PERCEIVED EFFECTS OF CLIMATE CHANGE ON TOURISM AND NATURAL RESOURCES IN PROTECTED AREAS IN KENYA: A CASE OF MAASAI MARA NATIONAL RESERVE

BY

GEORGE O. MANONO

A THESIS SUBMITTED TO THE DEPARTMENT OF TOURISM MANAGEMENT, SCHOOL OF TOURISM, HOSPITALITY AND EVENTS MANAGEMENT IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE CONFERMENT OF DOCTOR OF PHILOSOPHY IN TOURISM MANAGEMENT DEGREE, MOI UNIVERSITY

APRIL, 2015

DECLARATION

Declaration by the Candidate

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

Name: **GEORGE O. MANONO** **…………………….** **…………………**

Reg. NO: SBE/ /TOU/ DPIL/ 012/09 **Signature** **Date**

Declaration by Supervisors

This research thesis has been submitted for examination with our approval as the University supervisors.

Prof. Bob Wishitemi **…………………….** **………………**

Moi University **Signature** **Date**

Prof. Paul Omondi **…………………….** **…………………**

Moi University **Signature** **Date**

Prof. Moses Makonjio Okello, **…………………….** **…………………**

School of Field Studies, Kenya **Signature** **Date**

DEDICATION

This thesis is dedicated to my wife Damiannah Kieti, my son Meldardus Derrick Onyiego Manono, my daughter Vera Nyambori and my late father Nyakweba Areri, for their love and value for education.

ACKNOWLEDGEMENTS

Success in this study would not have been realized without the indispensable support and encouragement from various individuals and organizations.

I am profoundly grateful to my supervisors, Professor Bob Wishitemi for his constant advice and constructive criticism during this study even though he was unwell. I acknowledge Professor Moses Okello Makonjio for his tireless efforts of reading and guiding me through the entire process. I appreciate Professor Paul Omondi for his contribution to the entire study and for his useful input in the study that improved the work. I acknowledge Mr. Kwoba for his timeliness in assisting and putting the work in the right perspective. I also acknowledge him for working with me until late hours just to make this study successful.

I wish to thank the entire staff of the School of Tourism, Hospitality and Events Management for their continued support during the preliminaries of the study. I am indeed indebted to the Department of Travel and Tour Operations Management of Moi University for providing me with all the facilities and time I required during my entire study period.

I will not forget to thank the management of Moi University for offering me partial scholarship that enabled me complete the study. I sincerely extend my gratitude to the Deputy Vice Chancellors Office in charge of Academic Research and Extension for offering research funds.

Finally, I should like to thank my family members, my mother Teresa Moraa Nyakweba, my sisters Helen Bosibori, Josephine, and Gladys Nyambeki, my brothers Kainda and Caleb for their encouragement during my studies.

But most of all I thank my wife Damiannah Kieti for her critical analysis of the whole work, her constant spiritual support, patience, encouragement and managing our domestic affairs so capably whilst I was busy. Lastly but not least, I thank my son Meldardus Derrick Onyiego Manono and my daughter Vera Nyamori for their moral and tireless support during this study.

All honor and glory is to God Almighty for life, health and the spirit, which kept me going.

ABSTRACT

Like in other developing countries, the tourism industry in Kenya depends heavily on the recreational opportunities presented by the natural environments, which include pristine nature, spectacular landscapes, rare species, wildlife in their natural habitat, as well as, idyllic beaches. Despite this reality, Kenya is facing many environmental challenges and risks, perceived to be associated with climate change, that are increasingly threatening Kenya’s future of tourism and natural resource base. This scenario accentuates the need for a paradigm shift in Kenya's tourism and natural resources management to counteract the adverse risks of climate change. Thus, the general objective of this study was to establish the perceived effect of climate change on tourism and natural resources in Maasai Mara National Reserve (MMNR). Specifically, the study established (i) the perceived effect of climate change on animal community; (ii) the perceived effect of climate change plant community; (iii) the perceived effect of climate change quantity of surface water; (iv) tourism and tourists activities, as well as, (v) the adaptation strategies to climate change adopted in MMNR. The study employed a survey research design and mixed research methods for data collection. The sample size comprised of 400 respondents, where 300 were the local community and 100 were the staff of MMNR. The findings of the study revealed that climate change negatively affect animals, especially in causing changes in their breeding grounds (β=0.69), changes in animal populations (β=0.65), increased animal deaths (β=0.65), changes in migration routes (β=0.65) and patterns (β=0.63). Important perceived effect of climate change on plants were changes in plant species (β=0.70), plants’ adaptation strategies (β=0.65), changes in distribution of plants (β=0.64), changes in vegetation cover (β=0.63), and emergence of alien species (β=0.62). Climate change was also found to affect changes in rainfall seasons/patterns (β=0.72), water level in Mara River and its tributaries (β=0.71), and changes in the availability of fresh water (β=0.70). With regard to tourism, climate change was found to alter tourists’ visitation patterns (β=0.74), their activity patterns (β=0.72), and tourists’ numbers and activity diversity (β=0.68). Although most respondents (73.5%) felt that, the MMNR had put into place some climate change adaptation strategies, deficiencies in the strategies were evident, as respondents felt that there was a need for more research on climate change impacts (90.5%). The study concluded that climate change has a significant effect on the quantity of surface water, followed by tourism, animals and lastly plants. The study recommends that a comprehensive legislative framework that will exclusively address all facets of climate change should be developed and the relevant institutional frameworks should embrace it for implementation.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

DEFINITIONS OF OPERATIONAL TERMS

Climate - The composite or generally prevailing weather conditions of a region measured in as temperature, air pressure, humidity, precipitation, sunshine, cloudiness, and winds, throughout the year, averaged over a series of years usually 30 – 35 years (Anderson, 2006).

Climate change – It is the changes in the earth's weather, including changes in temperature, wind patterns and rainfall, especially the increase in the temperature of the earth's atmosphere that is caused by the increase of particular gases, especially carbon dioxide (Ensaa, 2011).

Ecosystem - A system formed by the interaction of a community of organisms with their environment (Dictionary.com, 2014).

National Reserve - An area of land that is protected and managed in order to preserve a particular type of habitat and its flora and fauna which are often rare or endangered and it is under the jurisdiction of the county government (De Freitas, 2005).

Natural Resource – This is material or substance such as a forest, a mineral deposit, or fresh water, that is found in nature and is necessary or useful to humans (Appiah, 2007).

Protected Area – It is a geographical area under security and surveillance inorder to ensure its conservation and the security of its natural resources and wildlife (Anderegg, 2010).

Tourism - It is a composite of activities, services, and industries that deliver a travel experience: transportation, accommodations, eating and drinking establishments, shops, entertainment, activity facilities, and other hospitality services available for individuals or groups that are traveling away from home (Goeldner and Ritchie, 2012).

Tourist – It is a person who travels from place to place for non-work reasons (Franklin, 2000).

LIST OF ABBREVIATIONS

FAO **-**Food and Agriculture Organisation

GHG **-** Green-House Gas

GWPF - Global Warming Policy Foundation

IPCC **-** Intergovernmental Panel on Climate Change

LDCs **-**Least Developed Countries

MMNR **-** Maasai Mara National Reserve

NCCAP - National Climate Change Action Plan

NCCRS - National Climate Change Response Strategy

UNOHRLLS - United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States

PASW **-** Predictive Analytics SoftWare

UN **-** United Nation

UNEP - United Nations Environment Programme

UNFF **-** United Nations Forum on Forests

UNWTO - United Nation World Tourism Organisation

WTO - World Tourism Organisation

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

1.1.1 Essence of climate change

The earth's climate has changed throughout history and the 2001 Intergovernmental Panel on Climate Change (IPCC) report, pointed out that it is widely recognized and accepted that the global climate system is changing (Intergovernmental Panel on Climate Change, 2001). Since pre-industrial times, a marked increase has been noted in the atmospheric concentrations of greenhouse gases such as carbon dioxide, methane and nitrous oxide primarily due to human activities such as fossil fuel burning, land-use change and agricultural activities (Gitay, Suarez, & Watson, 2002). Climate change is a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer (IPCC, 2007).

Many ecosystems including national reserves and parks are experiencing significant impacts from a changing climate caused by global warming. Glaciers are melting or have disappeared; alpine habitats are been replaced by warmer climate zones affecting the animals like the pika that depends on cold climate associated with higher altitude, wild fires are more frequent and severe, and sea water levels are rising. Anderson (2006) for example, observed that Glaciers National Park in United States would lose its name if glaciers disappeared and Joshua Tree National Park in United States would be no more without Joshua Trees. According to The Arctic Impact Assessment (2004) report, climate variability and human activities have caused a profound damage to wildlife in protected areas. For example, at Bandelier National

Monument in the United States (U.S), higher temperatures and drought have brought high mortality to the Pinoi pines, *Pinus densifloraas*, infestations of bark beetles have expanded to higher elevations and new ranges. At Everglades National Park in the United States, increasing sea level due to climate change may overwhelm the Mangroove communities that filter out saltwater and maintain the fresh water wetlands. Another example is at Canyon de Chelly National Park in the United States, where floods and fires have damaged historic structures and are threatening the loss of archeological sites (Arctic Climate Impact Assessment, 2004).

According to Williams and Haak (2011), tourism activities are more likely to be affected by the severity and frequency of extreme events experienced across destinations, leading to the loss of ecosystems resilience to absorb disturbances. Ecosystem degradation would also lead to a decline or a change in biodiversity with multiple negative feedbacks (for example the loss of coral reefs can jeopardize tourism and shoreline protection). Ramsar (2010), pointed out that climate change, the demand for water to irrigate and poor management decisions have reduced the size of Lake Chad by 90% over the past 40 years. Elsewhere, Brashares, Arcese and Sam (2001), pointed out that land use adjacent to many protected areas has changed drastically. Because of the effects of climate change on terrestrial ecosystems, future changes in rainfall and temperature are likely to result in changes in plant and animal species composition and diversity, and shifts of species range (United Nations Environmental Program, 2009).

1.1.2 Global tourism trends

According to United Nations (UN) (2010), tourism has been growing faster than the world export trade. In 2012 for example, United Nations World Tourism Organisation (2013) noted that international tourist arrivals worldwide surpassed the 1 billion mark for the first time. Besides, the international tourism receipts amounted to US $ 1.075 billion in 2012 compared to 1,042 billion realized in 2011 (UNWTO, 2013). The growth is expected to increase by an average of 3.3% per annum over the period 2010 to 2030, thereby reaching 1.4 billion by 2020 and 1.8 billion by the year 2030 (ibid, 2013). The most significant growth will be witnessed in Asia and the Pacific where the international tourism arrivals will reach 535 million by 2030. Likewise, the Middle East and Africa are expected to experience significant increase in the arrivals to 149 million and 134 million by 2030 respectively.

As a consequence of the tourism boom, many nations have been lured into the business. In fact, UN (1993) noted that after the widespread failures of the Import Substitution Industrialization (ISI) strategy and the difficulties experienced in the export trade, many countries, particularly in the developing world embarked on tourism as a strategy to attain development. Besides, in some of the developing countries with limited resources for export, tourism has become a major lifeline for the economic growth (Akama, 1999).

Despite the impressive growth in the tourism industry, it is worth mentioning that a good deal of tourism relies upon resources or assets that cannot be reproduced or cannot be easily reproduced (Tisdell, 1984). UNWTO (2013) and Holtz and Edwards (2003) upheld that all forms of tourism, whether in urban centers or in rural set-up relies on natural resources for supplies of food, clean water and other ‘ecosystem services’ that ultimately depend on biodiversity. UNWTO (2013) added that biodiversity contributes significantly to the attractiveness and quality of destinations, and therefore to their competitiveness. Furthermore, biodiversity is a direct attraction at the heart of nature-based tourism products, such as, wildlife watching, scuba diving or tourism in protected areas (UNWTO, 2013).

As noted by Tribe (2004), since the earliest times, the enjoyment of environments whether defined in natural or in socio-cultural terms has had a major impact in shaping a succession of tourism. Brenner, Arnegger and Job (2002), for instance, revealed that since the onset of the industrial revolution, the natural environment has been an object of desire for the majority of Western tourists. Studies by Holtz and Edwards (2003) on inbound tourist motivations to different international tourism destinations revealed that 40–60% of all international tourists are nature-based tourists. Arguably, the demand for nature experiences be they at the seaside, in the mountains, or in a rainforest, has brought tourists and tourism developers to the most far-flung corners of the earth (Brenner *et al*., 2002).

However, UNWTO (2013) reported that the existing natural resources is under increasing pressure worldwide, as more land is converted for human use from a natural state and as these human uses become more intensive. Additionally, Tisdell and Elgar (2005) pointed out that the natural resources are increasingly endangered or are disappearing due to several issues. First, there is an increased destruction of habitats by humans and consequently the fauna’s loss of food, shelter or other means of life-support. Secondly, people are harvesting many species at a faster rate than ever before. Thirdly, people are competing intensely with the species for crucial resources, thereby creating a shortage of the resources for the species. Fourthly, pollution and degradation of the biosphere thereby eliminating important elements of the life-support systems of a majority of species.

The loss of ecosystems and the species they contain usually destroys their support functions (UNWTO, 2013). For instance, natural forests and vegetation act as natural stores of water in watersheds. Destroying these forests leads to increased risk of flooding, erosion and drought as the natural water storage function they perform is lost. Biodiversity loss has severe economic consequences due to the costs of the resulting damage such as a decline in yields from fisheries, or a decline in tourism as a destination becomes less attractive for visitors.

1.1.3 Tourism trends in Kenya

Kenya is one of the most important tourism destinations in Africa. In 2010, Kenya was ranked 9th in the UNWTO list of tourism destination in Africa, 5th in Sub-Saharan Africa and 1st in East Africa in terms of the number of visitor arrivals. The international tourism arrivals in Kenya increased from 1.037 million tourists in 2000 to 1.823 million in 2011 (Government of Kenya, 2012). Meanwhile, the tourism receipts rose from Kshs. 21.5 billion in 2000 to Kshs. 97.9 billion in 2011, giving an annual growth rate of approximately 17%. Kenya is heavily dependent on tourism as a source of revenue for the National government and certain County government authorities. In fact, over the last decade, tourism contributed 14.7% of foreign exchange earnings and 11% of revenue to the exchequer (Government of Kenya, 2012). Consequently, the tourism industry has continued to feature prominently in policies, plans and programmes for Kenya’s economic growth. According to Table 1.1, the tourism and economic trends of the Kenya’s industry has shown significant improvement and growth.

Table 1.1 : Tourism and economic trends in Kenya from 2004 - 2012

Year	**GDP (USD billion)**	**Tourism revenue (USD billion) %GDP**	**Tourism numbers growth rate (%)**
2004	14.900	0.480 (3.22)	1,360,700
2005	16.100	0.610 (3.79)	1,478,900 (8.69)
2006	18.700	0.710 (3.80)	1,600,000 (8.19)
2007	22.500	0.820 (3.65)	1,817,000 (13.56)
2008	27.360	0.660 (2.41)	1,203,200 (-33.78)
2009	30.460	0.780 (2.85)	952,481 (-20.84)
2010	30.580	0.920 (3.00)	1,095,945 (15.06)
2011	32.190	1.230 (3.82)	1,265,136 (15.44)
2012	33.620	1.210 (3.60)	1,230,000 (-2.78)

Source: Okello and Novelli ,2014.

However, over the years, natural resources which are actually the bedrock of tourism development in Kenya have increasingly been faced with serious challenges. Environmental changes such as frequent drought, increased environmental damage, increased infestation of livestock by pests and diseases, increased urban-rural migration, increased biodiversity loss, depletion of wildlife and other natural resource base, changes in the vegetation type, decline in forest resources, decline in health standards and the spread of infectious diseases, are some of the challenges that are perceived to be brought about by climate change. Such changes have raised growing concern that much of natural resource base and ecological environment are disappearing, thereby causing many traditional tourist destinations to lose their attractiveness.

The 2010 National Climate Change Response Strategy (NCCRS) recognized the importance of the impact of climate change to Kenya’s development. Kenya Vision 2030, which is the long-term development blueprint for the country, aims to transform Kenya into “a newly industrializing, middle-income country providing a high quality of life to all its citizens in a clean and secure environment (Government of Kenya , 2007). A low carbon climate resilient development pathway, as set out in the National Climate Change Action Plan (NCCAP), can help meet Vision 2030’s goals through actions that address both sustainable development and climate change. Achieving long-term sustainable economic growth upto and beyond Vision 2030 in the face of climate change is a primary concern for the Kenyan government and its partners.

Kenya is already susceptible to climate related events and such events pose a serious threat to the socio-economic development of the country. Droughts and floods in particular with devastating consequences on the environment, society and the wider economy have continued to be reported. More importantly, Kenya’s growing population and economy coupled with urbanization have the potential to increase future Green-House Gas (GHG) emissions. Hence, the environmental and social conditions resulting from the country’s growth together with increased competition over resources may intensify the country’s vulnerability to climate risks.

1.2 Problem Statement

Kenya, and indeed the Horn of Africa region at large has in the last few years encountered the unprecedented challenge of the impacts of climate change and the corresponding socio-economic losses to communities. High dependence on climate-sensitive natural resources for livelihoods and economic sustenance inherently increased vulnerability to this phenomenon. According to Brenner *et al*., (2002), pristine nature, spectacular landscapes or the opportunity to view wildlife are undoubtedly quality features of tourism destinations such as national parks, reserves and other protected areas. However, the challenge of managing such natural resources of protected areas emanate not only from the inside of the protected areas boundaries, but also from the surrounding ecosystems, because most of protected land are open systems that face threats from adjacent areas. Consequently, the management of tourism development and natural resources has to consider the context of the landscape as well as past and future changes.

The excisions of protected forests more especially in Kenya are starting to have a negative effect on major natural assets and development investments. For instance, the continued destruction of the Mau complex forest in Kenya, is perceived to have led to water crisis whereby the perennial rivers have become seasonal and downstream flooding are increasing. In some places, the aquifer has dropped significantly while wells and springs are drying up (Kenya government, 2010). Government of Kenya (2010) categorically asserted that the degradation of the forest is a major threat to water resources, biodiversity and livelihoods of forest-dependent communities, thereby leading to conflicts over resources and land. Furthermore, Kenya's as well as Tanzania's tourism sectors have not been spared either since the survival of Lake Natron which is the main breeding ground for the millions of flamingos that populate many of the lakes in the Rift Valley is uncertain, with the water volume in the Ewaso Nyiro River which feeds the lake dropping significantly (Mbaria, 2004).

The consequences of climate variability influences in Maasai Mara ecosystem are of special concern. Recent evidence indicates that climate change has resulted to the shrinking of water levels of Mara River and its tributaries, excessive temperatures, prolonged drought and unexpected floods (Mutimba, Mayieko, Olum , & Wanyama, 2010). Indeed, it has been argued that the water level of Mara River has decreased, particularly during the dry season, consequently threatening the river-dependent wildlife for example the crocodiles and the hippopotamus in the Maasai Mara and Serengeti ecosystems (Global Warming Policy Foundation, 2011). This scenario accentuates the need for a paradigm shift in Kenya's tourism and natural resources management to counteract the adverse risks of climate change. Hence, the purpose of this study was to investigate the effects of climate change on tourism and natural resources in MMNR and its environs and consequently inform policy makers of the short-comings and opportunities for adaptation to climate change in the study area.

The knowledge gaps in existence include presence of limited literature on the effect of climate change on animals, plants, quantity of surface water and the adaptations and mitigations of the effects of climate change, particularly in protected areas in Kenya. In the wake of global warming, the expected output of the research is that it will provide information that will assist the various stakeholders who are directly and indirectly affected by the effects of climate change. The problem in the study lies on the premise that the effects of climate change on tourism and natural resource in Maasai Mara National Reserve as a protected area was yet to be assessed. Climate change can have a devastating effect on not only on tourism and its related activities, but also natural resources, hence the need for the study.

1.3 Research Objectives

1.3.1 General Objective

The general objective of the study was to establish the perceived effects of climate change on tourism and natural resources in protected areas in Kenya, where the researcher used Maasai Mara National Reserve (MMNR) as a case.

1.3.2 Specific Objectives

The following specific objectives aided in achieving the general objective:

(i) To determine the perceived effects of climate changes on animal community in MMNR.

(ii) To evaluate the perceived effects of climate changes on plant community in MMNR.

(iii) To assess the perceived effects of climate change on the quantity of surface water in MMNR.

(iv) To establish the perceived effects of climate change on tourism and tourists activities in MMNR.

(v) To determine adaptation strategies to climate change adopted in MMNR.

1.4 Research Hypotheses

The study tested the following null hypotheses:

$H_0$1: There is no significant effect of climate change on the animal community in the MMNR and its environs.

$H_0$2: There is no significant effect of climate change on the plant community in the MMNR and its environs.

$H_0$3: There is no significant effect of climate change on the quantity of surface water in the MMNR and its environs.

$H_0$4: There is no significant effect of climate change on tourists' activities in the MMNR and its environs.

$H_0$5: There are no adaptation strategies to climate change adopted in MMNR.

1.5 Justification and significance of the Study

Successive governments in Kenya have continued to underscore the role that tourism plays in socio-economic development of the country. The most recent effort-affirmation of the importance of tourism by the Kenya government is depicted in Kenya's Vision 2030. In this vision, the government aimed at spearheading tourism development with a goal of increasing international visitors to 3 million by 2012, and raising the average spent per visitor to least Kshs. 70,000 (Government of Kenya, 2007). In reality, this has not been achieved but the aim is still there. Like other developing countries, the tourism industry in Kenya depends heavily on the recreational opportunities presented by the natural environments.

It is estimated that 70% of tourism in Kenya is practiced in protected areas (Akama, 1999 cited in Korir, Muchiri, & Kamwea, 2013). With this study focusing on perceived effects of climate change on tourism and natural resource-base in Maasai Mara National Reserve, it provides a holistic understanding of its effect in protected areas and the adaptation strategies that can be put in place to curb the effect.

The study is contributing to the existing body of knowledge in terms of theory and practice concerning the effects of climate change. The research can be of help in the addition of new knowledge on how climate change affects tourism. Results of the study have provided guidance on the best practices in mitigating the effects of climate change. Study findings help scholars undertaking similar or related, and also aid government officials in planning for tourism development in relation to climate change. Research findings will assist also policy makers and opinion leaders in the tourism industry in formulating policies that would benefit all stakeholders. In terms of decision-making, the study results enlighten both existing and potential investors on key areas of investment in the sector particularly in the mitigation of climate change study area.

1.6 Scope of the study

The research focused on climate change as a subject area and how it influences tourism and natural resources according to the local community's perceptions at MMNR. The study addressed climate change as the independent variable and tourism activities and natural resources as the dependent variables. The study area encapsulated areas at the gates and surrounding of MMNR and they included Talek, Ololo, Sand River, Sekenani and Koiyaki. The target population comprised of 1,500 respondents. The study was undertaken in 2011 for a duration of three months.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

The chapter comprises of review of literature on climate change and its effect on animal community, plant community, quantity of surface water and tourism activities. The chapter also reviews the adaptation and mitigation strategies to climate change, the theoretical frameworks and culminates with the presentation of the study's conceptual framework.

2.1 Impact of climate change on animal community

Climate change affects wildlife species both directly and indirectly. Food and Agricultural Organization (2012) informed that climate change is expected to become one of the major drivers of extinction in this century because of changes in the breeding times of species and shifts in distributions caused by the variation in temperatures and precipitation regimes. Food and Agriculture Organisation (FAO) (2012) estimated that 20–30 percent of plant and animal species will be at higher risk of extinction due to global warming and that a significant proportion of endemic species may become extinct by 2050. For instance, the rainforests of Mission Beach in Queensland, Australia were seriously devastated by Cyclones Larry and Yasi in March 2006 and February 2011, respectively. By destroying their habitat and main food supply, the cyclones greatly affected the remaining populations of the already endangered Southern cassowary (*Casuarius casuarius*), a flightless bird, the third largest bird species after the ostrich and emu and an important seed disperser of the rainforest's trees (FAO, 2012; Kofron and Chapman, 2006). It is estimated that only 1,000 to 2,000 cassowaries remain in Northern Queensland. Under normal circumstances, habitat loss and fragmentation are considered the primary cause for their decline (Kofron and Chapman, 2006).

Elsewhere in Mali, FAO (2012) reported that the effect of climate change has reduced the number of elephants (*Loxodonta africana*) to 350 in the Sahel of Gourma, down from 550 in less than 40 years. Their range has shrunk considerably due mainly to climate change and the degradation of their habitat by livestock (Boucher, Myhre, & Myhre, 2009). During the dry season, the elephants congregate at seasonal lakes in the north, especially Lake Banzena. These seasonal lakes have been decreasing in size due to wind and plantations and livestock (Barnes, Héma and Doumbia, 2006) impede water erosion accentuated by deforestation, and access to them.

In Ethiopia, Dunbar (1998) reported that increase in local temperature is likely to push gelada upwards in search of suitable conditions, resulting in their occupying increasingly limited and fragmented habitats. Further fragmentation may arise from expanding agricultural areas, made possible at higher altitudes due to warmer temperatures, unsuitable habitat and gorges, which may confine the gelada to isolated patches. FAO (2012) reported that the gelada's ecology is unusually sensitive to ambient temperature due to its effect on the nutrient content of the grasses on which the gelada depend: these grasses only reach high nutritional values at specific temperatures. Gelada behaviour is also susceptible to changes in climate. For the gelada to survive in suitable habitats, its activities must include social behaviour patterns that allow it to create bonds with groups of conspecifics, to feed and rest (Dunbar, 1998).

The predicted effects of climate change on primates, for example, are highly negative. FAO (2012) reported that the Virunga Volcanoes Conservation Area of Central Africa contains the habitat for the largest population of mountain gorillas (*Gorilla beringei beringei*) as well as many other endemic species of animals and plants. However, if the predicted changes in temperature and precipitation occur in Central Africa, the Virunga endemics will face new threats. An increase in average temperatures would cause the vegetation zones to move upwards, reducing their extent and changing the distribution of many species. But the Afro-Alpine endemics on the summits would literally have nowhere to go.

The volcanoes form an archipelago of ecological islands and are just as vulnerable to climate change as species on oceanic islands that are facing rising sea levels. If they are unable to adapt to warmer conditions, they will become extinct unless trans-located by human intervention. If the montane forest dries out, it remains to be seen whether sufficient food plants can survive, and whether the gorillas will be able to adapt. The drier forest will be more susceptible to fire, which, along with the risk of the peat bogs drying out, would make the Virunga Volcanoes a significant carbon source rather than a sink.

Lehmann, Korstjens and Dunbar's (2010) study of the potential impacts of climate change on African apes reached conclusions consistent with those drawn for the gelada baboon. Gorillas (*Gorilla* spp.) and chimpanzees (*Pan* spp.) have temporal activity patterns that include time needed for maintaining social cohesion within groups of a given size. They also require resting time for thermoregulation to avoid heat overload or hyperthermia and/or to allow digestive processing (Lehmann *et al.*,2010).

Droughts have an important effect on herbivores in savannahs. For instance, the species residing in the Mara-Serengeti ecosystem have been reported to decline by 58 percent in the last 20 years due to drought-related effects on vegetation (Ottichilo, de Leew, Skidmore, Prins, & Said, 2000), and the 2009 drought in the Amboseli ecosystem reduced the wildebeest (*Connochaetes taurinus*) and zebra (*Equus quagga*) populations by 70–95 percent (Kenya Wildlife Service, 2010). The large mammals that inhabit such environments are adapted to the seasonality of the grassland resources and often undertake long-distance migrations. Most famous is the wildebeest migration in the Mara-Serengeti ecosystem (KWS, 2010). In many cases, these journeys cross national boundaries, implying that conservation activities should be coordinated by international agreements like those under the United Nations Environment Programme (UNEP) Convention on Migratory Species.

Climate change affects the productivity of vegetation and the composition of grassland species (Weddell, 1996). Droughts, in particular, cause a shift to less productive, more drought-tolerant plant species (Grime *et al.*, 2008). This change, in turn, affects the presence and behaviour of species that feed on such vegetation, often leading to population collapses within wildlife species, as recorded in Gonarezhou National Park, Zimbabwe, where 1,500 African elephants (*Loxodonta africana*) died after severe drought in 1991–1992 (Gandiwa & Zisadza, 2010).

Drought also kills many tree and succulent species as well as affecting variation in the life cycles of remaining species, which leads to declines in bird populations and other wildlife that rely on such plants (Gandiwa & Zisadza, 2010). Changes in temperature and/or precipitation have already led to considerable shifts within short periods (1–2 years) in the distribution of grassland bird species; these species are expected to decline as a consequence of climate change. Changing climate will therefore accelerate the trends of already decreasing bird populations (North American Bird Conservation Initiative and US Committee, 2010).

Drought also dramatically increases rates of breakdown in arid land and desert vegetation, leading to further desertification, soil erosion, dust storms and impacts on wildlife that live in these ecosystems (Omar & Roy, 2010). Similarly, extreme precipitation events affect wildlife. For instance, in the widely reported human suffering caused by recent flooding in Queensland, Australia, hundreds of orphaned bats were rescued by local carers. Serious losses of small macropods, especially wallabies, bandicoots and native rats and mice are also expected.

East Africa's mountains play a critical role in providing fresh, clean water, but several are now compromised by climate change. The upper catchment area of Mount Kenya comprises the afro-alpine zone, which is protected by the Mount Kenya National Park (about 70,000 ha) and the Mount Kenya National Forest Reserve (about 200,000 ha). This vast zone is one of Kenya's five crucial sources of freshwater and is home to biodiversity of national and global importance. Six rare or threatened species of large mammals occur here: the African elephant (*Loxodontia africana*), the country's largest remaining forest population; the black rhinoceros (*Diceros bicornis*) – only a few individuals survive; the leopard (*Panthera pardus*); the giant forest hog (*Hylochoerus meinertzhageni*); the mountain bongo (*Tragelaphus euryceros isaaci*), a critically endangered African antelope; and the black fronted duiker (*Cephalophus nigrifrons hooki*). There are many ungulates, primates, carnivores and small mammals, along with 53 out of Kenya's 67 African highland biome bird species, including the threatened and little-known Abott's Starling (*Cinnyricinclus femoralis*) (KWS, 2010; Bird Life International, 2011).

The effects of wildfires on local wildlife can be severe (FAO, 2012). Slow-moving animals are at the highest risk of mortality from flames and smoke. Escaping the fires is only the first step to survival. If habitat changes mean that displaced animals can no longer find food, compete for territory or access shelter, they will die of starvation or predation (Cochrane & Laurence, 2002).

In February 2009, following an unprecedented drought, Australia experienced the most disastrous wildfire in the nation's recorded history. The deadly combination of scorching temperatures and dry northwesterly winds from central Australia's desert regions resulted in fires that spread over 400,000 ha. Up to a million wild animals are thought to have perished as a result of the fires, along with an estimated 13,000 commercial farm animals, including sheep, beef and dairy cattle, goats, poultry and pigs. Many companion animals also lost their lives. Many animals were burned, mostly on the front and back feet but large numbers had more extensive burns (Kameniev, 2010; Voxy News Engine, 2009).

Climate change increases the frequency of extreme climatic events that impact disease cycles and this could emerge as more important than the changes in average climatic conditions (de La Rocque, Rioux, & Slingenbergh, 2008). Around 2010 in Africa, outbreaks of Rift Valley fever, a mosquito-borne disease, correlated with higher than average seasonal rainfall and have even occurred with shorter heavy rainfall. Many insect vectors have population booms associated with large amounts of rain, particularly after long periods of drought. The flooding that accompanies heavy rainfall can increase the spread of waterborne pathogens, exposing more animals to potential infections. Conversely, decreased rainfall and drought can result in animals congregating around limited food and water resources, thus increasing population densities and often resulting in increased transmission of pathogens and parasites.

Munson *et al.* (2008) contends that if extreme weather events become more frequent owing to climate change, mortality events caused by disruption of the ecological balance between hosts and pathogens are likely to become more common and to have devastating impacts on lion populations (Dybas, 2009; Munson *et al.*, 2008). For example, in 1994, an epidemic of Canine Distemper Virus (CDV) decimated the lion population in the Serengeti, causing the death of one-third of the resident population. This unusual die-off was followed by another event in 2001 in the nearby Ngorongoro Crater, the United Republic of Tanzania. Both of these CDV mortality events were linked to environmental conditions in 1994 and 2001, which were particularly dry and favoured the propagation of ticks in the Serengeti ecosystem.

The Amboseli Basin has undergone great changes in recent decades: the previous woodland grassland mosaic habitat has shifted to open grassland and daily maximum temperatures have increased dramatically (Altmann, Alberts, Altmann, & Roy, 2002; Western & Maitumo, 2004). More importantly, rain patterns have become more stochastic, with annual rainfall varying more than four-fold and the long dry season often preceded by a period of drought (Altmann *et al.*, 2002). The most recent severe drought, for example, was the result of poor rains in 2008 and a total failure of the main rainy season in 2009. The shrinking water sources attracted high aggregations of herbivores, which promptly overgrazed the area. This resulted in an exceptionally rapid population collapse over the course of the drought. The overall mortality rate of over 75 percent was nearly four times higher than recorded levels dating back to 1967, which never exceeded 20 percent of herbivore populations.

Wildebeest (*Connochaetes taurinus*) populations dropped by 92 percent between September and November 2009 and zebra (*Equus quagga*) populations by 71–85 percent, leaving only 312 wildebeest and 1,828 zebra surviving in the Amboseli

Basin. Other species affected by the drought include the African buffalo (*Syncerus caffer*) and Grant's gazelle (*Nanger granti*), which decreased by 65 percent and 66 percent, respectively, as well as large numbers of elephants (*Loxodonta africana*) and hippopotamuses (*Hippopotamus amphibius*) (KWS, 2010; Western, 2010; Western and Amboseli Conservation Program, 2010; Worden, Mose & Western, 2010).

2.2 Impact of climate change on plant community

2.2.1 Effect of climate change to plants as natural resources

Changes in the distribution and abundance of plant communities and habitat types have been widely observed. There is a growing body of evidence from all over the world that species and ecosystems are already changing due to climate change (FAO, 2012). Individuals, communities, organizations, and industries all benefit from natural resources (Browne and Hunt, 2007). These benefits arise through the consumption of natural resources and products derived from them, the provision of ecological services and functions, and the attainment of passive use values (for example, knowing that resources are appropriately protected) among others. Climate change has the potential to affect the benefits derived from natural resources.

Climate change will have a profound effect on the future distribution, productivity and the health of forests in Asia. The change in climate is said to affect the boundaries of forest types and areas, species population and migration, the occurrence of pests and diseases and forest regeneration. Forest fires may also increase in number. For example, in Nepal, it was observed that forest fires in unseasonably high temperatures continues to threaten the existence of species such as red pandas, leopards, monkeys and other wild animals.

While studying on the effect of climate change on plant community in least developed and small island states, UN-OHRLLS (2009), informed that the majority of semi-arid lands in Asia are rangelands, composed mainly of grasses or scrubs. With an increase in temperature of about 2°C to 3°C and a decrease in rainfall (future projections for the arid and semi-arid areas in Asia), grassland productivity will decline by 40 percent to 90 percent. Some rangelands in Nepal were already subject to degradation, and so, climate change represented an unwelcome additional environmental stress. Climate change had a negative impact on desert vegetation, especially on the plants with surface root systems that depend on precipitation moisture. These plants became more vulnerable to reduced water availability. Climate change also caused a shift in the dry land types in Asia, with semi-arid dry lands becoming not only drier but also desertified (IPCC, 2001).

Global Biodiversity Outlook report identified climate change as one of the main factors responsible for the current loss of biodiversity (Secretariat of the Convention on Biological Diversity, 2010). Some aspects of biodiversity loss through, for example, deforestation and the draining of wetlands, themselves exacerbated climate change by releasing centuries' worth of stored carbon.

2.2.2 Climate change and new plant diseases and pests

Climate change has also been implicated in the emergence of new plant diseases and pests (FAO, 2012). In the Mandakini Valley of northern India, scientists reported that the oak forests have been invaded by pine trees (between 1,000 and 1,600 m), particularly on south-facing slopes. This phenomenon can also be observed in many other valleys of the region. Many sources of water, such as springs, have dried up because of the disappearing oak trees and invading pines.

Reduced precipitation not only places animals and plants under stress, but increased the risk of forest fires. Globally, more than 350 million ha are estimated to be affected by vegetation fires each year, of which some 150 to 250 million ha are tropical forests (Appiah, 2007 ; UNEP, FAO & United Nations Forum on Forests(UNFF), 2009). Much of this arises from deliberate use of fire for clearing scrub or improving pasture, but extremes of dry weather increase the likelihood of such fires getting out of control. Changes recorded in grassland ecosystems include higher temperatures and less rain in summer, increased rates of evaporation, decreased soil moisture and an increase in the frequency and severity of droughts. Reduced rainfall also has an impact on fire regimes (that is the pattern, frequency and intensity of fires), which affect the survival of seeds in the soil, thereby regulating grass productivity (Gandiwa and Kativu, 2009).

Hemp (2009) pointed out that over the past 70 years, Kilimanjaro has lost more than one-third of its forest cover, mainly due to clearing in the lower parts and burning in the upper parts of the mountain and fires due to climate change led to the loss of nearly 150 km^2 of forest over the past three decades. Long-term meteorological data suggest that mean annual precipitation in the area decreased by up to 39 percent over the past 70 years and mean daily maximum temperatures increased at a rate of more than 2 ºC per decade (Hemp, 2009). Together with the enhanced solar radiation resulting from diminished cloud cover, these factors are responsible for intensified fire activity that destroys plant population (Hemp, 2009). Fire not only transforms land cover, it also maintains the newly established land types, completely changing the composition of vegetal species and the role that they play in the ecosystem. Caused by a decline in precipitation above the major cloud zone, fire causes a natural sharp discontinuity in the composition and structure of 20–30 m tall subalpine forests at 2,800–3,000 m. Non-native species (for example *Erica excelsa*) become dominant, forming dense monospecific stands about 10 m in height.

Mountain ecosystems cover close to 24 percent of the earth's land surface and, with their steep and varied topography and distinct altitudinal zones; they support a high variety of species and habitats and a high degree of endemism (FAO, 2012). However, climate change is exposing alpine and subalpine areas to increasing temperatures, with the projected result of a slow migration of ecosystems towards higher elevations. This is, however, not always the case: on Mount Kilimanjaro the opposite has been observed, with climate-induced fires causing a downward shift of the upper tree-line and a consequent reduction in important cloud-forest habitat (Hemp, 2009). Alpine plants, which are usually long-lived and slow growing, may have particular problems in adapting to a rapidly changing climatic environment and alpine vegetation likely reflected this lack of capacity to adapt. The expected migrations caused a disintegration of current vegetation patterns, seriously impacting the stability of alpine ecosystems by, for example, creating unstable transition zones with largely unpredictable behaviour (Gottfried, Pauli, Reiter, & Grabherr, 1999).

2.3 Impact of climate change on quantity of surface water

2.3.1 Climate change and the complexity of the ecosystem

Climate change affects different ecosystems in different ways, depending on the complexity and original characteristics of the system, geographical location and on the presence of factors that may regulate the extent of the changes. Degraded ecosystems are generally believed to be less resilient to climate change than intact and healthy ecosystems (FAO, 2012). Increased temperatures affect physical systems, as ice melts and snow cover is reduced, as well as affecting biological systems through a series of direct and indirect pressures. Physical systems include deep snow, glaciers and permafrost. Increases in temperature can lead to a drastic unbalancing of the physical system, causing irreversible losses. The water cycle and hydrological systems are affected by changing temperatures, often indicated by dry riverbeds or floods due to increased runoff. In semi-desert areas, the decreased availability of water is already placing additional pressures on wildlife, which aggregate around limited water points and compete with domestic livestock (de Leew, *et al*., 2001).

Biological systems are also being affected by increasing temperatures, which introduce changes in biophysical conditions that influence their development and maintenance. Changes in water availability affect the flowering and survival of aquatic plant species, as well as the abundance of wildlife species in affected areas shifting seasonal changes, which are already being recorded in most temperate regions, affect the timing of animal migrations and the flowering of plants, and thus destabilize the equilibrium of ecosystems that are far apart. One large potential ecological impact of such changes is mistiming, where, for instance, migrating animals arrive at times when their necessary food plants or animals are not available (Vissier & Both, 2005).

2.3.2 Climate change and marine and coastal ecosystems

Rising sea levels are affecting coastal areas through shoreline erosion, the loss of coastal wetlands and modification of coastal vegetation. Marine and coastal ecosystems are also disrupted by storms that damage corals directly through wave action and indirectly through light attenuation by suspended sediment and abrasion by sediment and broken corals. Higher temperatures also cause the expulsion of zooxanthellae (single-celled plants living in the cells of coral polyps), which leads to coral bleaching and has caused the loss of 16 percent of the world’s corals

(Wilkinson, 2004). Up to a third of corals are considered to be threatened with extinction due to climate change (Carpenter *et al.*, 2008). In a chain reaction, the death of corals causes the loss of habitat for many species of tropical fish. Many studies report changes in fish populations, recruitment success, trophic interactions and migratory patterns related to regional environmental changes due to changing climatic conditions (Hays, Richardson, & Robinson, 2005).

Variations in climate not only lead to the modification of ecosystems, they are also associated with a higher frequency of extreme weather events that have the potential to cause vast property destruction and loss of life. Weather events particularly associated with sudden natural disasters include extreme river floods, intense tropical and extra-tropical cyclone windstorms and their associated coastal storm-surges and very severe thunderstorms. The IPCC noted that “increased precipitation intensity and variability are projected to increase the risks of flooding and drought in many areas” (Bates *et. al*, 2008). The IPCC reported that future tropical cyclones will probably become more intense, with larger peak wind speeds and heavier precipitation (Parry *et. al*, 2007). Extreme weather events are usually rare, with return periods of between 10 and 20 years. The relationship between extreme weather events and climate change is not easy to establish, given that the record of significant temperature increase has been reported only since the 1970s. Thus, the number of events may not yet statistically support a correlation. Nevertheless, the links are now widely accepted by specialists (Helmer & Hilhorst, 2006).

2.3.3 Climate change and the changing environmental conditions

Changing environmental conditions facilitate the establishment of introduced species, which may become invasive and out-compete native species, leading to the modification of entire ecosystems (Chown *et. al.*,2007; McGeoch, *et al.*, 2010). For example, invasive species have been measured as growing faster than native species due to changing climatic conditions in the Mojave Desert, the United States of America (Smith, *et al*., 2000). Globalization of markets and the increased movement of people and merchandise have increased the translocation of species on local, regional and continental scales. Some species have expanded their range as temperatures have become warmer. Warmer temperatures have created opportunities for pathogens, vectors and hosts to expand their range, thereby enabling pathogens to be present in new geographical locations and, potentially, to infect new hosts, which in some cases can result in morbidity or mortality of wildlife, livestock or humans. Diseases that were kept at low infection levels because of temperature restrictions are now reported to have become fatal and endemic.

FAO (2012) reported that many of Himalaya glaciers (source of ten of the largest Asian rivers; Yellow River, Irrawady, Ganges, Mekong and Brahmaputra) are now receding more rapidly than the world average and the rate of retreat has increased in recent years. If current warming continues, glaciers located on the Tibetan Plateau are likely to shrink from 500,000 km^2 (the 1995 baseline) to 100,000 km^2 or less by the year 2035. This melting will increase water runoff in rivers with subsequent flooding events.

The Amazon Basin has historically been subjected to severe droughts once or twice in a century. In 2010, the region experienced the third drought in only 12 years (Sundt, 2010; University College London, 2011). The 2010 drought was reported to be more widespread and severe than the previous drought in 2005, which itself was identified as a once-in-a-century event (Lewis *et al.*, 2011). The worst hit areas, such as the Brazilian state of Mato Grosso, received only 25 percent of the normal precipitation during July to September 2010, and most of Amazonia saw a significant reduction in rainfall. River levels reached record lows, impacting all river users, from shipping vessels to pink river dolphins (*Inia geoffrensis*). In August, the Bolivian Government declared a state of emergency because forest fires were burning out of control. Overall, this has led to concerns that the Amazon forest might have reached, or be close to reaching, a "tipping point" from which it will be unable to recover.

Higher temperatures will mean more rain than snow, raising the risk of flooding for mountains and down-stream lowland ecosystems. Changes in permafrost and hydrology are being widely recorded, for example in Alaska, the United States of America (Hinzman *et al.*, 2005), while snow packs are declining throughout western North America, melting 1–4 weeks earlier than they did 50 years ago (Mote *et al*, 2005; Westerling *et al*, 2006).Warmer temperatures will also have an impact on the depth of mountain snow packs and glaciers, changing their seasonal melts and affecting large downhill areas that rely on them as a freshwater supply. Glacial lake outburst flooding can have immediate and dramatic impacts on local ecosystems (Bajracharya *et al.*, 2007). Shifts in seasons will affect the timing of ice and snow melts and consequent water runoff, in turn affecting the timing of processes and activities that depend on water, including agriculture. Changes in stream and river flow will affect the micro fauna living in aquatic ecosystems, thus having an impact on fish and waterfowl species (Bajracharya *et al*., 2007)

2.3.4 Climate change and water

Hemp (2009) study of vegetation changes on the slopes of Kilimanjaro over the past 30 years used the observation of fixed vegetation plots and analyses of satellite images to reveal changing fire regimes. Fire alters the species composition and structure of the forests and is affecting the Kilimanjaro ecosystem to a far greater extent than the well-known melting of glaciers. In fact, under natural conditions the forests of Kilimanjaro above 1,300 m receive nearly 1,600 million m^3 of water annually: 95 percent from rainfall and 5 percent from fog interception. As a result, about 500 million m^3 of water (31 percent) percolates into the groundwater or into streams. The changes in vegetation composition and precipitation regimes have reduced fog precipitation to close to zero. The loss of 150 km^2 of forest since 1976 to fire corresponds to an estimated loss of 20 million m^3 of fog water deposition per year. This is equivalent to the annual water demand of the 1.3 million people inhabiting the Kilimanjaro region (13,209 km^2) in 2002 (Hemp, 2009; Kenya National Bureau of Statistics, 2010).

Alpine regions are also a prominent feature of many protected areas, and these are some of the most sensitive to warming temperatures, with many cold-adapted species that depend on glaciers and snowpack (Bunn, 2009). Climate change is also likely to disrupt patterns of precipitation and water availability, as well as the condition of water resources. Warming temperatures and changes in the timing and intensity of precipitation affects the way in which snowpack and glaciers regulate stream flow and runoff, especially in mountainous ecosystems. In the mountains, a warming climate causes more precipitation to fall as rain rather than snow, leading to earlier and potentially larger, spring run-off events. In addition to changes in water availability and flooding, changes in timing and magnitude of spring runoff affect the success and timing of the spawning of fish and emergence of insects (Williams & Haak, 2011).

In addition, decreased snowpack and earlier, higher pulses of runoff in the spring mean less water in the summer and fall, especially in dry western ecosystems. Models in the Rocky Mountains predict significant declines in summer stream flow, with effects on both the survival of aquatic species and water availability for surrounding vegetation and associated animal species, compounding the effects of warmer air temperatures on plant and animal species, and increasing fire frequency and intensity (Shepherd & Gill, 2010).

In Kenya, climate change now affects the water catchment area of Mount Kenya, which is witnessing the diminishment of ice caps and a reduction in rainfall. Mount Kenya glaciers have lost 92 percent of their mass in the last century and their volume and extent have shown a drastic decrease in recent years. In the recent past, melting snow contributed to the rivers and kept the catchment humid, while moderating the dry seasons. Presently, early and shortened snow-melt periods have implications for rivers and springs: dry season flows progressively decline and the land becomes drier and less productive. The forest is affected because of more frequent fires and slower regeneration of vegetation (FAO, 2012). In Kenya, climate change has exacerbated Local farmers human-wildlife conflict, due to the close proximity of human settlements to the protected areas (UNEP, 2009). A lack of melt-water and degradation of the vegetation were reported to cause wildlife to migrate downstream in search of water and food, placing wildlife conflict at the top of the concerns expressed by the members of the Mount Kenya East Environmental Conservation Forest Association living in the Meru South District (International Fund for Agricultural Development, 2009).

Table 2.1 below depicts the erratic rainfall patterns as a result of climate change at MMNR. The statistics clearly shows irregular rainfall pattern in a span of over a decade ago.

The overall rainfall of Maasai Mara National Reserve between 2000 - 2010													
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Totals
2000	0	0	0	0	0	0	25.8	10	24	13.5	100	95	268.3
2001	231.5	53.5	54	156.5	61.5	23	130.9	40	54	104	66.9	0	975.8
2002	136	70.1	91.8	91.5	187.2	34.5	75	20	0	9	131	203	1049.1
2003	69	40.5	125	142	119	76	6	100.4	34.2	57.6	33.4	95	898.1
2004	129	77	82	0	83	6	25	64	40	12	133	94	745
2005	58	32	123	91	281	112.2	14.2	95.8	33.5	38.7	46.5	9.2	935.1
2006	42	67	170.9	147.6	85.5	62	39.2	25.2	28.6	10.5	138	238.5	1055
2007	144	192.5	79	53	10	45	23	21	65.5	21	0	34	688
2008	84	149	118	45.5	0	21	49	108	65.5	46.5	118.5	0	805
2009	73.5	41	40	161	65	10	0	10	9	39	30	147	625.5
2010	0	73	104.5	86	157	27	37	25	85	3	33	0	630.5
Totals	967	795.6	988.2	974.1	1049.2	416.7	425.1	519.4	439.3	354.8	830.3	915.7	8675.4

Table 2.1 : The overall rainfall of Maasai Mara National Reserve between 2000 - 2010

Source : The Kenya Meteorological Department, 2011

2.3.5 Climate change and the quality of life

UN-OHRLLS (2009) forecasted that climate change will have a significant impact on the quality of life in most of the Least Developed Countries. It is projected that by 2020, between 75 and 250 million people will be exposed to an increase of water stress owing to climate change in Africa. Coupled with increased demand, this will adversely affect livelihoods and exacerbate water-related problems in Africa (IPCC, 2007). Glacier melting in the Himalayas is projected to increase flooding, rock avalanches from destabilized slopes, and affect water resources within the next two to three decades.

IPCC (2007) foresaw that as a result of climate change, river flow is also predicted to decrease as glaciers recede. The Least Developed Countries (LDCs) of Bhutan and

Nepal will likely to be severely affected by these changes. The predictions for climate change in Africa seem to show a trend of decreased precipitation in current semi-arid to arid parts of the continent. One of the main impacts of climate change will be a reduction in soil moisture in the sub-humid zones and a reduction in runoff. This may pose a problem for the future water resources of these sub-humid regions. UN-OHRLLS (2009) notes that however, precipitation scenarios are not the same everywhere in Africa, as simulations seem to indicate a possible increase in precipitation in East Africa but a decrease in rainfall in Southern Africa for the next 100 years. These changes in precipitation will affect the levels of water storage in lakes and reservoirs as they respond to climate variability. This could cause major problems for lakes, such as Lake Chad, which has already decreased in size by about 50 percent in the last 40 years.

UN-OHRLLS (2009) noted that for the Niger River Basin, which covers the LDCs of Benin, Guinea, Mali and Niger (in addition to Nigeria, a non-LDC), a possible 10 percent change in precipitation, potential evaporation and runoff have been predicted. The Zambezi River, however, has the worst scenario of decreased rainfall (about 15 percent), increased potential evaporative losses (about 15 percent to 25 percent) and diminished runoff (about 30 percent to 40 percent). The Zambezi River and its basin feed the LDCs of Angola, Democratic Republic of Congo, Malawi, Mozambique, Tanzania and Zambia, as well as the non-LDCs of Botswana, Namibia and Zimbabwe (Brouwer, Brander, & Van Beukering, 2008).

The Gambia River, which is particularly important to Gambia, Guinea and Senegal, is also very sensitive to climate change. Climate change alone could cause a 50 percent change in runoff in the Gambia River catchment. A 1 percent change in rainfall can cause a 3 percent change in runoff for the Gambia River, and this could have serious repercussions, increased salt-water intrusion among them. UN-OHRLLS (2009) predicts that as in Africa, Least Developed Countries in Asia are likely to suffer from the adverse effects of climate change on water resources. Water availability is expected to be highly vulnerable to future climate change with significant changes in runoff systems. Increases in the high latitudes and near the equator, and decreases in the mid-latitudes have been predicted for Asia. In general, most of the climate models project an increase in annual mean rainfall over most of Asia (Anderegg, 2010).

Surface runoff is predicted to decline in the arid and semi-arid zones of Asia and this would have a detrimental effect on the availability of water for irrigation. The average annual runoff in certain basins could decline by as much as 27 percent by 2050 (IPCC, 2001). The perennial rivers in the High Himalayas receive water from the melting of snow and glaciers. The melting season of snow occurs at the same time as the summer monsoon season, so any intensification of the monsoon would cause flood disasters in Himalayan catchments. Countries such as Nepal and Bangladesh would be at risk of increasing flood disasters in the wet season. The intensity of extreme events may be higher in a warmer climate, which would also increase the risk of flash floods in parts of Nepal and Bangladesh (De Freitas, 2005).

New water management strategies and increased investments will be required to help Asia cope with future water problems. The effects of climate change on the water systems and public water supply in the arid and semi-arid regions of Asia will require priority attention to avoid local and international conflicts. Many of the watersheds in Asia are already stressed by intensive land use and unfavourable climates thus making them highly vulnerable to climate change if no appropriate adaptation strategies are developed (IPCC, 2001).

2.4 Impact of climate change on tourism activities

2.4.1 Climate change and experience of visitors

As climate, water, and fire regimes, as well as plant and animal species change in protected areas, so will the character of the landscape and the experience of visitors. Climate strongly affects the suitability of locations for recreation, and drives the amount and seasonality of activity (World Tourism Organization - United Nations Environmental Programme, 2008). The effect of climate change on tourism is likely to manifest themselves in a number of different ways according to local conditions. Many of these impacts will develop indirectly through increased stresses placed on environmental systems. Nicholls, (2006) explained that the link between climate change and tourism implies complex interactions and can be described as a two-way relationship.

2.4.2 Climate change and risk in tourism

According to UN-OHRLLS (2009), climate change could also place tourism at risk. Based on WTO (2005) survey, the economic benefits of tourism in Africa, which according to 2004 statistics accounts for 3 percent of worldwide tourism, may be altered with climate change. However, very few assessments of projected impacts on tourism and climate change are available, particularly those using specific scenarios. Modelling climate changes as well as human behaviour, including personal preferences, choices and other factors, is exceedingly complex. Although scientific evidence is still lacking, it is probable that flood risks and water pollution-related diseases in low lying regions (coastal areas), as well as coral reef bleaching as a result of climate change, could have a negative impact on tourism (UN-OHRLLS, 2009). African and Asian places of interest for tourists, including wildlife areas and parks, may also attract fewer tourists under marked climate changes. Hamilton, Maddison and Tol (2005) cautioned that climate change could, for example, lead to a shift of tourist activity towards the poles, as well as a shift from lowland to highland tourism.

Amelung, Nicholls and Viner (2006) indicated that climate change also significantly affects the tourism industry, most importantly due to its effect on the attractiveness of tourism destinations and tourist flows. Tourism depends on natural resources, such as water, coastlines, landscapes, biodiversity and others. These influence the potential attraction of destinations (Amelung *et al.*,2006). However, climate change threatens the loss of some of these relevant natural resources (Gössling & Hall, 2006).

Empirical studies have shown that climate change has a significant influence on the tourism and tourism activities (De Freitas, 2005; Hall & Higham, 2005; Gössling & Hall, 2006). Intergovernmental Panel on Climate Change (2007) publication concluded that climate is an important consideration for tourists' destination decisions and that climatic variable can explain tourists' flows. For example, for a large number of tourism activities and for the majority of international tourists, warm temperatures are the ideal independent of the tourist's origin (Lise & Tol, 2002).

Amelung *et al*., (2006) examined how the Tourism Climate Index explains seasonality. They indicate the most suitable regions for tourism in specific seasons in the years 2020, 2050 and 2080. Elsewhere, Gómez-Martín (2006) used seven climatic variables and comfort indices to demonstrate the level of comfort of tourists in specific destinations and how this can help to explain the geographic and temporal distribution of tourism in Catalonia, Spain. In Namibia, Barnes, MacGregor & Alberts (2012) found out that on average, tourism value might decline at 0.4% per annum, and livestock income might decline at 1% per annum over that period.

The direct effects of temperature on the comfort and experience of visitors is likely to affect recreation decisions. Studies indicate that a shift of attractive climatic conditions for tourism towards higher latitudes and altitudes is very likely (WTO-UNEP, 2008). Southern parks and wildernesses may see a decrease in visitor use as temperatures creep upward. However, studies show that northern, mountainous parks in the US and Canada will receive a greater number of visitors over the next fifty years. One study predicts an increase in park visits of 10-13% in Rocky Mountain National Park due to a lengthening of the peak summer season, while another predicts a similar increase in parks through the 2050s in the Canadian Rocky Mountains (Scott, Jones, & Konopek, 2007).

An increase in seasonal length and number of annual visitors may increase visitor impact on some protected areas, requiring additional management, infrastructure, or regulation (Scott *et al*., 2007). Alpine regions in particular may be vulnerable to the effects of increased visitor use. Climate change may also have subtle yet potentially far-reaching adverse effects on recreation experiences and visitor perceptions about protected areas and wilderness. Declines in charismatic wildlife populations may lead nature-watchers, photographers, and hunters to seek other habitats that offer more substantial populations (Sasidharan, 2000). Radically altered ecosystems due to species loss, increasing fire frequency, vanishing glaciers, or other changes may negatively affect the attachment of people to the landscape, as their identification with historical aesthetic decreases (Lemieux, Beechy, & Gray, 2011). These changes to the characteristics of protected areas may reduce the perceived attractiveness of these landscapes. A study of projected visitation to parks in the Canadian Rockies indicates that, under scenarios of species loss and glacier melts predicted for the 2080s, nearly one-fifth of visitors would no longer utilize these parks, and many others would visit less frequently (Scott *et al*., 2007). The main observations to emerge from literature review on the relationship between climate change and tourism is that both the causes and the consequences of this relationship are of significant importance, that they have a significant economic impact, and that both require attention.

2.5 Adaptation and Mitigation Strategies to Climate Change

With the major greenhouse gas emitters failing to curb emissions, it is clear that CO_2 levels will continue to rise. Even if emission reductions that would limit carbon dioxide levels to their 1990 levels were enacted today, climate change would continue to occur, and further warming would be unavoidable (Hare & Meinshausen, 2006). In order to respond to climate change the tourism system has two main options: mitigation and adaptation. Mitigation of climate change "relates to technological, economic and social changes and substitutions that lead to emission reductions" (IPCC, 2007). Important to notice is that mitigation can be realised through market mechanisms and technological innovation, but that the most important factor to reduce GHG emissions significantly will be the behavioural change (Simpson, Gössling, Scott, Hall, & Gladin, 2008). There is pervasive understanding in the literature regarding the basic measures to be undertaken in order to combat climate change in the tourism sector: adaptation and mitigation (UNWTO, 2013).

2.5.1 Mitigation

Chapman (2007) noted that despite road transport being the biggest producer of greenhouse gases in the transport sector, the major contributor is road freight, unrelated to tourism activities. UNWTO (2013) recorded that air transport is the largest transport-related polluter in the tourism industry. Moreover, the environmental damage of aviation is larger because greenhouse gases are released directly into the upper atmosphere and this increases their negative effects (Chapman, 2007; UNWTO, 2013).

There are various mitigation measures designed to limit the contribution of air transport to greenhouse gases emissions and a number of studies consider the beneficial effects of the inclusion of air transport in emission trade systems (Chapman, 2007; Scheelhaase & Grimme, 2007; Mendes & Santos, 2008). Chapman (2007) contended that there is need for behavioural change by replacing air transport with other modes of mobility such as inter-city rail travel instead of short haul flights. For technological mitigation measures, Chapman (2007) reported that aircraft manufacturers should design their aircraft to reduce fuel consumption, the use of alternative fuels and modification in the operational procedures for landing and taking off. These studies concluded that the reduction of emissions addressed by these mitigation measures is unclear, and in any case a single type of measure is not sufficient for the target of sustainable aviation. What is required is a combination of technological, behavioural and management changes (Chapman, 2007).

Another mitigation strategy ‘eco tax’ to the aviation industry came after the Kyoto Protocol (Tol, 2007). Tol examined how an eco-tax may affect emissions and the impact of the tax on tourist flows (Tol, 2007). This study concluded that the willingness to invest in climate change mitigation and to pay for its consequences was higher than was generally assumed. This is due to the recognition of responsibility for climate change and its effects on the quality of life of future generations. Brouwer, Brander and Van Beukering (2008) considered the extent to which air passengers will accept such a tax, highlighting factors such as passengers’ knowledge and awareness of the impacts of flying on the environment and the links with climate change, the contribution of air transport to the problem and knowledge about the Kyoto Protocol.

Moving away from the aviation industry, Bode, Hapke and Zisler (2003) recorded that reductions in emissions may be achieved by reducing energy consumption by promoting energy consciousness and energy saving behaviour on the part of the tourist and tourism industry employees. Lee (2000) suggested that a key factor in the success of these strategies is the capacity of companies to innovate, adopt renewable energies and incorporate new energy saving technologies. Further proponents of energy saving technologies such as Bode *et al.*, (2003) proposed the use of solar panels, low energy lighting, room keys to operate lights, light sensors and the simultaneous education and consciousness of tourists and employees in the problem of climate change and in the use of these technologies as the key to reducing the carbon print of tourism and especially of the accommodation subsector.

2.5.2 Adaptation

The focus of much of the attention of research on tourism and climate change is on the measures undertaken to adapt to the new scenarios. Nevertheless, there is general agreement that the tourism industry is approximately five to seven years behind in research terms on climate change when compared with other economic sectors. Adaptation is a key component of coping with climate change. Spittlehouse and Stewart (2003:2) defined adaptation as “adjustments in ecological, social and economic systems in response to… changes in climate”. This is in contrast to changes in behaviour to reduce greenhouse gas emissions or to try to prevent further changes in climate (Spittlehouse & Stewart, 2003). The term adaptation covers many activities that can be classified in several ways (for example by timing, leads, type, and social scale categories) (Becken, 2005, Grothmann & Patt 2005).

Hernandez and Ryan (2011) inform that there are important differences in the adaptation measures undertaken in the tourism industry, in terms of the various subsectors, activities and destinations. For example, in the case of beach tourism and the protection of the coastline, research suggested that institutions play a key role in adaptation measures. It is suggested that institutional policies are required to go beyond the adaptation policies of private tourism companies (Hernandez & Ryan, 2011).

Hamilton (2007) analysed what adaptation strategies would be more appropriate from an economic point of view for companies involved in beach tourism. He suggests that soft measures may be more beneficial than hard solutions, as hard measures cause a relevant environmental impact which could reduce the price that tourists would be willing to pay for accommodation, and this would mean a financial loss for companies (Hamilton, 2007).

Behavioural changes often involve the substitution of one tourism or recreation activity for another. About 50% of recreational anglers surveyed in the southern United States stated that there were other recreational activities (for example camping, hunting, golf, and swimming) that would provide them with the same level of satisfaction as fishing (Ditton & Sutton, 2004). The ability of tourists and recreationists to substitute areas and activities arises because the activity is seldom the reason for taking a trip. Instead, recreation and tourism pursuits are goal-oriented behaviours that focus on the achievement of psychological outcomes (Browne & Hunt, 2007). These psychological outcomes include relaxation, solitude, escape, challenge, and affiliation among others. Therefore, individuals may achieve these outcomes from a wide array of settings and activities.

Consideration of climate change impacts and opportunities should become a formal part of long-term planning processes for any resource-dependent industry (Ohlson, McKinnon, & Hirsch, 2005). Operators should assess whether new products and services are needed to cope with climate change effects (Mather, Viner, & Todd, 2005; Gyimothy, 2006). While companies that make business decisions around climate change may profit, adaptation has diminishing marginal returns. Producers may eventually be forced to close if natural resources upon which they depend are severely degraded.

Community adaptation is important for forest dependent and nature-based-tourism dependent communities (Browne & Hunt, 2007). Residents of forest-based communities are at greater risk from the socio-economic effects of climate change on forests and the forest industry and they are also the least likely to be equipped to adapt. Residents of forest-based communities may not have easy access to information about climate change. This may result from the isolation of forest-based communities and a lack of broader social networks (Davidson, Williamson, & Parkins, 2003). Available information likely supports the views of local industry representatives without concern for other viewpoints (Davidson *et al*. 2003). In addition, residents of single industry communities are unlikely to question the authority of industry representatives (Davidson *et al*. 2003). Women, who often express greater concern about climate change risk and are more likely to support climate change policies (Zahran, Brody, Grover, & Vedlitz, 2006), may be underrepresented in the leadership of male oriented forest-based communities (Davidson *et al*. 2003). Females are also less likely than males to exhibit activism towards the forestry sector (McFarlane & Hunt, 2006). Therefore, forest-based communities may have less appreciation for the potential effects of climate change and be less willing to take proactive measures. Residents of these communities also usually possess specialized skills and these communities have a shortage of human capital (Davidson *et al*. 2003).

Resiliency is a key factor that will allow forest-based communities an opportunity to adapt successfully to climate change. General methods of enhancing community resiliency include policies supporting economic diversification (entrepreneurship ethic, effective community organizations, strong leadership, and commitment to the community), programs supporting the development of human capital (for example adult education programs, skills training, and health care) and infrastructure development (for example utilities) (Teitelbaum, Beckley, Nadeau, & Southcott, 2003).

Adaptation policies adopted by governments should be publicly acceptable and account for differences in value systems. Measures of public opinion can help governments assess strategies that may be publicly acceptable. Governments must also consider ethical issues, intergenerational equity, and distributional equity associated with adaptation strategies. The public is more likely to accept and comply with policies that they believe are fair and just (Lawrence, Daniels, & Stankey, 1997). The amount of adaptation that institutions or resource managers undertake may depend on their risk tolerance. Many argue for the use of the precautionary principle: society should act to minimize the likelihood of potentially irreversible environmental consequences from occurring (Hussen, 2000).

2.6 Theoretical frameworks

2.6.1 Growth Theory

According to the growth theory, constant economic growth and population growth are the most concrete and obvious reasons for a conflict arising between people’s economic and natural environment and the indirect cause of worse living conditions on Earth. This theory was relevant to the study because population growth can result from increased human activities, which in turn result to climate change. Increased human activities as a result of population growth especially in the developed countries has resulted to more human activities, some of which have been detrimental to the environment.

The problem of unplanned growth has been worsened by rural urban migration. The World Bank estimated by the year 2015, half of the developing world's absolute poor will be in urban areas (Aluko, 2012). It is worth noting that although urban housing problem is a global phenomenon, the situation is worse in the developing countries, which has adverse effect on climate change (United Nations Human Settlements Programme, 2013). Housing deficiency in developing nations has escalated to unprecedented levels, hence created a large proportion of slum dwellers that live illegally in places without authorization and property rights (UN, 2011).

2.6.2 Behavior Theory

Environmental behavioral theory explains the existence of environmental damage through the absence of environmental social ethics and as a product of human ignorance. This theory means that some of the manifestations of climate change are directly and indirectly due to the behavior of persons. In the wake of the global of carbon footprint, more concern has been on the destruction of the ozone layer, which shields the earth from the harmful rays of the sun. When the relevant people and stakeholders have proper environmental behavior, the effects of climate change will be reduced.

2.6.3 Sustainability Theory

The theory attempts to prioritize and integrate economic and social responses to environmental and cultural problems (Norton, 2005). Ecological ethics theory considers the ethical relationship between human beings and natural environment; it actually looks at man's attitude towards the environment. This theory mentioned informed the study because they relate to matters of climate change and global warming. If the issue of sustainability is observed, sustainable development can be guaranteed. The current generation is at stake in the wake of global climate change concern and governments especially in the developed countries are doing everything in their power to ensure that the adverse effects of climate change are reduced to guarantee sustainability.

2.7 Conceptual Framework

After reviewing theories on the relationship between natural environment (biodiversity) on tourism development and natural resource base, a conceptual model was developed for the research showing the influence of independent variable (climate change on the dependent variables (Tourism, Tourist Activities and Natural Resource Base – NRB). The conceptual framework for the study indicates the relationship between the independent variable; climate change action effect on dependent variables denoted by tourism and natural resources. The model is illustrated in Figure 2.1.

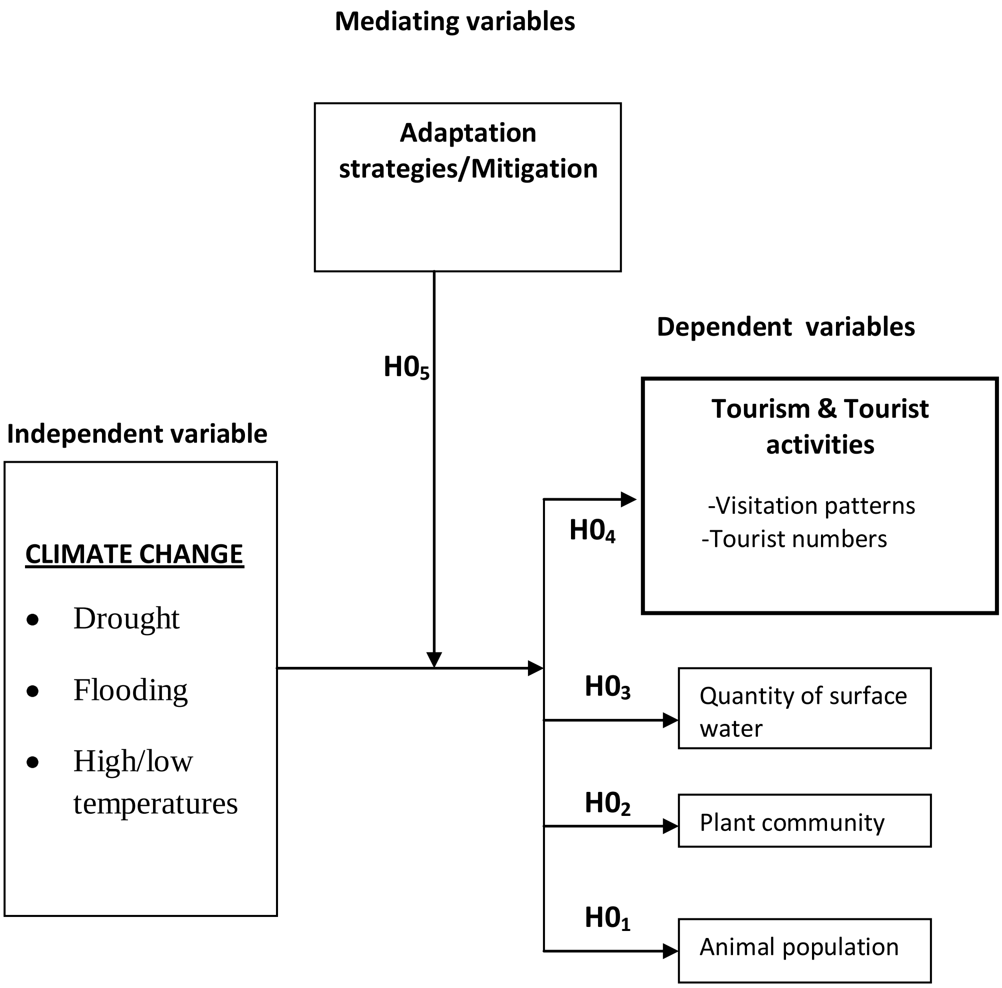

Figure 2.1: Link between climate change and tourism and touristic activities

Source: Author, 2013.

A relationship between climate change on tourism and natural resources where only effects of global warming from the elevated greenhouse gas concentrations worldwide included are those of rising sea levels, higher temperatures, and a higher incidence of extreme events. These effects could be experienced in the Maasai Mara ecosystem and tourism activities and natural resources are affected. There are three indicators of dependent variables; tourism and natural resources although their actions intertwine each other.

For example, tourist willingness to travel to a particular destination will be determined by the climatic condition of the place. Natural resources are explained by looking at the availability of the unique and rare fauna available in a specific ecosystem and this is dictated by climatic changes in the destination. Other indicators of natural resources include determining the quantity of surface water from the major rivers and their tributaries and also the level of ground water over time. Plant species was also researched in terms of abundance, introduction of alien species and their adaptation strategies.

Altered weather patterns may affect the comfort and safety of tourists while longer term climate and seasonal changes can alter the natural resources upon which many domestic and wild animals depend on. For example flooding will affect the crossing of wildebeest to the neighbouring Serengeti national park in Tanzania. Changes in climate will therefore be a new and important element of shaping tourism and the state of natural resources. For example due to increased warm temperatures, majority of plant population might dry up thereby increasing the vulnerability of fires. In of fires, large quantities of smoke and ash is emitted into the air and can be carried into popular tourist areas by the wind and case irritation to eyes and lungs to visitors and wild animals or people living nearby the national reserve. Also, agricultural activities on the higher lands (sources of water) impact on the level of water (H_20) quantity in the low land areas. This increases drought level thereby affecting the livelihoods of the wild animals, residents and establishments downstream. This happens in cases where agriculture is practiced and the reliance for irrigation is dwindling ground water supplies. This might affect biodiversity and extinctions will be likely to occur. Since tourism is heavily dependent on natural scenery and biophysical resources for tourism activities they provide, changes to natural resources will alter tourism patterns. To manage the effects of climate change on tourism and natural resources, adaptive strategies come in. for example, the adaptive strategies might be behavioural (on the tourism side of it) or technological strategies (multiple actors for example landscaping and slope development). The main actors in the adaptation strategies include governments, media, tourism stakeholders and the society in general.

Humanity now faces an environmental emergency largely because of misunderstanding importance for humankind's own subsistence. This environmental crisis exists at three distinct levels of community:

1. Globally, with manifestations in, among other things, climate change and threats to the ozone layer
2. Regionally, with manifestations in, among other things, acid rain (Europe); deforestation and loss of biodiversity (South America and Asia); as well as in land degradation and desertification (Africa)
3. Locally, with manifestations in, among other things, soil and water pollution; as well as in various examples of absolute resource scarcity It is in reaction to the environmental threats confronting the quality of human life and to human survival itself and also the Tourism industry in that the concept of environmental security became a basis for public policy.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Study Area

The study was carried out in Maasai Mara National Reserve and its environs. The Maasai Mara National Reserve (Center at 01 30' S,35 00' E; Altitude 4,921 – 7,119 ft (1500 to 2170 m) was nominated for designation as a World Heritage Site in 1996 in recognition of the 450 species of flora present. It is 700 sq mi (181,200 ha) and the surrounding wildlife dispersal areas are 1864 sq mi (482,800 ha). The Maasai Mara National Reserve is owned and managed by the Narok County Council and Transmara County Council. There are now about 4,000 beds in the Greater Mara Ecosystem: 1,000 are in the Reserve and 3,000 in conservancies outside Reserve Habitats in the Maasai Mara are varied, including open rolling grassland, riverine forest, *Acacia* woodland, swamps, non-deciduous thickets, boulder-strewn escarpments, and *Acacia*, *Croton* and *Tarchonanthus* scrub (Karanja, 2003). These ecosystems and the Mara River support a spectacular array of wildlife. Figure 3.1 depicts the gates of MMNR and its environments which formed the study area. Talek, Sand River, Olomutatiek, Sekenani, Olooloo, and Musiara gates are clearly shown on the map.

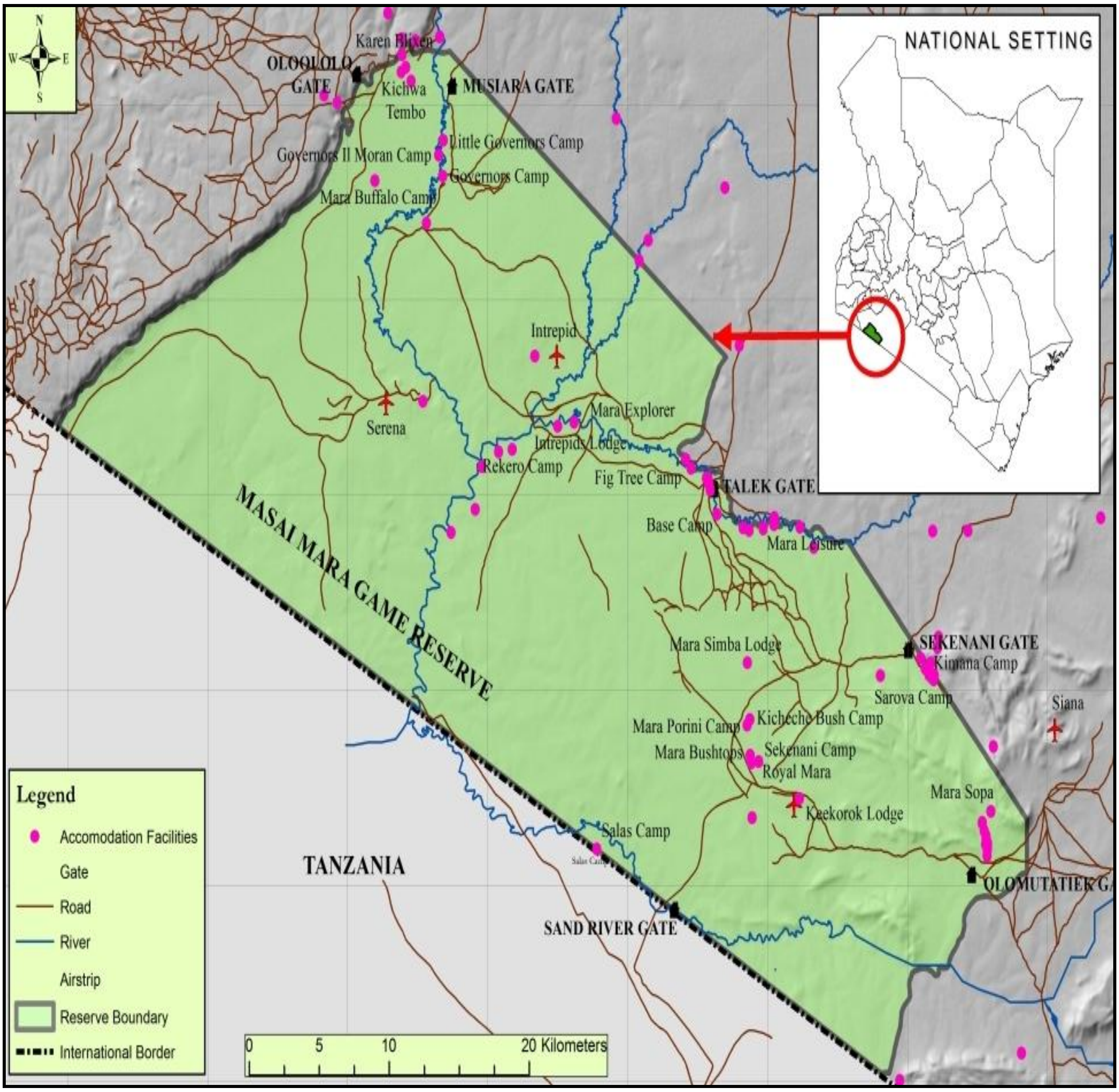

Figure 3.1 : Map of Maasai Mara national Reserve

Source : Kenya Wildlife Service, 2010.

To the north, east and west are large parcels of land demarcated as group ranches, owned and inhabited by the semi-nomadic pastoral Maasai people. This communal land forms an extensive wildlife dispersal area for the reserve, comprising the group ranches of Siana at 587 sq. mi. (152,000 ha), Koiyaki at 462 sq. mi. (94,000 ha), Olkinyei at 308 sq. mi. (80,000 ha), Lemek at 254 sq. mi. (66,000 ha), Kimindet at 142 sq. mi. (37,000 ha), Olorien at 100 sq. mi. Angata Baragoi at 30 sq. mi. (7,900 ha). Where the rainfall is erratic and unpredictable, the resulting fixed, small land-holdings are widely regarded as ecologically inappropriate, unable to support reliably either farming or ranching. As subdivision proceeds, the movement of wildlife is inevitably impeded and human-wildlife conflict increases.

The Sand, Talek and Mara Rivers are the main rivers draining in to the reserve. Shrubs and trees fringe most drainage lines and cover hill slopes and hilltops. The terrain of the reserve is primarily open grasslands with seasonal river lets in the southeast region are clumps of the acacia tree. The western border is the Esoit (Siria) escarpment of the Great Rift Valley. Wildlife seems to be more concentrated here as the swampy ground mean that access to water is always good, while tourist disruption is minimal. The easternmost border is 224 kilometers from Nairobi and hence it is the eastern regions which are most visited by tourists . The population of the Narok town is 40,000 people as per the 2009 census (KNBS, 2010).

3.2 Methodology

The methodological approaches adopted in this study comprised a combination of qualitative and quantitative methods. The quantitative approach was adopted to establish respondents' opinions to identical questions while qualitative techniques were used to probe for personal opinions of the respondents.

3.3 Research Design

Research design deals with a logical problem and not a logistical problem (Yin, 2002). The study employed survey research design that allowed surveys of sample population at different points in time and exploratory research design, where the gathering of data was through observing people, actions and situations and exploring the individuals' attitudes, preferences or behaviors in informational issues of this research and attempting to provide an explanation. According to Mugenda and Mugenda (2003), this design is a systematic inquiry into which the researcher does not have direct control of the independent variables because their manifestation has already occurred. The survey design was economical because it allowed rapid data collection and helped investigator to understand the population from the sample to be decided.

3.4 Study and target population

The study population involved communities living within MMNR ecosystems and the staff working in MMNR. The study therefore targeted a total population of one thousand five hundred people (1,500) who reside in Maasai Mara and its environs (see table 3.1).

3.5 Sample and Sampling method

A representative sample was chosen from the target population and used in the study. According to Neumann (2000), an effective sample should possess diversity, representativeness, reliability, accessibility and knowledge. This enables the researcher to derive from the population detailed data within reasonable periods and efficient resource use. The researcher ensured a high degree of correspondence in the sampling population to enhance accuracy. The sample size was obtained from a total target population of 1600 people.

The target population belonged to two groups namely; local community and the staff of the MMNR. Stratified sampling was employed in carrying out the study. Kothari (2004) and Oso and Onen (2005) noted that stratified random sampling is a process of selecting respondents using well-defined strata. In this study, the two groups formed the strata. To ensure a proportionate representation of all the groups in the study, the sample contributed by each group was weighted according to each group's target population (Oso & Onen, 2005). The complete sample size for the groups used in the study is presented in Table 3.2 derived from the Morgan Table 3.1 below.

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	246
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	351
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	181	1200	291	6000	361
45	40	170	118	400	196	1300	297	7000	364
50	44	180	123	420	201	1400	302	8000	367
55	48	190	127	440	205	1500	306	9000	368
60	52	200	132	460	210	1600	310	10000	373
65	56	210	136	480	214	1700	313	15000	375
70	59	220	140	500	217	1800	317	20000	377
75	63	230	144	550	225	1900	320	30000	379
80	66	240	148	600	234	2000	322	40000	380
85	70	250	152	650	242	2200	327	50000	381
90	73	260	155	700	248	2400	331	75000	382
95	76	270	159	750	256	2600	335	100000	384

Table 3.1: Determining sample size from a given population

Source: Krejcie and Morgan, 1970

Table 3.2 : Sample Size

Respondent category	**Target**	**Procedure**	**Sample Size**
Local Community	1400	Simple random sampling	302
Staff of MMNR	200	Simple random sampling	132
Total	**1600**		**434**

Simple random sampling was used to select individuals from each of the two strata. Mugenda and Mugenda (2003) defined simple random sampling as a process of selecting respondents without any particular sequence where everyone in the study population has an equal chance of being selected. This method therefore ensured that any member of the target population could have participated in the study, hence ensuring that the findings of this study were representative of the residents around the MMNR. A sampling frame of all members of the target population for each stratum was prepared and used to select individuals for the study using a table of random numbers. A sampling frame is a complete list of all the members of the population that we wish to study (Kothari, 2004).

3.6 Data Collection Instruments

The study employed multidimensional approach to data collection, involving the collection of both qualitative and quantitative data. Furthermore, according to Patton (2002), every method of collecting data has its limitation and multiple methods are usually helpful in achieving accuracy of the results. Hence, data collection for this study involved the use of two methods; questionnaires and interview schedules. Indeed, the data collection methods adopted were interactive and humanistic as recommended by Crotty (1998).

3.6.1 Questionnaires

The questionnaires were the main instruments for collecting primarily quantitative data. A questionnaire is a research instrument consisting of a series of questions and other prompts for gathering information from respondents (Neumann, 2000). A survey questionnaire was considered appropriate because of its ability to permit quickly generation of appropriate amount of baseline information required for the purpose of this study. Moreover, the data collected using questionnaires is easily analyzable. Rating scales such as the Likert type of scale, frequently used by a large majority of researchers to measure attributes of people, was the format adopted the study (Kitzinger & Barbour, 1999). Besides, open-ended questions were included to allow respondents to express their ideas in their own words.

The questions were arranged to start with very general and relatively 'easy' questions building up to more specific and 'in-depth' issues. The technique built an easy rapport at the beginning, and gained the confidence of those being questioned. The study utilized two sets of questionnaires. One for the local communities and the other for the staff working within MMNR. Each set of questionnaire consisted of 7 sections. Section A captured respondent's general information, section B solicited information on respondent's awareness of climate change and; sections C, D, E, F and G captured information on effect of climate change on animals, plants, tourist activities and adaptation to climate change respectively.

3.6.2 Interview Schedules

Structured oral interviews were used mainly to collect qualitative data from opinion leaders. This involved face to face interviews between the researcher and the key informants. Structured interviews were easy to carry out because the questions were prepared in advance. Interviews eliminated many sources of bias that could be associated with the other methods of data collection like in questionnaires. For instance, there was a chance for clarifications in case of any misunderstanding between the researcher and the respondent through probing. The interview schedule also gave respondents the freedom of answering questions. The investigator used interviews mainly to follow up ideas, probe responses, and investigate motives and feelings which the questionnaire captured comprehensively.

3.7 Validity and Reliability of Research Instruments

3.7.1 Validity of Research Instruments

According to Kothari (2004), validity is the quality attributed to a proposition or a measure of the degree to which they conform to established knowledge or truth. Validity therefore refers to the extent to which an instrument (for instance, the questionnaire) can measure what it ought to measure, that is, the extent to which an instrument asks the right questions in terms of accuracy. If the questionnaires collected the needed information, then, they were valid (Hopkins, 2000). Mugenda and Mugenda (2003) looked at validity as the accuracy and meaningfulness of inferences, based on research results.

Content validity of the instrument was determined in two ways. First, the researcher discussed the items in the instrument (questionnaire) with supervisors and colleagues from the School of Tourism, Hospitality and Events Management and that of Business and Economics, Moi University. Since the determination of content validity is judgmental, all these people helped to refine the definition of the topic of concern, the items to be scaled and the scales to be used.

Secondly, content validity of the instrument was determined through piloting, where responses of the subjects were checked against the research objectives. Piloting involved using 20 community members the neighboring Kajiado County.

3.7.2 Reliability of Research Instruments

The test of reliability is another important test of sound measurement to provide consistent results. According to Mugenda and Mugenda (2003), the reliability of an instrument is the measure of the degree to which a research instrument yields consistent results or data after repeated trials. Reliability thus aims at ascertaining the consistency of responses collected by the instruments, which was achieved through administration of the questionnaires or portions of the questionnaire to the same respondents at different times in order to assess how stable the answers were. This was accomplished during piloting. A reliability coefficient analysis, employing Cronbach Alpha correlation coefficient, was carried out to determine the reliability of research instruments. Where the Cronbach alpha values were found to be above the threshold of 0.7, the items were judged as being reliable. Where the value was less than 0.7, the items were revised.

3.8 Data collection procedure

This involved the process of taking the research instruments to the field for the purpose of data collection. Before the actual data collection, a research permit was sought and obtained from the National Council for Science and Technology after which the research authorization letter was dispatched to the relevant agencies under MMNR. These included Narok County Council, Kenya Wildlife Service, Ministry of Agriculture, Ministry of Water and Irrigation, Provincial Administration (DC, Dos & Chiefs), Kenya Forest Service, Conservationists and other concerned stakeholders within the eco system.

Before administration of questionnaires, the researcher booked appointments with the opinion leaders before making a formal visit on the respective day of the appointment. Upon visiting, the researcher picked the samples of respondents and issued them with the questionnaires. The respondents were given 40 minutes to fill the questionnaires after which the questionnaires were collected. Whenever any problem amongst the respondents arose with respect to filling the questionnaires, the researcher assisted them before taking away the questionnaires. The researcher then assembled all the collected information and appreciated the respondents before leaving.

Interviews were conducted keeping strict privacy after getting informed consent from the respective study participant. This was ascertained by putting the signature of the interviewers from the respective field areas and then they checked by the supervisors and principal investigator (Researcher). The supervisors checked the collected data for its completeness, clarity and consistency. Corrections were made accordingly with each data collector, communicating with the principal investigator.

3.9 Data Preparation

Several steps were undertaken to ensure the veracity of the data that was used in the final analysis. These included checking and editing of the collected questionnaires, coding, transcribing, and cleaning of the data. The collected questionnaires were checked for completeness, missing pages, and non-following of instructions. The questionnaires with missing pages or missing biographical information of the respondents were discarded. Questionnaires with complete biographical information but with missing responses on all the other questions were likewise discarded.

It is important to note that all the questionnaires with complete biographical information and some other questions answered were included in the analysis, with the unanswered questions treated as missing data. This was germane because while the missing information for other questions may be inferred from the means and trends of the rest of the data, the missing biographical information cannot be similarly treated. Illegible and incomplete answers were edited to improve their readability and completeness.

The data was coded by assigning alpha or numeric codes to answers, which allowed them to be subjected to statistical techniques. The codes were selected after reading through the questionnaires and noting the general trend of answering. Although ordinal, this allowed these variables to be considered to have metric properties, which permitted more useful statistical tests such as t-tests to be conducted (Norušis, 2010).

The data was transcribed into a computer spreadsheet and then exported into a statistical programme, Predictive Analysis Software (PASW), Version 20 (formerly, Statistical Package for Social Sciences, SPSS). In order to check the accuracy of the transcribed data, the data was compared with randomly selected questionnaires. Additionally, the data was cleaned by identifying and correcting for the missing values and outliers. Apart from the absent information, missing values in data set are undesirable as they prevent the execution of certain statistical procedures, such as tests for normality (Byrne, 2009). Outliers or extreme values distort many statistics, such as the mean and all the attendant statistics based on the mean, for example, the Analysis of Variance (ANOVA) (Field, 2009). Outliers were identified by the Validate Data procedure while missing values was ascertained by the Missing Value Analysis procedure, both present in PASW. Since missing values did not involve any biographical information, they were filled by the means of the affected variables. For the outliers, the questionnaires with the offending values were traced and the correct values on the questionnaire were then transcribed again into the PASW data editor.

3.10 Data analysis

Qualitative data arising from interviews was analyzed by the method of content analysis. The purpose of doing qualitative data analysis was to reduce the amount of text and organize responses to identify broad trends and themes in the data. Content analysis created a structure that allowed the organization of open-ended information. Several analytical tools, described in the following section, were employed in the analysis of quantitative data, arising from questionnaires.

3.10.1 Descriptive Statistics

Descriptive statistics were used to describe, summarize, and organize the data. Three sets of these methods were used: frequency distributions, measures of central tendency, and measures of dispersion. Frequency distributions, ordered arrangement of all variables, showing the number of occurrences in each category, was used to summarize data, which was then displayed in tables and graphs (Norusis, 2010). Average or typical values of the data were given by the central tendency measures of the mean (the arithmetic average of values in a set) (Bryman, 2008). Dispersion (variability) of data was given by the standard deviation (the average difference between observed values and the mean).

3.10.2 Chi – Square Tests, t – tests and Analysis of Variance (ANOVA)

Chi-square (χ^2) tests of goodness of fit were used to test if significant differences existed on the frequencies of different categories. Means in the study were compared using either t – tests or Analysis of variance (ANOVA). T –tests were used when the groups being compared were just two, for instance, the mean perceived climate impact amongst members of staff and members of the local community. Since the means being compared belonged to two distinct (independent) groups, for example, staff and the local community, independent samples t- tests were used. Where the groups were more than two, ANOVA was used, for example, when ranking the respondents' means of the various causes of climate change, for instance, deforestation, overharvesting of trees, human settlement, agriculture, and greenhouse emissions. Since the means being compared were merely summaries of different questions answered by the same individual, a Repeated Measures (RM) – ANOVA, rather than a one-way ANOVA was used, to prevent violating the assumption of independent observations.

ANOVA merely says that the means being compared are different without saying the specific pairs which are different. Thus, with more than two categories of the independent variable (for example, deforestation, overharvesting, agriculture and green-house emissions), post hoc tests were conducted to establish the specific pairs of means which were different from each other (Field, 2009). The Bonferroni test was used to conduct the post hoc tests, because it is powerful and carries out a correction for multiple comparisons, unlike other tests such as LSD (Least Squares Difference method) (Field, 2009). For t – tests, post hoc analysis was unnecessary since with a significant result, one can straightaway tell which mean was higher and which one was lower.

3.10.3 Tests of the Research Hypotheses

The null hypotheses under study were fifth fold: Climate change has no perceived effects on animals found in MMNR, climate changes has no perceived impacts on plants in MMNR, climate change has no perceived effects on the quantity of surface water, climate change has no perceived impacts on tourism activities in MMNR, and there are no adaptation strategies to climate change adopted in MMNR. Four hypotheses were analysed using structural equation modelling – path analysis (SEMPATH), which was undertaken using the Amos Statistical Program (version 18) whereas the last hypothesis was analysed using frequency distributions.

SEMPATH is a family of multivariate statistical analytic tool that seeks to explain the relationship among multiple variables (Cooper & Schindler, 2006; Hair, Babin, Money, & Samouel, 2003). Structural equation modelling was chosen in preference to the traditional regression procedure for the following reasons. SEMPATH analysis has the ability to incorporate latent and observed variables (indicators) for a single independent or dependent variable; there is improvement of statistical estimation by accounting for a larger number of measurement variables thus more representation of theoretical concepts and ability to specify and improve measurement error; it is versatile in terms of combining dependence and correlation relationships (Heir *et al*., 2006) and, finally, though SEMPATH examines the structure of interrelationships expressed in a series of matrix equations similar to those of multiple regression equations, in applied work like this study, a graphical path diagram helps visualize them better (Cooper & Schindler, 2006). Table 3.2 below summarizes the tools used to test the hypotheses in the study.

Table 3.3 **:** Summary of Hypothesis Testing Techniques and Test Statistic

Stated hypothesis	**Hypothesis Testing**	**Test Statistic**
$H0_1$: There is no significant effect of climate change on the animal community in MMNR and its environs	Structural equation modelling (SEMPATH analysis)	Path coefficient (regression weight, β) Test significant P<.05
$H0_2$: There is no significant effect of climate change on the plant community in MMNR and its environs	Structural equation modelling (SEMPATH analysis)	Path coefficient (regression weight, β) Test significant P<.05
$H0_3$: There is no significant effect of climate change on the quantity of surface water in MMNR and its environs	Structural equation modelling (SEMPATH analysis)	Path coefficient (regression weight, β) Test significant P<.05
H_04: There is no significant effect of climate change on tourism activities in MMNR	Structural equation modelling (SEMPATH analysis)	Path coefficient (regression weight, β) Test significant P<.05
H_05: There are no adaptation strategies to climate change adopted in MMNR.	Frequency analysis	None

Source: Author (2013)

All probabilities reported are based on two tailed test as each comparison has two possible directions and is advisable when the study is exploratory and controversial in nature (Cooper & Schindler, 2006). The first four hypotheses are depicted in Figure 3.1

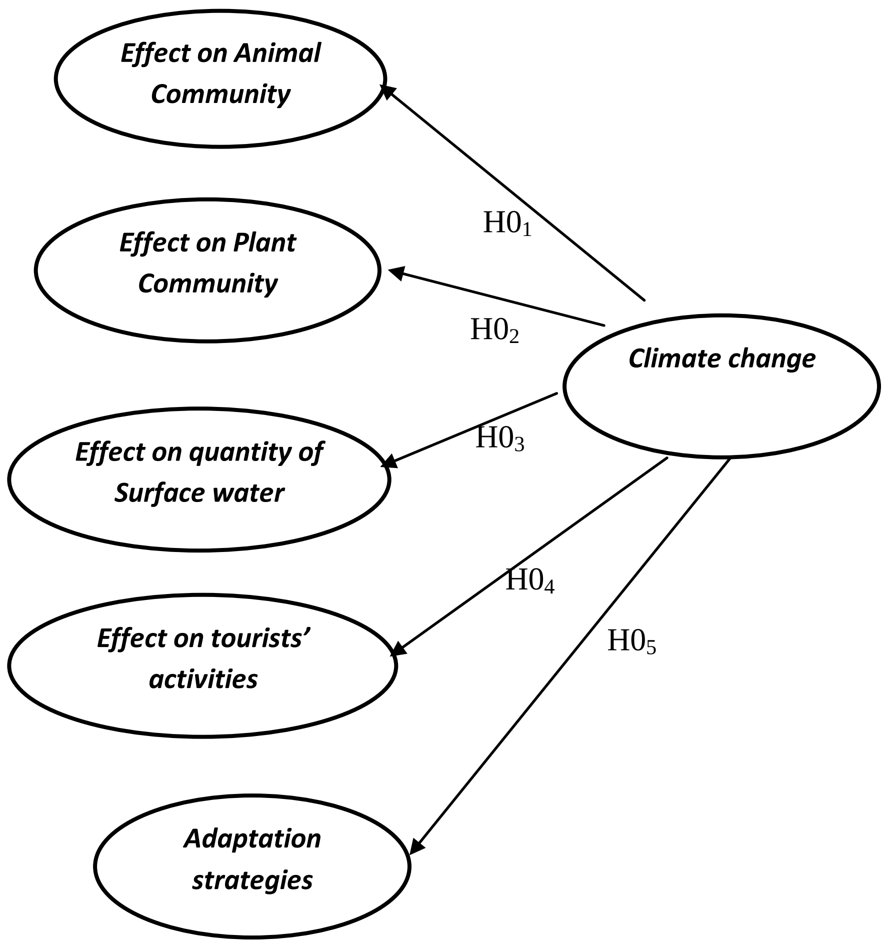

Figure 3.2 : Path Model

Source: Author (2013)

3.11 Ethical Considerations

The research attempted to maintain duty of confidentiality by ensuring the respondents' information was used for the purpose of research only as well as maintaining human dignity while gaining knowledge. This achieved through informed consent from the various sources of secondary data that implored and avoided unethical means such as plagiarism that is lifting of data directly and copying to the work was not allowed. In addition, the whole research process was under the researcher through the support of able supervisors. Individuals who were not volunteers continued from the beginning or from any part of the interview had right to do so. Privacy and strict confidentiality were maintained during the interview process.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.0 Introduction

This chapter presents and discusses the findings of the study both for the staffs and the local community in MMNR. The study aimed at establishing the perceived effects of climate change on tourism and natural resources in protected areas, using the case of Maasai Mara National Reserve, Kenya. Specifically, the study was guided by the following objectives;

i) To determine the perceived effect of climate changes on animal community in MMNR.
ii) To establish the perceived effect of climate changes on plant community in MMNR.
iii) To establish the perceived effect of climate change on the quantity of surface water.
iv) To establish the perceived effect of climate change on tourists' activities in MMNR.
v) To establish adaptation strategies to climate change adopted in MMNR.

4.1 Demographic Profile of Respondents

The demographic information sought included the respondent's gender, age, highest education level, occupation and working period. The respondents were drawn from two groups: local community members living in the environs of the MMNR and staff of the MMNR, and hence, it was germane to document their separate profiles (Table 4.1).

Table 4. 1: Demographic information of the respondents

Demographic information	**Respondent type**	**Categories**	**Percent**
Respondents' gender	Staff	Male	80.0
		Female	20.0
		Total	100.0
	Local community	Male	94.0
		Female	6.0
		Total	100.0
Respondent's age	Staff	21-30 years	25.5
		31-40 years	70.0
		41-50 years	4.5
		Total	100.0
	Local community	21-30 years	11.5
		31-40 years	84.5
		41-50 years	4.0
		Total	100.0
Highest education level	Staff	None	5.0
		Primary	28.0
		Secondary	55.0
		College	5.0
		University	7.0
		Total	100.0
	Local community	None	2.0
		Primary	77.0
		Secondary	5.5
		College	6.5
		University	9.0
		Total	100.0
Occupation	Staff	Warden	6.5
		Ranger	3.5
		Work with NGO	9.5
		County council	42.0
		Other	38.5
		Total	100.0
	Local community	Warden	5.5
		Ranger	3.0
		Work with NGO	6.0
		County council	79.0
		Other	6.5
		Total	100.0
Working period	Staff	Less than 5 years	45.0
		6 – 10 years	51.5
		11 – 15 years	1.0
		Over 21 years	2.5
		Total	100.0
	Local community	Less than 5 years	15.5
		6 – 10 years	5.0
		11 – 15 years	0.5
		Over 21 years	79.0
		Total	100.0

Source: Field Data, 2013.

The results indicated that the respondents were disproportionately male (staff: male were 80%, female were 20% and local community: male were 94%, female were 6%). This suggested that employment in the MMNR may be skewed towards male and among the communities living around the reserve; men could be more proactive than females. Most of the respondents were aged between 31 and 40 years (staff were 70%, local community were 84.5%), suggesting that the bulk of the respondents could have lived long enough to be aware of changes in the climate. Hence, their perceptions about climate change are likely to be empirical rather than imaginative. Fewer respondents belonged to the 21-30 years (staff were 25.5%, local community were 11.5%) and 41-50 years (staff were 4.5%, local community were 4%) age brackets.

On education, the results indicated that while the majority of staff had secondary education (n=110, 55%), the bulk of the local community possessed primary education (n=154, 77%). This suggested that the staff of MMNR might have better insight on climate change compared to the local community. The results also implied that interventionist strategies in response to climate change might need to be applied differently amongst the local community and staff members of MMNR. Interestingly, there were slightly more people with college or university education among the local community (15.5%) as compared with the staff (12%), suggesting that pockets of the local community might have had as good conception of climate change, if not better, compared with the staff. Similarly, the proportion of the local community with no education (2%) was slightly lower relative to the staff with no education (5%).

The occupations of the local community members were found to be more confined, with most of them working in the county council (n=158, 79%). However, for staff the results indicated that they had more varied occupations. Although the majority

(42%) were county council members, 38.5% of the respondents held other positions within the reserve. Whereas those working with NGOs were represented by 9.5%, the wardens were represented by 6.5% while the rest (3.5%) were rangers. The fact that the respondents were drawn from various occupations suggested that the findings of this study were likely to mirror the perceptions of wider segments of society.

The perceived effects of climate change on natural resources and tourism could be easily established by someone that has worked in a protected area for a long period of time and has seen substantive changes over time. Hence, it was important to establish the period that the respondents had worked in MMNR or lived in the present area of residence (that is within the environs of MMNR). The results indicated that 51.5 % (n=103) of the staff and 79% (n=158) of the local community members had worked and/or lived in the MMNR for between 6 – 10 years and over 21 years, respectively. This suggested that a critical proportion of the respondents had worked in MMNR for long enough to witness changes in the climate.

4.2 Cross-tabulation

4.2.1 Local community

Table 4. 2: Cross tabulation of causes of climate change and gender of the local community

Cross tabulation of causes of climate change and gender of the local community

		Gender		Total	
		Male	**Female**		
Deforestation	Least important	88.9%	11.1%	100.0%	χ^2 = 5.206 df=4 p=0.267
	Less important	75.0%	25.0%	100.0%	
	Important	100.0%	0.0%	100.0%	
	More important	80.0%	20.0%	100.0%	
	Most important	95.0%	5.0%	100.0%	
Human settlement	Least important	66.7%	33.3%	100.0%	χ^2 = 31.200 df=4 p<0.001
	Less important	100.0%	0.0%	100.0%	
	Important	60.0%	40.0%	100.0%	
	More important	100.0%	0.0%	100.0%	
	Most important	96.4%	3.6%	100.0%	
Agriculture	Least important	80.0%	20.0%	100.0%	χ^2 = 39.425 df=4 p<0.001
	Less important	80.0%	20.0%	100.0%	
	Important	70.6%	29.4%	100.0%	
	More important	99.4%	0.6%	100.0%	
	Most important	73.3%	26.7%	100.0%	
Over utilization of natural resources	Least important	81.8%	18.2%	100.0%	χ^2 = 8.040 df=4 p=0.090
	Less important	66.7%	33.3%	100.0%	
	Important	100.0%	0.0%	100.0%	
	More important	90.0%	10.0%	100.0%	
	Most important	95.3%	4.7%	100.0%	
Green house emissions	Least important	99.4%	0.6%	100.0%	χ^2 = 54.605 df=4 p<0.001
	Less important	100.0%	0.0%	100.0%	
	Important	75.0%	25.0%	100.0%	
	More important	71.4%	28.6%	100.0%	
	Most important	61.1%	38.9%	100.0%	
Construction of infrastructure	Least important	81.8%	18.2%	100.0%	χ^2 = 53.244 df=4 p<0.001
	Less important	100.0%	0.0%	100.0%	
	Important	63.6%	36.4%	100.0%	
	More important	71.4%	28.6%	100.0%	
	Most important	66.7%	33.3%	100.0%	
Over harvesting of indigenous trees	Least important	90.0%	10.0%	100.0%	χ^2 = 34.940 df=4 p<0.001
	Less important	100.0%	0.0%	100.0%	
	Important	55.6%	44.4%	100.0%	
	More important	66.7%	33.3%	100.0%	
	Most important	97.1%	2.9%	100.0%	

Source: Researcher 2013

From the study results, a cross tabulation was conducted between gender of the local community and the causes of climate change (Table 4.2). The results revealed that deforestation had a χ^2 of 5.206 and a significance of 0.267, while human settlement had a χ^2 of 31.2 and a significance of 0.001. Agriculture had a χ^2 of 39.425 and a significance of 0.001, while over-utilization of natural resources had a χ^2 of 8.04 and a significance of 0.09. Greenhouse emissions had a χ^2 of 54.605 and a significance of 0.01, construction of infrastructure had a χ^2 of 53.244 and a significance of 0.01 and over harvesting of indigenous trees had a χ^2 of 34.940 and a significance of 0.01. The findings clearly indicate that deforestation was the main cause of climate change in the study area.

Table 4. 3: Cross tabulation of causes of climate change and age of the local community

Crosstabulation of the causes of climate change and age of the local community						
		Age			Total	
		21-30	31-40	41-50		
Deforestation	Least important	66.7%	33.3%	0.0%	33.3%	χ^2 = 53.771 df=8 p<0.001
	Less important	50.0%	50.0%	0.0%	33.3%	
	Important	33.3%	33.3%	33.3%	100.0%	
	More important	40.0%	40.0%	20.0%	100.0%	
	Most important	6.7%	89.9%	3.4%	100.0%	
Human settlement	Least important	66.7%	33.3%	0.0%	100.0%	χ^2 = 90.503 df=8 p<0.001
	Less important	60.0%	40.0%	0.0%	100.0%	
	Important	50.0%	40.0%	10.0%	100.0%	
	More important	60.0%	20.0%	20.0%	100.0%	
	Most important	3.0%	94.1%	3.0%	100.0%	
Agriculture	Least important	60.0%	20.0%	20.0%	100.0%	χ^2 = 130.962 df=8 p<0.001
	Less important	100.0%	0.0%	0.0%	100.0%	
	Important	29.4%	47.1%	23.5%	100.0%	
	More important	1.9%	98.1%	0.0%	100.0%	
	Most important	46.7%	33.3%	20.0%	100.0%	
Over utilization of natural resources	Least important	81.8%	18.2%	0.0%	100.0%	χ^2 = 114.828 df=8 p<0.001
	Less important	100.0%	0.0%	0.0%	100.0%	
	Important	66.7%	33.3%	0.0%	100.0%	
	More important	20.0%	60.0%	20.0%	100.0%	
	Most important	2.9%	93.5%	3.5%	100.0%	
Green-house emissions	Least important	4.8%	93.9%	1.2%	100.0%	χ^2 = 98.321 df=8 p<0.001
	Less important	100.0%	0.0%	0.0%	100.0%	
	Important	37.5%	62.5%	0.0%	100.0%	
	More important	57.1%	42.9%	0.0%	100.0%	
	Most important	33.3%	33.3%	33.3%	100.0%	
Construction of infrastructure	Least important	54.5%	27.3%	18.2%	100.0%	χ^2 = 124.003 df=8 p<0.001
	Less important	2.5%	97.5%	0.0%	100.0%	
	Important	27.3%	36.4%	36.4%	100.0%	
	More important	28.6%	57.1%	14.3%	100.0%	
	Most important	66.7%	25.0%	8.3%	100.0%	
Over harvesting of indigenous trees	Least important	60.0%	40.0%	0.0%	100.0%	χ^2 = 82.434 df=8 p<0.001
	Less important	75.0%	0.0%	25.0%	100.0%	
	Important	33.3%	55.6%	11.1%	100.0%	
	More important	66.7%	16.7%	16.7%	100.0%	
	Most important	4.1%	93.0%	2.9%	100.0%	

Source: Researcher 2013

A cross tabulation was conducted between age of the local community and the causes of climate change (Table 4.3). Deforestation had a χ^2 of 53.771 and a significance of 0.01, while human settlement had a χ^2 of 90.503 and a significance of 0.001. Agriculture had a χ^2 of 130.962 and a significance of 0.001, while over-utilization of natural resources had a χ^2 of 114.828 and a significance of 0.01. Greenhouse emissions had a χ^2 of 98.321 and a significance of 0.01, construction of infrastructure had a χ^2 of 124.003 and a significance of 0.01 and over harvesting of indigenous trees had a χ^2 of 82.434 and a significance of 0.01. The findings clearly indicate that deforestation was the main cause of climate change in the study area.

4.2.2 Staff of MMNR

Table 4. 4: Cross tabulation of causes of climate change and age of the staff of MMNR

Cross tabulation of causes of climate change and age of the staff of MMNR						
		Age			Total	
		21-30	31-40	41-50		
Deforestation	Least important	41.7%	50.0%	8.3%	100.0%	χ^2 = 41.027 df=8 p<0.001
	Less important	72.2%	27.8%	100.0%	100.0%	
	Important	66.7%	33.3%	100.0%	100.0%	
	More important	25.0%	62.5%	12.5%	100.0%	
	Most important	15.9%	80.0%	4.1%	100.0%	
Human settlement	Least important	40.0%	60.0%	0.0%	100.0%	χ^2 = 27.232 df=8 p<0.001
	Less important	17.4%	78.3%	4.3%	100.0%	
	Important	45.0%	35.0%	20.0%	100.0%	
	More important	50.0%	41.7%	8.3%	100.0%	
	Most important	22.2%	76.1%	1.7%	100.0%	
Agriculture	Least important	50.0%	50.0%	0.0%	100.0%	χ^2 = 47.142 df=8 p<0.001
	Less important	15.6%	80.0%	4.4%	100.0%	
	Important	66.7%	33.3%	0.0%	100.0%	
	More important	18.8%	50.0%	31.2%	100.0%	
	Most important	23.7%	74.6%	1.7%	100.0%	
Over utilization of natural resources	Least important	50.0%	50.0%	0.0%	100.0%	χ^2 = 73.746 df=8 p<0.001
	Less important	35.3%	64.7%	0.0%	100.0%	
	Important	25.0%	66.7%	8.3%	100.0%	
	More important	4.1%	92.8%	3.1%	100.0%	
	Most important	77.8%	16.7%	5.6%	100.0%	
Green-house emissions	Least important	7.5%	92.5%	0.0%	100.0%	χ^2 = 94.915 df=8 p<0.001
	Less important	37.5%	62.5%	0.0%		
	Important	23.1%	74.4%	2.6%		
	More important	46.2%	34.6%	19.2%		
	Most important	65.4%	23.1%	11.5%		
Construction of infrastructure	Least important	77.8%	11.1%	11.1%		
	Less important	2.2%	97.8%	0.0%	100.0%	
	Important	61.1%	33.3%	5.6%	100.0%	
	More important	31.2%	37.5%	31.2%	100.0%	
	Most important	38.8%	58.2%	3.0%	100.0%	
Over harvesting of indigenous trees	Least important	58.3%	33.3%	8.3%	100.0%	χ^2 = 88.540 df=8 p<0.001
	Less important	71.4%	14.3%	14.3%	100.0%	
	Important	6.9%	89.7%	3.4%	100.0%	
	More important	71.4%	17.1%	11.4%	100.0%	
	Most important	10.3%	88.0%	1.7%	100.0%	

Source: Researcher, 2013

A cross tabulation was conducted between age of the staff of MMNR of and the causes of climate change (Table 4.4). Deforestation had a χ^2 of 41.027 and a significance of 0.01, while human settlement had a χ^2 of 27.232 and a significance of 0.001. Agriculture had a χ^2 of 47.142 and a significance of 0.001, while over-utilization of natural resources had a χ^2 of 82.098 and a significance of 0.01. Greenhouse emissions had a χ^2 of 73.746 and a significance of 0.01, construction of infrastructure had a χ^2 of 94.915 and a significance of 0.01 and over harvesting of indigenous trees had a χ^2 of 88.540 and a significance of 0.01. From the perspective of the staff, human settlement was the main cause of climate change in the study area.

4.3 Awareness of Climate Change

It was important to determine awareness of climate change among the respondents as it could help to shape the appropriate interventionist strategies.

4.3.1 Pervasiveness of Climate change message

Table 4.5 presents the results of whether the respondents had ever heard of climate change. A cross tabulation was used to compare the responses of the staff and members of the local community.

Table 4. 5: Awareness of climate change among the respondents

Have you ever heard of climate change?				
		Yes	No	Total
Staff	Frequency Percentage	96 96.0	4 4.0	100 100.0
Local community	Frequency Percentage	290 97.0	10 3.0	300 100.0

Source: Field Data, 2013.

The results indicated that both the staff (96%) and local community (97%) had overwhelmingly heard of climate change as depicted in Table 4.5. Thus, the message of climate change appears to be pervasive among the communities and staff of the MMNR.

4.3.2 Level of knowledge about climate change

The responses of the staff and members of the local community were compared using a cross tabulation on the respondents' level of knowledge with respect to climate change (Table 4.6).

Table 4.6: Respondent's knowledge level about climate change

		Level of knowledge				
		Non-expert	Somewhat knowledgeable	Knowledgeable	Expert	Total
Staff	Frequency	2	72	25	1	100
	Percentage	2.0	72.0	25.0	1.0	100
Local community	Frequency	5	236	53	6	300
	Percentage	1.5	82.0	14.0	2.5	100

Source: Field Data, 2013.

The results showed that very few respondents considered themselves as experts (1.8%) or non-experts (1.8%) on matters of climate change. This suggested that although the respondents perceived themselves as not having specialized training on climate change, they felt that they could make intelligent deductions about climate change. Because these cases were very few, they were removed from the analysis to prevent some cells in the table having fewer than the minimum expected counts.

It was also germane to determine how the level of knowledge on climate change varied with the respondents' gender, age and education. These results are presented in Table 4.7.

Table 4. 7: Relationship between climate change knowledge and demographic variables

			Level of knowledge		
Variable Respondents' category			Somewhat knowledgeable	Knowledgeable	Total
Gender	Male	Frequency	276	62	338
		Percentage	81.7	18.3	100.0
	Female	Frequency	32	16	48
		Percentage	66.7	33.3	100.0
	Total	**Frequency**	**308**	**78**	**386**
		Percentage	**79.8**	**20.2**	**100.0**
Age	21-30 years	Frequency	36	34	70
	31-40 years	Percentage	51.4	48.6	100.0
	41-50 years	Frequency	269	34	303
	Total	Percentage	88.8	11.2	100.0
		Frequency	3	10	13
	None	Percentage	23.1	76.9	100.0
		Frequency	**308**	**78**	**386**
	Primary	**Percentage**	**79.8**	**20.2**	**100.0**
Education		Frequency	6	2	8
	Secondary	Percentage	75.0	25.0	100.0
		Frequency	184	25	209
	College	Percentage	88.0	12.0	100.0
		Frequency	98	20	118
	University	Percentage	83.1	16.9	100.0
		Frequency	7	15	22
	Total	Percentage	31.8	68.2	100.0
		Frequency	13	16	29
		Percentage	44.8	55.2	100.0
		Frequency	**308**	**78**	**386**
		Percentage	**79.8**	**20.2**	**100.0**

Source: Field Data, 2013.

The results in Table 4.7 showed that a significantly higher proportion of females perceived themselves to be knowledgeable about climate change (33.3%) compared with males (18.3%) whereas more males were found to be somewhat knowledgeable (81.7%) compared with females (66.7%). This suggested that females in the study felt that they had superior knowledge about climate change as compared to males, which could be attributed to the fact that females in the study were older and better educated than males as established in sections 4.2 and 4.3 above.

This conclusion was buttressed by the finding that respondents aged between 41-50 years had the highest proportion of knowledgeable people about climate change (76.9%) compared with those in the 31-40 years age bracket (11.2%). Amongst younger respondents (those aged between 21-30 years), the proportions were roughly evenly split, with 51.4% somewhat knowledgeable and 48.6% knowledgeable. Results in Table 4.8 indicated that education was positively correlated with the level of knowledge about climate change, with respondents having college and university education rating themselves as highly knowledgeable with respect to climate change (68.2% and 55.2%, respectively).

4.3.3 Causes of climate change

Table 4.8 presents the various causes of climate change established by the study. The respondents perceived climate change can be caused by seven main factors, namely; deforestation, human settlement, agriculture, overutilization of natural resources, greenhouse emissions, infrastructure and overharvesting of indigenous trees. A repeated measures of Analysis of Variance (RM – ANOVA) was conducted to test the respondents' rating of the seven causes of climate change and was found to be significant ($F = 6.394$, $p<.001$). This indicated that respondents considered the causes of climate change as being different in their ability to cause climate change. Post hoc analysis was conducted by the Bonferroni tests and the results are presented in Table 4.9 below. The mean was for the coded variable where 1 stood for least important, 2 was less important, 3 was important, 4 was more important and 5 was most important. Additionally, the means are presented in Figure 4.1 in a descending fashion to allow for their easy visualization.

Table 4. 8: General causes of climate change

Cause (n=400)	**Mean**	**Std. Deviation**
Deforestation	4.51[a]	1.128
Human settlement	4.30[b]	1.208
Agriculture	3.92[c]	1.075
Over utilization of natural resources	4.18[b]	1.055
Green-house emissions	1.97[e]	1.445
Construction of infrastructure	2.73[f]	1.265
Over harvesting of indigenous trees	4.41[a]	1.122

Means with similar letters are not significantly different by the Bonferroni Test.

Source : Field Data, 2013.

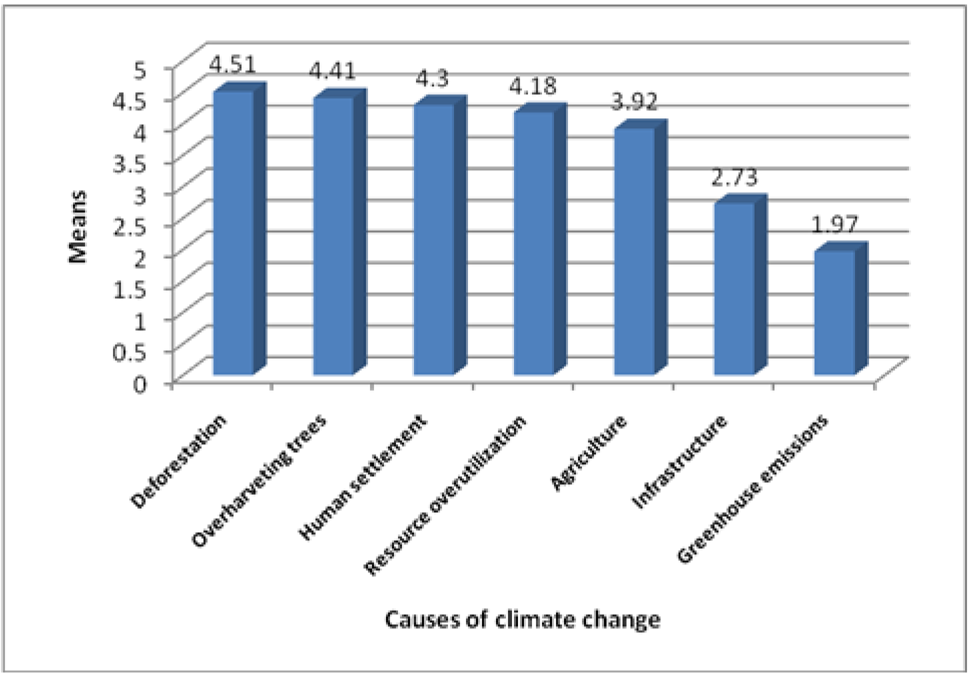

Figure 4.1 **:** Causes of climate change

Source: Field Data, 2013.

Precisely, the results indicated that the respondents rated deforestation and overharvesting of indigenous trees as the greatest causes of climate change, followed by human settlement and the over utilization of natural resources. Deforestation or logging has been of main concern in Kenyan forests. According to Cochrane and Laurence (2002), logging do not only include loss of habitat for animals in the forests, but also changes in the microclimatic environment, erosion of soil and modification of fire regimes with the impact depending on the type of logging, that is whether commercial mechanized logging with heavy equipment or local exploitation of timber through for example pit-swaying and firewood collection. All these cause deforestation and climate change eventually. The least important cause of climate change was found to be green-house emissions, followed by the construction of infrastructure.

It was also important to find out whether both the local community and staff had similar rating of the causes of climate change. Generally the research findings revealed that both the staff and local community members perceived deforestation, overharvesting of indigenous trees and human settlement to be the greatest contributors of climate change while greenhouse emissions and construction of infrastructure were considered the least (Table 4.9 and figure 4.2).

Table 4. 9: Causes of climate change in the MMNR: a comparison between local community and staff of MMNR

Cause	**Respondent type**	**Number**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Deforestation	Staff	100	4.32	1.255	.089
	Local community	300	4.71	.950	.067
Human settlement	Staff	100	3.95	1.355	.096
	Local community	300	4.66	.917	.065
Agriculture	Staff	100	3.98	1.358	.096
	Local community	300	3.87	.685	.048
Over utilization of natural resources	Staff	100	3.74	.887	.063
	Local community	300	4.63	1.025	.072
Green house emissions	Staff	100	2.38	1.489	.105
	Local community	300	1.56	1.275	.090
Construction of infrastructure	Staff	100	3.21	1.420	.100
	Local community	300	2.25	.855	.060
Over harvesting of indigenous trees	Staff	100	4.19	1.175	.083
	Local community	300	4.62	1.025	.072

Source: Researcher (2013)

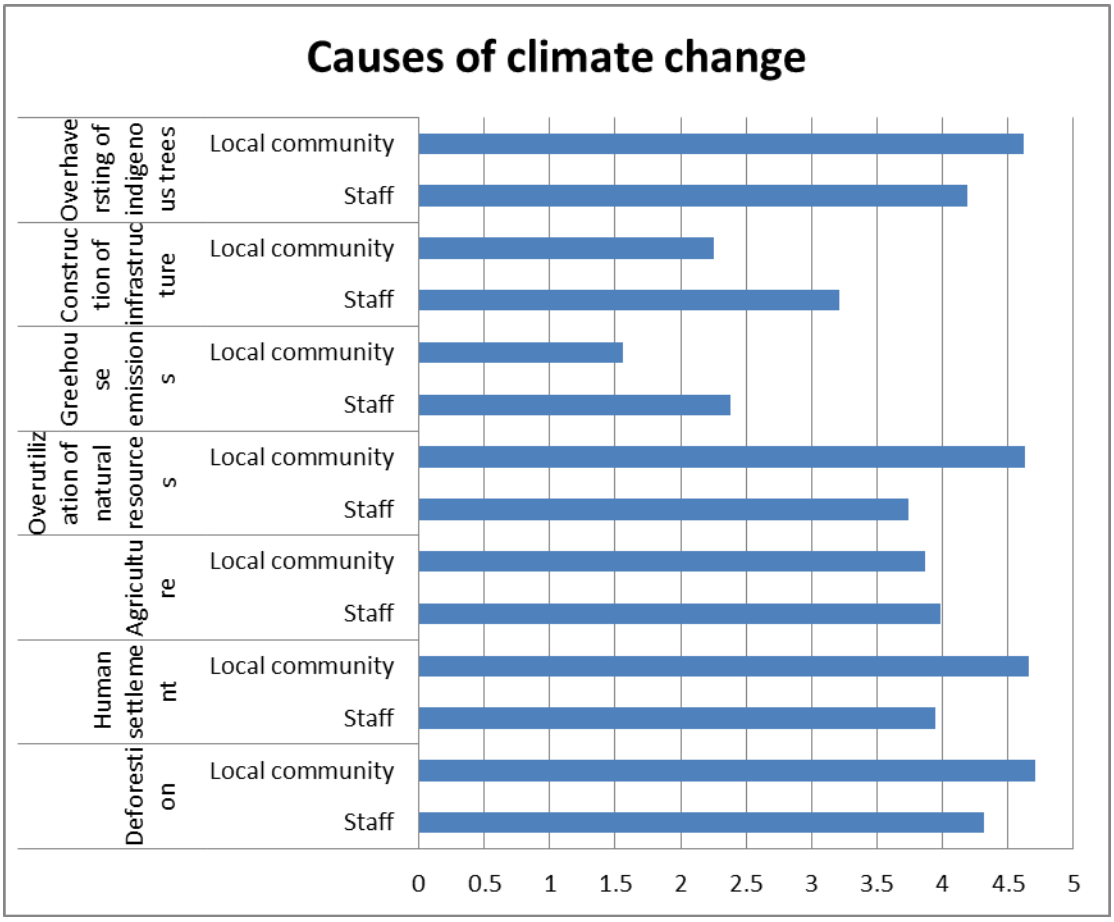

Figure 4.2 **:** Causes of climate change grouped according to respondent category

Source: Field Data, 2013.

However, whereas members of the local community found the overutilization of natural resources to be among the most important causes of climate change, staff members gave it a lower rating. An independent samples t - test was conducted to test whether the respondent type (membership to staff or local community) had a significant main effect on the perception of climate change.

The results of the independent samples t- test in Table 4.10 revealed that a significant main effect of respondent type at $p < 0.05$ was found for every climate change cause except for agriculture {t = 1.023, p=0.307}. This underscores that fact that the local community felt that deforestation, human settlement, overutilization of natural resources and overharvesting of indigenous trees were important causes of climate change compared to members of staff. However, with respect to greenhouse emissions and infrastructure construction, the local community perceived them to be less important causes of climate change relative to staff members.

Table 4. 10: Results of the independent samples t tests

Cause of climate change	T	Df	Sig (2-tailed)
Deforestation	-3.459	398	.001
Human settlement	-6.094	398	.001
Agriculture	1.023	398	.307
Over utilization of natural resources	-9.237	398	.001
Greenhouse emissions	5.953	398	.001
Infrastructure construction	8.191	398	.001
Overharvesting indigenous trees	-3.900	398	.001

4.3.4 Manifestations of climate change

Section 4.3.1 above showed that most respondents in the study were aware of climate change. It was important to establish if they could point out physical changes that had occurred in the MMNR and its environs to indicate that climate change had occurred (Table 4.11). According to the perceptions of the respondents, climate change in the MMNR principally manifested itself through increased droughts, floods, erratic rain patterns and elevated temperatures. Most respondents (78%) reported that erratic rainfall patterns was the most important sign of climate change, followed by droughts (72 %), floods (53%) as shown in Plate 4.1, and lastly, increased temperatures (46%).

Plate 4.1 : Overflowing Mara River

Source : Researcher, 2013

Table 4. 11: Manifestations of climate change

Manifestation (n=400)	Frequency	Percentage
Droughts	286	72
Floods	213	53
Erratic rain patterns	311	78
Increased temperatures	184	46

Source: Field Data, 2013.

4.4 Effect of Climate Change on Animals

Table 4.12 shows the perceptions of the respondents towards the possible effect of climate change on wild animals in MMNR. Every member of the local community felt that climate change affected wild animals in the reserve. Among the staff, an overwhelming 98% of them held a similar opinion. It was therefore germane to find out how climate change influenced animals in the reserve. The study theorized that the effect of climate change on animals could include changes in their population, species diversity, composition, extinction, changes in migration routes and patterns. Others included changes in breeding grounds, infections and increased deaths of animals. The number of respondents who considered each of these factors as a possible climate change effect on animals is presented in Table 4.13.

Table 4. 12: Effect of climate change on wild animals in MMNR

	Staffs		**Local community**	
	Frequency	**Percent**	**Frequency**	**Percent**
Yes	98	99	300	100
No	2	1	0	0
Total	100	100	300	0

Source : Field Data, 2013.

Table 4. 13: Effect of climate change on animals

Effects	Responses N	Responses Percent	Percent of cases	
Changes in animal population	394	13.3	98.5	χ^2 =22.219, df=2, p<0.001
Changes in species diversity	238	8.0	59.5	χ^2 =66.292, df=2, p<0.001
Changes in species composition	311	10.5	77.8	χ^2 =39.732, df=2, p<0.001
Extinction of animal species	156	5.3	39.0	χ^2 =81.395, df=2, p<0.001
Changes in migration routes	392	13.2	98.0	χ^2 =35.837, df=2, p<0.001
Changes in migration patterns	394	13.3	98.5	χ^2 =22.219, df=2, p<0.001
Changes in animal migration species	155	5.2	38.8	χ^2 =67.495, df=2, p<0.001
Changes in breeding grounds	396	13.4	99.0	χ^2 =5.722, df=2, p=0.057
Changes in animal infections	131	4.4	32.8	χ^2 =31.919 df=2, p<0.001
Increased animal deaths	395	13.3	98.8	χ^2 =23.652, df=2, p<0.001
Total	**2962**	**100**	**740.5**	

Source: Field Data, 2013.

The number of responses (2962) was more than the number of respondents in the study (400). This was because most respondents felt that climate change had more than one effect on animals, that is, the question was a multiple response type. An overwhelming number of respondents felt that climate change affected animal breeding grounds (n=396, 99%), followed by increased animal deaths (n=395, 98.8%), changes in animal populations (n=394, 98.5%), changes in migration patterns (n=394, 98.5%) and changes in migration routes (n=392, 98%). However, fewer respondents thought that climate change affected infections in animals (n=131, 32.8%), changes in migrating animal species (n=155, 38.8%) and extinction of animals (n=156, 39%). Indeed, the majority of the management of MMNR were particularly conscious about the effects of climate change on animal community. For instance, in one of the interview, the interviewee asserted that:

> *Due to limited food and water resources, there has been a significant change in terms of animal population. 40 years ago, there used to be plenty of animals around here and some used to stay with our livestock but in recent times, the wild animals' population has drastically reduced*
>
> MMNR – Interview - 1

He further observed that:

> *There used to be a lot of different animals that one could see any time but of recent, say ten years ago, one can only see a few species for example the gnu, wildebeest, zebras, giraffes, and lions. However, the black rhino, wild dogs, stripped hyenas, the cheetah and the leopard are hardly spotted*
>
> MMNR – Interview - 1

He added:

> *I have never realized if there is any animal that has completely disappeared. They only relocate to other places where they find plenty of food and where they feel comfortable in terms of habitats*
>
> MMNR – Interview - 1

With respect to changes on migration routes and patterns one of the respondent had this to say:

> *Due to the tourists' interference, in that they block the migration corridors, so as to have the best view of the animals, animals especially the wildebeests have changed their migration routes to avoid disturbance while enroute to their destination. MMNR lodges have been built on the migration routes, thus scaring away the animals, hence they change their routes. The migration patterns have also changed due to unpredictable rain seasons and temperatures. Some wildlife species for example the gnu, zebras and lions have decided not to migrate when other species do, hence they have been termed as resident animals since they do not move with the rest*

Additionally, one of the community members affirmed that:

> *More often than not, the breeding grounds can easily not be identified of late. A long time ago, say 30 years ago, we could know where certain animals for example the elephants were breeding*
>
> MMNR – Interview - 2

Indeed another respondent recalled that:

> *When I was young 30 years ago, there used to be many and a variety of wild animals, the ground cover was adequate since there were a lot of shrubs and lianas where the herbivores fed but with the mushrooming homesteads and competition from the livestock, food for the animals become scarce and hence the famous saying that the animals that are aggressive survive while the weak ones die out of starvation. Thus, the slogan, 'survival for the fittest.' Most deaths of the animals are caused by diseases because the shrubs that they used to feed on as medicinal plants are no longer there. This has extended to human beings*
>
> MMNR – Interview - 3

4.4.1 Significance of Climate Change effect on Animals

Analysis of variance was conducted where the dependent variable was animal community and the independent variables were the causes of climate change which include over harvesting of indigenous trees, agriculture, greenhouse emissions, deforestation, construction of infrastructure, human settlement and over utilization of natural resources as depicted in Table 4.14. The F was 18.299 while the significance was 0.001.

Table 4. 14: ANOVA[a] of effect of climate change on animal community

ANOVA[a] of effect of climate change on animal community and causes of CC						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	5.993	7	.856	18.299	.001[b]
	Residual	8.188	175	.047		
	Total	14.181	182			
a. Dependent Variable: animal						
b. Predictors: (Constant), Over harvesting of indigenous trees, Agriculture, greenhouse emissions, Deforestation, Construction of infrastructure, Human settlement, Over utilization of natural resources						

Source: Field Data, 2013.

On the coefficients of effect of climate change on animal community and causes of climate change as shown in Table 4.15, deforestation had a significance of 0.001, human settlement had 0.012, agriculture had 0.934, over utilization of natural resources had 0.234, greenhouse emissions had 0.097, construction of infrastructure had 0.029 and overharvesting of indigenous trees had 0.669. From this, it is explicit that agriculture had a higher significance and hence deemed to be causing significant effect on the animal community.

Table 4. 15: Coefficients of effect of climate change on animal community

Coefficients[a] of effect of climate change on animal community and causes of CC						
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.061	.167		12.333	.001
	Deforestation	.128	.028	.368	4.524	.001
	Human settlement	.093	.036	.280	2.547	.012
	Agriculture	.003	.039	.007	0.083	.934
	Over utilization of natural resources	-.054	.045	-.149	-1.195	.234
	Green house emissions	-.033	.020	-.121	-1.669	.097
	Construction of infrastructure	-.070	.032	-.188	-2.202	.029
	Over harvesting of indigenous trees	.013	.031	.043	.429	.669
a. Dependent Variable: animal						

The study also sought to find out how significant was climate change on the parameters measuring the impact on wild animals, with the scale ranging from 1 (unimportant) to 4 (very important). These results are presented in Table 4.16 below. A repeated measures Analysis of Variance (RM – ANOVA) was conducted to test whether the respondents' perception of climate change on the various effect on animals were similar and was found to be significant (Table 4.16).

Table 4. 16: Significance of effects of climate change on animals

Animal effect	**Mean**	**Std. Deviation**	
Changes in animal populations	3.98[a]	.809	χ^2 =80.097, df=6, $p<0.001$
Changes in species diversity	2.52[b]	1.659	χ^2 =30.473, df=6, $p<0.001$
Changes in species composition	2.75[c]	.684	χ^2 =111.748, df=4, $p<0.001$
Extinction of animal species	1.58[d]	.948	χ^2 =88.137, df=6, $p<0.001$
Changes in migration routes	3.89[a]	.933	χ^2 =105.381, df=6, $p<0.001$
Changes in migration patterns	3.87[a]	.909	χ^2 =108.043, df=6, $p<0.001$
Changes in animal migrating species	2.62[c]	1.680	χ^2 =92.949, df=6, $p<0.001$
Changes in breeding grounds	3.87[a]	.991	χ^2 =104.893, df=6, $p<0.001$
Changes in animal infections	1.91[e]	.913	χ^2 =87.869, df=6, $p<0.001$
Increased animal deaths	3.95[a]	.853	χ^2 =75.403, df=6, $p<0.001$

Source: Field Data, 2013.

Post hoc analysis was conducted by the Bonferroni tests and the results are presented in Table 4.16 above. The means are presented in Figure 4.3 in a descending manner to enable easier visualization.

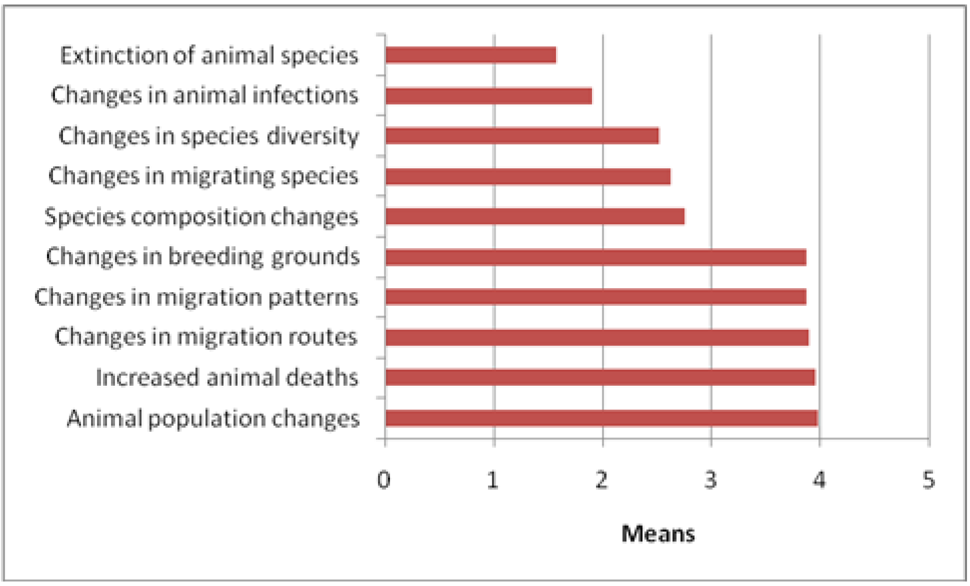

Figure 4.3 **:** Differences in effect of climate change on animals

Results from Table 4.16 and figure 4.3 indicate that climatic change effect on animals could be divided into three hierarchical groups: a band of the biggest effect consisting of changes in animal populations, increased animal deaths, changes in migration routes and patterns and changes in breeding grounds.

An independent samples t – test was conducted to test whether the respondent type (membership to staff or local community) had a significant main effect on the perception of climate change effect on animals. The results of the independent samples t test are presented in Table 4.17.

Table 4. 17: Independent samples t- tests on climate change effect on animals

Effect	Respondent	T	Df	Mean	Sig
Changes in animal population	Local Community	77.506	198	3.74	0.001
	Staff	64.689	199	4.16	0.001
Changes in species diversity	Local Community	46.560	199	1.07	0.001
	Staff	46.589	199	3.87	0.001
Changes in species composition	Local Community	76.437	199	2.74	0.001
	Staff	46.160	199	2.71	0.001
Extinction of animal species	Local Community	28.430	199	1.27	0.001
	Staff	25.438	199	1.92	0.001
Changes in migration routes	Local Community	47.140	199	3.52	0.001
	Staff	55.036	199	4.03	0.001
Changes in migration patterns	Local Community	46.863	199	3.50	0.001
	Staff	57.663	199	4.02	0.001
Changes in migrating species	Local Community	26.951	199	1.29	0.001
	Staff	44.048	199	3.90	0.001
Changes in breeding grounds	Local Community	47.282	199	3.52	0.001
	Staff	48.509	199	3.98	0.001
Changes in animal infections	Local Community	54.416	182	2.16	0.001
	Staff	21.398	199	1.68	0.001
Increased animal deaths	Local Community	82.487	198	3.79	0.001
	Staff	55.039	199	4.05	0.001

Source: Field Data, 2013.

Changes in animal population according to the local community had $t=77.506$, $df=198$ and $p<0.001$ and on the staff it had $t=64.689$, $df=199$ and $p<0.001$. This meant that the staff were of the opinion that there were changes in animal population as a result of climate change. From the local community, changes in species diversity had $t=46.560$, $df=199$ and $p<0.001$ and on the staff it had $t=46.589$, $df=199$ and $p<0.001$. This meant that the staff were the opinion that there were more changes in species diversity as a result of climate change.

On the locals, changes in species composition had t=76.437, df=199 and p<0.001 and on the staff it had t=46.160, df=199 and p<0.001. Extinction of animal species had t=28.430, df=199 and p<0.001 for the locals and t=25.438, df=199 and p<0.001 for the staff. Changes in migration routes had t=47.140, df=199 and p<0.001 for the locals and t=55.036, df=199 and p<0.001 for the staff. Changes in migration patterns had t=46.863, df=199 and p<0.001 for the locals and t=57.663, df=199 and p<0.001 for the staff.

Changes in migrating species had t=26.951, df=199 and p<0.001 for the locals and t=44.048, df=199 and p<0.001 for the staff. Changes in breeding grounds had t=47.282, df=199 and p<0.001 for the locals and t=48.509, df=199 and p<0.001 for the staff. Changes in animal infections had t=54.416, df=199 and p<0.001 for the locals and t=21.398, df=199 and p<0.001 for the staff. Increased animal deaths had t=82.487, df=199 and p<0.001 for the locals and t=55.039, df=199 and p<0.001 for the staff.

Apart from changes in animal infections, staff recorded greater effect of climate change on animals relative to members of the local community, with the greatest difference being observed on changes in species diversity and changes in migrating animal species. Generally, the staff considered changes in species diversity and changes in migrating species as significant results of climate change on animals but the local community considered them as relatively insignificant.

4.4.2 Climate change alteration of the management of animals in future

Table 4.18 presents the results of the perceptions of the respondents on how climate change will alter the management of animals in the next 10 and 25 years. The results indicate that the means of the variables investigated (lowest =3.58 and highest = 4.85) were all above the halfway mean (2.5). This implies that a majority of the respondents, regardless of whether they were staff or local community members felt that climate change would completely alter the management of animals in the MMNR in both the next 10 and 25 years. Nonetheless, the independent samples t – tests showed that the means of the local community were significantly higher at $p<.05$ compared to those of staff, indicating that the local community had a bleaker prognosis of the impacts compared with staff.

More importantly, for both staff and local community, the means of these variables were always lower for the 10-year prediction period compared to the 25-year period, which indicated that both cadres of respondents felt that the effects of climate change on animals are amplified with the passage of time.

Table 4. 18: Climate change influences on animals in the next 10 and 25 years

Effect (n=400)	**Respondent type**	**Mean**	**Standard deviation**
Climate change will completely alter management of animals over the next 10 years.	Staff Local community	3.58 4.73	1.667 .735
Climate change will completely alter management of animals over the next 25 years.	Staff Local community	3.89 4.85	1.544 .619

Source: Field Data, 2013.

4.4.3 Test of Ho_1

The first research hypothesis stated that there is no significant effect of climate change on the animal community in the MMNR and its environs. To test this hypothesis, climate change was specified as an exogenous, measured variable while the perceived effect were postulated as observed endogenous variables. The path diagram is shown in Figure 4.4 below.

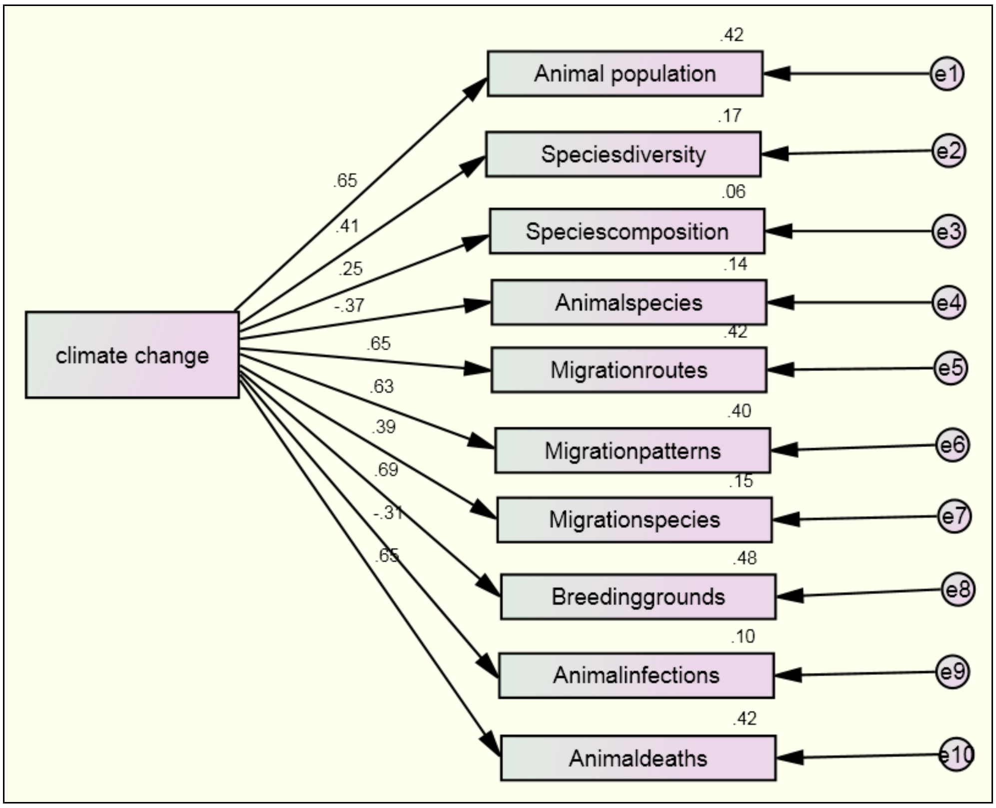

Figure 4.4**:** Output SEMPATH model of the relationship between climate change and perceived effect on wild animals

Table 4.19 below shows the unstandardized regression weights also called structural (path) coefficients, their standard errors (SE), critical ratios (CR), and their p values.

Table 4. 19: Un-standardized Regression Weights

			Estimate	S.E.	C.R.	P	Label
Animalpopulation	<---	climateChange	.590	.035	16.863	***	par_1
Speciesdiversity	<---	climateChange	.741	.083	8.955	***	par_2
Speciescomposition	<---	climateChange	.188	.037	5.124	***	par_3
Animalspecies	<---	climateChange	-.382	.048	-8.019	***	par_4
Migrationroutes	<---	climateChange	.770	.045	17.126	***	par_5
Migrationpatterns	<---	climateChange	.732	.045	16.291	***	par_6
Migrationspecies	<---	climateChange	.708	.084	8.464	***	par_7
Breedinggrounds	<---	climateChange	.860	.045	19.135	***	par_8
Animalinfections	<---	climateChange	-.317	.049	-6.483	***	par_9
Animaldeaths	<---	climateChange	.628	.037	17.128	***	par_10

The regression weight, also called a path coefficient, p coefficient or a beta weight, is similar to beta coefficient in ordinary linear regression and is similarly calculated. It also estimates the strength of the relationship between a predictor and a criterion variable by predicting the amount of change in the dependent variable for each one unit change in the independent variable. Table 4.19 shows that all the regression coefficients for the model are significantly different from zero beyond the 0.01 level, as indicated by the column labelled p (the AMOS program outputs three asterisks when the calculated p value is < 0.001), which implied that climate change had perceived impacts on animals.

The critical ratios are simply the path coefficients divided by their corresponding standard errors. For example, 0.590/0.035 = 16.863. A critical ratio is therefore a t value that is used to test the null hypothesis that path coefficient is not significantly different from zero. At 95% confidence interval, a critical ratio that is greater than 1.96 means that the path coefficient is significantly different from zero. All the critical ratios in Table 4.19 are above 1.96 (smallest = 5.124; highest = 19.135). Thus, the probability of getting critical ratios as large as these ones in absolute value is less than 0.001. In other words, the regression weights for all the hypothesised relationships in Table 4.19 are significantly different from zero at the 0.001 level (two-tailed). Thus, the null hypothesis that climate change has no perceived impacts on animals in the MMNR was rejected.

A positive coefficient means that the predicted value of the dependent variable increases when the value of the independent variable increases whereas a negative beta weight implies the opposite. Except for the perceived effect on extinction of animal species (coefficient = -0.382) and changes in animal infections (coefficient = -0.317), all the path coefficients for the remaining eight hypothesized relationships are positive. This indicated that when climate change increases, it causes changes in animal populations, species diversity, species composition, and alters the animals' migration routes, patterns and migrating species. It also causes changes in the animals' breeding grounds and accelerates animal deaths. However, climate change was perceived to reduce extinction of animal species and their infections. This implied that the respondents perceived climate change as having minimal effects on these variables.

The path coefficient predicts the amount of change in the dependent variable for each one unit change in the independent variable. For instance, the path coefficient in the model from climateChange (climate change) to Animalpopulation (changes in animal population) was 0.590. This indicated that when climate change increases by one unit on its scale, changes in animal population will go up by 0.590, *ceteris paribus*.

The standardized regression weights (shown on the path diagram in Figure 4.4) are measured in standard deviation units and are therefore not dependent on the units of measurement of the variables and are more amenable for comparing several independent variables which have been measured in different units. For instance, the standardized regression weight of the path from climate change to changes in animal population was 0.65, which implied that when climate changes increases by one standard deviation, changes in animal population increases by 0.65 standard deviations. The results in Figure 4.4 indicated that climate change had the greatest perceived effect on changes in breeding grounds (β=.69), changes in animal populations (β=.65), increased animal deaths (β=.65), changes in migration routes (β=.65) and patterns (β=.63). The perceived least impacts of climate change were found to be changes in animal infections (β= -.31) and extinction of animal species (β= -.37).

R square measures how much variability in the dependent variable the predictors account for. For instance, the R square for changes in animal population was 0.42, which implied that climate change could account for approximately 42% of the variance in changes in animal populations. R^2 values above 0.40 are considered high (Hoyle, 1995). Thus climate change could explain reasonably high variation in changes in animal population (R^2=0.42), changes in migration routes (R^2=0.42), changes in migration patterns (R^2=0.40), changes in breeding grounds (R^2=0.48), and increased animal deaths (R^2=0.42). However, since none of the animal impacts had an R square value of 100%, it implied that other factors, other than climate change, could also cause these effects.

4.5 Effect of climate change on plant community

Table 4.20 presents the perceptions of the respondents towards the possible effect of climate change on plants in MMNR. Nearly every member of the local community (n=198, 99%) felt that plants are currently affected by climate change related effect while amongst the staff, a majority of them (n=162, 81%) had a similar opinion. It was therefore important to establish the possible effect of climate change on plants (see table 4.21).

Table 4. 20: General response on the effect of climate change on plant community in MMNR

Effect of climate change on plants	Staffs		Local community	
	Frequency	**Percent**	**Frequency**	**Percent**
Yes	81	81.0	297	99.0
No	19	19.0	3	1.0
Total	100	100.0	300	100.0

Source: Field Data, 2013.

Since respondents could choose more than one effect, the number of responses (2529) were more than the number of respondents in the study (400). An overwhelming number of respondents felt that climate change influenced changes in plant species distribution patterns (n=394, 99.3%), changes in plant species composition (n=396, 99%), changes in plants adaption strategies (n=396, 99%), changes in plant species diversity (n=394, 98.5%), emergence of alien plant species (n=393, 98.3%) and changes in vegetation cover (n=391, 97.8%). Only fewer respondents (n=162, 40.5%) felt that climate change could cause the extinction of plant species (Table 4.21).

Furthermore, some of the respondents, who were interviewed had this to say:

> *After flooding, new or alien plants grow on bare ground, hence colonizing the whole area, thus affecting the original vegetation. This brings about changes in plant species and the distribution patterns of plants. The floods and drought have brought changes in this area, hence the vegetation cover change*
>
> MMNR – Interview - 4

Indeed,

> *The change in temperature, soils, rainfall patterns have brought significant changes in the following: changes in plant species, changes in plant distribution patterns and introduction of alien species of plants. Some plants have been forced to adapt to the current situation of the climate. You get some plant species growing where you least expect them.*

MMNR – Interview - 5

Table 4. 21: Possible effect of climate change on plant community

Effect on plant community	**Responses**		**Percent of**
	N	**Percent**	**cases**
Changes in plant species diversity	394	15.6	98.5
Changes in plant species composition	396	15.7	99.0
Changes in plant species distribution patterns	397	15.7	99.3
Emergence of alien plant species	393	15.5	98.3
Extinction of plant species	162	6.4	40.5
Changes in plants' adaptation strategies	396	15.7	99.0
Changes in vegetation cover	391	15.5	97.8
Total	**2529**	**100.0**	**632.3**

Source: Field Data, 2013.

4.5.1 Significance of Climate Change effect on Plants

Analysis of variance was conducted where the dependent variable was plant community and the independent variables were the causes of climate change which include over harvesting of indigenous trees, agriculture, greenhouse emissions, deforestation, construction of infrastructure, human settlement and over utilization of natural resources as depicted in Table 4.22. The F was 19.618 while the significance was 0.001.

Table 4. 22: ANOVA on effect of climate change on plant community

ANOVA of effect of climate change on plant community and causes of CC						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	13.934	7	1.991	19.618	0.001[b]
	Residual	19.380	191	0.101		
	Total	33.315	198			
a. Dependent Variable: plant						
b. Predictors: (Constant), Over harvesting of indigenous trees, Agriculture, green-house emissions, Construction of infrastructure, Deforestation, Over utilization of natural resources, Human settlement						

On the coefficients of effect of climate change on plant community and causes of climate change as shown in Table 4.23, deforestation had a significance of 0.001, human settlement had 0.001, agriculture had 0.549, over utilization of natural resources had 0.965, greenhouse emissions had 0.001, construction of infrastructure had 0.007 and overharvesting of indigenous trees had 0.431. From this, it is explicit that over utilization of natural resources had a higher significance and hence deemed to be causing significantly effect on plant community.

The study also endeavored to establish the importance of each climate change effect on plants, with the scale ranging from 1 (unimportant) to 5 (very important). The results are presented in Table 4.24 and figure 4.5 below. Basically, means with similar letters down a column are not significantly different by Bonferroni tests.

Table 4. 23: Coefficients[a] of effect of climate change on plant community

Coefficients[a] of effect of climate change on plant community						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.022	.194		10.414	.001
	Deforestation	.166	.035	.386	4.744	.001
	Human settlement	.211	.043	.473	4.943	.001
	Agriculture	-.024	.040	-.041	-.601	.549
	Over utilization of natural resources	-.002	.037	-.004	-.044	.965
	Greenhouse emissions	.083	.022	.253	3.679	.001
	Construction of infrastructure	-.091	.033	-.189	-2.726	.007
	Over harvesting of indigenous trees	-.031	.039	-.077	-.790	.431
a. Dependent Variable: plant						

A repeated measures of Analysis of Variance (RM – ANOVA) was conducted to test whether the respondents' perception of climate change effects on plants were similar. According to the results, respondents rated differently the perceived impacts on plants resulting from climate change. Further, the results revealed that the greatest climatic change effect on plant community included changes in vegetation cover, changes in plant adaptation strategies and changes in plant species distribution (Table 4.24 and Figure 4.5).

Table 4. 24: Importance of effects of climate change on plants

Plant effect (n=400)	**Mean**	**Standard deviation**
Changes in plant species diversity	3.87[a]	.917
Changes in plant species composition	3.50[b]	.715
Changes in plant species distribution patterns	3.96[c]	.839
Emergence of alien plant species	3.82[a]	1.016
Extinction of plant species	1.91[d]	1.314
Changes in plants' adaptation strategies	3.98[c]	.787
Changes in vegetation cover	4.02[c]	.771

Source: Field Data, 2013.

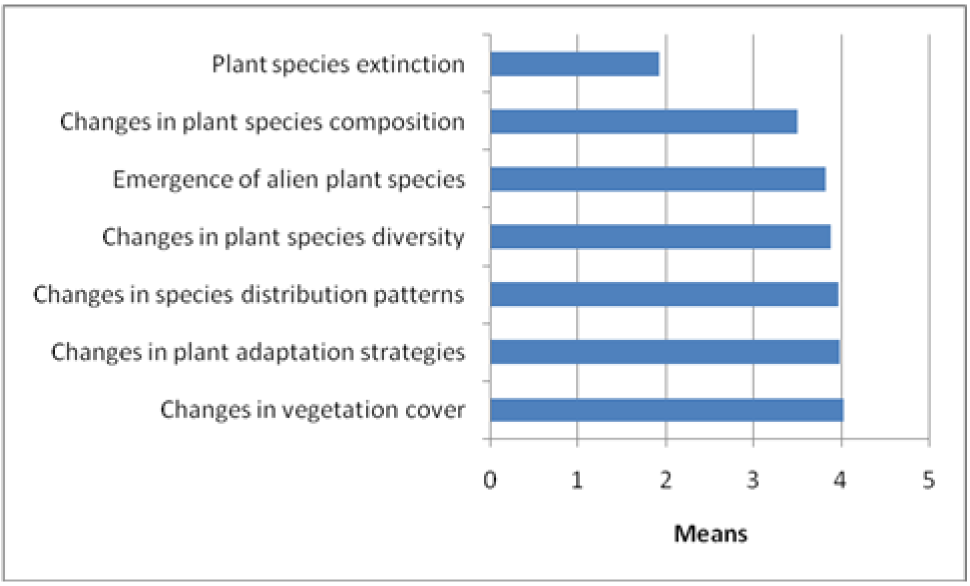

Figure 4.5 **:** Differences in impacts of climate change on plants

Also important were changes in plant species diversity, emergence of alien plant species and changes in plant species composition. The least effect of climate change was found to be the extinction of plant species. Table 4.25 below presents the respondents' rating of the various climate change affects plants grouped according to the type of respondent.

Table 4. 25: Climate change impacts on plants according to respondent type

Effect on plant community	Respondent type	Mean	Standard deviation
Changes in plant species diversity	Staff	4.04	1.036
	Local community	3.70	.744
Changes in plant species composition	Staff	3.29	.653
	Local community	3.71	.715
Changes in plant species distribution patterns	Staff	4.13	.992
	Local community	3.80	.611
Emergence of alien plant species	Staff	3.87	1.267
	Local community	3.77	.677
Extinction of plant species	Staff	2.28	1.418
	Local community	1.54	1.086
Changes in plants' adaptation strategies	Staff	4.09	.988
	Local community	3.86	.489
Changes in vegetation cover	Staff	4.16	.943
	Local community	3.87	.512

Source: Field Data, 2013.

An independent samples t – test was conducted to test whether the respondent type (membership to staff or local community) had a significant effect on the perception of climate change effect on plants. The results of the independent samples t test are presented in Table 4.26, where the significant effect of climate change on plants were found to be changes in plant species distribution patterns, changes in plant species composition, changes in plants adaption strategies, changes in plant species diversity, emergence of alien plant species and changes in vegetation cover. More importantly, both staff and local community also considered extinction of plant species as the least effect of climate change.

Table 4. 26: Independent samples t-tests on climate change effect on plants

Effect on plant community	Respondent	T	Df	Mean	Sig
Changes in plant species diversity	Local community	70.605	199	3.71	0.001
	Staff	-	-	1.00	0.001
Changes in plant species composition	Local community	73.581	199	3.71	0.001
	Staff	-	-	1.00	0.001
Changes in species distribution patterns	Local community	88.127	199	3.80	0.001
	Staff	-	-	1.00	0.001
Emergence of alien plant species	Local community	78.604	198	3.77	0.001
	Staff	-	-	1.00	0.001
Extinction of plant species	Local community	20.081	199	1.55	0.001
	Staff	40.44	199	1.41	0.035
Changes in adaptation strategies	Local community	112.049	199	3.87	0.001
	Staff	-	-	1.00	0.001
Changes in vegetation cover	Local community	107.333	199	3.88	0.001
	Staff	83.634	199	1.02	0.012

Source: Field Data, 2013.

Concerning the local community, changes in plant species diversity had a t of 70.605, df of 199 and a significance of 0.001. There was no value for the staff because it had a mean of 1. On the locals, changes in plant species composition had t=73.581, df=199 and p<0.001. There was also no value for the staff because it had a mean of 1. Changes in species distribution patterns had t=88.127, df=199 and p<0.001 and there was also no value for the staff because it had a mean of 1. From the perspective of the locals, emergence of alien plant species had t=78.604, df=198 and p<0.001 and there was also no value for the staff because it had a mean of 1.

Extinction of plant species according to the local community had t=20.081, df=198 and p<0.001 and on the staff it had t=40.44, df=198 and p=0.035. Changes in adaptation strategies had t=112.049, df=198 and $p<0.001$ and there was also no value for the staff because it had a mean of 1. Finally, changes in vegetation cover according to the local community had t=107.333, df=198 and $p<0.001$ and on the staff it had t=83.634, df=198 and p=0.012. Again, apart from changes in species composition, members of staff perceived climate change impacts on plants as being more severe compared with local community members, because the means of the former were found to be greater than that of the latter.

4.5.2 Climate change alteration of the management of plants in future

The perceptions of the respondents on how climate change will alter the management of plants in the next 10 and 25 years are presented (Table 4.27). According to the findings most of the respondents, regardless of whether they were staff or local community members felt that climate change would completely alter the management of plants in the MMNR in both the next 10 and 25 years, because the means of all the variables were above 4 (lowest =4.18 and highest = 4.76).

Table 4. 27: Climate change effect on plants in the next 10 and 25 years

Effect (n=300)	**Respondent type**	**Mean**	**Standard deviation**
Climate change will completely alter management of plants over the next 10 years.	Staff Local community	4.18 4.68	1.172 0.836
Climate change will completely alter management of plants over the next 25 years.	Staff Local community	4.45 4.76	0.971 0.785

Source: Field Data, 2013.

As for management of animals independent samples t – tests revealed that the means of the local community were significantly higher at $p<0.05$ compared to those of staff, indicating that the local community predicted more dire climate change effect on plants as compared with staff. Nonetheless, for both staff and local community, the means of these variables were lower for the 10-year prediction period compared to the 25-year period, which indicated that both cadres of respondents felt that the effects of climate change on plants (similar to animals) are augmented with the passage of time.

4.5.3 Test of Ho_2

To test the second null hypothesis that there is no significant effect of climate change on the plant community in the MMNR and its environs, climate change was specified as an exogenous, measured variable while the perceived effect were modelled as observed endogenous variables. The resultant path diagram is shown in Figure 4.6 below.

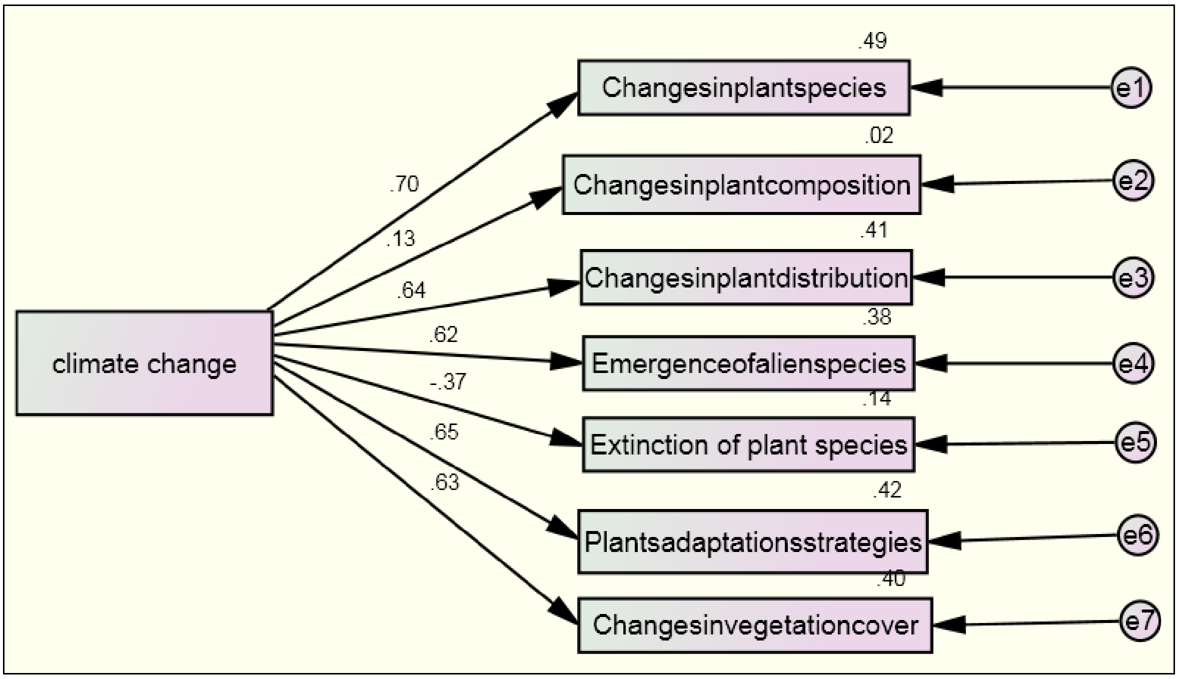

Figure 4.6**:** Output SEMPATH model of the relationship between climate change and perceived plant effects

Table 4.28 below shows the unstandardized regression weights, their standard errors (SE), critical ratios (C.R), and their p values. All the regression coefficients for the model are significantly different from zero beyond the 0.05 level, as indicated by the column labelled p, which implied that climate change had perceived effect on plants (Table 4.28). These findings are supported by the values of critical ratios, which were all found to be greater than 1.95. Thus, the null hypothesis that climate change has no effect on plants in the MMNR was rejected.

Table 4. 28: Un-standardized Regression Weights

			Estimate	S.E.	C.R.	P	Label
Changesinplantspecies	<---	climateChange	.715	.036	19.760	***	par_1
Changesinplantcomposition	<---	climateChange	.104	.039	2.634	.008	par_2
Changesinplantdistribution	<---	climateChange	.592	.036	16.494	***	par_3
Emergenceofalienspecies	<---	climateChange	.698	.044	15.733	***	par_4
Extinctionofplantspecies	<---	climateChange	-.538	.068	-7.926	***	par_5
Plantsadaptationsstrategies	<---	climateChange	.566	.033	17.001	***	par_6
Changesinvegetationcover	<---	climateChange	.542	.033	16.382	***	par_7

Source: Field Data, 2013.

All the path coefficients in Table 4.28 were positive except for perceived impacts on extinction of plant species (coefficient = -0.538). This indicated that when climate change increases, it causes changes in plant species, plant composition, distribution, emergence of alien plant species, plants' adaptation strategies and changes in vegetation cover. However, climate change was perceived has not having any effect on the extinction of plants.

The standardized regression weights (shown on the path diagram in Figure 4.6) indicated that perceived climate change had the greatest influence on changes in plant species (β=0.70). This showed that when the perceived climate change increases by one standard deviation, changes in plant species goes up by 0.70 standard deviations. Climate change was also perceived to have strong effects on plants' adaptation strategies (β=0.65), changes in distribution of plants (β-0.64), changes in vegetation cover (β=0.63) and emergence of alien species (β=0.62). However, the least impacts of climate change were perceived to be changes in plant composition (β=0.13) and extinction of plant species (β= -0.37).

Climate change explained reasonable variance in changes in plant species (R^2=0.49), changes in plants' adaptation strategies (R^2=0.42), changes in plant distribution (R^2=0.41) and changes in vegetation cover (R^2=0.40), which implied that these factors could be predicted to a large degree with changes in climate. However, perceived climate change was found to account for only a little variance in changes in plant composition (R^2=0.02) and extinction of plant species (R^2=0.14), indicating that other factors, other than climate change, could account for these variations. The unexplained variance in all the factors (none of them had R^2 values equal to 100%) could be attributed to non-climate related factors not specified in the model and to the error terms (labeled e1 to e7) in the model.

4.6 Effect of Climate Change on Surface Water Quantity

Table 4.29 presents the perceptions of the respondents towards the general effect of climate change on quantity of the surface water in MMNR. Both members of staff (n=193, 96.5%) and local community (n=199, 99.5%) felt overwhelmingly that the quantity of surface water is currently affected by climate change' related effects.

Table 4. 29: Effect of climate change on the quantity of surface water in MMNR

Is quantity of surface water affected by climate change' related impacts?	**Staffs**		**Local community**	
	Frequency	**Percent**	**Frequency**	**Percent**
Yes	93	96.5	299	99.5
No	7	3.5	1	0.5
Total	100	100.0	300	100.0

Source: Field Data, 2013.

Almost every respondent felt that climate change has resulted in changes in rainfall amounts (n=397, 99.3%), changes in rainfall duration (n=396, 99%) and changes in rainfall seasons/patterns (n=396, 99%). An overwhelming number of respondents also felt that climate change has resulted in changes in the availability of fresh water (n=393, 98.3%) and changes in water level in Mara River and its tributaries (n=385, 96.3%) (Table 4.30) and also emphasizes in Plate 4.2.

Table 4. 30: Effect of climate change on quantity of water in MMNR

	Responses		Percent of cases
	N	Percent	
Changes in amount of rainfall	397	20.2	99.3
Changes in duration of rainfall	396	20.1	99.0
Changes in rainfall seasons/patterns	396	20.1	99.0
Changes in availability of fresh water	393	20.0	98.3
Changes in water level in Mara River and its tributaries	385	19.6	96.3
Total	**1967**	**100.0**	**491.8**

Source: Field Data, 2013.

Besides, the following sentiments from some of the interviewees and the subsequent Plate 4.1 below tell it all:

> *In my own opinion, the over utilization of the natural resources, for example, water, grazing pastures, forests and human settlement will completely alter the sequence of rains, temperature and even the entire ecosystem, and the management of these resources at large*
>
> MMNR – Interview -6

Other agreed,

> *This is because the prolonged drought dries up rivers and swamps and more especially the vegetation cover and when rains come, because of the weak soils, the plants are uprooted and swept down with floods*
>
> MMNR – Interview - 4

Plate 4.2: Shrinking water levels of Mara river

Source: Researcher (2013)

4.6.1 Significance of Climate Change effects on Surface Water Quantity

ANOVA was done where the dependent variable was surface water and the independent variables were the causes of climate change which include over harvesting of indigenous trees, agriculture, greenhouse emissions, deforestation, construction of infrastructure, human settlement and over utilization of natural resources as depicted in Table 4.31. The F was 34.181 while the significance was 0.001.

Table 4. 31: ANOVA of surface water and causes of climate change

ANOVA[a] of surface water and causes of climate change						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	22.812	7	3.259	34.181	0.001[b]
	Residual	18.020	189	0.095		
	Total	40.832	196			
a. Dependent Variable: Surface water						
b. Predictors: (Constant), Over harvesting of indigenous trees, Agriculture, Greenhouse emissions, Construction of infrastructure, Deforestation, Over utilization of natural resources, Human settlement						

On the coefficients of effect of climate change on surface water and causes of climate change as shown in Table 4.32, deforestation had a significance of 0.001, human settlement had 0.001, agriculture had 0.799, over utilization of natural resources had 0.228, greenhouse emissions had 0.877, construction of infrastructure had 0.006 and overharvesting of indigenous trees had 0.271. From this, it is clear that greenhouse emissions had a higher significance and hence deemed to be causing significantly effect on surface water. This is because greenhouse emissions affect the ozone layer that can result to erratic rains.

Table 4. 32: Coefficients[a] of causes of climate change

Coefficients[a] of surface water and causes of climate change						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.274	.192		11.855	.001
	Deforestation	.207	.036	.426	5.734	.001
	Human settlement	.178	.042	.360	4.218	.001
	Agriculture	-.010	.040	-.015	-.255	.799
	Over utilization of natural resources	.044	.036	.099	1.210	.228
	Green house emissions	-.003	.022	-.009	-.155	.877
	Construction of infrastructure	-.091	.033	-.166	-2.760	.006
	Over harvesting of indigenous trees	-.044	.040	-.099	-1.105	.271
a. Dependent Variable: Surface water						

Moreover, the significant perceived effect of climatic change on the quantity of surface water included changes in water level in Mara River and its tributaries, changes in rainfall seasons/patterns, changes in the duration of rainfall, and changes in the amount of rainfall, whose means were found not to be significantly different (Table 4.33 and Figure 4.7).

Table 4. 33: Effects of climate change on quantity of surface water

Effect (n=400)	Mean	Standard deviation
Changes in amount of rainfall	3.92^a	.907
Changes in duration of rainfall	3.92^a	.806
Changes in rainfall seasons/patterns	3.97^a	.762
Changes in availability of fresh water	3.86^b	.944
Changes in water level in Mara River and its tributaries	3.99^a	.827

Source: Field Data, 2013.

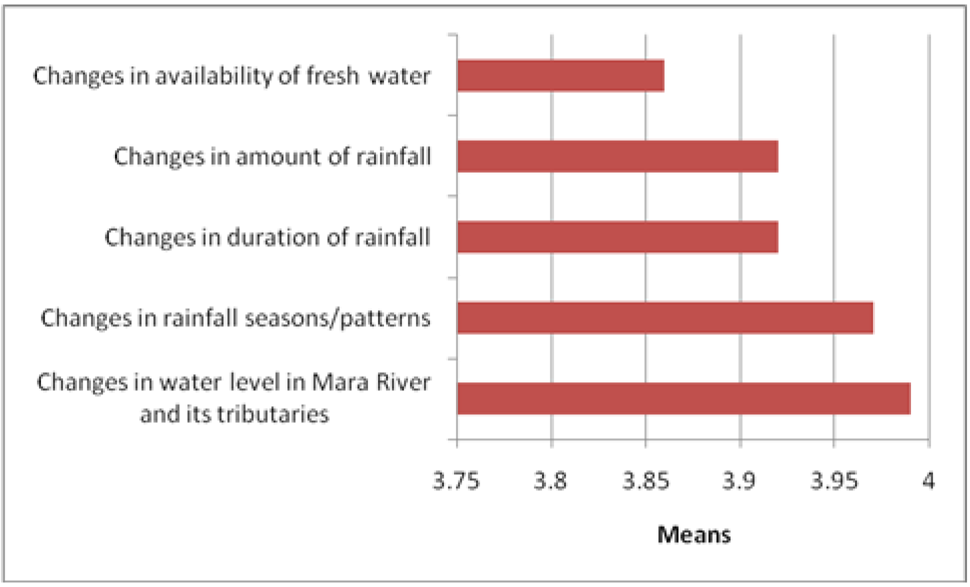

Figure 4.7 **:** Differences in effect of climate change on the quantity of surface water

Table 4.34 below presents the respondents' rating of the various climate change effect on the quantity of surface water grouped according to the type of respondent.

Table 4.34: Climate change effect on surface water quantity according to respondent type

Effect on quantity of surface water	Respondent type	Mean	Standard deviation
Changes in amount of rainfall	Staff	4.05	1.083
	Local community	3.80	.662
Changes in duration of rainfall	Staff	4.02	1.012
	Local community	3.82	.502
Changes in rainfall seasons/patterns	Staff	4.07	.969
	Local community	3.87	.444
Changes in availability of fresh water	Staff	3.93	1.156
	Local community	3.79	.656
Changes in water level in Mara river and its tributaries	Staff	4.09	1.041
	Local community	3.89	.513

Source: Field Data, 2013.

An independent samples t – test was conducted to test whether the respondent type (membership to staff or local community) had a significant effect on the perception of climate change effect on surface water quantity. The results of the independent samples t-test are presented in Table 4.35. These results reflected the findings presented in Table 4.34 where the perceived significant effect of climate change on water quantity were changes in Mara River, changes in rainfall patterns, changes in rainfall duration and amount whereas the least impact was change in freshwater availability. The perceptions of staff and local community members were found not to be different with respect to change in fresh water availability. However, significant differences at $p<.05$ were found between the perceptions of staff and members of the local community on all the remaining variables.

Table 4.35: Independent samples t tests on climate change effects on water quantity

Effect on quantity of surface water	T	Df	Sig (2-tailed)
Changes in amount of rainfall	2.843	398	.005
Changes in duration of rainfall	2.575	398	.011
Changes in rainfall seasons/patterns	2.782	398	.006
Changes in availability of fresh water	1.543	398	.124
Changes in water level in Mara River and its tributaries	2.524	398	.012

Source: Field Data, 2013.

4.6.1 Climate change alteration of quantity of surface water

Table 4.36 below presents the perceptions of the respondents on how climate change will alter the quantity of surface water within a period of 10 and 25 years. Most of the respondents, regardless of whether they were staff or local community members, felt that climate change would completely alter the quantity of surface water in the MMNR in both the next 10 and 25 years, because the means of all the variables were above 3.5 (lowest =3.89 and highest = 4.80). As for management of animals and plants (section 4.5 and 4.6, respectively), independent samples t – tests revealed that the means of the local community were significantly higher at $p<.05$ compared to those of staff, indicating that the local community predicted more severe climate change impacts on the quantity of surface water compared with staff. Lastly, for both staff and local community, the means of these variables were always lower for the 10-year prediction period compared to the 25-year period, which indicated that both cadres of respondents felt that the effects of climate change on the surface water quantity (similar to animals and plants) are magnified with the passage of time.

Table 4.36: Climate change effect on quantity of surface water in the next 10 and 25 years

Effect (n=400)	**Respondent type**	**Mean**	**Standard deviation**
Climate change will completely alter quantity of surface water over the next 10 years.	Staff	3.89	1.255
	Local community	4.69	0.870
Climate change will completely alter quantity of surface water over the next 25 years.	Staff	4.07	1.317
	Local community	4.80	0.796

Source: Field Data, 2013.

4.6.2 Test of Ho_3

To test the third null hypothesis that there is no significant effect on climate change on the quantity of surface water in the MMNR and its environs, climate change was specified as an exogenous, measured variable while the perceived impacts were modelled as observed endogenous variables. The resultant path diagram is shown in Figure 4.8 below.

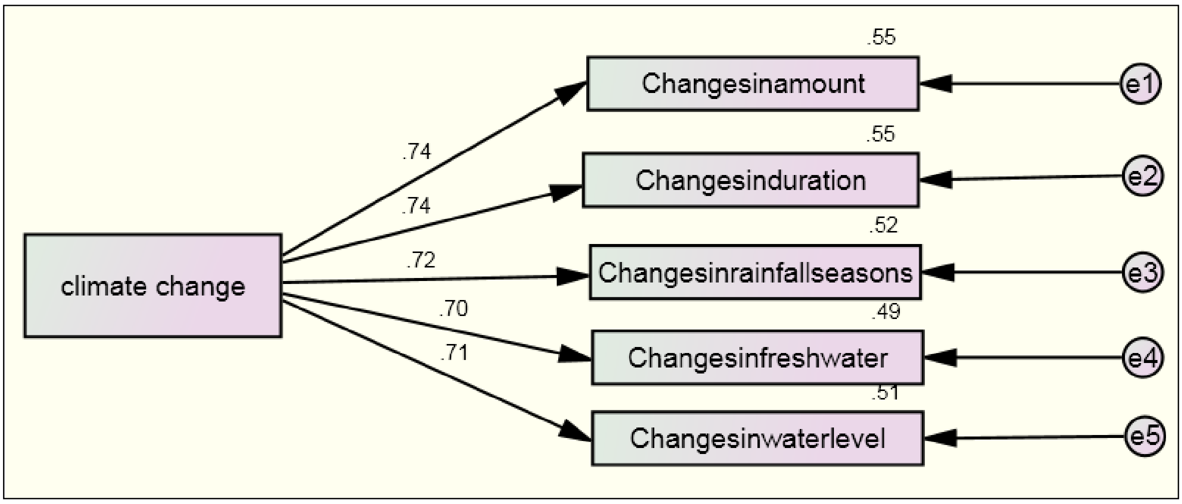

Figure 4.8 **:** Output SEMPATH model of the relationship between climate change and perceived effect on the quantity of surface water

Source: Field Data, 2013.

Table 4.37 below shows the unstandardized regression weights, their standard errors (SE), critical ratios (C.R), and their p values. Clearly, all the regression coefficients for the model are significantly different from zero beyond the 0.05 level, as indicated by the column labelled p, which implied that climate change had perceived impacts on quantity of water surface. This finding was supported by the values of critical ratios, which were all found to be greater than 1.95. Thus, the null hypothesis that climate change has no perceived effect on the quantity of surface water in the MMNR was rejected.

Table 4. 37: Un-standardized Regression Weights

			Estimate	S.E.	C.R.	P	Label
Changesinamount	<---	climateChange	.739	.034	21.941	***	par_1
Changesinduration	<---	climateChange	.664	.030	22.242	***	par_2
Changesinrainfallseasons	<---	climateChange	.615	.029	20.877	***	par_3
Changesinfreshwater	<---	climateChange	.730	.037	19.713	***	par_4
Changesinwaterlevel	<---	climateChange	.659	.033	20.239	***	par_5

Additionally all the path coefficients in Table 4.37 were positive, which implied that when climate change increases, there will be consequent changes in the amount of rainfall, duration of rainfall, rainfall seasons and patterns, availability of fresh water and changes in the water level in Mara River and its tributaries. For instance, an increase in climate change of one unit will cause a change in the amount of rainfall of 0.739, when other factors are kept constant.

The standardized regression weights (shown on the path diagram in Figure 4.8) indicated that perceived climate change had the greatest influence on changes in the amount of rainfall (β=0.74) and changes in the duration of rainfall (β=0.74). Thus, when the perceived climate change increases by one standard deviation, changes in either the amount of rainfall or it duration will increase by 0.74 standard deviations. A consideration of beta values indicated that climate change was also perceived to have strong influences on changes in rainfall seasons/patterns (β=0.72), changes in water level in Mara River and its tributaries (β-0.71), and changes in the availability of fresh water (β=0.70).

The R square values (Figure 4.8) for the variables measuring quantity of surface water were high (minimum=0.49; maximum=0.55), which indicated that climate change had a lot of influence on the quantity of surface water. Again, the unexplained variance in the factors could be attributed to non-climate related factors not specified in the model and to the error terms in the model.

4.7 Effect of climate change on tourists' activities

The study also investigated whether climate changes could affect tourists' activities in one way or another. The results indicated that the respondents felt that tourist activities in MMNR are currently, affected by climate change related effects (Table 4.38). This perception was found to be stronger among local community members (n=195, 97.5%) as compared to staff members (n=170, 85%). These effects include dying of wild animals, which in turn could affect the number of tourists coming into the reserve because the wildlife is one of the best attraction point for the tourists.

Table 4. 38: General effects of climate change on tourist activities in MMNR

Are tourists' activities affected by climate change?	**Staffs**		**Local Community**	
	Frequency	Percent	Frequency	Percent
Yes	85	85	293	97.5
No	15	15	7	2.5
Total	100	100	300	100

Source: Field Data, 2013.

A majority of the respondent felt that climate change has resulted in changes in visitors' numbers (n=396, 99.2%), changes in visitation patterns (n=396, 99.2%), changes in tourists' activity diversity (n=395, 99%) and changes in tourists' activity patterns (n=394, 98.7%) as depicted in Table 4.39.

Table 4. 39: Effect of climate change on tourists' activities in MMNR

	Responses		Percent of
	N	Percent	cases
Changes in visitors' numbers	396	25.0	99.2
Changes in visitation patterns	396	25.0	99.2
Changes in tourists' activity diversity	395	25.0	99.0
Changes in tourists' activity patterns	394	24.9	98.7
Total	**1581**	**100.0**	**396.2**

Source: Field Data, 2013.

4.7.1 Importance of Climate Change effects on Tourists' Activities

Analysis of variance was conducted where the dependent variable was tourist's activities and the independent variables were the causes of climate change, which included over harvesting of indigenous trees, agriculture, greenhouse emissions, deforestation, construction of infrastructure, human settlement and over utilization of natural resources as depicted in Table 4.40. From the analysis of variance (ANOVA), F was 42.866 with a significance of 0.001.

Table 4. 40: ANOVA of tourist activity and causes of climate change

ANOVA[a] of tourist activity and causes of climate change						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	37.591	7	5.370	42.866	.001[b]
	Residual	23.928	191	0.125		
	Total	61.519	198			
a. Dependent Variable: Tourist activity						
b. Predictors: (Constant), Over harvesting of indigenous trees, agriculture, greenhouse emissions, construction of infrastructure, deforestation, overutilization of natural resources, human settlement						

Source: Field Data, 2013.

On the coefficients of effect of climate change on tourist's activities and causes of climate change as shown in Table 4.41, deforestation had a significance of 0.001, human settlement had 0.001, agriculture had 0.718, over utilization of natural resources had 0.865, greenhouse emissions had 0.439, construction of infrastructure had 0.001 and overharvesting of indigenous trees had 0.007. From this, it is explicit that over-utilization of natural resources had a higher significance and hence deemed to be causing significant effect on tourist activities.

Table 4. 41: Coefficients[a] of tourist activity and causes of climate change

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	2.156	.215		10.005	.001
	Deforestation	.167	.039	.286	4.292	.001
	Human settlement	.178	.047	.291	3.769	.001
	Agriculture	.016	.045	.020	.362	.718
	Over utilization of natural resources	.007	.041	.013	.170	.865
	Green house emissions	.019	.025	.044	.776	.439
	Construction of infrastructure	-.144	.037	-.220	-3.845	.001
	Over harvesting of indigenous trees	.118	.043	.217	2.705	.007

a. Dependent Variable: touristactivity

The study also sought to find out the importance of the various climate change related effects on the activities of tourists, using a scale ranging from 1 (unimportant) to 4 (very important) (table 4.42).

Table 4. 42: Importance of effects of climate change on tourists' activities

Effect (n=400)	Mean	Standard deviation
Changes in visitors' numbers	3.86	1.008
Changes in visitation patterns	3.90	.838
Changes in tourists' activity diversity	3.88	.902
Changes in tourists' activity patterns	3.93	.818

Source: Field Data, 2013.

A repeated measures Analysis of Variance (RM – ANOVA) was conducted to test whether the respondents' perception of various climate change effect on tourists' activities were similar and was found not to be significant. This indicated that respondents viewed climate change similarly with respect to climate change and changes in visitors' numbers, patterns, diversity of activities and activity patterns. Table 4.43 present the respondents' rating of the various climate change effect on tourists' activities according to the type of respondent.

Table 4. 43: Climate change effect on tourists' activities according to respondent type

Effect on tourists' activities	Respondent type	Mean	Standard deviation
Changes in visitor numbers	Staff	4.01	1.163
	Local community	3.72	.803
Changes in visitation patterns	Staff	4.04	.955
	Local community	3.76	.674
Changes in tourists' activity diversity	Staff	3.93	1.143
	Local community	3.83	.560
Changes in tourists' activity patterns	Staff	4.01	1.030
	Local community	3.85	.516

Source: Field Data, 2013.

An independent samples t – test was conducted to test whether the respondent type (membership to staff or local community) had a significant effect on the perception of climate change effect on tourists' activities. The results of the independent samples t test are presented in Table 4.44. Generally, the perceptions of staff and local community members were found not to be different with respect to changes in tourists; activity diversity. However, significant differences at $p<.05$ were found between the perceptions of staff and members of the local community on all the remaining variables.

Table 4. 44: Independent samples t-tests on climate change effects on tourism

Effect on tourists' activities	T	Df	Sig (2-tailed)
Changes in visitors' numbers	2.804	398	.005
Changes in visitation patterns	3.329	398	.001
Changes in tourists' activity diversity	1.175	398	.241
Changes in tourists' activity patterns	1.973	398	.049

Source: Field Data, 2013.

4.7.2 Climate change alteration of Tourists' activities

With respect to respondents' perceptions on how climate change will alter tourists' activities within a period of 10 and 25 years, most of the respondents, regardless of whether they were staff or local community members, felt that climate change would completely alter tourists' activities in the MMNR in both the next 10 and 25 years (table 4.45).

Table 4. 45: Climate change influences on plants in the next ten and 25 years

Effect (n=400)	Respondent type	Mean	Standard deviation
Climate change will completely alter tourists' activities over the next 10 years.	Staff	4.12	1.22
	Local community	4.66	0.900
Climate change will completely alter tourists' activities over the next 25 years.	Staff	4.35	1.02
	Local community	4.88	0.526

Source: Field Data, 2013.

Similar to climate change effects on the management of animals, plants and quantity of surface water (section 4.5, 4.6, and 4.7 respectively), independent samples t – tests revealed that the means of the local community were significantly higher at $p<.05$ compared to those of staff. This showed that the local community predicted more severe climate change effects on tourists' activities relative to staff, for both the 10-

year and 25-year period. Again, as observed for the management of animals, plants and water quantity, the means of the variables were lower for the 10-year prediction period compared to the 25-year period.

4.7.3 Test of Ho_4

To test the fourth null hypothesis that there is no significant effect of climate changed on tourists' activities in the MMNR, climate change was specified as an exogenous, measured variable while the perceived effects were modelled as observed endogenous variables. The resultant path diagram is shown in Figure 4.9 below.

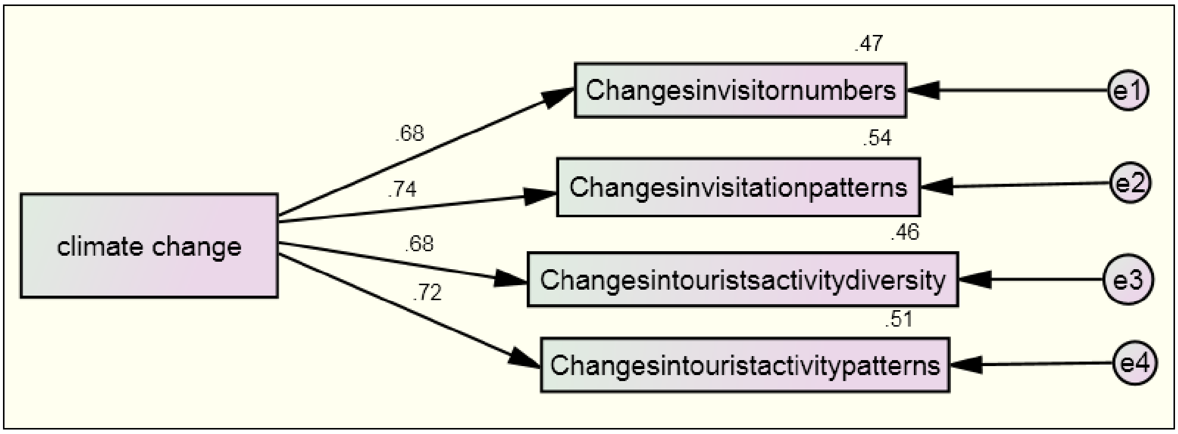

Figure 4.9**:** Output SEMPATH model of the relationship between climate change and perceived effects on tourists' activities

Table 4.46 below shows the unstandardized regression weights, their standard errors (SE), critical ratios (C.R), and their p values. All the regression coefficients for the model are significantly different from zero beyond the 0.01 level, as indicated by the column labelled p, which implied that climate change had perceived impacts on tourists' activities. This finding is supported by the values of critical ratios, which were all found to be greater than 1.95. Thus, the null hypothesis that climate change has no perceived effects on tourists' activities in the MMNR was rejected.

Table 4. 46: Un-standardized Regression Weights

			Estimate	S.E.	C.R.	P	Label
Changesinvisitornumbers	<---	climateChange	.764	.041	18.750	***	par_1
Changesinvisitationpatterns	<---	climateChange	.682	.031	21.674	***	par_2
Changesintouristsactivitydiversity	<---	climateChange	.677	.037	18.372	***	par_3
Changesintouristactivitypatterns	<---	climateChange	.650	.032	20.491	***	par_4

All the path coefficients in Table 4.49 were positive, which implied that when climate change increases, there would be consequent changes in visitor numbers, visitation patterns, tourists' activity diversity and tourists' activity patterns. The standardized regression weights (Figure 4.9) indicated that perceived climate change had the greatest influence on changes in visitation patterns (β=0.74), changes in tourists' activity patterns (β=0.72), and lastly, changes in both visitor numbers and tourists' activity diversity (β=0.68). However, the fact that the beta values for all the four variables were high (minimum=0.68 and maximum=0.74), the results suggested that climate change is likely to have an effect of all the variables.

The R square values (Figure 4.9) for the variables measuring tourists' activities were also found to be high (minimum=0.46; maximum=0.54), which indicated that climate change had a lot of influence on tourists' activities. The unexplained variance in the factors could be attributed to non-climate related factors not specified in the model and to the error terms (labeled e1 to e4) in the model.

4.8 Model of climate change impacts in MMNR

The conceptual framework of the study was tested against the data collected from the respondents using structural equation modeling – path analysis (SEM-PATH). The path diagram is presented in Figure 4.10.

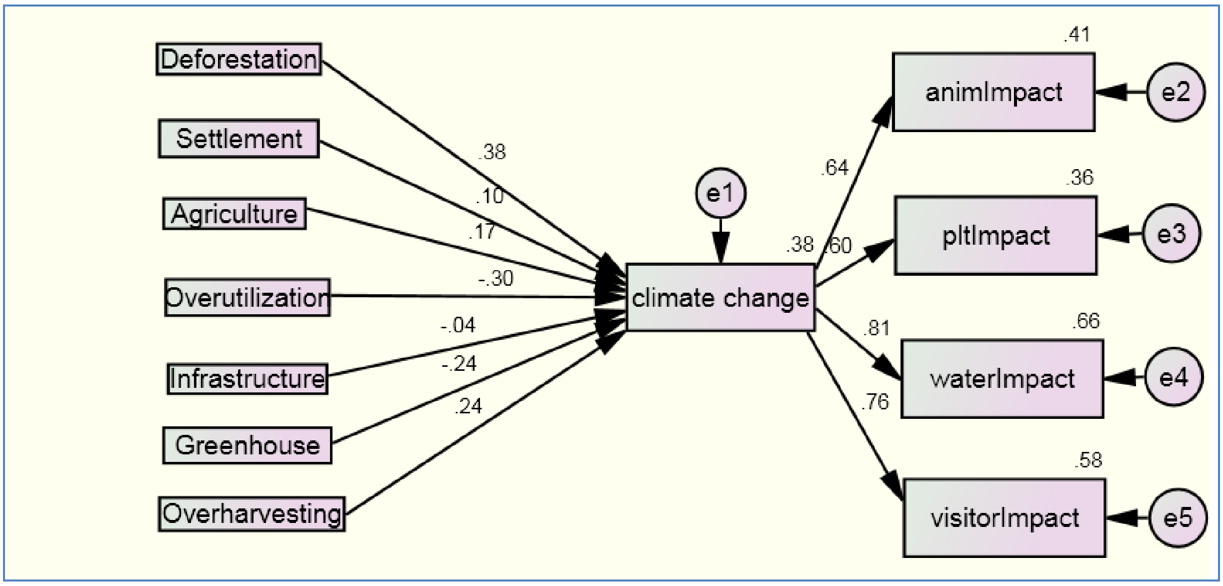

Figure 4.10 **:** Output SEMPATH model of the causes and effects of climate change.

Key: animl=animal; plt=plant

The model in Figure 4.10 links the causes of climate change with its effects. Several fit measures indicated that the overall fit of the model to the data was adequate. The model chi-square, also called discrepancy function, likelihood ratio chi-square, chi-square fit index, or chi-square goodness of fit was significant [P (CMIN) = 936.165, df =34, p <.01], suggesting that the model's covariance structure may not have been similar to the observed covariance matrix. However, considering the other goodness of fit indexes, this was discounted because the chi-square tends to be too conservative, that is, prone to Type II error. The normed fit index (NFI), the comparative fit index (CFI) and Incremental fit index (IFI) were 0.739, 0.743, and 0.746, respectively. Since, they were close to 1 (they range from 0 to 1), this indicated that the model fitted adequately to the data.

Table 4.47 below shows the unstandardized regression weights, their standard errors (SE), critical ratios (C.R), and their p values.

Table 4. 47: Un-standardized Regression Weights

			Estimate	S.E.	C.R.	P	Label
Climate Change	<---	Deforestation	.288	.030	9.604	***	par_5
Climate Change	<---	Settlement	.068	.028	2.422	.015	par_6
Climate Change	<---	Agriculture	.134	.031	4.256	***	par_7
Climate Change	<---	Overutilization	-.244	.032	-7.590	***	par_8
Climate Change	<---	Infrastructure	-.027	.027	-1.010	.312	par_9
Climate Change	<---	Greenhouse	-.142	.023	-6.041	***	par_10
Climate Change	<---	Overharvesting	.181	.030	6.014	***	par_11
animImpact	<---	climateChange	.434	.027	16.239	***	par_1
pltImpact	<---	climateChange	.383	.026	14.888	***	par_2
waterImpact	<---	climateChange	.688	.025	27.527	***	par_3
visitorImpact	<---	climateChange	.694	.030	23.231	***	par_4

The regression coefficients for deforestation, human settlement, agriculture and overharvesting of indigenous trees were significant at $p < .05$ and positive, which indicated that, increases in these factors causes a consequent worsening of climate change and vice versa. On the other hand, the coefficient for infrastructure construction was not significant at $p<.05$ ($B=-0.027$, $p=0.312$), which suggested that this factor might not affect climate change. Although significant, the coefficients for greenhouse emissions and overutilization of natural resources were negative, implying that according to the perceptions of the respondents, these factors were not influential in causing climate change. The highest standardized regression weight recorded was for deforestation (β=0.38), suggesting that this was the strongest cause of climate change, which was in keeping with considering these factor as being fundamental in section 4.9 above. It was followed by overharvesting of indigenous trees (β=0.24), agriculture (β=0.17), and human settlement (β=0.10).

The R square value for climate change was .38, which indicated that deforestation, human settlement, agriculture, overutilization of resources, infrastructure construction, greenhouse emissions and overharvesting of indigenous trees, could only explain 38% of the variance in climate change.

The path coefficients in Table 4.47 running from climate change to animal, plant, quantity of surface water and tourists' effects were all significant beyond the 0.01 level, which implied that climate change influences all these factors. In addition, the coefficients were all positive, implying that increases in climate change exacerbated effects on animals, plants, water and tourists, and vice versa. The standardized regression weights in Figure 4.10 showed that climate change has the biggest effect on the quantity of surface water (β=0.81), followed by tourists (β=0.76), animal effects (β=0.64), and lastly, on plants (β=0.60). Not surprisingly, the R square values reflected this pattern. The highest R^2 was found for water effects (0.66), because climate change could explain a lot of its variance, followed by visitor effects (R^2=.58), animal effects (R^2=.41) and lastly, plant effects (R^2=.36).

4.9 Adaptations to Climate Change

4.9.1 Adaptation strategies to climate change

It was also important to establish from the staff in the study whether adaptation strategies to climate change and the monitoring of its impacts were extant in the MMNR. According to the respondents, a lot of research (Yes: n=193, 96.5%; No: n=7, 3.5%) has been conducted to investigate the nature and scale of climate change effects in the Mau Forest and not in the MMNR. Hence, this study could be useful in providing insights on the degree of climate change effects in the MMNR. Research on climate change was found to be mainly carried out by NGOs (n=170; 85%), followed distantly, by consultants (n=17, 8.5%) and university researchers (n=11, 5.5%). It is thus crucial for other players, especially universities, to step up their research activities on climate change.

Most respondents (Yes: n=181, 90.5%; No: n=19, 9.5%) felt that some kind of initiative was being taken or considered to deal with some of the identified climate change's related effects. Table 4.48 below presents the initiatives being undertaken or considered to deal with some of the identified climate change's related effects.

Table 4. 48: Initiatives/responses being undertaken or considered to mitigate the effects of climate change

		Response being undertaken	**Response being considered**
Legislation	Frequency	169	31
	Percent	84.5	15.15
Planning	Frequency	90	110
	Percent	45.5	55
Design of protected area	Frequency	91	109
	Percent	45.5	54.5
Research, monitoring and reporting	Frequency	69	131
	Percent	34.5	65.5
Education and interpretation	Frequency	158	42
	Percent	79	21
Extension and outreach	Frequency	40	160
	Percent	20	80

Source: Field Data, 2013.

The common initiatives undertaken to mitigate the effects of climate change in MMNR include legislation that had a representation of 84.5% and education and interpretation, with had a representation of 79%, extension and outreach, which had an 80% representation and research, monitoring and reporting that had a representation of 65.5%. Besides, most of the respondents (n=147, 73.5%) felt that the MMNR had a climate change adaptation strategy. However, the research findings revealed several gaps in the strategies adopted in the MMNR (see table 4.49).

Table 4. 49: Opinions on climate change adaptation strategies

	Name of variable	S.D		Disagree		N.O		Agree		S.A	
		Fq	%	Fq	%	Fq	%	Fq	%	Fq	%
1	Need for more research on climate change impacts	8	4.0	2	1.0	9	4.5	33	16.5	148	74.0
2	Prioritize detecting and monitoring climate change	2	1.0	5	2.5	7	3.5	33	16.5	153	76.5
3	Too many uncertainties about climate change to develop adaptation strategies	14	7.0	13	6.5	5	2.5	29	14.5	139	69.5

Source: Field Data, 2013.

Majority of the respondents felt that there was need for more research on climate change impacts (strongly agree: n=148, 74%) and that detecting and monitoring of climate change should be a priority for protected areas (strongly agree: n=153, 76.5%). This indicated that although climate adaptation strategies could be in place, they appeared to be deficient. Many respondents (strongly agree: n=139, 69.5%) also felt that there were too many uncertainties about climate change to develop adaptation strategies, which suggested that there was a need for more creative studies that could delineate the true nature and scale of climate change.

The protected areas in Kenya requires some information that might help the people either working or communities living in these areas work on reducing climate change. The information perceived to be most important to the respondents was on the topic of detecting climate changes, which had a mean of 2.775 (Table 4.50). The reasons for this maybe if the respondents are given lessons on detecting this changes they can strive to reduce the damage that might be caused by the climate change in the long run.

Table 4. 50: Informational needs on various aspects of climate change

Area of information Need		**No need for more information**	**Need for some more information**	**Need for much more information**	**Mean**	**Total**
Detecting climate changes	%	3	16.5	80.5	2.775	100
Ecological consequences of climate change	%	24	12	73	2.58	100
Impacts of climate change on tourists visitations	%	4	20.5	75.5	2.715	100
Impacts of climate change on tourists on planning and management	%	15	13	72	2.57	100
Strategies for managerial response to climate change	%	14.5	10	75.5	2.61	100
Ways of communicating facts, sequences and solutions to climate change	%	22.5	7.5	70	2.475	100

Other topics that the respondents required more information in were impacts of climate change on tourists' visitations (mean = 2.715), which could help them increase the number of tourists and strategies for managerial response to climate change which had a mean of 2.61. Consequently, there were several employees in MMNR, (n= 199, 99.5%), who were willing to take part in a working group on climate change and protected areas.

4.9.2 Test of Ho_5

Therefore from the foregoing results, the fifth hypothesis (H_05) that 'There are no adaptation strategies to climate change adopted in MMNR' is rejected. This means that the MMNR has put in place measures to ensure there adaptation strategies to climate change adopted in MMNR.

CHAPTER FIVE

DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter presents the discussion of the research findings in relation to the study objectives and hypotheses. The findings were used to draw conclusions and the recommendations. Summary of results are presented in section 5.2, discussions are made in section 5.3, conclusions in section 5.4, while recommendations are presented in section 5.5.

5.1 Summary of results

The overarching aim of this study was to find out perceived effect of climate change on tourism and natural resources and adaptations strategies in protected areas. Specifically, the study aimed to determine the perceived effects of climate changes on animals, plants, quantity of surface water, tourism activities in the MMNR and the adaptation strategies to climate adopted in the reserve. The results indicated that deforestation (β=0.38) was the strongest perceived cause of climate change. Other important causes included overharvesting of indigenous trees (β=0.24), agriculture (β=0.17), and human settlement (β=0.10). The least important perceived cause of climate change was found to be green-house emissions (β=-0.24) and construction of infrastructure (β=-0.04). SEMPATH and frequency analyses showed that climatic change effects on animals could be divided into three hierarchical groups: a band of the significant effects consisting of changes in animal populations, increased animal deaths, changes in migration routes and patterns and changes in breeding grounds. The second consisted of factors perceived to have moderate effect on animals: changes in species composition, changes in migrating species and changes in species diversity. The last tier consisted of two factors, changes in animal infections and extinction of animal species, factors found to have the effect as their means were the lowest. Both staff and the local community members felt that climate change would completely alter the management of animals in the MMNR in both the next 10 and 25 years and that the effects of climate change on animals are amplified with the passage of time. However, the local community had a bleaker prognosis of the effects as compared with staff.

Conversely, the important perceived climate change effects on plants were found to be changes in plant species (β=0.70), plants' adaptation strategies (β=0.65), changes in distribution of plants (β-0.64), changes in vegetation cover (β=0.63), emergence of alien species (β=0.62) and changes in plant composition (β=0.13) (as revealed by SEMPATH and frequency analyses). The least effect was found to be the extinction of plant species (β= -0.37). Whereas the staff perceived the current climate change effects on plants as being more severe compared with local community members, the latter predicted direr climate change impacts on plants for both the next 10 and 25 years compared to the former.

Likewise, SEMPATH and frequency analyses indicated that perceived climate change had the greatest influence on changes in the amount of rainfall (β=0.74) and changes in the duration of rainfall (β=0.74). Climate change was also perceived to have strong influences on changes in rainfall seasons/patterns (β=0.72), changes in water level in Mara River and its tributaries (β-0.71), and changes in the availability of fresh water (β=0.70). Just like for plant impacts, while the staff perceived current climate change impacts on the quantity of surface water as being more severe compared with local community members, the latter predicted a more harsh climate change impacts on surface water quantity in both the next 10 and 25 years compared to the former.

Most of the respondents (local community: 97.5% and staff: 85%) felt that tourist activities in MMNR are currently, affected by climate change related impacts. SEMPATH analysis indicated that perceived climate change had strong influences on changes in visitation patterns (β=0.74), changes in tourists' activity patterns (β=0.72), and lastly, changes in both visitor numbers and tourists' activity diversity (β=0.68).

Although most respondents felt that the MMNR had a climate change adaptation strategy, deficiencies in the strategies exist, as a majority of the respondents felt that there was need for more research on climate change impacts, detecting and monitoring of climate change should be a priority for protected areas and that too many uncertainties existed about climate change to develop adaptation strategies. To mitigate the effects of climate change, the most pertinent information required by MMNR includes detection of climate changes, impacts of climate change on tourists' visitations, strategies for managerial response to climate change, and ecological consequences of climate change.

5.2 Discussion

This study found that while the majority of staff had secondary education (55%), the bulk of the local community possessed primary education (77%), which indicated that the community might not be highly educated. Several studies of Maasai participation in formal education have been carried out, all reiterating the low levels of school attendance by eligible children (Gorham, 1980; Holland, 1996; Coast, 2002). When combined with the traditional antipathy of the Maasai to sending their children to school (Coast, 2002), the low levels of education reported amongst the respondents in this study might be unsurprising. Female participants in this study were found to be generally better educated and older compared to their male counterparts. Studies have generally reported a marked sex bias in completion of primary school education among the Maasai, with far fewer women than men having attended school (Holland, 1996; Coast, 2002). Thus, because of low education, most Maasai women are likely to be tied to household chores, meaning that only a few of them (probably those with good education and who are older) are venturesome, and hence, getting an opportunity to participate in this study.

This study found awareness of climate change was pervasive amongst both members of staff (96%) and local community (97%). This was unlike an assessment carried out by Mutimba *et al.,* (2010) on climate change vulnerability and adaptation preparedness in Kenya, in which they concluded that climate change awareness, especially in the countryside, is quite low. A Gallup poll carried out between 2007 and 2008 by Pelham (2009) reported that 56% of Kenyans had some knowledge of global warming, whereas 44% of them had no notion of climate change. If the study area typifies the rest of the country, then, the findings from this study indicate that climate change awareness programs undertaken by the government, NGOs and the media are likely to have been effective.

This study found that staff members rated themselves as being more knowledgeable on climate change compared with members of the community, which might have resulted from the fact that more staff had secondary education whereas the bulk of the local community possessed primary education (Pelham, 2009). However, very few staff (1%) and local community (2.5%) members considered themselves as experts on climate change matters. This is in agreement with the aforementioned study of

Pelham (2009), which found that of the 56% of Kenyans who reported knowledge of climate change, many were found not to be well versed in various climate change issues such as adaptation and mitigation arguments.

This study found that deforestation was perceived as the strongest cause of climate change. Other important causes included overharvesting of indigenous trees, agriculture, and human settlement. The least important perceived cause of climate change was found to be green-house emissions and construction of infrastructure. Evidence has suggested that climate change is caused by both natural and man-made factors over a period of time (Coast, 2002). The natural processes implicated in climate change include volcanic eruptions, variations in the sun's intensity or very slow changes in ocean circulation or land surfaces which occur on time scales of decades, centuries or longer.

However, human activities have been found to be far, the major cause of climate change through the continuous release of green-house gases and aerosols into the atmosphere, by changing land surfaces, and by depleting the stratospheric Ozone Layer (Crowley, 2000; IPCC, 2001; Foukal *et al.,* 2006). The influence of external factors on climate can be broadly compared using the concept of radiative forcing (a measure of the influence a factor has in altering the balance of incoming and outgoing energy in the Earth). A positive radiative forcing, such as that produced by increasing concentrations of greenhouse gases, tends to warm the surface. A negative radiative forcing, which can arise from an increase in some types of aerosols (microscopic airborne particles) tends to cool the surface (IPCC, 2001).

The most important greenhouse gases that have been found to cause positive radiative forcing include carbon (IV) oxide (CO_2), methane (CH_4), nitrous oxide/nitrogen (I) oxide (N_2O). In addition, halocarbon gases that have been found to be both ozone-depleting and greenhouse gases include trichloroflouromethane ($CFCl_3$), dichlorodifluoromethane (CF_2Cl_2), chlorodiflouromethane (CHF_2Cl) and 1, 1, 1, 2-tetraflouroethane (CF_3CH_2F) (IPCC, 2001). The finding by this study that deforestation is a major cause of climate change is in line with scientific evidence. Forests play a huge role in the carbon cycle, by absorbing carbon (IV) oxide and giving out oxygen during the day. When forests are cut down, not only does carbon absorption cease, but also the carbon stored in the trees is released into the atmosphere as CO_2 if the wood is burned or even if it is left to rot after the deforestation process (Karl & Trenberth, 2003). Although, smaller crops, such as plants and agricultural crops also draw in carbon dioxide and release oxygen, forests store up to 100 times more carbon than agricultural fields of the same area. Hence, deforestation contributes to climate change by increasing the level of carbon (IV) oxide, the most dominant human-influenced greenhouse gas.

For instance, the radiative forcing due to increases of the well-mixed greenhouse gases from 1750 to 2000 is estimated to be 2.43 Wm^{-2} : 1.46 Wm^{-2} from CO_2 (60%); 0.48 Wm^{-2} from CH_4 ; 0.34 Wm^{-2} from the halocarbons; and 0.15 Wm^{-2} from N_2O (IPCC, 2001). It is estimated that more than 1.5 billion tons of carbon dioxide are released to the atmosphere due to deforestation, mainly the cutting and burning of forests, every year. In fact, whereas cars and trucks have been found to account for about 14 percent of global carbon emissions, 15 percent is usually adduced to deforestation (Stott *et al*., 2000). Thus, with respect to deforestation as a contributing factor of climate change, the respondents were correct. However, they could not be able to explain the exact science that links deforestation with the greenhouse effect and global warming or ozone depletion.

Overharvesting of indigenous trees, agriculture, and human settlement will contribute to climate change for similar reasons as deforestation, because all these activities involve the cutting down of some trees. In addition, agricultural activities produces gases such as CH_4, N_2O, NO and NH_3, all implicated for their radiative or chemical effects in the atmosphere (Li, 2000). Under cultivated conditions, agricultural soils are subject to a various anthropogenic disturbance including tillage, fertilization, irrigation, manure amendment, weeding and liming, which elevate the emission of these gases into the atmosphere (Li, 2000). Nitrification (the microbial oxidation of ammonia) has been observed to be the main source of NO and N_2O under aerobic conditions (Equation 5.1) (Hutchinson & Davidson, 1993; Bollmann & Conrad, 1998).

Nitrification:

$$NH_4^+ \rightarrow \underset{NO \quad N_2O}{H_2NOH} \rightarrow \overset{\downarrow}{NOH} \rightarrow \overset{\downarrow}{NO_2^-} \rightarrow NO_3^- \qquad (Equation\ 5.1)$$

Denitrification (the sequential reduction of nitrate to dinitrogen [N_2] driven by denitrifying bacteria under aerobic conditions (Equation 5.2) is another main source of N_2O and NO from soils (Anderson & Levine, 1986; Poth & Focht, 1998).

Denitrification:

$$NO_3^- \rightarrow NO_2^- \rightarrow NO \rightarrow N_2O \rightarrow N_2 \qquad (Equation\ 5.2)$$

Methane is an end product of the biological reduction of CO_2 or organic carbon under anaerobic conditions (Equation 5.3) (Holland & Schimel, 1994).

Methane production: $CO_2 + 8H^+ \rightarrow CH_4 + 2H_2O$ $(Equation\ 5.3)$

Or

$Organic\ C + 4H^+ \rightarrow CH_4$

The least important cause of climate change was found to be green-house emissions, which was contrary to scientific evidence, which suggests that the emission of greenhouse gases, for instance, carbon (IV) oxide, methane, and nitrous oxide are largely responsible for climate change (IPCC, 2001). The possible explanation for this was that the study area had a low concentration of industries and vehicular traffic, which are notorious emitters of these gases (IPCC, 2001). Indeed, studies suggest that the worst emitter of greenhouse gases is the developed world rather than developing countries (UN, 2010; Anderegg, 2010; Crowley, 2000).

In MMNR there were many climate change impacts on the animals observed among both the sampled staff and the local community. The most prominent effects were changes in animal populations, increased animal deaths, changes in migration routes and patterns, and changes in breeding grounds. The findings in this study are in agreement with Harding and McCullum, (1997), and Hannah, Lovejoy and Schneider (2005) who conducted a research that suggested that climate change will affect every aspect of biodiversity from individual organisms through to populations, species, and ecosystems. Its impacts will be incremental to other drivers such as anthropogenic habitat degradation, habitat loss, pollution, and altered natural disturbance regimes. They also stated that this will have a negative synergy between climate change and non-climate stressors will lead to dramatic and unpredictable species and ecosystem responses.

Changes in animal populations because of climate change could be caused by increased animal deaths, changes in migration patterns and breeding grounds. According to the respondents in this study, there has been a reduction in the population of the gnu, wildebeest, zebras, giraffes, and lions while the black rhino, wild dogs, stripped hyenas, the cheetah and the leopard are hardly spotted. Animal deaths could occur in various ways: Heat is a direct stressor of animal physiology, which could cause the malfunctioning of animals' enzymes (Dawson, 1992). Rising temperatures affect the availability of vegetation and food necessary for survival, which could cause animals to starve to death (Johnston & Schmitz, 1997). Various biological mechanisms affected by temperature such as nesting and mating will fail to occur under extreme climate change conditions, for instance, drought (Visser, van Noordwijk, Tinbergen, & Lessells, 1998). Animal diseases triggered by threshold climate events become more common and deadly while studies show that animal species must expend more time and energy on thermoregulation, when their climatic environment is suboptimal (Dunbar, 1998).

A study by Thomas *et al*. (2004) modeled the expected impact of gradual climate change on 1,103 species (including mammals, birds, reptiles, and insects) and predicted that 15–37% would be committed to extinction by 2050. In contrast, over the same period, global habitat loss—the other major source of ecosystem destruction—leads to projected extinction ranges from 1–29%, with figures in the lower end of the range being most plausible. Put in another way, climate change could be more destructive to nonhuman life than all other sources of habitat loss combined. As the lead researcher in the study remarked that "well over a million species could be threatened with extinction as a result of climate change" (Thomas *et al*., 2004). In fact, according to projections by IPCC (2002), for every degree Celsius increase that the globe experiences, two scenarios, predicted by working group 1 (WG1), WG1 A2 and WG1 B1 are likely to ensue (Figure 5.1), both resulting in substantial loss of species.

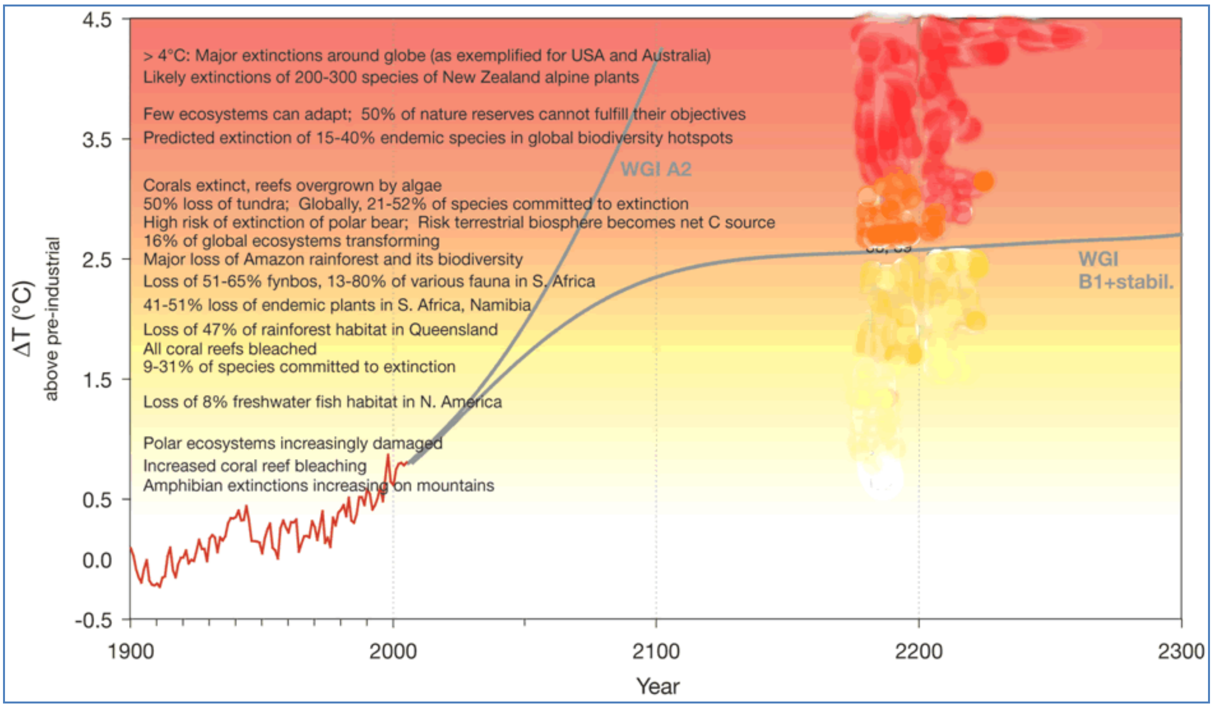

Figure 5. 1: Projected risks due to temperature increase over the next 300 years

Source : IPCC, 2007.

This study found that important perceived climate change effects on plants were changes in plant species, plants' adaptation strategies, changes in distribution of plants, changes in vegetation cover, emergence of alien species and changes in plant composition whereas the least effect was found to be the extinction of plant species. These findings are in line with research by Currie (1991) which indicated that temperature and water availability account for more than 75% of the variability in plant species richness over broad spatial scales. Changes in climate will also alter interactions between species, including patterns of competition, symbiosis, mutualism, predation, and dominance (Currie, 1991). By altering rainfall patterns (for instance, increased droughts) and temperature, climate change could explain the observable changes in plant species, their distribution and vegetation cover in this study. Changes in plant distribution and extended range of pests and pathogens caused by climate change could allow invasion by alien species (McCarty, 2001). For instance, *Prosopis juliflora* ('mathenge') has become dominant in important ecosystems of Baringo, Tana River, Garissa and other semi-arid areas of the country.

In addition, excessive growth of some tree species has been observed including the excessive growth of *Acacia reficiens* (acacia) after the 1997 El-nino in North-Eastern Province (NEP) that suppressed the growth of various species that form grasslands for wildlife and livestock (Mutimba *et al*., 2010). Increases in temperature could lead to a shift of vegetation to higher elevations, which are cooler, while some species could become extinct. Indeed, across the country, some tree species including *Melia volkensii, Terminalia spinosa, Delonix elata*, and *Hyphenea corriaceae* in North Eastern Province, and *Psychotria* species in the Taita Hills, Coast Province, are either extinct or their numbers have dramatically reduced. In addition, the projected rise in temperatures and long periods of drought could lead to more frequent and more intense fires, with estimates showing that Kenya has lost more than 5,700 ha of forests per year to forest fires, over the past 20 years (Mutimba *et al*., 2010).

This study found that perceived climate change had the greatest influence on changes in the amount of rainfall and changes in the duration of rainfall. Climate change was also perceived to have strong influences on changes in rainfall seasons/patterns, changes in water level in Mara River and its tributaries, and changes in the availability of fresh water. Studies suggest that climate change could directly influence precipitation amount, intensity, frequency and type. Warming accelerates land surface drying and increases the potential incidence and severity of droughts. A well-established physical law (the Clausius-Clapeyron relation) determines that the water-holding capacity of the atmosphere increases by about 7% for every 1°C rise in temperature.

Over the 20th century, based on changes in sea surface temperatures, it is estimated that atmospheric water vapour increased by about 5% in the atmosphere over the oceans, which has generally increased precipitation intensity and the risk of heavy rain and snow events. Basic theory, climate model simulations and empirical evidence all confirm that warmer climates, owing to increased water vapour, lead to more intense precipitation events even when the total annual precipitation is reduced slightly, and with prospects for even stronger events when the overall precipitation amounts increase. The warmer climate therefore increases risks of both drought − where it is not raining and floods where it is but at different times and/or places (Trenberth *et al*., 2007). For instance, the summer of 2002 in Europe brought widespread floods but was followed a year later in 2003 by record-breaking heat waves and drought. The distribution and timing of floods and droughts is most profoundly affected by the cycle of El Niño events, particularly in the tropics and over much of the mid-latitudes of Pacific-rim countries (Trenberth *et al*., 2007).

This study found that perceived climate change had strong influences on changes in visitation patterns, changes in tourists' activity patterns, and lastly, changes in both visitor numbers and tourists' activity diversity. Since Kenya's tourism depends in a large part on the country's wilderness and wildlife, it is highly susceptible to climate change. Wildlife both in national parks and game reserves depend on either natural rivers feeding the national parks or manmade wells and dams for its survival, whose water levels have reduced while others have completely dried up (Mutimba *et al*., 2010). According to KWS (2010), 'extraordinary and prolonged dry seasons', have increased wildlife deaths, with 14 elephants dying in 2007, 28 in 2008 and 37 in 2009

(Mutimba *et al*., 2010). True to what respondents in this study asserted, the water volume of the Mara River have been found to have reduced, due to climatic variations and the destruction of the Mau catchment, which has had a toll on the eighth wonder of the world – the spectacular migration of hundreds of wildebeests between the Serengeti National Park in Tanzania and the Maasai Mara Reserve in Kenya across the Mara River (Mutimba *et al*., 2010). Thus, tourism is negatively affected as the number of wildlife declines due to reduced drinking water and the increasing inhabitable wilderness.

The earth's climate has warmed 0.3^0 to 0.6^0 over the last 100 years, with warming occurring rapidly during the periods 1925 – 1944 and 1998 – 1997 (Jones *et al*. 1999; IPCC, 2001). Changes in precipitation have also been recorded (McCarty, 2001). According to the Government of Kenya (2010), the evidence of climate change in Kenya is unmistakable, with extreme and harsh weather being the norm in the country. Since the early 1960s, temperatures have risen throughout the country, for both night time (increased by 0.7 – 2^0 C) and day time (elevated by 0.2 – 1.3^0 C) temperatures. Figure 5.2 shows temperature changes in Nairobi.

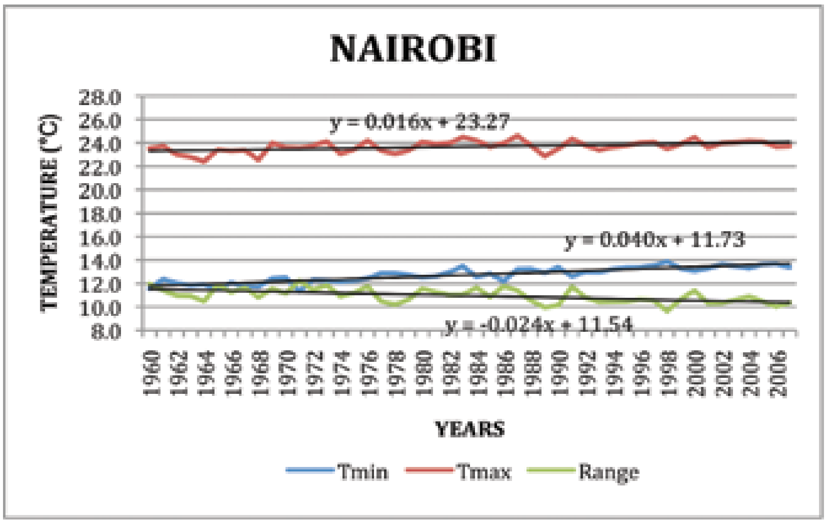

Figure 5. 2 **:** Temperature changes in Nairobi since 1960

Rainfall has become irregular and unpredictable, with intense downpours when it rains. There is a general decline of rainfall in the main rainfall season of March- May (the "Long Rains"), with frequent and prolonged drought in the long rains season. On the other hand, there are more rains during September to February, suggesting that the "Short Rains" (October-December) season is extending into what is normally hot and dry period of January and February (GoK, 2010).

Clearly, climate change has occurred in the country and to that extent, the respondents in this study were correct. According to them, climate change has the biggest influence on the quantity of surface water (β=0.81), followed by tourists (β=0.76), animal impacts (β=0.64), and lastly, on plants (β=0.60). Thus, climate change awareness in the MMNR is quite high (although not the specific science), which is contrary to findings by Mutimba *et al*. (2010), which suggested low awareness in the countryside, especially among the rural folk. This could be because of frequent research activities by NGOs, consultants, and to a less extent, university researchers. This study found that although the MMNR had a climate change adaptation strategy, deficiencies in the strategies are extant, as respondents felt that there was need for more research on climate change impacts, detecting and monitoring of climate change should be a priority for protected areas and that too many uncertainties existed about climate change to develop adaptation strategies. To mitigate the effects of climate change, the most pertinent information required by MMNR includes detection of climate changes, impacts of climate change on tourists' visitations, strategies for managerial response to climate change, and ecological consequences of climate change.

Hence, there is a need for the government to enact an exclusive climate change policy and legislation that creates or sets out the mandates of a leading institution, which will spearhead climate change adaptation and mitigation in the country. A few policies are already in place such the National Energy Policy (Sessional Paper No. 4 of 2004), Policy on Environment and Development (Sessional Paper No.6 of 1999) and the Food Policy (Sessional Paper No. 3 of 1993), among others (Ministry of Energy, 2004). Legislations include the Environment Management coordinating Act, EMCA of 1999, the Energy Act 2006, the Forests Act 2005 and the Water Act 2002. However, these policies and legislations do not exclusively address climate change, but have a few aspects and clauses that do. Hence, there is a need to create an omnibus legislative framework that exclusively addresses all facets of climate change and how it can be mitigated.

5.3 Conclusion

The Intergovernmental Panel on Climate Change (IPCC) published a series of reports in 2007 that set forth conclusions about the causes and effects of global warming as well as the costs and benefits of solving the problem associated with climate change. The reports, which drew on the work of more than 2,500 of the world's leading climate scientists and were endorsed by 130 nations around the world including Kenya, confirmed the consensus of scientific opinion on the key questions related to global warming. Taken together, the reports are intended to help policymakers worldwide make informed decisions and develop effective strategies to reduce greenhouse gas emissions and control global warming and climate change in general.

In MMNR, the main causes of climate change were found to be deforestation and human settlement and other human activities in the protected areas. Due to the need to occupy and own new homes, people encroach into forests where they participate in activities, for instance, logging, agriculture and charcoal burning that destroy the forests and eventually bring about climate change. Climate change was perceived to negatively affect wild animals, by changing animal populations, increasing animal deaths, changing migration routes, patterns and breeding grounds, and altering species composition and diversity. The study found that the crucial plant impacts resulting from climate change included changes in plant species, plants' adaptation strategies, changes in distribution of plants, changes in vegetation cover, emergence of alien species and changes in plant composition whereas the least impact was found to be the extinction of plant species. Climate change was also found to influence changes in the amount, duration, and seasons/patterns of rainfall and changes in water level in Mara River and its tributaries and to alter changes in visitation patterns, changes in tourists' activity patterns, and changes in both visitor numbers and tourists' activity diversity. Climate change was found to have the biggest influence on the quantity of surface water, followed by tourists, animal impacts, and lastly, on plants. The study also found a need to create an omnibus legislation that would exclusively address all facets of climate change and how it can be mitigated.

5.4 Recommendations

Basing on the findings of this study the researcher came up with the following recommendations to the government, the ministry of tourism, management of protected areas, management of MMNR and other stakeholders. They include:

i. The Kenyan government should come up with legislations to prevent deforestation and human settlement in protected areas as well as educating the local community on the importance of planting trees on their farms, as these are the main causes of climate change.

ii. Due to climate change effect on vegetation cover, the management of protected and other stakeholders should plant trees in these areas and also prevent human activities.

iii. To avoid death of wild animals and change in their species the management of MMNR should formulate policies that would ensure clean water access by the animals and enough food for them.

iv. The management of MMNR should establish ways of communicating facts, sequences and solutions to climate change to the staff to encourage curbing of climate change

REFERENCES

Akama, J. (1999). The Evolution of Tourism in Kenya. *Journal of Sustainable Tourism*, *7*(1), 6–25.

Altmann, J., Alberts, S. C., Altmann, S. A., & Roy, S. B. (2002). Dramatic change in local climate patterns in the Amboseli basin, Kenya. *African Journal of Ecology, 40*, 248-251.

Aluko, O. (2012, April). Impact of poverty on housing condition in Nigeria : A case study of Mushin Local Government Area of Lagos State. *Journal of African Studies and Development, 4*(3), 81 - 89.

Amelung, B., Nicholls, S., & Viner, D. (2006). Implications of Global Climate Change for Tourism Flows and Seasonality. *Journal of Travel Research, 45*(3), 285-296.

Anderegg, W. R. (2010, June 21st). Expert Credibility in Climate Change. *Proceedings of the National Academy of Sciences, 107*(27), 12107-12109.

Anderson, B. (2006). Becoming and being hopeful : Towards a theory of affect. *Environment and Planning D: Society and Space, 24,* 733-752.

Anderson, I., & Levine, J. (1986). Relative rates of nitric oxide and nitrous oxide production by nitrifiers, denitrifiers, and nitrate respirers. *Applied Environmental Microbiology, 51*, 938-945.

Andy, F. (2009). *Discovering Statistics Using SPSS* (3rd ed.). London: SAGE Publications Inc.

Appiah, M. (2007). Fire : A necessary evil. In T. Heikkilä, R. Grönqvist, & M. Jurvélius (Eds.), *Wildland fie management handbook for trainers* (pp. 238–245). Helsinki, Finland: Development Policy Information Unit, Ministry for Foreign Affairs of Finland.

Arctic Climate Impact Assessment. (2004). *Impacts of a warming Arctic.* Cambridge, UK: Cambridge University Press.

Bajracharya, S. R., Mool, P. K., & Shrestha, B. (2007). *Impact of climate change on Himalayan glaciers and glacial lakes: Case studies on GLOF and associated hazards in Nepal and Bhutan.* Kathmandu: International Centre for Integrated Mountain Development and United Nations Environmental Programme Regional Office Asia and the Pacific.

Barnes, R. F., Héma, E. M., & Doumbia, E. (2006). Distribution des éléphants autour dune mare sahélienne en relation avec le chattel domestique et la vegetation ligneuse. *Pachyderm*, 35–41.

Bates, B. C., Kundzewicz, Z. W., Wu, S., & Palutikof, J. P. (2008). *Climate change and water : Technical Paper of the Intergovernmental Panel on Climate Change.* Geneva, Switzerland: IPCC Secretariat.

Becken, S. (2005). Harmonising climate change adaptation and mitigation : The case of tourist resorts in Fiji. *Global Environmental Change, 15*, 381-393.

Bode, S., Hapke, J., & Zisler, S. (2003). Need and Options for a Regenerative Energy Supply in Holiday Facilities. *Tourism Management, 24*, 257-266.

Bollmann, A., & Conrad, R. (1998). Influence of O2 availability on NO and N2O release by nitrification and denitrification in soils. *Global Change Biology*, 387-396.

Boucher, O., Myhre, G., & Myhre, A. (2009). Direct human influence of irrigation on atmospheric water vapour and climate. *Climate Dynamics, 22*(1), 597–603.

Brashares, J. S., Arcese, P., & Sam, M. K. (2001). Human demography and reserve size predict wildlife extinction in West Africa. *Proceedings of the Royal Society of London B, 268*, 2473–2478.

Brouwer, R., Brander, L., & Van Beukering, P. (2008). A Convenient Truth: Air Travel Passengers' Willingness to Pay to Offset their CO2 Emissions. *Climatic Change, 90*, 299-313.

Browne, S. A., & Hunt, L. M. (2007). *Climate change and nature-based tourism, outdoor recreation, and forestry in Ontario : Potential effects and adaptation strategies.* Thunder Bay, Ontario: Centre for Northern Forest Ecosystem Research.

Bryman, A. (2008). *Social Research Methods.* New York: Oxford University Press.

Bunn, A. (2009). The rock and ice problem in national parks: An opportunity for monitoring climate change impacts. *Park Science, 26*(1), 23 - 40.

Byrne, B. M. (2009). *Structural equation modeling with AMOS : Basic concepts, applications, and programming.* (2nd, Ed.) London: Psychology Press.

Carpenter, K. E., Abrar, M., Aeby, G., Aronson, R. B., Banks, S., & Bruckner, A. (2008). One - third of reef-building corals face elevated extinction risk from climate change and local impacts. *Science, 321*, 560–563.

Chapman, L. (2007). Transport and Climate Change : A Review. *Journal of Transport Geography, 15*, 354-367.

Chown, S. L., Slabber, S., McGeoch, M. A., Janion, C., & Leinaas, H. P. (2007). Phenotypic plasticity mediates climate change responses among invasive and indigenous arthropods. *Proc. R. Soc, 274*(1625), 2531–2537.

Coast, E. (2002). *Maasai socio-economic conditions: cross-border comparison.* London: LSE Research Online.

Cochrane, M. A., & Laurance, W. F. (2002). Fire as a large-scale edge effect in Amazonian forests. *Journal of Tropical Ecology, 18*, 311–325.

Cooper, D. R., & Schindler, P. (2006). *Business Research Methods.* (9th, Ed.) New York, NY: McGraw Hill Irwin.

Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process.* Thousand Oaks, CA:: Sage.

Crowley, T. J. (2000). Causes of climate change over the past 1000 years. *Science, 289*, 270-277.

Currie, D. J. (1991). Energy and large-scale patterns of animal and plant-species richness. *Nature, 137*, 27 - 49.

Davidson, D., Williamson, T., & Parkins, J. (2003). Understanding climate change risk and vulnerability in northern forest-based communities. *Canadian Journal of Forest Research, 33*, 2252–2261.

Dawson, W. R. (1992). Physiological responses of animals to higher temperatures. In R. L. Peters, & T. E. Lovejoy (Eds.), *Global Warming and Biological Diversity* (pp. 158 -170). New York, NY: Sage.

De Freitas, C. R. (2005). Tourism, Recreation and Climate Change Assessment. In M. C. Hall, & J. Higham (Eds.), *Tourism, Recreation and Climate Change* (pp. 29 - 43). Clevedon: Channel View Publications.

de Leew, J., Waweru, M. N., Okello, O. O., Maloba, M., Nguru, P., Said, M. Y., . . . Reid, R. S. (2001). Distribution and diversity of wildlife in northern Kenya in relation to livestock and permanent water points. *Biological Conservation, 100*(3), 297–306.

Dictionary.com. (2014). *Ecosystem*. Retrieved from Dictionary.com: http://dictionary.reference.com/browse/ecosystem

Ditton, R. B., & Sutton, S. G. (2004). Substitutability in recreational fishing. *Human Dimensions of Wildlife, 9*, 87-102.

Dunbar, R. I. (1998). Impact of global warming on the distribution and survival of the gelada baboon: A modelling approach. *Global Change Biology, 4*(2), 293–304.

Dybas, C. L. (2009). Infectious diseases subdue Serengeti lions. *Bio science, 59*(1), 8-13.

Ensaa. (2011, Apri 25th). *Defining Climate Change.* Retrieved November 29th, 2014, from Ensaa.eu: http://www.ensaa.eu/index.php/climate-change/97-defining-climate-change.html

Food and Agricultural Organization. (2012). *State of the world's forests.* Rome: Food and Agriculture Organization of the United Nations.

Foukal, P., Frohlich, C., Spruit, H., & Wigley, T. M. (2006). Variations in solar luminosity and their effect on the earth‘s climate. *Nature, 443*, 161-166.

Franklin, A. (2000). *Tourism : An Introduction.* London: SAGE Publications.

Gandiwa, E., & Kativu, S. (2010). Influence of fire frequency on Colophospermummopane and Combretum apiculatum woodland structure and composition in northern Gonarezhou National Park, Zimbabwe. *Koedoe, 51*(1), 685.

Gandiwa, E., & Zisadza, P. (2010). Wildlife management in Gonarezhou National Park Southeast Zimbabwe: climate change and implications for management. *Nature & Faune, 25*(1), 95–104.

Gitay, H., Suarez, A., & Watson, R. T. (2002). *Climate change and biodiversity: IPCC Technical Paper V.* Geneva: Intergovernmental Panel on Climate Change.

Global Warming Policy Foundation. (2011, Novermber 19th). *IPCC introduces new climate change definition*. Retrieved from Thegwpf.org: http://www.thegwpf.org/ipcc-introduces-new-climate-change-definition/

Goeldner, C., & Ritchie, B. (2012). *Tourism: Practices, Principles,Philosophies* (12th ed.). New Jersey: John Wiley and Sons, Inc.

Gómez-Martín, M. B. (2006). Climate Potential and Tourism Demand in Catalonia (Spain) during the Summer Season. *Climate Research, 32*, 75-87.

Gorham, A. (1980). *Education and social change in a pastoral society : Government initiatives and local responses to primary school provision in Kenya Maasailand.* Westview Press: Evangelou.

Gössling, S., & Hall, M. (2006). *Tourism and Global Environmental Change: Ecological, Social, Economic and Political Interrelationships.* New York, NY: Routledge.

Gottfried, M., Pauli, H., Reiter, K., & Grabherr, G. (1999). A fine-scaled predictive model for changes in species distributions patterns of high mountain plants induced by climate warming. *Diversity and Distributions, 5*(6), 241–252.

Government of Kenya . (2007). *Kenya Vision 2030: A Globally Competitive and Prosperous Kenya.* Nairobi: Government Printers.

Government of Kenya. (2010). *National Climate Change Response Strategy.* Nairobi: Government Printers.

Government of Kenya. (2012). *Economic Survey 2012.* Nairobi: Government Printers.

Grime, J. P., Fridley, J. D., Askew, A. P., Thompson, K., Hodgson, J. G., & Bennett, C. R. (2008). Long-term resistance to simulated climate change in an infertile grassland. *Proceedings of the National Academy of Sciences of the United States of America, 105*, 10028–10032.

Grothmann, T., & Patt, A. (2005). Adaptive capacity and human cognition : The process of individual adaptation to climate change. *Global Environmental Change*, *15*, 199-213.

Gyimothy, S. (2006). New marketing perspectives for global environmental change. In S. Gossling, & C. Hall (Eds.), *Tourism and Global Environmental Change: Ecological, Social, Economic and Political Interrelationships* (pp. 251-261). New York, NY: Routledge.

Hair, J., Babin, B., Money, A., & Samouel, P. (2003). *Essentials of Business Research Methods.* New York, NY: John Wiley and Sons.

Hall, M. C., & Higham, J. (2005). Tourism, Recreation and Climate Change. In M. C. Hall, & J. Higham (Eds.), *Tourism, Recreation and Climate Change* (pp. 3-28). Clevedon: Channel View Publications.

Hamilton, J. M. (2007). Coastal Landscape and the Hedonic Price of Accommodation. *Ecological Economics, 62*, 594-602.

Hamilton, J. M., Maddison, D. J., & Tol, R. S. (2005). Climate Change and International Tourism: A Simulation Study. *Global Environmental Change, 15*(3), 253-266.

Hannah, L., Lovejoy, T. E., & Schneider, S. H. (2005). Biodiversity and climate change in context. In T. E. Lovejoy, & L. Hannah (Eds.), *Climate change and biodiversity.* New Haven, CT: Yale University Press.

Harding, L. E., & McCullum, E. (1997). Ecosystem response to climate change in British Columbia and Yukon : Threats and opportunities for biodiversity. In E. Taylor, & B. Taylor (Eds.), *Responding to global climate change in British Columbia and Yukon* (Vol. 1). Victoria, BC: BC Ministry of Environment, Lands and Parks.

Hare, B., & Meinshausen, M. (2006). How Much Warming Are We Committed to and How Much Can Be Avoided? *Climatic Change, 75*(1 - 2), 111–149.

Hays, G. C., Richardson, A. J., & Robinson, C. (2005). Climate change and marine plankton. *Trends in Ecology and Evolution, 20*(6), 337–344.

Helmer, M., & Hilhorst, D. (2006). Editorial: natural disasters and climate change. *Climate, 30*(1), 1–4.

Hemp, A. (2009). Climate change and its impact on the forests of Kilimanjaro. *African Journal of Ecology, 47*, 3–10.

Hernandez, A. B., & Ryan, G. (2011). Coping with climate change in the tourism industry. *Tourism and Hospitality Management, 17*(1), 79-90.

Hinzman, L. D., Bettez, N. D., Bolton, W. R., Chapin, F. S., Dyurgerov, M. B., Fastie, C. L., . . . Hollister, R. D. (2005). Evidence and implications of recent climate change in northern Alaska and other Arctic regions. *Climate change, 72*, 251–298.

Holland, E., & Schimel, D. (1994). Ecosystem and physiological controls over methane production in northern wetlands. *Journal of Geography Research, 99*, 1563-1571.

Holland, K. (1996). *The Maasai on the horns of a dilemma: development and education.* Nairobi: Gideon S. Were Press.

Holtz, C., & Edwards, S. (2003). Linking Biodiversity and Sustainable Tourism Policy. In D. A. Fennell, & R. K. Dowling (Eds.), *Ecotourism Policy and Planning* (pp. 39 - 54). Trowbridge: CABI Publishing.

Hopkins, W. G. (2000). *Quantitative Research Design*. Retrieved January 3rd, 2012, from Sportsci.org: www.sportsci.org/jour/0001/wghdesign.html

Hussen, A. M. (2000). *Principles of environmental economics: Economics, ecology and public policy.* London, UK: Routledge.

Hutchinson, G., & Davidson, E. (1993). Processes for production and consumption of gaseous nitrogen oxides in soil. In L. Harper, A. Mosier, & J. Duxbury (Eds.), *Agricultural Ecosystems Agricultural Ecosystems* (pp. 79-93). New York, NY: Sage.

Intergovernmental Panel on Climate Change. (2001). *The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge and New York: Cambridge University Press.

Intergovernmental Panel on Climate Change. (2007). *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the IPCC.* Cambridge, UK: IPCC.

International Fund for Agricultural Development . (2009). *Case study from Kenya – Mount Kenya East Pilot Project for Natural Resources Management:*

increasing the resilience of the ecosystem to human and natural stresses. IFAD's response to climate change through support to adaptation and related actions. Rome: Comprehensive report: final version.

Johnston, K. M., & Schmitz, O. J. (1997). Wildlife and climate change : Assessing the sensitivity of selected species to simulated doubling of atmospheric CO2. *Global Change Biology, 3*(6), 531-544.

Jones, P. D., Horton, E. B., Folland, C. K., Hulme, M., Parker, D. E., & Basnett, T. A. (1999). The use of indices to identify changes in climatic extremes. In T. R. Karl, N. Nicholls, & A. Ghazi (Eds.), *Weather and climate extremes : Changes in variations and a perspective fromthe insurance industry.* The Netherlands: Kluwer Academic Publications.

Karanja, G. (2003). Tourism Impacts in the Maasai Mara National Reserve. In M. J. Walpole, G. G. Karanja, N. W. Sitati, & N. Leader-Williams (Eds.), *Wildlife and People : Conflict and Conservation in the Maasai Mara, Kenya* (pp. 5 - 16). London: International Institute for Environment and Development.

Karl, T. R., & Trenberth, K. E. (2003, December 5th). Modern global climate change. *Science, 302*, 1719-1723.

Kenya National Bureau of Statistics. (2010). *National Population and Housing Census.* Nairobi: KNBS.

Kenya Wildlife Service. (2010). *Mount Kenya National Park/Natural Forest/ Lewa Wildlife Conservancy (extension).* Retrieved from Unesco/org: www.whc.unesco.org/en/tentativelists/5510/

Kitzinger, J., & Barbour, R. S. (1999). Introduction: the challenge and promise of focus groups. In R. S. Barbour, & J. Kitzinger (Eds.), *Developing Focus Group Research : Politics, Theory and Practice* (pp. 1 - 20). London: Sage.

Kofron, C. P., & Chapman, A. (2006). Causes of mortality to the endangered Southern Cassowary Casuarius casuariusjohnsonii in Queensland, Australia. *Pacific Conservation Biology*, *12*, 175–179.

Korir, J., Muchiri, J., & Kamwea, J. (2013). Wildlife-Based Tourism, Ecology and Sustainability of Protected Areas in Kenya. *Journal of Natural Sciences Research, 3*(3), 40 - 48.

Kothari, C. R. (2004). *Research Methodology : Methods and Techniques* (2nd ed.). New Delhi: New Age International Publishers.

Krejcie, R. V., & Morgan, D. W. (1970). Determining Sample Size for Research Activities. *Education and Psychological Measurements, 30,* 607-610.

Lawrence, R. L., Daniels, S. E., & Stankey, G. H. (1997). Procedural justice and public involvement in natural resource decision-making. *Society and Natural Resources, 10*(6), 577-589.

Lee, H. (2000). Climate Change Policy and the Sustainable Future. *International Review for Environmental Strategies, 1*, 17-23.

Lehmann, J., Korstjens, A. H., & Dunbar, R. I. (2010). Apes in a changing world : The effects of global warming on the behaviour and distribution of African apes. *Journal of Biogeography, 37*(12), 2217–2231.

Lemieux, C., Beechy, J. T., & Gray, P. A. (2011). Prospects for Canada’s protected areas in an era of rapid climate change. *Land Use Policy, 28*, 928-941.

Lewis, S., Brando, P. M., Phillips, O. L., van der Heijden, G. M., & Nepstad, D. (2011). The 2010 Amazon Drought. *Science, 331*(6017), 554.

Li, C. S. (2000). Modelling trace gas emissions from agricultural ecosystems. *Nutrient Cycling in Agroecosystems*, 259-276.

Lise, W., & Tol, R. S. (2002). Impact of Climate on Tourist Demand. *Climate Change, 55*, 429-449.

Mather, S., Viner, D., & Todd, G. (2005). Climate and policy changes : Their implications for international tourism flows. In M. Hall, & J. Higham (Eds.), *Tourism, Recreation and Climate Change* (pp. 63-85). London, UK: Channelview Press.

Mbaria, J. (2004). *Destruction of Mau Forest Complex Threatens Kenya's Entire Economy*. Retrieved from Ogiek.org: http://www.ogiek.org/news/news-post-04-10-13.htm

McCarty, J. (2001). Ecological consequences of recent climate change. *Conservation Biology*, *15*(2), 320 - 331.

McFarlane, B. L., & Hunt, L. M. (2006). Environmental activism in the forest section. *Environment and Behavior, 38*, 266–285.

McGeoch, M. A., Butchart, S. H., Spear, D., Marais, E., Kleynhans, E. J., Symes, A., . . . Hoffmann, M. (2010). Global indicators of biological invasion: Species numbers, biodiversity impact and policy responses. *Diversity and Distributions, 16*(1), 95–108.

Mendes, L. M., & Santos, G. (2008). Using Economic Instruments to Address Emissions from Air Transport in the European Union. *Environment and Planning A, 40*, 189-209.

Ministry of Energy. (2004). *The Energy Bill, 2004.* Nairobi: Ministry of Energy.

Mote, P. W., Hamlet, A. F., Clark, M. P., & Lettenmaier, D. P. (2005). Declining mountain snowpack in western North America. *Bulletin of the American Meteorological Society, 86*(1), 39–49.

Mugenda, O., & Mugenda, A. (2003). *Research Methods : Quantitative and Qualitative Approaches.* Nairobi: Acts Press.

Munson, L., Terio, K. A., Kock, R., Mlengeya, T., Roelke, M. E., Dubovi, E., . . . Packer, C. (2008). Climate extremes promote fatal co-infections during canine distemper epidemics in African lions. *PLoS ONE, 3*(6), e2545.

Mutimba, S., Mayieko, S., Olum , P., & Wanyama, K. (2010). *Climate change vulnerability and adaptation preparedness in Kenya.* Nairobi: Heinrich Böll Stift ung, East and Horn of Africa.

Neumann, L. (2000). *Social Research Methods : Qualitative and Quantitative Approaches.* Massachusetts: Needham Heights.

Nicholls, R. J. (2006). Storm surges in coastal areas. In M. Arnold, R. S. Chen, U. Deichmann, M. Dilley, A. L. Lerner-Lam, R. E. Pullen, & Z. Trohanis (Eds.), *Natural disaster hotspots: case studies. Disaster risk management series* (Vol. 6, pp. 79–108). Washington, DC: The World Bank.

North American Bird Conservation Initiative, US committee. (2010). *The State of the Birds 2010 Report on Climate Change, United States of America.* Washington, DC: U.S. Department of the Interior.

Norton, B. G. (2005). *Sustainability: A Philosophy of Adaptive Ecosystem Management.* Chicago, IL: University of Chicago Press.

Norušis, M. J. (2010). *PASW Statistics 18 : Statistical Procedures Companion.* Upper Saddle River, NJ: Prentice Hall/Pearson Education.

Ohlson, D. W., McKinnon, G. A., & Hirsch, K. G. (2005). A structured decision-making approach to climate change adaptation in the forest sector. *The Forestry Chronicle, 81*(1), 97–103.

Okello, M. M., & Novelli, M. (2014). Tourism in the East African Community (EAC): Challenges, opportunities, and ways forward. *Tourism and Hospitality Research, 14*(1 - 2), 53 – 66.

Oso, W. Y., & Onen, D. (2005). *A general Guide to writing Research Proposal and Report: A handbook for beginning Researchers*. Kisumu, Kenya: Options Printers and Publishers.

Ottichilo, W. K., de Leew, J., Skidmore, A., 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*, 202–216.

Parry, M. L., Canziani, O. F., Palutikof, J. P., van der Linden, P. J., & Hanson, C. E. (2007). *Climate change 2007: impacts, adaptation, and vulnerability.* Cambridge, UK: Cambridge University Press.

Pelham, B. W. (2009, April 22nd). *Awareness, Opinions About Global Warming Vary Worldwide : Many unaware, do not necessarily blame human activities*. Retrieved July 13th, 2014, from Gallup.com: http://www.gallup.com/poll/117772/awareness-opinions-global-warming-vary-worldwide.aspx

Poth, M., & Focht, D. (1998). 15-N kinetic analysis of N2) production by Nitrosomonas europaea : An examination of nitrifier denitrification. *Applied Environmental Microbiology, 49*, 1134-1141.

Ramsar. (2010). *Reservoirs of Biodiversity. Factsheet 6.* Retrieved July 11th, 2011, from Ramsar.org: www.ramsar.org/pdf/info/services_06_e.pdf

Sasidharan, V. (2000). Climatic Change and Wildland Recreation : Examining the Changing Patterns of Wilderness Recreation in Response to the Effects of Global Climate Change and the El Niño Phenomenon. *USDA Forest Service Proceedings RMRS-P, 15*(2), 149 - 152.

Schaeffer, M., Baarsch, L., Adams, S., de Bruin, K., De Marez, L., Freitas, S., . . . Hare, B. (2013). *Africa Adaptation Gap Technical Report : Climate-change impacts, adaptation challenges and costs for Africa.* New York, NY: UNEP.

Scheelhaase, J. D., & Grimme, W. G. (2007). Emissions Trading for International Aviation : An Estimation of the Economic Impact on Selected European Airlines. *Journal of Air Transport Management, 13*, 253-263.

Scott, D., Jones, B., & Konopek, J. (2007). Implications of climate and environmental change for nature-based tourism in the Canadian Rocky Mountains : A case study of Waterton Lakes National Park. *Tourism Management, 28*, 570-579.

Shepherd, A., & Gill, K. (2010). Climate change and future flows of Rocky Mountain rivers: Converging forecasts from empirical trend projection and down-scaled global circulation modeling. *Hydrological Processes, 24*(7), 384-387.

Simpson, M. C., Gössling, S., Scott, D., Hall, C. M., & Gladin, E. (2008). *Climate Change Adaptation and Mitigation in the Tourism Sector: Frameworks, Tools and Practices.* WMO : Paris, France: UNEP, University of Oxford, UNWTO,.

Smith, S. D., Huxman, T. E., Zitzer, S. F., Charlet, T. N., Housman, D. C., Coleman, J. S., . . . Nowak, R. S. (2000). Elevated CO2 increases productivity and invasive species success in an arid ecosystem. *Nature, 408*(6808), 79–82.

Spittlehouse, D. L., & Stewart, R. B. (2003). Adapting to climate change in forest management. *Journal of Ecosystems Management, 4*, 7–17.

Stott, P. A., Tett, S. F., Jones, G. S., Allen, M. R., Mitchell, J. F., & Jenkins, G. J. (2000, December 13th). External control of 20th century temperature by natural and anthropogenic forcings. *Sceince, 3*(1), 2133-2137.

Sundt, N. (2010). *Another extreme drought hits the Amazon and raises climate change concerns.* Boston, MA: WWF Climate Blog.

Teitelbaum, S., Beckley, T., Nadeau, S., & Southcott, C. (2003). Milltown revisited: Strategies for assessing and enhancing forest-dependent community sustainability. In *Towards Sustainable Management of the Boreal Forest.* Ottawa, ON: National Research Council Research Press.

The Kenya Meteorological Department. (2011). *Mara Rainfall.* Narok: KMD.

Thomas, C. D., Cameron, A., Green, R. E., Bakkenes, M., Beaumont, L. J., & Collingham, Y. C. (2004). Extinction risk from climate change. *Nature, 427*, 145–148.

Tisdell, C. (1984). *Tourism, the environment, international trade and public economics, Asian- Australian Joint Research Project.* Canberra: Australian National University.

Tol, R. S. (2007). The Impact of Carbon Tax on International Tourism. *Transportation Research Part D, 12*, 129-142.

Trenberth, K. E., Jones, P. D., Ambenje, P., Bojariu, R., Easterling, D., Klein-Tank, A., . . . Zhai, P. (2007). Observations : Surface and atmospheric climate change. In S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, . . . H. L. Miller (Eds.), *Climate Change 2007 : The physical science basis : Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge, UK: Cambridge University Press.

Tribe, J. (2004). *The Economics of Recreation, Leisure and Tourism* (3rd ed.). Burlington, MA: Elsevier.

UNEP, FAO & UNFF. (2009). *Vital forest graphics.* Nairobi: UNEP.

United Nations. (2010). *United Nations Framework Convention on Climate Change.* New York, NY: UN.

United Nations. (2011). *Population Distribution, Urbanization, Internal Migration and Development : An International Perspective.* New York, NY: UN.

United Nations Environmental Program. (2009). *UNEP Year Book 2009: new science and developments in our changing environment.* Nairobi: UNEP.

United Nations Human Settlements Programme. (2013). *State of the World's Cities 2012/2013 : Prosperities of cities.* Nairobi, Kenya: Routledge.

United Nations World Tourism Organization. (2013). *Tourism and Biodiversity: Achieving common goals towards sustainability.* Madrid: World Tourism Organization.

University College London. (2011). *Global drought monitor.* London, UK: UCL press.

UN-OHRLLS. (2009). *The Impact of Climate Change on the Development Prospects of the Least Developed Countries and Small Island Developing States.* Landlocked Developing Countries and Small Island Developing States: United Nations Office of the High Representative for the Least Developed Countries.

Visser, M. E., van Noordwijk, A. J., Tinbergen, J. M., & Lessells, C. M. (1998). Warmer springs lead to mistimed reproduction in Great Tits (Parus major).

Proceedings of the Royal Society of London - Series B : Biological Sciences, 265(1408), 1867-1870.

Vissier, M. E., & Both, C. (2005). Shifts in phenology due to global climate change: the need for a yardstick. *Proceedings of the Royal Society B: Biological Sciences, 272*(1581), 2561–2569.

Weddell, B. J. (1996). Geographic overview: climate, phenology and disturbance regimes in steppe and desert communities. In D. M. Finch (Ed.), *Ecosystem disturbance and wildlife conservation in western grasslands – A symposium proceedings. General Technical Report RM-GTR-258* (pp. 3–12). Fort Collins, USA: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.

Weeden, C. (2005). Aqualitative approach to the ethical consumer: The use of focus groups for cognitive consumer research in tourism. In B. Ritchie, P. Burns, & C. Palmer (Eds.), *Tourism Research Methods. Integrating Theory with Practice.* Wallingford: CABI.

Westerling, A. L., Hidalgo, H. G., Cayan, D. R., & Swetnam, T. W. (2006). Warming and earlier spring increases western US forest wildlife activity. *Science, 313*(5789), 940–943.

Western, D. & Amboseli Conservation Program. (2010). *Amboseli Conservation Program.* Nairobi: ACP.

Western, D., & Maitumo, D. (2004). Woodland loss and restoration in a savanna park : A 20-year experiment. *African Journal of Ecology, 42*, 111–121.

Wilkinson, C. (2004). *Status of coral reefs of the world 2004.* Townsville, Australia: Australian Institute of Marine Science.

Williams, J. E., & Haak, A. (2011). Potential consequences of climate change to persistence of cutthroat trout populations. *North American Journal of Fisheries Management*, *29*, 533-548.

Worden, J., Mose, V., & Western, D. (2010). *Aerial census of wildlife and livestock in Eastern Kajiado.* Nairobi: Amboseli Conservation Program.

World Tourism Organization - United Nations Environmental Programme. (2008). *Climate change and tourism: Responding to global challenges.* Madrid, Spain: WTO - UNEP.

Yin, R. K. (2002). *Case Study Research : Design and Methods.* London: Sage.

Zahran, S., Brody, S. D., Grover, H., & Vedlitz, A. (2006). Climate Change Vulnerability and Policy Support. *Society & Natural Resources*, *19*(9), 771-789.

APPENDICES

Appendix I : Questionnaire For The Local Community Around Maasai Mara National Reserve

Interview Date: ………………… Questionnaire No. ………………..

Dear Respondent,

I am a student pursuing a Doctor of Philosophy degree in Tourism Management in the Department of Tourism Management of Moi University. I am carrying out a research on "**Perceived Effects of Climate Change on Tourism and Natural Resources in Protected Areas in Kenya: A Case of Maasai Mara National Reserve".** I kindly request for your participation in the study by providing information requested below. I assure you that the information hereby given will be used for academic purposes only and will be treated with utmost confidentiality.

Thank you for your participation.

Yours sincerely,

GEORGE MANONO

SECTION A: GENERAL INFORMATION (TICK WHERE APPROPRIATE)

1. Gender [01] Male [02] Female

2. Age (years) [1] Below 21 [2] 21 – 30 [3] 31 – 40[4] 41 -50 [5] Above 51

3. Level of Education [1] None [2] Primary [3] Secondary [4] College [5] University [6] Any other (specify) …………………….

4. Occupation [1] Warden [2] Ranger [3] Working with NGOs [4] County Council Member [5] Any other (specify) …………………………

5. Length of stay [1] Less than 5 years [2] 6 – 10 years [3] 11 -15 years [4] 16 – 20 years [5] Over 21 years

SECTION B: AWARENESS OF CLIMATE CHANGE

6. Have you ever heard of climate change?

   [1] Yes [2] No

7. Kindly rate your level of knowledge with respect to climate change. Please select one option.

   [1] Non-expert

   [2] Somewhat knowledgeable

   [3] Knowledgeable

   [4] Expert

8. Arrange the following causes of climate change in order of importance. Use the options:

   [1] Least important [2] Less important [3] Important [4] More important.

[1] Deforestation	1	2	3	4	5
[2] Human Settlement	1	2	3	4	5
[3] Agriculture	1	2	3	4	5
[4] Over utilization of natural resources	1	2	3	4	5
[5] Greenhouse emissions	1	2	3	4	5
[6] Construction of infrastructure	1	2	3	4	5
[7] Over harvesting of indigenous trees	1	2	3	4	5

[8] Any other? Specify…………………………………………………………….

SECTION C: EFFECT OF CLIMATE CHANGE ON ANIMALS

9. Are wild animals with Maasai Mara National Reserve currently affected by climate changes related impacts? [1] Yes [2] No

10. If yeas in 9 above, please complete the following questions. Please tick any impact being observed:

    [1] Changes in animal population

    [2] Changes in species diversity

    [3] Changes in species composition

    [4] Extinction of animal species

    [5] Changes in migration routes

    [6] Changes in migration patterns

    [7] Changes in animal migration species

    [8] Changes in breeding grounds

    [9] Changes in animal infections

    [10] Increased animal deaths

    [11] Any other? Specify …………………………………………………

11. How significant are climate change effects on the following. Please select one of the following options: [1] unimportant [2] Slightly important [3] Important [4] Very important

[1] Changes in animal population

[2] Changes in species diversity

[3] Changes in species composition

[4] Extinction of animal species

[5] Changes in migration species

[6] Changes in breeding grounds

[7] Changes in animal migration species

[8] Changes in breeding grounds

[9] Changes in animal infections

[10] Increased animal deaths

12. How much do you agree with the following statements? Please select one of the following options: 1. Strongly disagree 2. Disagree 3. Neither 4. Agree 5. Strongly agree

[1] Climate change will completely alter management of animals in Maasai Mara

National Reserve over the next 10 years.

[2] Climate change will completely alter 1 2 3 4 5

Management of animals in MMRN over the

Next 25 years. 1 2 3 4 5

SECTION D: EFFECT OF CLIMATE CHANGE ON PLANTS

13. Are plants within Maasai Mara National Reserve currently affected by climate change related effects?

    [1] Yes [2] No

14. If yes in 13 above, please complete the following questions. Tick any effect being observed:

    [1] Changes in plant species diversity

    [2] Changes in plant species composition

    [3] Changes in plant species distribution patterns

    [4] Emergence of alien plant species

    [5] Extinction of plant species

    [6] Changes in plants' adaptations strategies

    [7] Changes in vegetation cover

    [8] Any other? Specify ……………………………………………………

15. How significant is the effect of climate change having on the following? Please select one of the following options: 1. Unimportant 2. Slightly important 3. Important

    4. Very important.

[1] Changes in plant species diversity	1	2	3	4	5
[2] Changes in plant species composition	1	2	3	4	5
[3] Changes in plant species distribution patterns	1	2	3	4	5
[4] Emergence of alien plant species	1	2	3	4	5
[5] Extinction of plant species	1	2	3	4	5

[6] Changes in plants' adaptations strategies	1	2	3	4	5
[7] Changes in vegetation cover	1	2	3	4	5

16. How much do you agree with the following statements? Please select one of the following options: 1. Stronglydisagree 2. Disagree 3. Neither 4. Agree 5. Strongly agree.

[1] Climate change will completely alter management of plants in Maasai Mara National Reserve over the next 10 years.	1	2	3	4	5
[2] Climate change will completely alter management of plants in Maasai Mara National Reserve over the next 25 years.	1	2	3	4	5

17. Is the quantity of surface water within Maasai Mara National Reserve affected by climate change related impacts? [1] Yes [2] No

18. If yeas in 17 above, please complete the following questions. Please tick any effect being observed:

[1] Changes in amount of rainfall

[2] Changes in duration of rainfall

[3] Changes in rainfall seasons/patterns

[4] Changes in availability of fresh water

[5] Changes in water level in Mara River and its tributaries

19. How significant is the effect of climate change having on the following? Please select one of the following options: 1. Unimportant 2. Slightly important 3. Important 4. Very important.

[1] Changes in amount of rainfall	1	2	3	4
[2] Changes in duration of rainfall	1	2	3	4
[3] Changes in rainfall seasons/patterns	1	2	3	4
[4] Changes in availability of fresh water	1	2	3	4
[5] Changes in water level in Mara River and its tributaries	1	2	3	4

20. How much do you agree with the following statements? Please select one of the following options: 1. Strongly disagree 2. Disagree 3. Neither 4. Agree 5. Strongly agree

[1] Climate change will completely alter quantity of Surface water in Maasai Mara National Reserve Over the next 10 years.	1	2	3	4
[2] Climate change will completely alter the quantity Of surface water in Maasai Mara National Reserve Over the next 25 years.	1	2	3	4

SECTION F: EFFECT OF CLIMATE CHANGE ON TOURISTS' ACTIVITIES

21. Are the tourists' activities within Maasai Mara National Reserve currently affected by climate change related impacts:[1] Yes [2] No

22. If yes in 21 above, please complete the following questions. Please tick any effect being observed:

    [1] Changes in visitors' numbers

    [2] Changes in visitation patterns

    [3] Changes in tourists' activity diversity

    [4] Changes in tourists' activity patterns

    [5] Any other? Specify…………………………………………………………

23. How significant is the effect climate change is having on the following? Please select one of the following options: 1. Unimportant 2. Slightly important 3. Important 4. Very important.

[1] Changes in visitor numbers	1	2	3	4
[2] Changes in visitation patterns	1	2	3	4
[3] Changes in tourists' activity diversity	1	2	3	4
[4] Changes in tourists' activity patterns	1	2	3	4

24. How much do you agree with the following statements? Please select one of the following options: 1. Strongly disagree 2. Disagree 3. Neither 4. Agree 5. Strongly Agree

[1] Climate change will completely alter tourists' activities in Maasai Mara National Reserve over the next 10 years.	1	2	3	4
[2] Climate change will completely alter tourists' activities in Maasai Mara National Reserve over the next 25 years.	1	2	3	4
[3] Climate change will completely alter overall visitation levels in Maasai Mara National Reserve over the next 25 years.	1	2	3	4

SECTION G: GENERAL COMMENTS

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

Appendix II : Questionnaire for the staff of Maasai Mara National Reserve

DATE: ………………… QUESTIONNAIRE NO. ………………..

Dear Respondent,

I am a student pursuing a Doctor of Philosophy degree in Tourism Management in the Department of Tourism Management of Moi University. I am carrying out a research on "**Perceived Effects of Climate Change on Tourism and Natural Resources in Protected Areas in Kenya: A Case of Maasai Mara National Reserve."** I kindly request for your participation in the study by providing information requested below. I assure you that the information hereby given will be used for academic purposes only and will be treated with utmost confidentiality.

Thank you for your participation.

SECTION A: GENERAL INFORMATION (TICK WHERE APPROPRIATE)

1. Gender [01] Male [02] Female
2. Age (years) [1] Below 21 [2] 21 – 30 [3] 31 – 40[4] 41 -50 [5] Above 51
3. Level of Education [1] None [2] Primary [3] Secondary [4] College [5] University [6] Any other (specify) …………………….
4. Occupation [1] Warden [2] Ranger [3] Working with NGOs
   [4] County Council Member [5] Any other (specify) …………………………
5. Length of stay [1] Less than 5 years [2] 6 – 10 years [3] 11 -15 years
   [4] 16 – 20 years [5] Over 21 years

SECTION B: AWARENESS OF CLIMATE CHANGE

6. Have you ever heard of the term climate change or climate change?

   [1] Yes [2] No

7. Kindly rate your level of knowledge with respect to climate change. Please select one option.

   [1] Non-expert

   [2] Somewhat knowledgeable

   [3] Knowledgeable

   [4] Expert

8. Arrange the following causes of climate change in order of importance. Use the options:

   [1] Least important [2] Less important [3] Important [4] More important.

[1] Deforestation	1	2	3	4	5
[2] Human Settlement	1	2	3	4	5
[3] Agriculture	1	2	3	4	5
[4] Over utilization of natural resources	1	2	3	4	5
[5] Greenhouse emissions	1	2	3	4	5
[6] Construction of infrastructure	1	2	3	4	5
[7] Over harvesting of indigenous trees	1	2	3	4	5

[8] Any other? Specify………………………………………………………….

SECTION C: EFFECT OF CLIMATE CHANGE ON ANIMALS

9. Are wild animals with Maasai Mara National Reserve currently affected by climate changes related impacts? [1] Yes [2] No

10. If yeas in 9 above, please complete the following questions. Please tick any effect being observed:

    [1] Changes in animal population

    [2] Changes in species diversity

    [3] Changes in species composition

    [4] Extinction of animal species

    [5] Changes in migration routes

    [6] Changes in migration patterns

    [7] Changes in animal migration species

    [8] Changes in breeding grounds

    [9] Changes in animal infections

    [10] Increased animal deaths

    [11] Any other? Specify ……………………………………………………………

11. How significant are climate change effect on the following. Please select one of the following options: [1] unimportant [2] Slightly important [3] Important [4] Very important

[1] Changes in animal population

[2] Changes in species diversity

[3] Changes in species composition

[4] Extinction of animal species

[5] Changes in migration species

[6] Changes in breeding grounds

[7] Changes in animal migration species

[8] Changes in breeding grounds

[9] Changes in animal infections

[10] Increased animal deaths

12. How much do you agree with the following statements? Please select one of the following options: 1. Strongly disagree 2. Disagree 3. Neither 4. Agree 5. Strongly agree

[1] Climate change will completely alter management of animals in Maasai Mara

National Reserve over the next 10 years.

[2] Climate change will completely alter	1	2	3	4	5
Management of animals in MMRN over the					
Next 25 years.	1	2	3	4	5

SECTION D: EFFECT OF CLIMATE CHANGE ON PLANTS

13. Are plants within Maasai Mara National Reserve currently affected by climate change related impacts?

[1] Yes [2] No

14. If yes in 13 above, please complete the following questions. Tick any effect being observed:

[1] Changes in plant species diversity

[2] Changes in plant species composition

[3] Changes in plant species distribution patterns

[4] Emergence of alien plant species

[5] Extinction of plant species

[6] Changes in plants' adaptations strategies

[7] Changes in vegetation cover

[8] Any other? Specify ……………………………………………………

15. How significant is the effect of climate change having on the following? Please select one of the following options: 1. Unimportant 2. Slightly important 3. Important 4. Very important.

[1] Changes in plant species diversity	1	2	3	4	5
[2] Changes in plant species composition	1	2	3	4	5
[3] Changes in plant species distribution patterns	1	2	3	4	5
[4] Emergence of alien plant species	1	2	3	4	5
[5] Extinction of plant species	1	2	3	4	5
[6] Changes in plants' adaptations strategies	1	2	3	4	5
[7] Changes in vegetation cover	1	2	3	4	5

16. How much do you agree with the following statements? Please select one of the following options: 1. Strongly disagree 2. Disagree 3. Neither 4. Agree 5. Strongly agree.

[1] Climate change will completely alter management of plants in Maasai Mara National Reserve over the next 10 years.	1	2	3	4	5

[2] Climate change will completely alter management of plants in Maasai Mara National Reserve over the next 25 years. 1 2 3 4 5

17. Is the quantity of surface water within Maasai Mara National Reserve affected by climate change related effect? [1] Yes [2] No

18. If year in 17 above, please complete the following questions. Please tick any effect being observed:

    [1] Changes in amount of rainfall

    [2] Changes in duration of rainfall

    [3] Changes in rainfall seasons/patterns

    [4] Changes in availability of fresh water

    [5] Changes in water level in Mara River and its tributaries

19. How significant is the effect of climate change having on the following? Please select one of the following options: 1. Unimportant 2. Slightly important 3. Important 4. Very important.

[1] Changes in amount of rainfall	1	2	3	4
[2] Changes in duration of rainfall	1	2	3	4
[3] Changes in rainfall seasons/patterns	1	2	3	4
[4] Changes in availability of fresh water	1	2	3	4
[5] Changes in water level in Mara River and its tributaries	1	2	3	4

20. How much do you agree with the following statements? Please select one of the following options: 1. Strongly disagree 2. Disagree 3. Neither 4. Agree 5. Strongly agree

[1] Climate change will completely alter quantity of
Surface water in Maasai Mara National Reserve
Over the next 10 years. 1 2 3 4

[2] Climate change will completely alter the quantity
Of surface water in Maasai Mara National Reserve 1 2 3 4
Over the next 25 years.

SECTION F: EFFECT OF CLIMATE CHANGE ON TOURISTS' ACTIVITIES

21. Are the tourists' activities within Maasai Mara National Reserve currently affected by climate change related effects:[1] Yes [2] No

22. If yes in 21 above, please complete the following questions. Please tick any impact being observed:

    [1] Changes in visitors' numbers

    [2] Changes in visitation patterns

    [3] Changes in tourists' activity diversity

    [4] Changes in tourists' activity patterns

    [5] Any other? Specify……………………………………………………………

23. How significant is the effect climate change is having on the following? Please select one of the following options: 1. Unimportant 2. Slightly important 3. Important 4. Very important.

[1] Changes in visitor numbers	1	2	3	4
[2] Changes in visitation patterns	1	2	3	4
[3] Changes in tourists' activity diversity	1	2	3	4
[4] Changes in tourists' activity patterns	1	2	3	4

24. How much do you agree with the following statements? Please select one of the following options: 1. Strongly disagree 2. Disagree 3. Neither 4. Agree 5. Strongly Agree

[1] Climate change will completely alter tourists' activities in Maasai Mara National Reserve over the next 10 years.	1	2	3	4
[2] Climate change will completely alter tourists' activities in Maasai Mara National Reserve over the next 25 years.	1	2	3	4
[3] Climate change will completely alter overall visitation levels in Maasai Mara National Reserve over the next 25 years.	1	2	3	4

SECTION G: GENERAL COMMENTS

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

SECTION H: ADAPTIONS TO CLIMATE CHANGE

25. Has the nature and scale of climate change's impacts been investigated through research?

[1] Yes [2] No

26. If yes in 25 above, who has conducted this study?

1. Non-Governmental Organizations

2. University Researchers

3. Consultants

4. Any other? Specify ---

27. Is any response being taken or being considered to deal with any of the identified climate change's related impacts?

[1] Yes [2] No

28. If Yes, identify the specific climate change response being undertaken or being considered.

Please use the option: 1-Response being undertaken 2- Response being considered

Legislation	1	2
Planning	1	2
Design of protected area	1	2
Research, monitoring and reporting	1	2
Education and interpretation	1	2
Extension and outreach	1	2

Any other? Specify …………………………………………………………..

29. Do you have a climate change adaption strategy(ies)

Yes ( ) No ( )

30. Indicate the response that best represents your view on each of the following statements.

Please select one of the following options: 1 – Strongly disagree; 2- Disagree; 3- Neither

4-Agree; 5-Strongly agree\

[1] There is a need for more research on the impact Of climate change	1	2	3	4	5
[2] Detecting and monitoring climate change should be A priority for protected areas management	1	2	3	4	5
[3] There are too many uncertainties regarding climate Change to develop adaption strategies for Protected Areas	1	2	3	4	5

31. Do you monitor climate change impacts?

[1] Yes [2] No

32. If Yes in 31 above, list some of the monitoring initiatives

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

33. Do you have specific climate change indicators for monitoring climate change?

[1] Yes [2]No

34. If yes in 33 above list some of the indicators

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

35. Rate the level of information your protected area would require on climate change related topics. Use the following options:

1- No more information; 2- some more information; 3- much more information

[1] Detecting climate changes	1	2	3
[2] Ecological consequences of climate change	1	2	3
[3] Impacts of climate change on tourists visitations	1	2	3
[4] Impacts of climate change on planning and management	1	2	3
[5] Strategies for managerial response to climate change	1	2	3
[6] Ways of communicating facts sequences and solutions To climate change	1	2	3

[7] Any other? Specify --

37. Would you be willing to participate in working group on climate change and protected areas?

[1] Yes [2] No

SECTION H: GENERAL COMMENTS

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

…………………………… ……………………………………………………………….