EFFECTS OF CLIMATE CHANGE ON NATURAL RESOURCES AND TOURISM SUSTAINABILITY IN MAASAI MARA NATIONAL RESERVE, KENYA

LABAN KIPKEMOI ROTICH

B.T.M. (Moi); M.T.M. (Moi)

AHTX/06537P/2016

A Thesis Submitted in Partial Fulfillment of the Requirements for the Award of the Degree of Doctor of Philosophy in Tourism Management

in

The School of Hospitality and Hunan Ecology

of

The Technical University of Kenya

September 2022

DECLARATION

This thesis is my original work and has not been presented in any other institution for a degree award or other qualification.

LABAN KIPKEMOI ROTICH

AHTX/06537P/2016

Signature…...…….. Date.....

This thesis has been submitted with our approval as supervisors:

Signature…….……..... Date…….…….....

PROF. RICHARD O. B. MAKOPONDO, PHD, MIH
SCHOOL OF HOSPITALITY AND HUMAN ECOLOGY
THE TECHNICAL UNIVERSITY OF KENYA

Signature ……..... Date.……..

DR. NEHEMIA K. KIPRUTTO
DEPARTMENT OF TRAVEL AND TOUR OPERATIONS MANAGEMENT
MOI UNIVERSITY

Signature……..……..... Date.……..……..

DR. DAVIS W. BARASA
DEPARTMENT OF HOSPITALITY AND LEISURE STUDIES
THE TECHNICAL UNIVERSITY OF KENYA

DEDICATION

I dedicate this thesis to my family for their encouragement, faith, prayers, concern and continuous support in my entire education endeavors.

ACKNOWLEDGEMENT

My Doctor of Philosophy journey has been challenging and rewarding. I have significantly grown both academically and personally over this period. I am immensely indebted to a number of people as well as organizations for their assistance, encouragement and contribution towards this endeavor. I wish to convey my gratitude to the collective efforts that have contributed and assisted in the writing of this research work.

This thesis was made possible by the critical assessment and guidance of my supervisors. I am incredibly grateful to my supervisor, Professor Richard O. B. Makopondo. From the very first meeting we held to the final stages of this study, he has been a critical force, firstly, by challenging and shaping my thinking; secondly, in supporting my specific research area; thirdly, by sharing with me his encouraging research testimonies; and, lastly, by continually inspiring me to excel and to always move onwards and upwards academically.

Special mention and thanks to Dr. Nehemia Kiprutto and Dr. Davis W. Barasa for their unparalleled support and advice that resulted to this work. They have been my light in the dark and I cannot thank them enough for their continuous source of intellectual inspiration. Their unfailing counsel, expertise and support through the research process and writing of this thesis have been so valuable.

I would also wish to extend special thanks and profound appreciation to the Directorate of Resource Surveys & Remote Sensing (DRSRS), Kenya Meteorological Department (KMD), Regional Centre for Mapping of Resources for Development (RCMRD), Mara Conservancy, and Kenya Wildlife Service (KWS) for their incredibly kind assistance. From Dr. Ayugi Samson Okoth I received energetic guidance and encouragement both personally and academically. Finally, I give unlimited thanks and praise to God.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF BOXES

LIST OF ABBREVIATIONS AND ACRONYMS

ANOVA - Analysis of Variance

AO - Area of Interest

CC - Climate Change

CO_2 - Carbon dioxide

COP - Conference of Parties

DRSRS - Directorate of Resource Surveys and Remote Sensing

DVGM - Dynamic Global Vegetation Model

EFA - Explanatory Factor Analysis

ERVs - Exceptional Resource Values

ETS - Emissions Trading Scheme

EU - European Union

FAO - Food and Agricultural Organization

FOC - Friends of Conservation

GCE - General Climate Models

GCM - Global Climate Modeling

GDP - Gross Domestic Product

GHGs - Green house gases

GME - Greater Mara Ecosystem

GoK - Government of Kenya

HFCs - Hydro fluorocarbons

HTM - Hamburg Tourism Model

IBA - International Bird Area

ICCA - Institute of Climate Change Adaptation

IEA - International Energy Agency

ILO - International Labor Organization

INC/FCC - Intergovernmental Negotiating Committee for a Framework Convention on Climate Change

INDCs - Intended Nationally Determined Contributions

IPCC - Intergovernmental Panel on Climate Change

IRI - International Research Institute

ITF - International Transport Federation

IUCN - International Union for Conservation of Nature

JKIA - Jomo Kenyatta International Airport

KCCWG - Kenya Climate Change Working Group

KMD - Kenya Meteorological Department

KMO - Kaiser-Mayor-Oklin

KNBS - Kenya National Bureau of Statistics

KWS - Kenya Wildlife Service

LAC - Latin America and Caribbean

MIA - Moi International Airport

MK - Mann-Kendall

MMNR - Maasai Mara National Reserve

NACOSTI - National Commission for Science, Technology and Innovation

NAP - National Adaptation Plan

NCCAP - National Climate Change Action Plan

NCCC - National Climate Change Council

NCCRS - National Climate Change Response Strategy

NDVI - Normalized Difference Vegetation Index

NEMA - National Environmental Management Authority

NPBM - National Performance and Benefit Measurement

NPP - Net Primary Productivity

NS - Natural Resources

PA’s - Protected Areas

PCA - Principal Component Analysis

RCMRD - Regional Centre for Mapping of Resources for Development

SDGs - Sustainable Development Goals

SPSS - Statistical Package for Social Sciences

STTA - Sustainable Travel and Tourism Agenda

TS - Tourism Sustainability

UN - United Nations

UNEP - United Nations Environment Program

UNEP - United Nations Environmental Programme

UNFCCC - United Nations Framework Convention on Climate Change

USA - United States of America

USD - United States Dollar

USGS - United States Global Surveys

VIF – Variance Inflation Factor

WCC - World Climate Conference

WHS - World Heritage Site

WMO - World Meteorological Organization

WTMA - Wet Tropics Management Authority

WTO - World Tourism Organization

WTTC - World Travel & Tourism Council

WWF - World-Wide Fund for Nature

DEFINITION OF OPERATIONAL TERMS

Adaptation - the process of adjustment to actual or expected climate and its effects, in human systems. Adaptation seeks to moderate or avoid harm or exploit beneficial opportunities (IPCC, 2014).

Big Five - the lion, leopard, elephant, buffalo and rhino (World Bank, 2018).

Climate - the mean and variability of relevant atmospheric variables such as temperature, precipitation and wind, usually 30 years according to the World Meteorological Department (2010).

Climate change - long-term change in the statistical distribution of weather patterns (for example temperature, precipitation) over decades to millions of years of time (Muhammad, 2013).

Climate variability - time scales ranging from months to decades, falling between the extremes of daily weather and the long-term trends associated with climate change (IRI, 2004).

Impacts - the effects on natural and human systems of extreme weather and climate events of climate change (IPCC, 2014). This study explores social, economic as well as environmental impacts of climate change.

Natural Resources - the core resources of the environment, which includes the flora and fauna species (Chen, *et al.*, 2017). This study identifies wildlife and vegetation as variables under natural resources.

Resilience - the capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation (IPCC, 2014).

Risk - the potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if their occurrence (IPCC, 2014). This study explores drought and flooding situations as risks in the sustainability of the tourism industry.

Tourism sustainability - tourism that takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment and host communities (WTO, 2015). The economic, social and environmental impacts of climate change on tourism are explored.

ABSTRACT

The tourism industry contributes significantly to global economic development, particularly in terms of job creation and wealth creation in developing nations and regions where tourism is frequently the primary source of revenue. However, there is worldwide concern on climate change as one of the biggest obstacles for attaining development. The tourism sector in Kenya that is nature based is not immune to climate change. This study used systems theory to investigate the effects of climate change on natural resources and tourism sustainability in Maasai Mara National Reserve (MMNR). The extent to which climate change affects natural resources that tourism depends on is explored. The specific objectives of the study were: To establish the effects of climate change on natural resources in MMNR; to identify the effects of natural resources on tourism sustainability in MMNR; to determine the relationship between climate change and tourism sustainability in MMNR; and to explore the mediating effects of climate change and natural resources on tourism sustainability in MMNR. Explanatory and descriptive research designs were used in this study. In Narok County, the target population was 169,220 households, 300 tourists, and 18 experts. Simple random sampling, convenience sampling, and snowball sampling were used to sample 507 respondents that included 399 households, 90 tourists, and 18 experts. Key informant interviews were used to collect data from climate change experts and tourists while structured questionnaires were administered to the heads of households in the local community. The Cronbach Alpha Coefficient was used to evaluate instrument reliability, while expert opinion was used to determine validity. Data from the interviews was analyzed qualitatively using thematic analysis. The normalized difference vegetation index (NDVI) technique was used to evaluate changes in vegetation cover using satellite images. Rainfall and temperature data were analyzed using the Man Kendall trend test. With the help of SPSS V.23, quantitative data was analyzed using descriptive and inferential statistics. The relationship between the variables was determined using linear regression while the mediation effects were tested using the Process Macro. The study findings indicated that there was a positive significant relationship between climate change and natural resources (β=0.286 and p=0.000), a positive significant relationship between natural resources and tourism sustainability (β=0.393 and p=0.000); and controlling for the mediator (natural resources), climate change remained a significant predictor of tourism sustainability (c' = 0.730). Therefore, rainfall and temperature variations trigger a mediating effect on vegetation that supports wildlife populations which forms the foundation of Kenya's tourism. These wildlife populations have the potential to influence sustainability of the tourism industry. The study findings raise the need for urgent interventions by the tourism industry stakeholders to consider developing alternative wildlife based tourism products in the advent of declines in wildlife populations as a result of erratic rainfall and temperature patterns. In addition, tourism destination managers need to have contingency plans in the advent of extreme climate events. It is crucial that relevant policy frameworks aimed at addressing climate change effects and its associated risks on wildlife that the tourism industry thrives on are enacted and fully implemented.

CHAPTER ONE

INTRODUCTION

This chapter presents the study background information: generally describes the relationship between climate change and tourism sustainability mediated by natural resources; explains the research problem; outlines the purpose of the study; states the objectives, research questions and hypotheses; explains the significance of the study; sets the scope of the study; as well as highlights the assumptions, limitations and delimitations of the study.

1.1 BACKGROUND OF THE STUDY

1.1.1. Tourism and tourism sustainability

Tourism refers to activities of persons identified as visitors who travel to locations outside of their regular surroundings for a period of less than a year for reasons such as holidays, leisure, recreation, business, health, and education (WTO, 2019). It is a significant driver of socioeconomic development in both developed and developing countries, accounting for 10% of worldwide employment and 10% of global GDP (WTO, 2019). Tourism is a fast developing phenomenon, with tourism-related activities accounting for an increasing percentage of overall economic activity in most nations (WTO & ILO, 2014). Conversely, tourism activities create both positive as well as negative social, cultural and economic impacts on tourism destinations. Some of the tourism activities contribute to environmental damage through pressure on fragile ecosystems, land, air and water pollution.

Growing awareness of tourism's negative effects, particularly on the environment, combined with widespread acceptance of the idea of sustainable development, led to a global rethinking of tourism's long-term economic, social, and environmental viability (WTO, 2010). Tourism's

negative effects have sparked concern, giving rise to the notion of sustainable tourism (Sarfaraz *et al.,* 2015). Sustainable tourism, therefore, refers to 'tourism that takes full account of its future economic, social and environmental impacts while addressing the needs of visitors, the industry, the environment and host communities' (Patterson, 2016).

Sustainable tourism aims to provide stable jobs and income opportunities, as well as social services to host communities, while also maintaining vital ecological processes and contributing to the conservation of natural heritage and biodiversity, all while respecting the socio-cultural authenticity of host communities through the preservation of buildings and livelihoods (WTO, 2013). This study examined the tourism sector's social, economic, and environmental sustainability in light of climatic changes. Climate change has the potential to jeopardize the tourism industry's long-term viability (Scott, 2021).

Tourism contributes to climate change through the aviation industry, which is the largest emitter of CO_2. For example, worldwide transportation, which includes both passenger (car, rail, air) and freight (maritime, air, surface) emissions, is projected to have totaled 7,230 million tonnes, accounting for 23% of all man-made CO_2 emissions (ITF, 2019). International tourism transport emissions are expected to increase by 45% between 2016 and 2030, from 458 million tonnes of CO_2 in 2016 to 665 million tonnes of CO_2 in 2030 (WTO, 2019). Due to low travel propensity and several infrastructural limitations, Africa is expected to have relatively low surface emissions (WTO, 2019). Conversely, with low CO_2 emissions in developing countries, Africa is expected to bear the burden of adverse impacts of climate change due to low adaptive capacity (Reddy, 2011).

Biodiversity forms the foundation of the tourism industry through nature based attractions that draw visitors to tourism destinations, especially in Africa and, in particular, Kenya. As a result, the consequences of climate change pose a serious danger to tourism. For example, extreme

weather events can result in the loss of biodiversity as well as harm to destination assets and attractions (WTO, 2019). Climate change has the potential to damage and disturb cultural and natural assets, lowering visitor appeal and limiting economic possibilities for local people (WTO, 2019). Indeed, according to Hoogendoorn and Fitchett (2018), climate change is expected to decrease tourist sustainability and long-term profitability.

1.1.2. Climate change

Climate refers to the average weather conditions such as temperature, precipitation, and wind from months to thousands of years (IPCC, 2018). This study adopts IPCC (2018) definition of climate change that describes climate change as a change in the state of climate that can be identified through statistical tests where changes in mean and or the variability weather elements persist for longer periods, usually decades.

Weather and climate in a particular tourism destination are key determinants of tourism success and are most important in controlling tourist flows globally (Moreno, 2010; Scott & Lemieux, 2010). On the one hand, climate plays a significant role in the comparative selection of a tourist destination, while, on the other, climate change has the potential to alter popularity of tourism localities and regions (Rosselló, 2015).

Climate change indicators are extreme weather occurrences such as heavy rainfall coupled with flooding and extreme drought caused by exceptionally low precipitation. Tourism activities are affected by catastrophic climatic phenomena such as storms, floods and rises of sea level that make tourism destinations progressively become unsuitable for tourism (Rogerson, 2016). Climate change is one of the most serious global issues as rainfall patterns have become erratic and unpredictable in many regions of Africa (Nyamwange, 2016). This is a clear indicator of the effects of climate change. In Kenya, climate change related challenges, for example variations in

weather patterns by virtue of frequent and prolonged droughts and floods, have been observed (Nyamwange, 2016).

Kenya's wildlife and tourist attractions are major contributors to the economy and are vulnerable to the impacts of climate change (Nyamwange, 2016). For instance, Kenya's MMNR is susceptible to climate change (Muchoki, 2018). Furthermore, extreme weather events such as El Nino rains have a negative impact on wildlife and biodiversity, resulting in fewer opportunities for tourism, as demonstrated by the case of Lake Nakuru National Park, where El Nino rains caused a rise in water levels, causing migration of water birds, including flamingos that are a major tourist attraction (Nyamwange, 2016).

Climatic change is characterized by floods and drought conditions that directly and indirectly impact tourism activities. As a result of extreme weather events such as floods, access to tourist locations and tourist activities such as wildlife safari is highly likely to be impeded. Therefore, this study explores the potential impact of erratic rainfall and temperature on the wildlife including sustainability of the tourism industry in MMNR. It is not clearly known whether the tourism industry will achieve its sustainability in the advent of changing climate conditions.

1.1.3 Influence of climate change on tourism sustainability

The rise in temperatures is linked to increase in GHGs such as CO_2 and methane that is the subject of climate change science. These temperature rises have the potential to have a detrimental impact on tourism (Hoogendoorn & Fitchett, 2018). When temperatures rise beyond human comfort levels, tourists are likely to experience thermal discomfort (Hunt & Watkiss, 2011). Temperature rise is an example of indirect effects that affect the natural environment which makes up the tourist attraction (Hambira *et al.*, 2013). There is a serious concern that

temperature increase adversely affects tourism because of the dependency of tourism on the natural environment (Rogerson & Sims, 2012).

In the Okavango Delta in Botswana excessively warm temperatures were found to have negatively affected tourist operators in outdoor activities that can not be climate controlled such as boat and canoe rides that were often cancelled (Hambira *et al.,* 2013). In Northern Tunisia, during summer and autumn, climate is increasingly becoming too hot for sight-seeing activities (Köberl *et al.,* 2016). Extreme weather events including storms, floods and drought can lead to closure of a tourist destination, resulting in long term costly damage (Darkoh *et al.,* 2014) as well as decline in social, economic and environmental benefits of tourism.

It is vital to emphasize that severe droughts can endanger food security, resulting in the allocation of such resources to visitors at the expense of the local population, jeopardizing the possibility for equitable and sustainable tourism growth (Dillimono & Dickinson, 2015). In 2000 flooding in Okavango Delta's Moremi Game Reserve resulted in financial losses and several tourist staff laid off (Darkoh *et al.,* 2014). This means that climate change has the potential to negatively impact the socio-economic benefits of tourism.

Increasing temperatures have been reported to cause difficulties for tourism operators in Botswana (Hambira *et al.,* 2013). Botswana tour operators have shifted their scheduled tourism activities to cooler times, including setting up of bigger swimming pools, to ensure long-term profitability of tourism operations (Hambira *et al.,* 2013). On the other side, tourists often look for alternative activities on bad weather days (Hoogendoorn *et al.,* 2016). Long periods of extreme climate are likely to limit tourist numbers (Hoogendoorn and Fitchett, 2018). With reduced tourist numbers, it is highly likely that the socioeconomic as well as environmental benefits of tourism will dwindle, implying an unsustainable tourism industry.

1.1.4. Influence of climate change on natural resources

Climate change manifests itself through extreme climate events of low rainfall and high temperatures that is associated with drought scenarios. As a result, the natural environment's response to rising temperatures may be divided into three categories: migration, phenological alterations, and yield decreases (Fitchett *et al.,* 2015). More importantly, increasing temperatures threaten to induce mass wildlife migration in areas such as the Okavango Delta as well as in Kenya and Tanzania, potentially eliminating key tourist attractions (Hambira *et al.,* 2013). Furthermore, storm falls are raging and devastating tourist industries in South Africa, which is exposed to tropical cyclones in tourist destinations on the eastern part of the nation (Fitchett *et al.,* 2016). Storms affect infrastructure such as roads and bridges that are crucial in providing access to tourist destinations (Fitchett *et al.,* 2016).

In Nigeria floods have restricted visitor access to tourism sites (Dillimono & Dickinson, 2015). Increased precipitation and floods can lead to crocodiles and hippos moving into tourist destinations (Hambira & Saarinen, 2015). Also, drought and desertification events have the ability to change the fauna diversity and spatial distribution of wildlife in protected areas such as game reserves (Hoogendoorn and Fitchett, 2018). Climate change can potentially cause desertification leading to desert invasions which is associated with prolonged dry climate conditions that influence the aesthetic component of tourism. These conditions have been observed in Kgalagai Trans-frontier Park and a number of localities in Nigeria (Dillimono & Dickinson, 2015). Wildlife that plays a critical role in the tourism industry is affected by vegetation reduction due to drought events caused by climate change. Vegetation provides both habitat and food for wildlife (Steyn and Spencer, 2012).

What is known is that majority of tourist attractions in African countries, including Kenya, are found outdoor, for example, beach and nature-based tourism; thereby implying greater reliance

on climate and weather conditions (Hoogendoorn and Fitchett, 2018). Additionally, nature-based tourism forms the foundation of the tourism industry with close connections with climate that is already changing. It is not clearly known how climatic changes will impact natural resources such as wildlife that are important for the tourism industry that this study sought to explore and contribute to the body of knowledge. Also, knowledge and information on how climate change will influence the socio-economic and environmental sustainability of the tourism industry remains scanty and marred with misunderstanding and misconceptions that this study seeks to address.

1.2. PROBLEM STATEMENT

Climate change is among one of the most serious global challenges. For instance, many parts of Africa have and continue to experience irregular and unpredictable rainfall as some regions also grapple with severe floods (Nyamwange, 2016). The impacts of climate change and accompanying socio-economic consequences on communities remain exceptional challenges for Kenya (Manono, 2015). Climate change impacts have the potential to affect natural resources such as wildlife and biodiversity that are critical in supporting tourism (KEPSA, 2014). Kenya's tourism industry is nature-based and is dependent on rich biodiversity (Munyiri, 2015). Kenya has a variety of premium national parks and reserves in different sections of the country that make wildlife tourism a key tourism product (Muchoki, 2018).

Wildlife remains a focal attraction for the Kenyan tourism sector (Ngaruya, 2013). However, key natural resources that wildlife depends on for survival, for example water and forage, are susceptible to climate variability. For instance, in the Mara-Serengeti ecosystem, vegetation growth is mainly determined by rainfall which influences the population of large herbivores (Muchoki, 2018) that attract tourists. In this region rainfall in the past 30 years has been

characterized by periods of predominantly wet years followed by dry years. These fluctuations encompass climate change by virtue of rainfall and temperature variables that result in either the occurrence of drought, floods and changes in temperature (Muchoki, 2018).

Consequently, the implications of continued climate variations are mostly on habitats and quality of vegetation for wildlife that deteriorate and lead to disruptions in wildlife migration patterns and populations due to a reduction in vegetation cover (Muchoki, 2018). Muchogu (2014) highlights concerns about loss of vegetation cover and increased mortality of wildlife in the Greater Mara Ecosystem. Ogutu *et al.* (2016) also report a myriad of threats facing protected areas including droughts that are significant indicators of climate change. The report indicates that droughts have caused a decline in all wildlife species by about 70% during the years 1977-2016. Kenya Wildlife Service (KWS) has also cited wildlife mortality during prolonged and dry seasons (Kanga *et al.,* 2013).

In Kenya's MMNR Ogutu (2016) claims that a combination of variables, including climate change, have resulted in catastrophic reductions in wildlife populations. According to the dynamic global vegetation model (DVGM), 54 of the 855 wildlife species (6%) in the Greater Maasai Mara may find the future climate inappropriate by 2050, while 101 of the 793 species (13%) in the MMNR may no longer find MMNR climatically favourable by 2050 (Coldret and Turpie, 2019). Manono (2015) also argues that climate change has resulted to a decrease of the Mara River water levels during the dry seasons. Furthermore, tourism infrastructure in MMNR face increased flood risks that is likely to impact socioeconomic benefits of tourism by impacting negatively on tourism demand (Coldret and Turpie, 2019).

Kanga *et al.* (2013) affirm that due to variations in rainfall patterns in MMNR as a result of climate change, the timings of the famous wildebeest migration changes from year to year shifting to earlier than expected or late. Therefore, climate change has the potential to cause far-

reaching consequences for tourism destinations mainly dependent on natural resources. This is because climate change is likely to be a major driver for extinction of migratory and resident wildlife species. Consequently, it can lead to socioeconomic vulnerability of communities depending on tourism due to reduced attractiveness and lower tourism activity and related income (Ngaruiya, 2013). The sustainability of the tourism industry is possibly compromised at this point as climate change affects natural resources such as wildlife that support the tourism industry.

1.3. PURPOSE OF THE STUDY

The purpose of this study was to assess the effects of climate change on natural resource and tourism sustainability in Maasai Mara National Reserve (MMNR).

1.4. RESEARCH OBJECTIVES

1. To establish the effects of climate change on natural resources in MMNR.
2. To identify the effects of natural resources on tourism sustainability in MMNR.
3. To determine the relationship between climate change and tourism sustainability in MMNR.
4. To explore the mediating effect of climate change and natural resources on tourism sustainability in MMNR.

1.5. RESEARCH QUESTIONS

1. To what extent does climate change affect natural resources in MMNR?
2. What are the effects of natural resources on tourism sustainability in MMNR?
3. What is the relationship between climate change and tourism sustainability in MMNR?
4. What are the mediating effects of climate change and natural resources on tourism sustainability in MMNR?

1.6. RESEARCH HYPOTHESIS

H_{O1}: There is no significant influence of climate change on natural resources in MMNR.

H_{O2} There is no significant influence of natural resources on tourism sustainability in MMNR.

H_{O3}: There is no significant relationship between climate change and tourism sustainability in MMNR.

H_{O4}: There are no significant mediating effect of natural resources and climate change on tourism sustainability in MMNR.

1.7. JUSTIFICATION OF THE STUDY

Climate change impacts pose serious risks as well as challenges for the tourism industry globally, and especially in developing countries. For instance, regional knowledge gaps regarding the effects of climate change on tourism exist (IPCC, 2018). More importantly, climate change has the potential to cause far reaching consequences for the future of tourism (Scott *et al.*, 2019). This brings middle income countries such as Kenya into the focus of research process on climate change and tourism. For the tourism industry, on one hand, the latter contributes to economic growth as well as climate change. On the other hand, the impact of climate change is also predicted to adversely affect the tourism sector. Therefore, effects of climate change are of great interest and importance for the tourism industry stakeholders. While substantial progress has been made in studying implications of climate change in different areas, climate change impacts on the tourism industry remains under-explored (Becken, 2019).

Furthermore, published tourism and climate change research in developing countries remains scanty (Scott *et al.,* 2016). Large gaps exist in research on the impacts of climate change on tourism. For instance, tourism sector content in the regional chapters of the Intergovernmental Panel on Climate Change (IPCC) assessment reports on potential impacts of climate change

remain poorly understood for Africa (Scott *et al.,* 2016). Also, a dire need exists to boost practical research concerning the impacts of climate change on tourism because tourism is one of the most important and highly promising economic activities in Africa (Scott *et al.,* 2019). Therefore, this research seeks to expand the knowledge as well as deepen the understanding of the relationship between climate change, natural resources and sustainability of tourism.

1.8. SIGNIFICANCE OF THE STUDY

This research is important for the following reasons: Natural resources form the basis and foundations of the tourism industry, especially in Kenya. At the same time climate change has the potential to influence the quality, nature and abundance of natural resources that the tourism industry depends on. This will possibly have a direct influence on the economic, environmental as well as social benefits that tourism generates. Therefore, it is vital that the implications of climate change on wildlife and vegetation as well as social, economic and environmental sustainability be known and determined in order to inform the current and future planning, development and management of the tourism industry in Kenya.

Findings from the study have the potential to provide an understanding of the complex relationship between climate change, natural resources and tourism. This will enable tourism stakeholders capitalize on opportunities posed by climate change, strengthen their resilience and adaptive capacity to the negative effects of climate change. Also, findings will offer data for future tourist investments. More importantly, tourism stakeholders will be better positioned to anticipate what is likely to occur, and develop appropriate plans to mitigate potential negative effects while maximizing positive effects of climate change.

Knowledge creation and building on the effects of climate change on natural resources and tourism sustainability will inform policymakers and the tourism industry operators. For example,

the findings of the study have the potential to inform government guidelines, operating procedures, strategic plans, and legal frameworks in combating climate change impacts, particularly on adaptation and mitigation strategies in the face of extreme climate change events. Furthermore, the study provides a basis for data generation, hypothesis testing, and future theory formation in the fields of climate change and tourism sustainability where insufficient research has been observed. Without this, it is difficult to develop a consistent set of research methodologies, and perhaps more crucially, develop models that constitute a bridge between the observational and theoretical levels that can assist in building a coherent knowledge base for understanding, explanation and prediction of climate change.

1.9. SCOPE OF THE STUDY

This study was delimited to investigating climate change effects on natural resources and sustainability of tourism. This means the study narrowed to only two variables on climate change, which is rainfall and temperature, were used to measure climate change. This is because of the readily available quantitative data on rainfall and temperature. Natural resources was a mediator variable and was operationalized by wildlife and vegetation variables only. Other natural resources for instance sunshine, water bodies, landscape and forests were not included. Wildlife and vegetation have a close relationship and a direct association with wildlife tourism, justifying their inclusion. Future studies ought to be conducted in other tourism attractions such as marine parks, conservancies, sanctuaries in order to draw comparison and further similarities. The study focused on climate change implications on a single sector, which is the tourism industry, despite the fact that the tourism sector is heavily intertwined as well as interlinked with other sectors of the economy, for example infrastructure, security and agriculture, with greater multiplier effects.

1.10. STUDY LIMITATIONS

MMNR is a vast rural area with almost inadequate public transport and public amenities. This made data collection difficult with limited financial resources. A research grant support was sought from the Mara Triangle with no feedback. Two research assistants from the local community were recruited and trained on data collection. The two research assistants had their first degree with rich indigenous knowledge and know how about the study area. They were also able to speak the local Maasai language and simplify the concept of climate change to the host community, making data collection a success. Questionnaires were used for data collection where prompting and testing are difficult, limiting the breadth of responses and the potential of extra data being received. A pilot study was conducted in the Mara Triangle making the questionnaires detailed and specific to avoid this limitation.

Furthermore, interviews consume much time in terms of preparation, scheduling, writing letters and booking appointments in a busy working environment. The researcher took leave off official duties, ensuring enough time was allocated during this period. A key informant interview was conducted where it was not easy to prove that the interviewees were in fact knowledgeable and informed and that they were representative of their peers in their information and recommendations. The researcher did a background check of all key informants with close consultation with the supervisors before inclusion in the study. This ensured the key informants were well versed and had the requisite experience and expertise to be included in the study. Lastly, the sample comprised the host community in MMNR, tourists, climate change, natural resources and sustainable tourism experts. Therefore, involvement of more tourism stakeholders would result in a more comprehensive research output.

1.11. ASSUMPTIONS OF THE STUDY

Firstly, the study assumed that key informants, tourists and host community who took part in the study were well informed about implications of climate change on natural resources and tourism sustainability. Secondly, an assumption was made that climate change influences natural resources and, eventually, sustainability of tourism. Thirdly, it was assumed that the researcher was able to control other non-climate related factors that influence climate change as there exists a part of the model that has these other factors developed, and that the impact of other factors such as poaching, natural diseases and human encroachment are minimal. Fourthly, the primary determinant of tourism sustainability was considered to be climate change. Fifthly, it was assumed that all respondents provided all information required confidentially, truthfully and with utmost honesty. Sixthly, the study assumed that the household population in Narok South Sub-County where MMNR is located was evenly distributed. Lastly, the study assumed that the various ratings of opinions on climate change and tourism sustainability are accurate.

CHAPTER TWO

LITERATURE REVIEW

This chapter begins with a review of the literature that describes the phenomenon of climate change as well as its historical development. Then a discussion follows about the relationship between climate change, natural resources and tourism sustainability, based on the objectives of the study. Tourism organizations responses to climate change and climate change effects on tourist's arrivals, tourism operations and natural tourism resources (wildlife and vegetation) are also showcased. Further, an explanation of possible challenges and opportunities posed by climate change for the tourism industry is presented. Finally, a summary of the chapter and its conclusion are described.

2.1. THE CONCEPT OF CLIMATE CHANGE AND ITS INFLUENCE ON TOURISM

The World Climate Conference (WCC) was the first to explicitly describe human-induced climate change as a major environmental problem to be addressed by developing environmental policies (Vlassopoulos, 2012). According to the conference, climate change was defined as the difference between two identical climate states, such as the difference between climates of two decades (WMO, 1979). Climate change is defined by Cater *et al.* (2015) as alteration in the long-term average weather experienced on a global scale. Increasing temperatures cause extreme weather and climate events such as heavy precipitation, droughts, and sea level rise that are becoming more often and intense as a result of climate change (Semenza and Kristie, 2019).

Human activities have caused 1.0°C of global warming since pre-industrial times, according to the IPCC (2018) report, and are expected to reach 1.5°C between 2030 and 2052. Climate change is accelerating and will continue to accelerate, according to the report findings. With accelerating

climate change impacts, it is not clear how the tourism industry and its sustainability will be affected. The report further indicates that temperatures will rise as well as the frequency, severity, and length of heat waves, including heavy precipitation events throughout the world, and the risk of drought. Variations in the frequency or length of weather factors such as precipitation and severe temperatures pose considerable risk to tourists and their travel experience (De Urioste-Stone *et al.,* 2016). These variations in climate and weather conditions have the potential to make nature-based tourism sites less attractive to tourists (Dube and Nhamo, 2020).

Climate change is already affecting high altitude areas of Asia and the Himalayas as the glacier covering decreases (Murtaza and Romshoo, 2016). In other countries, such as Taiwan, their national parks have experienced declines in tourism due to irregularities in precipitation (Liu, 2016). Iran in the Middle East is affected by high temperatures that cause severe heat waves which caused declines in tourist inflow (Yazdanpanah *et al.,* 2016).

Islands are diminishing in other locations such as Vann Island in India's Mannar Gulf that reduced to 84% of its original size and is anticipated to be entirely submerged by 2022 as the sea level increases (Jayaprakash *et al.,* 2016). Forests in North Africa are major tourist sites where tourism activities such as bird watching, hiking and nature walks are common. Climate change has significantly affected these forests, in particular, with regard to increased extreme events such as forest fires and precipitation changes (Médail, 2017). This raises concerns about the potential of forests to support tourism-related activities in future.

Altered precipitation, extreme heat and storms have also affected Latin America and the Caribbean (LAC) (Siddiqui and Imran, 2019). It is reported that the Amazon Basin is at risk, facing extreme drought by the end of the 21st century (Dai, 2013). Moreover, a modeled

prediction suggests that climate change will increase forest fires in the Amazon Basin by 12% before 2050 (Seneviratne *et al.*, 2012).

Climate change results to the following effects: bush encroachment in national parks located in arid and semi-arid environments (Midgley and Bond, 2015), detrimental effects to wildlife habitats (Di Minin *et al.,* 2016), and disruption in predatory-prey interaction (Creel *et al.,* 2016). A study by Dube *et al*. (2018) reveals that tourists are worried about the impacts of climate change on tourist resorts including wildlife as a tourist attraction and that they could be forced to make changes to their future travel patterns as well as destination choices. Mushawemhuka *et al*. (2018) also argues that due to extreme weather events caused by climate change, including severe rains that rendered tourism destinations inaccessible, demand for air conditioning in accommodation establishments has increased. This will definitely have an influence on sustainability of the tourism industry especially in tourism attractions already experiencing climate change impacts.

Catastrophic weather occurrences in form of droughts, heat waves and flooding have been on the increase in South Africa (Dube and Nhamo, 2019). Other studies have emphasized that such extreme events would certainly undermine tourist activities (Dube and Nhamo, 2019; Van Wilgen *et al.,* 2016). Kilungu *et al.* (2017) note that wildlife migration patterns have been disrupted in Tanzania's Serengeti National Park due to climate change impacts, causing dramatic wildlife losses with the potential of altering tourism seasonality. The sustainability of the tourism industry is certainly negatively affected by such wildlife losses as the industry especially in Kenya is significantly dependent on wildlife.

Muchoki (2018) asserts that the impacts of climate change in MMNR are not confined to wildlife but also droughts and floods which impact overall tourism. For instance, during periods of extreme rainfall flood waters destroy tourism infrastructure and amenities and in some cases

render game drive roads impassable. Muchoki (2018) further asserts that during rainy season accommodation facilities including tented camps in MMNR face serious risks of flooding as some of them close down, implying limited options for tourists. This implies that projections of increased flooding in terms of severity and intensity will negatively affect tourism facilities in the future and consequently raising questions about the ability of the tourism industry to be sustainable.

2.1.1. Evolution of climate change discourse

Conversations around climate change were initiated by French mathematician and Physician Jean Fourier in 1824 in an article published 'Annales de la Chimie *et de* Physique' where he discovered greenhouse effect that is the core of the argument on climate change (Vlassopoulos, 2012). Climate change was solely discussed in the scientific community ever since it emerged in the early 19th century to the end of the 20th century in 1970 (Vlassopoulos, 2012). From the early 1970s onwards there was a significant rise of environmentalism that triggered interests and concerns about climate change, culminating in programs and research to study and acknowledge the extent of anthropogenic climate change (Rahman, 2013).

1972 saw the convening of the United Nations Human and Environment Conference that put climate change on the global policy agenda (Hongyuan, 2015). In the following years, for instance 1990s, discussions on climate change and a rise of environmental movement intensified. The First World Climate Conference (WCC) was conducted by the World Meteorological Organization (WMO) in 1979 and identified climate change as an important worldwide issue and issued a declaration calling on Governments to foresee and guard against potential climate risks (Rahman, 2013).

Between February 1991 and May 1992, the Intergovernmental Negotiating Committee for the Framework Convention on Climate Change (INC/FCCC) held five sessions (Hongyuan, 2015). Consequently, the United Nations Framework Convention on Climate Change (UNFCCC) was adopted on May 9, 1992, in Rio de Janeiro Brazil and opened for signatures at the United Nations Conference on Climate Change and Development in June 1992 where it received 155 signatures to ratify the convention. The Conference of Parties (COP) took over the ultimate authority for the convention after the Rio de Janeiro Conference and held its inaugural meeting (COP 1) in Berlin in early 1995. Conference of Parties 2 (COP 2) was convened in Geneva in June 1996 and determined that the human influence on the global climate posed challenges to socioeconomic development (Hongyuan, 2015). In the year 1997 the Kyoto Protocol (COP 3) was launched by UNFCCC with more than 150 nations adopting the protocol. The protocol came into force with the aim of reducing global greenhouse gases to 7% below the 1990 level between the years 2008 and 2012.

The Kyoto Protocol is recognized as a major solid commitment in tackling global climate change and the United Nations Framework Convention on Climate Change (UNFCCC) convened conferences of parties (COP 1-12) that ended in 2012 (Hongyuan, 2015). However, the Kyoto Protocol was not ratified by the United States (Leggett, 2020). Climate change discourse moved from a solely scientific issue to a public agenda between 1970 and 2012, and it is now more likely to be a development challenge (Rahman, 2013). Figure 2.1 depicts the overall history of climate change discourse across three centuries, illustrating how it has changed over time (Rahman, 2013).

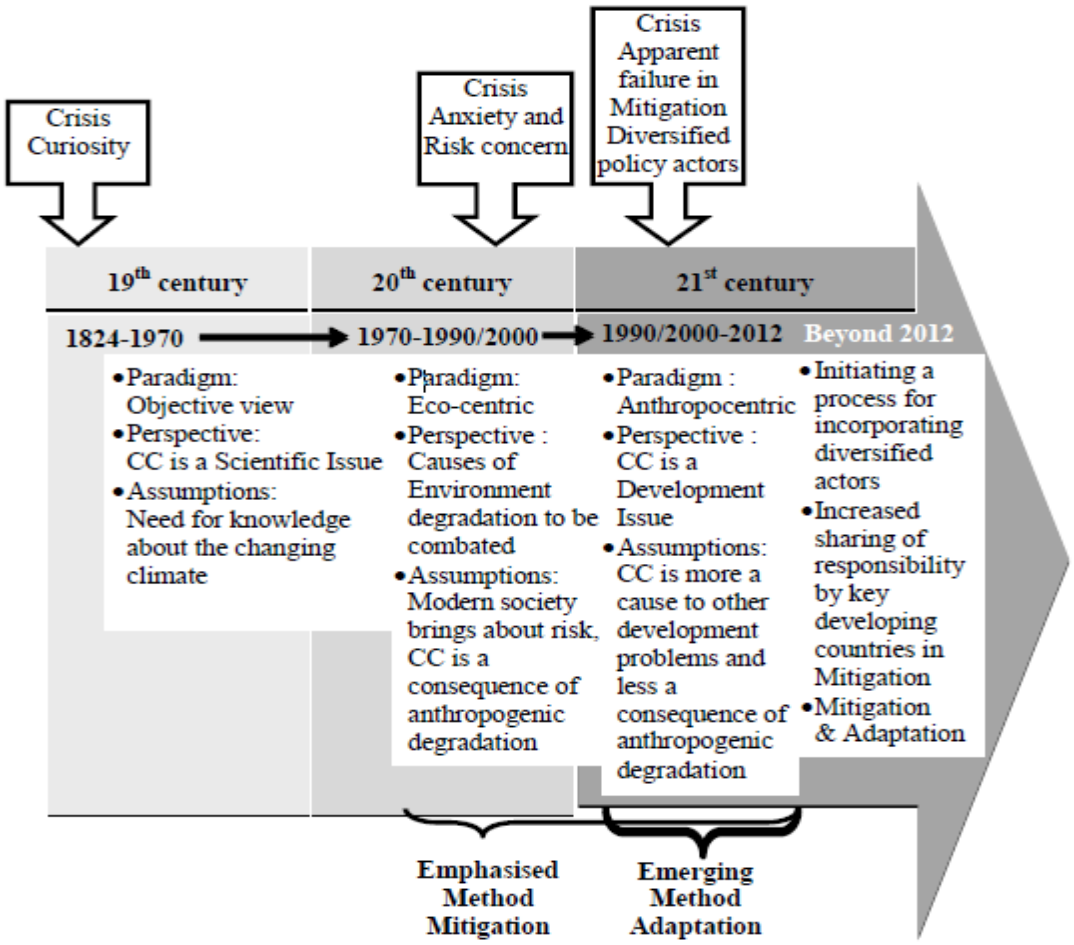


Figure 2.1: Evolution of the climate change discourse
Source: Rahman (2013).

Beyond 2012

In 2011 in Durban the Kyoto Protocol was extended to a second cycle (COP 12-17) of commitments requiring governments to cooperate on the Post 2020 Climate Roadmap with legal effect by 2015 (Hongyuan, 2015). China and the USA and other nations agreed to conclude by 2015 a legally binding agreement setting concrete carbon reduction targets beginning in 2020 (Hongyuan, 2015). The climate conference of 2013 in Warsaw resolved to invite all conference parties to draft their Intended Nationally Determined Contributions (INDCs) (McDonald, 2013).

All states were required to submit their INDCs plans to the UN website for publication and onward showcase to the public according to the 2014 Lima Agreement. The UNFCCC acknowledges that these INDCs form the foundation for climate action by 2020 when new accords become operational (Hongyuan, 2015). The European Union (EU) was one of the first parties to declare their INDCs as part of its target to decrease emissions by 40% by 2030. India is likely to develop mechanisms to increase energy as China declared that it intends to reduce carbon emissions by 2030 and increase its share in non-fossil fuel primary energy consumption by about 20% (Hongyuan, 2015). Table 2.1 gives a detailed summary of the evolution of climate change discourse.

Table 2.1 Detailed summary of the evolution of climate change discourse, 1990-2020

1979: Climate change was identified as global problem by the First World Climate Conference.
1988: Toronto's Changing Atmosphere Conference led public debate by recommending the development of a worldwide comprehensive atmospheric framework treaty for over 340 participants from 46 nations. The WMO and UNEP set up the Intergovernmental Climate Change Panel (IPCC).
1990: The IPCC issued the First State of the World Climate Assessment report, with a strong impact on policy makers and the public.
1992: UN Conference on Environment and Development held in Rio de Janeiro, Brazil (Earth Summit). The United Nations Climate Change Framework Convention was formed including Agenda 21.
1994: Climate Convention entry into force.
1995: First Conference of Parties (COP 1) held in Berlin, Germany. The Convention Party concluded that the obligations under the Convention were inadequate for industrialized nations and initiated discussions on further commitments under the Berlin Mandate.
1996: In preparation for (COP 2) in Geneva, Switzerland. The IPCC completed its second assessment report. It determined that there is a perceptible human effect on the global climate, which poses a threat to human and economic growth based on the existing data.
1997: UNFCCC launched and adopted the Kyoto Protocol (COP 3) in Kyoto, Japan.
1998: COP 4 was held in November in Buenos Aires, Argentina and agreed on a two-year strategy to complete the so-called Buenos Aires action plan (BAPA).
1999: The agenda of (COP 5) held in Bonn, Germany and was based on Buenos Aires action plan (BAPA).
2000: COP 6 was held in The Hague, Netherlands. Only the US and the EU made progressive commitments.
2001: COP 7 was held in Marrakech, Morocco. The Kyoto protocol was criticized and more binding targets set.
2002: COP 8 held in New Delhi, India and adopted the Delhi Ministerial Declaration on Climate Change and Sustainable Development.
2003: Decisions on afforestation and reforestation were approved in December 2003 at COP 9 in Milan, Italy.
2004: COP 10 held in December in Buenos Aires, Argentina and focused mostly on climate change adaptation and one of the outputs was a program for adaptation and reaction measures in Buenos Aires.
2005: COP 11 held in Montreal, Canada. The Kyoto Protocol came into effect.
2006: COP 12 held in Nairobi, Kenya dubbed the Conference of Nairobi on Climate Change.
2007: COP 13 held in Bali, Indonesia. The talks focused on GHG reduction in the post-2012 context
2008: COP 14 held in Poznan, Poland.

2009: COP 15 held in Copenhagen, Denmark. Prospective adoption of the post-2012 climate change regime.
2010: COP 16 held in Cancun, Mexico. Legally binding global emission targets for wealthy nations realized.
2011: COP-17 and MOP-7, Durban, South Africa. Durban Platform for Enhanced Action made all countries at the UN climate change conference confirm to a legal framework toward a new global pact that would bring all major emitters developed and developing into its fold.
2012: The 18th session of the Conference of the Parties (COP 18) to the UN Framework Convention on Climate Change (UNFCCC) and the eighth session of the Conference of the Parties serving as the Meeting of Parties to the Kyoto Protocol (COP/MOP 8) took place in Doha, Qatar.
2013: COP 19 held in Warsaw. The 195 Parties to a UN Climate Convention will apply "to everyone" without differentiating between rich and poor states, as laid forth in the Kyoto Protocol, reinforced the basic concept of the Varsovian Consensus.
2014: COP 20 held in Lima, Peru. The Lima Agreement requires INDCs to be submitted to all nations on the website of the United Nations.
2015: The 21st Conference of the Parties (COP 21) and the 11th Conference of the Parties acting as the conference of the CMP Parties were held in Paris, France.
2016: COP 22 was held in Marrakech, Morocco. The summit was crucial in addressing pressing UNFCC issues.
2017: The Conference of the Parties held its 23rd session (COP 23) in Bonn, Germany.
2018: COP 24, also called the 2018 Katowice Conference on Climate Change was in Katowice, Poland. In 2018.
2019: COP 25, 25th Climate Change Conference of the United Nations. The event took place in Madrid, Spain.
2020: Start of the five year cycles for updates and progress reports on emissions reductions
2021: COP 26, which is to be held in Glasgow, Scotland, in 2021, is the 26th United Nations Climate Change Conference.

Source: Compiled by Researcher (2020) from (https://unfccc.int/timeline/)

2.2. THE GLOBAL TOURISM INDUSTRY AND CLIMATE CHANGE

In the last 50 years, the global tourism industry has undergone enormous growth and development (WTO, 2018). The economic contribution of the tourism sector to the world economy was USD 7.2 trillion in 2015 (9.8% of global GDP) while creating 284 million jobs, representing 9.1% of the worlds jobs (WTTC, 2016). In fact, tourism is the third largest category of export after petroleum and chemicals globally. In addition, in 2019 tourism accounted for 7% of world trade, which accounted for up to 20% of GDP for some nations, employing one in every 10 people worldwide (WTO, 2020). In the same year foreign visitor arrivals totaled 1,461 million, generating USD 1,494 billion in tourism revenues, up 4% from the previous year, consolidating a ten-year trend of tourism growing faster than the global economy as a whole (WTO, 2020). The tourism sector is significantly more important in hundreds of destination areas and over 90 nations where tourism contributes to more than 10% of national GDP and a substantial part of employment (WTTC, 2016).

Corona virus pandemic triggered an unprecedented decrease in demand and extensive limitations on travelling in the year 2020, which is the worst in the history of world tourism with foreign arrivals falling by 74% (WTO, 2021). The number of foreign arrivals in tourism locations was 1 billion lower in 2020 than the year before (WTO, 2021). The decline in international tourism travel is projected to lose from USD $910 billion to USD $1.3 trillion in export revenues from tourism, according to the World Tourism Barometer (WTO, 2021). WTO experts forecast increasing demand for open-air and natural tourism when tourism rebounds in 2021/2022 (WTO, 2021). Figure 2.2 shows global international tourism receipts (exports) in the period 2000-2020.

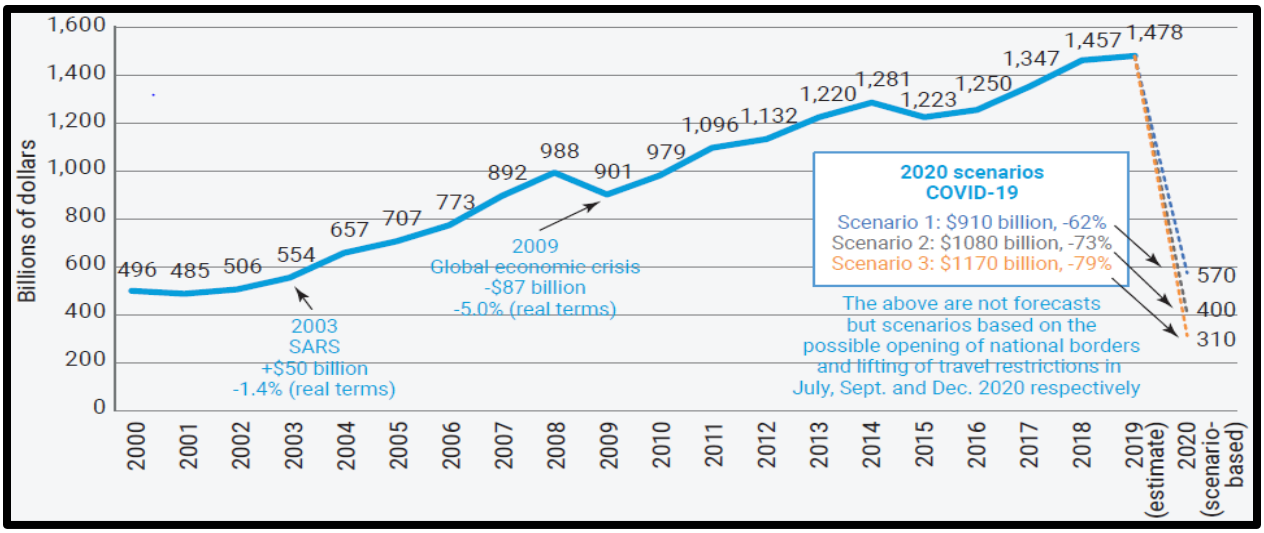


Figure 2.2. International tourism receipts (exports) between 2000-2019 as well as 2020 scenarios.
Source: WTO (2020)

Despite its worldwide socioeconomic significance, the tourism sector is confronted with an unprecedented challenge of climate change that has been the topic of global discussion and debate to date. For example, Agenda 21 was created during the Earth Summit in Rio de Janeiro, Brazil, in 1992. In 1997 the United Nations Framework Convention on Climate Change (UNFCC) launched the Kyoto Protocol in Japan, which sparked the current climate change and

tourism debate. In 2010 and 2012 two international conferences on climate change and tourism were conducted. The Kyoto Protocol expired in 2012 and the Nationally Determined Contributions (NDCs) process began, requiring countries to disclose their climate actions from the year 2020. Table 2.2 indicates a summary of major events in relation to climate change and tourism globally.

Table 2.2: Major events related to climate change and the global tourism industry

1992: Earth summit held in Rio de Janeiro, Brazil. The summit produced Agenda 21. Agenda 21 for Travel & Tourism that was designated one of the major economic areas that could contribute positively to sustainable development.
1996: The World Travel and Tourism Committee, the World Tourism Organization and the Earth Council united in launching an action plan entitled "Agenda 21 for Travel and Tourism: Towards Environmentally Sustainable Development" based on the Rio Declaration on Environment and Development (Earth Summit).
2003: First international conference on climate Change and tourism held in Djerba, Tunisia, resulting in the Djerba Climate Change Declaration, which highlighted how important climate change is to the sustainability of the global tourism sector.
2006: World Meteorological Organization (WMO) in conjunction with the WTO set up a team of experts on climate and tourism to further the implementation and understanding of climate and meteorological data in the tourism industry.
2007: Second international conference on climate change and tourism was held in Davos, Switzerland. It was organized by the World Tourism Organization (WTO), United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO). Davos Declaration was the outcome of the conference. The declaration recognized not just the realities of climate change and the interaction between tourism and travel, but also the need for a long-term strategy to minimize emissions of greenhouse gas from inside the industry.
2008: WMO and UNEP in cooperation with Oxford University published a report titled "Climate change and tourism response to global challenges" in support of the Davos Declaration.
2009: WTTC established ambitious goals for the tourism industry to reduce carbon emissions by at least 50 percent by 2035, with an intermediate aim of 30 percent by 2020.
2010: WTTC published a report titled "Climate change, a joint action approach to climate change, goals for the development of framework and partnerships to support policy-making and the implementation of actions to decrease greenhouse emissions for tourism, 2010 (GHGs)
2012: COP 13 where aviation was included in European Union, WTO side event.
2015: WTTC reported on developments at COP 21 and detailed the sector's preparation for travel & tourism actions to mitigate climate change.
2016: World Travel and Tourism Council summit held in Dallas to discuss climate change influence on travel and tourism.
2017: International Year of Sustainable Tourism Development (IYSTD) held in Madrid, Spain. Offered an opportunity for travel and tourism stakeholders to meet and discuss climate change challenges for the sector.
2019: Transforming Tourism for Climate Action side event at COP 25 held in Madrid, Spain. Led by the WTO and the governments of France and Spain in conjunction with UN Environment. The Nationally Determined Contributions (NDC) Partnership Plans were launched by six nations.
2020: COP 26 event which was rescheduled to 2021 due to COVID-19.
2021: COP 26 scheduled for 2021 in Glasgow, Scotland. Countries were expected showcase their Nationally Determined Contributions (NDC) including plans to cut emissions from the travel and tourism sector.

Source: Modified from Zeppel (2011); WTO (2009).

The tourism industry is vulnerable to climate change impacts as it also contributes to climate change. According to the WTTC and ITF (2019) report, the tourism industry is at a danger from the effects of climate change. The report identifies extreme weather events that are likely to cause increased insurance costs and safety concerns, as well as biodiversity loss and damage to tourism attractions. Also, because of the competitiveness of tourist industries is based on natural and cultural resources, continued climatic changes can cause disruption of cultural and natural assets. This is likely to cause a negative impact on the tourism industry through decreasing the attractiveness of destinations and hence a decline in the number of visitors, coupled with limited economic opportunities for local communities (WTO & ITF, 2019).

Analysis by Lenzen *et al.* (2018) approximates tourism contribution to the global anthropogenic CO_2 at 8%. WTO (2018) estimates 75% of global tourism sector CO_2 emissions are being caused by transportation, in particular 40% air transport, 30% car transport and 3% other transport, while accommodation and tourist activities account for 21% and 4% respectively. Furthermore, Gossling and Peeters (2015) assessed the global sector global environmental impact and concluded that global tourism contributed 1.12 Gt (gigatonnes) of CO_2 over 1900-2010. Lenzen *et al.* (2018) also report that in the years 2009-2013 tourism's global carbon footprint increased from 3.9Gt to 4.5 Gt of CO_2.

Tourism-related CO_2 emissions totaled 982 million tonnes in 2005, including both overnight and same-day tourists, accounting for 18% of total transport emissions and 3.7% of all man-made CO_2 emissions worldwide (WTO & UNEP, 2019). In 2016 tourism-related transport-related CO_2 emissions were 1,597 million tonnes, with overnight stays accounting for 1,371 million tonnes and same-day visitors accounting for 200 million tonnes (WTO & ITF, 2019). In 2030, total tourism-related CO_2 emissions (excluding cruises) are expected to reach 1,998 million tonnes,

with 1,768 million tonnes accounting for all night-time emissions and same-day visitors accounting for 230 million tonnes (IEA, 2018).

Despite the fact that climate is one of the major tourism resources that drive and shape the tourism industry, climate change is predicted to have adverse effects on the tourism industry (Hall *et al.,* 2015). For example, climate change impacts are predicted to affect natural resources such as wildlife that are critical in supporting the tourism industry. Dogru *et al.* (2019) assert that deteriorations in natural resources continue because of changing climate patterns as negative impacts on sustainable tourism growth are eminent. Both domestic and international tourism flow patterns are projected to shift concurrently to large-scale climate changes (Bujosa *et al.,* 2015). The tourism industry has become more cognizant of the susceptibility of tourism to climate change (Gössling and Scott, 2018), although the impact of climate change on the tourism sector remains unpredictable at the regional and local levels (Scott *et al.,* 2019).

Following the Paris Agreement and the 2030 Agenda for Sustainable Development, national partnership was opened to countries and international institutions that are committed to the ambitious implementation of the Nationally Determined Contributions (NDCs). The partnership provides members with access to a global knowledge and resource network to support their work of climate action. Kenya joined the NDC Partnership in 2017 and sought assistance in updating its National Climate Change Action Plan (NCCAP) for 2018-2022, which includes the country's SDGs, NDC, National Adaptation Plan, Medium-Term Plan, and the Big Four Agenda, a national economic development plan (GoK, 2017).

Due to its potential for rapid growth and a key driver of global economic development, Mukogo (2014) acknowledges that the tourism sector has the potential to make a significant contribution in combating climate change. Attesting to this opinion are the current tourism industry practices such as eco-rating schemes for tourism organizations, emphasis on green tourism products with

minimal carbon foot-print and, most importantly, tourists are becoming more conscious about the environment, hence demanding environmentally friendly tourism products and services. As tourists continually seek destinations with favorable climate, current popular ones are likely to become less attractive (Rosselló, 2015). Consequently, this phenomenon will negatively impact the sustainability of tourism.

2.2.1. Tourism and climate change in Africa

Africa has been identified as one of the most susceptible continents to climate change effects (IPCC, 2014). According to Rogerson (2016), climate change impacts on tourism are high in middle income countries such as Kenya. This is because of shortage of scientific research in the area of climate and tourism in Africa (Njoroge, 2015). Boley (2014) further argues that many researchers claim that the consequences of changing climate will cause middle income countries face the largest amount of impacts. This is possibly attributed to low adaptive capacity coupled with insufficient research and knowledge in climate change science and tourism. According to Serdeczny *et al.* (2015), the impacts of climate change in Sub-Saharan Africa include a warming trend causing more frequent extreme heat events and changes in rainfall patterns. These changes will definitely have ramifications for the tourism industry.

The tourism industry in Africa is mainly nature based. For instance, South Africa's tourism sector is centered on nature and wildlife encounters that play a key role in its development (Dube and Nhamo, 2019). Seasonality of tourism, visitor choice of destinations, availability of tourist attractions and activities, including overall holiday enjoyment, are all influenced by the climate factors (Dubois *et al.*, 2016). Therefore, climate change has the potential to affect the tourism industry's sustainability in Africa (Hoogendoorn *et al.*, 2016). For instance, tourists are affected by extreme thermal discomfort and direct effects of increased temperatures when temperatures

surpass the human comfort level (Gössling and Schumacher, 2010.). Additionally, indirect impacts of temperature changes with varying levels affect the natural environment that is part of the tourist attraction (Hambira *et al.,* 2013).

Climate changes by way of extreme weather events pose significant threats to wildlife and tourism (Midgley and Bond, 2015). Progressive climate changes via frequent occurrences of storms, floods and rising sea levels can cause tourism sites become unsuitable for tourists (Hoogendoorn *et al.,* 2016). This climate related catastrophes have the potential to close down tourist destinations as well as cause long-term economic loss (Darkoh *et al.,* 2014). This phenomenon has been observed in African nations such as Botswana, Tanzania, Zambia and Zimbabwe, where climate change has affected the patterns of wildlife migration, diminished biodiversity and disrupted patterns of tourism flow (Dube *et al*., 2018; Dube and Nhamo, 2018, 2019a; Kilungu *et al*., 2017).

In Southern Africa's national parks, high temperatures and increasing aridity have been identified to cause flora and wildlife declines (Dube and Nhamo, 2019). A research study by Woodroffe *et al.* (2017) revealed that severe temperatures in South Africa's national parks have adverse impacts on tropical carnivores and other ungulates with concerns that tourism in the area will be negatively affected. In addition, the tourism sector in South Africa has been subject to infrastructural damage by storms. This is because of the location of nature and beach-related tourism facilities and attractions in the eastern part of the country that is exposed to tropical cyclones (Fitchett *et al.,* 2016).

In Nigeria floods have hampered accessibility to tourist destinations and hindered tourism activities (Dillimono & Dickinson, 2015). The same situation applies to the Okavango Delta in Botswana (Darkoh *et al.,* 2014) as well as the Limpopo Province (Fitchett *et al.,* 2016) and the south coast of South Africa (Hoogendoorn *et al.,* 2016). Concerns exist that the Okavango Delta

would no longer provide tourist attractions under prolonged drying conditions as fluctuations in rainfall patterns are adequate to change travel decisions, and affect activities such as boat excursions that will be increasingly unavailable (Hambira & Saarinen, 2015).

Climate change impacts such as desertification are linked to prolonged dry weather conditions that can alter the aesthetic component of tourism that have been observed in Kgalagai Trans-frontier Park as well as several locations in Nigeria (Dillimono & Dickinson, 2015). Most crucially, aridification and drought conditions can significantly affect wildlife population, including variety and specie distribution in game reserves (Hoogendoorn and Fitchett, 2018) such as MMNR. Under these conditions, it is highly likely that achieving sustainable development and growth of the tourism sector will be a challenge as tourism revenue dwindles from reduced tourism-related activities.

2.2.2. Tourism industry in Kenya

Kenya ranks among the top biodiversity rich countries globally, characterized by iconic wildlife species, including extensive conservation spaces as the country's key tourism assets. Kenya's tourism industry contributes to 10% of Gross Domestic Product (GDP) and employs 11% of the country's overall workforce (GoK, 2018). The country's tourism sector has shown significant growth since 2015, with tourism arrivals increasing by 3.9%, from 2.02 million arrivals in 2015 to 2.05 million arrivals in 2019 (GoK, 2019), and a 37.33% increase, representing 1.47 million visitors in 2017 (GoK, 2020). Domestic tourism in Kenya increased by 9.03%, from 3,654,144 visitors in 2017 to 3,974,243 visitors in 2018 (GoK, 2019). Figure 2.3 shows overall international tourist arrivals in Kenya from 1995-2019 while figure 2.4 indicates international visitor arrivals as well as tourism earnings from 2015-2019.

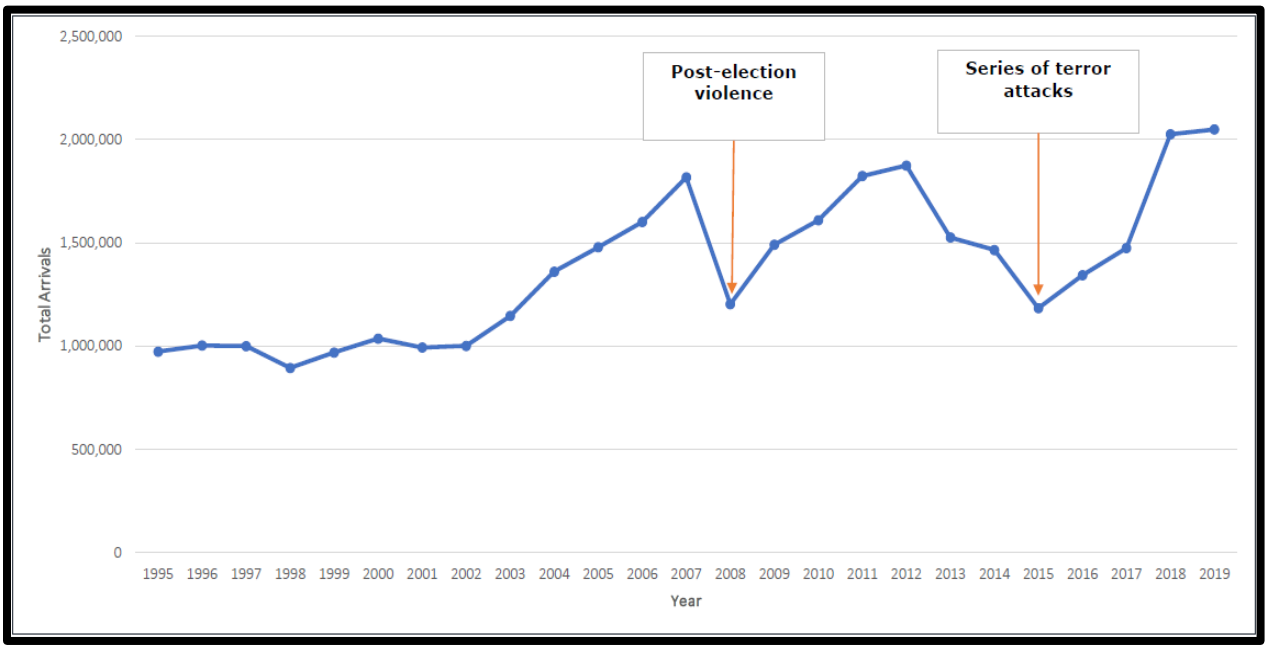


Figure 2.3. International visitor arrivals in Kenya 1995-2019
Source: GoK (2021**)**

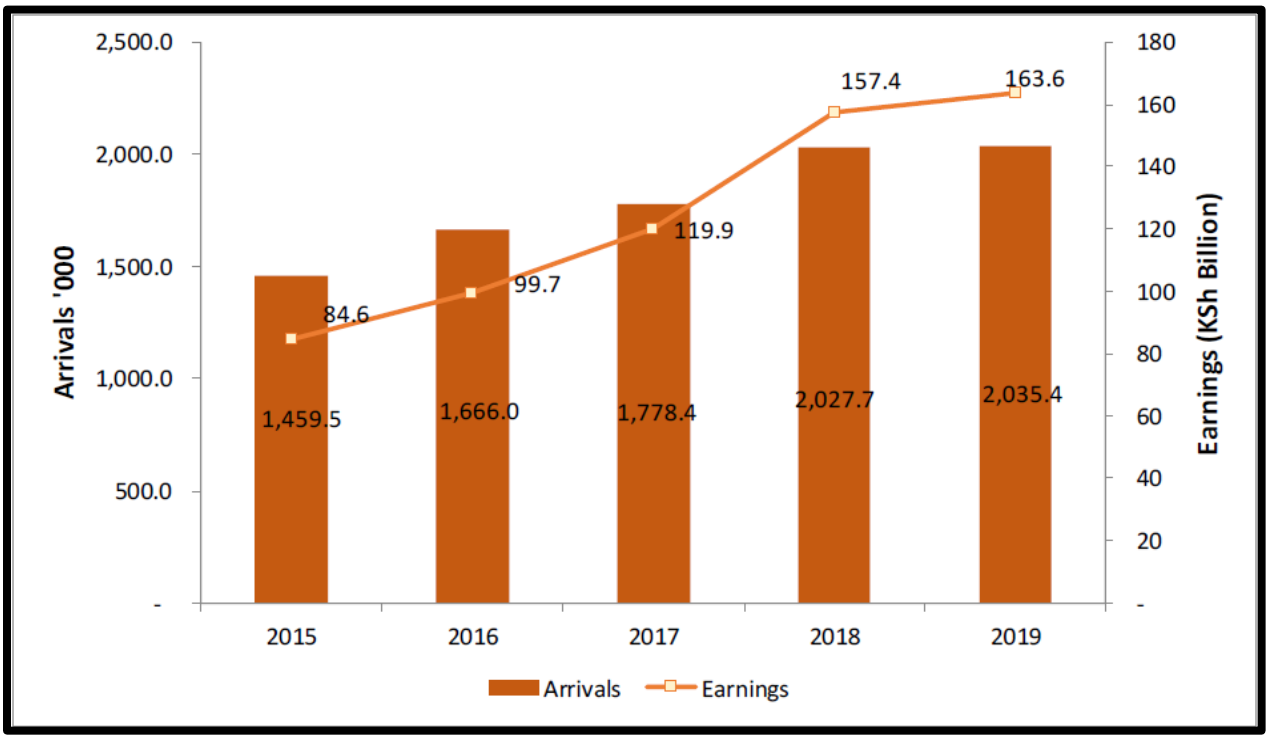


Figure 2.4. International visitor arrivals and tourism earnings, 2015-2019
Source: GoK (2021)

According to WTTC (2019), Kenya's Protected Areas (PAs) cover is 12% of the country's terrestrial area and 1% of its maritime area, and is home to a diverse array of wildlife species stretching from the Indian Ocean to wooded ecosystems, extensive savannah plains, mountains, and the Great Rift Valley. These protected areas are at the core of Kenya's tourism economy that is primarily based on wildlife tourism. Kenya has recorded an impressive rise in wildlife tourism in recent decades, owing to regulatory reforms that have resulted in the creation of national parks and reserves as well as the prohibition of hunting (WTTC, 2019). The three major categories of tourism products in Kenya are: wildlife safari, coastal tourism for the highly competitive "sun, sea and sand" segment of the global market; and the business and conference trips (World Bank, 2017). Table 2.3 shows Kenya's main types of tourism products.

Table 2.3. Kenya's tourism products

Safari tourism	Coastal tourism	Business and conference travel
• Based on natural and wildlife assets. • The Kenya Wildlife Service, (KWS) is responsible for management of national parks and executing plans to protect biodiversity.	• Caters to the competitive "sun-sea-sand" segment of the global market. • Ranges from mass-packaged tourism of Mombasa coastal resorts to culturally rich destinations such as Lamu.	• Independent business travelers from domestic, regional, and international markets, and conference and meeting attendees. • Kenyatta International Convention Centre (KICC) in Nairobi is the largest conference facility in East Africa.

Source: World Bank (2017)

The number of visitors to national parks and reserves grew by 3.7% in 2019, which was a slowed growth compared to 20.3% growth in the year 2018 (GoK, 2021). Table 2.4 shows the number of visitors to national parks and game reserves for the period 2015-2019. In contrast, pristine ecosystems and rangelands have been transformed into land for agriculture with a rise in population seeking settlement and infrastructure growth causing biodiversity losses coupled with

increasing impacts of climate change (Ojwang *et al.*, 2017). This implies challenges for the tourism industry that is heavily dependent on nature and biodiversity.

Table 2.4. Number of Visitors to National Parks and Game Reserves, 2015-2019.

'000

Park/Reserve	2015	2016	2017	2018	2019*
Nairobi	133.1	153.1	154.5	196.7	208.2
Nairobi Safari Walk	139.2	149.3	165.9	158.7	123.3
Nairobi Mini Orphanage	328.2	390.4	367.7	414.8	385.0
Amboseli	86.9	114.6	145.5	175.8	191.7
Tsavo (West)	31.8	50.2	55.3	74.1	61.3
Tsavo (East)	75.2	84.8	120.5	167.0	177.9
Aberdare	34.7	41.3	43.7	43.2	46.9
Lake Nakuru	188.9	214.7	216.0	242.0	233.0
Masai Mara	146.9	146.3	172.7	291.2	286.0
Haller's Park	115.4	121.1	117.9	165.8	301.6
Malindi Marine	29.3	31.5	31.6	29.1	28.8
Lake Bogoria	71.4	90.8	67.6	74.6	72.4
Meru	17.3	19.8	16.7	18.8	17.7
Shimba Hills	17.2	21.2	24.0	25.6	24.2
Mt. Kenya	18.5	19.1	20.2	25.9	24.8
Samburu	8.5	10.8	11.1	11.4	12.7
Kisite/Mpunguti	24.8	34.4	38.4	50.3	53.3
Mombasa Marine	26.2	29.5	32.2	39.8	40.8
Watamu Marine	24.3	33.9	43.5	67.5	72.6
Hell's Gate	120.2	154.4	206.5	165.8	165.6
Impala Sanctuary(Kisumu)	212.1	256.5	200.2	309.4	306.8
Mt. Longonot	53.3	64.5	88.0	60.1	60.1
Others[1]	49.5	52.6	45.6	61.4	80.6
Total	**1,952.8**	**2,284.7**	**2,385.2**	**2,868.9**	**2,975.2**

Source: GoK (2020)

2.2.3. Wildlife in Kenya

Kenya is characterized by outstanding network of Protected Areas (PAs) as well as natural habitats, including rich natural resources and ecosystems that support a diversity of wildlife species (GoK, 2018) essential for supporting the tourism sector. The tourism industry in Kenya is mainly nature-based or wildlife based owing to a variety of parks, reserves, sanctuaries and conservancies. Kenya has a total of 22 national parks, 28 national reserves, 5 national

sanctuaries, 160 conservancies, 234 forest reserves, 5 marine reserves, 4 marine parks, 6 world heritage sites (WHS), 66 important bird areas (IBA), 6 Ramsar sites and 6 biospheres (GoK, 2018) as shown in figure 2.5. The tourism sector in Kenya is founded on these rich arrays of natural resources.

A wildlife safari is one of the most important tourism products comprising a game drive, wildlife photography and wildlife viewing in protected areas. Findings from a study by Sanghi *et al.* (2017) point out that despite a diversified economy, wildlife tourism is deeply integrated into the economic fabric of Kenya in a complex fashion that stimulates a great number of employment opportunities and socio-cultural benefits. Wildlife populations are highly concentrated in the southern and north-eastern areas of Kenya, as indicated in Figure 2.6. Habitat changes as well as anthropogenic factors explain this particular scenario as wildlife corridors and dispersal areas are affected by the identified factors. However, there is significant evidence of catastrophic declines in wildlife populations globally (Ceballos *et al.,* 2017; Marco *et al.,* 2014).

However, wildlife and wildlife habitats continue to face unprecedented chronic and new challenges, for example climate change, population increase, pollution and invasive species, including unplanned developments that are all threats to biodiversity (GoK, 2018). Aduma *et al.* (2018) argue that severe temperature occurrences are projected to be more frequent and more severe, causing biodiversity changes and impact on mobility as well as survival for large herbivores because of global land surface warming. Such changes have the potential to negatively influence the social, economic and environmental sustainability of the nature-based tourism industry.

Ogutu *et al.* (2016) assert that extreme wildlife losses have been documented for large locations of Africa such as West, Central and Eastern Africa. These declines raise concerns about the future of wildlife with rainfall declines coupled with rise in temperatures as some of the

identified causes for the decline in wildlife population. For instance, elephant population trends in Kenya declined from 170,000 to 20,000 between the year 1970 and 1987 after which the numbers started rising on a low scale (GoK, 2017) as shown in figure 2.7. Population declines of several wildlife species have been observed, notably the lesser kudu, waterbuck and hartebeest. These declines endanger future wildlife population viability or survival unless urgent, drastic and sustained remedial initiatives are taken to restore depleted populations (Ogutu *et al.,* 2016).

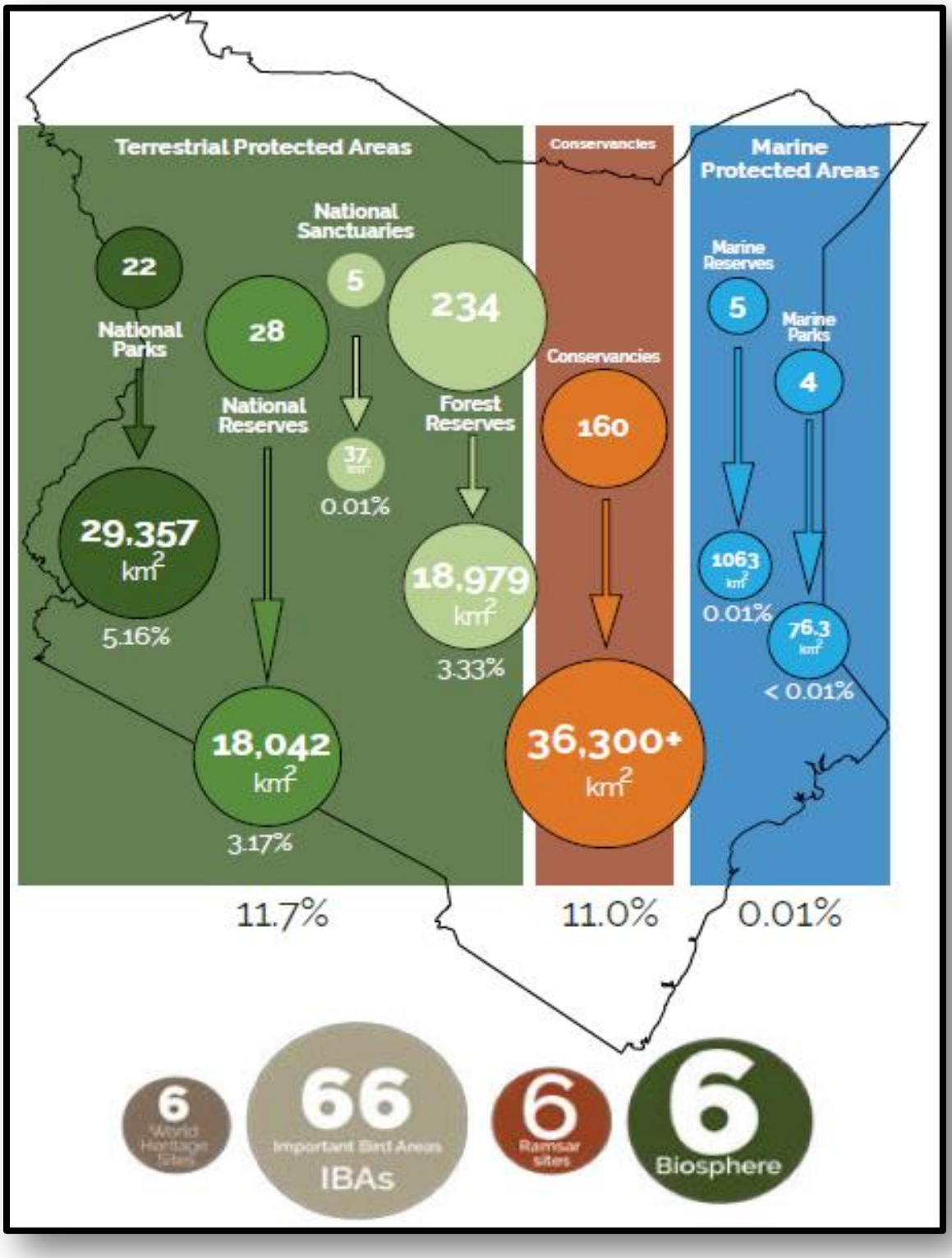


Figure 2.5. Map of Kenya showing natural resources vital for tourism industry
Source: GoK (2018)

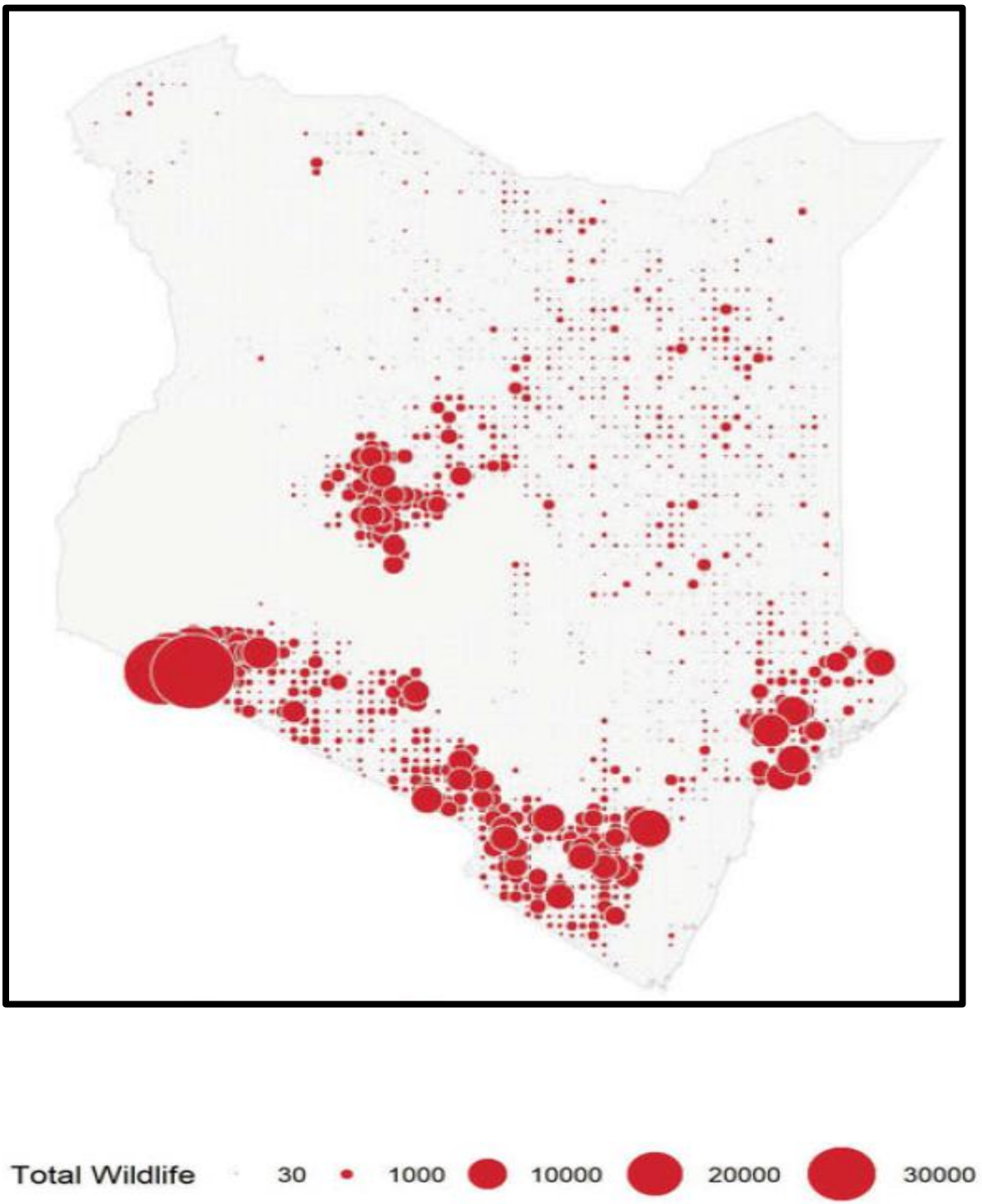


Figure 2.6. Wildlife population distribution in Kenya
Source: Ogutu *et al.* (2016)

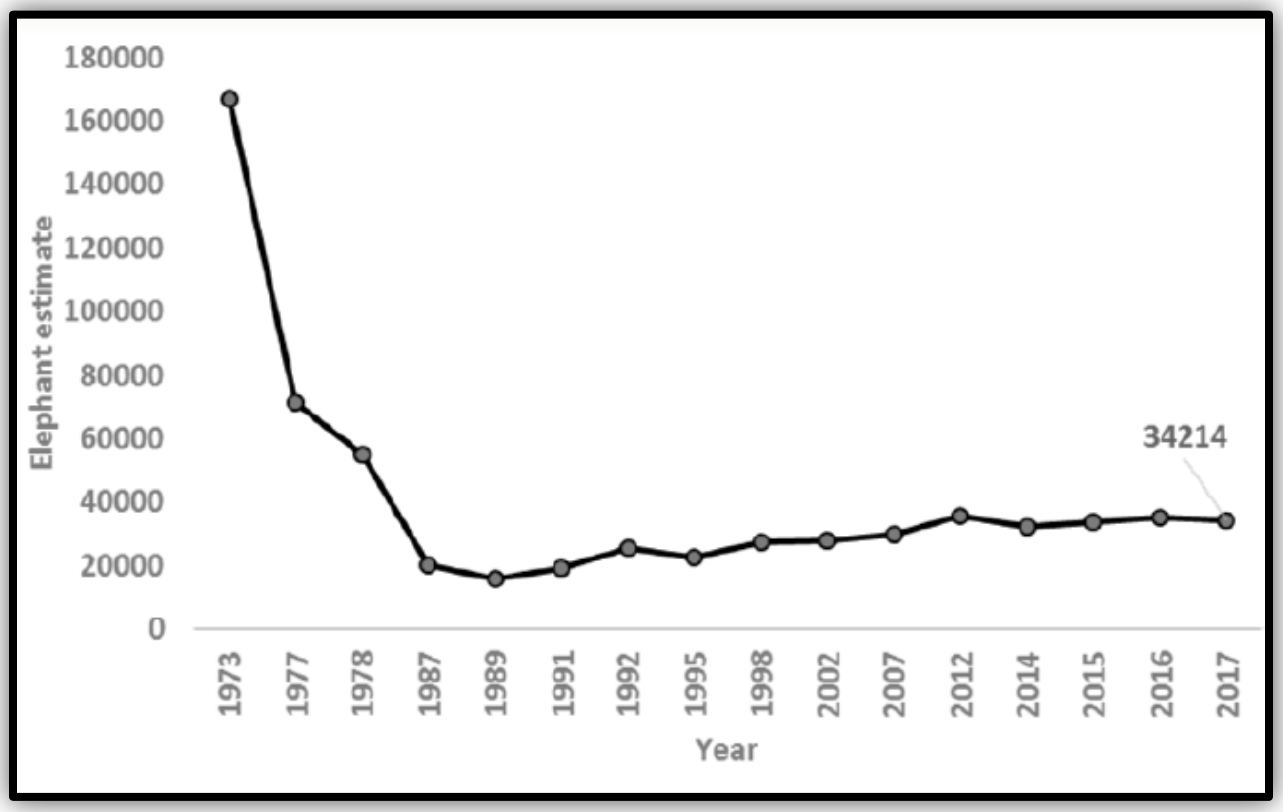


Figure 2.7. Trends in the national elephant population 1973-2017
Source: GoK (2019)

Declines in wildlife populations are caused by human related activities such as pastoralism, exacerbated by climate change in African rangelands and protected areas (Ogutu *et al.,* 2014). According to Damania *et al.* (2019), reasons for the decline in Kenya's wildlife have been widely documented (Ottichilo *et al.,* 2000, 2001; Okello *et al.,* 2016; Western *et al.,* 2009) and they include an interconnected suite of pressures typically linked to habitat conversion factors such as population growth, the expansion of arable agriculture, illegal fencing, poaching and intrusive infrastructure.

One of the identified causes of declining wildlife population is climate change and variability manifested by declining rainfall and striking rise in the minimum-maximum temperatures that result to vegetation browning trend (Ogutu *et al.,* 2016). An analysis by Ogutu *et al.* (2016),

focusing on the status and trends of wildlife population in Kenya using aerial sample survey monitoring data collected by the Directorate of Resource Surveys and Remote Sensing (DRSRS) of Kenya during 1977–2016, point out a disturbing loss of wildlife, averaging 68.1% (or 1.7% per year).

Ogutu *et al.* (2016) assert that wildlife numbers declined by 48.7% in the period 1977–1980 and by a further 20% between 1994–1997 as well as 2011–2013. The study estimates the population of wildlife and livestock in 20 counties in the Kenya rangelands between 1977 and 2013 show a striking increase in the numbers of goats and camels and concurrent extreme declines in the numbers of 15 of 18 common wildlife species.

Furthermore, Damania *et al.* (2019) also assert that in Kenya, wildlife has declined across the country and that for certain species the decline has been catastrophic, especially the ungulates and predators. The authors note the highest decline in wildlife loss was observed in West Pokot with 99% of its wildlife lost while the smallest decline was observed in Laikipia with a 7% decrease in wildlife biomass. Additionally, three major tourist-dependent counties of Narok, Kajiado and Taita Taveta showed varying trends; Narok with high dependence on wildlife-based tourism lost approximately 70% of its wildlife, Kajiado 60% and Taita Taveta 40% between the period 1977-2016 (Damania *et al.*, 2019).

Consequently, Kenya was ranked 5th in Africa in terms of the number of threatened species within its boundary (IUCN, 2018). The declining wildlife population has the potential to impact tourism sustainability in Kenya. It is not clearly known how the decline in wildlife numbers will influence the tourism industry that is heavily reliant on wildlife that this study seeks to ascertain. The sustainability of the tourism industry could be rendered unsustainable as social, economic and cultural benefits of tourism are lost as a result of reduced visitation to protected areas experiencing declines in wildlife populations.

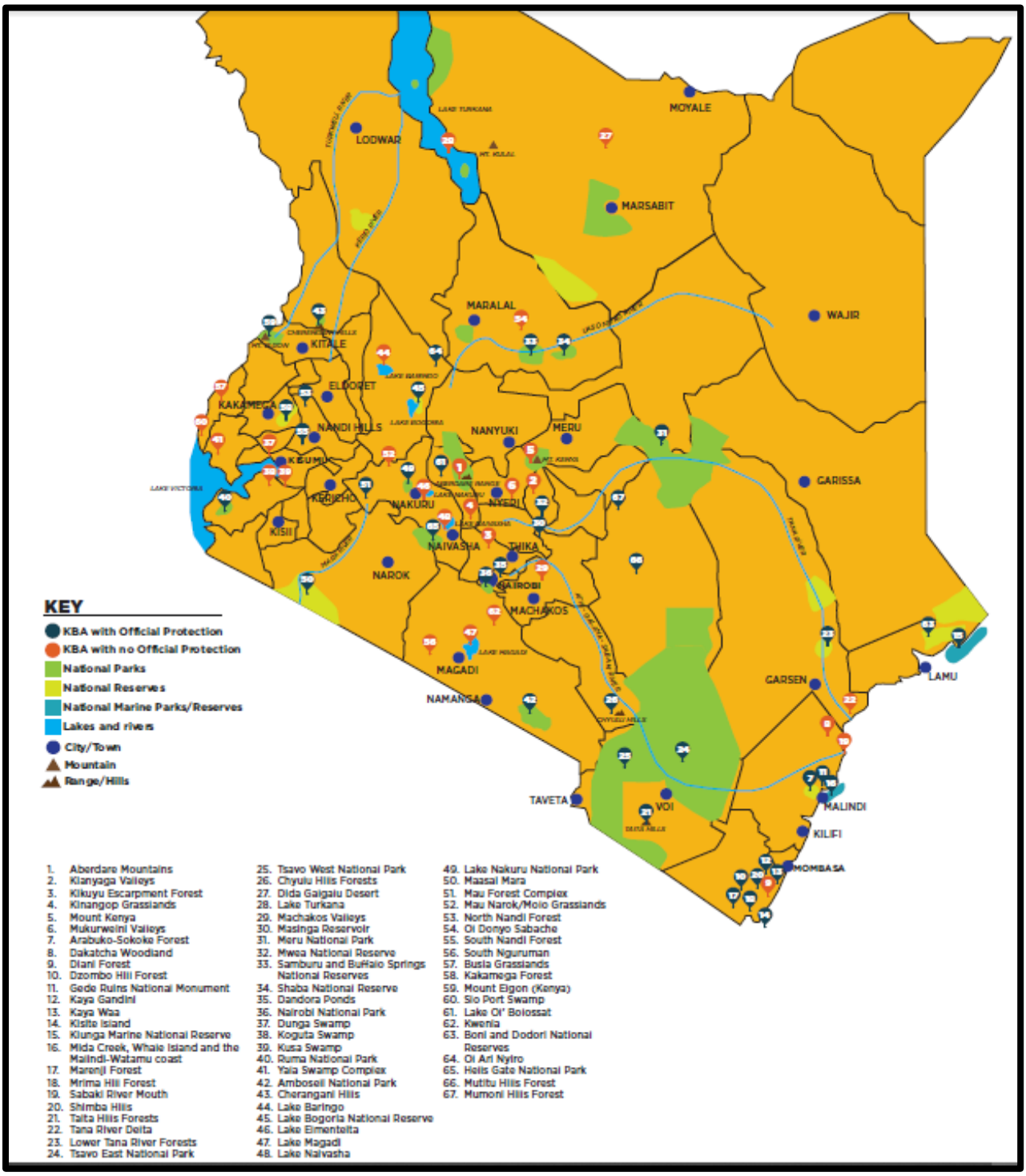


Figure 2.8. Map of protected areas in Kenya
Source: Kenya's Key Biodiversity Areas Status & Trends Report (2017).

2.2.4. Relationship between rainfall, wildlife population and vegetation

Ogutu *et al.* (2016) assert that rainfall is a central climate component influencing wildlife population dynamics for African savannahs via its impact on primary vegetation production. For instance, the population of African major herbivores decline during drought periods because of reduced vegetation biomass (Voeten *et al.,* 2009). Extreme food scarcities during drought periods are often associated with catastrophic deaths of many ungulates in African savannahs (Dublin *et al.,* 2015). Therefore, droughts negatively affects wildlife populations.

In the Serengeti National Park, severe drought of 1993-1994 killed 14,448 (40%) of 36,119 buffalo (Metzger *et al.,* 2010) and a quarter of a million of 1.5 million wildebeest (Mduma *et al.,* 1999). Similarly, in the Ngorongoro Crater, the 1999-2000 droughts, which were similarly severe and extensive, killed 1,500 buffaloes and nearly all buffalo calves under 9 months old (Estes *et al.,* 2006). Droughts have the greatest impact on wildlife populations when they are faced with severe food scarcity and are forced to restrict their movements or occupy areas that are experiencing drought-related food scarcity (Dublin and Ogutu, 2015).

Rainfall is a core factor that determines ungulate population, according to studies conducted in the Serengeti and Kruger National Parks (Marshal *et al.,* 2011). Elsewhere, Okello *et al.* (2016), in a research on population densities of elephants and large herbivores in the Amboseli ecosystem, conclude that droughts are accompanied by limited availability of water and vegetation as well as significantly high heat load due to rising temperature that negatively affect elephant survival and reproduction and ultimately their population size.

Droughts cause elevated rate of elephant deaths, leading to declines in their population and densities. While land use changes, habitat loss and degradation are acknowledged as major threats to Amboseli ecosystem; climate unpredictability and the occurrence of drought are also emerging environmental challenges (Okello *et al.,* 2016). Therefore, the tourism industry in

Kenya that is dependent on wildlife is at a greater risk of climate change impacts such as drought. Droughts and other climate change related impacts have the potential to reduce socioeconomic benefits that tourism provides to host communities as well as its stakeholders.

2.2.5. Government of Kenya engagement on climate change

Kenya's National Climate Change Response Strategy (NCCRS) was launched in 2010 with the goal of putting in place measures to address the challenges posed by climate change and variability. Participatory workshops with stakeholders from ministerial sectors were held both nationally and regionally to forge the strategy. The strategy is composed of ten chapters covering the history of environmental change and difficulties in combating environmental changes, evidence and impacts of climate change in Kenya, the links between the strategy and Vision 2030, including adaptation and mitigation measures.

The main objective of the plan was to start off conversations on climate change to result into legislation of policies that address climate change impacts. The strategy acknowledges evidence of climate change in Kenya such as rising country-wide temperatures and irregular as well as unpredictable rainfall patterns, including severe and harsh weather (GoK, 2010). According to the strategy, minimum temperatures have risen by 0.7 to 2.0 degrees Celsius, while maximum temperatures rose by 0.2 to 1.3 degrees Celsius, depending on the season and region.

An overall decline of rainfall in the main rainfall season of March-May (long rains) has been documented and a general positive trend (more rains) between September-February. This implies that the short rains for the period October to December is extending into what is normally hot and dry period of January and February (GoK, 2019). Hence, Kenya's natural resources, particularly its unique flora and fauna that are among the country's most valuable natural assets are now affected by climate change. Some of the impacts of climate change outlined in the plan

that are relevant to this inquiry. More notably, the number of indigenous and iconic wildlife species has drastically dwindled (GoK, 2010).

In 2013 the National Climate Change Action Plan (NCCAP) was developed in order to ratify the National Climate Change Strategy of 2010. The plan comprises a low carbon climate resilience pathways, regulatory policy recommendations, analysis of adaptation and priority action, consideration of mitigation options, technological requirements, and recommendations for knowledge management and capacity development (GoK, 2013-2017).

The plan highlights the impacts of climate change on water availability, loss of biodiversity and decreased landscape aesthetics, natural hazard frequency, coastal erosion and flooding, and vector-borne diseases on the tourism industry to varied degrees. The strategy does not include precise information on the specific consequences of climate change for the tourism industry. It identifies climate change mitigation and adaptation interventions in sectors such as agriculture, water resources, forestry, and energy, and notes that while tourism-related greenhouse gas (GHG) emissions are low in comparison to Kenya's overall national emissions, many low-carbon actions such as solar water heating and more efficient passenger vehicles can be implemented (GoK, 2013-2017).

Strategies to slow down emissions, especially from the tourism industry, as well as development of mitigation and adaptation measures remain of low priority by the government. Interventions targeting the tourism sector have not been fully adopted by the stakeholders, raising concerns on the government’s commitment to curtail climate change impacts. The plan advocates for marketing Kenya as a low carbon footprint destination with sustainable tourism activities and resource efficiency regulations as well as greening the sector with inadequate action plans as well as policy frameworks.

Furthermore, the plan estimates that Kshs. 968.6 billion (USD 12.1 billion) is anticipated to have been lost by the 2008 to 2011 droughts in Kenya. In addition, in each of the financial years between the years 1998-1999 and 1999-2000 it is estimated that the droughts resulted in a 16% decline in GDP. The 1997-1998 El Nino floods are estimated to have cost Kenya Kshs. 62 billion (USD 777 million) in transport infrastructure damages and Kshs. 3.6 billion (USD 45 million) in water infrastructure, amounting to 11% of loss of GDP (GoK, 2013-2017). Transportation infrastructures as well as water supply are critical services for the tourism industry's success as any damages to these infrastructures disrupts tourism activities.

Kenya's transition to a low-carbon and climate resilient development path is guided by the second National Climate Change Action Plan (NCCAP) 2018-2022, which includes actions by the National and County levels of Government including the private sector and the civil society (GoK, 2016). The plan puts much emphasis on forests adaptation and mitigation measures with nothing mentioned about wildlife and tourism.

Based on the National Climate Change Response Strategy (NCCRS) of 2010, the National Adaptation Plan (NAP 2013-2017) was launched in the year 2015 and provides a framework that will enable Kenya deliver its Nationally Determined Contributions (NDC) in accordance with the Paris agreement of the United Nations Framework Convention on Climate Change (UNFCCC). NAP illustrates the country's vulnerability to climate change, with a focus on existing and future climate trends. The plan also establishes institutional frameworks, including monitoring and assessment procedures. It also identifies priority actions in 20 planning sectors in the short, medium, and long-term planning periods, based on the assertion that climate change affects all socioeconomic sectors (GoK, 2016). The adaptation plan was key in the enactment of Climate Change Act of 2016, which specifies institutional frameworks for climate change coordination and establishes organizations such as the National Climate Change Council, Ministry of Climate

Change Affairs with a Climate Change directorate and a Cabinet secretary in charge of climate affairs as shown in figure 2.9.

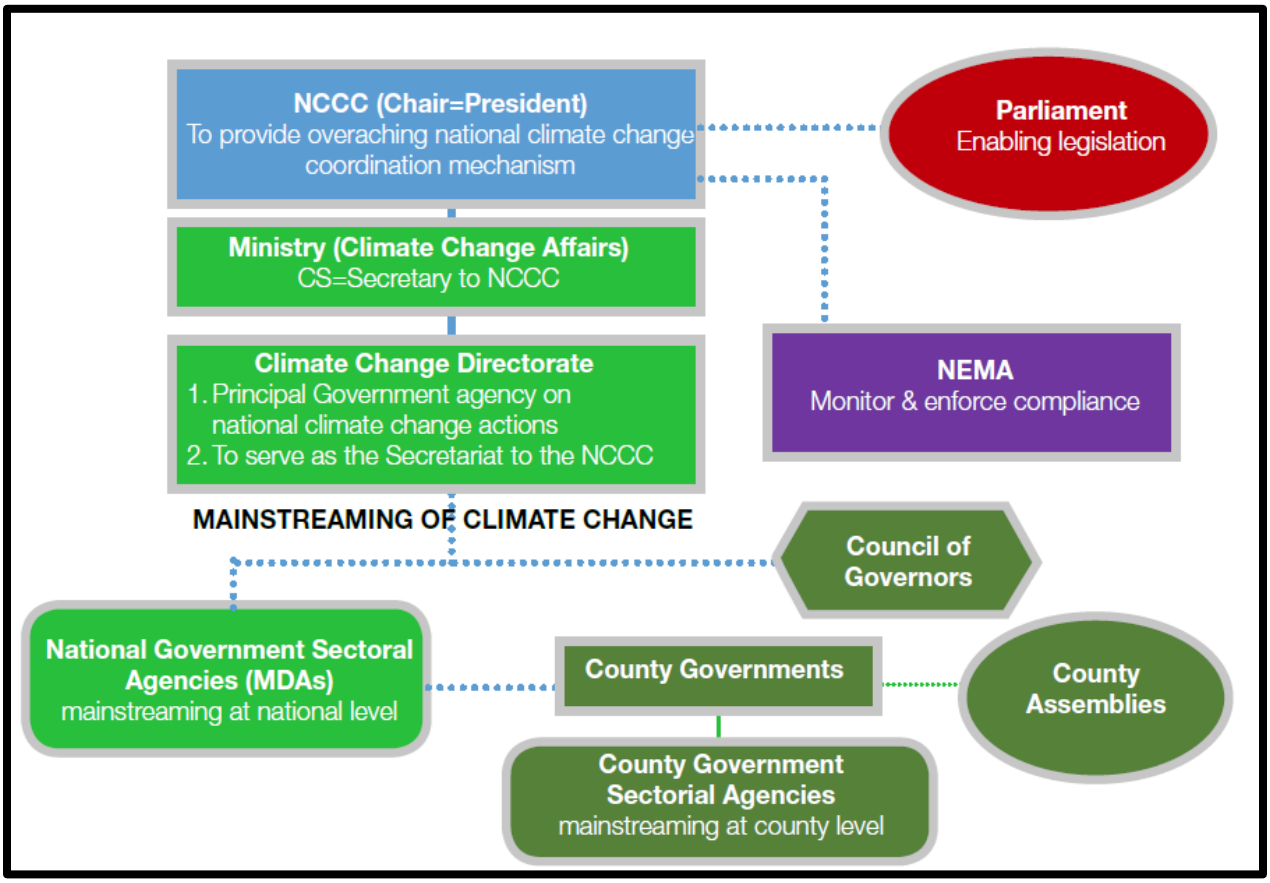


Figure 2.9: Climate change institutional coordination structures in the climate change Act (2016)
Source: Gok (2018) derived from description in the Climate Change Act (2016).

Climate change has the potential to limit the growth of the tourism sector through infrastructure interruptions, loss and degradation of natural habitats, and changes in demand according to the adaptation strategy. It's worth noting that other sectors of the economy, including agriculture, fisheries, oil, and natural resources, as well as livestock development have relevant supportive Government projects and initiatives to curtail climate change impacts. The tourism sector remains vulnerable to adverse impacts of climate change as there no ongoing projects or actions

by the Government to ensure sustained growth of the tourism industry under changing climatic conditions. There are no active Government programs or attempts to mitigate the effects of climate change in the tourism sector. Sadly, the climate change Act of 2016 has not yet been fully implemented together with the national adaptation strategy 2015-2030, as it is still an ongoing process until 2030. Kenya's Nationally Determined Contributions (NDCs) were submitted to the United Nations Framework Convention on Climate Change in 2016. Since then, the country has amended and updated its ambitious NDCs that seek to reduce greenhouse gas emissions by 32% by the year 2030 at a cost of USD 62 billion.

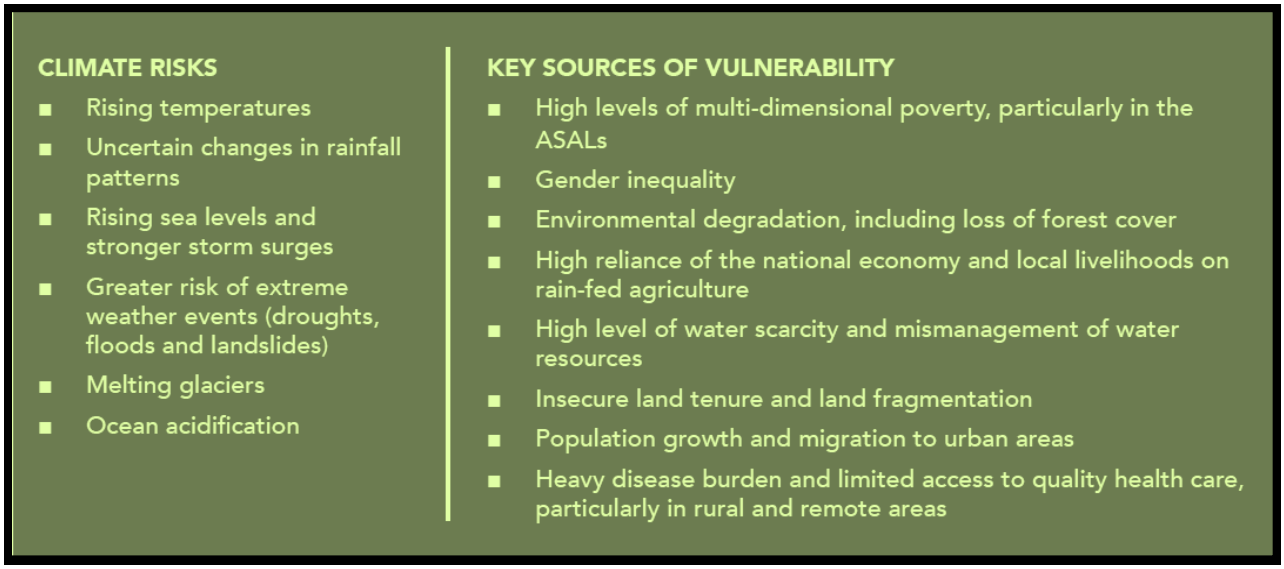
2.3. RELATIONSHIP BETWEEN CLIMATE CHANGE AND NATURAL RESOURCES

Biodiversity supports a wide range of nature-based tourism activities among them wildlife safari and photography. However, global loss of biodiversity presents a serious global problem that can cause adverse consequences on essential ecosystem functions (Saunders and Gell, 2017). The rate of biodiversity loss has already surpassed the safe planetary boundaries (Rockström *et al.,* 2009). Additionally, conservation areas have become too small, too few, and prone to change and have been proven to cause species extinction (Saunders & Gell, 2017).

Climate is a central aspect of the tourism industry that can both attract or repel tourists (Gomez 2005) by affecting the choice of recreation and limit time and space for tourism activities. Nature based tourism is a form of recreation that involves travel from normal environment and day-to-day routine to fauna-related surroundings such as the wilderness. Nature walks, bird-watching, jungle safaris, camping, hunting and recreational fishing, mountain climbing including water rafting are nature based tourism related activities (Blamey, 2001). This sector accounts for 40%–60% of foreign tourists in countries like Kenya, New Zealand and Nepal (Nyaupane, 2004). On the other hand, climate change has an influence on natural resources that support tourism (Scott,

2019). The Kenya Climate Change Action Plan (2018-2022) illustrates climate change impacts and risks on Kenya's tourism resources as well as infrastructure as shown in Box 2.1.

Box 2.1. Climate change impacts and risks on Kenya's tourism resources



Source: GoK (2018-2022)

Tervo-Kankare *et al.* (2013) argue that the impacts associated with climate change could interfere with cultural events or holiday periods in destinations like Rovaniemi in Finland where during Christmas holidays the image sold to tourists is heavily influenced by a snowy Christmas wonderland. The largest impacts of climate change are predicted to adversely affect nature-dependent tourism destinations (Hambira *et al.*, 2013).

According to more recent research, temperature changes have had substantial consequences on plant and wildlife communities. Biological impacts, according to Root *et al.* (2003), include changes in life cycle timing, including fruiting and flowering. Other changes include alteration in species abundance Krockenberg (2002) as well as range (Williams, 2003). Many populations of species are affected in terms of their quantity and distribution (Williams, 2003). Changes of this

kind raise specie extinction risks that are already vulnerable due to their narrow range of habitats, specialized habitat needs, limited movement ability and low genetic diversity (WTMA, 2008). With rising temperatures, species facing vulnerability will shift in range on both latitudinal and altitudinal scales (Hilbert *et al.,* 2011). In addition, indigenous species will be exposed to weather changes through prolonged dry seasons that impede food production and reproduction.

As temperatures rise, the likelihood of species migrating will rise as current ecosystems will be exposed to a number of new predators, pathogens (Walther *et al.*, 2002; Dukes, 2003) and competitors including diseases against which there may be no natural defenses (WTMA 2008). In some situations, migration of species is difficult and some species will be rendered extinct. An increased risk of fire near forest borders is likely to be experienced implying further burden on already strained ecosystems (Williams, 2003; Hopkins *et al.,* 1993). The physical impacts of these changes include landscape alterations and their aesthetical characteristics thereby negatively affecting the tourism industry.

2.3.1. Rainfall and temperature scenarios in Kenya

Changes in rainfall and temperature patterns have been recorded in the East African region (Omondi *et al.,* 2014). Similarly, between 1961 and 2010, rising minimum and maximum temperature trends were recorded throughout the Greater Horn of Africa (Omondi *et al.,* 2014). According to the fifth IPCC assessment report (2014), temperatures across the African continent is predicted to rise quicker than in other places, particularly in dry areas. In recent years, both the long and short rainy seasons have decreased in spatial and temporal variability coupled with an increased frequency of droughts in East Africa (GoK, 2017).

Using a high emission scenario for climate modeling for the Eastern Africa region, average annual temperatures are projected to rise by 0.9°C by 2035, 2.2°C by 2065 and 4°C by 2100

(Christensen *et al.,* 2013). A majority of IPCC reports conclude that precipitation predictions are more uncertain compared to temperatures and that by the end of the 21st century, East Africa will have a wetter climate coupled with more severe precipitation and less droughts as the proportion of rainfall that occurs in long rain season is expected to increase (GoK, 2018).

While models forecast greater rainfalls in the future for the region, recent data show a declining trend in what is called the 'East Africa climate paradox' (Lyon & Vigaud, 2017). For example a declining rainfall trend has been recorded in some parts of Kenya (Omondi *et al.,* 2014). However, projections are that average precipitation in the semi-arid areas of North Kenya will increase by 10% and the weather in the Eastern African region will be wet through the mid-21st century (Shongwe *et al.,* 2011).

There have been observations of evidence of climate change in Kenya. For instance, since the early 1960s, both minimum (night time) and maximum (day time) temperatures have been on an increasing trend with minimum temperatures rising from 0.7°C-2.0°C and maximum from 0.2°C-1.3°C (GoK, 2010). According to forecasts from the Global Climate Modeling (GCM), the average yearly temperature is expected to rise by between 0.8°C and 1.5°C by the 2030s and between 1.6°C to 2.7°C by the 2060s (GoK, 2016).

On rainfall, increased year to year variability during the year has been observed and there is a general decline of rainfall in the main rainfall season of March-May (long Rains), implying drought in the long rain season is more frequent and prolonged. Moreover, throughout September to February, a generally positive trend (more rains) is projected as the short rainy season (October-December) extends over the ordinarily hot and dry January and February seasons (GoK, 2010). Other studies demonstrate Kenya's October to December (OND) rainfall is increasing and March-May (MAM) rainfall is reducing (Ongoma and Chen, 2017). In addition,

Shongwe *et al.* (2011) and Otieno and Anyah (2013) maintain that a rise in March to May (MAM) precipitation is probable by the end of the twenty-first century.

Drought and floods are the major indicators of climate change in Kenya that is caused by rising temperatures and more precipitation respectively. Flooding in Kenya occurs every three to four years on average, and is connected to the El Nino or La Nina phenomenon, which triggers extreme weather as Kenya's annual rainy seasons is increasingly getting wetter with sudden and or late onsets causing floods and inundation (GoK, 2016).

2.3.2. Rainfall and temperature influence on vegetation cover and wildlife

The quantity, quality and distribution of plants throughout Earth's history is a function of, among other factors, changing rainfall patterns that can influence the temporal distribution of plant functional types and vegetation cover in a region (Walther *et al.,* 2002). The structure and functioning of natural resources systems, especially wildlife and vegetation, are strongly influenced by rainfall patterns as water availability is very important for the survival of wildlife and plant communities.

The Normalized Difference Vegetation Index (NDVI) shows plant vigor (Serneels *et al.*, 2001), and there is a time lag between precipitation and vegetation development implying any interruptions in global and regional precipitation can cause a direct impact on the ecosystems such as the Mara (Richmond-Coggan, 2016). Rainfall and temperature variations are likely to cause changes in plants and vegetation distribution and consequently wildlife populations. For example, a study by Mduma *et al.* (1999) discovered that rainfall in the dry season has a significant impact on wildebeest (connochaetus taurinus) populations because it directly impacts the most important extrinsic variable that is food availability. Further, rainfall variations of up to

two months prior to the actual birth date have also been proven to impact zebra birth dates (Richmond-Coggan, 2016).

Wildlife species and ecological communities and ecosystems have been subjected to temperature variations over ecological and evolutionary time scales as ecological responses to climate change may include change in species range, high mortality and biome shifts (Falk and Miller, 2016). Plant and wildlife populations respond to rainfall fluctuations. Normally, such rainfall and temperature fluctuations immediately influence natural resources, especially wildlife and vegetation. For instance, flowering and survival of aquatic plant species and the population of wildlife is affected by changes in water availability (FAO, 2012).

A significant cause of wildlife extinction is predicted to be climate changes that negatively impact the breeding of species including shifts in distribution caused by temperature and precipitation variations (FAO, 2012). Indeed, floods and drought have increased in frequency and intensity. For example, the frequency of drought has risen from once every five years in the 1970s to once every two or three years in the 1990s, and once every year since 2000 (Howden, 2009). Droughts and floods negatively affect vegetation, including wildlife population, with the potential to affect sustainability of nature-based tourism.

The impacts of climate change on wildlife populations have already been observed at local, regional and global levels (FAO, 2012). For example Savannahs and steppes are primarily grassland ecosystems that herbivore wildlife depends on as a type of food. However, with global temperature, increases these savannah ecosystems, grasslands and steppes are expected to shift their distribution pole wards (Briggs *et al.,* 2002). In fact, in many tropical ecosystems such as savannahs, yearly variations in vegetation dynamics are controlled primarily by rainfall variations and temperature. Consequently, 20–30% of plants and wildlife species are at a risk of extinction, with a high percentage of endemic species predicted to go extinct by 2050 (FAO,

2012). Furthermore, drought-related effects on vegetation have affected wildlife species in the Mara-Serengeti ecosystem to drop by 58% for the previous 20 years (Ottichilo *et al.,* 2000). Additionally, the 2009 drought in the Amboseli ecosystem caused declines in wildebeest and zebra populations by 70–95 % (KWS, 2010).

Climate change is projected to become more severe on species on the brink of extinction for example 70-80 % of red listed birds, amphibians and corals are susceptible to climate change impacts (Vié *et al.,* 2008). Extreme climatic events such as drought and inundation are expected to become more often (FAO, 2012), increasing the prevalence of fire in savannahs (Seppälä *et al.,* 2009). According to McKelvey and Buotte (2018), wildlife species that rely on a small range of habitat are particularly vulnerable to climate change when the habitat shrinks due to increased climate-related disturbance.

The Earth's average temperature has been rising since the industrial revolution. For instance, from the year 1880 to 2015 the average global surface temperature rose by 0.9°C (Henderson *et al.,* 2017). Rising temperatures will have a significant impact on wildlife communities that the tourism sector relies on as well as vegetation that serves as the primary food for wildlife. The average annual temperature has steadily risen in recent decades, and the next years are expected to be even warmer. Many ecosystems have experienced an increase in average annual temperatures, and scientific research suggests that future changes will be far more significant (FAO, 2012). The average global temperature from 1880 to 2020 is presented in Figure 2.10.

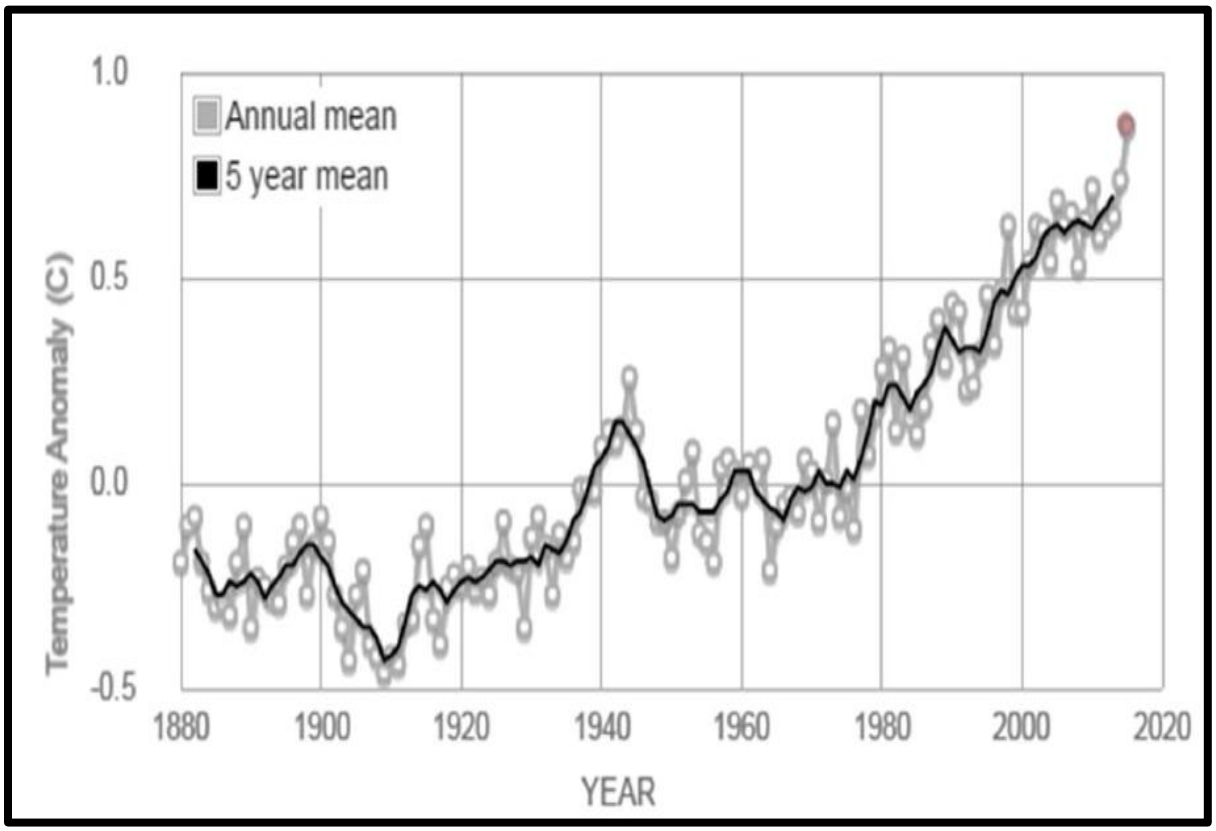


Figure 2.10. Global land-ocean temperature index 1880-2020
Source: NASA's Goddard Institute for Space (GISS)

There is broad consensus in the scientific community that global warming has been largely driven by increases in atmospheric GHGs emissions (Handerson *et al.*, 2017) which have been growing since the industrial revolution and were 60% higher in 2014 than they were in 1990 (World Bank, 2014) as shown below in figure 2.11.

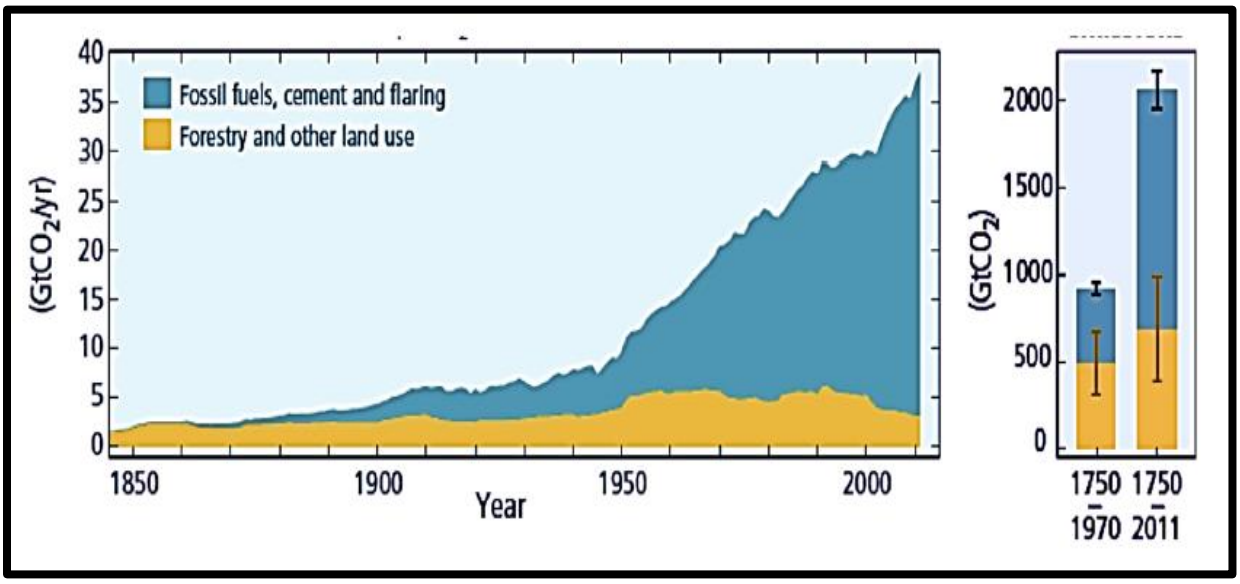


Figure 2.11. Atmospheric CO_2 emissions, gigatonnes CO_2 ($GtCO_2$)
Source: IPCC (2018).

What is not known clearly is the influence of rainfall and temperature variations on population of wildlife and abundance of vegetation cover that have the potential to impact sustainability of the tourism industry. What is known is that climate changes via erratic rainfall and temperature patterns pose potential impacts on vegetation productivity as well as wildlife vegetation. For example, severe drought stress accompanied by high temperatures can lead to widespread dieback of forest ecosystem (Allen *et al.,* 2015). Additionally, Musau (2018) holds the view that drought and wetness have significant effects on vegetation dynamics.

Climate change has the greatest impact on forest vegetation characterized by shifts in regeneration, growth, and mortality (Temperli *et al.*, 2013). Reduced water availability, rising temperatures, and rainfall variations affect growth services. For instance, production improves in some regions due to increased temperatures and longer growing seasons particularly at higher altitudes, but decrease in others where soil moisture decreases at lower altitudes (Halofsky and

Peterson, 2018). Insufficient temperature or humidity as well as frost and strong winds contribute to tree mortality (Joyce *et al.,* 2014).

One of the most significant concerns concerning the survival of wildlife and most importantly nature-based tourism is the impact of rainfall and temperature variations on wildlife and how vegetation will respond to future climate changes. Natural disturbances such as wildfires, insect outbreaks, illness, windstorms, and drought, as well as man-made disturbances such as wood harvesting and land conversion have a significant impact on the flora that wildlife relies on for sustenance, particularly the big five. Natural disasters are becoming more common and devastating as a result of climate change (Wang *et al.,* 2018). Such disturbances will undoubtedly reduce vegetation cover, leading to reduced food for wildlife, resulting to a reduction in their population and a possible decline in tourism dependent on wildlife.

2.3.3. Relationship between climate change and tourism

Main economic activities in Africa such as agriculture, fishing, and tourism are based on a stable climate system, hence, a stable climate system is critical for their success (Dzoga and Koske, 2014). Climate change is expected to significantly alter and weaken the natural resource base on which many forms of tourism are constructed and rely (Pandy, 2017). In addition, the impact is projected to be indirect to tourism destinations and affect their social, political, and economic environment as health, water availability, food systems, and production systems will all be affected (Valls, 2009).

Climate change is expected to drastically affect the tourism landscape as well as communities defined by higher levels of poverty, triggering conflict over access to essential resources (Rogerson, 2016). Based on future scenarios proposed by a number of studies about the possible impacts of climate change on tourist demand and flows, the Intergovernmental Panel on Climate

Change (IPCC) concludes that climate change will determine the choice of tourism destination, seasons, and length of stay (Michailidou, *et al.,* 2016).

Climate is either the most or one of the most significant variables that visitors consider when choosing a travel destination (Scott *et al.,* 2018). Furthermore, climate change has consequences for the entire tourism sector as it affects the economic viability of tourist sites and activities, as well as visitor behavior (Hall *et al.,* 2015). In addition, tourists choose ecologically favorable locations as tourism activities continue depleting natural resources and contributing to climate change (Gössling *et al,* 2010). As the risks of climate change increases, increasing attention is focused on adapting tourist sites to reduce risks and maximize economic potential (Becken, 2010). The relationship between climate change and tourism can be better understood by considering how climate change affects tourism and how tourism impacts climate change (Hall *et al.,* 2015).

Air travel, for example, has been identified as the leading source of greenhouse gases in the atmosphere, which contribute to climate change. In Kenya, majority of tourists arrive and depart by air transport, for example in Moi International Airport (MIA) and Jomo Kenyatta International Airport (JKIA) the numbers have been rising from 2015-2019 as shown in the Figure 2.12.

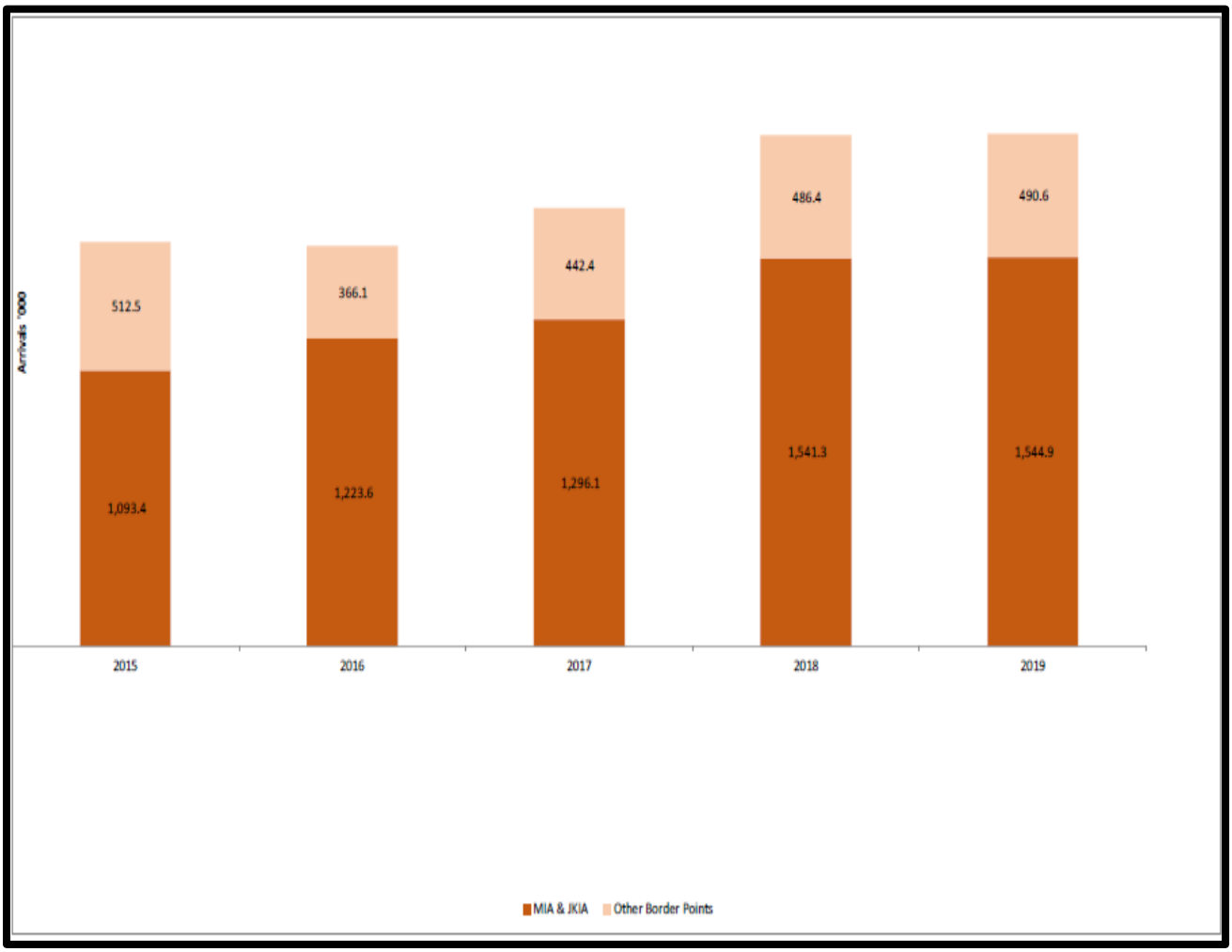


Figure 2.12. Number of international visitor arrivals through MIA and JKIA, and other border points, 2015-2019
Source: KNBS (2020)

The nature of the interaction between the atmosphere and the leisure activities outside can be viewed as a function of local climatic conditions (de Freitas *et al.,* 2008). Climate variables take several forms, for example rain, physiological such as temperatures and psychological characterized by clear blue skies, while some take the form of a mix of all three. Scientists are now in agreement that the temperature element of the environment is the most important factor outweighing other factors in tourism destination choice (Gossling and Scott, 2018).

Climate systems are no longer as stable as they once were; their variability is highly likely to get worse in future if present greenhouse gas emission patterns continue (IPCC, 2007). Climate variability can cause fire events as well as massive and irreversible changes in plant and animal communities, negatively affecting the scenic values they provide. This is likely to trigger substantial disruptions in several tourism markets (Gossling and Scott, 2018).

For example, the 2003 heat wave in France caused fifteen thousand deaths as well as dramatic changes in conventional visitor flows from the Mediterranean traditional resorts to Northern and West beaches (WTO, UNEP, WMO, 2008). Climate change impacts vary in kind and degree on global tourism destinations (Michailidou *et al.,* 2016). Possible variations in the flows of tourists and in the demand patterns of tourism worldwide can lead to redistribution of revenue, employment and community development or stagnation all influencing profitability and viability of tourism business (WTO-UNEP-WMO, 2008).

Extreme weather events, such as rising sea levels, less snowfall, wildfires, and infectious illnesses, are some of the consequences of climate change that will affect visitors' comfort and safety (Michailidou *et al.,* 2016). Heat waves (WTO-UNEP-WMO, 2008), fires and dry seasons (Scott & Lemieux, 2010), hurricanes (Becken & Hay, 2007), accidents, transportation delays, and cancellations (Koetse & Rietveld, 2009) have been reported. These events caused injuries and life losses to tourist including inducing insecurity for tourists and cancellation of next season reservations (Michailidou *et al.,* 2016).

Climate change impacts tourism destinations, implying that with changing climate conditions other destinations become new tourist hotspots (Kyriakidis & Felton, 2008). The impacts will not be the same across the globe, with likely impacts on the environmental aesthetic, loss of biodiversity, erosion, and damage caused by rising sea levels, which would alter visitor demand and flow into an area, affecting economies (Walmsley, 2011). For example, a temperature

increase of 20°C is estimated to reduce the number of ski resorts from 85% to 63% (Abegg and Koenig (1997).

Such changes will undermine the profitability of low-level ski resorts and force them to close down frequently or divert towards summer activities or produce artificial snow, although the latter option may not be sustainable in the long run. Fast retreating glaciers have transformed the scenic landscapes (Hall and Farge, 2003) to extend that the tourism demand falls (Scott and Laws 2005). A Spanish study estimates that tourism flows will decrease by at least 20% by 2080, because European summer temperatures have been steadily rising (Hein, 2019). In addition to variations in temperatures and precipitation, the abundance of natural resources that define the attractiveness of any tourism destination will be influenced by climate change (Gössling and Hall 2006; Gössling *et al.*, 2012).

Drought caused major forest fires in Yellowstone National Park during the summer of 1988, leading to the closure of campsites and seasonal visitor's accommodation being closed four weeks earlier than usual (Franke, 2000). Total annual visitors to Yellowstone in 1988 declined by 15% with predicted total losses of US$60 million in forest fires (Bhandari, 2014). Therefore, the tourism industry stakeholders, governments and scholars are increasingly recognizing climate change as one of the biggest concerns for tourism sustainability at both short and long-term destination and enterprise levels (WTO, UNEP & WTO, 2008).

2.4. CLIMATE CHANGE AND TOURISM SUSTAINABILITY

The term ‘sustainable tourism’ is interchangeably used with ‘responsible tourism’, ‘ecotourism’ and ‘ethical tourism' (Cater *et al.,* 2015). Sustainable tourism strives to reduce negative impacts of tourism activities on the environment, society and economy and encourage mutual beneficial exchanges that result in an ecologically sustainable, economically viable as well as ethically and

socially equitable tourism (Pan *et al.,* 2018). A suitable balance of the economic, social and environmental aspects of tourism are necessary to establish tourism sustainability at the same time fulfilling the needs of the tourists and tourism destinations while offering opportunities to further development in the future, as well as maintaining heritage integrity, ecological integrity, biological diversity, and life support system (Pan *et al.,* 2018).

Climate change impacts have the potential to completely derail sustainable tourism initiatives as Scott and Becken (2010) note that climate change is the greatest challenge to sustainable tourism in the 21st century. Furthermore, it has been argued that tourism may never be totally sustainable, but the "sustainable development of tourism is a continuous process of improvement" (Gonzales, 2016). The social, economic and environmental impacts of climate change on the tourism industry are predicted to be of considerable magnitude in the long term (Gonzales, 2016). Pan *et al.* (2018) assert that as sustainable tourism activities mainly cover the environmental, economic, social and cultural aspects of development. Figure 2.13 demonstrates the concept of sustainable tourism composed of the identified four aspects.

A major problem which has been identified is the possibility of encouraging sustainable tourism in middle income countries, as this is affected negatively by climate change (Amelung and 2007). Viner and Agnew (1999) assert that parks and reserves are based on wildlife distribution and climate conditions which means that the effects of climate change such as the frequency of floods, drought, and land degradation could affect vegetation, ecological zones and, consequently, the distribution of wildlife. This would result to a reduction of viability of recreational activities such as wildlife safaris implying reduced social, economic and environmental benefits for tourism stakeholders and, consequently, reduced tourism sustainability.

Figure 2.13. Four conceptual aspects required for achieving sustainable tourism
Source: Adopted from Pan *et al.* (2018)

Climate change poses a challenge for sustainable tourism because the tourism industry contributes to climate change and is affected by climate change. According to (Turton, 2009) in order to acquire long-term sustainable development, the tourism sector has to deal with many climate changes response challenges. Furthermore, Scott (2021) asserts that there can be no sustainable tourism if the issue of climate change is not addressed amicably through global reduction of CO_2 levels in the atmosphere. The tourism industry cannot be considered sustainable unless it can be eventually decarbonized to a level consistent with the science-based policy targets of the Paris Climate Agreement (Scott, 2021).

According to Bibbings and Burns (2009), social scientists must collaborate with environmental scientists, climatologists, and meteorologists to generate insights into the cultural and behavioral

adjustments required counter climate change. According them, given the magnitude of emission reduction necessary to achieve climate stability, the creation of a new travel culture is vital key to decrease tourism-induced emissions. To reduce CO_2 emissions from tourism, human behavior must change. This includes the development of new travel cultures that replace the high-carbon lifestyles that now drive tourism.

Furthermore, affluent individuals avoid long-haul flights since they are socially undesirable because they emit massive volumes of CO_2 into the environment, contributing to climate change. According to the International Energy Agency (IEA), behavioral adjustments such as eliminating flights less than one hour in length and lowering long-haul and business travel numbers by three quarters can result in a third of the CO_2 reductions needed by 2030 (Scott, 2021).

While technology has the potential to address the high carbon emissions produced by the tourism supply and consumption chain, it is such an environment issue that social norms, habits, practices and travel trends have to be challenged and changed to prevent disastrous consequences (Bibbings and Burns 2009). This means that, in order to decarbonize the tourism sector, a paradigm change to a new set of low-carbon tourism products as well as climate-sensitive tourist experiences is required. Additionally, a need exists for the tourism industry to undertake a complete overhaul of the tourism production and consumption value chain to reflect zero CO_2 footprints. Thus, sustainability of the tourism industry is adequately guaranteed.

2.5. EMPIRICAL LITERATURE REVIEW

Climate change and tourism research has received insufficient attention, resulting in significant knowledge gaps (Enríquez and Bestard, 2020). Furthermore, there is widespread agreement that the tourism industry lags behind other economic sectors in climate change research, with Becken (2005) alluding that “while the larger climate change debate has largely focused on mitigation

until recently, the sparse research specifically dealing with tourism and climate change has largely concentrated on adaptation."

Elsewhere, several studies have reviewed direct climate change effects on tourism (Gössling *et al.* 2012); Becken, 2013; Rosselló-Nadal, 2014) as majority of the literature is on climate as a resource for tourism and builds on studies that seek to identify comfortable conditions for tourists by means of different climate indices (Scott *et al.*, 2004; Amelung & Viner, 2006; Amelung and Viner, 2007; Moreno and Amelung, 2009) or to develop demand models to estimate potential shifts in tourism flows or visitation patterns as a result of climate change (Rosselló-Nadal *et al.*, 2014; Goh, 2012; Tol and Walsh, 2012; Bujosa and Rosselló, 2013).

Other studies have explored tourist's behavior (Berrittella *et al.*, 2006; Bujosa *et al.*, 2015). Hamilton *et al.* (2005) conclude that tourists would spend more holidays in the home country and they will choose destinations in higher latitude. Elsewhere Perch-Nielsen (2010) and Toimil *et al.* (2018) examine the different types of destinations for example coastal areas and reveal that beach tourism destinations will experience losses of recreational value because of extreme climate related events. Ghaderi *et al.* (2014), Abegg and Koenig (1997), Moen and Fredman (2007), and Rutty *et al.* (2017) assess climate change impacts on ski tourism and report that the ski resort in lower regions suffered severe consequences such as a decrease in ski season length and increase in water usage for snowmaking.

Research conducted on rural populations in 10 Sub-Saharan countries (DR Congo, Ethiopia, Ghana, Kenya, Nigeria, Senegal, South Africa, Sudan, Tanzania, and Uganda) by the BBC World Service Trust demonstrates that these populations have very little understanding of climate change despite already dealing with its impacts (Wolf, 2011). It is generally accepted that climate is an important part of the region's tourism resource base. However, its roles in

determining the suitability of a region for tourism is often assumed to be self-evident and, therefore, require no elaboration (deFreitas *et al.,* 2008).

Relatively, little is known other than in general terms about the effects of climate change on tourism or the role it plays and even less is known about the economic impact or significance of climate on commercial prospects for tourism (de Freitas *et al*., 2008). Rogerson & Sims (2012) point out that uncertainty exists regarding the long-term consequences of a changing environment on tourism and only recently has such consequences been researched within an African context. This agrees with Leiserowitz (2006) arguement that while the climate change debate has continued for several decades raising increased concern and awareness as it remains a low priority in respect to other social and environmental issues.

Becken (2010) also emphasizes that the key issue is why such pressing issues today such as climate change and environmental problems are not dealt with the same enthusiasm and ideals as disasters of the past like war. The UNDP (2012) observes that a comprehensive analysis of the climate risks facing Kenya and the country's capacity to respond to these risks has not yet been undertaken. Further, the relationship between tourism and climate has been studied for a long time (Scott *et al.,* 2005) and fewer studies focus on how tourism contributes to climate change (Becken, 2005) than vice-versa. Weaver (2011) also notes the rudimentary state of knowledge about the relationships between tourism and climate change.

Moreno (2010) observes that significant knowledge gaps remain on tourists' behavioral responses to climate or environmental change. Hall (2012) suggests that the relationship that exists between tourism and climate change is considered differently by the various research practices and fields of discipline. What results is an extremely unbalanced evaluation of tourism and climate change in terms of both the focus and approach and therefore certain methods are dominant in some studies than others. Additionally, Gössling *et al.* (2012) notes that the level of

adequacy of tourism knowledge with respect to climate change adaptation and impacts is inadequate with regards to accommodation establishments and very inadequate with regards to tourists.

Much of the existing research in tourism have acknowledged the sensitivity of the sector to changing climatic conditions at the tourism destination, attributable to the fact that the destination's climate is one of the most important factors in a traveler's decision-making process (Agnew & Palutikof, 2006; Amelung, Nicholls & Viner, 2007; Bigano, Hamilton & Tol, 2006; de Freitas, 2008; Matzarakis *et al.,* 2007) while also defining the timing, length and quality of tourism seasons (Lise & Tol, 2002; Scott, Gössling & de Freitas, 2009).

2.6. RESEARCH GAPS

The effects of climate change on tourism have been investigated through various approaches, with the goal to assess climate change implications for the tourism industry across various geopolitical regions, countries and cities (Rutty *et al.,* 2017). Earlier studies have examined the effects of changes in climate variables such as temperature and precipitation on tourism demand (Gómez & Martín, 2005). Existing studies have mainly focused on forecasting changes in climatic variables based on simulations and developing adaptation and mitigation strategies (Michailidou *et al.,* 2016). However, these climate change scenarios do not take non-climatic factors, such as economic, social, and political factors into consideration, such a gap in the literature calls for a comprehensive vulnerability and resilience assessment (Dogru *et al.,* 2019). Therefore, because of the indicated research gap, this study examines the impacts of changes in climate variables (temperature and precipitation) on natural resources (wildlife and vegetation) that support the tourism industry. The sustainability of the tourism industry is also examined in same scenario under changing climate conditions.

Studies by Dogru *et al.* (2019) conceptualized the relationship between climate change and tourism in theoretical frameworks of vulnerability, and further empirically examined the impacts of vulnerability on tourism demand. However, their study fails to investigate how the tourism industry is sensitive and resilient to climate change in various nations depending on economic growth. The effects of climate change on tourist flows have also been simulated (Amelung & Nicholls, 2007).

Findings from previous studies indicate that climate change has a detrimental influence on the tourism sector (Dogru *et al.,* 2019). These studies predict a drop in tourism demand, implying that existing tourist destinations, such as coastal cities, island economies, and ski resorts, would be affected by climate change in the near future (Neuvonen *et al.*, 2015). However, the relationship between climate change and tourism is more complex than they appear to be depicted by models that simply use climate change scenarios to estimate visitor demand and flows (Gössling *et al.*, 2012).

It is problematic to use climatic variables (temperature and precipitation) as proxies for analyzing possible negative effects on tourism since there are no theoretical foundations for such research (Goh, 2012). The results of these models cannot be properly contextualized without a theoretical foundation, because they do not account for predicted economic, political, and social changes, which are crucial for comprehending climate change ramifications (Ford *et al.*, 2012). This study adopts systems theory to assess the social, cultural, and environmental effects of climate change. Füssel and Hildén (2014) suggest that mitigation and adaptation strategies can generate unsatisfactory results when economic, political, and social factors are not taken into consideration. Unfortunately, the majority of the studies identified did not take into account climate induced environmental changes that receive relatively less attention (Enrquez and Bestard, 2020).

There has been a significant amount of research that has identified climate change as a major problem for tourism, largely in part because they are so closely linked as tourism is affected by climate change as well as impacts of climate change (Gössling, *et al.,* 2012). Conversely, Mushawemhuka *et al.* (2018) together with Kilungu *et al.* (2019) argue that there is a dearth of empirical studies on the impact of climate change on tourism on the African continent. They further point out that the bulk of literature that has emerged from the African continent over the past few years has mainly consisted of literature reviews which add little to no value in the debate.

Moreno (2010) notes that the tourism sector is slowly becoming more educated about climate change and is, therefore, going to be more prepared to incorporate climate change planning into its operations. However, a large amount of information on the effects of changing conditions on tourism stakeholders such as tourists is still missing. A need exists to address a clear understanding of the implications for climate change to the tourism industry and its sustainability. Additionally, the social, economic and cultural relationships as well as influence of climate variability are not clearly known. The complex nature of the tourism system calls for expanding and deepening the concept of sustainability under changing climate conditions.

2.7. THEORETICAL FRAMEWORK

Academic disciplines enhance their understanding through engagement in theoretical activity. Harding and Blokland (2014) define theoretical activity as "any degree of explanatory method that works with relatively abstract conceptions or ideas to describe the reality." They further argue that it contains concepts about what is important and what is not important and behind are ideas on how things operate. Therefore, this study was entirely guided and grounded on systems theory.

2.7.1. Systems Theory

Tourism is often wrongly characterized as a linear system and has been approached from single disciplines (Becken, 2009). Wong and Thirumoorthy (2015) argue that systems theory was developed by Leiper (1979). Hall and Page (2010) assert that Leiper was an early advocate of the adoption of systems approach towards understanding tourism and other research studies drawing on the systems theory work of planners such as Gunn and Clare (2002) and geographers such as Matley (1972). Leiper (1979) was not the first tourism scholar to advocate for systems approach in tourism research works; others include King (1987), Hall (2008), Page (2006) and Netto (2009) investigated the relationship between tourism and leisure (Leiper, 1984, 1985, 1989b) and its implications for travel markets and management, including with respect to business and convention travel (Leiper *et al.*, 2008).

Majority of the researchers now conclude that complexity and uncertainty are at the core of the climate variability and tourism relationship (Becken, 2009; Amelung and Viner, 2007). According to IPCC (2007), systems theory is applicable and relevant in understanding anthropogenically driven global climate change which is complex. Hence systems science is critical to understanding the complex changes of increasing GHGs and radiative forcing that is linked with temperature changes, precipitations pattern, and resource availability, habitat quality for species as well as economic, ecological and social contexts. Systems theory, therefore, is relevant to explain the effects of climate variability on natural resources and thereby tourism sustainability.

Systems theory proposes that tourism is a complex phenomenon involving many different but related players such as tourists, tour operators and local populations who interact with each other at different temporal and spatial scales (Becken, 2009; Hein *et al.,* 2009). Indeed, the nature of the tourism industry through its linkages with other sectors of the economy can be best

understood and described by systems theory and more importantly how climate change is being addressed across all the sectors linked with tourism. This is because tourism is a highly complex and diverse sector involving stakeholders from a range of different sub-sectors that can be sufficiently analyzed using systems approach.

Several stakeholders including tourism businesses, public sector organizations, community groups, accommodation providers, transportation providers, those involved in forward and backward linkages to the tourism, value chain and tourists themselves form the system (Jopp *et al.,* Mair, 2010). Other components of the system include the suppliers, tourism staff, the local community, local, national, and international tour operators and agents, transport systems and both domestic and international tourists themselves (Hein *et al.,* 2009).

Published reports from UNFCC and IPCC point out clearly that change in the climatic system will significantly affect the tourism industry resulting to opportunities and challenges scenarios. More intense and intensive extreme events such as flooding, drought, rising temperatures, storms, heat waves and intensive rainfall will impact the tourism industry activities in varying levels. Therefore, systems theory is more applicable to understanding climate change implications across tourism allied sectors including strategies to combat climate change that could vary from one sector to the other. Temperature and precipitation patterns brought by increasing GHGs emissions and the direct impact on resources (wildlife and vegetation) and consequently sociocultural and environmental facets of tourism stakeholders are assessed using systems theory.

Systems theory has the following weak points: although separating the tourist system from other systems facilitates the study; it also leads to a fragmented view of the study object; and when separating tourism into a system, it is important to remember that tourism is part of a larger system, such as the social system. However, systems theory has the following advantages: by

creating a model (conceptual design), one has an overview of climate change impacts on tourism as a whole; it is also possible to segment the system into parts and study them separately with regard to climate change impacts. Lastly, it is possible to separate the tourist system from other systems, thus enabling an interdisciplinary study of climate change impacts on tourism.

2.8. CONCEPTUAL FRAMEWORK

The conceptual framework in figure 2.14 below shows the relationship between the independent, dependent and mediator variables. Natural resource is the mediator variable, whereas the tourism sustainability is the dependent variable, and, finally, climate change is the independent variable.

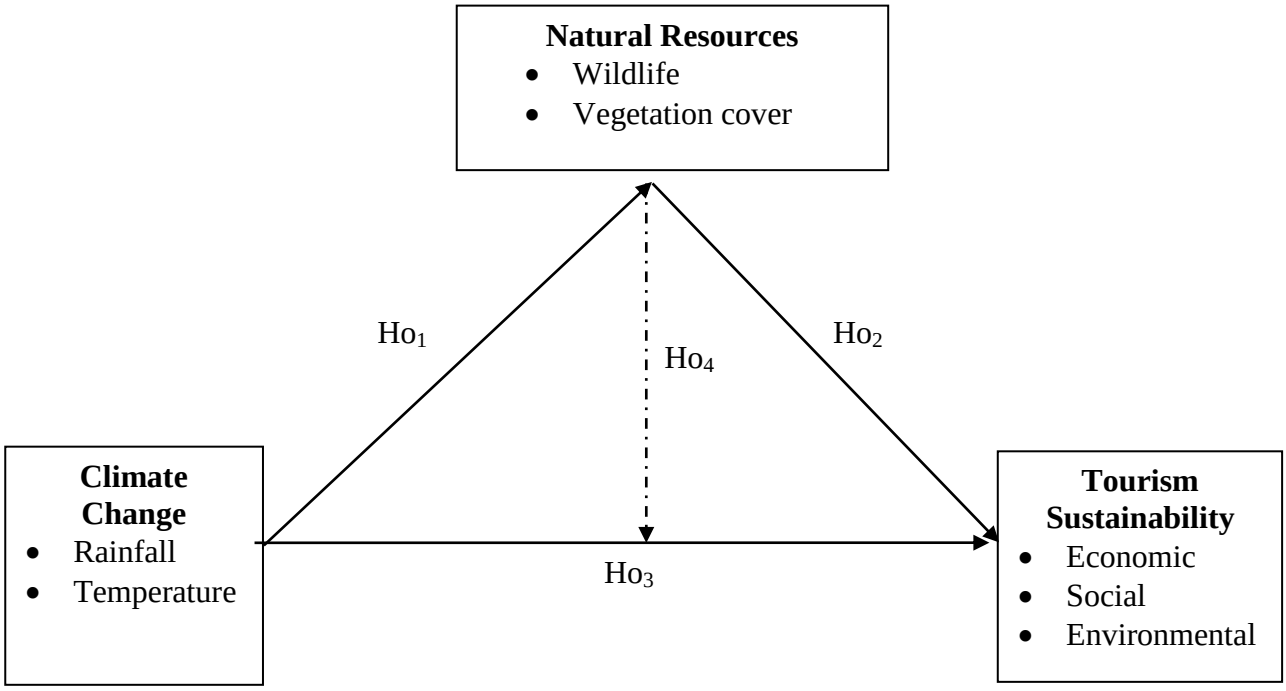


Figure 2.14. Conceptual framework on the relationship between climate change, natural resources and sustainable tourism

Source: Author (2020).

Figure 2.14 illustrates tourism sustainability as the dependent variable and is affected by climate change which is the independent variable. Natural resources act as the mediator variable. Operationalizing the variables, climate change has rainfall and temperature constructs, natural resources has wildlife and vegetation constructs while tourism sustainability has social, economic as well as environmental constructs. The interrelation between climate change, natural resources and tourism sustainability is conceptualized. Climate change through rainfall and temperature patterns are likely to trigger a control effect on natural resources (wildlife and vegetation cover) that will possibly influence tourism sustainability through economic, social and environmental constructs that this study seeks to

The tourism industry in Kenya is heavily nature based and dependent on wildlife that in turn rely on rainfall and temperature patterns through which vegetation thrives availing sufficient food for wildlife population to increase. Availability of a variety of wildlife species is a major boost for the nature based tourism industry as tourists seek unique wildlife based experiences. Declines in wildlife populations have the potential to reduce the number of visitors to tourism destination areas. This can cause a decline in social, economic and environmental benefits from reduced tourism activities, implying the tourism industry is not sustainable.

Climate change through extreme events of flooding and drought brought by rapid changes in rainfall and temperature patterns have the potential to reduce wildlife population hence affecting the tourism industry and its sustainability that this study explores. In summary, rainfall and temperature variations exhibited by flood and drought phenomena are evidence of climate change. These variations can potentially impact natural resources such as wildlife that the tourism industry is anchored on. Additionally, tourism activities including sustainability of tourism face the risk of being negatively impacted by extreme climate events. In conclusion,

climate changes pose great risks to the sustainability of the tourism industry. It is not known clearly how climate changes will influence the sustainability of the tourism industry.

CHAPTER THREE

RESEARCH METHODOLOGY

This chapter explains the research methodology of the study. It presents a description of the study area, followed by a detailed analysis of the research approach and research design adopted by the study, describes the target population, the sample size, sampling procedure and research instruments, reliability and validity, methods of data analysis and ethical considerations.

3.1. STUDY AREA

Maasai Mara National Reserve (MMNR) is widely recognized as the jewel crown of Kenya's protected area system and accounts for the reserve's role in preserving East Africa's great wildebeest migration. It is acknowledged internationally as one of the seven wonders of the world (MMNR Management Plan, 2009-2019). MMNR occupies the southern area (Narok South Sub-County) of the Greater Mara Ecosystem (GME) to the Tanzania border, totaling 1,530 km^2 of protected land (Seno and Shaw, 2002). Narok South Sub-County covers an area of 10,412.1 Km^2 which is the largest, with 5 divisions, 28 locations, 52 sub-locations and 62,412 households. It is followed by Narok North Sub-County and Narok West Sub-County while the smallest is Emurua Dikirr with an area of 275.4 Km^2, comprising two divisions, six locations, 12 sub-locations and 15,098 households (GoK, 2019) as summarized in figure 3.1 and 3.2.

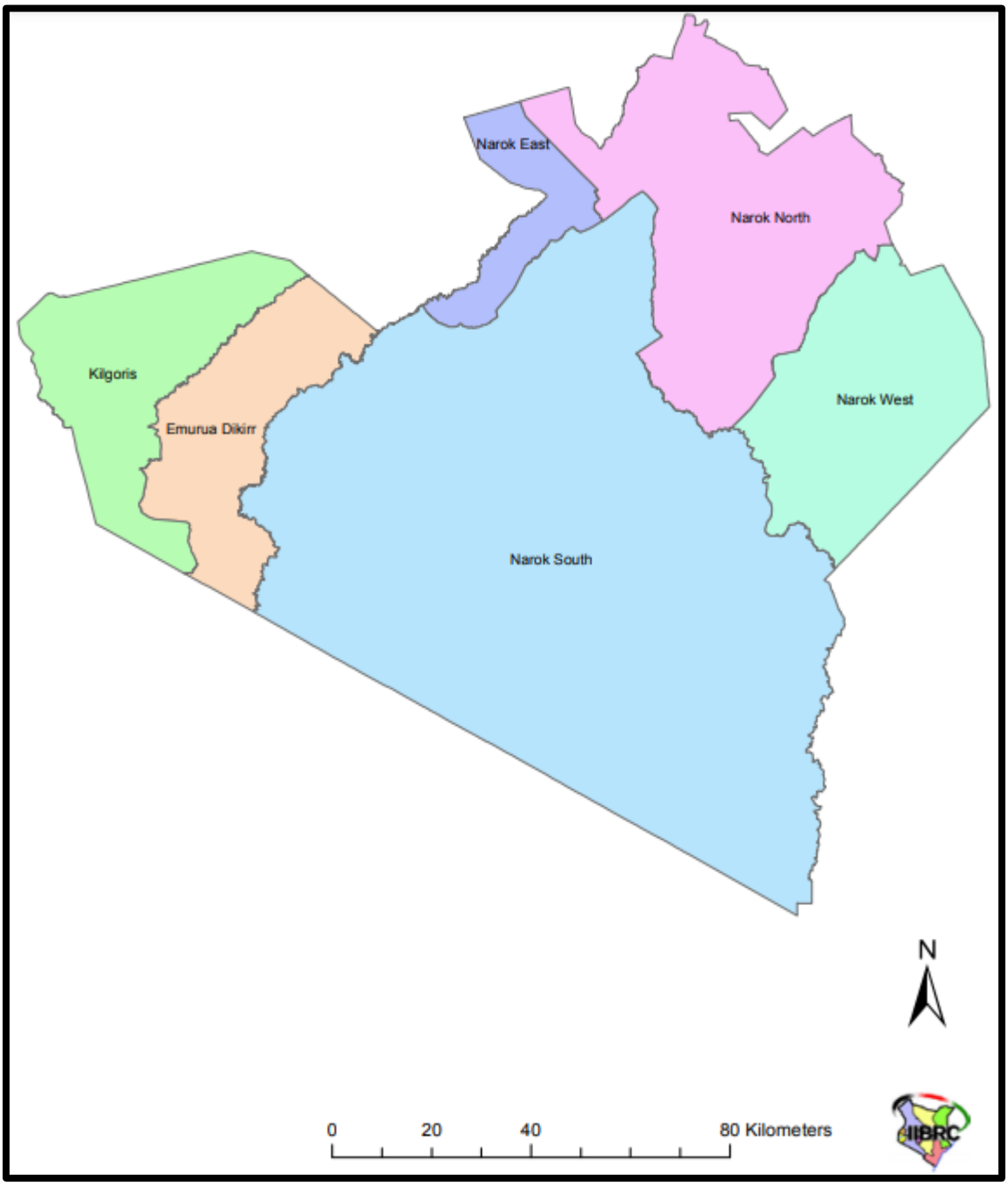


Figure 3.1. Map showing sub-counties in Narok County, MMGNR (Study area) located in Narok South Sub-County.
Source: GoK (2010)

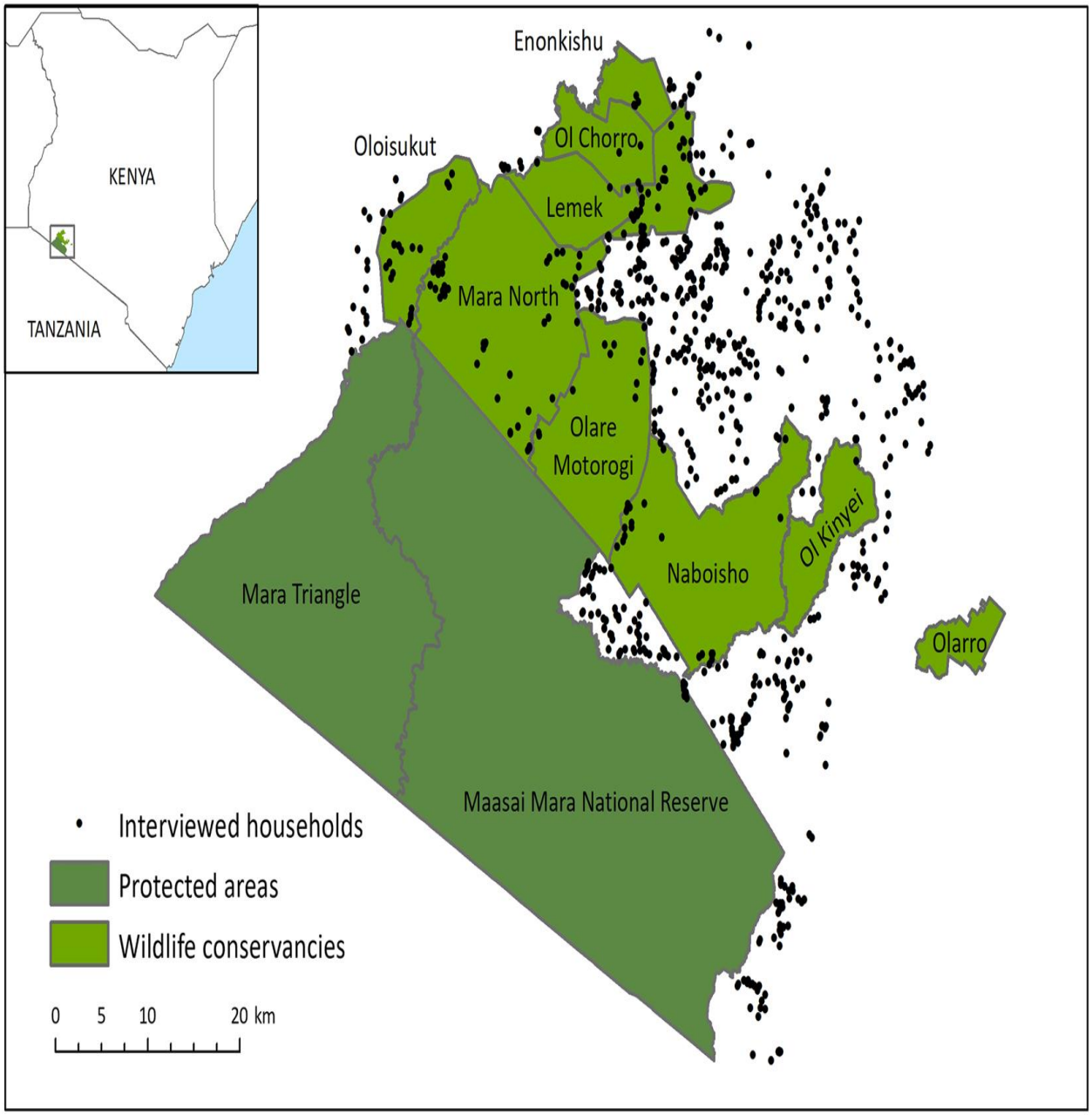


Figure 3.2. Detailed map showing study area in Narok South Sub-County
Source: Adopted from Broekhuis *et al* (2018)

3.1.1. Natural resources in MMNR

MMNR and Serengeti National Park share a grassland ecosystem that extends into surrounding areas and is famous for the annual wildebeest migration most commonly known as 'one of the greatest wildlife spectacles on earth'. The unique aspect of the Greater Mara-Serengeti Ecosystem is the yearly large migration of mammals between the Serengeti National Park, the Ngorongoro conservation area and the surrounding environment, which comprises about two million wildebeests, zebras and gazelles (MMNR Management Plan, 2009-2019).

The Mara River has its origin in the Mau hills and flows southwest through the footpath of the Siana escarpment, to the south through the Mara National Reserve. Then it flows west into Lake Victoria as all watercourses from the plains drain into the Mara River, the Sand and Talek rivers form the largest tributaries of the Mara River and drain into the national reserve and Siana Plains (Bhandari, 2014).

The Exceptional Resource Values (ERVs) highlight major natural resources and other aspects that benefit the local and international tourists, and, most importantly, the maintenance of the region's distinctive natural traits, characteristics and ecology. The Mara ecosystem varies from grasslands and shrub-lands to wooded grasslands and shrubby and wooded riverine vegetation, while the central plains, where most of the herbivores graze, comprise short and tall as well as wooded grassland that are mainly composed of *balanites* and *tundra* found primarily in the Mara triangle, which is located in the western part of the reserve. However a shrubby grassland community is dominant within the Mara reserve, the Loita hills, and southern parts of the Koyaki Ranch (Bhandari, 2014).

MMNR forms a small part of a much larger complex protected area including the Serengeti National Park, Ngorongoro Conservation Area, and a number of game reserves, which together cover over 25,000 Km^2, supporting a huge diversity and abundance of resident ungulates and

other herbivores, which combined with the annual migrations, provide sufficient food to support one of the highest densities of carnivores in Africa including lions, hyenas, leopards, and cheetahs (MMNR Management Plan, 2009-2019).

MMNR is classified as an Important Bird Area (IBA) by Bird Life International as a result of the abundance of birds in the area, where six out of the seven species of volture found in Kenya (Egyptian, Hooded, Griffon, Nubian, White-backed and White-headed) are in the reserve and in total over 500 bird species are known to occur, including 53 birds of prey (MMNR Management Plan, 2009-2019). The choice of MMNR as a study area was informed by the ERVs. Table 3.1 shows ERVs in MMNR.

Table 3.1. MMNR Exceptional Resource Values (ERVs)

Category	Exceptional Resource Value
Biodiversity	**- Large mammal migrations**
	- Natural Ecosystem
	- Faunal diversity
	- The Mara River
Scenic	**- Wilderness qualities**
	- Mara, Talek and Sand Rivers
Social	**- National economic importance**
	- Local economic importance
	- Security
Cultural	**- Maasai culture and community**

Source: Modified from MMNR Management plan (2009-2019)

3.1.2. Tourism activities, facilities and services in MMNR

Development of tourist facilities in the reserve has been rapid in response to the increasing number of visitors when the first lodge, Keekorok, was established in 1963 and by the year 1997, the number of permanent hotels had reached 25, excluding outside tented camps and temporary tented camps inside the reserve as safari tourism enterprises and big hotels are mainly owned by the International corporations and firms from Western European and Indian origins (Bhandari, 2014). Currently, the reserve has approximately 31 permanent tourist facilities including 29 lodges, camps with a total bed capacity of 1,382 guests in addition to 20 open camp sites, three view/picnic sites and nine other tourist facilities (Kamau *et al*, 2017). Figure 3.3 shows tourist facilities within MMNR.

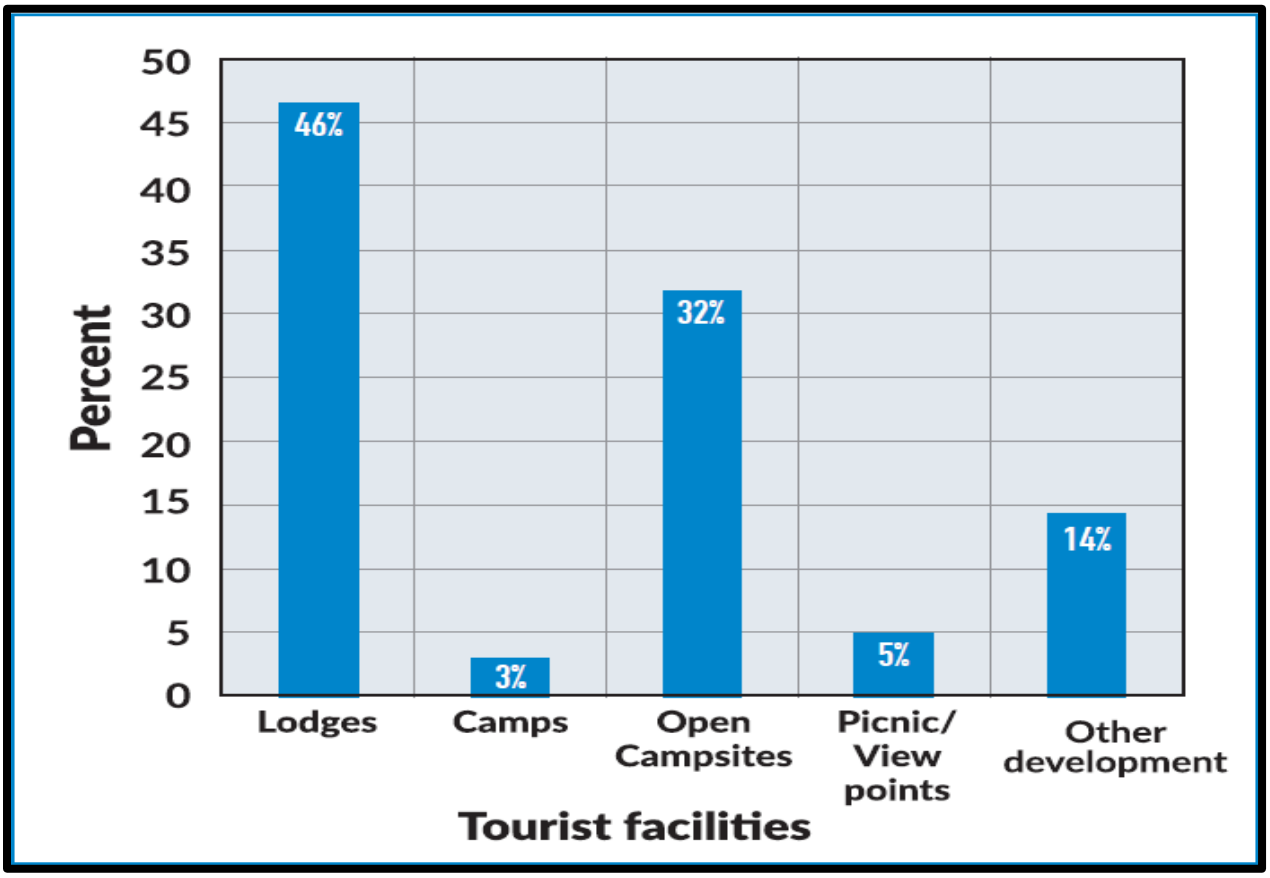


Figure 3.3. Tourist facilities and other development within MMNR
Source: Adopted from Kamau *et al.* (2017)

3.2. RESEARCH DESIGN

A research design refers to procedures for collecting and analyzing data to answer the research question (Cresswell, 2014). The research design used was explanatory and descriptive research designs. Explanatory was used for qualitative while descriptive was used for quantitative data. Explanatory design forms the first step of research when the universe of study is unknown (Cooper & Schindler, 2008). The design looks for causes and reasons, and identifies the reasons for occurrences and attempts to explain why things happen or why things happen the way they do (Small *et al.,* 2011). According to Saunders *et al*. (2011), studies that establish causal relationships between variables use explanatory design. Explanatory research design was suitable because the studies was mainly concerned with quantifying a relationship and identify a cause-effect relationship. Additionally, the design was deemed appropriate for the study as it allowed use of inferential statistical analysis to organize, describe and summarize data collected.

Descriptive design aims at obtaining information that can be analyzed for the purpose of establishing a basis for making decisions. The descriptive survey design enables the researcher to explore and describe the relationship between variables in their natural setting. The descriptive design often results in the generation of solutions to significant problems that are more than just a collection of data analysis and interpretation. This design was also found more appropriate because it enabled the researcher to develop crucial new knowledge.

3.3 RESEARCH PARADIGM

A research philosophy outlines the way data of a certain phenomenon should be gathered and analyzed (Saunders *et al.,* 2011). This study utilized a pragmatic paradigm since it integrates qualitative and quantitative techniques in various research stages (Tashakkori & Teddlie, 2003). Pragmatist researchers focus 'what' and 'how' of the study problems (Creswell, 2014).

Pragmatism is usually regarded as the philosophical partner for mixed methods research (Tashakkori &Teddlie, 2010). It provided a set of assumptions about knowledge and enquiry that underpins mixed methods approach and which distinguishes the approach from purely quantitative approaches that are based on a philosophy of post-positivism and purely qualitative approaches that are based on a philosophy of interpretivism or constructivism. The researcher's intent was to make sense of and interpret the meanings others have about the world.

3.4. RESEARCH APPROACH/METHODOLOGY

Research methodology describes the general approach to research design as an action plan that links techniques with results (Creswell, 2014). The study adopted mixed approach that combines both qualitative and quantitative forms (Creswell, 2014). This approach is supported by Tashakkori & Teddlie (2010) who argue that it helps to answer questions which cannot be answered by qualitative or quantitative approaches alone. This research used quantitative and qualitative data and hence mixed approach for this study was considered suitable. One important advantage of employing mixed method research is that it simultaneously allowed the researcher to address confirmatory questions regarding the effect of climate change on the relationship between natural resources and tourism sustainability in MMNR through both questionnaires and interviews.

3.5. TARGET POPULATION

Target population is defined as all the members of a real or hypothetical set of people, events or objects to which a researcher wishes to generalize the results of the research study (Borg & Gall, 2017). Target population of a study refers to a group of individuals taken from the general population who share similar characteristics. The target population of the study was 316, 681

respondents comprising 169, 220 household in Narok County (GoK, 2018), 146, 900 tourists (GoK, 2015) and 18 experts drawn from government and non-governmental organization.

Within the household, heads of household were interviewed because of their status in the family and society to have indigenous knowledge as well as understanding and rich experience about changes in the immediate environment and more specifically issues of climate change, natural resources and tourism sustainability. Furthermore, repeat tourists were targeted as from their past visits they had crucial information about any changes they could have noticed or experienced especially on climate change and natural resources.

Finally, experts were drawn from the climate change, natural resources and tourism sustainability disciplines. The experts were key informants to the study because of their expertise in climate change, natural resources and tourism sustainability. Supervisors guided the process of identifying the experts based on their field of expertise including trustworthiness. Climate change experts were drawn from; Institute of Climate Change and Adaptation (ICCA) at University of Nairobi, Directorate of Climate Change, Ministry of Environment and Natural Resources, Nairobi and Kenya Climate Change Working Group (KCCG). Natural resources experts were drawn from Directorate of Resource Surveys and Remote Sensing (DRSRS), Regional Centre for Mapping of Resources for Development (RCMRD), Kenya Wildlife Service (KWS), Vetinary Office. Also included were wardens and sergeants based in MMNR. Tourism sustainability experts were drawn from Sustainable Travel and Tourism Agenda (STTA), Nairobi who had previous and ongoing tourism sustainability programs and projects in MMNR.

List of experts

Climate change experts	*Natural resources experts*	*Tourism sustainability experts*
Institute of Climate Change and Adaptation (ICCA) at University of Nairobi.	Directorate of Resource Surveys and Remote Sensing (DRSRS).	Sustainable Travel and Tourism Agenda (STTA), Nairobi.
Directorate of Climate Change, Ministry of Environment and Natural Resources, Nairobi.	Regional Centre for Mapping of Resources for Development (RCMRD).	
Kenya Climate Change Working Group (KCCG).	Kenya Wildlife Service (KWS), Vetnary Officer. Wardens and sergeants based in MMNR.	

Source: Author (2019)

3.6. SAMPLING SIZE AND SAMPLING PROCEDURE

3.6.1. Sample size

While the larger the sample the lower the probability that findings will be bias holds, emerging and unforeseen situations can quickly set in when samples get over specific size that need to be balanced against the researchers' resources (Gill *et al.,* 2010). Larger sampling sizes reduce sampling error but at a decreasing rate. For the determination of the sample size, several statistical formulas are available. The study adopted Yamane (1967) formula for calculation of sample size from a population;

$$n = \frac{N}{1 + N\left(e^2\right)}$$

Where, N is the population size and e is the level of precision with ±5% precision. Assuming 95% confidence level and p =0.5 the sample size is summarized as shown in table 3.2 below. As Fowler (2002) points out, the method for estimating sample size has almost little influence on

how well the sample is likely to describe the population, and it is uncommon for the population fraction to be an essential factor when deciding on sample size (Fowler, 2002). The sample size was 507 respondents comprising 399 households, 90 tourists and 18 experts.

Table 3.2. Sampling frame

	Target population	**Sample size**
Community members	169, 220	399
Tourists	300	90
Experts	18	18
Total	**169,538**	**507**

3.6.2. Sampling procedure

Given that the target population is heterogeneous and due to the nature of MMNR, the study adopted two types of sampling methods: probability sampling, and non-probability sampling. Each of these methods included different types of techniques of sampling. Non-probability sampling used includes snowball, purposive sampling and convenience sampling. Probability sampling included simple random and stratified random sampling.

Probability sampling means that every item in the population has an equal chance of being included in the sample. One way to undertake random sampling would be the researcher constructing a sampling frame first and then uses random number generation or computer program to pick a sample from the sampling frame (Zikmund, 2010). Probability or random sampling has the greatest freedom from bias but may represent the costly sample in terms of time and energy for a given level of sampling error (Brown, 2019).

Non-probability sampling is often associated with case study research design and qualitative research. With regards to the latter, case studies tend to focus on small samples and are intended

to examine a real-life phenomenon, not to make statistical inferences in relation to the wider population (Yin, 2003). A sample of participants or cases does not need to be representative or random, but a clear rationale is needed for the inclusion of some cases or individuals rather than others.

Firstly, Narok County where MMNR is located was stratified according to sub-counties, where each of these categories formed a stratum. The household was stratified into four strata representing the four sub-counties namely, Transmara West, Narok North, Narok South and Transmara East. MMNR is located in Narok South with a total of six wards, namely, Majimoto, Ololulunga, Melelo, Loita, Sogoo and Sagamia. Stratified random sampling was appropriate as it enabled the researcher to represent not only the overall population but also key sub-groups of the population such as even further into wards. Stratified sampling also allowed a great deal of variation within the population. According to Adejimi *et al.* (2010), stratification is beneficial as it considers each stratum independently. Stratification helps to reduce standard error by providing some control over variance. The technique provides a better comparison across strata (Saunders *et al.*, 2007).

Secondly, simple random sampling was used to select 399 heads of household from the six wards to fill the questionnaire. A target of 66 heads of households per ward was determined. Through the lottery method, ballot papers were put in the lottery box containing a 'YES' or 'NO' in different ballot boxes representing the six wards. The researcher visited the first ward in the homestead and a head of household was requested to pick a ballot paper, if they picked a 'YES' they were taken through the questionnaire filling exercise and if they selected a 'NO' they did not fill the questionnaire and the researcher moved to the next household. The process went on for all the wards. On average the questionnaire filling session took ten minutes.

Simple random sampling was used because each respondent had an equal chance of inclusion in the sample. It was appropriate because the entire population was relatively large, diverse and sparsely distributed, hence random sampling technique helped to achieve the desired sample size. Simple random sample meant that every case of the population had an equal probability of inclusion in sample (Ghauri and Gronhaug, 2005). The advantage of using this design is that it was easily understood and results projectable, while its limitation was that it is difficult to construct sampling frame, expensive, lower precision and no assurance of representativeness.

On the experts, firstly they were purposively identified based on the objectives of the study. Secondly, snowball sampling technique was used to sample the 18 experts that had the understanding about climate change, natural resources and tourism sustainability. Face to face interviews were conducted on climate change experts, natural resources experts and tourism sustainability experts. At the end of every interview, each of the experts proposed another expert in the same category of expertise who was interviewed until the responses became similar. For instance, initially two climate change experts based at the University of Nairobi's Institute of Climate Change and Adaptation were interviewed. At the end of the expert interview, the study had additional two experts from Directorate of climate change and two more experts from the Kenya climate change working group (KCCG). The same applies to natural resources experts that totaled six experts with an initial target of two experts.

Snowball sampling is a non-probability sampling method that uses a few cases to help encourage other cases to take part in the study, thereby increasing sample size. This approach is most applicable in small populations that are difficult to access due to their closed nature for example secret societies and inaccessible professions (Breweton and Millward, 2001). The advantage of using this method is its rare characteristics, and its disadvantage being time-consuming.

The researcher visited the tourists inside the reserve at Mara Serena Safari Lodge, Mara River Camp, Mara Engai Lodge, Mpata Safari Club and Keekorok Lodge and used convenience sampling to interview the tourists. Convenience sampling refers to selecting participants because they are often readily and easily available. Typically, convenience sampling tends to be a favored sampling technique among students as it is inexpensive and an easy option compared to other sampling techniques (Ackoff, 1953). Convenience sampling often helps to overcome many of the limitations associated with research. The advantages of using convenience sampling included: it was inexpensive, consumed minimal time, and most convenient. The disadvantages were: selection bias, sample not representative and not recommended by descriptive or casual research (Ackoff, 1953).

3.7. DATA COLLECTION INSTRUMENTS AND PROCEDURES

3.7.1. Data Sources

Both primary and secondary data are employed for the study. Primary data was collected through direct communication with the respondents using structured questionnaires and interview guides as the main source of data. Secondary data was collected from published and unpublished sources related to the present study. This included textbooks, publications, tourism development plans, dissertations and other works, including magazines and journals written by different scholars. Kenya Climate Change Working Group (KCCWG) reports, Intergovernmental Panel on Climate Change (IPCC) publications, United Nations Framework on Climate Change (UNFCC) publications and the Kenya National Library Services, Nairobi branch formed the basis of data collection. Only relevant information was extracted and fully acknowledged.

3.7.2. Temperature and Precipitation

Rainfall as well as temperature data for the study area were collected. Temperature and rainfall data were obtained from Kenya Meteorological Department Weather station located in Narok Town. To ensure accuracy, consistency as well as comparisons of these data, the study also collected rainfall data obtained from 15 rain gauges in the Mara region where thirteen of the 15 gauges in the Mara are operated by the World-Wide Fund for Nature (WWF) and Friends of Conservation (FOC) as part of the Maasai Mara Ecological Monitoring Programme. Rainfall as well as temperatures data are useful to analyze climatic changes. The data was then analyzed to generate annual mean values.

3.7.3. Questionnaire

Questionnaires refer to set questions that give answers of the research objectives in a set of ways. According to Kombo and Tromp (2006), a questionnaire is a research instrument that gathers data over a large sample. Most questionnaires are designed to gather already structured data and include a set of answers which the respondent can choose from, although some may include more open-ended questions which allow the respondent to answer the question in their own way; others give a provision where all the participants are asked the same questions in the same order and using the same wording and have the same set of answers to choose from (Matthews & Ross, 2010). Primary data was collected by use of structured questionnaires that capture the various variables of the study. This was done during the period September-December, 2019.

According to Kothari (2008), questionnaires are usually free from the interview bias as the answers are in respondent's own words. Respondents had an adequate time to give well thought out answers. Orodho (2008) also argues that a questionnaire is an efficient research tool which when used the researcher obtains personal ideas from a respondent. Questionnaires were

preferred in the study for collecting data because the questions, wordings and sequence were identical to the effects of climate change on natural resources and tourism sustainability. Questionnaires had the advantage of obtaining standard responses to items, making it possible to compare between sets of data as it also allows participants to give their own opinion on the issues at stake (Matthews & Ross, 2010).

Questionnaires were designed to address specific study objectives. It had both closed-ended and open-ended questions that were administered to the heads of households neighboring MMNR as well as tourist's visiting the reserve whom participated in the study as shown in appendix II and III respectively. The closed ended items gave precise information that minimized information bias and facilitated data analysis. This was in form of a Likert Scale anchored by five-points ratings ranging from strongly disagree to strongly agree.

3.7.4. Interview Guide

Orodho (2008) postulates that many people are willing to communicate orally than in writing and they would provide data more readily and fully than on a questionnaire. According to Christensen *et al.* (2013) the advantages of using a structured interview is that the researcher was able to clarify any queries concerning the questions. This ensured that answers are reliably aggregated and allow comparisons to be made. Participants also discover, uncover or generate the rules by which they are playing this particular game. The interviewer becomes more skilled at interviewing, in general in terms of the strategies which are appropriate for eliciting responses (Tight *et al.*, 2006). A structured interview schedule was used to gather information from the key informants.

3.7.5 Reliability and validity of the instruments

The pilot study enables the researcher to assess the clarity of the questionnaire items so that those items which are inadequate or vague are modified to improve the quality of the research instrument validity and reliability.

3.7.5.1. Reliability

The reliability of a measure refers to the consistency of measurement (Passer, 2014). Reliability includes test–retest reliability and internal-consistency reliability that refers to the consistency of a measure (Passer, 2014). The study adopted Cronbach's Alpha of 0.7% level to measure reliability. The generally agreed upon lower limit for Cronbach's Alpha is =>0.70 but may decrease to =>0.60 in explanatory research and increase up to ≥0.80 in studies that require more stringent reliability (Hair *et al*., 2016).

The instrument was administered in a consistent fashion to enhance reliability of the measurement instrument. The questionnaires were assessed for their reliability through a pilot study conducted in the Mara Triangle in the month of August 2019. A research instrument is reliable if after being administered to different groups of respondent's yields consistent results. Cronbach's Alpha coefficient was used to assess the internal consistency or homogeneity among the items. The highest Cronbach's Alpha was observed for tourism sustainability with a coefficient of 0.921 and the lowest coefficient was for climate change (0.706) as shown in Table 3.3.

Table 3.3. Reliability Statistics

	Cronbach's Alpha	**N of Items**
Climate change	.706	7
Natural resources	.711	7
Tourism sustainability	.921	20
Overall	**.900**	**34**

Natural resources had a coefficient of .711. The study findings depicted that on overall the Cronbach's Alpha coefficient was 0.900. Since the coefficient was above 0.7 when all the constructs were combined and considered reliable. The coefficients presented revealed that the statements used in the questionnaire were reliable in all the measurement scales used having, achieved the recommended reliability level of 0.7 (Hair *et al*., 2016). This implies that the scales had a high degree of internal consistency among the measurement items. This can be attributed to the fact that all the questionnaire items were adopted from published journals or articles that have been empirically tested.

A reliability coefficient of 0.7 or over was assumed to reflect the internal reliability of the instruments (Fraenkel & Wallen, 2000). The questionnaires were reliable after many typographical errors and omissions detected were corrected in the instrument and was sufficient to use in the main study. The questionnaires were refined on the basis of the responses and the items which required revision was done to make them more meaningful before pilot study and the actual collection of data.

3.7.7 Validity

Validity refers to a measure that actually assesses what it is claimed to assess (Passer, 2014). In other words, validity refers to whether a measure actually assesses the attribute that it claims to assess (Passer, 2014). Face validity concerns the degree to which the items on a measure appear to be reasonable. Content validity represents the degree to which the items on a measure adequately sample the entire set of items that could have been included. Criterion validity focuses on how well a measure can predict a criterion (Passer, 2014).

Predictive validity and concurrent validity represent two types of criterion validity as construct validity is demonstrated when a measure has consistently been shown to assess the underlying construct that it claims to assess. Convergent validity and discriminant validity, along with content and criterion validity, provide evidence for the construct validity of a measure (Passer, 2014). The researcher used expert opinion to assess the validity of the data collection tools. The researcher also sought the assistance of supervisors to improve validity of the instrument. The expert opinion in this case was the supervisors who assessed the data collection tools meant to determine the influence of climate variability on natural resources and tourism sustainability.

To determine content validity of the instrument, the researcher sought suggestions from a panel of lecturers at the School of Hospitality and Human Ecology at The Technical University of Kenya. Judgmental opinion from experts was sought, this agrees with (Hargerman *et al.,* 2010) arguing that the main strength of expert opinion in decision-making and identifying future research needs is that it does not seek to identify consensus within a group, but rather, it highlights the current diversity of ideas within an expert community that may not be voiced in more public forum.

The study established content and face validity to assess the accuracy, meaningfulness, appeal and appearance of the data collection instruments. To determine content validity of the instrument items, the supervisors assisted in ensuring that the instruments are in relation to the set objectives and content area under study. Their suggestions and comments were used as a basis to modify the research items and make them adaptable to the study. They reviewed and analyzed the contents of the questionnaires and interviews schedules to ascertain if the instruments are suitable for the purpose for which they were set. Revisions to the instruments were made to reflect supervisor's suggestions.

3.8. DATA COLLECTION PROCEDURES

The researcher obtained an introductory letter from the University, which assisted in conducting the research. After obtaining an introductory letter, the researcher sought a research permit from the National Council for Science, Technology and Innovation (NACOSTI). Permission to collect data was obtained from the MMNR. Institutional Research and Ethics Committee approved the study. This was followed by recruitment of research assistants. Two research assistants who assisted in administering the questionnaires to the respondents were identified and trained before actual data collection. The respondents were assured of their confidentiality which was maintained in dealing with their responses. Data was collected

3.9. DATA ANALYSIS

After all data was collected, the researcher conducted data cleaning, which involved identification of incomplete or inaccurate responses and correcting to improve the quality of the responses. The data was coded and entered in the computer for analysis using the Statistical Package for Social Sciences (SPSS V 22). The research results yielded both qualitative and quantitative data. Interviews conducted yielded qualitative data that was analyzed qualitatively using content analysis. Questionnaires yielded quantitative data that was analyzed using quantitative techniques of descriptive statistics and inferential statistics.

The main descriptive statistical analysis that was used include mean, percentages, standard deviation and frequencies to cater for the Likert Scale that had been used in the study. According to Orodho (2008), the advantage of descriptive statistics is that they enable the researcher to use one or more numbers for example mean and standard deviation to indicate the average score and variability of scores of a sample. Inferential statistics were used to analyze the relationship between variables. This was done using Pearson correlation coefficient and multiple regression

analysis. Pearson product moment of correlation was used to determine the effects of climate change on the relationship between natural resources and tourism sustainability in MMNR.

The techniques for interval and ratio-scaled variables were adopted. The multiple regression analysis explained the extent to which climate variability effect (independent variable) predicts tourism sustainability (dependent variable). Multiple regression analysis was adopted to test the hypotheses. The coefficient of determination (R square) was used as a measure of the explanatory power to show how the independent variable explains the dependent variable. Adjusted R square was used as a measure of explanatory power of the independent variable in exclusion of the dependent variable. The F statistics (ANOVA) was used as a measure of the model goodness of fit.

Factor analysis was used to actualize data reduction by looking for groups among the inter-correlations of the sets of variables which best explained the latent construct. The analysis process involved taking large sets of measurement variables and seeking out options of summarizing the data into smaller sets of factors or components (Pallant, 2005). The Principal Components factor analysis (PCA) technique was used in Exploratory factor analysis (EFA) to reduce the number of measurement variable, while at the same time retaining as much of the information in the original data set.

After the initial extraction of component factors, a choice had to be made on the rotation method. This study used the PCA method to calculate factors with Varimax rotation method. The procedure entailed SPSS 22.0 building a column for each factor extracted and then placing the scores of the factors for each subject inside the column. Once placed in the columns, the scores were then used to identify groups of subjects. Ultimately, all items that were loading below 0.50 were deleted while those with more than 0.50 loading factor were retained, summed up to create a score that was subjected to inferential analysis (Hair *et al.,* 2016).

3.9.1. Multiple regression models

Tabachnick *et al.* (2007) described regression analysis as a technique that allows for assessment of the relationship between one dependent variable and several independent variables as set out in the objectives and the hypotheses. Specifically, the study used PROCEES Macro for SPSS developed by Hayes (2013) to test the relationships among the variables. It is a hierarchical type of multiple regression technique tool used to evaluate the relationship between a set of independent variables and the dependent variable controlling for the impact of different set of variables on the dependent variable (Hayes, 2014).

The test statistics was computed by entering the sample data in SPSS version 22 with PROCESS Macro add on application by Hayes (2014). The statistics was derived for comparison and to confer judgment on the hypotheses tested in this study. R showed the magnitude of correlation between the DV and the IV, the coefficients of determination (R^2) on how well the model fits the data, regression coefficient (Beta coefficient) and the (p-values). According to Field (2005), the significance level (p-value) for each of the variables should be less than 0.05 to demonstrate that the variable is making a statistically significant contribution to the prediction of the dependent variable.

McClelland and Judd (1993) states that the significance levels for interaction terms need to be lowered to $p < 0.10$, since interaction effects was difficult to detect and frequently suffer from low power, this suggestion was adopted. Several relationships are estimated; direct relationship between climate change and natural resource as well as tourism sustainability; indirect relationships by testing the mediation effect of natural resource on the relationship between climate change and tourism sustainability.

3.9.2 Assumptions of multiple regression

The assumptions of multiple regression identified was of primary concern in the research and included; linearity, homoscedasticity, normality, and multicollinearity. Normality assumption was based on the shape of normal distribution and gives the researcher knowledge about what values to expect (Keith, 2006). The researcher tested this assumption through several pieces of information; visual inspection of data plots, skew, kurtosis, and P-Plots (Osborne & Waters, 2002). Normality was further checked through histograms of the standardized residuals. Linearity was established using multiple regressions to estimate the relationship between dependent and independent variables when the relationship is linear in nature (Osborne & Waters, 2002).

Examination of the residual plots showing the standardized residuals and the predicted values was useful in detecting violations in linearity (Stevens, 2009). Residual plots showed the standardized residuals and the predicted values were used to establish linearity. The assumption of homoscedasticity refers to equal variance of errors across all levels of the independent variables (Osborne & Waters, 2002). This means that the study assumed that errors are spread out consistently between the variables (Keith, 2006).

Homoscedasticity was checked using visual examination of a plot of the standardized residuals by the regression standardized predicted value (Osborne & Waters, 2002). Homoscedasticity was checked using the standardized residual scatter plot. The results show whether standardized residuals concentrated in the center (around 0) and whether their distribution was rectangular.

Multicollinearity occurs when several independent variables correlate at high levels with one another or when one independent variable is a near linear combination of other independent variables (Keith, 2006). Statistical software packages included collinearity diagnostics that measure the degree to which each variable is independent of other independent variables.

Tolerance and VIF statistics were used to carry out the diagnosis. Small values for tolerance and large VIF values show the presence of multicollinearity (Keith, 2006).

3.9.3. Mediation

Studies in behavioral science commonly dwell on variable relationships above all the notion that an independent variable explains variability in a dependent variable; however, Hayes and Preacher (2014) observed that two variables are causally related is not sufficient. They argued that it is of scientific interest to demonstrate how or by what means a causal effect occurs. A mediator explains why there is a causal relationship between variables. This means that the independent variable causes the mediator and the mediator in turn causes the dependent variable (Wu *et al.,* 2008). In this study, it was more informative to interrogate by what means climate change (CC) exerts its influence on tourism sustainability (TS). This lays the basis for testing the mediation hypothesis, whose procedure was pioneered by Baron and Kenny (1986). Muller *et al.* (2005); Preacher *et al*. (2007) and Hayes and Preacher (2014) acknowledge this procedure.

The procedure involves running three regression models thus;

Model I: the predictor variable must significantly predict the outcome variable. Model II: the predictor variable must significantly predict the mediator. Model III: the mediator must then significantly predict the outcome variable in the presence of IV. And for decision rule, the IV must predict the DV less strongly in model III than in model I to confirm a mediated effect. The study hypothesized that natural resources (NR) is not responsible for the causal effect of Climate change on tourism sustainability (TS). Mediation was tested using PROCESS *macro* which provides for a bootstrap procedure to correct for biases and testing for significance at 95% confidence interval. Following the guideline stated above, the following processes were undertaken:

Step I: the relationship between climate change and tourism sustainability was tested and checked for significance; this was a prerequisite to testing the subsequent models (Model 1 and 2).

Step II: The relationship between climate change and natural resources by setting the later as the outcome variable in the regression equation was tested. The objective was to ascertain the significant relationship between climate change and natural resources to proceed. **Step III:** The relationship between natural resources and tourism sustainability while controlling for climate change which involves including both the independent variable and the mediating variable in the regression equation was assessed.

Though traditional procedure of testing mediation has been that of Baron and Kenny (1986) in this study the PROCESS *Macro* procedure by Hayes (2013) was used, in which particular model 4 (Figure 3.4) was adopted. As shown, the indirect effect of climate change (X) on tourism sustainability (Y) through natural resources (M) is expressed as the product of ***a*** and ***b;*** while the direct effect of X on Y is represented by **c**.

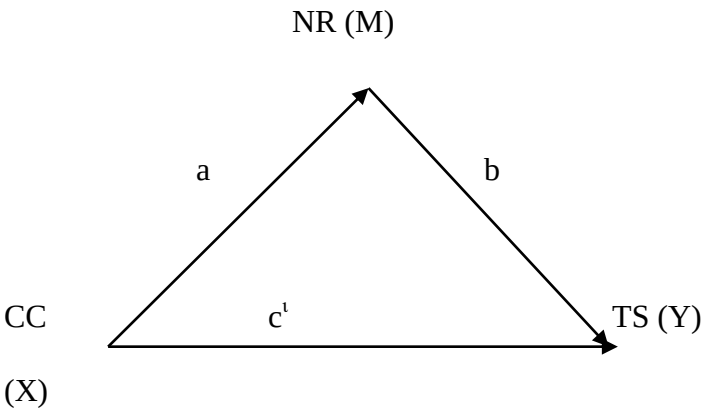


Figure 3.4. Mediation conceptual model (Model 4)
Source: Hayes (2013)

According to Baron and Kenny (1986), Muller *et al.* (2005), and Preacher *et al*. (2007), mediation hypothesis was tested through three regression models under the following four conditions of mediation.

a) Model I: the predictor variable must significantly predict the outcome variable.
b) Model II: the predictor variable must significantly predict the mediator.
c) Model III: the mediator must then significantly predict the outcome variable.
d) And IV must predict the DV less strongly in model III than in model I.

To demonstrate mediation the follow equations was derived to assess the hypothesized model.

$y=\alpha_1 + \beta_1 \boldsymbol{X} + \varepsilon_1$.....(3.1)

$M=\alpha_2+\beta_2 \boldsymbol{X}+\varepsilon_2$.....(3.2)

$y= \alpha_3 + \beta_3 \boldsymbol{X} + \beta_3 \boldsymbol{M} + \varepsilon_3$.....(3.3)

Where

X = Represents Independent variable climate change

Y=Represents tourism sustainability.

M = Represents mediating variable of natural resource

$\alpha_{1\to3}$=Represents the Y intercept (constant)

$X_{1\to3}$ = Represents the effect of climate change on tourism sustainability

$\beta_1 \to \beta_3 =$ Represents slope coefficients denoting the influence of the associated independent variables over the dependent variable.

$\varepsilon_{1\to3}$=Represents the error terms.

The objective was to establish whether there is a significant relationship between climate change and natural resource in order to proceed. The study hypothesized that natural resource are not responsible for the causal effect of climate change and tourism sustainability in MMNR. Step III established the relationship between natural resource and tourism sustainability while controlling for climate change which involves including both the independent variables and the mediating variables in the regression equation to establish the effect of the natural resource and tourism sustainability is performed.

Mediation was tested using the (Baron & Kenny 1986) steps by: Establishing the relationship between climate change and tourism sustainability was tested and checked if it was significant in order to proceed; determining the relationship between climate change and natural resource by setting the later as the outcome variable in the regression equation that is tested. As stated above the study hypothesized that natural resources does not mediate the relationship between climate change and tourism sustainability but if the effects of climate change become less significant in model III compared to model I then I should have evidence to the contrary. Finally, Sobel (1982) test was applied to confirm significance of the mediated effect. To confirm mediation, a Sobel (1982) test result is generated automatically by PROCEES, if it turns a significant result then there is a mediated effect.

3.9.4. Normalized Difference Vegetation Index (NDVI)

The normalized difference vegetation index (NDVI) is a critical parameter for identifying vegetation abundance and it has an obvious correlation with vegetation cover. This is because temporal variation corresponds to vegetation change and growth, areas that have the same vegetation exhibit similar curves. Therefore, the long-term sequence of NDVI information derived from long-term remote-sensing images has led to NDVI time series of remote-sensing data becoming a crucial source of information on land cover classification.

NDVI is used to extract the various features presented in satellite imagery. Vegetation indices allow the researcher to delineate the distribution of vegetation and soil based on the characteristic reflectance patterns of green vegetation. The NDVI is a simple numerical indicator that can be used to analyze the remote sensing measurements from a remote platform and assess whether the target or object being observed contains live green vegetation or not. The normalized difference vegetation index (NDVI) is obtained based on differences in pigment absorption features in the red and near-infrared regions of the electromagnetic spectrum. The values of NDVI range from −1.0 to 1.0, increasing positive NDVI values indicate increasing amounts of green vegetation. NDVI values near zero and decreasing negative values indicate non-vegetated features such as barren surfaces, bare lands and water.

Since it has many advantages such as the simplicity of the algorithm, the capacity to broadly distinguish vegetated areas from other surface types, more sensitive to detect green vegetation than using a single band, it can be used to monitor local or global vegetation changes, which can indicate environmental changes brought by natural factor such as climate changes and anthropogenic activities such as urban expansion process to assess crop production and net primary productivity (NPP) of vegetation, and it was also mostly used to indicate climate changes by establishing relationship between climatic factors and NDVI.

NDVI is calculated as; NDVI= (Near Infrared-Red) / (Near Infrared+Red). The NDVI is motivated by the observation vegetation, which is the difference between the NIR and red band; it should be larger for greater chlorophyll density. It takes the (NIR - red) difference and normalizes it to balance out the effects of uneven illumination such as shadows of clouds or hills. The Normalized Difference Vegetation Index (NDVI) is widely used for monitoring green vegetation over large areas and provides an index of primary productivity (Justice *et al.*, 1985). NDVI or "greenness index", is a ratio of red and infrared channels which contrasts the two signals and effectively expresses the degree of pixel greenness (Ottichilo *et al.*, 2000).

The role of prevailing climatic conditions on vegetation activity, especially the relationship of Normalized Difference Vegetation Index (NDVI) to climatic variables, has been widely validated across different regions of the world. At the regional scale, various studies have focused on arid or semi-arid areas where NDVI is highly sensitive to climatic fluctuations. Their study demonstrated a linear relationship between precipitation and NDVI when precipitation was less than approximately 500 mm/yr or 50-100 mm/month. Similar results were also found by Wang *et al.* (2003), who examined the temporal responses of NDVI to precipitation and temperature in the central Great Plains in USA in Kansas and concluded relationship between precipitation and NDVI is strong and predictable when viewed at the appropriate spatial scale. There are also a number of different studies that have analyzed the influence of precipitation, temperature, atmospheric circulation on vegetation dynamics and biomass at high latitudes.

At the global scale, Kawabata *et al.* (2001) analyzed inter-annual trends in annual and seasonal vegetation activities from 1982 to 1990 and its relationships to temperature and precipitation. Their study indicated increased vegetation activities over extensive regions in the northern middle-high latitudes because of gradual increase in temperature. They also concluded that regions in which NDVI seasonal extremes are not accurately predicted are mainly high latitude

zones, mixed and disturbed vegetation types, and other remote locations where climate station data are sparse.

Moreover, the geographical distribution of global greening trends and their climatic correlates was investigated. They reported that temperature was the primary climatic factor associated with greening in the northern high latitudes and Western Europe while precipitation was a strong correlate of greening in fragmented region only, while decreases in greenness in southern south America, southern Africa, and Central Australia were strongly correlated to both increase in temperature and decreases in precipitation. Elsewhere, other studies have indicated some relationships between NDVI, rainfall and biomass in the dry lands (Ottichilo *et al.*, 2000).

Prince (1991) demonstrates that there is a strong linear relationship between the satellite observation of vegetation indices and the seasonal primary production. Farrar *et al.* (1994) and Richard and Poccard (1998) have reported a linear relationship between rainfall and NDVI in most savanna ecosystems in Africa where rainfall is the limiting factor (<900 mm). NDVI has been used in monitoring East African and African vegetation dynamics according to Justice *et al.* (1986), Townshend *et al.* (1991), desert locust monitoring (Hielkema, 1981), evaluation of suitability of vegetation characteristics in arid lands Huete and Jackson (1987) and determination of herbaceous biomass (Prince and Tucker 1986).

3.9.4.1. Methodology for Normalized Difference Vegetation Index (NDVI)

The NDVI images from the years 1975 to 2018 were processed to obtain specific NDVI values per land cover category. The random points on each image were generated for specific land use category and the multi values extracted using Geostastistical technique. The points were then averaged to obtain a specific NDVI values for a given year. The generated points were later extracted through a process of geostatistical technique by multi values regression function. The

random points were separately obtained through computed averages for respective monthly NDVI values in order to get the mean annual NDVI for specific land category.

3.9.5. Analysis of rainfall and temperature data

The rainfall and temperature data was analyzed. A number of techniques are used for analyzing series trends, the most commonly used technique by meteorologist is the Mann-Kendall (MK) test (Zhang *et al.*, 2016) that was adopted. There are advantages of using this test, The Mann-Kendall test is non-parametric and does not require normally distributed data and also has a low sensitivity to missing data.

3.10. ETHICAL CONSIDERATIONS

During the study, the following ethical considerations were considered; informed consent, privacy, confidentiality and accuracy. The researcher informed the respondents on the purpose and aim of the study, the possible consequences and the use of the information. Participation in the study was voluntary. In order to ensure confidentiality of the results, the questionnaires were coded and therefore respondents not identified. To ensure high level of accuracy, the research avoided omissions, fabrications and contrivance as much as possible. In addition, research authorization letters were sought from relevant institutions for example Kenya Wildlife Service (KWS), National Commission for Science and Technology (NACOSTI) and Institutional Research and Ethics Committee. Information gathered was not disclosed by other parties as anonymity of research participants was protected.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

This chapter presents the study results as well as discussions in line with the study objectives. The study sought to establish the effects of climate change on natural resources in MMNR, identify the effects of natural resources on tourism sustainability in MMNR, determine the relationship between climate change and tourism sustainability in MMNR and to explore the mediating effects of natural resources and climate change and on tourism sustainability in MMNR. Both descriptive and inferential statistics were used to analyze the data and presented in form of tables, charts and figures. This chapter is organized as follows: firstly, response rate, secondly demographic information, thirdly descriptive analysis, fourthly regression and lastly process macro analysis.

4.1. RESPONSE RATE

Out of a sample size of 507 respondents involved in the study, the overall response rate was 67.85%, since only 344 of the respondents responded and 163 did not respond adequately due to inconsistent information provided. This is shown in Table 4.1.

Table 4.1. Response Rate

	Sample size	**Responded**		**Did not respond**	
		Freq	**%**	**Freq**	**%**
Community members	399	295	73.9	104	26.1
Tourists	90	35	39.0	55	61.0
Experts	18	14	77.7	4	22.3
Total	**507**	**344**	**6**	**163**	**32.15**

The response rate results above concur with (Draugalis *et al.,* 2008) asserting that a response rate of over 60% should be the goal of researchers. Therefore, this response rate was found to be suitable for purpose of this study.

4.1.1. Demographic information of respondents

The demographic information sought from the host community members (Household heads) included; age, gender, education level, marital status and employment status of the community as shown in Table 4.2. The findings indicate that 156 (52.9%) of the respondents were male and 139 (47.1%) were female. This indicates that there was gender disparity in the distribution of community members neighboring MMNR involved in the study. This is supported by GoK (2019) census where Narok County had a population of more male than female, Male were 579,042 while female 578,805. This, however, represented a good proportion of gender diversity among respondents.

On the age of the respondents, the results indicated that 113 (38.3%), were aged between 26 and 35 years, with 81 (27.5%) of respondents aged between 36 and 45 years, while 56 (19%) aged 15 and 25 years and finally 45 (15.3%) aged above 45 years. Majority of the respondents were in their youthful age. This finding concur with GoK (2019) census where 70% of Kenya's population are below the age of 24 years with those of age 60 and above account for 5% of the total population.

From the analysis of the respondents' level of education, 78 (26.4%) of the heads of household had diploma level of education, with 77 (26.1%) having higher diploma, with 65 (22%) were form four leavers, while 32 (10.8%) had primary level of education and (23) 7.8% undergraduate. Based on these results, one can conclude that the community members had the

relevant education necessary to proactively participate in issues regarding climate change, natural resources and sustainable tourism.

Table 4.2. Demographic of the community

Variable	Category	Frequency	Percent	Cumulative Percent
Gender	Male	156	52.9	52.9
	Female	139	47.1	100.0
	Total	**295**	**100.0**	
Age	15-25 years	56	19.0	19.0
	26-35 years	113	38.3	57.3
	36-45 years	81	27.5	84.7
	Above 45 years	45	15.3	100.0
	Total	**295**	**100.0**	
Education level	Primary	32	10.8	10.8
	Secondary	65	22.0	32.9
	Diploma	78	26.4	59.3
	Higher diploma	14	4.7	64.1
	Undergraduate	23	7.8	71.9
	Masters	6	2.0	73.9
	Others	77	26.1	100.0
	Total	**295**	**100.0**	
Marital status	Single	61	20.7	20.7
	Married	165	55.9	76.6
	Separated	48	16.3	92.9
	Widowed	21	7.1	100.0
	Total	**295**	**100.0**	
Employment status	Employed	106	35.9	35.9
	Self employed	63	21.4	57.3
	Unemployed	126	42.7	100.0
	Total	**295**	**100.0**	

On marital status, majority of the community members 165 (55.9%) were married, with 61 (20.7%) single, 48 (16.3%) separated and 21 (7.1%) widowed. This indicates that most of the community members were married. These results agree with (GoK, 2015) indicating that 70% of women in the age bracket of 20-49 were married in Narok County. On the employment status, 126 (42.7%) of the community members were unemployed, with 106 (35.9%) employed and only 63 (21.4%) self-employed. This implies that most of the community members were not employed. This is in agreement with Narok County integrated development plan (2018-2022) reporting that self-employment is the main form of employment accounting for more than 60% of all form of employments.

4.2 EFFECTS OF CLIMATE CHANGE ON NATURAL RESOURCES IN MMNR

The first objective was to establish climate change effects on natural resources in MMNR. Climate change was measured using rainfall and temperature constructs, while natural resource was determined using wildlife population and vegetation cover constructs.

4.2.1. MMNR mean annual rainfall

At the time of data collection, the most current data that was available for rainfall and temperature was for the years 1977-2016. Therefore, the mean annual rainfall of MMNR for a period of 39 years (1977-2016) was analyzed and summarized in Figure 4.1. The results indicate that the mean annual rainfall received in MMNR was 1134.8 mm between 1977 and 2016. Out of the 39 years, 17 years received maximum average rainfall. Furthermore, within the same window period, 22 years received minimum average rainfall that was below average as indicated in Figure 4.1.

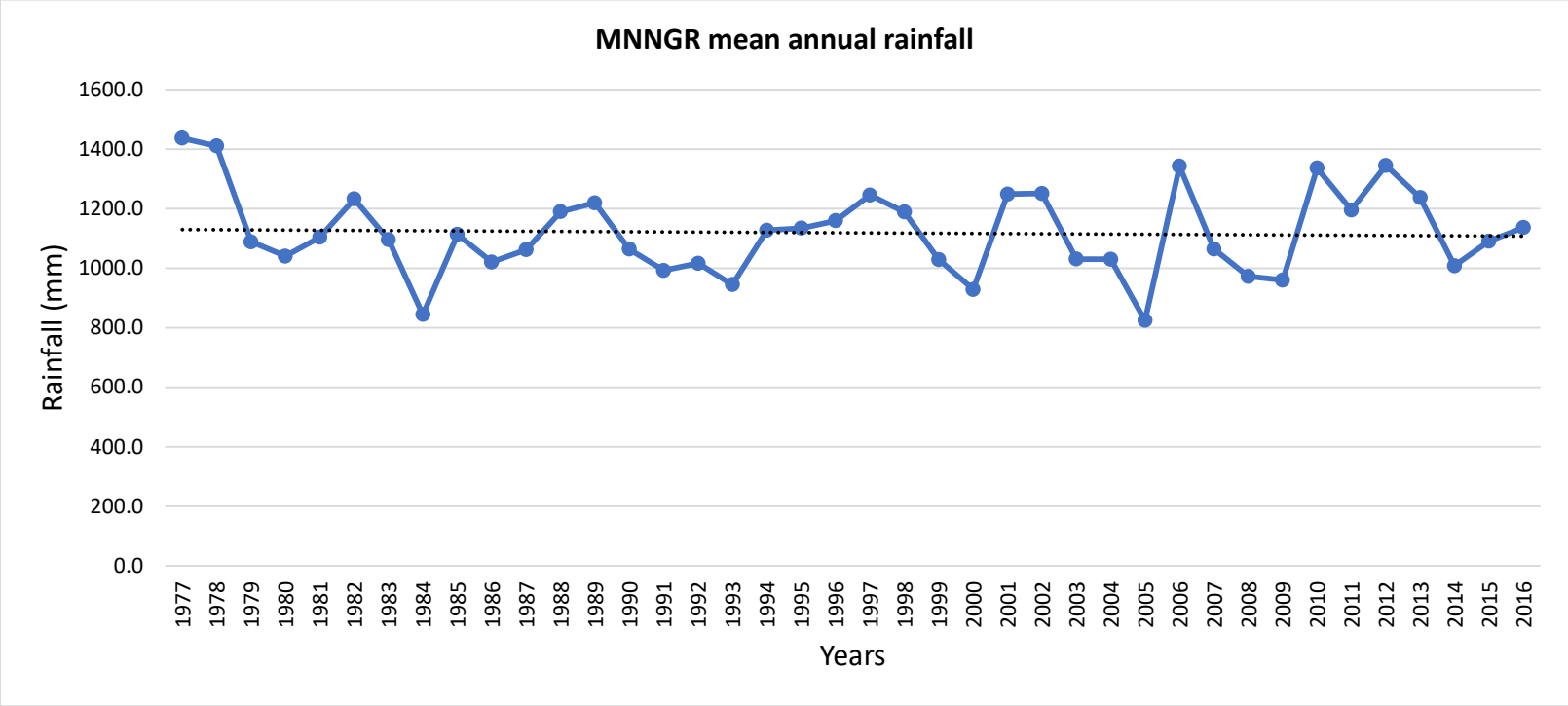


Figure 4.1. Maasai Mara annual average rainfall.
Source: Author (2020)

The standard deviation from the mean annual rainfall was ±152.67mm, indicating a deviation from the mean between 1977 and 2016. The study results suggest a decline in rainfall patterns characterized by rainfall variation which is the same case with previous studies revealing that there has been an increase in the number of reported hydro meteorological disasters in the region from an average of less than 3 events/year in the 1980s to over 7 events/year in the 1990s and almost 10 events/year from 2000 to 2006 with a particular increase in floods; from an average of less than one event per year in the 1980s to seven events per year between 2000 and 2006 (Shongwe, 2010). More importantly, the results agree with evidence of global climate system disruption where land and sea temperatures continued the warming trend (Scott, 2021).

Furthermore, human activities continue to warm the world by approximately 1.2°C (WMO, 2020) since pre-industrial era (1850-1900) and the period (2010-2019) has been the warmest on record with the warmest six years all being since 2015 (WMO 2020). Additionally, rainfall variations as indicated by these results concur with Dogru *et al.* (2019) arguing that the tourism industry is considered to be highly vulnerable to climate change (rainfall and temperature variations). These revelations concur with the systems theory adopted by the study. Disruptions of weather and climatic conditions caused by climate change poses challenges for the sustainability of tourism by virtue of rainfall and temperature variations characterized by droughts and flooding.

These results also agree with the findings of a study by Ogutu (2008) that revealed extreme drought occurred in the years 1993, 1997, 1999, 2000 and moderate droughts in 1991 and 1994 in which during these periods the current study found minimum amount of rainfall received for instance in the year 2000 (928mm), 1993 (945mm) and 1991 (992mm). Low rainfall patterns have potential to cause drought conditions that could result in a decline in wildlife population because of scarcity of food and water. For example Lindmark *et al.* (2018) argues that climate

change affects population growth as well as structure in many species that decline in population and abundance.

Variations in rainfall patterns have the possibility to affect the sustainability of the tourism industry in Kenya through decline and extinction of wildlife species. This is because vegetation quality as well as quantity is important for the survival of wildlife and most importantly is closely related and controlled by rainfall patterns. Ogutu *et al.* (2014), argues that variability in precipitation largely determines seasonal changes in vegetation quantity and quality especially alternations of wet and dry seasons that account for nutrient concentrations. Systems theory supports these assertions because challenges in any part of the system in our case climate change pose a ripple effect in other parts of the system (tourism sustainability).

The growth and production rates for grass and nutrient content in the green leaves are determined by rainfall, thus climate change through erratic rainfall will affect vegetation quality as well as potentially affecting vegetation communities and herbivore population dynamics (Barbosa *et al.*, 2014). Aduma *et al.* (2018) also discovered that rainfall dynamics negatively affected the population of elephants in Amboseli ecosystem. As a result of variation in rainfall patterns due to climate change, it is highly likely that wildlife populations in tourism attractions such as parks, reserves and conservancies will be negatively affected thereby affecting sustainability of the tourism industry. Liu *et al.* (2020) asserts that drought scenarios affect recreation and tourism by negatively impacting the physical resources such as wildlife that define the nature and quality of the natural environments on which tourism thrives.

A study by Hall *et al.* (2015) discovered that climate change is anticipated to have adverse impacts on the tourism industry because climate is one of the key resources for tourism that shapes and drives its success. For instance, rainfall exerts a controlling influence on the availability and quality of vegetation and surface water for herbivores in African terrestrial

ecosystems with implications for wildlife population dynamics (Bartzk *et al.,* 2016). Additionally, rainfall is the principal driver of the population dynamics of savannah herbivores according to Ogutu *et al.* (2008) because it controls plant biomass production Sankaran *et al.* (2005) which affects herbivore birth (Ogutu *et al.,* 2008).

Moreover, excessive rainfall can adversely affect small herbivores that require high-quality forage through diluting plant nutrient concentration (Olff *et al.,* 2002). More so, during low rainfall years, wildlife species are forced to travel longer distances between water and foraging grounds making their offspring more vulnerable to predation (Loveridge *et al.,* 2006). Therefore, based on these findings, rainfall variations have the potential to cause increased predation risks, habitat change and species extinction hence decline in population that will cause a negative influence on the tourism industry.

A study by Ogutu *et al.* (2016) reveals extreme wildlife losses have recently been documented for large parts of Africa, including Western, Central and Eastern Africa on average by 68% between 1977 and 2016. Ogutu *et al.* (2016) argues that causes of the wildlife declines occur both inside and outside protected areas and are caused by declining rainfall and a striking rise in temperatures. Based on studies reviewed and highlighted, this study suggests reduced sustainability of the tourism industry with the prediction that frequent droughts and floods will become more intense into the future. Grounded on the rainfall results presented, there is a high variation in rainfall patterns (too much or very little) in the Mara with possible cause to declines in wildlife populations. Therefore, there is a high likelihood of declines in wildlife populations to pose a direct effect on the tourism industry. Declines in tourist arrivals and consequently tourism revenue are likely to be experienced especially in Kenya where the tourism industry is heavily nature based. This will result to dwindling economic, social as well as environmental benefits that accrue from tourism.

It is important to note that tourists visiting Kenya have a keen interest on wildlife experiences despite the fact that they could be attracted to other tourist attractions for instance the local Maasai culture. Additionally, Shongwe (2010) asserts that favorable climatic conditions at tourism destinations are key attractions for tourists and weather can ruin the vacation while climate can devastate a holiday destination. Bhandari (2014) further argues that climate change will impact tourism directly by changes in temperature, extreme weather events and other climatic factors that will also transform the natural environment that attracts tourists. Thus, grounded on the study results, rainfall as well as temperature variations have the potential to alter MMNR natural environment that is a tourist fortress leading to declines in tourist's arrivals and consequently reduced social, economic as well as environmental benefits of tourism.

4.2.2. MMNR mean annual temperature

MMNR reserve mean monthly temperature for the last 39 years was analyzed and presented in Figure 4.2. From the mean monthly temperature analysis, the months of July and September had the lowest amount of temperature of 9.5^0C and August at 9.7^0c. The months that recorded the highest temperature was February with 26.9^0C.

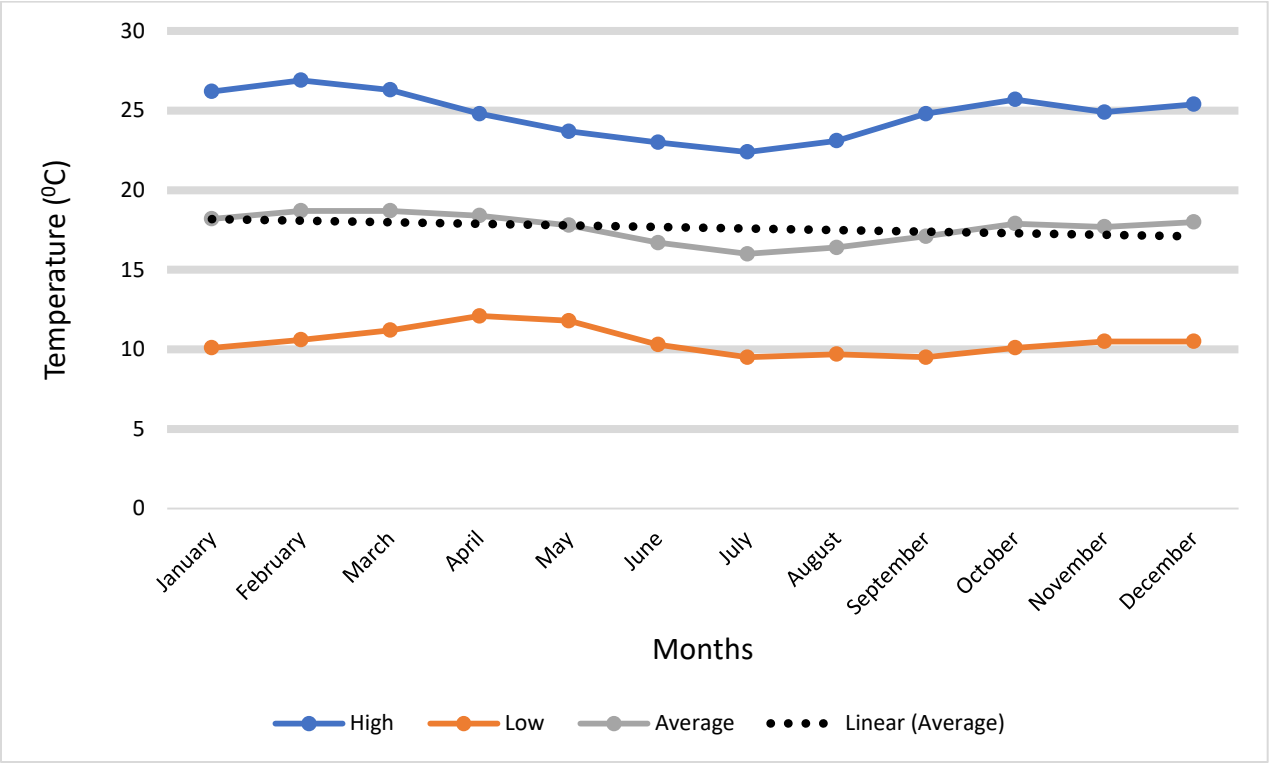


Figure 4.2. Mean monthly annual temperature between 1977 and 2016
Source: Author (2020)

Based on the study results in Figure 4.2, the mean annual temperature in MMNR was 18^0C. Furthermore, MMNR had experienced temperature variations within the given period. This implies that the game reserve had experienced average temperature variations between the years (1977-2016). These findings concur with Aduma *et al.* (2018) suggesting that temperature variations are likely not to be uniform throughout the year and are expected to occur erratically. Besides, according to (IPCC, 2007) report, the surface temperature of the earth has risen by 0.6 ± 0.2˚C over the 20th century. It is further projected to rise from 1.1˚C to 6.4˚C over the 21st century (Aduma *et al.*, 2018).

Niang *et al.* (2014) also asserts that temperatures in Africa is projected to rise faster than the rest of the world and could exceed 2°C by mid 21st century and 4°C by the end of the 21st century. These rising temperatures have the potential to negatively affect wildlife populations as well as

the sustainability of the tourism industry. It is anticipated that the East African region will experience a reduction in the amount of precipitation received during the already dry season, which is likely to trigger more recurrent and severe droughts in the region (Aduma *et al.,* 2018).

In Kenya, biodiversity landscape supports the wildlife-based tourism industry by virtue of protected areas in form of wildlife parks, conservancies, sanctuaries and reserves. These protected areas that support the tourism industry are grappling with a number of challenges including compelling evidence of declines in wildlife population. For instance, the World Bank (2018) projects a 3°C global warming will reduce savannahs such as the Maasai Mara by approximately one-seventh of their total current land area.

Lyon & DeWitt (2012) argue that there has been an overall reduction in both the long (March-May) and short (November-December) rainy seasons and an increase in spatial and temporal variability of rainfall and increased frequency of droughts in East Africa in recent years. In addition, Ottichilo *et al.* (2000) notes that climatic effects point to the decline of wildlife populations as analysis of rainfall trends indicates that MMNR experienced devastating droughts during the periods, 1984, 1986 and 1993. Droughts are associated with extremely high temperatures that reduce vegetation for wildlife including availability of water. Moreover, with climate changes, majority of the wildlife species are likely to be subjected to climatic environments that surpass their physiological tolerance. Thus, due to this exposure, wildlife will experience physiological stress (Huey, Kearney, Krockenberger, 2012) reduced level of fitness (Francisco *et al.,* 2011; Kearney *et al.,* 2009; Oswald, Huntley, 2011) or the threat of being extinct (Sinervo *et al.,* 2010).

The above findings agree with Ogutu *et al.* (2016) study that identified causes of declining wildlife population as climate change and variability manifested by declining rainfall and striking rise in the minimum-maximum temperatures that result in vegetation browning trend. Ogutu *et al.*

(2016) further argues that rainfall and temperature variability and change are some of the factors that have contributed to wildlife population declines. Therefore, based on these findings, this study suggests that extremely high as well as low temperatures are likely to negatively affect wildlife dynamics in terms of population and survival rates. As such, wildlife population declines are likely to be experienced thereby rendering tourism attractions unviable. Consequently, the social, economic as well as environmental benefits of tourism will dwindle.

4.2.3 Community members views on climate change

The community members neighboring MMNR were asked to indicate on a five-point Likert Scale their level of agreement on several statements describing climate change. The items on the constituted five-point Likert Scale were; SA-strongly agree, A-agree, N-neutral, D-disagree, and SD-strongly disagree. The communities were asked to score on statements explaining the climate change variable. The descriptive analysis used included frequencies, percent, means and standard deviation as summarized in the following sections. Strongly agree (SA) and agree (A) fall under a mean of above 3.6, for N (Neutral) the mean ranged between 2.6-3.5, and lastly for Strongly disagree (SD) and disagree (D) the mean was below 2.5. Descriptive statistics were mean and standard deviation as presented in Table 4.3.

Two hundred and ninety-five questionnaires were administered to local community members addressing climate change, natural resources and tourism sustainability variables. Based on the results, one can conclude that most of the respondents 232 (78.6%) agree that the rainfall patterns have changed, with 15.9% undecided and 5.4% disagreed (*M=4.02; SD=0.83*). Also, majority 243 (82.4%) of the respondents agree that Mara river water flow level has changed, with 12.9% undecided and 4.7% disagreed, (*M=4.25; SD=0.87*). In addition, most of the respondents 181 (61.4%) agreed that climate change adaptation & mitigation strategies exist for example

conservation awareness and education of host communities, with 27.8% undecided and 10.9% disagreed (*M=3.65; SD=0.90*).

Furthermore, the results indicate that majority of the respondents 203 (68.8%) agreed that temperatures have risen than before, with 19% undecided and 12.2% disagreed (*M=3.68; SD=0.86*). What is more, majority of the respondents 120 (40.7%) were undecided that drought is rampant, with 37.9% disagreed and 21.4% agreed (*M=2.77; SD=0.79*). Similarly, the results point out that most of the respondents 161 (54.6%) disagreed that floods scenarios were common, with 38% undecided and 7.4% agreed (*M=2.43; SD=0.79*). Finally, the results point out that majority of the respondents 177 (60%) were undecided that the rainfall experienced is high, with 20% disagreed and 20% agreed (*M=3.03; SD=0.74*).

Table 4.3. Community members views on climate change

Statement	SA		A		N		D		SD		Mean	STD DEV
	F	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**		
Drought is rampant in MMNR	2	.7	61	20.7	120	40.7	91	30.8	21	7.1	**2.77**	**0.88**
Floods scenarios are common in MMNR	1	.3	21	7.1	112	38.0	130	44.1	31	10.5	**2.43**	**0.79**
Temperatures have risen in Maasai Reserve than before	36	12.2	167	56.6	56	19.0	34	11.5	2	.7	**3.68**	**0.86**
The rainfall experienced in MMNR is high	12	4.1	47	15.9	177	60.0	57	19.3	2	.7	**3.03**	**0.74**
Rainfall patterns in MMNR has changed	85	28.8	147	49.8	47	15.9	15	5.1	1	.3	**4.02**	**0.83**
Mara river water flow level has changed	141	47.8	102	34.6	38	12.9	13	4.4	1	.3	**4.25**	**0.87**
Climate change adaptation & mitigation strategies exist in MMNR	46	15.6	135	45.8	82	27.8	28	9.5	4	1.4	**3.65**	**0.90**
Mean											**3.41**	**.444**

From the study, seven statements were used to measure community perception on climate change that had an overall mean of 3.41 associated with a standard deviation of 0.444. Based on these results, one can conclude that most community members agree on the statements used to measure climate change in MMNR. The study findings reveal that local Maasai community perception about climate change can be summed as; rainfall patterns have changed overtime, river Mara water flow level has changed characterized by flooding during rainy seasons and extremely low levels in the dry season, climate change adaptation & mitigation strategies exist for instance conservation education and the temperatures have risen than before. However, the host community members did not find rampant droughts, flooding scenarios as common and that the rainfall experienced was not high.

The above findings agree with previous studies for example, (Gundula *et al.,* 2016) asserting that divergent temporal changes of rainfall patterns have been documented for the Serengeti-Mara ecosystem and other parts of East Africa. While the IPCC reports very likely increases in rainfall

over parts of Eastern Africa, Niang *et al.* (2014) finds that there are also several references reporting evidence of decreased wet season rainfall in recent decades in the same region (Funk *et al.*, 2008, Williams and Funk 2011, Lyon and DeWitt, 2012).

Nonetheless, General Climate Models (GCE) for East Africa indicates an increase in short rains (October-December) by 5-20% between 2020 and 2030 and 25-50% between the period 2050 and 2070 (Otieno *et al.*, 2017). With intense rainfall, flooding occurs as Kenya experiences flooding every three to four years. Future predictions reviewed indicate that such flooding events will increase in terms of intensity and frequency in future. It is therefore definite that rainfall variations in the Mara have caused changes in River Mara water levels during rain and drought seasons. This has had an influence on wildlife population dynamics as explained earlier. It is likely that visitor numbers could decline with intense rainfall variations due to inaccessibility of tourism attractions for example the case in Nigeria (Dillimono & Dickinson, 2015) thus impacting negatively on sustainability of the tourism industry.

4.2.4 MMNR Natural Resources

The variable natural resource was operationalized through wildlife population and vegetation cover constructs. Big five population data was analysed in comparison with climate change data. Changes in vegetation cover were determined using Normalized Difference Vegetation Index (NDVI) method. The community member's views sought on natural resources solidified wildlife population as well as NDVI results.

4.2.4.1 Wildlife population trends in MMNR

The study sought to analyze Big five (Lion, Leopard, Rhino, Elephant, Buffalo) population trends in MMNR because these are the common wildlife species. This was done in order to draw

comparisons with the rainfall and temperature patterns as well as vegetation abundance and distribution. A relationship is highly likely to exist between rainfall and temperature patterns that influence vegetation abundance and distribution that impact wildlife population. Rainfall and temperature variations are the key indicators for climate change that control vegetation growth as well as abundance which is crucial food for wildlife especially herbivore. Therefore, it is likely that wildlife population could be controlled by rainfall as well as temperature patterns that influence availability of vegetation.

Wildlife population data was sought from the Directorate of Resource Surveys & Remote Sensing (DRSRS). DRSRS routinely conducts aerial surveys every five years, collecting wildlife population data since 1977. At the time of data collection, Elephant, Buffalo and resident wildebeest data was obtained while Lion, Rhino and Leopard data was not found. It was established that it is difficult to locate and count Lion and Leopard because during daylight aerial counting, Lion and Leopard tend to hide as they are nocturnal. Data available were from Elephant, Buffalo and resident Wildebeest and were analyzed from 1977-2016, and the results are as shown in Table 4.4 below.

Table 4.4. Resident wildebeest, Buffalo, Elephant population (1977-2016) in MMNR

	1977-1981	**1982-1986**	**1987-1991**	**1992-1996**	**1997-2001**	**2002-2006**	**2007-2011**	**2012-2016**
Resident Wildebeest	19421	4711	13090	22529	12284	6263	9476	17777
Bufallo	1385	867	916	1063	400	656	336	964
Elephant	80	87	105	228	223	135	83	157

Source: DRSRS (2016)

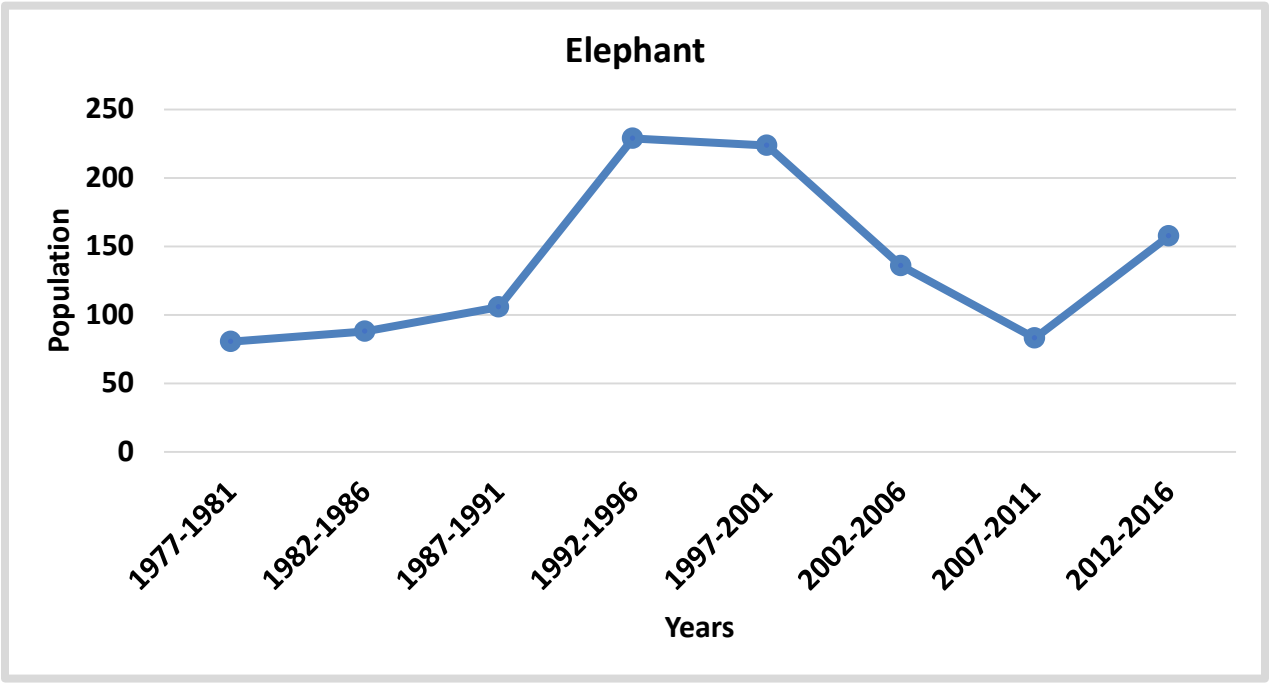


Figure 4.3. Elephant population (1977-2016)
Source: DRSRS (2016)

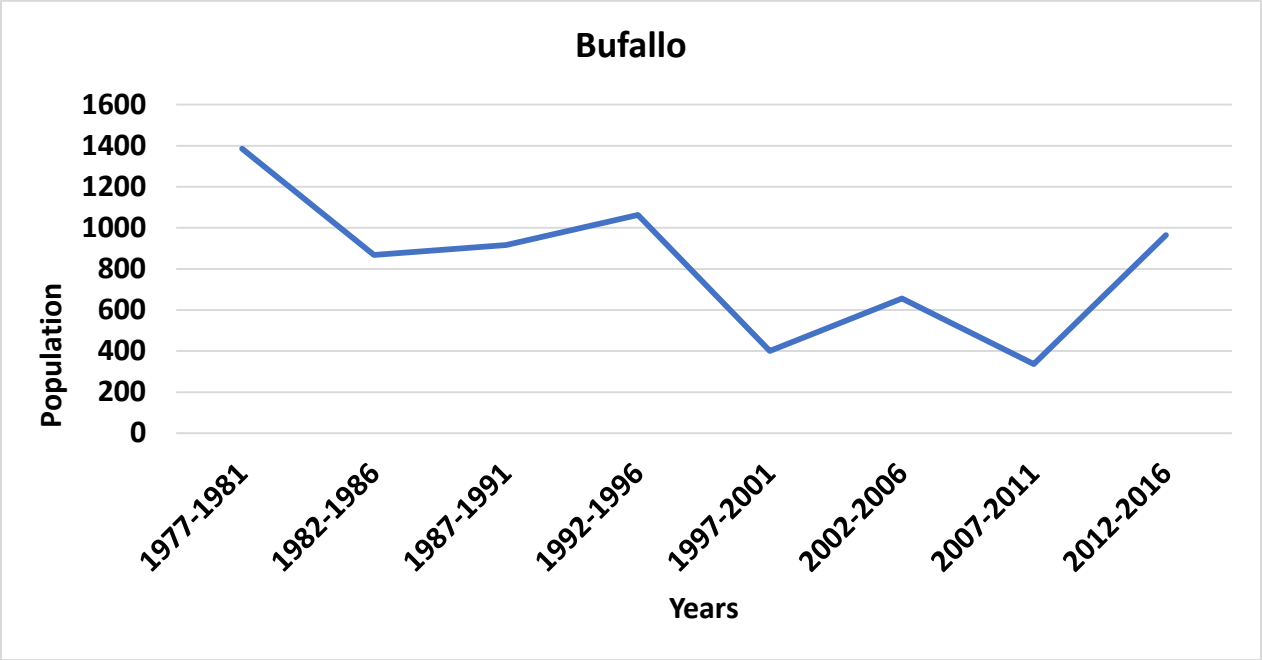


Figure 4.4. Buffalo population (1977-2016)
Source: DRSRS (2016)

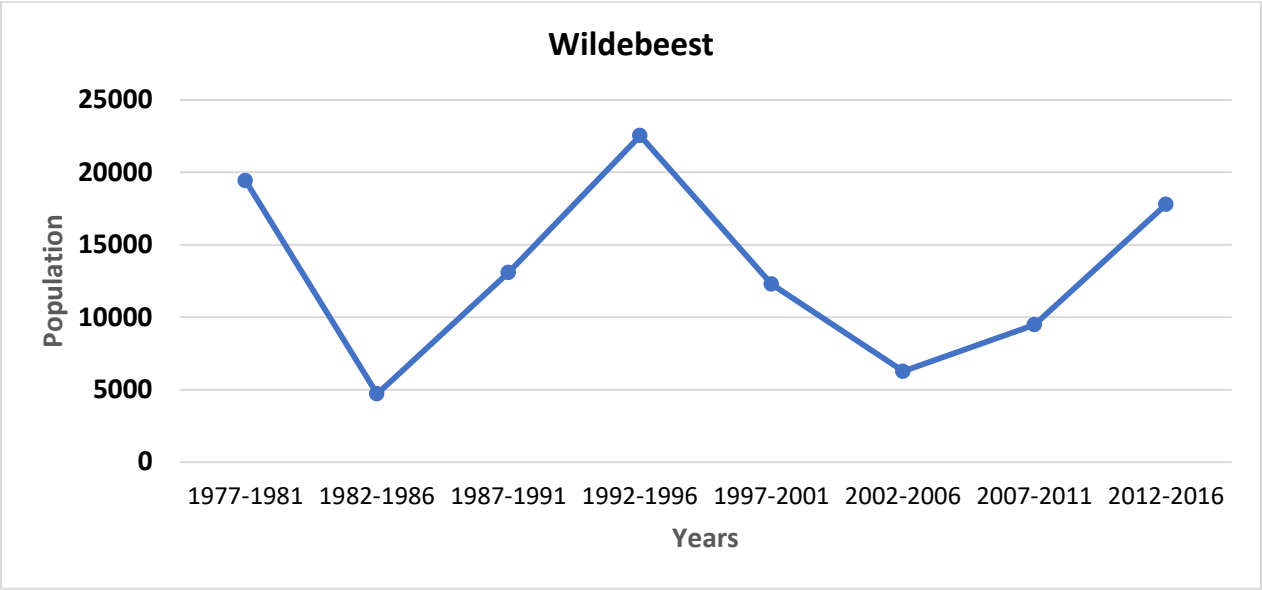


Figure 4.5. Resident Wildebeest (migratory and resident) population (1977-2016)
Source: DRSRS (2016)

The results indicated that the Elephant populations from the year 1977-1991 have been on a moderate rise reaching 100, until the period 1991-1996 where there was a steady increase in population from 110 to 240. During the period 1996-2001-2007-2011 there was drastic decline in Elephant population from 200 to 80 Elephants. This is possibly attributed to drought during the years 1997, 1999 and 2000. These outcomes correspond with the study rainfall results that indicated 2005 had the lowest mean annual rainfall of 824mm followed by the year 2000 with 928mm, 2009 with 960mm and 2008 with 972mm.

Due to low rainfall during the identified period it is possible that it contributed to a decline in elephant population. Finally, the period 2011-2016 saw a steady increase in Elephant population from a population of 80-160. It is likely that this rise in elephant population is because of favorable climate conditions during the mentioned period as average annual rainfall was generally high for example 2011 (1195mm), 2012 (1345mm), 2013 (1236mm) and 2014 (1008mm).

Buffalo population results indicated a rapid population variation. The period 1977-1982 experienced a steady decline from a population of 1400 to 900. These results concur with the study rainfall data where there was an incident of a striking decline in rainfall for four consecutive years 1977 (1590mm), 1978 (1410mm), 1979 (1088mm) and 1980 (1040mm) as shown in Figure 4.1. Hence, this study suggests that rainfall variations have the potential to result to a decline in buffalo population. Between the years 1982-1994, there was moderate rise in population from 900-1050. This could be attributed to rising rainfall patterns during the said time period.

During the period 1996-1999, there was a steady decline in Buffalo population from 1050-400. This is because of low rainfall, for instance in 1993 the calculated average annual rainfall was 945mm. Between the years 1999-2004, there was a rise in Buffalo population from 400-650 and a decline in population from 650-350 during the period 2004-2008. A steady rise in Buffalo population from 350-950 is observed from the period 2011-2016. All this is attributed to rainfall variations characterized by high rainfall to declining rainfall, stable rainfall and again high rainfall patterns as shown in Figure 4.1.

The resident wildebeest population's results indicate variation of low and high population numbers. Between 1977 and 1982 there was a sharp decline in population from 2,000-5,000. The period 1983-1996 experienced a steady rise in population from 5,000 to 22, 500. Interestingly, the period 1996-2004 the population declined drastically from 22, 500 to just 6, 000. This could be attributed to the drought of the years 1997, 1999 and 2000. Finally, a slow steady rise in population from 6, 000-18, 000 resident wildebeest was experienced between the years 2004-2016. This outcome could be as a result of a fairly stable rainfall pattern as shown in Figure 4.1.

4.2.4.2 Vegetation cover

Normalized Difference Vegetation Index (NDVI) measures changes in vegetation cover. Satellite images of the study area were obtained in order to calculate vegetation cover changes. The images were obtained from Landsat Satellite (1975 to 2020) with intervals of 5 years) and 90m resolution used for calculation of Normalized Difference Vegetation Index (NDVI) that measures change in vegetation cover. The Raw Landsat data was processed to generate Normalized Difference Vegetation indices from ArcGis Software. Several Satellites capture data in form of row and paths of up to 15-meter resolution. MMNR lies on path 169 row 061 of the satellite. The image was downloaded from the United States Geological Survey (USGS) GLOVIS.

The images were obtained in the raw nature in form of bands. Layer stacking was important to combine band three and band four needed for NDVI calculation. Image geo-rectification was done after band combination. Image subset for the area of interest (AOI) was clipped by the boundary of MMNR shape file. Band four captures the near infrared used for mapping vegetation and band three used to map. NDVI is calculated by the formula :(Band 4-band 3)/ (band 4+band 3). This calculation is done in by ArcGis. Atmospheric, Radiometirc and Geometric corrections were done before NDVI calculations. These calculations were done by the help of Landsat tools for windows. The following figures indicate vegetation cover changes of the study area from 1975-2020.

4.2.4.3 Landsat data tabulation

YEAR	LANDSAT SENSOR TYPE	DATE OF IMAGE ACQUISITION	BANDS USED	PATH AND ROW
1975	Landsat 2 Multispectral Scanner (MSS)	26/03/1975	6 (NIR), 5 (RED)	169/061
1980	Landsat 3 Multispectral Scanner (MSS)	19/02/1980	5 (RED), 6 (NIR), 7 (NIR)	169/061
1985	Landsat 5 Thematic Mapper (TM)	01/09/1985	3 (RED), 4 (NIR)	169/061
1990	Landsat 4 Thematic Mapper (TM)	03/01/1990	3 (RED), 4 (NIR)	169/061
1995	Landsat 5 Thematic Mapper (TM)	21/01/1995	3 (GREEN), 4 (RED)	169/061
2000	Landsat 7 Enhanced Thematic Mapper (ETM)	12/02/2000	3 (RED), 4 (NIR)	169/061
2005	Landsat 7 Enhanced Thematic Mapper (ETM)	21/09/2005	3 (RED), 4 (NIR)	169/061
2010	Landsat 5 Thematic Mapper (TM)	16/12/2010	3 (RED), 4 (NIR)	169/061
2015	Landsat 8 Operating Land Image (OLI)	24/08/2015	4 (RED), 5 (NIR)	169/061
2020	Landsat 8 Operating Land Image (OLI)	05/02/2020	4 (RED), 5 (NIR)	169/061

4.2.4.4 Scale and key for the topographic maps

The color ramp shows the level of vegetation for each location. Red color depicts non-vegetated areas, pink rose quartz depicts low vegetated areas, lemon grass shows moderate vegetated areas, and light olivenite depicts healthy vegetated areas while fern green indicates very healthy vegetated areas as below.

EPOCHS	INDICATION	COLOR NAME
<0	Non-vegetated areas	Red
0-0.2	Low vegetated areas	Pink rose quartz
0.2-0.5	Moderate vegetated areas	Lemon grass
0.5-0.8	Healthy vegetated areas	Light olivenite
0.8-1.0	Very healthy vegetated areas	Fern green

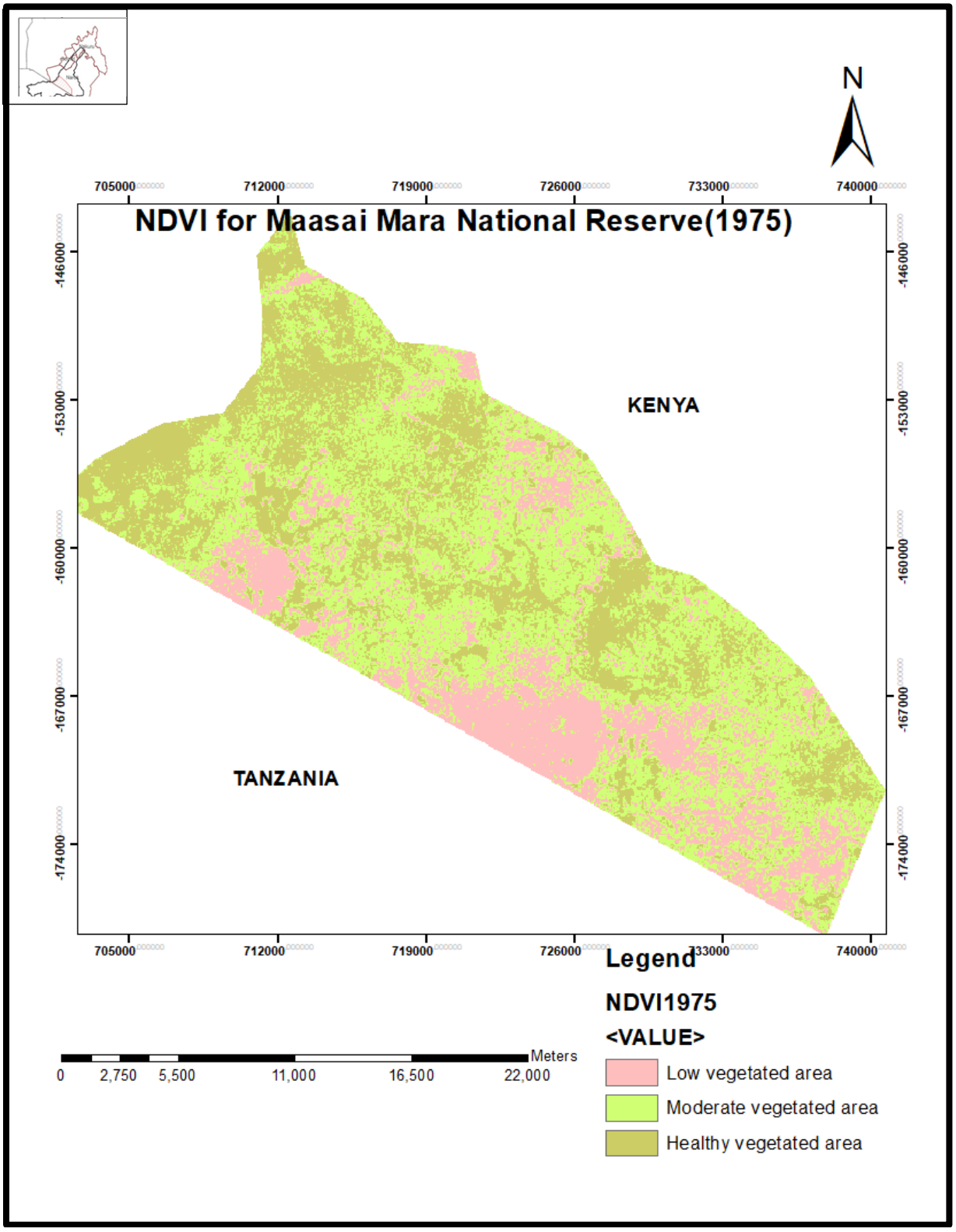


Figure 4.6. NDVI Map for the year 1975
Source: Author (2020)

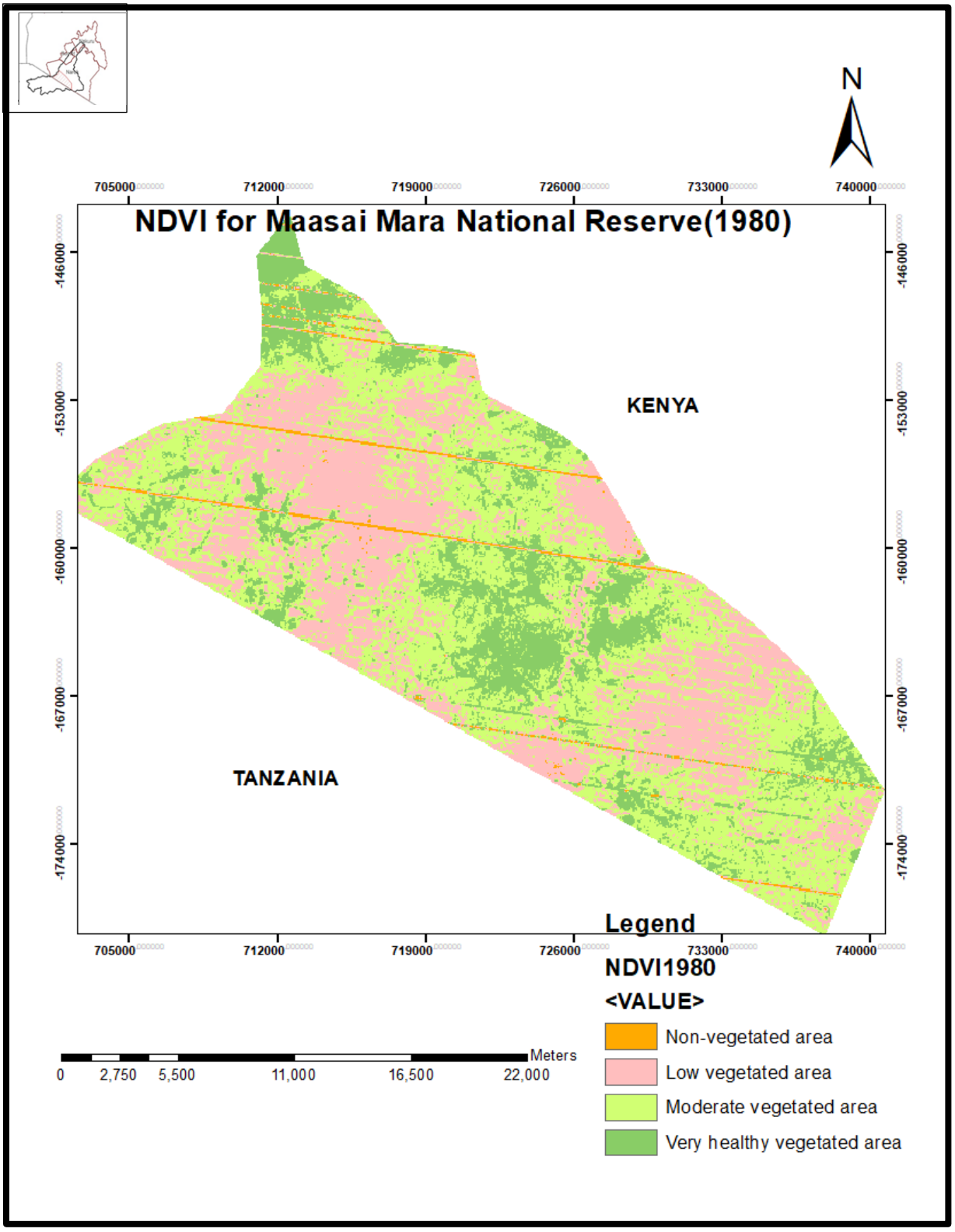


Figure 4.7. NDVI Map for the year 1980
Source: Author (2020)

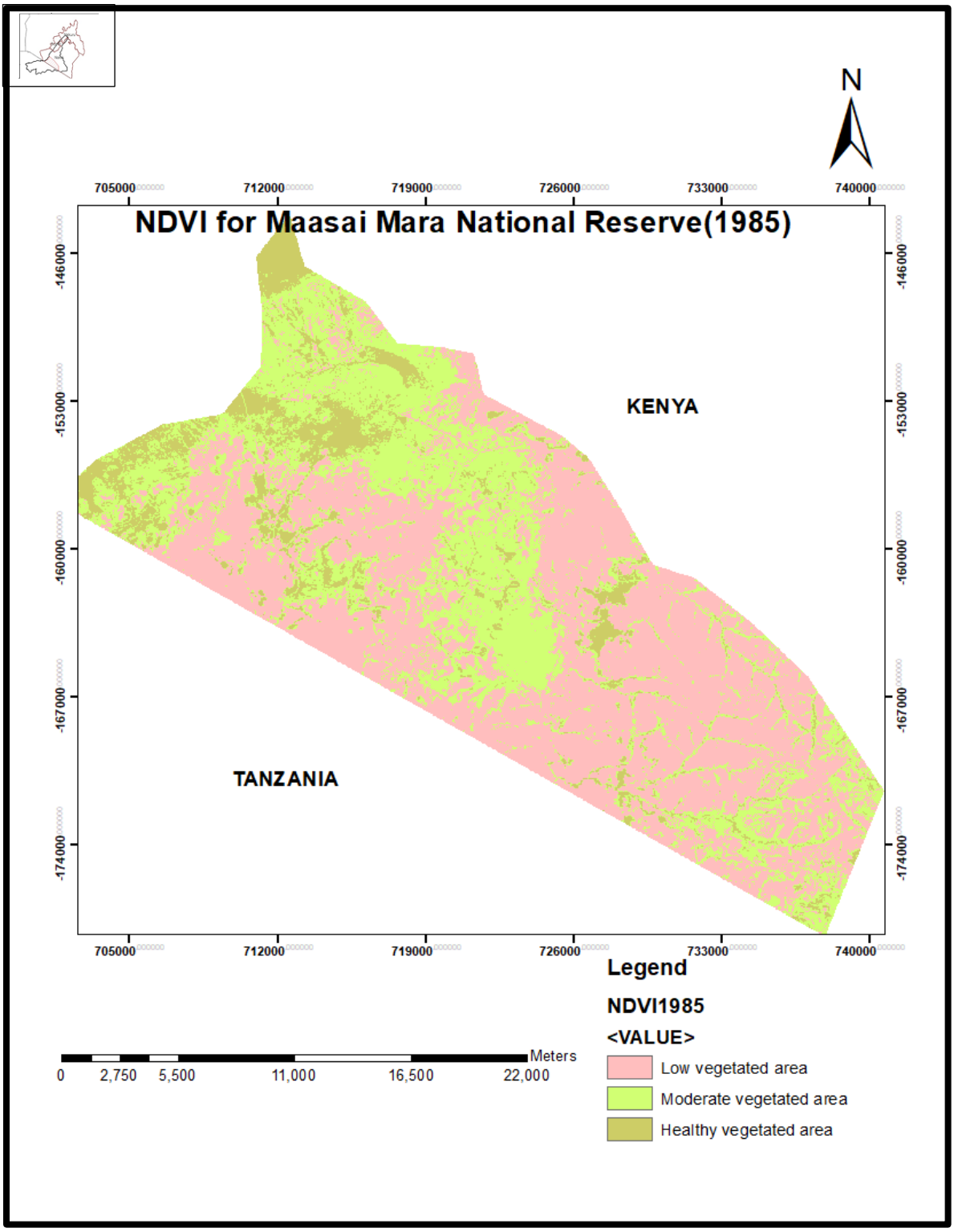


Figure 4.8. NDVI Map for 1985
Source: Author (2020)

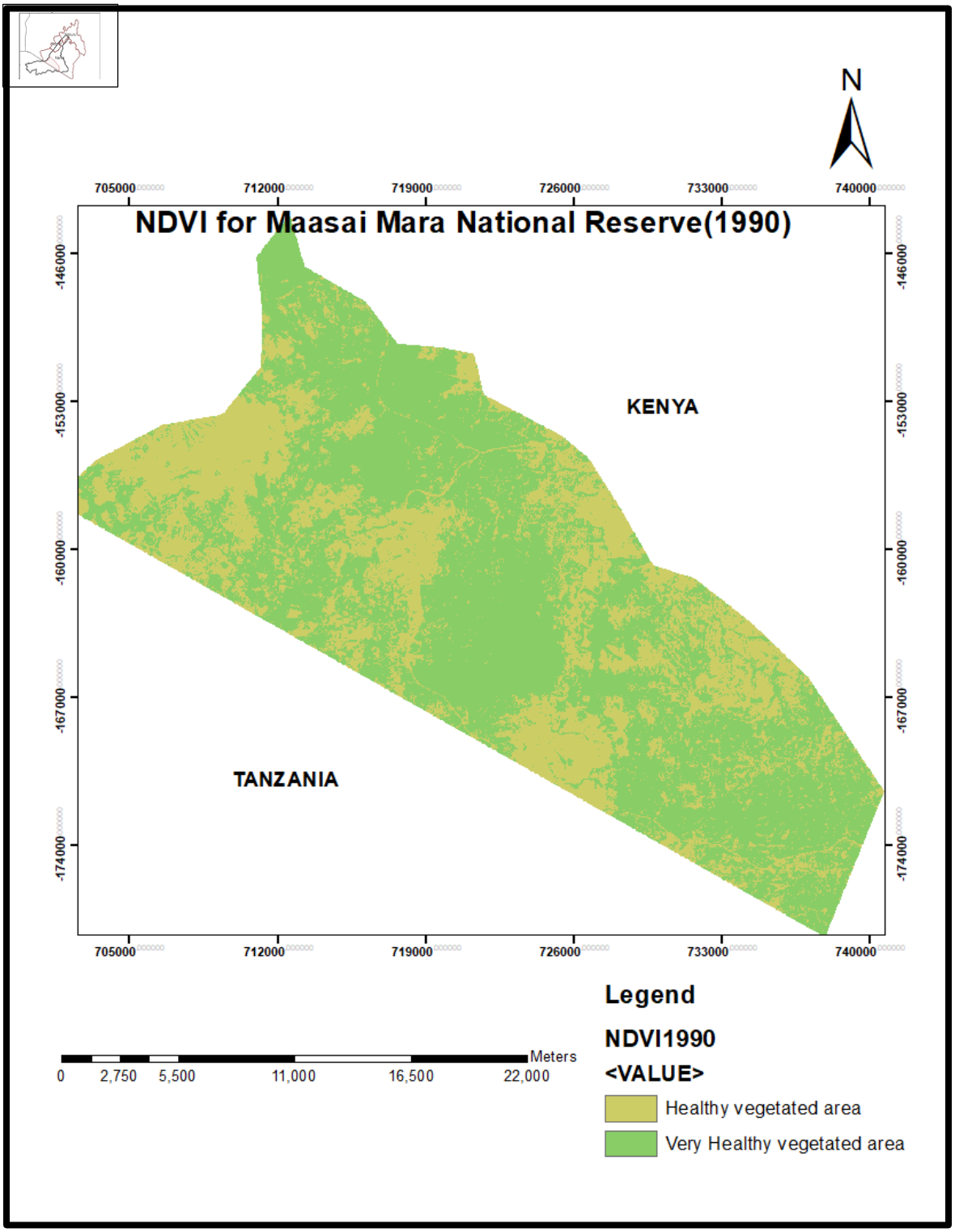


Figure 4.9. NDVI value for the year 1990
Source: Author (2020)

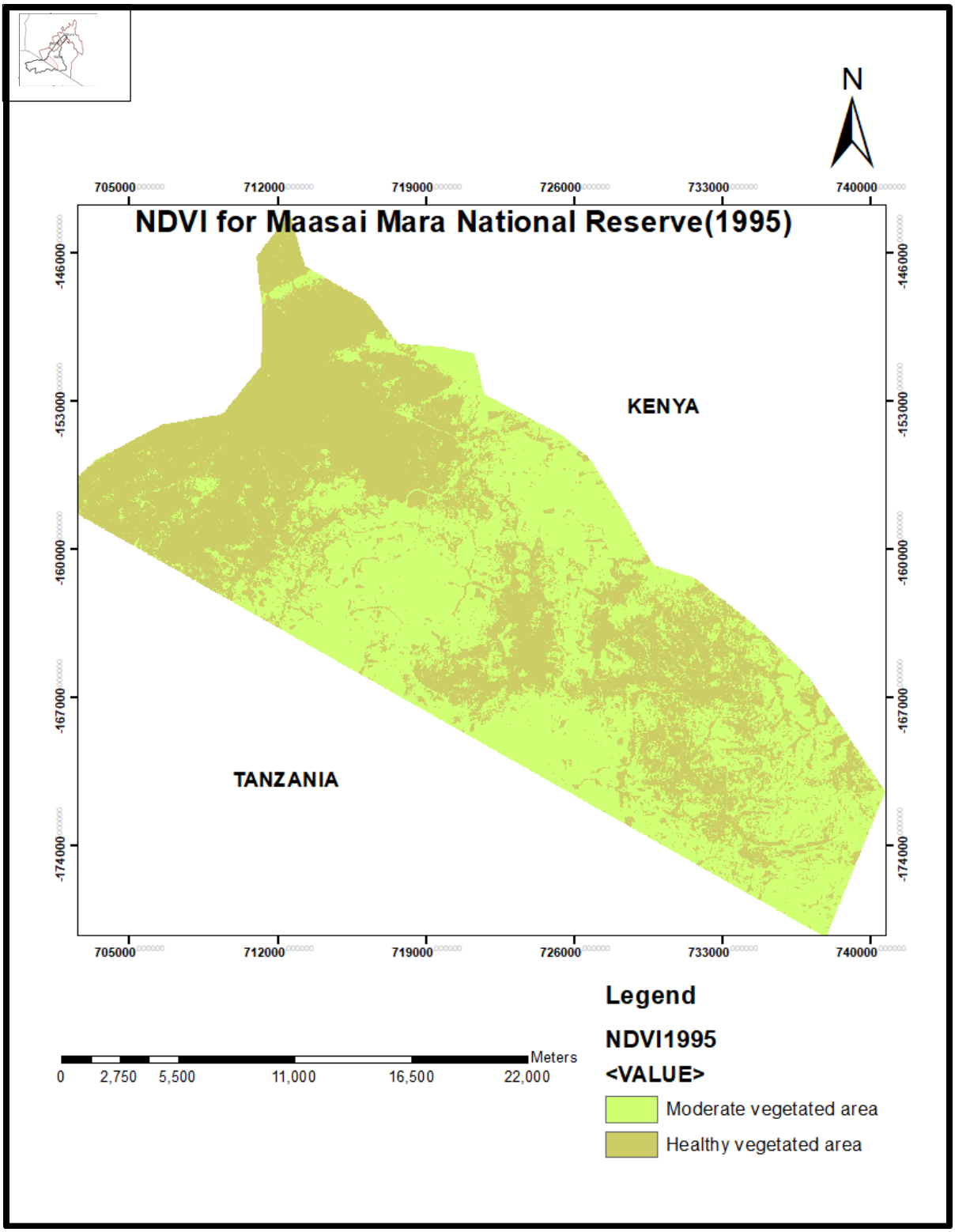


Figure 4.10. NDVI Map for the year 1995
Source: Author (2020)

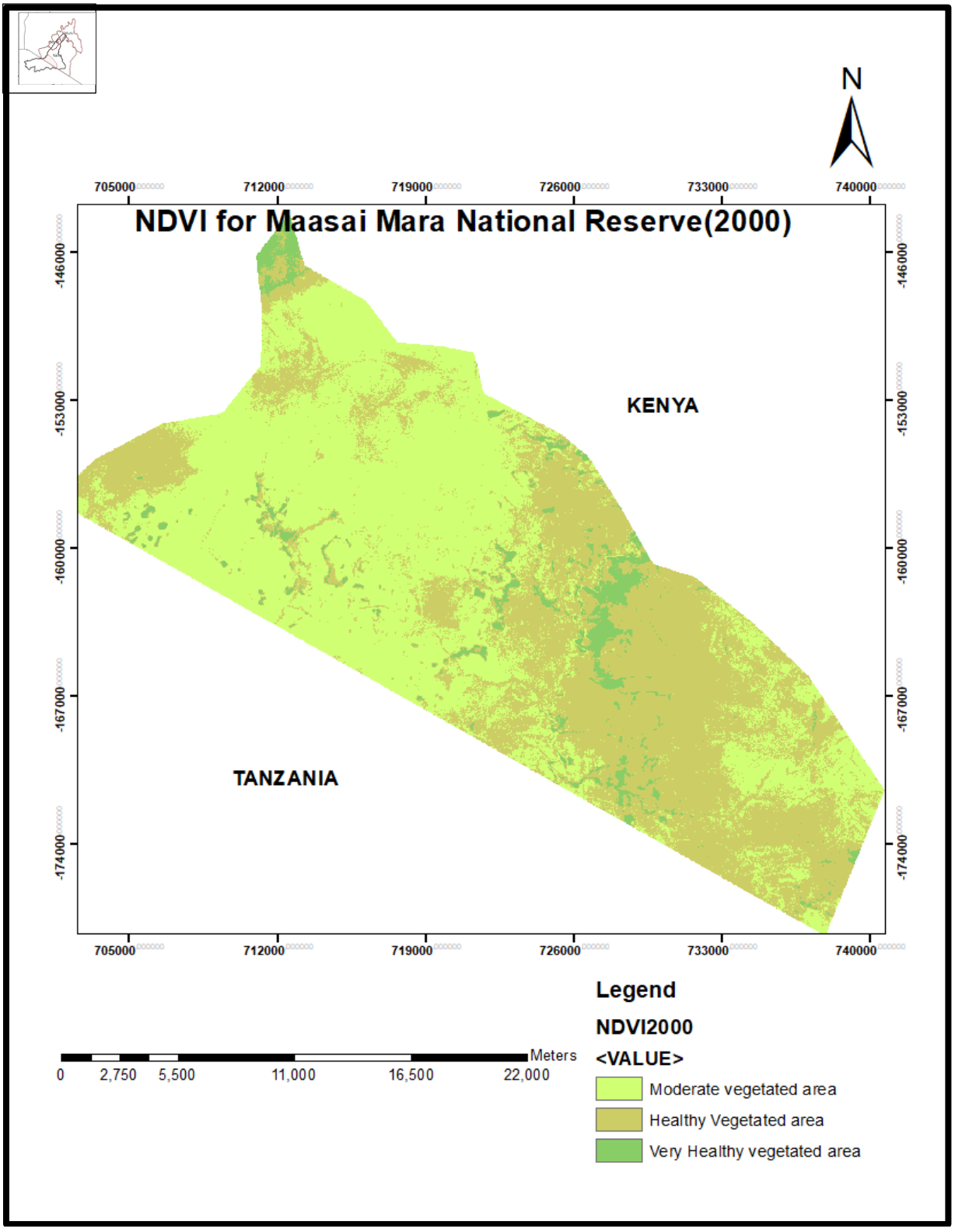


Figure 4.11. NDVI Map for the year 2000
Source: Author (2020)

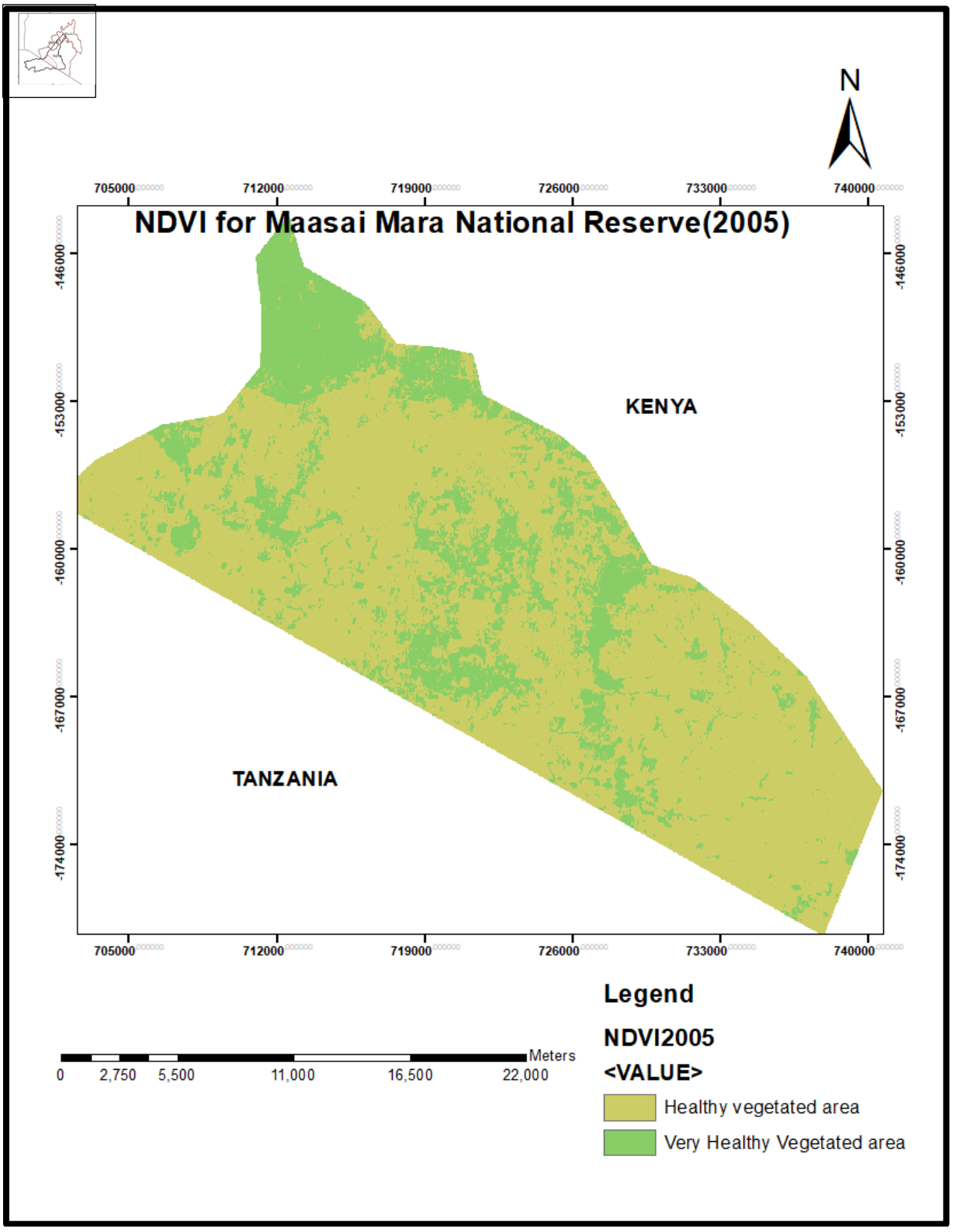


Figure 4.12. NDVI map the year 2005
Source: Author (2020)

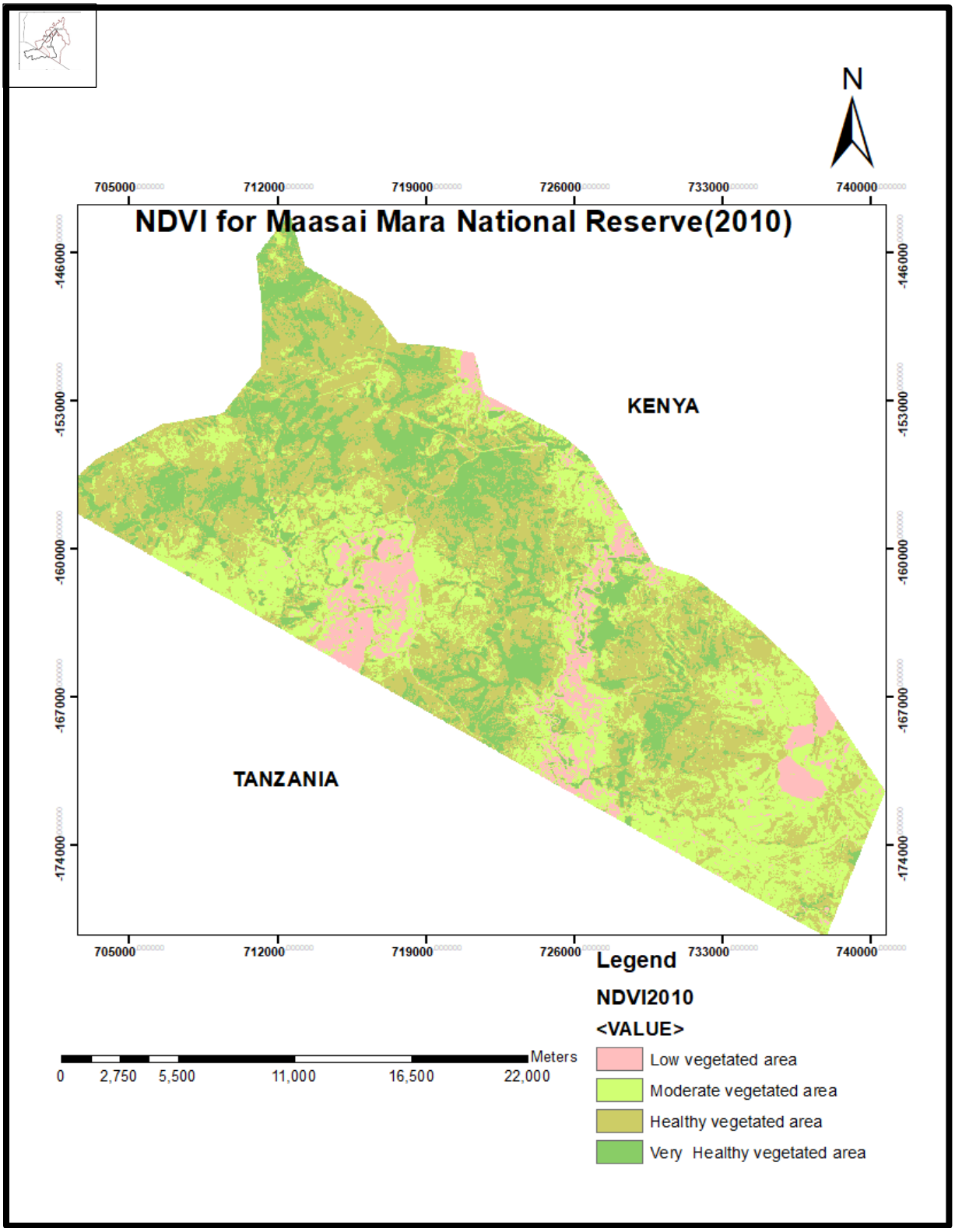


Figure 4.13. NDVI map for the year 2010
Source: Author (2020)

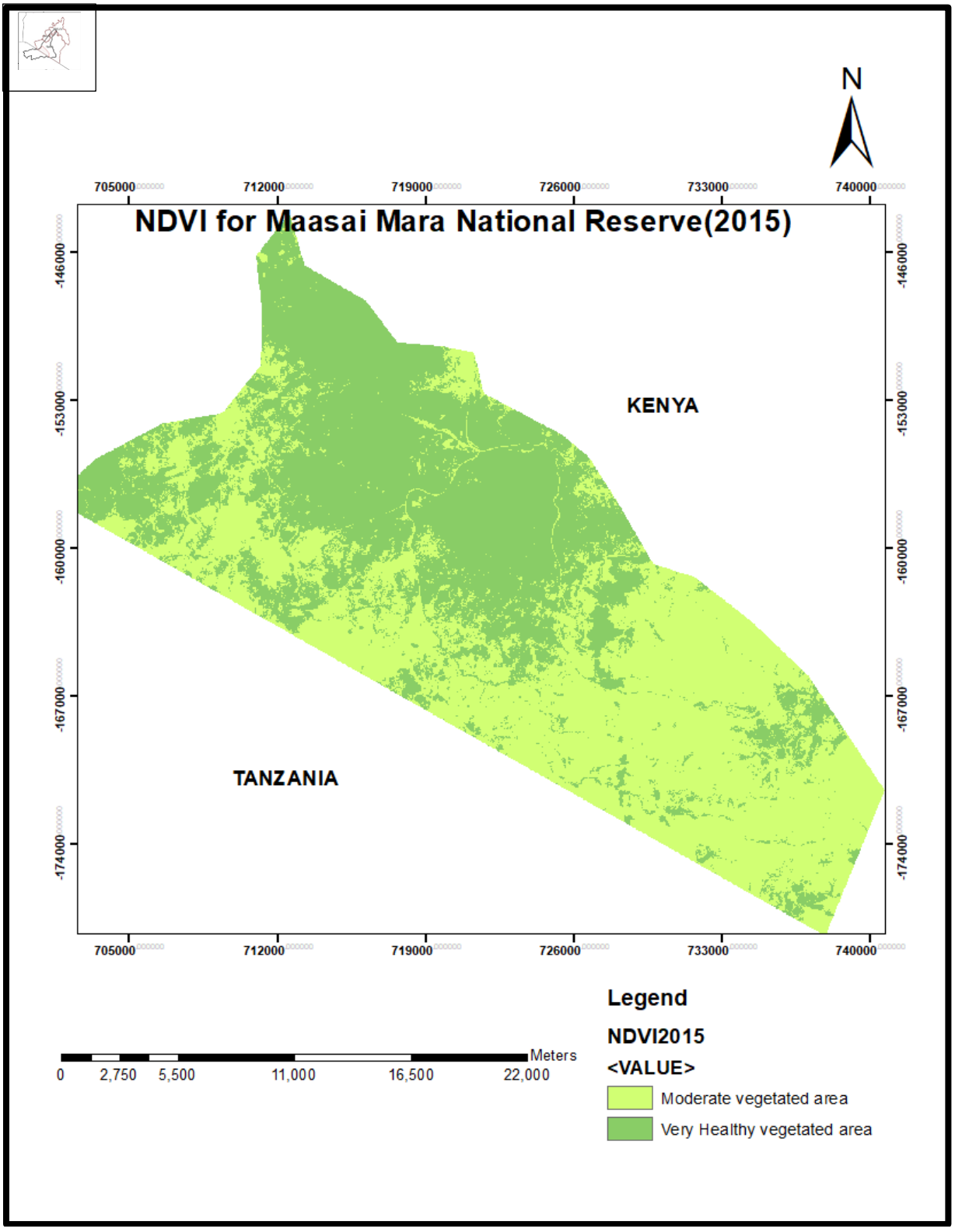


Figure 4.14. NDVI map for the year 2015
Source: Author (2020)

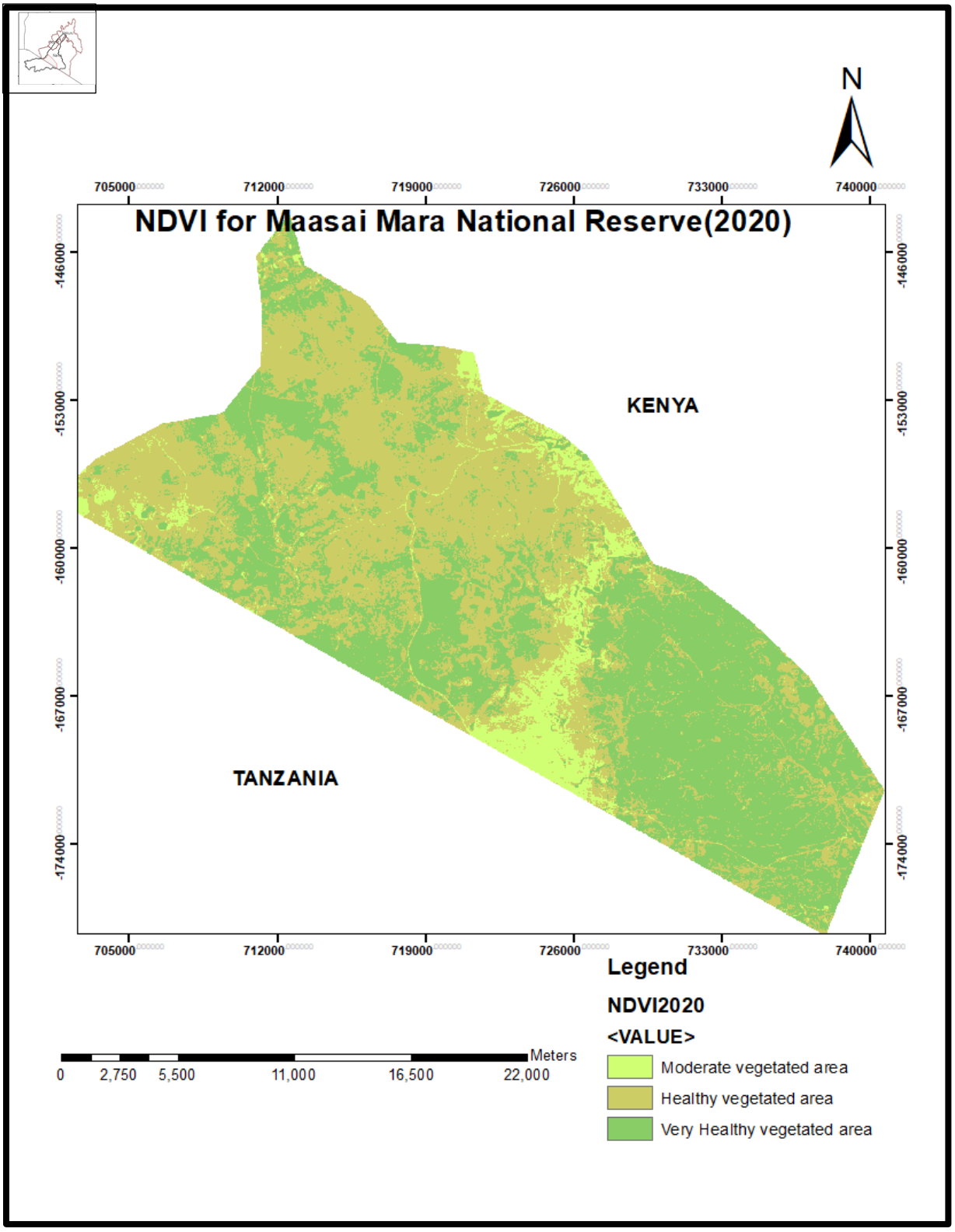


Figure 4.15. NDVI map for the year 2020
Source: Author (2020)

NDVI for the year 1975

The NDVI value ranges from -1 implying no vegetation, to zero for very little vegetation and 1 very high amounts of vegetation. During the year 1975, vegetation abundance as well as distribution in MMNR was generally high as shown in Figure 4.6. These findings agree with calculated mean average annual rainfall of 1351.68mm in 1975 which was generally high justifying the healthy vegetation of NDVI = 0.5, 0.32, 0.29 and 0.26 for moderate vegetated areas, and 0.20 for low vegetated areas. It is highly likely that the high amounts of vegetation cover prompted high survival rates of wildlife. For the years 1975 as well as 1980 and 1985, the vegetation cover ranged from medium (0 value) to high (1). Vegetation distribution was evenly spread throughout the MMNR.

NDVI for the year 1980

Five years later, the vegetative value of the reserve did not change significantly. The year 1980 saw improved vegetation depicted by NDVI value of 0.918 compared to the previous year indicating very healthy vegetation areas, 0.36 and 0.27 for moderate vegetated areas, 0.19 for low vegetated areas and 0.03 for non-vegetated areas. These findings agree with the average rainfall that was high with an average value of 1040mm hence fern greenness in majority of the areas in the reserve. Despite the vegetation changes, still there was enough vegetation inside the reserve that possibly warranted high survival of wildlife that supports the tourism industry. There is specifically high vegetation along the boundary of Narok County because of the presence of river Mara that gives rise to riverine vegetation. Figure 4.7 graphically shows the NDVI distribution within the reserve.

NDVI for the year 1985

For the subsequent year 1985, there is a reduction in vegetation cover within the reserve compared to the previous years. For the year 1985, vegetation is moderately high. This is attributed by distribution of non-vegetated areas of NDVI of 0.17 as well as moderate vegetated areas of NDVI of 0.41, 0.30 and 0.23 within the reserve. Low vegetated areas had an NDVI of 0.17. This could be attributed to a fairly high rainfall averaging 1113mm which is a decline compared to the previous year. Rainfall declines have the potential to negatively affect wildlife population. Figure 4.8 shows the distribution of vegetation.

NDVI for the year 1990

Vegetation for the year 1990 registered an NDVI value of 0.94, 0.93, 0.92 and 0.91 for very healthy vegetated areas and 0.75 for healthy vegetated areas. This is a slight improvement compared to the previous year 1985. This is attributed to a high a rainfall of 1219mm that is above average compared the rainfall of 1985 that was 1113mm and below average. Therefore, increase in rainfall above the average improves the vegetation and possibly wildlife populations because of availability of forage. This is depicted in the Figure 4.9.

NDVI for the year 1995

The year 1995 indicates a slight decrease in vegetation cover compared to the previous year with an NDVI of 0.716 for healthy vegetated areas, 0.55, 0.47 and 0.39 for moderate vegetated areas and 0.29 for low vegetated areas. This is attributed to stable rainfall in the year 1995 recording an average of 1134mm. Despite the rise of rainfall in the year 1995 of 1134mm, the vegetation did not improve that much due to the decline of rainfall in the previous years. There is a concentration

growth of vegetation cover at the South Western side of the reserve, while the North Eastern part of the reserve exhibits low amount of vegetation as shown in figure for 4.10.

NDVI for the year 2000

The year 2000 was the worst year in the reserve. There was very little vegetation distribution as evidence by NDVI value of 0.88 for very healthy vegetated areas, 0.68 for healthy vegetated areas, 0.56, 0.49 and 0.44 for moderate vegetated areas. This is because the year 2000 experienced the lowest rainfall ever with an annual calculated mean of 928mm supporting moderate vegetation in the reserve. Majority of the areas in the reserve are red in color indicating very low vegetation and consequently implying a high likelihood of a decline stable in wildlife population as supported by Elephant and resident Wildebeest population that show a declining trend from the period 1977-2001. With the exception of the areas around the River Mara that indicate presence of vegetation as shown in Figure 4.11.

NDVI for the year 2005

After five years, the year 2005 marked an improvement of vegetation from the previous year with an NDVI value of 0.88 for very healthy vegetation, 0.69, 0.62, 0.57, and 0.54 for healthy vegetated areas. Despite an average low rainfall of 823mm, vegetation cover was abundant due to high amounts of rainfall the previous year for instance 2004 having 1029mm, 2003 having 1030mm and 2002 recording 1250mm. It is highly likely that rainfall and temperature were stable during this period resulting to improved vegetation cover. Vegetation is also fairly well distributed across the reserve hence improved survival rate of wildlife as shown in Figure 4.12.

NDVI for the year 2010

The year 2010 indicates a decline in vegetation cover of as well as abundance compared to the previous year. The NDVI value of 0.80 for very healthy vegetated areas, 0.52 for healthy vegetated areas, 0.46 and 0.4 for moderate vegetated areas and 0.23 for low vegetated areas. This is definitely attributed to a drastic decline in rainfall in the two preceding years of 2009 with 959mm and the year 2008 with 972mm. Such changes have the potential to reduce wildlife populations that can in turn result in reduced visitor numbers in the reserve. This is shown in Figure 4.13.

NDVI for the year 2015

Compared with the previous year 2010, the year 2015 indicates a drop-in vegetation cover from NDVI value of 0.6 to 0.4 respectively. This drop is attributed to rainfall decline in that year that was below the average. The year 2015 shows a moderate vegetation cover of NDVI values of 0.53, 0.43, 0.37 and 0.31. A healthy vegetated area of NDVI value of 0.8 is recorded. These values prompted a fairly moderate vegetation distribution with the calculated average rainfall of approximately 1000mm. This is shown in Figure 4.14.

NDVI for the year 2020

The year 2020 experienced an improvement of vegetation from the previous year 2015 as indicated by the fern green and light olivenite colors. This is supported by a with a high NDVI value of 0.8 for very healthy vegetation, 0.61 and 0.56 for healthy vegetated areas followed by 0.49 and 0.40 for moderate vegetated areas. The North West part of the reserve had abundant vegetation. Generally, there is fair distribution of vegetation. This improvement in vegetation

cover is attributed to improved rainfall and temperature conditions compared to the previous year. This is shown in Figure 4.15.

For 40 years, MMNR experienced climatic changes attributed to variations in rainfall and temperature patterns. Analysis of NDVI values from 1975 to 2020 strongly supports this hypothesis. The results indicate variations in NDVI values. NDVI values were on record high in 2005 and 2020 while declines are observed in several other years such as 1985. The year 1985 was the worst hit period because it recorded the lowest NDVI value characterized by reduced vegetation. This phenomenon is attributed to high temperatures and low rainfall coupled by drought experienced in the year 1985.

In the year 2005, NDVI values were record highest with a value of 0.8 for very healthy vegetated areas, and 0.69, 0.62, 0.57 and 0.54 for healthy vegetated areas. Additionally, the year 2020 recorded high NDVI values indicating healthy vegetation supporting wildlife population. The NDVI values were 0.8 for very healthy vegetated areas, and 0.61, 0.56, 0.49 and 0.40 for healthy vegetated areas. This is due to the presence of rainfall throughout the year which facilitates and maintains abundant vegetation.

The NDVI values of the year 1985 were the lowest indicating non-vegetated areas as well as medium vegetated areas in most parts of the park. The NDVI values were 0.17 for non-vegetated areas and 0.41, 0.30 and 0.23 for moderate vegetated areas. The reduction of NDVI can be attributed by a drastic change in both the temperatures and rainfall patterns. Conclusively, for approximately 40 years, MMNR reserve experienced climatic changes which resulted to reduction in NDVI. The maps of the study area presented affirm presence of a strong correlation between rainfall and NDVI. When rainfall is above average it translates to high vegetation content hence high NDVI values. Based on these results, this study concludes that MMNR vegetation cover

underwent variations of low and high vegetation undoubtedly due to rainfall as well as temperature variations. Such variations have the potential to affect the tourism industry. This is because of a consensus that climate and natural resources are strong determinants of tourism globally (Rutty *et al.,* 2016). Additionally, these results concur with Sheriff (2019) findings that in East Africa climate change is expected to reduce vegetation quality.

For instance the year 1985, vegetation cover in MMNR drastically declined compared to previous years. These findings agree with the World Bank (2018) that projects aridity in sub-Sahara Africa will increase due to temperature and rainfall changes. Additionally, the projected declines in long rainy season and short rainy season, an increase in spatial and temporal variability of rainfall and increase in both maximum and minimum temperatures will have an impact on both vegetation and livestock and wildlife (Aduma *et al.,* 2018). In fact, Niang, *et al.* (2014) suggests that climate change is severely altering weather patterns and could significantly reduce vegetation. Therefore, the reduction of vegetation quality through combined effects of climate change and human land cover changes poses a significant threat to biodiversity (Segan *et al.,* 2016) that supports the tourism industry.

Wildlife especially ungulate population are to a large extend regulated by forage quality (Hopcraft *et al.,* 2010). For instance, in East African Savannahs, grass growth is mainly regulated by soil fertility and rainfall (Bartzke *et al.,* 2018). Therefore, with climate change effects specifically rainfall variations, availability and quality forage for wildlife will reduce hence a decline in population of most herbivore species. Also, rising temperatures will surpass species thresholds as indicated in the recent studies on potential impacts of climate on wildlife in the savannah ecosystems of Kenya (Aduma *et al.,* 2018; Piniewski *et al.,* 2017).

Other studies such as Gundula *et al.* (2016) observed declines in Normalized Difference Vegetation Index (NDVI) in the Mara region of Kenya between 1984 and 2003. These

observations approve the current study results depicting a general variation in NDVI. Therefore, a decline in vegetation will result in decline in wildlife population as vegetation is the key source of food for herbivore wildlife survival. In fact, Niang *at al.*, (2014) claim that reduced forage quality combined with changes in human land use are predicted to pose the biggest threat to wildlife in Eastern Africa. Hence, tourism industry will undoubtedly be affected by dwindling wildlife populations. Therefore, due to compelling evidence of climate change impacts on wildlife tourism as well as its sustainability, it is highly likely that in future protected areas may no longer host wildlife tourism activities because of reported as well as observed wildlife declines.

4.2.5. Community members views on natural resource

The study further sought to obtain community members' views on natural resources (wildlife and vegetation) that were measured on a five-point Likert Scale on their level of agreement on several statements describing natural resources. A total of 7 statements were used to determine the community member's perception on the natural resources and their responses summarized using a 5-point Likert Scale; (SA - Strongly Agree, A - Agree, N - Neutral, D - Disagree, SD - Strongly Disagree). Descriptive statistics which include mean and standard deviation were used to summarize the responses as presented in Table 4.5.

Table 4.5. Community members views on Natural Resource

	SA		A		N		D		SD		Mean	STD.DEV.
Statement	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**		
Tree population in Maasai Mara has reduced	40	13.6	87	29.5	48	16.3	98	33.2	22	7.5	**3.08**	**1.21**
Big five population has reduced in MMNR	37	12.5	146	49.5	67	22.7	35	11.9	10	3.4	**3.56**	**0.97**
There is a change in vegetation cover in MMNR	74	25.1	153	51.9	41	13.9	21	7.1	6	2.0	**3.91**	**0.92**
Wildlife and livestock conflict for water in the reserve	69	23.4	148	50.2	49	16.6	22	7.5	7	2.4	**3.85**	**0.94**
Wildlife and livestock conflict for pasture in the reserve	31	10.5	84	28.5	112	38.0	62	21.0	6	2.0	**3.24**	**0.97**
The vegetation and grassland species have declined in the Mara	56	19.0	138	46.8	63	21.4	26	8.8	12	4.1	**3.68**	**1.01**
There is a shift in grassland and habitats distribution in Mara	110	37.3	127	43.1	36	12.2	19	6.4	3	1.0	**4.09**	**0.92**
Mean											**3.63**	**.573**

Based on these results, majority of the respondents 183 (62%) agreed that the Big five population had reduced, with 22.7% undecided and 15.3% disagreed (*M=3.56; SD=0.97*). Furthermore, majority of the respondents 227 (77%) agreed that there is a change in vegetation cover, with 13.9% undecided and 9.1% disagreed (*M=3.91; SD=0.92*). What is more is that, most of the respondents 217 (73.6%) agreed that available resources such as space and water control wildlife and livestock population dynamics, with 16.6% undecided and 9.9% disagreed (*M=3.85; SD=0.94*).

Majority of the respondents 194 (65.8%) agreed that vegetation and grassland species have declined in the Mara, with 21.4% undecided and 12.9% disagreed (*M=3.68; SD=1.01*). Furthermore, most of the respondents 237 (80.4%) agreed that there was a shift in grassland and habitat distribution in the Mara, with 12.2% undecided and 7.4% disagreed (*M=4.09; SD=0.92*). The study findings also suggest that majority of the respondents 127 (43.1%) agreed that tree population has reduced, with 40.7% disagreed and 16.3% undecided (*M=3.08; SD=1.21)*. Additionally, the findings indicate that 115 (39%) of the respondents agreed that conflict arises as a result of herbivore wildlife and livestock grazing on pasture, with 38% undecided and 23% disagreed (*M=3.24; SD=0.97*).

From the study, the seven statements used to measure natural resource had an overall mean of 3.61 associated with a standard deviation of 0.573. The findings reveal that most community members agreed on the statements used to measure natural resources. The results suggest that the community perceived natural resources to have reduced the population of Big five. This is can be attributed to a combination of factors including rainfall and temperature variations that affect vegetation cover. As indicated earlier, there is a direct relationship between rainfall and temperature variations on vegetation growth that supports wildlife population. As such, flooding

and drought events inhibit vegetation growth. Consequently, wildlife populations are affected by dwindling vegetation cover.

Furthermore the local communities reported changes in vegetation cover, wildlife and livestock conflict over resources such as vegetation and water, vegetation and grassland species decline and a shift in grassland and habitats distribution. These changes affirm climate change effects on natural resources. The respondents were not certain whether tree population had reduced. The tourism industry will be directly as well as indirectly affected by these changes especially reduced wildlife population. These results concur with Moreno and Becken (2019) suggestion that climate change may trigger the occurrence of tourism industry crisis in many destinations leading to a decline in tourism numbers, environmental degradation and social disruption and most importantly sustainability of the tourism sector.

4.2.6. Climate change factor analysis

The validity of the instrument was measured through Bartlett's Test of Sphericity (Muhammad, 2013). The Bartlett's test of sphericity was used as a test of the adequacy of the correlation matrix. In addition, Kaiser-Mayor-Oklin measures of sampling adequacy (KMO) and Bartlett's test of sphericity were applied to test whether a relation between the study variables exist. Kaiser-Mayor- Oklin was used as a measure of sampling adequacy and a value of >.5 was acceptable.

The component factor analysis with Varimax rotation was conducted on all variables to extract factors from the scales of each construct. The principle component analysis and Varimax rotation were performed in all the items that had factor loadings lower than 0.50 were eliminated as postulated by Hair *et al.*, (2016). After performing the factor analysis of each variable, the statement responses were summed to create a score and subjected to inferential analysis. The factor analysis results of climate change construct, indicated that the KMO was 0.671 and the

Bartlett's Test of sphericity was significant ($p<.05$) and a chi square of 486.738 (Table 4.6).

Table 4.6. Rotated factor matrix on measurement items for climate change

Survey Items	Component	
	1	2
Drought is rampant in Maasai Mara National Reserve		.610
Floods scenarios are common in Maasai Mara National Reserve		.869
Temperatures have risen in Maasai Reserve than before	.739	
The rainfall experienced in Maasai Mara Reserve is high		.784
Rainfall patterns in Maasai Mara Reserve has changed	.830	
Mara river water flow level has changed	.829	
Climate change adaptation and mitigation strategies exist in Maasai Mara National Reserve		
KMO	.671	
Approx. Chi-Square	486.738	
Bartlett's Test of Sphericity (P<0.001) df=21		
Eigenvalues	2.583	1.505
% of Variance (58.406)	32.032	26.374

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 3 iterations.

Two variables were charged with the climate change variable according to the Varimax rotated principle component which explained 58.41% variance with autonomous values greater than 1. The Maasai Mara National Reserve has removed one assertion stating there are adaptation to and reduction of climate change measures, while retaining, calculating and renaming the 6 other claims for future analyzes.

4.2.7. Natural resource factor analysis

Natural resource statements were subjected to factor analysis and two components with Eigen values greater than 1 were extracted which cumulatively explained 57.355% of variance as shown in (Table 4.7).

Table 4.7. Rotated factor matrix on measurement items for Natural Resource

Survey Items	Component	
	1	**2**
Tree population in Maasai Mara has reduced	.783	
Big five population has reduced in Maasai Mara Reserve	.642	
There is a change in vegetation cover in Maasai Mara Reserve		.774
Wildlife and domestic animals compete for water in the reserve		.844
Wildlife and domestic animals compete for pasture in the reserve	.696	
The vegetation and grassland species have declined in the Mara	.645	
There is a shift in grassland and habitats distribution in Mara		.620
KMO	.710	
Approx. Chi-Square	434.685	
Bartlett's Test of Sphericity (P<0.001) df=21		
Eigenvalues	2.658	1.357
% of Variance (57.355)	28.764	28.591

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 3 iterations.

The natural resource indicated that the KMO was 0.710 and the Bartlett's Test of sphericity was significant (p<.05) and chi square (434.685). No statements were deleted and all the ten statements retained, computed and renamed non-conformities for further analysis.

4.2.8. Simple regression analysis on climate change and natural resources in MMNR

The study sought to establish the effects of climate change on natural resources in MMNR. The coefficient of determination (R squared) of 0.137 shows that 13.7% of natural resources can be explained by climate change. The adjusted R-square of .137% indicates that climate change in exclusion of the constant variable explained the change in natural resources by 13.5% and the remaining percentage can be explained by other factors excluded from the model. These results are shown in Table 4.8.

Table 4.8. Climate Change effects on Natural Resources Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.371[a]	.137	.135	.41162	.137	46.697	1	293	.000

a. Predictors: (Constant), Natural

The result of Analysis of Variance (ANOVA) for regression coefficient as shown in Table 4.9 revealed (F=46.697, p value = 0.000). Since the p-value is less than 0.05 it means that there exists a significant relationship between climate change and natural resources.

Table 4.9. Climate change and Natural resources ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.912	1	7.912	46.697	.000[b]
	Residual	49.643	293	.169		
	Total	57.555	294			

a. Dependent Variable: Climate

b. Predictors: (Constant), Natural

The study hypothesized that climate change had no significant effect on natural resources. The study findings indicated that there was a positive significant relationship between climate change and natural resources (β=0.286 and p=0.000) as shown in Table 4.10. Therefore, a unit increase in climate change led to an increase in natural resources up to the optimum level. Over and above the optimum levels, flooding and drought events negatively affect natural resources as supported by NDVI analysis. Since the p-value was less than 0.05, the null hypothesis **(H_{o2})** was rejected and the alternative hypothesis accepted.

Table 4.10. Climate change and Natural resources Regression Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.364	.154		15.355	.000
	Natural	.286	.042	.371	6.834	.000

a. Dependent Variable: Climate

The regression analysis revealed that climate change had an influence on natural resources. This agrees with Ottichilo *et al.* (2000) who argue that there exists a well-established positive relationship between rainfall and primary production of vegetation especially grass in the semi-arid tropics. Therefore, during drought periods which are a significant indicator of climate change, primary production of vegetation is low hence affecting wildlife population. The population dynamics of herbivores are also determined by quantity and quality of food over a period long enough to enable the animal to deposit reserves of energy and protein stored in the body.

For every unit increase in rainfall, there was a corresponding increase of natural resources. This revelation concurs with Ottichilo (2000) asserting that there exists a significant relationship between resident wildebeest population trends and rainfall in MMNR, and that increase in rainfall totals (up to 1000 mm) appears to have led to increase in resident wildebeest numbers and vice versa. These results are consistent with previous studies examining the influence of climate change on natural resources. Quantity and quality of forage in semi-arid areas is largely influenced by rainfall, it is likely that frequent occurrence of droughts in the Mara ecosystem negatively influences wildlife populations through reduced reproductive and survival rates (Ottichilo *et al.,* 2000). This study points to a likelihood of climatic changes coupled by rapid changes in rainfall patterns manifested through flooding and drought events resulting in wildlife populations decline in MMNR.

4.3 EFFECTS OF NATURAL RESOURCES ON TOURISM SUSTAINABILITY IN MMNR

The second objective was to establish the effects of natural resources on tourism sustainability.

4.3.1 Community members' views on tourism sustainability

Tourism sustainability was measured using the social, economic and environmental sustainability constructs. The community members' responses on tourism sustainability were measured on a five-point Likert Scale where the community members indicated their level of agreement on several statements describing tourism sustainability. A total of 20 statements were used to determine the community member's perception on tourism sustainability and their responses were summarized using a 5-point Likert Scale. Descriptive statistics, mean and standard deviation were used to summarize the responses as presented in Table 4.11.

Based on the results, most of the respondents 241 (81.7%) agreed that there are sustainable tourism practices in MMNR, with 12.9% undecided and 5.5% disagreed (*M=4.04; SD=0.87*). Also, majority 236 (80%) of the respondents gave the impression to agree that MMNR conducts conservation education among their staff & tourists, with 11.5% undecided and 8.5% agreed (*M=4.03; SD=0.93*). In addition, most of the respondents 247(83.8%) agreed that Wildlife and Vegetation conservation programs exist in MMNR, with 8.5% undecided and 7.8% disagreed (*M=4.06; SD=0.88*). Furthermore, majority of the respondents seem to agree that reuse, recycling & reducing practices are carried out in MMNR (*M=4.00; SD=0.95*).

Table 4.11. Tourism Sustainability

Statement	SA		A		N		D		SD		Mean	STD. DEV
	F	%	F	%	F	%	F	%	F	%		
There are sustainable tourism practices in MMNR	88	29.8	153	51.9	38	12.9	9	3.1	7	2.4	**4.04**	**0.87**
MMNR conducts conservation education among their staff & tourists	98	33.2	138	46.8	34	11.5	20	6.8	5	1.7	**4.03**	**0.93**
Wildlife/Vegetation conservation programs exist in MMNR	94	31.9	153	51.9	25	8.5	19	6.4	4	1.4	**4.06**	**0.88**
Reuse, recycling & reducing practices are carried out in MMNR	91	30.8	148	50.2	30	10.2	18	6.1	8	2.7	**4.00**	**0.95**
There are environmental protection guidelines in Maasai Mara	14	47.8	113	38.3	20	6.8	13	4.4	8	2.7	**4.24**	**0.95**
There is richness of Maasai culture & heritage in the Mara	93	31.5	135	45.8	44	14.9	13	4.4	10	3.4	**3.98**	**0.97**
There is a rise of social amenities within Maasai Mara	11	39.0	124	42.0	40	13.6	12	4.1	4	1.4	**4.13**	**0.89**
There is preservation & conservation of the Maasai culture	11	38.6	119	40.3	46	15.6	11	3.7	5	1.7	**4.11**	**0.91**
Tourism unites the community and encourage people to work together and support each other in MMNR	83	28.1	161	54.6	31	10.5	14	4.7	6	2.0	**4.02**	**0.87**
Tourism promotes the development of public facilities in Mara	14	47.8	101	34.2	33	11.2	17	5.8	3	1.0	**4.32**	**1.92**
Tourism brings people of different backgrounds and cultures into the community in MMNR	72	24.4	154	52.2	38	12.9	26	8.8	5	1.7	**3.89**	**0.93**
There is reduced profitability of tourism enterprises in Mara due to flooding/drought scenarios	28	9.5	42	14.2	129	43.7	88	29.8	8	2.7	**2.98**	**0.97**
Host communities within the Mara have the ability to create wealth thorough tourism	85	28.8	154	52.2	35	11.9	16	5.4	5	1.7	**4.01**	**0.88**
There are better recreational facilities in the MMNR because of tourism	95	32.2	143	48.5	30	10.2	19	6.4	8	2.7	**4.01**	**0.96**
There is improvement of livelihood among local communities in MMNR	13	45.1	116	39.3	26	8.8	16	5.4	4	1.4	**4.21**	**0.91**
There is increased employment opportunities in the Mara	14	50.5	145	49.2	19	6.4	17	5.8	6	2.0	**4.26**	**0.96**
There is improvement in the local economy strength in MMNR	10	34.6	28	9.5	13	4.4	-	-	7	2.4	**4.09**	**0.91**
Increase in prices and property values makes it difficult for sections of people to live in the Mara	70	23.7	156	52.9	49	16.6	14	4.7	6	2.0	**3.92**	**0.88**
There is increased urban development within the reserve	91	30.8	166	56.3	23	7.8	10	3.4	5	1.7	**4.11**	**0.82**
Tourism is good for the economy because the money that visitors spent when they visit Mara helps stimulate the economy	15	53.2	107	36.3	18	6.1	9	3.1	4	1.4	**4.37**	**0.84**
Mean											**4.04**	**.576**

Majority of the respondents 228 (77.3%) agreed that there exists a rich Maasai culture & heritage in the Mara with 14.9% undecided and 7.8% disagreed (*M=3.98; SD=0.97*). What is more, majority of the respondents 144 (82.7%) agreed that tourism unites the Maasai community and encourage people to work together and support each other in MMNR with 10.5% undecided and 6.7% disagreed (*M=4.02; SD=0.87*). Further, majority of the respondents 239 (81%) agreed that host communities within the Mara have the ability to create wealth through tourism with 11.9% undecided and 7.1% disagreed (*M=4.01; SD=0.88*). Moreover, majority of the respondents 238 (80.7%) agreed that there are better recreational facilities in the MMNR because of tourism with 10.2% undecided and 9.1% undecided (*M=4.01; SD=0.88*).

The results also indicated that most of the respondents 127 (86.1%) agreed that there are environmental protection guidelines, with 6.8% undecided and 7.1% disagreed (M=4.24; SD=0.95). Also, majority of the respondents 135 (81%) agreed that there is a rise of social amenities within MMNR with 13.6% undecided and 5.5% disagreed (M=4.13; SD=0.89). Furthermore, majority of the respondents 130 (78.9%) agreed that there are preservation & conservation initiatives for the Maasai culture with 78.9% undecided and 5.4% disagreed. Also, majority of the respondents 257 (87.1%) agreed that there is an increase in urban development within the reserve, with 11.2% undecided and 9.5% disagreed (M=4.11; SD=0.91).

In addition, majority of the respondents 115 (82%) agreed that tourism promotes the development of public facilities in the Mara, with 11.3% undecided and 6.8% disagreed (M=4.32; SD=1.92). Furthermore, majority of the respondents 129 (76.6%) agreed that there is improvement of livelihoods among local communities in MMNR with 8.8% undecided and 6.8% disagreed (M=4.21; SD=0.91). Moreover, majority of the respondents 159 (99.7%) agreed that there is increased employment opportunities in the Mara with 6.4% undecided and 7.8% disagreed (*M=4.26; SD=0.96*). What is more is that majority of the respondents 38 (44.1%) agreed that

there is improvement in the local economy strength as a result of tourism with 6.4% undecided and 7.8% disagreed (*M=4.09; SD=0.92*).

Furthermore, majority of the respondents 122 (89.5%) agreed that tourism is good for the local economy because the money that tourists spend when they visit MMNR that helps stimulate the economy with 6.1% undecided and 4.5% disagreed (*M=4.37; SD=0.84*). Also, majority of the respondents, 129 (43.7%) of the respondents were undecided that there is reduced profitability of tourism enterprises in the Mara due to flooding/drought scenarios, with 23.7% agreed and 32.5% undecided (*M=2.98; SD=0.97).*

Based on the results, the twenty statements used to measure tourism sustainability had an overall mean of 4.04 associated with a standard deviation of 0.576. Therefore, the results point out that majority of the community members agreed on the statements used to measure tourism sustainability. However, despite the findings that tourism sustainability initiatives exist in MMNR, the declining wildlife population as a result of rainfall and temperature variations coupled with reducing vegetation cover could hamper existing sustainable tourism initiatives. This assertion agrees with Dube and Nhamo (2020) asserting that climate change will undermine tourism activities and consequently tourism economies in Sub Saharan Africa by reducing the attractiveness of some of the most iconic natural tourism attractions in Africa.

Moreover, climate change will adjust the travel industry operations as a result of deteriorating climatic conditions (Hamilton and Tol, 2004). Local communities in the Mara had the ability to create wealth through tourism and improve their livelihoods. Availability of employment opportunities exist by virtue of tourism facilities and services. There were increased urban development within the reserve; tourism was good for the economy because the money that visitor spent while in the Mara helps stimulate the economy. While there was improvement of the local economy, property prices go up disfranchising locals from making purchases.

4.3.2 Tourism sustainability factor analysis

On the tourism sustainability construct, the factor analysis results showed four components with Eigen values greater than 1.0 and the total variance explained was 62.059% as shown in Table 4.12. The KMO measure of sampling adequacy of .915 indicating sufficient inter-correlation, while the Bartlett's Test of Sphericity was significant (Chi-square 3056.356, p=0.001). Two statements that there are sustainable tourism practices in MMNR and the host communities within the Mara had the ability to create wealth thorough tourism were deleted and the remaining 18 statements were retained, computed and renamed sustainability for further analysis.

Table 4.12. Rotated factor matrix on measurement items for Tourism sustainability

Survey Items	Component			
	1	2	3	4
There are sustainable tourism practices in Maasai Mara Reserve				
Maasai Mara National Reserve conducts conservation education among their staff & tourists			.680	
Wildlife/Vegetation conservation programs exist in Maasai National Reserve			.721	
Reuse, recycling & reducing practices are carried out in Maasai Mara National Reserve			.734	
There are environmental protection guidelines in Maasai Mara			.688	
There is richness of Maasai culture & heritage in the Mara	.753			
There is a rise of social amenities within Maasai Mara	.694			
There is preservation & conservation of the Maasai culture	.704			
Tourism unites the community and encourage people to work together and support each other in Maasai Mara National reserve	.719			
Tourism promotes the development of public facilities in Mara	.706			
Tourism brings people of different backgrounds and cultures into the community in Maasai Mara National reserve	.575			
There is reduced profitability of tourism enterprises in Mara due to flooding/drought scenarios				.914
Host communities within the Mara have the ability to create wealth thorough tourism				
There are better recreational facilities in the Maasai Mara Reserve region because of tourism		.630		
There is improvement of livelihood among local communities in Maasai Mara National Reserve		.743		
There is increased employment opportunities in the Mara		.692		
There is improvement in the local economy strength in Maasai Mara National Reserve		.672		
Increase in prices and property values makes it difficult for sections of people to live in the Mara		.620		
There is increased urban development within the reserve		.573		
Tourism is good for the economy because the money that visitors spent when they visit Mara helps stimulate the economy		.598		
KMO	.915			
Approx. Chi-Square	3056.3			
Bartlett's Test of Sphericity (P<0.001) df=190	56			
Eigenvalues	8.477	1.533	1.239	1.163
% of Variance (62.059)	20.790	18.585	16.486	6.198

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 10 iterations.

4.3.3. Simple regression analysis of natural resources on tourism sustainability in MMNR.

The study sought to explore the effects of natural resources on tourism sustainability in MMNR. The coefficient of determination (R squared) of 0.153 shows that 15.3% of tourism sustainability can be explained by natural resources. The adjusted R-square of .150 indicates that natural resources in exclusion of the constant variable explained the change in tourism sustainability by 15% and the remaining percentage can be explained by other factors excluded from the model. The standard error of estimate (0.531) shows a small deviation of the independent variables from the line of best fit. These results are shown in Table 4.13.

Table 4.13. Natural resources and tourism sustainability model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.391[a]	.153	.150	.53137	.153	52.832	1	293	.000

a. Predictors: (Constant), Natural

The result of Analysis of Variance (ANOVA) for regression coefficient as shown in Table 4.14 below revealed (F=52.832, p value = 0.000). Since the p-value is less than 0.05 it means that there exists a significant relationship between natural resources and tourism sustainability in MMNR.

Table 4.14. Natural resources and Tourism Sustainability ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14.917	1	14.917	52.832	.000[b]
	Residual	82.729	293	.282		
	Total	97.646	294			

a. Dependent Variable: Sustain

b. Predictors: (Constant), Natural

The study hypothesized that natural resources had no significant effect on tourism sustainability. The study findings indicated that there was a positive significant relationship between natural resources and tourism sustainability (β=0.393 and p=0.000) as summarized in Table 4.15. Therefore, a unit increase in natural resources led to an improvement in tourism sustainability up to the optimum level. Since the p-value was less than 0.05, the null hypothesis was rejected. It was concluded that natural resources affect tourism sustainability positively.

Table 4.15. Natural resources and tourism sustainability regression coefficients

Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	Std. Error	Beta		
1	(Constant)	2.607	.199		13.113	.000
	Natural	.393	.054	.391	7.269	.000

a. Dependent Variable: Sustainability

The regression analysis revealed that natural resources had an influence on tourism sustainability. For every unit increase in natural resources, there was a corresponding increase of tourism sustainability. These results were consistent with previous studies examining the influence of natural resources on tourism sustainability. For instance, Kyriakidis and Felton (2008) assert that as weather patterns begin to change, other tourism destinations become new tourist hotspot. Climate change impacts that affect the tourism industry include droughts and floods including rising sea levels.

Biodiversity loss due to prolonged drought had a negative effect on tourism destinations attractiveness, activities and operations. This agrees with Ackerman (2008) that more violent hurricanes will threaten the properties of the local population which can cause social unrest and money that could have gone to poverty alleviation may have to be invested in recovering the damages of climate change.

4.4 EFFECTS OF CLIMATE CHANGE ON TOURISM SUSTAINABILITY

The third objective was to determine the effects of climate change on tourism sustainability.

4.4.1 Community members views on how climate change affect tourism sustainability

Local community members neighboring to MMNR were requested to indicate their opinion on the effects of climate change on tourism sustainability using a five-point Likert Scale. A total of 32 statements were used to determine the community member's views on tourism sustainability and responses summarized using a 5-point Likert Scale. Descriptive statistics, mean and standard deviation were used to summarize the responses as presented in Table 4.16. Most of the respondents 153 (51.9%) agreed that drought and flooding scenarios have increased in the MMNR affecting wildlife population, with 23.1% undecided and 25.1% disagreed (*M=3.23; SD=1.07*). Also, majority of the respondents 149 (50.5%) agreed that flooding and drought scenarios in the reserve seem to result in loss of biodiversity, with 32.9% undecided and 16.6% disagreed (*M=3.43; SD=0.91*).

Table 4.16. Effects of Climate change on natural resource and tourism sustainability

Statement	SA		A		N		D		SD		Mean	STD. DEV.
	F	%	F	%	F	%	F	%	F	%		
Scenarios of drought and floods have increased in the wildlife population reserve	15	5.1	138	46.8	68	23.1	47	15.9	27	9.2	**3.23**	**1.07**
The loss of biodiversity resulting from floods and droughts in the reserve	30	10.2	119	40.3	97	32.9	46	15.6	3	1.0	**3.43**	**0.91**
Higher temperatures decrease the backup food and water supply	58	19.7	162	54.9	52	17.6	13	4.4	10	3.4	**3.83**	**0.91**
Drought and flooding in the reserve will reduce conservation and preservation measures	43	14.6	93	31.5	124	42.0	28	9.5	7	2.4	**3.46**	**0.94**
Because of lower water availability and increased heat there is tree death in the reserve.	44	14.9	94	31.9	122	41.4	33	11.2	2	.7	**3.49**	**0.90**
Such fluctuations in precipitation and temperature on the reserve immediately influence wildlife and plants.	62	21.0	157	53.2	46	15.6	24	8.1	6	2.0	**3.83**	**0.92**
The reserve's wildlife species are vulnerable to changes in precipitation and temperature that contribute to population decreases as well as deaths or changed species.	56	19.0	201	68.1	27	9.2	9	3.1	2	.7	**4.02**	**0.68**
The dry circumstances in the reserve are generating human wildlife conflict and drive lions towards waterholes next to the human settlement.	108	36.6	151	51.2	20	6.8	12	4.1	4	1.4	**4.18**	**0.83**
Species in the reserve have a risk of disrupting seasonal cycles of food production and reproduction during extended dry seasons.	50	16.9	170	57.6	48	16.3	15	5.1	12	4.1	**3.78**	**0.93**
During drought circumstances in the reserve, the danger of increasing fires is expected to raise further pressures for fragile ecosystems	115	39.0	109	36.9	46	15.6	17	5.8	8	2.7	**4.04**	**1.01**
Increasing temperatures in the area impact plant production and grassland composition	40	13.6	157	53.2	68	23.1	25	8.5	5	1.7	**3.68**	**0.87**
Erratic rainfall in the reserve impacts the productivity of vegetation and the composition of grassland species	16	5.4	56	19.0	99	33.6	115	39.0	9	3.1	**2.85**	**0.95**
Drought and floods decrease cover in the reserve vegetation	45	15.3	127	43.1	96	32.5	-	-	27	9.2	**3.64**	**0.85**
Increased temperatures in the reserve influence the abundance and number of plants and animal populations	64	21.7	186	63.1	28	9.5	14	4.7	3	1.0	**4.00**	**0.77**
Increasing temperatures change the distribution of grasslands and ecosystems in the reserve	66	22.4	177	60.0	41	13.9	9	3.1	2	.7	**4.00**	**0.74**
Increasing heat and dryness led to changes in the flow of the river Mara that affected the reserve movement of wild animals	115	39.0	127	43.1	34	11.5	17	5.8	2	.7	**4.14**	**0.88**
Drought and flooding in the reserve will reduce conservation and preservation measures	35	11.9	94	31.9	108	36.6	57	19.3	1	.3	**3.36**	**0.94**
The decrease in vegetation undermines the reserve's tourist sustainability	50	16.9	185	62.7	48	16.3	11	3.7	1	.3	**3.92**	**0.71**
Wildlife decline in the reserve has an impact on tourist sustainability	101	34.2	144	48.8	41	13.9	7	2.4	2	.7	**4.14**	**0.79**
The decrease in natural resources impacts tourism companies' profitability inside the reserve	53	18.0	178	60.3	45	15.3	17	5.8	2	.7	**3.89**	**0.78**
Reserve tourism companies help affect the climate GHGs emissions	62	21.0	107	36.3	98	33.2	20	6.8	8	2.7	**3.66**	**0.97**
Drought and flood harm the reserve's cultural resources	28	9.5	83	28.1	115	39.0	51	17.3	18	6.1	**3.18**	**1.02**
Drought & floods makes tourism in the reserve less viable	54	18.3	147	49.8	64	21.7	23	7.8	7	2.4	**3.74**	**0.93**
Drought and floods in the reserve worsen poverty	53	18.0	130	44.1	82	27.8	27	9.2	3	1.0	**3.69**	**0.91**
New customs and habits while traveling will minimize the reserve carbon footprint	97	32.9	134	45.4	48	16.3	12	4.1	4	1.4	**4.04**	**0.88**
Higher temperatures raise the operating costs, such as reserve heating and cooling	58	19.7	152	51.5	69	23.4	16	5.4			**3.85**	**0.79**
Rapid precipitation patterns decrease the tourism activity range in the reserve	89	30.2	154	52.2	39	13.2	10	3.4	3	1.0	**4.07**	**0.81**
Drought and floods in the reserve decrease guests' length of stay	94	31.9	145	49.2	40	13.6	13	4.4	3	1.0	**4.06**	**0.85**
Drought and floods limit the profitability of reserve tourist companies	57	19.3	135	45.8	87	29.5	15	5.1	1	.3	**3.79**	**0.82**
Infrastructure damages flood conditions in the reserve	142	48.1	116	39.3	25	8.5	9	3.1	3	1.0	**4.31**	**0.83**
Flooding and drought in the reserve impair the capacity of the community to develop rich tourist	59	20.0	136	46.1	80	27.1	17	5.8	3	1.0	**3.78**	**0.87**
Flooding prevents tourist sites from accessing the reserve	120	40.7	124	42.0	32	10.8	13	4.4	6	2.0	**4.15**	**0.92**
Mean											**3.79**	**0.44**

Most of the respondents 220 (74.6%) agreed that rising temperatures are likely to be reducing food and water supply in the reserve with 72.5% undecided and 7.8 % disagreed. Also, majority 219 (74.2%) of the respondents agreed that wildlife as well as vegetation cover are directly affected by such variations in rainfall and temperature with 15.6% undecided and 10.1% disagreed (*M=3.83; SD=0.92*). In addition, majority of the respondents 136 (46.1%) agreed that flooding and drought in the reserve appear to reduce environmental conservation and protection initiatives with 36.6% undecided and 19.6% disagreed (*M*=3.36; *SD*=0.94).

Furthermore, most of the respondents 138 (46.8%) agreed that it is likely that tree mortality in the reserve is due to reduced water availability and higher temperatures, with 41.4% undecided and 11.9% disagreed (*M=3.49; SD=0.90*). Moreover, most of the respondents 257 (87.1%) agreed that wildlife species in the reserve seem exposed to variations of rainfall and temperature leading to either decline in population, mortality or altered species ranges, with 3.8% disagreed and 9.2% undecided (*M=4.02; SD=0.68)*. What is more, most of the respondents 259 (87.8%) agreed that drought situations in the reserve push lions to waterholes adjacent to human settlement causing human wildlife conflict, with 6.8% undecided and 5.5% disagreed (*M=4.18; SD=0.83*).

Furthermore, majority 220 (74.5%) of the respondents agreed that wildlife species in the reserve are vulnerable to longer dry seasons interrupting seasonal patterns of food production and reproduction, with 16.3% undecided and 9.2% disagreed (*M=3.78; SD=0.93*). Most of the respondents 224 (75.9%) agreed that the risk of increased fires is likely to increase during drought situations in the reserve putting further pressure on weakened ecosystems with 15.6% undecided and 8.5% disagreed. Also, majority of the respondents 231 (78.3%) agreed that new travel cultures & behavior would reduce carbon footprint in the reserve with 16.3% undecided and 5.5% disagreed (*M=4.04; SD=0.88*).

In addition, majority of the respondents 197 (66.8%) agreed that rising temperatures in the reserve affects the productivity of vegetation and the composition of grassland species, with 23.1% undecided and 10.2% disagreed (*M=3.68; SD=0.87*). Most of the respondents 172 (58.4%) agreed that drought and flooding reduce vegetation cover in the reserve, with 32.5% undecided and 9.2% disagreed (*M=3.64; SD=0.84*). Also, from the study 250 (84.8%) of the respondents agreed that rising temperatures in the reserve affect plant & animal communities in terms of abundance & population with 9.5% undecided and 5.7% disagreed. In addition, most of the respondents 243 (82.4%) agreed that rising temperatures seem to shift grassland and habitats distribution in the reserve with 13.9% undecided and 3.8% disagreed (*M=4.00; SD=0.7).*

Furthermore, majority of the community members 242 (82.1%) agreed that rising temperatures and drought have led to changes in Mara river flows affecting resident wildebeest's migration in the reserve with 11.5% undecided and 6.5% disagreed (*M=4.14; SD=0.88*). These finding concurs with Dennis (2012) emphasizing that climate change would cause significant decrease in the stream flow of rivers as well as ground water recharge rates in soil water thus leading to higher demand of irrigation water. Moreover, most of the respondents 245 (83%) agreed that a drop in the big five population affects tourism sustainability in the reserve with 13.9% undecided and 3.1% disagreed (*M=4.14; SD=0.79).*

Majority of the community members 235 (79.6%) agreed that there was a decline in vegetation cover that affects tourism sustainability in the reserve with 36.6% undecided and 19.6% disagreed (*M=3.92; SD=0.71).* Also, most of the respondents 231 (78.3%) agreed that decline in natural resources affects profitability of tourism enterprises in the reserve with 15.3% undecided and 6.5% disagreed (*M=3.89; SD=0.78).* In addition, majority of the respondents 169 (57.3%) agreed that tourism enterprises in the reserve contribute to climate change through GHGs emissions with 33.2 undecided and 9.5% disagreed (*M=3.66; SD=0.97).*

Majority of the community members 201 (68.1%) agreed that drought & flooding makes tourism less sustainable in the reserve with 21.7% undecided and 10.2% disagreed (*M=3.74; SD=0.93)*. Also, most of the respondents 183 (62.1%) agreed that drought and flooding situations increase poverty levels with 27.8% undecided and 10.2% disagreed (*M=3.69; SD=0.91)*. Furthermore, majority of community members 210 (71.2%) agreed that rising temperatures increases the cost of operation for example heating and cooling in the reserve with 23.4% undecided (*M=3.85; SD=0.79)*. Moreover, majority of the community members 243 (82.4%) agreed that rapid rainfall patterns reduce the range of tourism recreational activities in the reserve with 13.2% undecided and 4.4% disagreed (*M=4.07; SD=0.81)*. What is more is that most of the respondents 239 (81.1%) agreed that drought and flooding in the reserve reduce the length of tourists stay with 13.6% undecided and 5.4% disagreed (*M=4.06; SD=0.85)*.

Majority of the community members 192 (65.1%) agreed that drought and flooding in the reserve reduce the profitability of tourism enterprises in the reserve with 29.5% undecided and 5.4% disagreed (*M=3.79; SD=0.82)*. Also, most of the respondents 258 (87.4%) agreed that flooding situations in the reserve damage the infrastructure with 8.5% undecided and 4.1% disagreed (*M=4.31; SD=0.83)*. In addition, majority of the community members 195 (66.1%) agreed that flooding and drought scenarios in the reserve reduce the community's ability to create wealth through tourism with 27.1% undecided and 6.8% disagreed (*M=3.78; SD=0.87)*.

Furthermore, most of the respondents 244 (82.7%) agreed that flooding seems to inhibit accessibility of tourist destinations in the reserve with 10.8% undecided and 6.4% disagreed (*M=4.15; SD=0.92)*. Moreover, the community members were not sure whether drought and flooding damage the cultural assets in the reserve with 111 (37.6%) agreed, 39.0% undecided and 23.4% disagreed (*M=3.18; SD=1.02)*. Finally, most of the respondents 124 (42.1%) disagreed

that erratic rainfall in the reserve affects the productivity of vegetation and the composition of grassland species with 33.6% undecided and 24.4% agreed (*M=2.85; SD=0.95).*

From the study, the 32 statements used to measure climate change effects on natural resource and tourism sustainability, natural resources had an overall mean of 3.79 associated with a standard deviation of 0.44. This indicated that most community members agree on the statements used to measure the effects of climate change on natural resource and tourism sustainability in MMNR. From the study findings, the community identified the effects of climate change on natural resource and tourism sustainability occurs through drought, flooding and rising temperatures that reduce food and water supply in the reserve.

The above results agree with Hall *et al.* (2015) in their examination of the potential effects of climate change on the Scottish tourist industry study that concluded that climate changes has affected the pattern of visitor activity and threatened the financial viability of tourism-related enterprises. Hence climate change has the potential to cut off economic, social and environmental benefits of tourism in MMNR. In addition, IPCC (2018) argue that anthropogenic climate change is already adversely affecting and will continue to adversely affect economic activities across the word.

Moreover, Hamilton *et al.* (2005), using Hamburg Tourism Model (HTM), predicts that with climate change preferred tourism destinations would shift to higher latitudes and altitudes and that tourist from temperate climates would spend more holidays in their home countries and therefore decrease worldwide tourism. Thus climatic changes will definitely result in disruption of tourist patterns and affect tourism sustainability. What is more is that the current high and low tourism seasons for MMNR are likely to change due to climate change. It is highly likely that tourist length of stay will be affected. Consequently, tourism benefits such as employment,

diversification of the local economy and improvement of local livelihoods could significantly reduce.

The study sought to examine the relationship between climate change and tourism sustainability in MMNR. Based on the regression model and Table 4.17 the coefficient of determination (R squared) of .395 shows that 39.5% of the variation in tourism sustainability in MMNR can be explained by climate change. The adjusted R square of .392 depicts that all the climate change in exclusion of the constant variable explained the variation in tourism sustainability in MMNR by 39.2% the remaining percentage can be explained by other factors excluded from the model. The standard error of estimate (.449) shows a deviation of the independent variables from the line of best fit.

Table 4.17. Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.628[a]	.395	.392	.44919	.395	190.950	1	293	.000

a. Predictors: (Constant), Climate

The regression model with climate change as a predictor was significant (F=190.95, p value =0.000) shows that there is a significant relationship between climate change and tourism sustainability in MMNR and the slope (β coefficient) is not zero as shown in Table 4.18.

Table 4.18. Climate change and tourism sustainability ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	38.528	1	38.528	190.950	.000[b]
	Residual	59.118	293	.202		
	Total	97.646	294			

a. Dependent Variable: Sustainability
b. Predictors: (Constant), Climate

Therefore, it can be implied that there is a significant relationship between tourism sustainability in MMNR and climate change. Thus, rejecting the null hypothesis as predicted that there is no significant relationship between climate change and tourism sustainability in MMNR. The study hypothesized that there is no significant influence of climate change on tourism sustainability in MMNR.

The study findings depicted that there was a positive significant relationship between climate change and tourism sustainability in MMNR (β_1=0.818 and p value<0.05) as shown in Table 4.19. Therefore, a rise in climate change leads to an improvement in tourism sustainability upto the optimum level. Beyond the optimum levels characterized by either drought or flooding, tourism sustainability is negatively affected. Since the p value was less than 0.05 the null hypothesis was rejected and the alternative hypothesis accepted. Therefore, climate change had a significant influence on tourism sustainability in MMNR.

Table 4.19. Climate change tourism sustainability regression coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1.249	.203		6.145	.000		
	Climate	.818	.059	.628	13.818	.000	1.000	1.000

a. Dependent Variable: Sustainability

The study found out that there was a positive significant effect of climate change and tourism sustainability in MMNR. This agrees with Dzoga and Koske, (2014) that a stable climate system is essential for prosperity of various economic activities because most of the economic activities in Africa such as agriculture, fishing and tourism are dependent on a stable climatic system. Frangialli (2005) asserts that tourists are attracted to the Mediterranean coasts and tropical islands

by ample sunshine, warm temperatures and little precipitation, escaping from harsher weather conditions and seasons in their home countries.

The findings of this study agree with previous studies (Kozak, 2002; Martín & Belén, 2005; Scott, 2008) that present climate as either the most or one of the most important factors that tourists consider when choosing a travel destination. Conversely, climate change phenomena have threatened the future of these economic systems. This also concurs with Hall *et al.* (2015) that a relationship exists between the changing climate and the tourism sector, in that climate change impacts on tourism whilst tourism impacts on climate change. For a fact, majority of tourism activities are dependent on weather conditions. Weather condition factors such as rain, storms, floods, hours of sunshine, temperature and humidity influences tourism activities for instance on a rainy day it was impossible to undertake a wildlife safari.

4.5 NATURAL RESOURCES MEDIATION EFFECT ON THE RELATIONSHIP BETWEEN CLIMATE CHANGE AND TOURISM SUSTAINABILITY

4.5.1 Multiple Regression Assumptions results

Before regression analysis was performed, the assumptions concerning the data must be made and the assumptions used in the research included: normality, linearity, homoscedasticity and multicollinearity. They were determined using SPSS statistical software. The results are presented below.

4.5.2. Normality

The assumption is based on the shape of normal distribution and gives the researcher knowledge about what values to expected (Keith, 2006). The researcher tested this assumption by checking

the histograms of the standardized residuals. The histograms of the residuals had a superimposed normal curve as shown in Figure 4.16.

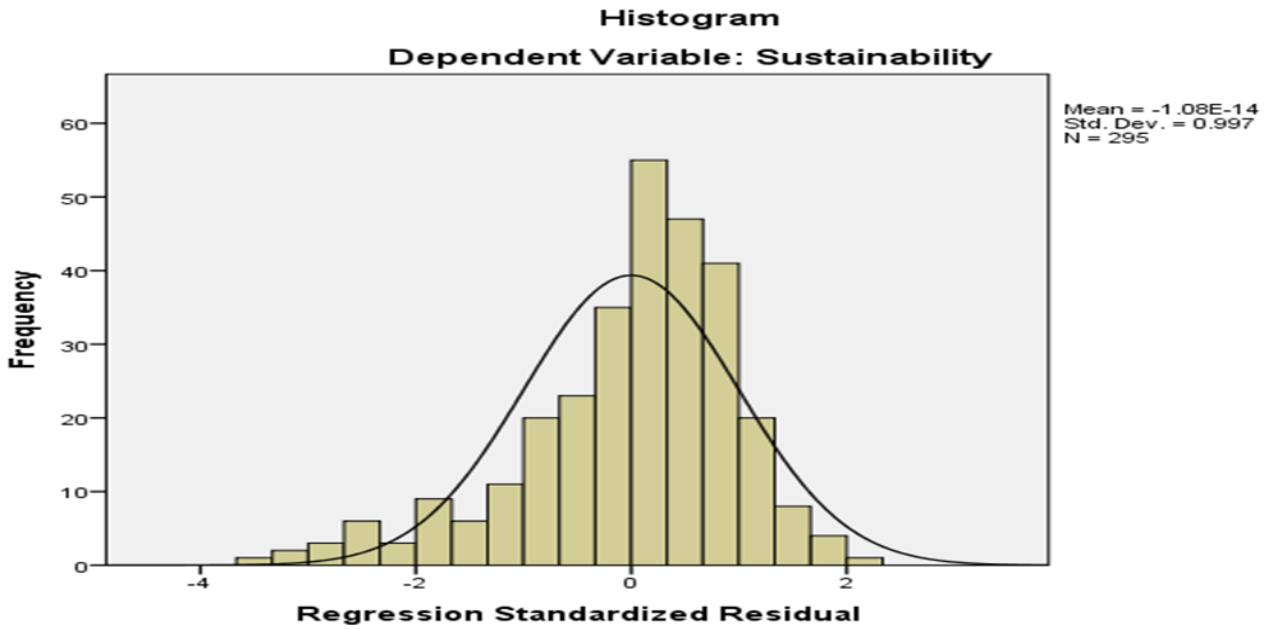


Figure 4.16. Normality

4.5.3. Linearity

Multiple regressions can accurately estimate the relationship between dependent and independent variables when the relationship is linear in nature (Osborne & Waters, 2002). Residual plots showing the standardized residuals and the predicted values were used to establish linearity as shown in Figure 4.17.

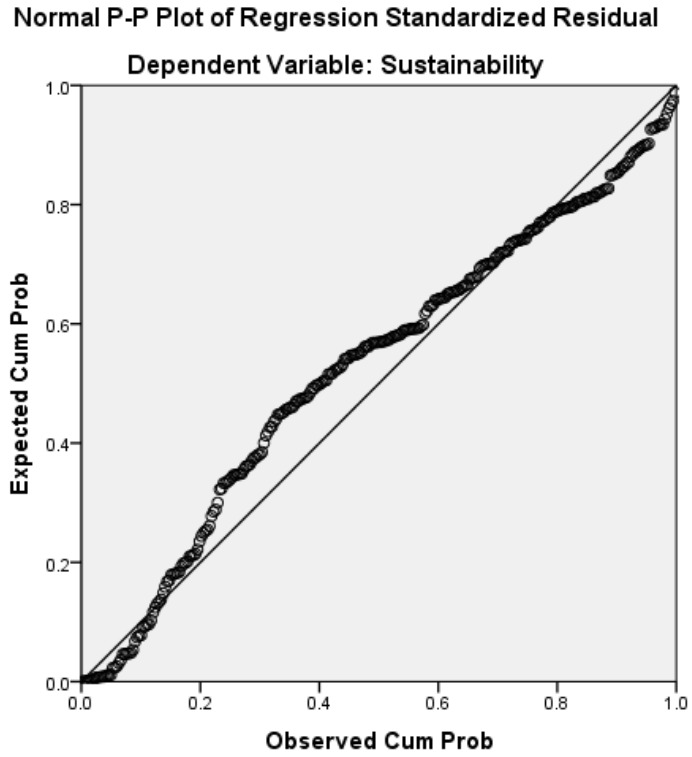


Figure 4.17. Linearity

4.5.4. Homoscedasticity

The SPSS statistical software scatterplots of residuals with independent variables was used to examine this assumption (Keith, 2006). The result shows standardized residuals concentrated in the center (around 0) and their distribution is rectangular. This is an indication that the variance of the residuals about the dependent variable scores are the same, an indication that homoscedasticity is not a problem. Homoscedasticity was checked using the standardized residual scatter plot as indicated in Figure 4.18.

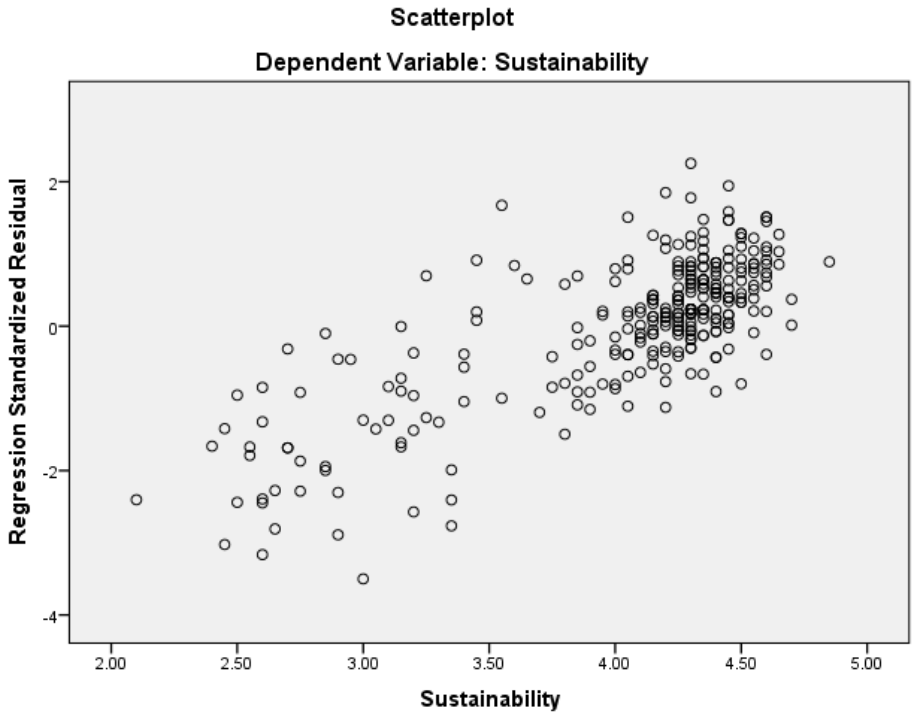


Figure 4.18. Homoscedasticity

4.5.5. Multicollinearity

Multicollinearity occurs when several independent variables correlate at high levels with one another or when one independent variable is a near linear combination of other independent variables (Keith, 2006). SPSS statistical software packages collinearity diagnostics was used to measure the degree to which each variable is independent of other variables. Tolerance and Variance Inflation Factor (VIF) statistics were used to carry out the diagnosis. The rule of thumb for VIF value should be less than ten and tolerance should be greater than 0.2 (Keith, 2006). Small values for tolerance and VIF showed no multicollinearity as shown in Table 4.20.

Table 4.20. Multicollinearity

Model		Collinearity Statistics	
		Tolerance	VIF
1	(Constant)		
	Natural resource	.863	1.159
	Climate change	.863	1.159

a. Dependent Variable: Sustainability

4.6. MEDIATION EFFECTS OF CLIMATE CHANGE AND NATURAL RESOURCES ON TOURISM SUSTAINABILITY

The fourth objective was to examine the mediation effect of climate change and natural resources on tourism sustainability. The independent variable representing climate change was computed and denoted climate as an independent variable. It is already established from the literature that climate change influence tourism sustainability. However, the mechanism is unknown. Therefore the study hypothesized that one of the mechanisms is natural resources.

The mediation effect of natural resources was conveniently tested using a special PROCESS Macro tool developed by Hayes (2013) using the regular linear regression menu item in SPSS application version 22. PROCESS Macro tool is an inbuilt measurement tool with a bootstrapped confidence interval request procedure prescribed by Hayes and Preacher (2014). Mediation effect was tested since the data met the assumptions prescribed by Hayes (2014). The four stages of the mediation process were followed as shown below;

1. Confirmed the significance of the relationship between climate change and tourism sustainability (X → Y) (Figure 12) and depicted in Table 4.21.
2. Checked and confirmed the significance of the relationship between climate change and natural resources (X → M)

3. Ascertained the significance of the relationship between the natural resources and the tourism sustainability in the presence of climate change (M|X → Y)
4. Examined whether the insignificance (or the meaningful reduction in effect) of the relationship between climate change and the tourism sustainability in the presence of natural resources (X|M → Y) is there.

The first part of the output indicates all variables in the analysis as hypothesized – the dependent variable TS→ (Y), independent variable climate change (Climate) → (X) and mediator natural resources (NR) → (M). The natural resources mediation effect on the relationship between climate change and tourism sustainability was checked by establishing the indirect, direct and total effect.

4.6.1. Total effect

This was assessed by determining the relationship between climate change and tourism sustainability (Table 4.21). The model results showed R^2=0.395 and was significant (p=0.000) an indication that climate change predict 39.5% of tourism sustainability. In this mediation model, the regression of climate change on tourism sustainability ignoring the mediator was significant, β = 0.818, t (293) = 13.82, p = <.000.

Table 4.21. Total Effect Model (Outcome: Tourism sustainability)

Model Summary

	R	R-sq	MSE	F	df1	df2	p
	.628	.395	.202	190.950	1.000	293.000	.000
Model							
	coeff	se	t	p			
constant	1.249	.203	6.145	.000			
Climate	.818	.059	13.818	.000			

This finding meant that a unit increase in climate change influences tourism sustainability by .818. It implies that climate change significantly influences tourism sustainability as shown in Figure 4.19 below. Substituting the equation with the results gave equation 4.1 thus;

Tourism sustainability=1.25+.818climate +.203.....(4.1)

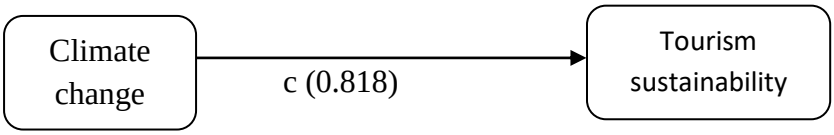


Figure 4.19. Analytical Model (Total effect)

4.6.2. Direct effect

The effect of climate change on natural resources was sought for the purpose of objective No.1. Table 4.22 indicated that the R^2=0.137 and was significant (p=0.000). Therefore, climate change predicts 13.7% of natural resources. From the mediation regression model, the effect of climate change on natural resources, was significant, $\beta = 0.480$, $t(293) = 6.83$, $p = <.000$.

Table 4.22. Model summary (Outcome: Natural resources)

	R	**R-sq**	**MSE**	**F**	**df1**	**df2**	**p**
	.371	.137	.284	46.697	1.000	293.000	.000
Model							
	coeff	se	t	p			
constant	1.996	.241	8.277	.000			
Climate	.480	.070	6.834	.000			

From these findings a unit increase in climate change causes 0.480 units increase in natural resources. Thus, climate change significantly contributes to the natural resources. Substituting equation with the results becomes equation 4.2 thus;

Natural resource = 1.996 + .480Climate +0.241….....(4.2)

4.6.3. Indirect effect

The indirect effect of natural resources on tourism sustainability, as well as the effect of climate change on tourism sustainability controlling for natural resources was sought. The model results [β = 0.184, t (292) = 3.83, p = <.000] as shown in Table 4.23. This indicated that natural resources controlling for climate change predict 42.3% of tourism sustainability. Further, the analysis revealed that, the effect of climate change on tourism sustainability controlling for natural resources was also significant, [β = 0.730, t (292) = 11.71, p = <.000].

Table 4.23. Indirect Effects Model Summary (Outcome: Tourism sustainability)

	R	**R-sq**	**MSE**	**F**	**df1**	**df2**	**p**
	.651	.423	.193	107.249	2.000	292.000	.000
Model							
	coeff	se	t	p			
constant	.881	.221	3.994	.000			
Natural	.184	.048	3.828	.000			
Climate	.730	.062	11.710	.000			

Though the indirect effect remained significant at 0.730, it reduced from 0.818 in model I (total effect). Substituting equation with the results becomes equation 4.3 thus;

Tourism sustainability=$.881 + .730climate + .184RU + .221$ .....(4.3)

This finding revealed that, controlling for the mediator (Natural resources), climate change remained a significant predictor of tourism sustainability, as denoted [c' = 0.730, t (292)], however the magnitude dropped from 0.818, this confirms the presence of partial mediation (Edwards and Lambert, 2007; Kenny and Baron, 1986). Figure 4.20 depicts the analytical mediation framework.

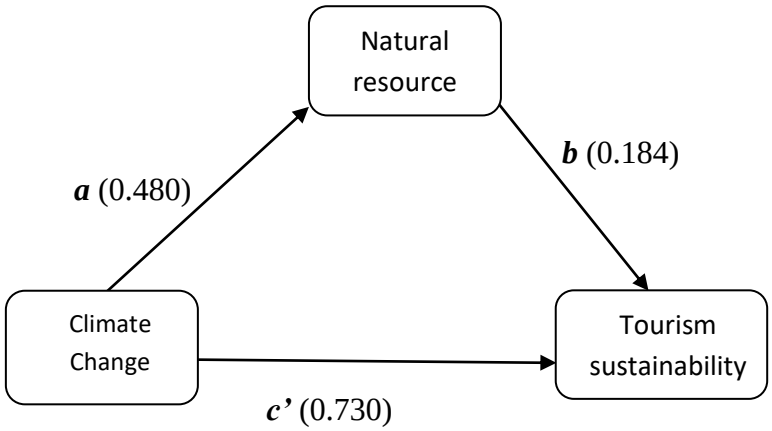


Figure 4.20. Analytical Model; Direct and indirect effect

4.6.4. Confirming mediation effect

Muller *et al.* (2005) suggested a confirmation of the existence of an equity relationship among the parameters of the models (Figure 4.14). The strength of the mediation was worked out from the Total effect as shown in Table 4.28. The mediating effect of natural resources was obtained as a product of two indirect paths of tourism sustainability (TS) denoted as *a* and *b* (Figure 4.10) which is equivalent to total effect minus direct effect. This confirms the figures given by regression output on Figure 4.10 above. This figure conforms to regression figure given in Table 4.24.

Indirect effect=*a* x *b* → (0.480 x 0.184) = 0.088= c-c'= (0.818-0.730) =0.088.

Table 4.24. Total, Direct, and Indirect Effects

Effect of X on Y	Total	Direct	Indirect
Effect	.818	.730	.088
SE	.059	.062	.038
T	13.818	11.71	
P	.0000	.0000	
LLCI			.020
ULCI			.167

A bootstrap procedure was used to test statistical significance of indirect effect in mediated models. It provides a 95% confidence interval for the value of the indirect effect *ab* in terms of unstandardized coefficients. The lower limit of confidence interval was .020 and the upper limit was .167. Since the confidence interval does not include zero at p <0.05, the null hypothesis **(HO_4)** that *ab* = 0 was rejected.

4.6.5. Normal theory tests for indirect effect

A sobel test is also given in the regression output showing partial mediation in the model [Z= 3.313, p = .0001] Table 4.25. This implies that natural resources are not the single dominant mediator, there may be other mediating variables through which climate change might influence tourism sustainability. Therefore, the hypothesis (**H_{O4}**) stating that natural resources do not mediate the relationship between climate change and tourism sustainability is rejected.

Table 4.25. Normal theory tests for indirect effect

Effect	se	Z	p
.088	.027	3.313	.001

Natural resources were found to be not a single dominant mediator through which climate change might influence tourism sustainability. This agrees with Becken (2007) that, there are multiple interactions between tourism and climate; climate is both a resource for the tourism experience and a risk. This agrees with Gossling and Scott (2018) assertion that climate change is one of the most serious threats and is likely to have the greatest long-term impact. Impacts are caused by changing weather patterns and, in some cases, fire events causing large scale and irreversible changes to plant and animal communities and the scenic values they provide. It is also likely that the impacts will generate large-scale disturbances in many tourism markets.

The findings also concur with Valls (2009) who states that climate change is projected to indirectly impact on tourism businesses and the social, political and economic environmental context in which tourism takes place at the destination level, by having a critical influence on health, water availability, food systems, and systems of production. These revelations also agree with Rogerson (2016) that the outcomes may serve to drastically change the tourism landscape within many communities, particularly in areas with high levels of poverty where conflict over access to essential resources is exaggerated by stresses related to climate change. This agrees with Pandy (2017) that climate change is projected to fundamentally alter or undermine the natural resource base upon which many forms of tourism are built and rely.

The findings of this study also agree with Gössling *et al.* (2010) that tourists choose destinations that they consider to have a favorable climate, whilst tourism uses environmental resources and contribute to climate change. As a result of climate change being recognized as a growing problem, increased attention is being focused on how particular tourist destinations can adapt in order to minimize the risks whilst maximizing opportunities particularly for the economy (Becken, 2010).

Therefore, natural resources are the foundations of the tourism industry. Favorable climate conditions (rainfall and temperature) support natural resources (vegetation and wildlife) and consequently viability of the tourism industry (socially, economically, environmentally) forming a system in totality that must work optimally. This forms systems theory that underpins this study and is supported by the study results. Climate change through variations in rainfall and temperature patterns as upheld by the showcased results have the potential to affect vegetation as the results indicate. Consequently, with projections of rising temperatures causing increased frequency of extreme events of flooding and drought, wildlife populations will decrease with reduced vegetation negatively affecting the sustainability of the tourism industry.

4.8. QUALITATIVE DATA RESULTS FROM INTERVIEWS WITH EXPERTS AND TOURISTS

4.8.1 Objective one: Climate change effects on natural resources

The study findings indicated that majority of them were from; East Africa, South Africa, United States of America (USA) and Europe. Also, there were domestic tourists travelling from various parts of the country to MMNR. All the tourists interviewed had visited MMNR for more than five times because of its excellent attractions compared to other destinations in the country. The study assumed that tourists with higher number of frequency of visits are highly likely to provide accurate information on climate change, natural resources and sustainability of tourism in MMNR.

Findings indicated most of the tourists observed reduced water flows in the Mara River during the dry season. Moreover, the tourists specified that the likely cause for reduced river Mara water level is due to the prolonged droughts throughout the years unlike the past. Furthermore, the findings suggest that one of the factors that determine tourist's visitation is time when there is great wildebeest migration that falls on the dry season; however, rainfall patterns have changed and remain unpredictable. One of the tourists interviewed reported, *Most times, my visits are scheduled for the month of June - August which experiences no rains or less rains, therefore less inconveniences compared to the rain seasons. Being aware of the weather and climate conditions therefore makes* MMNR *become the more preferable tourist attraction site in Kenya.*

Furthermore, the tourists reported various reasons how rising temperatures affects their stay in MMNR. The study findings indicated that during the months of June and August when the tourist's visited MMNR, the temperatures were high, therefore the tourists were not able to spot some of the wildlife especially the wild cats for instance Leopard and Cheetah and most of them would hide in the forests or shrubs and this forced some of them to reschedule their visits and

game drive programs. These findings agree with Hoogendoorn *et al.* (2016), Moreno and Becken (2009) who argue that climate and weather conditions may enable or limit tourist's participation in certain tourism activities.

With rising temperatures, most wildlife especially the Big five and wild cats are hardly seen or located. The tourists reported that the rising temperatures forced them to put more efforts to see the wild cats that went into hiding because of high temperatures. One of the interviewed tourists stated that ... *With high temperatures, I'm forced to reschedule my game drives from morning to evening hours with low temperatures.* Further, study findings indicated that most of them had not experienced flooding conditions during their visits.

However, one of the tourists reported; *With flooding, I was unable to visit some crucial wildlife sites in MMNR. My first-time experience with flooding was when travelling to and from an airstrip, it was problematic because of flooding and the flight booked was cancelled.*

Fourteen experts on climate change, natural resources and tourism sustainability were interviewed through face to face method on various aspects of the study. The study findings disclosed that most of the interviewed experts pointed out that rainfall and temperature variability in terms of volume and intensity as well as time are key indicators of climate change in Kenya. One of the experts reported: *Rainfall variability for example unexpected rainfall in terms of volume, intensity as well as timing including temperature variations are key indicators of climate change in Kenya.*

Furthermore, the study findings revealed that some of the climate change effects strongly evident in Kenya is reduced agricultural productivity as one of the interviewed experts stated: *"... traditional harvest from maize farming has been reducing per acre of land and simultaneously year after year, traditional foods such as sweet potatoes are no longer grown as before due to frequent flooding that washes the sweet potatoes away.*

Findings from the experts views also indicated that flooding affects wildlife population through washing away vegetation cover leaving behind bare ground with no or very little vegetation with low nutrient for survival of the herbivore for instance the wildebeest. This phenomenon results in death and reduction of herbivore species in the reserve including migration. Additionally, drought cyclones have become shorter and cause less food or vegetation in the reserve leading to death as well as migration of the big five. The study findings indicated that climatic changes affect natural resources for example variations in rainfall patterns affect the quality as well as quantity of vegetation that is crucial for the survival of herbivore such as the wildebeest. This agrees with the literature reviewed (Dube and Nhamo, 2020; Okello *et al.,* 2016) that availability and abundance of vegetation is highly likely to determine herbivore population.

Furthermore, drought and flooding scenarios affect tourism experiences by reducing wildlife population as one of the experts reported: *Tourism experience is not only affected by drought/flood, other factors affects the population of wildlife and the decline in population may not only be attributed to flood/drought but a combination of factors*.

The above findings agree with several previous studies, for instance Funk *et al.* (2008), that reveal that droughts became more severe during 1970-2006 in eastern and southern Africa. This agrees with some of the local communities who stated not to have experienced frequent floods in MMNR. Additionally, Ogutu *et al.* (2016) study observed striking rise in temperature in MMNR that coincides with the tourists interviewed who reported they had experienced rising temperatures in MMNR. Rising temperatures is highly likely to expose tourists to heat stroke and increased the need of air conditioning for tourism facilities in MMNR. Tourism activities such as wildlife safari are likely to be negatively affected by rising temperatures. This is because it is difficult to spot wildlife while in a game drive when temperatures are high as wildlife take cover.

Furthermore, the above findings concur with Bartzke *et al.'s* (2018) study that found out inter-annual variation in the wet season and dry season rainfall components in the Mara in which from 1917 onwards there was a decreasing trend in the annual rainfall component that switched to an increasing trend in 1935, after which rainfall increased from a low of about 600 mm to a high of about 850 mm in 1962, thereafter rainfall declined persistently to about 700 mm in 2015.

The study findings concur with Aduma *et al.* (2018) asserting that global land surface warming and increasing temperature events are expected to occur more frequently and more extremely causing changes in biodiversity and altering movement and survival of large herbivores. This is revelations approve some of the tourists interviewed who reported to have experienced changes in climate by virtue of increasing temperatures and reduced vegetation in the reserve. Climate change is predicted to have a major impact on flora and fauna geographical distribution (Ceballos *et al.,* 2017). As such, large wild terrestrial herbivore species are facing dramatic population declines and range contractions and nearly 60% are already threatened with extinction (Ripple *et al.,* 2015).

The Intergovernmental Panel on Climate Change (IPCC) report of 2007 indicates that, for every 1˚C rise in international mean temperature roughly 10% of species are likely to be exposed to disappearance risks (IPCC, 2007). Species disappearance especially for the big five would definitely negatively impact the sustainability of the tourism industry in Kenya now that extreme wildlife disappearances have already been reported by current studies. In fact, a study by Dube and Nhamo (2020) conducted in Serengeti National Park revealed that rainfall and temperature changes have been blamed for the loss of biodiversity and for altering seasonality in the reserve which could result in severe financial losses.

The ecosystems in the world are expected to experience varying stress from climate change impacts (Aduma *et al.,* 2018). Species responses include toleration, habitat shift or extinction that

are outcomes of exceeding species tolerance level of water and temperature stresses (Cahill *et al.,* 2012). Countless species are now being driven to change their geographic distributions and behavior as they respond to life threatening weather patterns that are associated with human induced climate change (Monzón *et al.,* 2011). As they respond to change in climatic conditions, species tend to increase, decrease, or shift their range subject to their tolerance thresholds (Monzón *et al.,* 2011). These changes would affect wildlife abundance hence a direct impact on the tourism industry.

Changes in seasonal natural life related events (phenology) such as plants flowering are also linked to climate change effects (Cahill *et al.,* 2012). These phenological changes affect migrant species which move around from one place to another in search for food, water and avoidance of poachers and predators (Aduma *et al.,* 2018). These species depend on environmental initiates like temperature and rainfall (Dunlop and Brown, 2008). Therefore, variations in temperature and rainfall patterns have the potential to affect wildlife population dynamics through which the tourism industry in Kenya thrives. Decline in wildlife population will definitely negatively impact sustainability of the tourism industry.

While there is fairly inadequate evidence of current extinctions being caused specifically by climate change alone, investigations insinuate that climate change could surpass habitat destruction as the greatest global threat to biodiversity over the next few decades (Leadley *et al.,* 2010). Changes in biodiversity is highly likely to negatively influence sustainability of the tourism industry especially in Kenya as the tourism industry is heavily nature based. Nature based tourism industry will not escape the consequences of a changing climate. There is a high likelihood that socioeconomic and environmental benefits of tourism would shift or reduce in protected areas hence severely affecting sustainability of tourism into the future.

4.8.2 Objective two: Natural resources effects on tourism sustainability

The study findings indicated that tourists visited MMNR because it is rated among the best tourism attractions with the yearly migration pattern of wildebeest known as 7th wonder of the world. This opinion is supported by one tourist who stated that: *The main reason I visited the Maasai Mara is the crossing of the River Mara by wildebeest.* Furthermore, the tourist's opinion on wildlife population especially the big five during their visits to MMNR was varied.

The tourists interviewed indicated that the Big five population is likely to have reduced compared to previous visits. As one of the tourists reported that: *During his forth visit; it was a big struggle for me to see the big five compared to my earlier visits.* Also, the study findings with tourists suggested that most of the tourists are likely to have observed reduced vegetation cover. Based on these findings, one can conclude that reduced vegetation cover is attributed to the effects of climate change on natural resources. These findings concur with previous findings in subtopic 4.2.3.

It was further established that the tourist had varied opinions on wildlife and vegetation conservation initiatives. Based on the findings, it is highly likely that wildlife and vegetation has reduced due to combined cause factors including climate change effects. Reduction of forest cover within MMNR was also observed by the tourists. Therefore, declining vegetation cover are some of the indicators of climate change effects that contribute to the decline of wildlife. These revelations concur with Ogutu *et al*. (2016) citing wildlife declines in protected areas as a result of climate change among other factors.

Furthermore, there was a high likelihood that the reduction of river Mara water level during dry seasons could be as a result of combined cause factors such as climate change, human encroachment by destruction of forests and the water catchment areas. What is more is that extreme events such as drought and flooding have intensified in the reserve. These events have

increased from seven events in a year in the 1990's to ten events in a year between 2000 and 2006 (Otieno *et al.,* 2017). Consequently, wildlife population definitely reduces with such events thereby negatively affecting the tourism industry and its sustainability.

Based on the study findings, one can conclude that rising temperatures could be attributed to changes in climate through human encroachment activities including burning of fossil fuel that increase carbon dioxide levels in the atmosphere. This finding concurs with Kilungu *et al.'s* (2019) study that notes that increasing temperatures on Mount Kilimanjaro has negatively affected aesthetics of the mountain due to a reduction in snow, waterfalls as well as wildlife population, hence fewer tourists' visits. Therefore, the sustainability of the tourism industry is in jeopardy.

The experts decried a dire need for more sustainable tourism actions to be carried out by county and national government as well as tourism stakeholders in order to restore the wildlife/vegetation conservation. MMNR stakeholders had the willingness and desire to protect wildlife and vegetation. The MMNR stakeholders had initiated plans, activities that aim at promoting sustainable tourism. Wildlife and vegetation conservation initiates in MMNR should be a top priority as the reserve accounts for 30% of the Country's wildlife resource and a significant source of wealth for the country (GoK, 2019).

4.8.3 Objective three: Climate change effects on tourism sustainability

Findings indicated that the ideal climate conditions that prompt tourist to visit MMNR was during the dry seasons and especially between the months of June and August. Furthermore, majority of the tourists agreed that favorable climate conditions prompt the tourists to visit MMNR. Tourists visited MMNR during the dry period because most tourist attraction sites are more accessible. Also, the findings suggest that conducive weather conditions for a game drive is likely during the

month of June-August, since there is no inconvenience caused by rains and flooding. Based on the findings, it is possible to conclude that during the months of June and August, MMNR had little or no rains. Therefore, the period was convenient for the tourists.

Furthermore, the study findings indicated that most tourists agreed to have experienced rising temperatures above normal during their visit(s) to MMNR. This finding agrees with Dube and Nhamo's (2020) study that found out that due to high temperatures there are high chances of tourists and employees to suffer from heatstroke and other heat related challenges hence a need to reschedule some of the tourist activities particularly those that take place during peak temperature periods of the day. Surprisingly, the study findings indicated that rising temperatures and drought situations did not reduce their length of stay.

Therefore, extreme climate conditions as a result of climate change have the possibility to cause disruption in tourist's visitation and participation in tourism activities leading to an unsustainable tourism industry. This is possible as climate change through extreme weather events such as drought and flooding are predicted to become more frequent and severe, implying tourism activities will definitely be disrupted through unavailability of favorable climate and weather conditions.

Based on these findings, it is possible to conclude that tourists avoid visiting MMNR during the rainy seasons to avoid flooding conditions. Additionally, it is very possible that flooding conditions affect tourists' stay during the rainy seasons as some areas are not accessible, therefore limiting the viewing of a variety of wildlife. Furthermore, the study findings suggest that flooding conditions inconveniences the tourists' daily programs for game drives and transfers. Consequently, during flooding tourists are unable to access their destinations as planned and some hotels close down due to flood waters, for example the case in Nigeria (Dube and Nhamo, 2020).

The study findings from the tourists suggest that all the tourists visiting MMNR had experienced the effects of climate change. The tourists reported to have experienced changes in weather and climate conditions as they reported change in rainfall patterns compared to the past visits. This finding agrees with Tierney *et al*. (2015) which asserts that majority of climate models predict devastating droughts in the long rain season (March-May) and increasing rainfall in the short rain period (October-December).

The study findings established that the nature of interaction of tourists and the local communities was good. The study findings also established that the local communities were proud about their culture. The tourists rated the nature of the interaction with the local communities to be great: they were able to learn about the Maasai culture, the beads items and importance of wildlife in their life. Some of the tourists interacted with local communities and learnt about the Maasai's lifestyle through various activities such as entertainment with local songs, eating cultural foods and drinks. The interaction was diverse and based on cultural significance of beadings and socioeconomic benefits they have gained from tourism.

One of the tourists reported: *The interaction was so much inclusive and therefore was able to learn a lot about their culture, lifestyle and their passion for wildlife. My interaction with the local was one of its kind, the community was so friendly, kind and appear more attractive to the tourists. I was able to learn a lot about the community through their lifestyle, cultural activities, beads and their perception about wildlife.*

Other tourists responded as below:

My interaction with the local community remained an indelible one because I was able to acquire more information on lifestyles and culture.

During my all visits to the MMNR I have visited the Manyatta's where I was able to exchange a lot with the locals about their culture, I was given a lot of milk to drink and involved in beading activities.

I was able to learn a lot about the communities through their lifestyle, cultural activities, beads and their perception about wildlife.

The tourists were able to learn and acquired more information about Maasai lifestyles, cultural activities, beads their perception on wildlife conservation. These reveal the socio-economic as well as environmental importance of tourism in uplifting the host community livelihoods. However, based on the study findings climate change impacts has the potential to reverse tourism benefits to local communities.

The experts understanding of sustainable tourism was sought and the findings indicated that sustainable tourism refers to conducting today's tourism in a manner that future generations will also be able to have the same ability to generate same benefits from tourism. What is more is that, the experts were in concurrence that climate change influences sustainability of tourism in terms of wildlife population in that climate change impacts are more when there are no proper land use plans and where there are proper land use plans, the impact is less.

Also, the experts stated that climate change has the potential to influence economic sustainability of tourism in terms of income and revenue accrued from tourism for example tourism attractions built along flood prone areas are likely to close down like the case of Serena camp hence reduced/little income and its associated benefits. The experts further argue that changes in climate have the potential to cause loss of tourism destinations and complete alterations of tourism attractions hence negatively affecting tourism sustainability.

The findings presented have the potential to impact the tourism industry and its sustainability. Declines in wildlife population would mean reduced tourist arrivals and consequently a decline in

tourism related benefits including revenues. Host communities depending on tourism as a source of livelihood will be affected. In such a scenario, the ability of tourism to generate beneficial benefits to its stakeholders will not be possible as wildlife that supports the tourism industry would be on the decline due to climate change related factors. It is possible that more environmental conflicts may arise as communities respond for alternative source of livelihoods due to the collapse of the tourism industry.

The experts also suggested that some of their efforts to address climate change effects include; generation of knowledge that prepares the tourism industry to be responsible businesses, capacity building and working with communities. The experts also proposed the following climate change and adaptation strategies; tourism product diversification, capacity building, working with communities as well as County Governments, going back to wide range conservation ways of water conservation to slow and reduce high evaporation so as to slow climate change, wide range ecological restoration., water restoration, water conservation as open dams are not the best way forward due to high evaporation underwater dams need to be started.

4.8.4 Thematic analysis

Qualitative data were analyzed using thematic framework analysis in order to generate themes from the sub-themes identified. A discussion on every theme was then discussed as per the objectives of the study. Themes as well as sub-themes were identified and generated from the experts as well as tourists whom were interviewed by the researcher on the effects of Climate change on natural resources. The themes are tabulated in Table 4.26.

Table 4.26. Objective one; Climate change effects on natural resources and tourism sustainability

Objectives	Sub-themes	Emerging themes
Rainfall ▪ **Reduced water flows in the Mara river during the dry season** ▪ **Rainfall patterns have change and remain unpredictable characterised flooding and drought events**	▪ Prolonged droughts throughout the years unlike the past is the likely cause for reduced Mara river in dry season ▪ Human encroachment by destruction of forests and the water catchment areas contribute to variations in rainfall patterns ▪ Flooding affects wildlife population through washing away vegetation cover leaving behind bare ground with no or very little vegetation and low nutrient ▪ Rise in human population and human encroachment including destruction of the river Mara water catchment areas are the primary causes unpredictable rainfall patterns	▪ Droughts and floods cause wildlife mortality resulting to reduced wildlife population ▪ Reduced rainfall causes scarcity of vegetation in the reserve leading to death as well as migration of wildlife ▪ Changes in rainfall patterns results in difficult to predict the great wildebeest migration
Temperature ▪ **Tourists reported to have experienced high temperatures above normal compared to their previous visits** ▪ **Temperatures were high on the months of June and August when the tourist's visited MMNR** ▪ **Extreme climate conditions (flooding and drought) as a result of climate change have intensified in MMNR**	▪ High temperatures imply high chances of tourists and employees to suffer from heatstroke ▪ With high temperatures, tourists were not able to spot some of the wildlife especially the wild cats for instance Leopard and Cheetah and most of them would hide in the forests or shrubs	▪ Climate and weather conditions enable or limit tourist's participation in certain tourism activities ▪ Disruption in tourist's visitation and participation activities leading to rescheduling of tourist activities (visits and game drive programs) disrupted by high temperatures during the day ▪ Reduced attractive tourism destinations due to flooding/drought events ▪ Drought and floods are predicted to become more frequent and sever ▪ High operational costs for tourism operators such as lodges posed by the need for air conditioning and cooling facilities and services

Table 4.27. Objective two and three: The effects of natural resources and climate change on tourism sustainability in MMNR

Objectives	Sub-themes	Emerging themes
Wildlife ▪ **Wildlife population decline with flood/drought events**	▪ Wildlife population declines negatively affects the tourism industry and its sustainability ▪ Variations in rainfall patterns affect the quality as well as quantity of vegetation that is crucial for wildlife survival	▪ Tourists keep off tourism sites that have no wildlife hence directly influencing livelihoods supported by tourism in affected areas ▪ The tourism industry is highly likely to be unsustainable with declines in wildlife population ▪ Livelihoods of local communities dependent upon tourism revenue is negatively impacted by reduced visitation
Vegetation ▪ **Decline of vegetation cover is highly likely caused by variations in rainfall and temperature patterns**	▪ Contribute to the decline of wildlife population ▪ Increased human-wildlife conflict	▪ Drought and flooding scenarios affect tourism experiences by reducing wildlife population ▪ Climate change through (drought and flooding) influences sustainability of tourism in terms of reduced aesthetics of the tourism attractions ▪ Reduced aesthetics of tourism attractions has the potential to cause a decline in tourist's numbers in the reserve. This is likely to negatively affect sustainability of tourism
Rainfall/temperature ▪ **Favorable climate conditions seem to prompt the tourists to visit MMNR** ▪ **Ideal climate conditions that prompt tourist to visit MMNR was during the dry seasons and especially between the months of June and August** ▪ **During the months of June and August, MMNR had little or no rains** ▪ **During the dry season most tourist attraction sites are more accessible** ▪ **With little or No rains its convenient for tourists as they are able to access MMNR with ease, no inconvenience caused by rains and flooding tourists avoid visiting MMNR during the rainy seasons in order to avoid flooding conditions** ▪ **Flooding conditions affects tourists stay during the rainy seasons as some areas are not accessible therefore limiting the viewing of a variety of wildlife**	**Social** ▪ Sustainable tourism aims to; ensure long-term operations providing social benefits/services (social amenities, infrastructure development ▪ Respect to socio-cultural authenticity of host communities by conserving built and living cultural heritage and tradition **Economic** ▪ Stable employment and income earning opportunities ▪ Tourism attractions built along flood prone areas close down during flooding hence incurring business loss ▪ Flooding conditions inconveniences the tourists' daily programs including game ▪ Due to flooding tourists are unable to access tourism destinations as planned and some hotels close down due to flood waters.rives and transfers **Environmental** ▪ MMNR stakeholders had the willingness and desire to protect wildlife and vegetation • Sufficient, permanent initiatives need to be in place to cater for adequate management of wildlife and vegetation in the advent of climate change • Maintain essential ecological processes and that help to conserve natural heritage and biodiversity	• Efforts to address climate change effects include; generation of knowledge that prepares the tourism industry to be responsible businesses, capacity building and working with communities • Changes in climate could lead to loss of tourism destinations and complete alterations of tourism attractions hence negatively affecting tourism sustainability ▪ Reduced spending for tourists is highly likely during flood or drought conditions ▪ Lodges/camps closing down imply job losses due to extreme climatic events advanced by climate change events ▪ Economic losses for tourism business and investments affected by climate change ▪ Disruption of tourism activities caused by extreme weather events imply low tourist spending • Need for more sustainable tourism actions to be carried out by County and National government as well as tourism stakeholders in order to restore the wildlife/vegetation conservation in MMNR • Climate change and adaptation strategies; tourism product diversification, capacity building, working with communities as well as County Governments, going back to wide range conservation ways of water conservation to slow and reduce high evaporation so as to slow climate change, wide range ecological restoration., water restoration, water conservation as open dams are not the best way forward due to high evaporation underwater dams need to be started. • Wildlife and vegetation conservation initiates in MMNR should be a top priority as the reserve accounts for 30% of the Country's wildlife resource and a significant source of wealth for the country.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

This chapter provides conclusions from the major findings based on the objectives of the study. Application of theories adopted is also explained in light of the findings. Finally, recommendations that are relevant to policy and planning, practice and theory are made. Based on the study findings, climate change has a direct effect on natural resources and tourism sustainability. More importantly, natural resources mediate the relationship between climate change and tourism sustainability.

5.1. CONCLUSION

The study has provided knowledge as well as an understanding of the complex relationship between climate change, natural resources and tourism sustainability. The conclusions are anchored on the respondents' answers obtained from the research questions sought by the study. The following conclusions were made.

5.1.1 The effect of climate change on natural resources

Variations in rainfall as well as temperature patterns have been observed for 39 years (1977-2016) in MMNR. These variations are characterized by drought and flood events which are significant indicators of climate change. This is supported by earlier reported evidence of increased frequency of drought cycles in MMNR. Drought and flooding events are associated with reduced vegetation and water supply for wildlife in the reserve. Consequently, wildlife population declines occur due to mortality from starvation. These revelations concur with a study by Dube and

Nhamo (2020) that established increased frequency of extreme weather events that result in rapid deterioration of flora and fauna.

More importantly, wildlife species in the reserve are vulnerable to longer dry seasons that disrupt seasonal patterns of food production and reproduction. This further increases the risks for declines in forage that leads to further population decline. Additionally, drought events in the reserve negatively affect the productivity of vegetation and eventually its cover in the reserve. This scenario was evident in MMNR where there was a significant change in vegetation cover. This was because of variations in rainfall and temperature patterns that caused changes in vegetation distribution. These revelations are similar to Minja's (2014) study that found local community in Mount Kilimanjaro perceived increased temperatures, decreased annual rainfall, water shortage, increased frequency of forest fire as key threats to natured based tourist attractions.

Therefore, in stable climate conditions, wildlife population thrives under quality vegetation brought by constant rainfall and temperature patterns. However, rainfall and temperature patterns continue to change. This is possibly attributed to variations in rainfall and temperature patterns comprised of drought and flooding events. For instance, higher temperature changes and precipitation patterns have been reported in Mount Kilimanjaro (Appelhans *et al.,* 2015). Therefore, variations in rainfall and temperature patterns directly influence natural resources.

5.1.2 The effect of natural resources on tourism sustainability

The study concludes that there was a positive and significant relationship between natural resources and tourism sustainability in MMNR. Conclusively, rainfall and temperature patterns pose a direct effect on tourism sustainability by influencing wildlife population which is a key resource for tourism. The foregoing concurs with Scott's (2021) affirmation that the global

climate change is a major challenge which is increasingly influencing tourism sector operations. In fact, natural resources positively influence tourism sustainability.

Biodiversity loss due to prolonged drought and rapid rainfall patterns will have a negative effect on tourism destinations attractiveness and operations including tourism activities that are dependent on weather conditions. This will have a negative influence on tourism sustainability. These findings are supported by Scott *et al.*'s (2019) revelation that the direct and indirect impacts of climate change will transform the sustainability of tourism. Therefore, natural resources mediate the relationship between climate change and tourism sustainability. Natural resources are not the only dominant mediator, there may be other mediating variables through which climate change influences tourism sustainability.

Climate change is one of the most serious threats to tourism sustainability and is likely to have the greatest long-term impact (Scott *et al.,* 2019). The impacts caused by changing weather patterns through rainfall and temperature results to a large scale and irreversible changes to plant and wildlife communities and the scenic values they provide consequently affecting sustainability of tourism. Tourism attractions experiencing declines in wildlife populations as well as aesthetics are highly likely not be visited by tourists. Such tourism attractions will likely be unable to sustain tourism activities. Therefore, climate change has the potential to reduce the sustainability of tourism (Hoogendoorn and Fitchett, 2018).

5.1.3 The relationship between climate change and tourism sustainability

There was a positive significant relationship between climate change and tourism sustainability in MMNR. Stable rainfall and temperature patterns guarantee availability of vegetation that wildlife population thrives and consequently tourism activities. This is supported by Mushawemhuka (2018) who emphasizes that climate determines the best season for nature based tourism because

it is a function of tourists comfort outdoors and the climatic impacts on the flora and fauna which they hope to see. Also, weather is an important factor determining the suitability for tourists to visit tourist attractions and their enjoyment of the experience (Dube and Nhamo, 2019). Therefore, climate change has the potential to reduce the long-term viability of tourism (Hoogendoorn *et al.,* 2018).

The study findings indicate that there exist attempts to conduct sustainable tourism practices in MMNR through conservation education programs among the staff and tourists. Further, the tourism industry has unified the local Maasai community as they are able to generate a variety of benefits from tourism including creating wealth. Additionally, the tourism industry brought a number of benefits: it has enabled construction of social amenities for local use; the tourism industry has also strengthened preservation of the Maasai culture, the development of public facilities, improved local livelihoods through creation of job opportunities; there has also been improvement of the local economy and consequently increased urban development. However, climate change has the potential to negate the aforementioned sustainable tourism initiatives in MMNR.

5.1.4 Mediating effect of climate change and natural resources on tourism sustainability

Climate change within Maasai Mara National Game Reserve is manifested through changing rainfall and temperature patterns. Rainfall has a control effect on the abundance as well as quality of vegetation for wildlife. The effect of climate change on natural resources occurs through drought and flooding patterns that reduce food and water supply in the reserve. From the study findings, rainfall as well as temperature patterns have drastically changed in Maasai Mara National Game Reserve over the past 30 years resulting in an increase in severe droughts cycles in Maasai Mara National Game Reserve.

These changes in rainfall and temperature patterns pose a direct effect on tourism sustainability by influencing the wildlife population that the tourism industry relies upon. However, natural resources is not the only dominant mediator, there may be other mediating variables through which climate change influences tourism sustainability. Natural resources mediate the relationship between climate change and tourism sustainability. Climate change is one of the most serious threats to tourism sustainability and is likely to have the greatest long-term impact. The impacts caused by changing weather patterns through rainfall and temperature results to a large scale and irreversible changes to plant and animal communities and the scenic values they provide consequently affecting sustainability of tourism.

5.2. RECOMMENDATIONS

The following recommendations are made based on the findings from the results of the study.

5.2.1 The climate change effects on natural resources

1. Variations in rainfall and temperature patterns cause extreme weather events such as flooding and drought. These events are likely to have significant impacts on wildlife that supports the tourism industry. Based on the study findings, Kenya Wildlife Service (KWS) should consider adoption of emerging and more recent technologies to locate wildlife under cover. This is because of missing Lion and Leopard data as census take place during the day when these wildlife are hidden and cannot be easily located.
2. Carbon emissions reduction from tourism as well as other anthropogenic activities provides an avenue to tackle climate change problem of extreme climate events that negatively affect wildlife. Tourism operations should relook at their operations and ensure reduced carbon emissions to the atmosphere as per set global standards.

3. It is important for conservation organisations to monitor vegetation changes and distribution in protected areas under changing climatic conditions in order to ensure quality vegetation for wildlife. This will ensure optimum wildlife population that is important for tourism.
4. Wildlife population declines as a result of climate change will negatively impact tourism sustainability. Protected areas such as MMNR may suffer or experience socio-economic as well as environmental losses in the event of wildlife population declines. Therefore, climate change adaptation as well as mitigation strategies by the tourism stakeholders ought to ensure sustainability of wildlife tourism. These mitigation and adaptation strategies include reforestation since trees act as carbon sinks.
5. Based on the data, awareness creation about the concept of climate change, challenges and opportunities posed is important to tourism stakeholders. Therefore, there is need for the ministry of tourism and wildlife to raise awareness of climate change effects on wildlife at the same time strengthens adaptation and mitigation strategies to ensure sustainability of tourism.

5.2.2 The effects of natural resources and climate change on tourism sustainability

1. The findings from this study have the potential to inform Kenyan Government climate change policies as well as develop respective legal framework. The climate change Act of 2016 that is silent on addressing climate change impacts and its associated risks especially on wildlife and the environment that the tourism industry in Kenya hinges upon. Furthermore, the research findings will inform policy suggestions on climate change impacts on wildlife as well as vegetation. Adequate policy and legal framework will ensure sufficient management of climate change effects such as droughts and flooding on the tourism industry hence securing sustainability of tourism in Kenya

2. The findings of this study on the direct effects of climate change impacts on wildlife will inform tourism stakeholders make management decisions under climate uncertainty. As rainfall and temperature patterns impacts wildlife population dynamics, tourism managers in protected areas should explore non nature-based tourism experiences for instance cultural and heritage tourism amid wildlife losses. Additionally, strategies to reduce wildlife based tourism carbon footprint should be developed. This will guarantee sustainability of the tourism industry.
3. Tourism service providers such as tented camps and lodges should adequately develop disaster preparedness strategies and infrastructure in the event of extreme floods and drought due to climate change. This would also include having insurance cover against extreme climate disasters. A number of tourism attractions in Kenya have already faced flooding conditions that has resulted in reserve road closures and buildings submerged with water. Extreme climate disaster management plans and infrastructure would ensure timely recovery from disasters and minimal damage.
4. Tourism stakeholders should focus on development of a resilient tourism industry that withstands the influence of climate change through full uptake of mitigation and adaptation strategies as well as policy frameworks.
5. Further, a need exists to mainstream climate change effects into tourism planning and development plans. For example the National Tourism Blueprint (2030) and the tourism agenda 2018-2022.

5.2.3 Theory recommendations

1. There has been no perfect solution to climate change impacts on natural resources and tourism sustainability. The tourism industry is a system comprised of several parts one among them natural resources (wildlife) that have to work together to deliver intended outcomes. Hence,

system thinking is best suited to understand the complexity of the relationship between climate change, natural resources and tourism sustainability that can be sufficiently analysed using systems theory.

2. Climate change poses risks to parts of the systems (natural resources) implying challenges to the entire systems and intended outcomes (tourism sustainability) that is highly likely to be hampered based on the study results. From the study finding that rainfall and temperature variations affect natural resources that mediate the relationship between climate change and tourism sustainability, this calls for systematic approach to understand this relationship. Climate change impacts are interpreted as an integrated whole affecting part such as the tourism industry and other sectors of the economy. Climate change impacts should be addressed with such a systematic approach. However, interaction between the tourism system and the climate system adds yet another layer of complexity. Hence, more relevant theories should be developed to enhance understanding of the climate change phenomenon and its interactions on various sectors of the economy.

5.3. SUGGESTION FOR FURTHER RESEARCH

While conducting this research, several research gaps were encountered regarding climate change impacts on natural resources and tourism sustainability. Therefore, the researcher made the following suggestions in relation to the study findings.

1.This study sought to establish the mediating effects of natural resources on the relationship between climate change and tourism sustainability in MMNR. Future climate change and related studies should consider focusing on other game reserves or protected areas (PAs) such as

parks, sanctuaries, community conservancies and marine parks, including wildlife dispersal zones outside protected areas.

2. There is also a need to use other climate change indicators other than rainfall and temperature that was used in this study. Most importantly, there is a great need to undertake studies to look at the potential effects of other drivers such land use and human settlement on wildlife dynamics, especially in savannah ecosystem that host majority of wildlife attractions that are crucial for the tourism industry in Kenya.
3. Moreover, with global warming as well as climate changes already happening, many tourism attractions as well as tourism generating regions are experiencing such changes. Therefore, it is imperative that upcoming research should explore the effects of climate change on tourist choice of attractions and their satisfaction levels, including tourist's length of stay in tourism destination already experiencing or anticipating climate changes.
4. Climate change effects on tourism resources and the tourism industry are quite widespread. Thus, projecting the future impacts of climate change, for example by developing modeling of the distribution of future climate space for wildlife, is important.
5. A need exists for future research analyses to account for the interactions and implications between different sectors of the economy with regard to climate change impacts.

REFERENCES

Abegg, B. and Koenig, U. (1997). Impacts of climate change on winter tourism in the Swiss Alps. *Journal of Sustainable Tourism*, 5: 46-58.

Ackerman, J. T. (2008). Climate change, national security, and the quadrennial defense review: Avoiding the perfect storm. *Strategic Studies Quarterly*, *2*(1), 56-96.

Ackoff, R. L. (1953). *The design of social research.* (No. 300.18 A2).

Adejimi, A., Oyediran, O. S., & Ogunsanmi, E. B. (2010). Employing qualitatively enriched semi structured questionnaire in evaluating ICT impact on Nigerian 'construction chain integration'. *The Built & Human Environment Review*, *3*(1), 49-62.

Aduma, M. M., Ouma, G., Said, M.Y., Wayumba, G.O, Omondi, P.A and Njino, L.W. (2018.). Potential impacts of temperature projections on selected large herbivores in savannah ecosytem of Kenya. *American Journal of Climate Change.*, 7:5-26.

Agnew, M. D., & Palutikof, J. P. (2006). Impacts of short-term climate variability in the UK on demand for domestic and international tourism. *Climate Research*, *31*(1), 109-120.'Ahmed I. H. (2009). *Climate Policy Intergration: Towards Operationalization.* New York: UN/DESA.

Allen, C. D., Breshears, D., D. and N. G. McDowell,. N. G. (2015). On underestimation of global vulnerability to tree mortality and forest die-off from hotter drought in the Anthropocene. Ecosphere, 129.

Amelung, B. and Viner, D. (2007). Implications of global climate change for tourism flows and seasonality. *Journal of Travel Research,* 285-296.

Amelung, B., & Nicholls, S. (2007). Implications of global climate change for tourism flows and seasonality. *Journal of Travel Research, 45*, 285–296. https://doi.org/10.

Amelung, B., & Viner, D. (2006). Mediterranean tourism: exploring the future with the tourism climatic index. *Journal of sustainable tourism*, *14*(4), 349-366.

Appelhans, T., Mwangomo, E., Otte, I., Detsch, F., Nauss, T., & Hemp, A. (2015). Eco-meteorological characteristics of the southern slopes of Kilimanjaro, Tanzania. *International Journal of Climatology*, 36(9), 3245–3258.

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of personality and social psychology*, *51*(6), 1173.

Bartzke G. S, Ogutu J. O, Mukhopadhyay S, Mtui D, Dublin H.T, Piepho HP. (2018). Rainfall trends and variation in the Maasai Mara ecosystem and their implications for animal population and biodiversity dynamics. *PLoS One.*, 13: 1–30.

Bartzke G. S., Ogutu J. O., Mtui D., Mukhopadhyay S., Piepho H.-P. (2016). *Modelled Trends in Climate and Vegetation.* Germany. Research Gate.

Becken S. (2005). Harmonising climate change adaptation and mitigation: The case of tourist resorts. *Channel View Publications*, 25-49.

Becken, S. (2009). The UN climate change conference, Bali: What it means for tourism. *Journal of Sustainable Tourism*, 16:2,246 - 248.

Becken, S. (2010). The importance of climate and weather for tourism. New Zealand: LEAP.

Becken, S. (2013). "A review of tourism and climate change as an evolving knowledge domain". *Tourism Management Perspectives*, pp. 53-62.

Becken, S. (2019). Decarbonizing tourism: Mission impossible? *Tourism Recreation Research*. https://doi.org/10.1080/02508281.2019.1598042.

Becken, S. and Hay, J. (2007). *Tourism and climate change: Risks and opportunities,* Clevedon: Channel View Publications.

Berrittella, M., Bigano, A., Roson, R. and Tol, R.S.J. (2006). A general equilibrium analysis of climate change impacts on tourism. *Tourism Management*, 913-924.

Bhandari, L., N. (2014). Is tourism beneficial? A case study from Maasai Mara national reserve, Narok, Kenya. *The Pacific Journal of Science and Technology*, pp. 466-468.

Bibbings, L. J. and Burns, P. M. (2009). The end of tourism? climate change and societal changes. *21st Century Society*, 4(1): pp. 31-51.

Bigano, A., Hamilton, J. M., & Tol, R. S. (2006). The impact of climate on holiday destination choice. *Climatic Change*, *76*(3-4), 389-406.

Bimonte, S. (2008). The "Tragedy of tourism resources" as the outcome of a strategic game: A new analytical framework. *Ecological Economics*, *67*(3), 457-464.

Blamey, R. K. (2001). Principles of ecotourism. *The encyclopedia of ecotourism*, *2001*, 5-22.

Boley, B. B. (2014). To travel or not to travel. *Both Have Implications*.

Brewerton, P. M., & Millward, L. J. (2001). Organizational research methods: A guide for students and researchers. Sage.

Briggs, J. M., Knapp, A. K., & Brock, B. L. (2002). Expansion of woody plants in tallgrass prairie: a fifteen-year study of fire and fire-grazing interactions. *The American Midland Naturalist*, *147*(2), 287-295.

Broekhuis, F., Kaelom, Sakat, D., K. and Elliot B., N. (2018). Human–wildlife coexistence: attitudes and behavioural intentions towards predators in the Maasai Mara, Kenya. Oryx, 2020, 54(3), 366–374 © 2018 Fauna & Flora International.

Brown, C. B. (1947). Studies in detergency; the oily constituent in naturally occurring domestic dirt. *Research; a journal of science and its applications*, *1*(1), 46.

Bujosa A, Rosselló J. (2013). Climate change and summer mass tourism: the case of Spanish domestic tourism. Climate Change.

Bujosa, A., Riera, A., & Torres, C. M. (2015). Valuing tourism demand attributes to guide climate change adaptation measures efficiently: The case of the Spanish domestic travel market. *Tourism Management*, *47*, 233–239.

Burns, T. R., Roszkowska E., Machado N., Johansson D. and Corte U. (2018). Paradigm shift in dame theory: sociological: sociological re-conceptualization of human agency, social structure, and agents' cognitive-normative frameworks and action determination modalities. *Social Sciences*, 17-20.

Cahill, A. E., Aiello-Lammens, M.E., Fisher-Reid, M. C. (2012.). How does climate change cause extinction? Proceedings of the Royal Society B:. *Biological Sciences.,* 280, 2012-1890.

Carter, R. W., Thok, S., O'Rourke, V., & Pearce, T. (2015). Sustainable tourism and its use as a development strategy in Cambodia: A systematic literature review. *Journal of Sustainable Tourism, 23*(5), 797-818.

Cater, C., Garrod, B. and Low, T.,. (2015). *The Encyclopedia of Sustainable Tourism*. *CABI*, Oxfordshire.

Ceballos, G., P. R. Ehrlich, and R. Dirzo. (2017). "Biological Annihilation via the ongoing sixth mass extinction signaled by vertebrate population losses and declines." proceedings of the national academy of sciences. 114 (30).

Chander, P. (2017). Game theory and climate change. Center for environmental economics and climate change jindal school of government and public policy change: Case of Kariba resort town, Zimbabwe. *Journal of Outdoor Recreation and Tourism*, 29, 100281. https://doi.org/10.1016/j.jort.2020.100281.

Chen, C-M., Chen, S-H., Lee, H-T., & Tsai, T-H. (2017). Exploring destination resources and competitiveness – A comparative analysis of tourists' perceptions and satisfaction toward an island of Taiwan. Ocean & Coastal Management, 119, 58-67.

Christensen, J.H., Krishna Kumar, K., Aldrian, E., An, S.-I., Cavalcanti, I.F.A., de Castro, M. & Zhou, T. (2013). Climate phenomena and their relevance for future regional climate change. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Stocker, T.F., Qin, D., Plattner, G.-K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex V., and Midgley P.M. (eds.). Cambridge: Cambridge University Press.

Coldret, K., and Turpie, J. (2019). Climate change vulnerability and adaptation assessment for the greater Mara ecosystem. Anchor Environmental Consultants Steenberg House, Silverwood Close, Tokai 7945.

Cooper, D. R., & Schindler, P. S. (2008). International edition: Business research methods. *New Delhi: MacGraw-Hill.*

Creel, S., Creel, N.M., Creel, A.M., Creel, B.M., (2016). Hunting on a hot day: effects of temperature on interactions between African wild dogs and their prey. *Ecology* 97 (11), 2910–2916.

Creswell, J. W. (2003). Research design: Qualitative, Quantitative, and mixed methods.

Creswell, J. W. (2014). Research Design: Qualitative, Quantitative and Mixed Methods Approaches (4th ed.). London: Sage Publications Ltd.

Creswell, J. W., & Zhang, W. (2009). The application of mixed methods designs to trauma research. *Journal of Traumatic Stress: Official Publication of The International Society for Traumatic Stress Studies*, *22*(6), 612-621.

Dai, A. (2013). Increasing drought under global warming in observations and models. *Nature Climate Change* 3(1):52–58, DOI 10.1038/nclimate1633.

Damania, Richard; Desbureaux, Sebastien; Scandizzo, Pasquale Lucio; Mikou, Mehdi; Gohil, Deepali; Said, Mohammed. (2019). When good conservation becomes good economics: Kenya's vanishing herds. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/33083 License: CC BY 3.0 IGO."

Darkoh, M. B. K., Khayesi, M., & Mbaiwa, J. E. (2014). Impacts and responses to climate change at the micro-spatial scale in Malawi, Botswana and Kenya. In M. A. M. Salih (Ed.), *Local climate change and society* (pp. 109–124). London: Routledge.

de Freitas, C. R. (2008). Tourism climatology: evaluating environmental information for decision making and business planning in the recreation and tourism sector. *International Journal of Biometeorology*, *48*(1), 45-54.

De Urioste-Stone, S. M., Le, L., Scaccia, M. D., & Wilkins, E. (2016). Nature-based tourism and climate change risk: Visitors' perceptions in Mount Desert Island, Maine. *Journal of Outdoor Recreation and Tourism*, *13*, 57–65.

deFreitas, C.R., Scott, D. and McBoyle, G. (2008). A second Generation Climate Index for Tourism (CIT): Specifications and Verifications. *International Journal of Biometeorology*, 52, pp.399-407.

Di Minin, E., Slotow, R., Hunter, L.T., Pouzols, F.M., Toivonen, T., Verburg, P.H., Moilanen, A., (2016). Global priorities for national carnivore conservation under land use change. Sci. Rep. 6, 23814.

Dillimono, H. D., & Dickinson, J. E. (2015). Travel, tourism, climate change, and behavioral change: Travellers' perspectives from a developing country, Nigeria. *Journal of Sustainable Tourism*, *23*(3), 437–454. doi: 10.1080/09669582.2014.957212.

Dinica, V. (2012). Tourism on Curaçao: Explaining the shortage of sustainability legislation from game theory perspective. *Journal of Environmental Policy & Planning*, 1-28.

Dogru, T., Marchio, E. A., Bulut, U., & Suess, C. (2019). Climate change: Vulnerability and resilience of tourism and the entire economy. *Tourism Management*, *72*, 292-305.

Draugalis, J. R., Coons, S. J., & Plaza, C. M. (2008). Best practices for survey research reports: a synopsis for authors and reviewers. *American journal of pharmaceutical education*, *72*(1).

Drummond, A., Hall, L., Sauer, J., & Palmer, M. (2018). Is public awareness and perceived threat of climate change associated with governmental mitigation targets? Climate Change, 149, 159–171.

Dube, K. & Nhamo, G. (2019). Climate change and potential impacts on tourism: Evidence from the Zimbabwean side of the Victoria Falls. *Environmental Development and Sustainability*, 21 (4), 2025–2041.

Dube, K., & Nhamo, G. (2020). Vulnerability of nature-based tourism to climate variability and change: Case of Kariba resort town, Zimbabwe. *Journal of Outdoor Recreation and Tourism*, *29*, 100281.

Dube, K., Nhamo, G., (2018). Climate variability, change and potential impacts on tourism: evidence from the Zambian side of the Victoria Falls. Environ. Sci. Policy 84, 113–123.

Dublin H., T. and Ogutu J., O. (2015). Population regulation of African buffalo in the Mara Serengeti ecosystem. *Wildlife Research*, 2015. CSIRO publishing 42, 382–393.

Dubois, G., Ceron, J. P., Gössling, S., & Hall, C. M. (2016). Weather preferences of French tourists: lessons for climate change impact assessment. *Climatic change, 136*(2), 339–351.

Dukes, J. S. (2003). Burning buried sunshine: human consumption of ancient solar energy. *Climatic change*, *61*(1-2), 31-44.

Dunlop, M. and Brown, P. (2008). *Implications of Climate Change for Australia's National Reserve System.* A Preliminary Assessment.

Dzoga, M. N., & Koske, J. K. (2014). Assessment of Beach hotels adaptation capacity to climate variability: The Case of Mombasa County, Kenya. *International Journal of Humanities and Social Science*, *4*(3), 1-4.

Enríquez, A., R . and Bestard A., B. (2020). Measuring the economic impact of climate-induced environmental changes on sun-and-beach tourism. Climatic change. Springer Nature

Estes, R. D., Atwood, J. L., and Estes, A. B. (2006). Downward trends in Ngorongoro Crater ungulate populations 1986–2005: conservation concerns and the need for ecological research. *Biological Conservation* 131, 106–120. doi:10.1016/j.biocon.2006.02.009.

Falk D. A., Millar C.I. (2016). The influence of climate variability and change on the science and practice of restoration ecology. In: Palmer M.A., Zedler J.B., Falk D.A. (eds). *Foundations of Restoration Ecology.* Island Press, Washington, DC.

FAO. (2012). *Wildlife in a changing climate.* Rome, Italy: Publishing Policy and Support Branch.

Farid, H., Hakimian, F., Nair, V., Nair, P. K., & Ismail, N. (2016). Trend of research on sustainable tourism and climate change in 21st century. *Worldwide Hospitality and Tourism Themes*, *8*(5), 516-533.

Farrar T.J., Nicholson S.E., Lare A.R. (1994). The influence of soil type on the relationship between NDVI, rainfall and soil moisture in semi-arid Botswana. *Remote Sensing of the Environment*, 50: 121-133.

Field, A. P. (2005). Is the meta-analysis of correlation coefficients accurate when population correlations vary?. *Psychological methods*, *10*(4), 444.

Fitchett, J. M., Grab, S. W., & Thompson, D. I. (2015). Plant phenology and climate change: Progress in methodological approaches and adaptation. *Progress in Physical Geography*, *39*(4), 460–482. doi: 10.1177/0309133315578940

Fitchett, J. M., Hoogendoorn, G., & Swemmer, A. W. (2016). Economic costs of the 2012 floods on tourism in the Mopani district municipality, South Africa. *Transactions of the Royal Society of South Africa*. doi: 10.1080/0035919X.2016.1167788

Ford, J. D., Bolton, K., Shirley, J., Pearce, T., Tremblay, M., & Westlake, M. (2012). Mapping human dimensions of climate change research in the Canadian arctic. Ambio, 41(8), 808–822. https://doi.org/10.1007/s13280-012-0336-8 Springer Netherlands.

Fowler, M. (2002). *Patterns of enterprise application architecture*. Addison-Wesley Longman Publishing Co., Inc..

Fraenkel, J. R., & Wallen, N. E. (2000). *How to design and evaluate research in education.* New York: McGraw.

Francisco B., and Piero C. (2011). Physiological correlates of geographic range in animals. *Annual Review of Ecology, Evolution, and Systematics.* 102710-145055.

Frangialli, F. (2005). *Secretary General, UN World Tourism Organisation at the technical conference on climate as a resource for tourism.* Beijing: WTO.

Franke, M. A. (2000). Yellowstone in the Afterglow: Lessons From Fires. Available at http://www.nps.gov/ yell/planyourvisit/publicationsafterglow.html. Retrieved on 9 July 2007.

Funk, C., M. D. Dettinger, J. C. Michaelsen, J. P. Verdin, M. E. Brown, M. Barlow, and A. Hoell. (2008). Warming of the Indian Ocean threatens eastern and southern African food security but could be mitigated by agricultural development. Proceedings of the National Academy of Sciences. 11081–11086.

Füssel, H.-M., & Hildén, M. (2014). How is uncertainty addressed in the knowledge base for national adaptation planning? *Adapting to an Uncertain Climate*, 41–66. New York, NY: Springer International Publishing.

Ghaderi, Z., Khoshkam, M., & Henderson, J. C. (2014). From snow skiing to grass skiing: Implications of climate change for the ski industry in Dizin, Iran. *Anatolia: An International Journal of Tourism and Hospitality Research*, *25*(1), 96–107.

Ghauri, P. N., & Grønhaug, K. (2005). *Research methods in business studies: A practical guide*. Pearson Education.

Gill, J., & Johnson, P. Clark. M. (2010). *Research Methods for Managers*.

Goh, C. (2012). Exploring impact of climate on tourism demand. *Annals of Tourism Research, 39*(4), 1859–1883. https://doi.org/10.1016/J.ANNALS.2012.05.027 Pergamon.

Gómez M. and Martín, M. B. (2005). Weather, climate and tourism a geographical perspective. *Annals of Tourism Research*, *32*(3), 571–591. https://doi.org/10.1016/J.ANNALS. 2004.08.004 Pergamon.

Gonzales, R. (2016). Five years after the revolutions, this is Egypt's Worst Dictatorship'. *CIDOB: Opinion*, *385*(02), 2016.

Goodwin H. (1996). In pursuit of ecotourism, biodiversity and conservation, Volume 5, Issue 3, p. 277-291.

Gössling, S. & Scott, D. (2018). Tourism and climate change mitigation: Embracing the Paris agreement – Pathways to decarbonization. Brussels: European Travel Commission.

Gössling, S. and Hall, M.,. (2006). Tourism and global environmental change: tourism and global environmental change. *Ecological, Social, Economic*, 50-62.

Gossling, S. and Peeters, P. (2015). Assessing tourism's global environmental impact 1900-2050. *Journal of Sustainable Tourism*, 23(5), pp. 639-659.

Gössling, S., & Hall, C. M. (2006). Uncertainties in predicting tourist flows under scenarios of climate change. *Climatic Change*, *79*(3-4), 163-173.

Gössling, S., & Schumacher, K. P. (2010). Implementing carbon neutral destination policies: Issues from the Seychelles. Journal of Sustainable Tourism, 18(3), 377–391.

Gossling, S., and Scott, D. (2018). Climate change and tourism: exploring destination vulnerability. *Tourism Review International*, 12: 1-3.

Gössling, S., Hall, C. M., Peeters, P., & Scott, D. (2012). The future of tourism: Can tourism growth and climate policy be reconciled? A mitigation perspective. *Tourism Recreation Research, 35*(2), 119-130.

Gössling, S., Scott, D., Hall, C.M., Ceron, J-P., and Dubois, G. . (2012). Consumer behaviour and demand response of tourists to climate change. *Annals of Tourism Research*, 39: 36-58.

Gössling, Schumer, H. (2010). The Future of Tourism: Can Tourism Growth and Climate Policy be Reconciled? A mitigation Perspective. *Tourism Recreation Research*, 119-130.

Government of the Republic of Kenya. (2018). National Climate Change Action Plan 2018-2022. Ministry of Environment and Forestry, Nairobi.

Government of Kenya (2010). Kenya Wildlife Service (2010). Strategic Plan 2008-2012. Nairobi, Kenya.

Government of Kenya (2010a). Interim Interdependent Boundaries Review Commission. Report on Delimitation of Constituencies and Recommendation on Local Authority Electorate Units and Administrative Boundaries for Districts and other Units. Nairobi, Kenya.

Government of Kenya (2010b). National Climate Change Response Strategy. Ministry of Environment and Mineral Resources. Nairobi, Kenya.

Government of Kenya (2013). National Climate Change Action Plan 2013-2017. Ministry of Environment and Mineral Resources. Nairobi, Kenya.

Government of Kenya (2016). Kenya National Adaptation Plan 2015-2030, Enhanced climate resilience towards the attainment of Vision 2030 and beyond. Ministry of Environment and Natural Resources. Nairobi, Kenya.

Government of Kenya (2018). National Climate Change Action Plan 2018-2022.Ministry of Environment and Forestry. Nairobi, Kenya.

Government of Kenya (2019). Kenya Population and Housing and Housing Census. Kenya National Bureau of Statistics. ISBN: 978-9966-102-09-6 All Rights Reserved Copyright©2019.

Government of Kenya. (2017). *Economic Survey Report.* Government Printer. Nairobi, Kenya.

Government of Kenya. (2018). *Economic Survey Report.* Government Printer. Nairobi, Kenya.

Government of Kenya. (2009). The 2009 Kenya Population and Housing Census "Counting Our People for the Implementation of Vision 2030", Nairobi. Kenya.

Government of Kenya. (2012). *Economic Survey Report, Kenya National Bureau of Statistics. Nairobi*: Government Printer.

Government of Kenya. (2018). *National Tourism Strategy*. Nairobi: Department of Tourism Ministry of East Africa, Commerce and Tourism.

Government of Kenya. (2020). Kenya National Bureau of Statistics. Economic Survey Report of 2020. Real Towers, Upper Hill along Hospital Road Nairobi.

Government of Kenya. (2021). Ministry of Tourism and Wildlife. Kenya Tourism Agenda 2018-2022. Nairobi, Kenya.

Gundula S. Bartzke., Joseph O. Ogutu, Devolent M., D., Mukhopadhyay, S., Hans-Peter P., H. (2016). Modelling trends and variation in climate of the Serengeti-Mara Ecosystem. Research Gate. 5-15.

Gunn, C., & Clare, V., T. (2002). Tourism Planning: Basics, Concepts, Cases, 4th edn, Routledge, New York.

Hagerman, S., Dowlatabadi, H, Satterfield, T., McDaniels, T. (2010). Expert views on biodiversity conservation in an era of climate change. *Global Environmental Change*, 192-207.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2009). *Análise multivariada de dados*. Bookman Editora.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2016). *Multivariate data analysis* (6th ed.). Upper Saddle River, NJ: Pearson University Press.

Hall, C, M. (2008). New Zealand tourism entrepreneur attitudes and behaviours with respect to climate change adaptation and mitigation. *International Journal of Innovation and Sustainable Development*, 229-237.

Hall, C. M. (2012). Tourism and climate change: Knowledge gaps and issues. *Critical Debates in Tourism*, pp.318-337.

Hall, C. M. and Higham, J. (2006). *Tourism, Recreation and Climate Change.* Clevedon: Channelview Publications.

Hall, C. M. and Page, S. (2006). *The Geography of Tourism and Recreation: Place, Space and Environment*, 3, London: Routledge.

Hall, C. M., & Page, S. (2010). The contribution of Neil Leiper to tourism studies. *Current Issues in Tourism*, *13*(4), 299-309.

Hall, C. M., Amelung, B., Cohen, S., Eijgelaar, E., Gössling, S., Higham, J., & Scott, D. (2015). On climate change skepticism and denial in tourism. *Journal of Sustainable Tourism*, *23*(1), 4-25.

Hall, M., H., P., and Farge, D., (2003). Modeled climate-induced glacial change in glacier National Park. *Bioscience* 53(2), 131-140.

Halofsky, J. E., & Peterson, D. L. (Eds.). (2018). Climate change and Rocky Mountain ecosystems. Springer.

Hambira, W. L., & Saarinen, J. (2015). Policy-makers' perceptions of the tourism-climate change nexus: Policy needs and constraints in Botswana. *Development Southern Africa*, *32*(3), 350–362. doi: 10.1080/0376835X.2015.1010716.

Hambira, W. L., Saarinen, J., Manwa, H., & Atlhopheng, J. R. (2013). Climate change adaptation practices in nature-based tourism in Maun in the Okavango Delta area Botswana: How prepared are tourism businesses? *Tourism Review International*, *17*, 19–29. doi: 10.3727/154427213X13649094288025

Hamilton, J. M., & Tol, R. S. J. (2004). The impact of climate change on tourism and recreation. Hamburg.: Centre for Marine and Climate Change, University of Hamburg.

Hamilton, J. M., Maddison, D. J. & Tol., R. S .J. (2005). Climate change and international tourism:a simulation study. *Global Environmental Change.* 15(3), pp. 253-266.

Harding, A., & Blokland, T. (2014). *Urban theory: a critical introduction to power, cities and urbanism in the 21st century*. Sage.

Hayes, A. F. (2013). Methodology in the social sciences. Introduction to mediation, moderation, and conditional process analysis: A regression-based approach.

Hayes, A. F., & Preacher, K. J. (2014). Statistical mediation analysis with a multicategorical independent variable. *British journal of mathematical and statistical psychology*, *67*(3), 451-470.

Hein, G. (2009). Learning science in informal environments: People, places, and pursuits. *Museums & Social Issues*, *4*(1), 113-124.

Hein, L., Metzger, M. J., & Moreno, A. (2009). Potential impacts of climate change on tourism; a case study for Spain. *Current Opinion in Environmental Sustainability*, *1*(2), 170-178.

Henderson, J. V., Storeygard, A., & Deichmann, U. (2017). Has climate change driven urbanization in Africa?. *Journal of development economics*, *124*, 60-82.

Henderson, R. M., Reinert, S. A., Dekhtyar, P., & Migdal, A. (2017). Climate change in 2018: *Implications for Business risk*, *1*.

Hilbert, D., Ostendorf, B., and Hopkins,M. (2011). Sensitivity of tropical forests to climate change in the humid tropics of North Queensland. *Austral Ecology*, 590-603.

Hongyuan Y. (2015). Evolution of the global climate governance system and its implications. World Century Publishing Corporation and Shanghai Institutes for International Studies China Quarterly of International Strategic Studies, Vol. 1, No. 3, 423–446.

Hoogendoorn, G., & Fitchett, M., J. (2018). Tourism and climate change: a review of threats and adaptation strategies for Africa, Current Issues in Tourism, 21:7, 742-759, DOI: 10.1080/13683500.2016.1188893.

Hoogendoorn, G., Grant, B., & Fitchett, J. (2016). Disjunct perceptions? Climate change threats in tow low-lying South African coastal towns. Bulletin of Geography: Socio-economic Hambira, W. L., & Saarinen, J. (2015). Policy-makers' perceptions of the tourism-climate change nexus: Policy needs and constraints in Botswana. Development Southern Africa, 32(3), 350–362.Series, 31, 59–71.

Hopcraft J. G. C. Olff, H., and Sinclair A. R. E. (2010). Herbivores, resources and risks: alternating regulation along primary environmental gradients in savannahs. *Trends Ecol Evol.*, 25: 119–128.

Hopkins, M., Ash, J., Graham, A., Head, J., and Hewett, R., (1993). Charcoal Evidence of the Spatial Extent of the Eucalyptus Woodland Expansions and Rainforest Contractions in North Queensland During the Late Pleistocene. *Journal of Biogeography*, 20: 357-372.

Howden, M. (2009). How humanitarian logistics information systems can improve humanitarian supply chains: a view from the field. In *Proceedings of the 6th international ISCRAM conference, Gothenburg, Sweden.*

http://climate.nasa.gov/vital-accessed 13th August 2018.

Huete, A. R., & Jackson, R. D. (1987). Suitability of spectral indices for evaluating vegetation characteristics on arid Rangelands. *Remote sensing of environment*, *23*(2), 213-IN8.

Huey R. B., Kearney M.R., Krockenberger A. (2012). Predicting organismal vulnerability to climate warming: roles of behaviour, physiology and adaptation. *Biological Sciences.*, 1665–1679.

Hunt, A., & Watkiss, P. (2011). Climate change impacts and adaptation in cities: A review of the literature. *Climatic Change*, *104*(1), 13–49. doi: 10.1007/s10584-010-9975-6.

Intergovernmental Panel on Climate Change. (2007). *The Physical Science Basis - Contribution of Working Group i to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge and New York: University Press Cambridge.

Intergovernmental Panel on Climate Change. (2014). Summary for policymakers. In: Climate change 2014: Impacts, adaptation, and vulnerability. Part A: Global and sectoral aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovermental Panel on Climate Change [Field CB, Barros VR, Dokken DJ, Mach KJ, Mastrandrea MD, Bilir TE, Chatterjee M, Ebi YL, Estrada YO, Genova RC, Girma B, Kissel ES, Levy AN, MacCracken S, Mastrandrea PR, White LL (eds)]. Cambridge University Press, Cambridge, UK and New York, USA. pp 1–32.

Intergovernmental Panel on Climate Change. (2018). Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.).

International Energy Agency (2018). *World Energy Outlook 2018,* IEA, Paris, DOI: https://doi.org/10.1787/weo-2018-en.

International Research Institute for Climate and Society. (IRI). The Earth Institute, Columbia University, Lamont Campus 61 Route 9W, Monell Bldg., Palisades, NY 10964-8000,

International Transport Forum ITF (2019), Transport Outlook, OECD Publishing, Paris, DOI: https://doi.org/10.1787/transp_outlook-en-2019-en.

International Union for Conservation of Nature. (2018). "The IUCN Red List of Threatened Species." Version 2018-2: http://www.iucnredlist.org. Downloaded on 17 March 2019.

Jayaprakash, M., Sivakumar, K., Muthusamy, S., Krishnamurthy, R. R., & Edward Patterson, J. K. (2016). Shrinking of Vann Island, Gulf of Mannar, SE coast of India: Assessing the impacts. *Natural Hazards, 84*(3), 1529–1538. doi:10.100711069-016-2496-5.

Jopp, R., DeLacy, T and Mair, J. (2010). Developing a framework for regional destination adaptation to climate change. *Current Issues in Tourism*, 13: 6, 591-605.

Joyce, L. A., Running, S. W., Breshears, D. D., Dale, V. H., Malmsheimer, R. W., SAMP-SON, R. N., ... & Woodall, C. W. (2014). Forests. *Climate change impacts in the United States: The third national climate assessment*, 175-194.

Justice , C. O. , Townshend , J. R. G. , Holben , B. N. , and Tucker , C. J. (1985). Analysis of the phenology of global vegetation using meteorological satellite data . *International Journal of Remote Sensing* , 6 , 1271 – 1318 . [Web of Science ®], [Google Scholar]Justice *et al.*, 1986.

Kamau, J., Okumu, J., Mwangi, C., and Bambo, J. (2017). Maasai Mara National Reserve Audit Policy Brief: Policy Paths toward Sustainable Management of Maasai Mara National Reserve.

Kanga, E. M., Ogutu, J. O., Piepho, H. P., & Olff, H. (2013). Hippopotamus and livestock grazing: influences on riparian vegetation and facilitation of other herbivores in the Mara Region of Kenya. Landscape and ecological engineering, 9(1), 47-58.

Kawabata, A., Ichii, K., & Yamaguchi, Y. (2001). Global monitoring of Inter annual changes in vegetation activities using NDVI and its relationships to temperature and precipitation. *International Journal of Remote Sensing*, 22, 1377-1382.

Keith, T. (2006). Multiple regression and beyond. Pearson Allyn & Bacon.

Kenya Private Sector Alliance (KEPSA). (2014). Climate change and the Tourism sector. briefing Note 7.

Kenya's key biodiversity areas status & trends report (2017). Accessed at https://issuu.com/nature_kenya/docs/2017_iba_report_final.

Kilungu, H., Leemans, R., Munishi, P., Nicholls, S., & Amelung, B. (2019). Forty years of climate and land-cover change and its effects on tourism resources in Kilimanjaro National Park. *Tourism Planning and Development.*, 1-19.

Kilungu, H., Leemans, R., Munishi, P.K., Amelung, B. (2017). Climate change threatens major tourist attractions and tourism in Serengeti National Park, Tanzania. In: LF, W., B, S., K, J., M, W., M, P., M, K. (Eds.), Climate Change Adaptation in Africa. eBook Packages: Springer, Cham, pp. 375–392.

King, B. (1987). Viewpoints: tourism – A new systematic approach?. *Tourism Management*, 8(3): 272–274.

Köberl, J., Prettenthaler, F., & Bird, D. N. (2016). Modelling climate change impacts on tourism demand: A comparative study from Sardinia (Italy) and Cap Bon (Tunisia), *Science of the Total Environment*. doi: 10.1016/j.scitotenv.2015.03.099.

Koetse, M. J., & Rietveld, R. (2009). The impact of climate change and weather on transport: an overview of research findings. Transportation Research Part D, 14, 205-221.

Kombo, D. K., & Tromp, D. L. (2006). Proposal and thesis writing: An introduction. *Nairobi: Paulines Publications Africa*, *5*, 814-30.

Kothari, C. R. (2008). Research methodology, methods and techniques (pp. 109-110). *New Delhi: New Age Inter-national (P) Limited*.

Kozak, M. (2002). Comparative analysis of tourist motivations by nationality and destinations. *Tourism Management*, 23(3), 221-232.

Krockenberger, A. (2002). A tropical rainforest possum that can't take the heat: handbook of conference abstracts of the 2nd joint meeting of the Ecological Society of Australia Inc., and the *New Zealand Ecological Society* Inc. *Ecology*, 1-6.

Kyriakidis, A. and Felton, J. (2008). *Too Hot to Handle? The Hospitality Industry Faces Up to Climate Change.* Davos: The Travel & Tourism Competitiveness Report.

Leadley, P., Pereira, H., and Alkemade, R. (2010). Biodiversity Scenarios: Projections of 21st Century Change in Biodiversity and Associated Ecosystem Services.

Leggett, A., J. (2020). The United Nations Framework Convention on Climate Change, the Kyoto Protocol, and the Paris Agreement: A Summary. Congressional research service report. https://crsreports.congress.gov

Leiper, N. (1979). Towards a definition of tourism, tourist, and the tourist industry. *Annals of tourism research, 6*(4), 390-407.

Leiper, N. (1984). Tourism and leisure: the significance of tourism in the leisure spectrum. In *Proceedings of the 12th New Zealand Geography Conference* (pp. 249-53). New Zealand Geographical Society Christchurch.

Leiper, N. (1985). The Japanese travel market and its potential for Australian tourist destinations: A research study. Qantas Airways Limited.

Leiper, N. (1989). Tourism systems: An interdisciplinary perspective. Department of Management Systems, Business Studies Faculty, Massey University.

Leiper, N., Witsel, M., & Hobson, P. (2008). Leisure travel and business travel: a comparative analysis. *Asian Journal of Tourism and Hospitality Research, 2*(1), 1.

Leiserowitz, A. (2006). Climate change risk perception and policy preferences: The role of affect, imagery, and values. *Climate Change,* 77, pp.45-72.

Lenzen, M., Sun, Y., Faturay F., Ting, Y., Geschke, A., Malik, A. (2018). The carbon footprint of global tourism. Macmillan Publishers Limited, part of Springer Nature.

Liebmann, B., Hoerling, M.P., Funk, C., Bladé, I., Dole, R.M., Allured, D., Quan, X., Pegion, P. and Eischeid, J.K. (2014). Understanding recent Eastern horn of Africa rainfall variability and change. *J. Climate,* 27: 8630–8645. http://doi.org/10.1175/JCLI-D-13-00714.1

Lindmark, M., Huss, M., Ohlberger, J. & Gårdmark, A. (2018). Temperature-dependent body size effects determine population responses to climate warming. *Ecol. Lett.* **21**, 181–189, https://doi.org/10.1111/ele.12880 (2018).

Lise, W., and Tol, R. S. J. (2002). Impact of climate on tourist demand. *Climate Change,* 429-449.

Liu, T., Smith K. H., Krop R., Haigh T., and Svoboda M. (2020). Critical analysis of the value of drought information and impacts on land management and public health. *Water 2020,* 12, 1064; doi:10.3390/w12041064.

Liu, T.-M. (2016). The influence of climate change on tourism demand in Taiwan national parks. *Tourism Management Perspectives, 20,* 269–275. doi:10.1016/j.tmp.2016.10.006.

Loveridge, A. J., Hunt J. E., Murindagomo F, and Macdonald D. W. (2006). Influence of drought on predation of elephant (Loxodonta africana) calves by lions (Panthera leo) in an African wooded savannah. *Journal of Zoology.*, 270: 523-530.

Lyon, B., and D. G. DeWitt. (2012). A recent and abrupt decline in the East African long rains. *Geophysical Research Letters.*, 39.

Lyon, B., and& Dewitt D.,Vigaud G, N. (2017). Unraveling East Africa's climate paradox. *Climate Extremes: Patterns and Mechanisms.* John Wiley & Sons, *Inc*, 265-81.

Maasai Mara National Reserve (MMNR), Management Plan . (2009-2019). Narok, Kenya.

Manono, G. (2015). Perceived effects of climate change on tourism and natural resources in protected areas in Kenya: A Case of Maasai Mara National Reserve.

March, H., Sauri, D., & Llurdes, J. C. (2014). Perception of the effects of climate change in winter and summer tourist areas: The Pyrenees and the Catalan and Balearic coasts, Spain. Regional Environmental Change, 14, 1189–1201.

Marco, D., Boitani, M., L, Mallon D, Hoffmann M, Iacucci A., Meijaard E. (2014). A retrospective evaluation of the global decline of carnivores and ungulates. *Conservation Biology*, 8:1109-1118.

Marshal, J. P., Owen-Smith, N., Whyte, I. J., and Stenseth, N. C. (2011). The role of El Niño–Southern Oscillation in the dynamics of a savanna large herbivore population. *Oikos* 120, 1175–1182. doi:10.1111/j.1600- 0706.2010.19155.

Martin, G. & Belén (2005). Weather, climate and tourism a geographical perspective. *Annals of Tourism Research,* 32(3), 571-591.

Mather, S., Viner, D. And Todel, G. (2005). Climate and policy changes: their implications for tourism flow. In C.R. Hall and J. Higham (eds.), *Tourism, Recreation and Climate Change* (63-85). Great Britain: Cromwell Press.

Matley, I. M. (1972). Perception of Environment: The Case of the Airman. *The Professional Geographer*, *24*(1), 23-25.

Matthews, B., & Ross, L. (2010). *Research methods a practical guide for the social sciences.* SAGE Publications, Inc.

Matzarakis, A., De Freitas, C. R., & Scott, D. (2007). Developments in tourism climatology. *Selbstverlag, Freiburg*.

McClelland, G. H., & Judd, C. M. (1993). Statistical difficulties of detecting interactions and moderator effects. *Psychological bulletin*, *114*(2), 376.

McKelvey, K. S., & Buotte, P. C. (2018). Effects of climate change on wildlife in the Northern Rockies. In *Climate change and Rocky Mountain ecosystems* (pp. 143-167). Springer, Cham.

Mduma, S. A. R., Sinclair, A. R. E., and Hilborn, R. (1999). Food regulates the Serengeti wildebeest: a 40-year record. *Journal of Animal Ecology*., 68(6): 1101-1122.

Médail, F. (2017). The specific vulnerability of plant biodiversity and vegetation on Mediterranean Islands in the face of global change. *Regional Environmental Change*, *17*(6), 1775–1790. doi:10.100710113-017-1123-7.

Metzger, K. L., Sinclair, A. R. E., Hilborn, R., Hopcraft, J. G. C., and Mduma, ,S., A., R. (2010). Evaluating the protection of wildlife in parks: the case of African buffalo in Serengeti. *Biodiversity and Conservation* 19, 3431–3444. doi:10.1007/s10531-010-9904.

Michailidou, A. V., Vlachokostas, C., & Moussiopoulos, N. (2016). Interactions between climate change and the tourism sector: Multiple-criteria decision analysis to assess mitigation and adaptation options in tourism areas. *Tourism Management*, *55*(August), 1–12.

Midgley, G.F., and Bond, W., J. (2015). Future of African terrestrial biodiversity and ecosystems under anthropogenic climate change. Nat. Climate Change. 5 (9), 823.

Minja, G. (2014). Vulnerability of tourism in Kilimanjaro national park and the livelihoods of adjacent communities to the impacts of climate change and variability. European Scientific Journal, 10(29), 217–230.

Moen, J., & Fredman, P. (2007). Effects of climate change on Alpine skiing in Sweden. *Journal of Sustainable Tourism*, *15*(4), 418–437.

Monzón, J., Moyer-Horner, L., & Palamar, M. B. (2011). Climate change and species range dynamics in protected areas. *Bioscience*, *61*(10), 752-761.

Moreno, A. (2010). Climate change and tourism: impacts and vulnerability in coastal Europe. Netherlands: Maastricht University.

Moreno, A., and Amelung, B. (2019). Climate change and coastal and marine tourism: review and analysis. *Journal of Coastal Research*, 56, pp.1140-1144.

Muchogu, J. O. (2014). Assessment of the environmental impacts of wildlife based tourism in Kenya's protected areas.

Muchoki, E. N,yambura. (2018). Adaptation of wildlife tourism to climate change. A case study of Maasai Mara National Reserve. MSc Thesis. Wageningen University and Research.

Muhammad, I. (2013). Climate change: A theoretical review. Interdisciplinary description of complex systems 11(1), 1-13, 2013.

Mukogo, R. (2014). Greening of the tourism sector an effective mitigation measure against climate change. Vermont: International Institute for Peace through Tourism.

Muller, D., Judd, C. M., & Yzerbyt, V. Y. (2005). When moderation is mediated and mediation is moderated. *Journal of personality and social psychology*, *89*(6), 852.

Munyiri, E., K. (2015). Vulnerability and adaptation of the tourism sector to climate change in Nairobi, coast and central tourist circuits in Kenya. Doctoral Thesis. Kenyatta University.

Murtaza, K. O., & Romshoo, S. A. (2016). Recent glacier changes in the Kashmir Alpine Himalayas, India. *Geocarto International*, *15*, 1–8.

Musau, F. M. (2018). *Geospatial dimensions of the linkages between ecosystem services and sustainable community development in Shimba Hills, Kwale County-Kenya* (Doctoral dissertation, Kenyatta University).

Mushawemhuka, W., Rogerson, J. M., & Saarinen, J. (2018). Nature-based tourism operators' perceptions and adaptation to climate change in Hwange National Park, Zimbabwe. *Bulletin of Geography: Socio-economic Series*, *42*, 115–127. https://doi.org/10.2478/bog-2018-0034.

Narok County Government. (2018-2023). County Integrated Development Plan.

NASA's Goddard Institute for Space (GISS).

Netto, A. P. (2009). "What is tourism? Definitions, theoretical phases and principles". In *Philosophical issues in tourism*, Edited by: Tribe, J. 43–61. Bristol, , UK: Channel View Publications.

Neuvonen, M., Sievänen, T., Fronzek, S., Lahtinen, I., Veijalainen, N., & Timothy, R. C. (2015). "Vulnerability of cross-country skiing to climate change in Finland – an interactive mapping tool. *Journal of Outdoor Recreation and Tourism, 11*(October), 64–79. https://doi.org/10.1016/J.JORT.2015.06.010 Elsevier.

Ngaruiya, G., W. (2013). Future of wildlife tourism in a changing climate: Case study of the Amboseli ecosystem in Kenya. Climate Change and Security (CLISEC) group, Universität Hamburg.

Niang I, Ruppel O., C, Abdrabo M. A, Essel A, Lennard C, Padgham J., and Urquhart P. (2014). *Africa, Climate Change 2014: Impacts, Adaptation and Vulnerability. In VR Barros et al., eds, Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* NY. United Kingdom.: Cambridge University Press.

Njoroge, N. (2015). Tourism, millennium development goals and climate change in Kenya. *African Journal of Hospitality, Tourism and* Leisure Vol. 4(1) - (2015) ISSN: 2223-814X Copyright: © 2014 AJHTL - Open Access- Online @ http//: www.ajhtl.com

Nordhaus, W. (2019). Climate change: The ultimate challenge for economics. American Economic Review, 109 (6), 1991–2014.

Nyamwange, M. (2016). Impacts of climate change on tourism in Kenya. Journal of Geography and Earth Sciences December 2016, Vol. 4, No. 2, pp. 1-10 ISSN 2334-2447 (Print) 2334-2455 (Online). Published by American Research Institute for Policy Development DOI: 10.15640/jges.v4n2a1.

Nyaupane, G. P., & Thapa, B. (2004). Evaluation of ecotourism: A comparative assessment in the Annapurna Conservation Area Project, Nepal. *Journal of Ecotourism*, *3*(1), 20-45.

Ogutu, J. O., Piepho H.-P, Said M. Y, Ojwang G. O, Njino L. W, Kifugo S. C, and Wargute, P. W. (2016). Extreme Wildlife Declines and Concurrent Increase in Livestock Numbers in Kenya: What Are the Causes? PLoS ONE 11(9): e0163249.

Ogutu, J. O., Piepho, H. P., & Dublin, H. T. (2014). Responses of phenology, synchrony and fecundity of breeding by African ungulates to interannual variation in rainfall. *Wildlife Research*, *40*(8), 698-717.

Ogutu, J. O., Piepho, H.-P., Dublin, H. T., Bhola, N., and Reid, R. S. (2008). Rainfall influences on ungulate population abundance in the Mara–Serengeti ecosystem. *Journal of Animal Ecology.*, 77, 814–829.

Ojwang', G. O., Wargute P. W., Said, M. Y, Worden, J. S., Davidson, Z., Muruthi, P., Kanga, E., Ihwagi, F., and Okita-Ouma, B. (2017). Wildlife Migratory Corridors and Dispersal Areas: Kenya Rangelands and Coastal Terrestrial Ecosystems

Okello, M., M., Kenana, L., Maliti H., Kiringe J. W, Kanga E., W. F., Bakari, S., Ndambuki S., Massawe E., Sitati, N., Kimutai D., Mwita, M, Gichohi N., Muteti D., Ngoru B., Mwangi P. (2016). Population density of elephants and other key large herbivores in the Amboseli ecosystem of Kenya in relation to droughts. *Journal of Arid Environments 135 (2016) 64-74.*

Olff, H., Ritchie M. E., and Prins, H. H. T. (2002). Global environmental controls of diversity in large herbivores. *Nature.*, 901-904.

Omondi, P., Awange, J.L., Forootan, E., Ogallo, L.A., Barakiza, R., Girmaw, G.B., Fesseha, I., Kululetera, V., Kilembe, C., Mbati, M.M. and Kilavi, M. (2014). Changes in temperature and precipitation extremes over the Greater Horn of Africa region from 1961 to 2010. *Inter. J. of Climatology*, 34(4), pp.1262-1277. http://doi.org/10.1002/joc.3763

Ongoma, V. and Chen, H. (2017). Temporal and spatial variability of tempera-ture and precipitation over East Africa from 1951 to 2010. *Meteorol Atmosc Phys* 129(2):131 – 144. https://doi.org/10.1007/s00703-016-0462-0.

Orodho, J. A. (2004). Techniques of writing research proposals and reports in education and social sciences. *Nairobi: Masola Publishers*.

Orodho, J. A. (2008). Techniques of writing research proposals and reports in education and social sciences. Bureau of educational research. *Kenyatta University, Nairobi, Kenya: Kanezja HP Enterprises*.

Osborne, J. W., & Waters, E. (2002). Four assumptions of multiple regression that researchers should always test. *Practical Assessment, Research, and Evaluation*, *8*(1), 2.

Oswald, S., A., Huntley B., and Collingham Y. C.,. (2011.). . Physiological effects of climate on distributions of endothermic species. *J. Biogeogr.*, 430–438.

Otieno, P. S., Ogutu, C. A., Mburu, J., & Nyikal, R. A. (2017). Effect of Global-GAP policy on climate change perceptions of smallholder French beans farmers in central and Eastern Regions, Kenya. *Climate*, *5*(2), 27.

Otieno, V. O. and Anyah, R.O. (2013). CMIP5 simulated climate conditions of the Greater Horn of Africa (GHA). Part II. Projected climate. *Clim. Dyn*. 41: 2099–2113. https://doi.org/10.1007/s00382-013-1694-z.

Ottichilo W.K., de Leeuw J., and Prins H.H.T. (2001). Population trends of resident wildebeest [Connochaetestaurinus hecki (Neumann)] and factors influencing them in the Maasai Mara ecosystem, Kenya. *Biological Conservation*, 97: 271-282.

Ottichilo, W. K., De Leeuw, J., Skidmore, A. K., Prins, H. H., & Said, M. Y. (2000). Population trends of large non-migratory wild herbivores and livestock in the Masai Mara ecosystem, Kenya, between 1977 and 1997. *African journal of Ecology*, *38*(3), 202-216.

Pallant, J. (2005). SPSS Survival Manual. 2nd edn.

Pan, S. Y., Gao, M., ; Kim, H., ; Shah, K.J., ; Pei, S.L., and ; Chiang, P., C. (2018). Advances and Challenges in Sustainable Tourism toward a Green Economy. Sci. Total Environ. 2018, 635, 452–469.

Pandy, W. R. (2017). Tourism enterprises and climate change: some research imperatives. *African Journal of Hospitality, Tourism and Leisure, Volume 6 (4),* 1-18.

Passer, M. W. (2014). *Research Methods: Concepts and Connections.* New York: Worth Publishers.

Patterson J., K. Carol (2016). Sustainable tourism. Business development, operations and management. *Human Kinetics,* United States.

Perch-Nielsen, S. L. (2010). The vulnerability of beach tourism to climate change-An index approach. *Climatic Change*, *100*(3–4), 579–606.

Piniewski M., Mezghani A, and Szcze, M. (2017). Regional projections of temperature and precipitation. Climate Change 2007 Physical Science Basis Summary of Policymakers Contribution of Working Group I to Fourth Assessment Report New York: Intergovernmental Panel of Climate Change.

Preacher, K. J., Rucker, D. D., & Hayes, A. F. (2007). Addressing moderated mediation hypotheses: Theory, methods, and prescriptions. *Multivariate behavioral research*, *42*(1), 185-227.

Preethi, B., Manigandan, J. and Suresh. M. V. (2019). Game theory and climate change. *International Journal of Engineering and Management Research*. e-ISSN: 2250-0758 | p-ISSN: 2394-6962 Volume- 9, Issue- 3.

Prince S., D., and Tucker, C., J. (1986). Satellite remote sensing of rangelands in Botswana II. *International Journal of Remote Sensing*, Vol. 7(11): 1555-1570.

Prince, S., D. (1991). Satellite remote sensing of primary production: comparison of results for Sahelian grasslands 1981-1988. *International Journal of remote sensing*, *12*(6), 1301-1311.

Rahman, M., I.-U. (2013). Climate Change: A Theoretical review. *Interdisciplinary Description of Complex Systems*, 1-13.

Reddy, M. (2011). Tourism and climate change risks: opportunities and constraints in South Africa. University of the Witwatersrand.

Richard, Y., and Poccard, I. (1998). A statistical study of NDVI sensitivity to seasonal and inter-annual rainfall variations in Southern Africa. *International Journal of Remote Sensing*,, 19915):2907-2920.

Richmond-Coggan., L. (2016). Assessing wildlife distribution and population trends in the Greater Mara Ecosystem, Kenya. *Research Gate.*, 10-14.

Ripple, W. J., Newsome, T. M., and Wolf, C. (2015). Collapse of the world's largest Herbivores. *Science Advances.*

Rockström, J. (2009). A safe operating space for humanity. *Nature*, 472-475.

Rogerson, C. M. (2016). Climate change, tourism and local economic development in South Africa. Local Economy, 31(1–2), 322–331. doi: 10.1177/0269094215624354.

Rogerson, J. M., & Sims, S. R. (2012). The greening of urban hotels in South Africa: Evidence from Gauteng. *Urban Forum*, *23*, 391–407. doi: 10.1007/s12132-012-9160-2.

Root, T., Price, J., Hall, K., Schneider, S., Rosenzeig, C., and Pounds, J. (2003). Fingerprints of global warming on wild animals and plants. *Nature*, 421: 57-60.

Rosselló, J. W. (2015). The use of tourism demand models in the estimation of the impact of climate change on tourism. *Revista Turismo em Analise*, 4-20.

Rosselló-Nadal, J. (2014) How to evaluate the effects of climate change on tourism. Tour Manag 42:334–340

Rutty, M., Gössling, S., Scott, D., & Hall, C. (2016). The global effects and impacts of tourism. *C. Hall, y S. Gossling, The Routledge Handbook of Tourism and Sustainability*, 36-62.

Rutty, M., Scott, D., Johnson, P., Pons, M., Robert Steiger, & Vilella, M. (2017). Using ski industry response to climatic variability to assess climate change risk: An analogue study

in eastern Canada. *Tourism Management, 58*(February), 196–204. https://doi. org/10.1016/J.TOURMAN.2016.10.020 Pergamon.

Sanghi, A.purva, Richard Damania, R., Farah Manji, F. and Maria Paulina Mogollon, M., P. (2017). Standing out from the herd: An economic assessment of tourism in Kenya (English). Washington, D.C., World Bank Group.

Sankaran, M., Hanan N. P., Scholes R.J., Ratnam J., Augustine D. J., and Cade B. S. (2005). Determinants of woody cover in African savannassavannahs. *Nature.*, 846-849.

Sarfaraz, H. Z., Maedeh S., R. M., & Edmundas K., Z. (2015). Sustainable tourism: a comprehensive literature review on frameworks and applications, Economic Research-Ekonomska Istraživanja, 28:1,1-30, DOI: 10.1080/1331677X.2014.995895.

Saunders, K. M., & Gell, P. A. (2017). Paleoecological Evidence for Variability and Change in Estuaries: Insights for Management. In *Applications of Paleo environmental Techniques in Estuarine Studies* (pp. 75-86). Springer, Dordrecht.

Saunders, M. N. (2011). *Research methods for business students, 5/e*. Pearson Education India.

Saunders, M., Lewis, P., & Thornhill, A. (2007). Research methods for business students (5th ed.). New Jersey: Prentice -Hall.

Scott, D, McBoyle G, and Schwartzentruber, M. (2004) Climate change and the distribution of climatic resources for tourism in North America. Climate Research, 27:105–117.

Scott, D. (2008). *Climate Change and Tourism: Responding to Global Challanges.* Bahamas: Carribean Regional Sustainable Tourism Development Programme.

Scott, D. (2021). Sustainable Tourism and the Grand Challenge of Climate Change. *Sustainability* 2021, *13*, 1966. https://doi.org/10.3390/su13041966.

Scott, D. and Becken, S. (2010). Adapting to climate change and climate policy: Progress, problems and potentials. *Journal of sustainable tourism*, 18 (3), 283-295.

Scott, D., & Lemieux, C. (2010). Weather and climate information for tourism. *Procedia Environmental Sciences*, 1, 146e183.

Scott, D., Gössling, S., & de Freitas, C. R. (2009). Preferred climates for tourism: case studies from Canada, New Zealand and Sweden. *Climate Research*, *38*(1), 61-73.

Scott, D., Hall, C. M., & Gössling, S. (2016). A review of the IPCC 5th assessment and implications for tourism sector climate resilience and decarbonization. *Journal of Sustainable Tourism*, 24(1), 8–30.

Scott, D., Hall, C. M., & Gössling, S. (2019). Global tourism vulnerability to climate change. Annals of Tourism Research 77 (2019) 49–61.

Scott, D.; Hall, C.M.; Gössling, S. (2019). Global tourism vulnerability to climate change. *Ann. Tour. Res.*, *77*, 49–61.

Scott, N., & Laws, E. (2005). Knowledge sharing in tourism and hospitality. *Journal of Quality Assurance in Hospitality & Tourism*, *7*(1-2), 1-12.

Scott., D., Gossling, S. and Hall, C.M. (Eds). (2005). Global environmental change and mountain tourism. *Tourism and Global Environmental Change*, 54-74.

Segan, D. B, Murray K. A., and Watson J. E. M. (2016). A global assessment of current and future biodiversity vulnerability to habitat loss-climate change interactions. *Glob Ecol Conserv.*, 5: 12–21.

Semenza, J., C. and Kristie, E., L. (2019). Climate change impact on migration, travel, travel destinations and the tourism industry. *Journal of Travel Medicine*, 2019, 1–13.

Seneviratne, S. I. (2012). *Changes in climate extremes and their impacts on the natural physical environment Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC)*. Cambridge, UK: Cambridge University Press.

Seno, S. K., & Shaw, W. W. (2002). Land tenure policies, Maasai traditions, and wildlife conservation in Kenya. *Society & Natural Resources*, *15*(1), 79-88.

Seppälä, R., Buck, A. & Katila, P., eds. (2009). *Adaptation of forests and people to climate change: a global assessment report.* Helsinki: IUFRO World Series.

Serdeczny, O., Adams, S., Baarsch, F., Coumou D., Robinson, A., Hare, W., Schaeffer, M., Mahe´ P.errette, and Reinhard, J., (2015). Climate change impacts in Sub-Saharan Africa: from physical changes to their social repercussions. Regional Environmental Change ISSN 1436-3798 Reg Environ Change. DOI 10.1007/s10113-015-0910-2.

Serneels, S., Said, M.Y., and Lambin, E. F.,. (2001). Land cover changes around a major east African wildlife reserve: The Mara ecosystem (Kenya). *International Journal of Remote Sensing.*, 22: 3397-3420.

Sheng, L. (2011). Regional competition and sustainable development: a game theory model for tourism destinations. *European Planning Studies*, *19*(4), 669-681.

Sheriff, G. (2019). Burden sharing under the Paris climate agreement. *Journal of the Association of Environmental and Resource Economists*, *6*(2), 275-318.

Shongwe, M. E. (2010). Projected Changes in Mean and Extreme Precipitation in Africa under Global Warming. Part II: East Africa. *Journal of Climate.*, 3719-3792.

Shongwe, M.,Oldenborgh, E. and Hurk, G. (2011). Projected changes in mean and extreme precipitation in Africa under global warming. *Climate Journal*, 18-33.

Siddiqui, S., & Imran, M. (2019). Impact of Climate Change on Tourism. In Sharma, R., & Rao, P.Environmental Impacts of Tourism in Developing Nations (pp. 68–83). IGI global. https://doi.org/10.4018/978-1-5225-5843-9.ch004.

Simpson, M.C., Gössling, S., Scott, D., Hall,C.M. and Gladin, E. (2008). Climate change adaptation and mitigation in the tourism sector: frameworks, tools and practices. Paris, France: Oxford University Press.

Sinervo, B., Mendez-De-La-Cruz, F., Miles, D. B., Heulin, B., Bastiaans, E., Villagrán-Santa Cruz, M., ... & and Gadsden, H. (2010). *Erosion of lizard diversity by climate change and altered thermal niches*. *Science*, *328*(5980), 894-899.

Small, Mario and Luis. (2011). "How to conduct a mixed methods study: recent trends in a rapidly growing literature." *Annual Review of Sociology. 37*: 57-86.

Sobel, M. E. (1982). Asymptotic confidence intervals for indirect effects in structural equation models. *Sociological methodology, 13*, 290-312.

Stevens, J. P. (2009). *Applied multivariate statistics for the social sciences* (5th ed.). New York, NY: Routledge.

Steyn, J. N., & Spencer, J. P. (2012). Climate change and tourism: Implications for South Africa. *African Journal for Physical, Health Education, Recreation and Dance*, *18*(1), 1–19.

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics,* Upper Saddle River.

Tashakkori, A. and Teddlie, C. (eds). (2003). *Handbook of Mixed Methods in Social and Behavioral Research.* CA: Sage Publications.

Tashakkori, A., & Teddlie, C. (2010). *Putting the human back in ''human research methodology''*: The researcher in mixed methods research.

Temperli, C., Bugmann, H., & Elkin, C. (2013). Cross-scale interactions among bark beetles, climate change, and wind disturbances: A landscape modeling approach. *Ecological Monographs*, *83*(3), 383-402.

Tervo-Kankare, K., Hall, C. M. & Saarinen, J. (2013). Christmas tourists' perceptions to climate change in Rovaniemi, Finland. *Tourism Geographies*, 292-317.

Tierney, J. E., Ummenhofer, C. C., Demenocal, P. B. (2015). Past and future rainfall in the Horn of Africa. Sci. Adv. 2015, 1, e1500682.

Tight, M., Blaxter, L., & Hughes, C. (2006). *How to research.* Berkshire.

Toimil, A., Díaz-Simal, P., Losada, I. J., & Camus, P. (2018). Estimating the risk of loss of beach recreation value under climate change. *Tourism Management*, 68, 387–400. doi:10.1016/j.tourman.2018.03.024.

Tol, R., S., J., and Walsh S. (2012). The impact of climate on tourist destination choice. ESRI Working Paper.

Travel Industry Association of America. (2002). Tourism works for America, annual report, 11th edition. Washington, DC: Travel Industry Association of America.

Turton, S. H. (2009). *The impacts of climate change on Australian tourism destinations: developing adaptation and response strategies-a scoping study.* Queensland: CRC for Sustainable Tourism.

United Nations Development Program. (2012). Shinyanga Soil Conservation Programme (HASHI). Tanzania. Equator Initiative Case Study Series, New York

United Nations Environmental Program & World Tourism Organisation. (2005). Making Tourism More Sustainable. *A Guide for Policy Makers*, 11-12.

United Nations Environmental Program. (2012). Making Tourism more Sustainable: A guide for policy makers. New York: UNEP

Valls, J. F. (2009). Tourism expert perceptions for evaluating climate change impacts on the Euro-Mediterranean tourism industry. *Tourism Review*, 41-51.

Van, Wilgen, N., J., Goodall, V., Holness, S., Chown, S.L., and McGeoch, M.A., (2016). Rising temperatures and changing rainfall patterns in South Africa's national parks. Int. J. Climatol. 36 (2), 706–721.

Vié, J., -C., Hilton-Taylor, C. & Stuart, S., N. (2008). Wildlife in a changing world: an analysis of the 2008 IUCN Red List of Threatened Species. Gland, Switzerland: IUCN.

Viner, D. and Agnew, M. (1999). Climate Change and its Impacts in Anglia: WWF-UK Climatic Research Unit.

Vlassopoulos, C. (2012). Competing definition of climate change and the post-Kyoto negotiations. *International Journal of Climate Change Strategies and Management*, 104-118.

Voeten, M. M., C. A. D. M., Van De Vijver, H. Olff & F. and Van Langevelde. (2009). Possible causes of decreasing migratory ungulate populations in an East African savannah after restrictions in their seasonal movements. African Journal of Ecology 48: 169-179.

Walmsley, A. (2011). Climate change mitigation and adaptation in the hospitality industry. *In Trends and Issues in Global Tourism*, 77-91.

Walther, G.-R., Post, E., Convey, P., Menzel, A., Parmesan, C., Beebee, T. J., Fromentin, J.-M., Hoegh-Guldberg, O. and Bairlein, F. (2002). Ecological responses to recent climate change. *Nature*, 389-395.

Wang L., Xiao huaWei, Kevin Bishop, Alison D. Reeves, Nadia Ursino, and Rita Winkler. (2018). Vegetation changes and water cycle in a changing environment. *Hydrol. Earth Syst. Sci.*, 1731–1734.

Wang, J., Rich, P. M., & Price, K. P. (2003). Temporal responses of NDVI to precipitation and temperature in the central Great Plains, USA. *International journal of remote sensing*, *24*(11), 2345-2364.

Weaver, D. (2011). Can sustainable tourism survive climate change? *Journal of Sustainable Tourism*, 19 (1).

Western, D., Russell S., Cuthill. (2009). The status of wildlife in protected areas compared to non-protected areas of Kenya. *PLoS One 4, e6140. doi: 10.1371/journal.pone.*, 0006140 PMID: 19584912.

Wet Tropics Management Authority. (2008). State of the Wet Tropics Report, 2007-2008. Cairns.

Williams, A. P., and C. Funk. (2011). A westward extension of the warm pool leads to a westward extension of the Walker circulation, drying eastern Africa. *Climate Dynamics.*, 37:2417–2435.

Williams, A., Karoly, D., and Tapper, N., . (2001). The Sensitivity of Australian fire danger to climate change. *Climate Change*, 171-191.

Williams, S., B. (2003). Climate Change in Australian tropical rainforests: An impending environmental catastrophe. *Proceedings of the Royal Society of London Series*, 270: 1887–1892.

Wolf, J. A. (2011). Individual understandings, perceptions, and engagement with climate change: insights from in-depth studies across the world. *Wiley Interdisciplinary Reviews: Climate Change*, 547-569.

Wong, K.., M. & Thirumoorthi, T. (2015). Tourism chapter 24. *Selected Theories in Social Science Resesrch*, 1-2.

Wood, P. J. (2010). *Climate Change and Game Theory: a Mathematical Survey*, CCEP working paper 2.10, Centre for Climate Economics & Policy, Crawford School of Economics and Government, The Australian National University, Canberra.

Woodroffe, R., Groom, R., & Weldon, J. (2017). Hot dogs: High ambient temperatures impact reproductive success in a tropical carnivore. *Journal of Animal Ecology*, *86*, 1–10.

World Bank (2017). An economic assessment of tourism in Kenya. Standing out from the Heard. The World Bank.

World Bank (2018). Supporting sustainable livelihoods through Wildlife tourism. The World Bank Group.

World Bank (2014). *Climate change, disaster risks and the urban poor: Cities building resilience for a changing world*, Washington: International Bank for Reconstruction and Development. Retrieved from http://siteresources.worldbank.org/Inturban_development/Resources/ 336387-1306291319853/Summary.pdf

World Meteorological Organization (1979). Proceedings of the World Climate Conference, A conference of experts on Climate and Mankind. Geneva.

World Meteorological Organization United in Science (2020). A Multi-Organization High-Level Compilation of the Latest Climate Science Information. Available online: https://public.wmo.int/en/resources/united_in_science (accessed on 10 February 2021).

World Tourism Organisation (2010). International recommendations for tourism statistics 2008. UNWTO, Madrid.

World Tourism Organisation (2005). Making Tourism more sustainable. A Guide for Policy Makers, 11-12.

World Tourism Organisation. (2008). *Climate Change Adaptation and Mitigation in the Tourism Sector, Frameworks, Tools and Practise.* Paris: Madrid.

World Tourism Organisation. (2009). From Davos to Copenhagen and beyond: *Advancing tourism's response to climate change.* Madrid.

World Tourism Organization and International Labor Organization (2014). Measuring Employment in the Tourism Industries – Guide with Best Practices, UNWTO, Madrid

World Tourism Organization and International Transport Forum. (2021). Transport-related CO_2 Emissions of the Tourism Sector , Modelling Results. Published by the World Tourism Organization (UNWTO), Madrid, Spain.

World Tourism Organization and United Nations Environment Programme (2019), *Baseline Report on the Integration of Sustainable Consumption and Production Patterns into Tourism Policies*, UNWTO, Madrid, DOI: https://doi.org/10.18111/9789284420605.

World Tourism Organization, United Nations Environment Program and World Tourism Organisation. (2008). Climate change and tourism responding to global challenges. ISBN: 978-92-844-1234-1 (UNWTO). ISBN: 978-92-807-2886-6.

World Tourism Organization. (2013). Sustainable tourism for development guidebook. *World Tourism Organization, European Commission, Madrid*.

World Tourism Organization. (2018). UNWTO tourism highlights 2018 edition. Retrieved from https://www.e-unwto.org/doi/pdf/10.18111/9789284419876.

World Tourism Organization. (2019). *Tourism Highlights 2016.* Madrid, Spain: UNWTO.

World Tourism Organization. (2020). Global and regional tourism performance. A compilation of data on outbound tourism by country, including data on international tourism expenditure and outbound trips. Madrd, Spain.

World Tourism Organization. (2021). Global survey among UNWTO Panel of Tourism Experts on the impact of COVID-19 on tourism. News release. Madrid, Spain.

World Travel and Tourism Council. (2019). The Economic impact of global wildlife tourism. travel and tourism as an economic tool for the protection of Wildlife. The Harlequin Building, 65 Southwark Street, London SE1 0HR, United Kingdom.

World Travel Tourism Organization and International Transport Forum (2019). Transport-related CO_2 Emissions of the Tourism Sector - Modelling Results, UNWTO, Madrid, DOI: https://doi.org/10.18111/9789284416660.

Wu, S., A. Cruz, R.V., Harasawa, H., Lal, M., Y., Punsalmaa, B., Honda, Y., Jafari, M., Li, C., and Huu Ninh, N. (2008). Asia. In Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J., and Hanson, C.E. (2007). Climate change 2007: Impacts, adaptation and vulnerability. *Cambridge University Press.*

Yamane, T. (1967). *Statistics:* An Introductory Analysis, and New York: Harperand Row.

Yazdanpana, H., Barghi, H., & Esmaili, A. (2016). *Effect of climate change impact on tourism: A study on climate comfort of Zayandehroud River route from 2014 to 2039.* Tourism Management Perspectives,17, 82–89. doi:10.1016/j.tmp.2015.12.002.

Yin, R. K. (2003). Case study research: design and methods (ed.). *Thousand Oaks*.

Zeppel, H. (2011). Climate Change and Global Tourism: A Research Compendium. Queensland: Australian Centre for Sustainable Business and Development.

Zhang, Y., Chen, Y., Westerhoff, P., & Crittenden, J. (2016). *Impact of natural organic matter and divalent cations on the stability of aqueous nanoparticles*. *Water research*, *43*(17), 4249-4257.

Zikmund, W. G., & Babin, B. J. (2010). *Exploring marketing research* (10th Edn) South-Western Cengage Learning.

APPENDICES

APPENDIX I: LETTER OF INTRODUCTION

I am Mr. Rotich K. Laban a student from The Technical University of Kenya pursuing a Doctor of Philosophy Degree in Tourism Management. Currently, I am conducting a study entitled **ASSESSING THE EFFECTS OF NATURAL RESOURCES ON TOURISM SUSTAINABILITY UNDER CLIMATE CHANGE.** The purpose of this study was purely for academic pursuit. Your help in filling in the questionnaire was highly appreciated and ALL information obtained was treated with utmost confidentiality.

Yours faithfully,

Rotich K. Laban.

APPENDIX II: QUESTIONNAIRE FOR THE HOST COMMUNITY IN MAASAI MARA NATIONAL RESERVE

This study seeks to establish the relationship between climate change, natural resources and tourism sustainability in Maasai Mara National Reserve (MMNR). The information being collected is used for academic purposes only and the researcher will keep such information with utmost confidentiality. Thank you for your participation.

Section A: Demographics

1. Gender: **Male [ ] Female [ ]**
2. Age: **15-25yrs [ ] 26-35yrs [ ] 36-45yrs [ ] Above 45yrs [ ]**
3. Marital Status: **Single [ ] Married [ ] Separated [ ] Widowed [ ]**
4. Level of Education: **Primary[ ] Secondary [ ] Diploma [ ] Higher Diploma [ ] Undergraduate [ ] Masters [ ] PhD [ ]**
5. Employment status: **Employed [ ] Self Employed [ ] Unemployed [ ]**

Section B: Climate change, Natural resources and tourism sustainability

6. The following are statements about climate change, natural resources and tourism sustainability in Maasai Mara National Reserve (MMNR). To what extent do you agree or disagree with these statements using the **keys** below**:**
   [5] Strongly Agree, [4] Agree, [3] Neutral, [2] Disagree and [1] Strongly Disagree

		1	2	3	4	5
1.	Drought is rampant in Maasai Mara National Reserve					
2.	Floods scenarios are common in Maasai Mara National Reserve					
3.	Temperatures have risen in Maasai Reserve than before					
4.	The rainfall experienced in Maasai Mara Reserve is high					
5.	Rainfall patterns in Maasai Mara Reserve has changed					
6.	Mara river water flow level has changed					
7.	Tree population in Maasai Mara has reduced					
8.	Big five population has reduced in Maasai Mara Reserve					
9.	There is a change in vegetation cover in Maasai Mara Reserve					
10	Wildlife and domestic animals compete for water in the reserve					
11	Wildlife and domestic animals compete for pasture in the reserve					
12	The vegetation and grassland species have declined in the Mara					
13	There is a shift in grassland and habitats distribution in Mara					
14	There are sustainable tourism practices in Maasai Mara Reserve					
15	Climate change adaptation & mitigation strategies exist in Maasai Mara National Reserve					
16	Maasai Mara National Reserve conducts conservation education among their staff & tourists					
17	Wildlife/Vegetation conservation programs exist in Maasai National Reserve					

18	Reuse, recycling & reducing practices are carried out in Maasai Mara National Reserve					
19	There are environmental protection guidelines in Maasai Mara					
20	There is richness of Maasai culture & heritage in the Mara					
21	There is a rise of social amenities within Maasai Mara					
22	There is preservation & conservation of the Maasai culture					
23	Tourism unites the community and encourage people to work together and support each other in Maasai Mara National Reserve					
24	Tourism promotes the development of public facilities in Mara					
25	Tourism brings people of different backgrounds and cultures into the community in Maasai Mara National Reserve					
26	There is reduced profitability of tourism enterprises in Mara due to flooding/drought scenarios					
27	Host communities within the Mara have the ability to create wealth thorough tourism					
28	There are better recreational facilities in the Maasai Mara Reserve region because of tourism					
29	There is improvement of livelihood among local communities in Maasai Mara National Reserve					
30	There is increased employment opportunities in the Mara					
31	There is improvement in the local economy strength in Maasai Mara National Reserve					
32	Increase in prices and property values makes it difficult for sections of people to live in the Mara					
33	There is increased urban development within the reserve					
34	Tourism is good for the economy because the money that visitors spent when they visit Mara helps stimulate the economy					

Section C: Effects of climate change on natural resources and tourism sustainability

7. The following are statements about the effects climate change on natural resource and tourism sustainability in Maasai Mara National Reserve (MMNR). To what extent do you agree or disagree with these statements using the **key:**
   [5] Strongly Agree, [4] Agree, [3] Neutral, [2] Disagree and [1] Strongly Disagree

	(Kindly tick where appropriate)	1	2	3	4	5
1.	Scenarios of drought and floods have increased in the wildlife population reserve					
2.	The loss of biodiversity resulting from floods and droughts in the reserve					
3.	Higher temperatures decrease the backup food and water supply					
4.	Drought and flooding in the reserve will reduce conservation and preservation measures					
5.	Because of lower water availability and increased heat there is tree death in the reserve.					
6.	Such fluctuations in precipitation and temperature on the reserve immediately influence wildlife and plants.					
7.	The reserve's wildlife species are vulnerable to changes in precipitation and temperature that contribute to population decreases as well as deaths or changed species.					
8.	The dry circumstances in the reserve are generating human wildlife conflict and drive lions towards waterholes next to the human settlement.					
9.	Species in the reserve have a risk of disrupting seasonal cycles of food production and reproduction during extended dry seasons.					
10.	During drought circumstances in the reserve, the danger of increasing fires is expected to raise further pressures for fragile ecosystems					
11.	Increasing temperatures in the area impact plant production and grassland composition					
12.	Erratic rainfall in the reserve impacts the productivity of vegetation and the composition of grassland species					
13.	Drought and floods decrease cover in the reserve vegetation					
14.	Increased temperatures in the reserve influence the abundance and number of plants and animal populations					
15.	Increasing temperatures change the distribution of grasslands and ecosystems in the reserve					
16.	Increasing heat and dryness led to changes in the flow of the river Mara that affected the reserve movement of wild animals					
17.	Drought and flooding in the reserve will reduce conservation and preservation measures					
18.	The decrease in vegetation undermines the reserve's tourist sustainability					
19.	A fall in 5 people in the reserve has an impact on tourist sustainability					
20.	The decrease in natural resources impacts tourism companies' profitability inside the reserve					
21.	Reserve tourism companies help affect the climate GHGs emissions					
22.	Drought and flood harm the reserve's cultural resources					

23.	Drought & floods makes tourism in the reserve less viable					
24.	Drought and floods in the reserve worsen poverty					
25.	New customs and habits while traveling will minimize the reserve carbon footprint					
26.	Higher temperatures raise the operating costs, such as reserve heating and cooling					
27.	Rapid precipitation patterns decrease the tourism activity range in the reserve					
28.	Drought and floods in the reserve decrease guests' length of stay					
29.	Drought and reserve floods limit the profitability of reserve tourist companies					
30.	Infrastructure damages flood conditions in the reserve					
31.	Flooding and drought in the reserve impair the capacity of the community to develop rich tourist					
32.	Flooding prevents tourist sites from accessing the reserve					

APPENDIX III: INTERVIEW GUIDE FOR TOURISTS IN MAASAI MARA NATIONAL RESERVE (MMNR)

This study seeks to investigate the relationship between climate change, natural resources and tourism sustainability in Maasai Mara National Reserve (MMNR). The information being collected is used for academic purposes only and the researcher will keep such information with utmost confidentiality. Thank you for your participation.

Section A: Background Information

Country of origin…….……

Number of visits to Maasai Mara National Reserve **1** [ ] **2** [ ] **3 [ ] 4 [ ] Above 5 [ ]**

Reasons for choosing to visit Maasai Mara National Reserve…….

Section B: Questions

1. Kindly comment if weather/climate conditions prompt you to visit Maasai Mara National Game Reserve? **YES** [ ] **NO** [ ]
2. If **YES** in 1 above, please describe your ideal weather/climate conditions that prompt you to visit Maasai Mara National Reserve?

   ……..……
3. Kindly describe what attracts you most to visit Maasai Mara National Reserve?.....……
   ……..……
4. In your own view, does the Maasai Mara National Reserve have any indicators of climate change? **YES** [ ] **NO** [ ]
5. Please indicate whether you have experienced any changes in weather/climate conditions in Maasai Mara National Reserve?.....…….

   ……..……
6. Kindly comment whether you have experienced rising temperatures above normal during your visit (s) to Maasai Mara National Reserve?

   YES [ ] **NO** [ ]
7. If **YES** in 6 above, please comment on how rising temperatures affects your stay in Maasai Mara National Reserve?.....
   ……..……
8. During your visit (s) to Maasai Mara National Reserve, please indicate whether you have experienced flooding conditions? **YES** [ ] **NO** [ ]
9. If **YES** in 8 above, comment on how flooding affects your stay in Maasai Mara National Reserve?.....

10. During your visit(s) to Maasai Mara National Reserve, comment on whether you have experienced reduced vegetation cover? **YES** [ ] **NO** [ ]

11. During your visit(s) to Maasai Mara National Reserve, what is your view on wildlife population especially the BIG FIVE?.....
……

12. Please indicate whether you have observed reduced water flows in Mara River?

YES [ ] **NO** [ ]

13. If **YES** in 12 above, indicate what could be the likely cause for reduced water flow in Mara
River?.....…
……

14. Kindly comment whether drought situations in Maasai Mara National Reserve reduce your length of stay? **YES** [ ] **NO** [ ]

15. Kindly comment on how you were received by the local communities during your visit (s) to Maasai Mara National
Reserve?.....……

16. Kindly please indicate whether the local communities in Maasai Mara National Reserve are proud about their culture? **YES** [ ] **NO** [ ]

17. Kindly describe the nature of your interaction with the local communities in Maasai Mara National Reserve?.....

……

18. Please indicate your view on wildlife/vegetation conservation initiatives in Maasai Mara National Reserve?.....

……

19. Kindly describe your understanding about sustainable tourism?
……

20. In your own opinion, comment on sustainability of tourism in Maasai Mara National Reserve?.....
……

21. Please comment on adaptation and mitigation strategies to changing climatic conditions in Maasai Mara National Reserve?
……

APPENDIX IV: KEY INFORMANT INTERVIEW GUIDE FOR NATURAL RESOURCES EXPERTS

This study seeks to investigate the relationship between climate change, natural resources and tourism sustainability in Maasai Mara National Reserve (MMNR). The information being collected is used for academic purposes only and the researcher will keep such information with utmost confidentiality. Thank you for your participation.

Section A: Background Information

Background of expertise…….……...

Areas of expertise…….....……..

Number of years in expertise (Please TICK below)

0-3 years [ ] **4-5 years** [ ] **6-7years** [ ] **8- 9 years** [ ] **Over 10 years** [ ]

Level of Knowledge of Maasai Mara ecosystem

Very Good [ ] **Good** [ ] **Acceptable** [ ] **Poor** [ ] **Very Poor** [ ]

Section B: Objectives

1. In your own opinion, how does climate change affect natural resources in Kenya?

2. With your knowledge of expertise, kindly comment on how flooding in Maasai Mara National Reserve affect;
   i. Wildlife population?

   ii. Vegetation cover?

3. In your own opinion, how does drought in Maasai Mara National Reserve affect;
   i. Wildlife population?

   ii. Vegetation cover?

APPENDIX V: KEY INFORMANT INTERVIEW GUIDE FOR TOURISM SUSTAINABILITY EXPERTS

This study seeks to investigate the relationship between climate change, natural resources and tourism sustainability in Maasai Mara National Reserve (MMNR). The information being collected is used for academic purposes only and the researcher will keep such information with utmost confidentiality. Thank you for your participation.

Section A: Background Information

Background of expertise……..……...

Areas of expertise…….....……..

Number of years in expertise (Please TICK below)

1-2 years [ ] **2-3 years** [ ] **3-5 years** [ ] **Over 5 years** [ ] **Over 10 years** [ ]

Level of Knowledge of Maasai Mara ecosystem

Very Good [ ] **Good** [ ] **Acceptable** [ ] **Poor** [ ] **Very Poor** [ ]

Section B: Questions

1. In your own opinion, does climate change affect tourism?
2. What would be your comment on how climate change affects the tourism industry?
3. In your own opinion, what would be your comment on how the said climate change indicators affect tourism activities such as a safari, wild life photography, wildlife, nature walk and camping?
4. In your own view, how does drought and flooding scenarios affect tourism activities in Maasai Mara National Reserve?
5. Based on your expertise, what is your understanding about sustainable tourism?
6. In your own opinion, explain the effects of climate change on tourism sustainability?
7. In your own view, what are the effects of climatic influenced natural resources on tourism sustainability?
8. In your own opinion, how does climate change influence environmental sustainability of tourism in terms of wildlife population?
9. Based on your expertise, how does climate change influence socio-cultural sustainability of tourism in terms of local community's livelihoods?
10. Based on your expertise, what is the relationship between climate change and tourism sustainability in Maasai Mara National Reserve?
11. In your own opinion, how does natural resources mediate the relationship between climate change and sustainability of tourism in Maasai Mara National Reserve?
12. In your own view, what strategies and actions has your organization put in place to address climate change effects on natural resources?
13. Based on your expertise, how effective would you say strategies put in place in addressing climate change effects on natural resources and sustainability of tourism are?
14. In your own opinion, what climate change adaptation strategies could be put in place to enhance sustainability of tourism?

APPENDIX VI: KEY INFORMANT INTERVIEW GUIDE FOR CLIMATE CHANGE EXPERTS

This study seeks to investigate the relationship between climate change, natural resources and tourism sustainability in Maasai Mara National Reserve (MMNR). The information being collected is used for academic purposes only and the researcher will keep such information with utmost confidentiality. Thank you for your participation.

Section A: Background Information

Background of expertise…….……...

Areas of expertise…….....……..

Number of years in expertise (Please TICK below)

1-2 years [ ] **2-3 years** [ ] **3-5 years** [ ] **Over 5 years** [ ] **Over 10 years** [ ]

Level of Knowledge of Maasai Mara ecosystem

Very Good [ ] **Good** [ ] **Acceptable** [ ] **Poor** [ ] **Very Poor** [ ]

Section B: Questions

1. Kindly, in your own opinion, what would you consider as key indicators of climate change in Kenya?

2. In your own view, which climate change effects are strongly evident in Kenya?

3. Kindly what would be your comment on rapid changes in rainfall patterns as a key indicator of climate change in Kenya?

4. Kindly what would be your comment on rising temperatures as an indicator of climate change in Kenya?

5. Kindly, what would be your comment on the causes of climate change in Kenya?

6. What would be your comment on plans/strategies the Kenyan Government has put in place to combat climate change?

7. Kindly comment on how successful/unsuccessful the strategies are that the Kenyan Government has developed in combating climate change?

8. What would be your comment on climate change adaptation/mitigation strategies in Kenya?

APPENDIX VII: PROCESS RESULTS (PROCESS PROCEDURE FOR SPSS RELEASE 2.13.2)

Run MATRIX procedure:

********** PROCESS Procedure for SPSS Release 2.13.2 **********

Written by Andrew F. Hayes, Ph.D. www.afhayes.com
Documentation available in Hayes (2013). www.guilford.com/p/hayes3

****
Model = 4
Y = Sustain
X = Climate
M = Natural

Sample size
295

****
Outcome: Natural

Model Summary

R	R-sq	MSE	F	df1	df2	p
.371	.137	.284	46.697	1.000	293.000	.000

Model

	coeff	se	t	p
constant	1.996	.241	8.277	.000
Climate	.480	.070	6.834	.000

Covariance matrix of regression parameter estimates

	constant	Climate
constant	.058	-.017
Climate	-.017	.005

****
Outcome: Sustain

Model Summary

R	R-sq	MSE	F	df1	df2	p
.651	.423	.193	107.249	2.000	292.000	.000

Model

	coeff	se	t	p
constant	.881	.221	3.994	.000
Natural	.184	.048	3.828	.000
Climate	.730	.062	11.710	.000

Covariance matrix of regression parameter estimates

	constant	Natural	Climate
constant	.049	-.005	-.009
Natural	-.005	.002	-.001
Climate	-.009	-.001	.004

********** TOTAL EFFECT MODEL **********

Outcome: Sustain

Model Summary

R	R-sq	MSE	F	df1	df2	p
.628	.395	.202	190.950	1.000	293.000	.000

Model

	coeff	se	t	p
constant	1.249	.203	6.145	.000
Climate	.818	.059	13.818	.000

Covariance matrix of regression parameter estimates

	constant	Climate
constant	.041	-.012
Climate	-.012	.004

********** TOTAL, DIRECT, AND INDIRECT EFFECTS **********

Total effect of X on Y

Effect	SE	t	p
.818	.059	13.818	.000

Direct effect of X on Y

Effect	SE	t	p
.730	.062	11.710	.000

Indirect effect of X on Y

	Effect	Boot SE	BootLLCI	BootULCI
Natural	.088	.038	.020	.167

Partially standardized indirect effect of X on Y

	Effect	Boot SE	BootLLCI	BootULCI
Natural	.153	.067	.036	.296

Completely standardized indirect effect of X on Y

	Effect	Boot SE	BootLLCI	BootULCI
Natural	.068	.029	.017	.128

Ratio of indirect to total effect of X on Y

	Effect	Boot SE	BootLLCI	BootULCI
Natural	.108	.050	.023	.218

Ratio of indirect to direct effect of X on Y

	Effect	Boot SE	BootLLCI	BootULCI

```
Natural      .121      .067      .024      .279

R-squared mediation effect size (R-sq_med)
          Effect   Boot SE  BootLLCI  BootULCI
Natural      .124      .036      .060      .203

Preacher and Kelley (2011) Kappa-squared
          Effect   Boot SE  BootLLCI  BootULCI
Natural      .084      .031      .024      .147

Normal theory tests for indirect effect
    Effect        se         Z         p
      .088      .027     3.313      .001
********** ANALYSIS NOTES AND WARNINGS **********
Number of bootstrap samples for bias corrected bootstrap confidence intervals:
     1000
Level of confidence for all confidence intervals in output:
    95.00
------ END MATRIX -----
```

APPENDIX VIII: EVIDENCE OF TWO PUBLISHED RESEARCH PAPERRS

(a) Rotich, K. L., Makopondo, R. O. B. M., Nehemia, K. K. and Barasa, W., D. (2020). *Perceived Effects of Climate Change on Tourism Sustainability in Maasai Mara National Game Reserve, Kenya.* International Tourism and Hospitality Journal. Print ISSN: 2616-518X, Online ISSN: 2616-4701. https://rpajournals.com.

(b) Rotich, K. L. Makopondo, R. O. B. M., Nehemia, K. K., and Barasa, W. D. (2019). *Climate change effects on natural resources availability and tourism sustainability in Maasai Mara National Game Reserve, Kenya.* African Journal of Hospitality, Tourism and Leisure, Volume 8 (5) - (2019) ISSN: 2223-814X. Open Access- Online @ http//: www.ajhtl.com.

APPENDIX IV: PICTURES FROM THE DATA COLLECTION

A dry Mara river during the dry season

Low water level in the Mara river in the dry season

APPENDIX IIV: PICTURES FROM THE DATA COLLECTION

Elephants in the rainy season with plenty of vegetation

A Women craft center and community water project as evidence of tourism sustainability