November/2022**

RESEARCH LICENSE

This is to Certify that Ms.. BEATRICE CHEPKOECH CHESEREK of Egerton University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Baringo on the topic: ASSESSMENT OF GREATER KUDU (TRAGELAPHUS STREPSICEROS) DISPERSAL IN THE LAKE BOGORIA LANDSCAPE, BARINGO COUNTY, KENYA for the period ending : 07/November/2023.

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Appendix H: Snap Shot of Abstract page (Article 1)

Open Journal of Ecology > Vol.13 No.12, December 2023

Check for updates

Knowledge, Attitudes and Practices of Locals towards Greater Kudu (*Tragelaphus strepsiceros, Pallas, 1766*) Conservation in Lake Bogoria Landscape, Kenya

Beatrice Chepkoech Cheserek*, George Morara Ogendi, Paul Mutua Makenzi

Department of Environmental Science, Egerton University, Egerton-Njoro, Kenya.

DOI: 10.4236/oje.2023.1312055 **PDF** **HTML** **XML** **69** Downloads **320** Views

Abstract

Several interventions have been suggested for averting and reducing wildlife declines including; securing dispersal areas and migratory corridors, strengthening and investing in local communities and landowners to create and develop community and private wildlife conservancies, and diversification of rural livelihoods through benefits from ecosystem services. Greater Kudu endemic to the Lake Bogoria landscape in Kenya is categorized as vulnerable to extinction due to unsustainable exploitation and management of resources although the continued economic importance of the Greater Kudu in the Lake Bogoria landscape is its best defense. A cross-sectional survey was conducted to analyze the status of knowledge, attitudes and practices (KAP) of locals towards the conservation of the Greater Kudu in the landscape. The survey was conducted using a semi-structured pre-tested questionnaire administered to target populations (N = 137 households). Face-to-face interviews of key informants (KI) and focus group discussions (FGDs) were also carried out. It was found that 84% of KAP respondents agreed that the landscape is rich with biodiversity while 77% of them agreed that conservation of the ecosystem is important for rural livelihoods. Further, 73% of KAP respondents agreed that the extinction of Greater Kudu in the Lake Bogoria landscape may lead to poverty. It is recommended that all-inclusive adaptive management and conservation strategies should embrace continuous monitoring, and understanding dispersal Greater Kudu to ensure its survival, in the landscape for improved livelihoods.

Appendix I: Snap Shot of Abstract page (Article 2)

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Effect of temperature and rainfall variability on greater kudu (*Tragelaphus strepsiceros*) population in Lake Bogoria landscape, Kenya

CHESEREK BEATRICE CHEPKOECH[1*], *OGENDI GEORGE MORARA*[1] & *MAKENZI PAUL MUTUA*[1]

[1]*Department of Environmental Science, Egerton University*
Corresponding Author: btcheserek1@email.com

Abstract

Climate change is one of the major factors threatening biodiversity and ecosystem services. Studies have proved that extremely high or low temperatures may lead to habitat degradation for the large herbivores in the Kenyan Savanna. Greater kudu (*Tragelaphus strepsiceros*), a large herbivore within Lake Bogoria Landscape (LBL) in Baringo County, Kenya is a major tourist attraction thus important revenue contributor for the County. Limited information on the effects of temperature and rainfall variability on greater kudu (GK) population in the landscape forms basis for this study. Long-term (1981 - 2022) temperature and rainfall monthly data was obtained from Kenya Meteorological Department. Transect line survey data collected by Lake Bogoria National Game Reserve since the year 2019 and data collected during the study period in 2022 were used to assess the abundance, distribution and trends of Kudu population for the last four (4) years. It was found that there is long-term and seasonal variation of maximum temperature, minimum temperature and rainfall and that both maximum and minimum temperature variability ($r(1) = -.42$, $p > 0.05$ and $r(1) = .45$, $p > 0.05$ respectively) and rainfall ($r(1) = -.10$, $p > 0.05$) did not significantly affect GK population although 98% of the total variation in GK population was related to rainfall variability. It was concluded that temperature and rainfall extremes have affect GK dispersal in the landscape. Deliberate efforts by conservation agencies to create awareness on effects of climate change, and the necessary governance structures and financial support provided towards adoption of sustainable and affordable production technologies will improve livelihoods of the communities.