

**FACTORS INFLUENCING HUMAN-ELEPHANT CONFLICTS IN EMBU NORTH
SUB-COUNTY, KENYA**

BY

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DECLARATION

This research project document is my original work and has not been submitted for a degree or any award in any other University.

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DEDICATION

This research project report is dedicated to my family especially my late father, Fred Wenya, for their love, support and encouragement during this study.

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ABBREVIATIONS AND ACRONYMS

KWS	Kenya Wildlife Service
HEC	Human Elephant Conflicts
HWC	Human Wildlife Conflicts
IUCN	International Union for Conservation of Nature
MKNP	Mount Kenya National Park
UNEP	United Nations Environmental Programme
KFS	Kenya Forest Service
MOU	Memorandum Of Understanding
FAO	Food Agriculture Organization

ABSTRACT

Mount Kenya has 900 km² of human settlements that adjoins the periphery of the Mount Kenya Forest Reserve in a 2 - 10 Km wide belt, and extended from the town of Nanyuki in the northern part towards the south and then eastward to the border between Embu and Meru South Districts. Wildlife forms a great part of Kenyan economy in terms of foreign exchange and good relations locally regionally and internationally. It's of importance that of the big five in Kenya, we have elephant, *Loxodonta Africana Africana*. Human wildlife conflicts have been one of greatest threats to conservation since it has led to retaliatory killings, negative perceptions of wildlife, loss of crops, human injuries, human deaths and poaching. There are farm practices that have fueled these conflicts where there are some crops like maize and cassava that have been proved to attract wildlife, in particular elephants to them. The farm practices like shamba system where farmers do crop farming in the forests have also led to encounters with the wildlife hence in the event there are bound to be conflicts due to intrusion. Wildlife barriers like electric fence, trenches and buffer zones are the indicators which when considered would have an impact to human wildlife conflicts. Human encroachment basically through the land use systems have had a major impact in reducing the elephant habitat which results to raids and crop destruction. Elephant encroachment on humans and crops has contributed to adaptive and reactive situations in and around protected areas. This study used descriptive research design targeting particularly the communities and households that live in Embu north and borders the Mount Kenya National reserve boundary for the factors that influence human elephant conflicts, (HEC) in that area. The results of 382 respondents were subjected to analysis with the focus on factors influencing HEC in Embu North Sub County. The results revealed that the population is aware of different types of barriers and fences are the most known to them at 76%. The respondents also acknowledged at 78% that poaching was the main contribution to HEC. This study also shows that over 90% of the communities around the protected area are sedentary farmers and 86% confirmed they used traditional methods to mitigate HEC in the project area. Damage to crops was higher than human injuries and they confirmed they reported to authorities whenever they were affected by the destructions or injuries. Embu stretch that boards the mountain is 26 Kilometres and the terrain is not uniform but with domination of valleys. In coming up with mitigation measures this study spells out options both in human approaches and physical barriers to curb the HEC. The results would be used for more research and for policy makers to implement recommendations.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Kenya's Vision 2030 is the country's new development covering the period 2008 to 2030 and its social pillar emphasizes on widespread prosperity that involves the building of a just and cohesive society that enjoys equitable social development in a clean and secure environment. This quest is the basis of transformation in eight key social sectors, namely: Education and Training; Health; Water and Sanitation; the Environment; Housing and Urbanisation. Human–elephant conflict (HEC) refers to the negative interactions between humans and elephants. Some of the negative effects of elephants on humans include crop-raiding, deaths and injuries to humans, and to livestock (Tchamba, 1995)

Elephants in the world are not confined to National Parks and Reserves (Douglas-Hamilton I, 1998). Hence, interactions with farmers, and specifically crop raiding by elephants targeting fields, pose serious social, political, economic and conservation problems. Historical accounts in Africa, Australia, Europe, Asia and America reveal not only the global nature of the practice, but also the changes in Fences (chili and electric) were the most effective at reducing the probability of damage to crops, followed by spotlights and fire. When either of these methods was used in combination with noise their efficacy was reduced, with the most pronounced negative effect seen with fences and spotlights. Mount Kenya is a global significance as a Man and Biosphere Reserve complex, a World Heritage Site and a region of significance conservation interest, a systematic approach to the conservation of the landscape is long overdue One of the major tasks of KWS is to protect people and their property against wild animals. The organization's failure to attain this goal is the chief cause of indignation that characterizes its relationship with communities neighboring wildlife protected areas. To minimize human-wildlife conflicts and to improve its relations with local communities, KWS has undertaken to fence off a number of wildlife protection areas. Indeed, the organization has been recognized as a world leader in wildlife power fencing by being among the first in the world to use modern high powered electric fencing around the country's wildlife protection areas.

Crop raiding frequently occurs at night and is occurs when elephants destroy crops, a behavior known as typically thought to involve male elephants. Accordingly, research efforts are now focused on finding effective farmer-managed deterrents that are both socially and economically suitable especially in ‘conflict’ zones where effective electric fences to separate humans from elephants are neither feasible nor affordable (Osborn & Parker, 2002). Recent continuous killing of the big five especially the elephant and rhinos in solio ranch, of abadares national park and in laikipia national park has been a serious national and international issue. The president of the republic of Kenya gave a warning in public that communities living around protected areas should work together with conservationists to avert poaching. Community members living in and around our northern Kenyan study sites tell anecdotes of elephants being ‘afraid’ of bees. Douglas-Hamilton I, 1998, experimentally tested this concept by deploying beehives in a frequently visited bush area and demonstrated that elephants avoid feeding on acacia trees hosting hives (both empty and full) of the African honeybee.

Sustained political and media interest in the problem presents a considerable challenge to *in-situ* conservation of elephants. For these reasons it is critical to identify where and why HEC occurs to avoid or prevent human–wildlife conflict, such as the curfews on school children created by the presence of elephants on or near to roads leading to schools (Hill, 2004). People often respond to these direct and indirect costs by actions such as injuring or killing animals, creating conflicts with wildlife authorities (Woodroffe *et al.*, 2005) or management interventions to control animal movement, such as fences. Enforcement of Shamba System regulations and a replanting programme by the Forest Department and some community groups was instrumental in achieving a significant reverse in plantation backlogs as recorded in 1999. The change in management has only been in place for three years and the major decrease in threats to the forest is due primarily to the efforts of Kenya Wildlife Service in protecting an area that had hitherto seen unrestricted and uncontrolled exploitation. Further strengthening of this capacity remains a high priority, particularly with regard to charcoal production and protection of wildlife from poaching.

1.2 Statement of the Problem

According to (WWF 2007b) human wildlife conflicts have an effect both to human beings and wild animals with the main battle ground being the habitat which is a scarce resource with

increasing populations of people. While it is widely recognized that in most cases elephants do not inflict the most damage to subsistence agriculture, they are generally identified as the greatest threat to African farmers. In the densely populated Caprivi region of Namibia, a population of 5 000 elephants – one of the largest free-ranging population of elephants – was responsible for twice as many aggressions as lions in the 1990s, and attacked over a larger area (O’Connell-Rodwell *et al.*, 2000). In Africa, conflict between wildlife and local communities has inevitably increased (Muruthi, 2005). This is perfectly illustrated by the conflict between humans and elephants. It is estimated that about 80 percent of elephant range lies outside protected areas. This habitat is rapidly being eliminated and fragmented by intensified agriculture, and is resulting in one of the most serious human-wildlife conflicts.

In Cameroon, of 236 herders questioned from 10 different villages along the borders of Waza National Park, 50 percent had a negative perception of lions Bauer (2003b). In the Niger, 81.5 percent of 154 people questioned between 2000 and 2006 in 87 villages in the peripheral zone of the W transboundary Park had a negative attitude towards predators, and 14 percent confirmed that they would kill predators (Hamissou and di Silvestre, 2008). Some particularly palatable food items can attract wildlife over rather long distances. This is the case for some crops. For instance, according to Barnes *et al.* (2003), of the crops planted outside the Kakum National Park in Ghana, maize and cassava particularly attract elephants. Maize is also the crop most frequently raided in the area around the Djona hunting zone in North Benin. It is raided twice as often as cotton, and far more often than groundnut and millet. Nuisance encounters with small animals, exposure to zoonotic diseases, physical injury or even death caused by attacks by large animals have high financial costs for individuals and society in the form of medical treatments. Nocturnal surveillance of fields results in a higher exposure to malaria (WWF, 2005).

In Mount Kenya which is a park and a national reserve has several wildlife species dwelling there including the elephant (*Loxodonta africana africana*). There have been reported incidences of crop raids, human injuries and human deaths caused by these conflicts majorly contributed by human encroachment (Jodi, *et al.*, 2006). Embu North Sub County borders the National Park and there are communities that live close to the buffer zone, Nyayo Tea Zone. They depend on the forest for firewood, honey, herbal medicine, grazing cattle and for water intakes maintenance. Its in the same forest that we have wildlife which roam around for

search of feeds and prey. This study intends to evaluate the factors influencing human elephant conflicts in Embu North Sub County.

1.3 Purpose of the study

The purpose of the study was to examine the factors influencing human elephant conflicts in Embu North Sub County in Embu County.

1.4 Objectives of the study

The following were the objectives of the study:

1. To establish how wildlife barriers influences human elephant conflicts in Embu North Sub County in Embu County
2. To determine the extent to which human encroachment in the forest ecosystem influences human elephant conflicts in Embu North Sub County in Embu County
3. To determine the extent to which elephant encroachment on crops and humans influence human elephant conflicts in Embu North Sub County in Embu County

1.5 Research Questions

The following are the research questions that will be answered by the study:

1. How does a wildlife barrier influence human elephant conflicts in Embu North Sub County in Embu County?
2. To what extent does human encroachment in the forest ecosystem influence human elephant t conflicts in Embu North Sub County in Embu County?
3. To what extent does elephant encroachment on crops and humans influence human elephant conflicts in Embu North Sub County in Embu County?

1.6 Significance of the study

This study is of importance to different individuals who include: The communities around the forest to understand the strategies of dealing with the elephants when they attack them; To policy makers in Embu county government to make decisions on the way forward to ensure communities especially the ones closer to the forest live in harmony with the wildlife especially the elephants.

1.7 Limitation of the study

Considering the project area coverage, this study will be carried in seven locations on the boarder of Mt. Kenya forest within the time limit and available resources.

1.8 Delimitation of the study

The findings of the study are limited to the factors influencing the human elephants conflicts only in Embu North Sub-County area. This project area has the highest biodiversity of elephants in Embu County that boarders Mount Kenya forest ecosystem. The target population for the study was all the residents of the area.

1.9 Basic assumptions

This research assumed that the respondents would avail themselves for the study and they would give honest and unbiased answers.

1.10 Definition of significant terms used in the study

Wildlife barriers- these are built structures like fences, trenches or other obstacles that restrain or obstruct access

Human encroachment in the forest ecosystem- Where people or human beings intrude in an area that is large chiefly with trees where there is interaction between organisms and the physical environment.

Human elephant conflicts- This is conflict through competition between human and elephants for limited space, destruction of crops and killing/injury of people by elephants.

Elephant encroachment on crops and human- These are the effects or the consequences that occur as a result of elephant raid on farm lands and or injuries/attacks the elephant causes to humans

1.11 Organization of the study

This study is organized in five chapters. Chapter One is the Introduction and offers the background of the study, statement of the problem and the objectives of the study among other preliminary topics. Chapter Two is on literature review and presents both a theoretical and a conceptual framework on which the study is based. Chapter Three offers the research methodology while Chapter Four in on data analysis, presentation and interpretation. Finally,

Chapter Five presents a summary of the main findings of the study, discusses these against what appears in literature and also offers a conclusions and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter discusses the available literature on human elephant conflict focusing infrastructure, human encroachment in the forest ecosystem, socio economic factors and the human elephant conflicts. It also contains the theoretical review and the conceptual framework.

2.2 Human elephant conflicts

Human–elephant conflict is increasingly jeopardizing elephant conservation as many elephants are killed by wildlife authorities in attempts to reduce conflict (Omondi *et al.*, 2004). Elephants are also killed illegally by local people in response to destruction of their crops and deaths and injuries to their livestock (Omondi *et al.*, 2004). In Kenya, for example, 130 elephants were killed in HEC situations between 1990 and 1993 where as elephants killed 108 people during the same period (Kiiru, 1995). In the Tsavo-Amboseli area inKenya, 15 people were killed and 24 injured by elephants between 1993 and 2004(Kioko *et al.*, 2006). In the same area during the same period, 44 elephants were killed (Kioko *et al.*, 2006).

Electric fences are increasingly being used to reduce crop damage by elephants (Andau &Payne 1992; Thouless & Sakwa, 1995).The fences act as physical as well as psychological barriers to separate elephants from settled areas. In Kenya, more than 1200 km of electric fencing has been installed to protect farmlands from elephants and an additional 1300km offencing is planned (Omondi *et al.*, 2004). Electric fences are expensive to install and maintain, most community fence projects in Africa are funded externally or by corporations.While electric fences are considered effective in reducing crop-raiding Hoare (2003), literature on the use of electric fencing to manage crop-raiding by elephants suggest that a number of factors including fence design, voltage, maintenance, elephant pressure, and behaviour may influence their success (Seidensticker, 1984; Thouless & Sakwa, 1995;Garai & Carr, 2001 and Hoare, 2003). Considering the high installation and maintenance cost of

electric fencing, there is a need for more research to establish the factors that determine the effectiveness of electric fences in deterring elephant from crop-raiding (Graham *et.al.*, 2009).

Elephants in Kenya are not confined to National Parks and Reserves (Douglas, Krink & Vollrath, 2005), and research efforts are now focused on finding effective farmer-managed deterrents that are both socially and economically suitable; especially in 'conflict' zones where effective electric fences to separate humans from elephants are neither feasible nor affordable (Osborn & Parker, 2003; Omondi, Bitok & Kagiri, 2004). Such methods have included the use of African honeybees, *Apis mellifera scutellata* in northern Kenya and in some parts of Laikipia (Lucy *et al.*, 2009) and chilly ropes in and around Masai Mara and Amboseli national park (Lucy *et al.*, 2009).

2.2.1 Elephant Habitats And Populations

Elephants are extremely adaptable, occupying a variety of habitats from desert to savanna, to gallery forest (Lausen & Bekoff 1978). Environmental factors affect elephant population dynamics, home range, migration patterns, diet, group size, and composition; all of which can vary tremendously, in turn influencing the dynamics of elephants and their habitats (Kangwana, 1996). An elephant's diet may include grass, herbs, bark, fruit and tree foliage. In savanna habitats, grass, may make up 70% of the elephants' diet in the wet season, with larger proportions of browse contributing to their diet as the dry season progresses. Estimates for mean daily intake range from 4% (Laws *et al.*, 1970) to 7% of body weight, with lactating females consuming proportionately higher quantities (Laws *et al.*, 1970). Elephants digest only 40% of what they consume.

Elephants are capable of greatly affecting the structure of vegetation and perhaps animal communities (Laws *et al.*, 1970). At high densities elephants reduce woodlands, converting them to more open grassland (Laws *et al.*, 1970). In many areas human expansion and poaching have forced elephants to alter traditional migration patterns and concentrate in protected areas (Western, 1989 & Poole *et al.*, 1992). At high densities, particularly where they have been compressed into protected areas, elephants can reduce biological diversity (Western, 1989).

In some cases the reduction of woody vegetation has been beneficial in opening up tsetse fly infested woodland and transforming bushland to grassland for grazers (Western, 1989). Often fire or logging may initiate change with elephants playing a maintaining role (Dublin *et al.*, 1990). As a keystone species, elephants will influence the distribution of other mammalian

species in a given ecosystem (Western, 1989). Other studies have also established that water availability and distribution are the most important factors affecting or limiting elephant local movement (Laws, 1970). The elephant distribution and habitat selection coincide with seasonal climatic changes and the corresponding changes in food and water availability (Viljoen, 1989). The seasonal use of habitat is probably an important mechanism of survival and optimum utilization of resources, while at the same time reducing the impact on dry season habitat (Viljoen, 1989).

Mount Kenya elephant population used to exhibit these seasonal movements (Chira, 2002). These movements probably conferred recovery time for vegetation resulting in reduced damage on vegetation in the reserve. Curtailment of these movements by the fence and subsequent increase in elephant density in the reserve may in the future exacerbate elephant impact on vegetation (Chira, 2002). However, currently there are no signs of serious elephant related impacts on vegetation as evidenced by high proportion of seedlings (<1m) woody plants (Chira, 2003). The animals use the riverine vegetation as well as other vegetation types further away probably due to accessibility of water along the Thuci and Thambana rivers during the dry season.

IUCN's African Elephant Status Report 2007, (Blanc *et al.*, 2007) says there are between 470,000 and 690,000 African elephants in the wild. By far, the largest populations are now found in southern and eastern Africa, which together account for the majority of the continental population. According to a recent analysis by IUCN'S experts, most major populations in eastern and southern Africa are stable or have been steadily increasing since the mid-1990s, at an average rate of 4.5% per year (Blanc *et al.*, 2007). Kenya's elephant population was reduced from 167,000 in 1973 to 20,000 individuals in 1989 due to massive poaching for the ivory (Litoroh *et. al.*, 2012). As a result of the ivory trade ban in 1989 and increased security efforts by KWS, poaching was significantly reduced by the 1990s (Litoroh *et. al.*, 2012). The elephant range in Kenya covers almost a fifth of the country of which almost half is within protected areas. The subsequent increase in elephant numbers coupled with loss and fragmentation of elephant range, as a result of human population increase and limited long term land use planning, has brought new management challenges. These challenges arise from conflicts between people and elephants as they compete for limited resources and habitat degradation by elephants due to confinement (Litoroh *et. al.*, 2012).

Small and fragmented populations are of concern because the probability of extinction increases exponentially with decreasing population size or with decrease in area occupied by a population (Burkey, 1989 and Hanski, 1999). Populations are more likely to survive in contiguous tracts than when subdivided (Burkey, 1989). Fragmentation may, however, improve the survival of a protected sub-population when a population is heavily persecuted.

Small populations are at risk of inbreeding depression and even in larger populations there can be a gradual loss of genetic variability (Franklin, 1980).

Movement between population fragments is important for species that need large areas. This may be the case for elephants and many African conservation areas may be spaced too widely apart to allow interchange (Siegfried *et al.*, 1998). Increased migration is however, not always beneficial for population persistence in fragmented populations.

2.2.2 Perception of Communities Living Adjacent to Wildlife Conservation Areas

Recent studies have indicated that the majority of the local people around protected areas are having negative feelings about state policies and conservation programmes (Roselyne, 2010). The alienation of grazing land for the exclusive use of wildlife and tourists has a very direct impact upon the local communities, and prompts them to raise questions about the wildlife policy. There is the perception in many local communities that the protection of wildlife leads to a 'people versus animals' scenario. Nevertheless, large areas of pastoral rangelands have been expropriated for exclusive wildlife conservation use (Roselyne, 2010). Wildlife-human conflicts are a consequence of the problem of resource utilisation in conservation areas. Such conflicts do not solve this problem but adversely affect the biodiversity. They harm people and property, and lead to the retaliatory killing of wildlife, in 82% of the protected areas in Kenya (Roselyne, 2010). The rise in human-wildlife conflict could evolve into a major crisis if a solution is not immediately found (Ogodo, 2003). Human-elephant conflict is emerging as the major threat to elephant conservation in Kenya. Its effective mitigation along with enhanced security will require dedicated effort from KWS, relevant government departments, private landholders, communities, county councils, and local and international partners (Litoroh *et al.*, 2012).

The lands outside the parks are crucial to wildlife since they serve as dispersal areas or buffer zones. These areas are threatened with increasing 'land sub-division, agricultural expansion and unplanned development of tourist accommodation, thus increasing human-wildlife

conflicts' Sindiga (1999). Amboseli and Maasai Mara provide a good case to examine conflicts between wildlife conservation and local people. The cases provide lessons not only on conflict resolution in conservation but also on the necessity of local support for successful tourism-led conservation Ogodo (2003). The presence of wildlife which has a capacity to live with many diseases without serious impact on their populations is a constant source of frustration to local livestock-keeping. Also, wild animals make cultivation impossible by destroying crops in the fields. Wildlife in many protected areas is under threat from human encroachment, poaching for commercial or subsistence purposes, habitat degradation, encroachment of incompatible land uses, loss of migration and dispersal corridors and areas, and ever increasing human-wildlife conflicts (Bruner *et al.*, 2001).

In a scenario where wildlife-induced damages to human property and life are neither controlled nor compensated, negative local attitudes towards conservation and wildlife resources become entrenched (Okello and Wishitemi, 2006). This is made worse when local communities do not benefit from wildlife resources and are alienated from wildlife-related economic enterprises such as the lucrative tourism industry. When local communities feel that both governments and conservation stakeholders value wildlife more than their lives, livelihoods, or their aspirations; retaliation and opposition to conservation initiatives can be swift and uncompromising. One solution to this is to empower communities to manage and benefit from wildlife resources found in communal group ranch dispersal areas. These sanctuaries, for most cases in Kenya, have the tourists in mind as key clients (Bruner *et al.*, 2001).

2.3 Wildlife barriers in protected areas

Barrier fences have been used to control problematic wildlife species since ancient times. Spotlights and fences are static or directional methods, compared to noise which generally involves the whole village shouting and creating a commotion, which is less directional and could be disorientating to elephants. The compromised efficacy of interventions when used with noise could be because noise caused the elephants to panic, perhaps split up or react more erratically and in doing so damage a greater area of the field in their attempts to escape. Elephants reacting to a directional and relatively static deterrent such as ground fire, fences, or a spotlight might react more calmly, moving away from the deterrent in a more controlled manner as a whole herd (Thouless, 1995). Villagers report that traditional methods, such as

fire and noise, are losing their effectiveness, which could be a reflection of the decreased efficacy of noise when used in conjunction with other methods. These methods were employed during the majority of incidents, increasing the likelihood of eventual habituation. Chili smoke was not effective at preventing damage to crops, perhaps due to the requirement that the wind blew in the right direction toward the elephants.

Enabling communities to defend their crops only addresses the symptoms of conflict and not the underlying cause, which is the increasing settlement and cultivation within elephant ranges (Barnes *et al.*, 2003). Unfortunately, successful mitigation might encourage greater cultivation in elephant ranges and to counteract this and develop a long-term solution, community-based intervention methods must be accompanied by conservation incentives and appropriate landscape-scale habitat management.

2.3.1 Electrified fences

Electrified fences are perceived to be the best solution for human-elephant conflict. However, as many projects will testify, they are never the panacea initially believed. It is only with careful planning, costly construction, commitment to maintenance, and in combination with some other means of evicting and/or punishing offending elephants that they are successful. Most local communities believe they are the ultimate solution and clamor for immediate construction once aware of their potential installation. Around the Maputo Elephant Reserve in Mozambique, 81% of farmers believed that electrified fences would control crop-raiding elephants (De Boer & Ntumi, 2001). If fences are not effective they only serve to habituate elephants to electricity and ‘fence-busting’ (be it by breaking through or walking around), and lead to frustration within the local communities after their failure.

2.3.2 Trenches and moats

Trenches have been used with some success in Asia. Along the border of Way Kambas National Park in Sumatra, Indonesia, trenches (2m wide by 3m deep) were found to be effective, and avoided by elephants, until crossed by a stream or river which made a natural crossing point, and generally resulted in erosion (Nyhus *et al.*, 2002). Dug by an excavator, their effectiveness was increased by erosion-resistant clay soils, vegetative ground-cover and regular maintenance by villagers. Trenches and/or moats have not been utilized much in Africa. In Laikipia district, Kenya, trenches and moats were constructed along the boundaries of the Aberdares and Mount Kenya. They were found to be ineffective as elephants soon

learnt to break down the walls and climb through (Thouless, 1995). Incorporation of fences with ditches proved as an efficient barrier to elephants. Even cabling run through stout poles just inside a game fence, that effectively ‘rhino-proofs’ the fence, is not entirely effective. Standard fencing is just one of many ways of demarcating a barrier to elephants and serves as a warning that to cross the barrier will result in harassment, or at worse death. As with most deterrent techniques, it is only useful in combination with other methods. Trenches and fires have history and were used from time immemorial as a traditional prevention method of being safe from attacks by wildlife. Deep trenches to the tune of 15 meters deep and 20m wide were used and this scared animals from trespassing since once trapped in them the animal would find it very difficult to be able to come out. They were constructed along the forest boundaries to ensure that the wildlife especially the large herbivores like the elephants and rhinos would not have access to agricultural lands of the farmers

2.4 Human-Elephant Conflicts

Land use planning is a fundamental human elephant conflict management strategy and offers possibly the best chance of overall success. However, because of the diversity of sites where human-elephant conflict occurs there are few guidelines or principles for addressing this process. Hoare, 1995 defines three main types of interface between elephants and people: hard edge (a clear, but open ended divide between people and elephants); isolated settlement, and mosaic (small clusters of farms intertwined with elephants). Human-elephant conflict is often an entry point for dialogue between the relevant stakeholders (e.g. local authorities concerned with agricultural, administrative and conservation interests, local organizations and even individuals). Participation in this dialogue allows some influence on wide-ranging decisions, including land use (Hoare, 1995).

In places where wildlife utilization and local natural resource management programs have been initiated, it is obviously much easier to influence such decisions Hoare (1995). Initiating the types of changes listed below is obviously aimed at realizing coexistence between elephants and people, with low levels of direct conflict (Hoare & Du Toit,1999). Conflict is only one part of a complex relationship between elephants and people that exist in the same area. This relationship differs significantly across sites of human-elephant conflict, but the basis of the conflict is typically spatial (i.e. the distribution of and interface between people and elephants) and temporal (i.e. seasonal) in nature, as opposed to numerical or density dependent (i.e. how many people and elephants live together).This is where the farmers have

had access to the forest for fire wood, bee keeping, shamba system of farming, spiritual reasons and to some extent researchers. This intrusion has seen an interaction between the humans and the animals where the animals have been scared away, some attacked, humans have also been scared away, attacked and injured or killed. Permits that are issued for grazing or collecting firewood have had an effect as the farmers go beyond the limits. They don't get to do exactly what takes them to the forests. There have been recoveries of sophisticated weapons in the forests with the farmers caught purportedly having permits but for different purposes other than the purpose that make them be in the forest. Some of the farmers have also gone to extend of staying or farming past the beacons set to mark the boundary of the forest Rheker (2002). This has contributed to reducing the habitat of wildlife especially of the elephants hence escalating conflicts

2.4.1 Farm Practices

The focus of human-elephant conflict mitigation strategies is often on manipulating elephant behavior and/or creating defensible boundaries that deny elephants access to certain areas. But this is a two way process, and the underlying motivation for these strategies is as much about elephant existence (and conservation) as it is about human existence. At least as many elephants in Africa live in unprotected areas as do in protected areas, with unprotected areas accounting for 80% of total elephant range in Africa Hoare (2003). Thus managing human-elephant conflict is vital for conserving elephant populations in unprotected areas, and still very important for those in protected areas where conflict prevails along the boundaries.

Modifying the spatial distribution of humans and/or their crops, changing the cropping regime (e.g. temporally, spatially and/or by introducing different crops), and possibly even developing the economy from agriculturally dependent to whatever might be locally viable, thus all fall into the realm of conflict management. The simple objective is to accommodate elephants in current and future land use plans (Du Toit, Hoare, 2000; Hoare, 1999). As Hoare (2001a) points out, dealing with a difficult human- elephant conflict situation provides an entry point for much wider conservation action, often culminating in issues far beyond those normally associated with elephants.

2.4.1.1 The Shamba System

In addition to its watershed values, the forest provides a wide range of domestic benefits. Uses authorized by the Forest Department include firewood collection and livestock grazing

– activities allowed as a management tool to suppress weeds in forest plantations and reduce biomass that could pose a fire hazard in the dry season (Njuguna P., *et al.* 2004). Other uses include beekeeping, fodder collection, water source, crop cultivation and provision of building materials and softwood for wood-based industries. Commercial forestry plantations were established using the practice known as the ‘Taungya System’, initially developed in Burma in the nineteenth century and adopted in Kenya in colonial times as the ‘Shamba System’ or Non-Resident Cultivation, (Wawiye, 2000) . This involved farmers cultivating agricultural crops in areas intended for softwood plantations and inter-cropping with tree seedlings until the tree canopy out shadowed the growth of the crops. Thus the Forest Department was able to benefit from the use of free labour in establishing their plantations while the farmers would contribute to national food production from the sale of their crops. However, poor enforcement and inadequate supervision, among other abuses, resulted in the virtual failure of plantation establishment (Rheker, 2002).

Various other factors have contributed to the severe environmental degradation of Kenya’s forests, leading to public scrutiny and outcry on forest destruction. Several institutions, conservationists and communities subsequently requested that Kenya Wildlife Service assess the environmental state of the Mount Kenya ecosystem. Kenya Wildlife Service therefore undertook a systematic aerial survey to determine the threats to the forest. The survey involved 53 intensive flight-hours at low level over the canopy. The results were published in August 1999 and established that all Mount Kenya’s forests were being affected by illegal activities leading to massive destruction, particularly in the mixed broadleaf forest, and an overall decrease in forest area. According to Rheker (2002), a total of 14,662 trees have been destroyed, including 6,720 camphor trees, in addition to 8,279 ha of forest having been extensively damaged. Charcoal kilns numbered 2,465, livestock was 4,258 head, 143 fields of marijuana covered almost 200 ha, 21 sites were affected by fire; and 120 landslides were found, mostly coinciding with heavily logged areas. Of the land under Shamba System cultivation, 76% was not planted with any tree seedlings and many natural areas had been encroached by settlement. The situation clearly indicated that the Forest Department lacked the capacity to manage and protect the Forest Reserve, with disastrous consequences for biodiversity, water catchment, soil and industrial forestry.

Although legislation concerning forests is fairly comprehensive and spread over several legal acts, they were administered without co-ordination by persons unaware of the conservation

significance of their powers. Furthermore, the penalties in most of this legislation are very low, (Njuguna *et al* 2004), in comparison to the potential gains from illegal activities and are consequently not an effective deterrent. This well-catalogued and publicized devastation led to a groundswell of public criticism and was the catalyst for the Government of Kenya to take major policy decisions. The most significant was the gazetting of Mount Kenya National Reserve in place of the Forest Reserve, excluding plantations, on 24 July 2000, and a transfer of management authority from the Forest Department to Kenya Wildlife Service. This new status afforded enhanced protection over the indigenous forests and Kenya Wildlife Service immediately mounted special operations to round up illegal material and bring to justice those who were apprehended. Some 1,300 arrests have been made and forest produce impounded, including over 4,000 pieces of indigenous hardwood. Marijuana fields occur deep within the forest and are now routinely accessed by helicopter with ranger units uprooting and burning the narcotic.

2.4.3 Logging As A Resource Need.

Illegal logging, especially of Camphor and Cedar, encroachment into the fringes of the indigenous forest, extensive charcoal production and marijuana cultivation were recorded throughout the indigenous forest. Ideally, agro forestry systems, capable of providing substantial net economic and ecological benefits to households and communities, should be readily adopted by farmers instead of logging. According to studies done by Dunn W. 2001, there are higher Net Present Values (NPVs) for agro forestry systems when compared to monoculture systems, yet farmers in developing countries show low rates of adoption and result to forest logging activities as a solution. Burley (2002) suggested that the major conditions which must be satisfied before rural people will plant trees are economic, socio-cultural, and environmental and land ownership.

One of the critical factors that have been given consideration in determining the potential acceptability and viability of agro forestry is land fragmentation, land tenure systems and tree ownership. Land fragmentation at generational transfers has become a more important tendency in nearly all types of holdings. Rules of inheritance of land by all sons in a family and a larger family size inevitably imply a rapid fragmentation of family land.

In areas already heavily populated with average land holdings of less than 2 hectares such as parts of western Kenya, the land fragmentation continues much below the limits of capacity

to reproduce a family. According to F. A. O (2000), this fragmentation has continued in spite of the legal instructions against sub-divisions below a minimum for reproducing a family. This has reduced land sizes among families leaving only small pieces of land for food production. (F. A. Caveness, & W.B. Kurtz, 2000) gave the assertion that patterns of technology adoption will be shaped by the structure of opportunities and constraints presented by the rules of tenure. In the study of Agro forestry adoption and risk perception by farmers in Senegal it was established that land ownership was one of the two predominant factors (the other was labour) affecting the adoption of agro forestry practices. For instance, women worldwide have been at the centre-stage of economic production, including agricultural, livestock and business sectors. In Africa, where the mainstay of most economies is farming or agriculture and livestock production, women contribute to 80% of the workforce. In most parts of Africa, women are closely associated with production of food and raw materials for the industrial sector.

Indeed, women are also more directly involved in small-scale crafts and localized industries, trade and general business. However, women who comprise over half of the world's population, rarely own any reasonable forms of property; do not have adequate access to the same, and do not even make major decisions pertaining to allocation and use of such property. Among farming communities where the basic property is land, women's access to it is determined by men as a matter of patriarchy cultural tradition. According to a study carried out by Women and Law in East Africa in 1995 on Inheritance Laws and Practices in Kenya, women only own land to the extent that they perceive or believe this is the case especially within marriage or other cohabitation relationships. Among various Kenyan communities, women do not traditionally own land or other immovable properties. At best, they have usufruct rights, which are hinged on the nature of the relationship obtaining between them and men either as husbands, fathers, brothers or such other male relatives. Such access can be denied, as it is dependent on the whims of such male benefactors. This situation does not only place women in a precarious position in terms of their survival and livelihoods, but stifles their effective role and contribution to national development Njaguna (2004). With agriculture and other land based natural resources being the main sources of livelihood, the consequences for women not owning, controlling or accessing land are grave.

Agro forestry depends on people's rights to plant and use trees, rights which in turn depend on the prevailing systems of land tenure and tree tenure. Tree tenure is often distinct from

land tenure, but they affect each other (Kioko *et al* 2006). Tree tenure consists of a bundle of rights over trees and their produce, which may be held by different people at different times. These rights include rights to own or inherit trees, the rights to plant trees, the right to use trees and their products, the rights to dispose of trees and the right to exclude others from the use of trees and tree products. The nature of the tree, the nature of the use and the nature of the person or group influences who and what rights (Kioko *et al* 2006). Land owners tend to be relatively advantaged in terms of their rights to trees.

2.4.4 Poaching

Poaching is common, relatively unstigmatized, differentially treated by the legal system, and lacks a human victim; therefore, it is sometimes conceptualized as “folk crime” (Forsyth *et al.*, 1998; Muth 1998; Ross 1961). Muth, 1998 comments that law enforcement officials treat poaching as a minor offense, similar to other folk crimes—littering, gambling, minor traffic violations and jay walking. From a criminal law standpoint, poaching violations are *mala prohibita*, rather than *mala in se*—whereby the list of conservation laws/ regulations vary by statute, rather than being inherently wrong and universally denounced (Beirne & Messerschmidt 2006). Although there are instances where individuals and communities denounce poaching of iconic animals (Colomy & Granfield 2009), examples of this outrage are rare. Despite societal and moral disregard for the legitimacy of poaching, and its potential to threaten biodiversity, recent attention within sociological and criminological research on poaching largely overlooks how to deter poachers from committing fish and wildlife violations. Building from Eliason’s, 2008 theoretical and empirical foundation, a sample of game wardens and poachers from the state of Maine were used to understand how traditional conservation law enforcement may undermine its primary goal—voluntary compliance—by inciting poacher defiance against game wardens, and creating incentives for future poaching. Drawing from criminological literature on defiance and deterrence, it was contended that the generalist role among game wardens may prove more effective as a deterrent approach for poaching than traditional conservation law enforcement. The qualitative data presented reinforced the literature by documenting the strategies poachers and game wardens perceive as useful for deterring poaching. New and alternative trajectories that advance the theoretical and empirical knowledge for research on poaching and conservation law enforcement was the way to go. The seduction of crime Katz (1988) for some poachers derives from demonstrating superior local knowledge and hunting skills (Forsyth & Marckese 1993;

Forsyth 1993). Interactions between game wardens and poachers are possible sources of contention, as are the legitimacy of conservation laws and officers.

2.5 Crop destruction

Incidences of elephant's crop raids in Mount Kenya area have escalated in the recent past causing considerable damage to the fragile local economy that is mainly peasant farming. Studies on crop-raiding predisposing factors, nature and extent of the damage in this region are scanty. Thus, this was the aim of this study. There has been an increase in incidences of elephant raids on people and their property in recent times arousing much attention from both conservationists and wildlife managers in Kenya (Kamweya, 2002; Waithaka, 1994) and elsewhere in Africa (Osborn and Parker, 2001). The damage on farms is quite severe in some areas especially those that border forested protected areas (Kenya Wildlife Service, 1996; Parker and Osborn, 2001; Waithaka, 1994). This damage has serious implications on management and conservation of elephants because it has created and escalated hostility of the adversely affected community towards elephants (Kamweya, 2002; Waithaka, 1994).

Despite the efforts that have been put to mitigate this conflict including erection of high voltage electric fence in some hotspots areas, the results have generally been disappointing, partly due to inherent limitations of the strategies that have been used in the past (Hoare, 1995) . Proactive strategies to resolve the conflict would require knowledge of the extent and severity of the damage caused by the problem animals. Anecdote information indicate that wild animals including elephants in Mount Kenya region invade farms and cause much damage to crops, fences and other infrastructure as well as cause death and injury to people and livestock. However, the damage related specifically to elephants is scanty, and mostly addressed only a few areas with heavy elephant damage such as Hombe and Gathiuru, which are located on western slopes of Mount Kenya (Omondi *et al.*, 1998). Despite the reports and concerns raised on need to control elephant incursions on farms and other entities, there is little research done to establish the severity and frequency of elephant infestations in farms.

Elephant movements in Mount Kenya and elsewhere in Africa have been shown to be linked with resources (food, water and mineral licks) availability. Overall, the single-most major threat to elephant conservation is the exponential increase in human population leading to encroachment into, and loss of elephants habitats. This has led to restriction of elephants in fragmented range (Caughley, 1976; Cumming *et al.*, 1990). This often results to failure of the

fragmented elephant populations to maintain an increase in numbers due to various reasons such as loss of foraging home range and genetic drift Parker (1990). Inevitably, elephants venture out of these confinements into the surrounding human settlements where they raid crops and cause other forms of damage.

There has been an increase in incidences of elephant raids on people and their property in recent times arousing much attention from both conservationists and wildlife managers in Kenya and elsewhere in Africa (Parker and Osborn, 2001). The damage on farms is quite severe in some areas especially those that border forested protected areas (Kenya Wildlife Service, 1996; Parker and Osborn, 2001; Waithaka, 1994). This damage has serious implications on management and conservation of elephants because it has created and escalated hostility of the adversely affected community towards elephants (Kamweya, 2002). Despite the efforts that have been put to mitigate this conflict including erection of high voltage electric fence in some hotspots areas, the results have generally been disappointing, partly due to inherent limitations of the strategies. Consequently, the impacts of elephants on the land surrounding Mount Kenya forests were also extensive. This extensiveness of the likely sections elephants would attack farms prohibits meaningful patrol for lack of enough personnel and resources. While the overall damage levels were moderately low, those individuals whose farms were attacked by elephants experienced loss and suffering. There were several methods used by KWS in collaboration with the surrounding communities to alleviate the damage problem. These included erection of fences, wooden stockades, brick walls, vegetation barriers, moats and scaring away of the animals but were largely ineffective. Since the serious conflict continue to occur in many other sections within the study area, concerted efforts by several interested parties are presently undertaking proactive fencing programmes to reduce the incidences of damage.

The government policy on managing such issues as contained in the Wildlife Management and Conservation Act of 1976 is overly protective of wildlife at the expense of the local community who feel unprotected from wildlife menace. Apart from those few areas where electric fences have been installed in Mount Kenya and elsewhere in Kenya such as Aberdare and Shimba Hills National parks (Njuguna *et al* 2004).

2.6. Human injury.

Farming along the slopes of Mount Kenya is particularly intense and elephants trying to leave the safety of the forests cause huge damage to crops and sometimes injure or, in rare incidences, even kill people as they battle to save their livelihoods. The forest is home to around 3,000 elephants that once roamed freely between the mountain and other safe habitats (Kioko *et al* 2006). Now dense populations surround our protected areas and conservancies. Rural residents, especially agricultural producers and forest landowners have typically borne the brunt of wildlife damage. The terms predator control, animal damage control, animal damage management, vertebrate pest control, vertebrate pest management, and wildlife damage management have been used to describe economic losses directly caused by wildlife Chira (2003).

The phrase human–elephant conflict is now commonly used to describe situations that involve any negative interactions between humans and elephants. Humans have modified plant and animal communities by introducing exotics (Graham *et al* 2009). Many of the introduced species did not have the capability to develop an adaptive coexistence with organisms already present in the system. Such occurrences attract wildlife movement especially during lean pasture periods leading to conflict like is witnessed in Embu with the primates. The specific effects of such introductions and the management changes that accompany them (e.g., habitat alteration, predator control, disease) on the population dynamics of native flora and fauna were unpredictable; in most cases the balance and stability of the natural community were altered Litoro (2012). Exotic species, such as livestock, pets, and agricultural crops that have been deliberately introduced by humans may displace native species. Native species may be redefined as biological pests when they compete with or prey upon the beneficial species introduced by humans (Lucy *et al* 2009). In many cases, domestic animals and introduced plants have not acquired an adequate resistance to native predators, herbivores, and diseases and are unable to sustain themselves at acceptable economic levels without human intervention. For example, cultivated plants developed in the absence of native herbivores may lack the necessary adaptations to survive the herbivory of locally overabundant wildlife populations. The economic and environmental sustainability of these altered systems depends on achieving and maintaining a balance among human uses, vegetation, and herbivory as modified by predation, disease, and other density-dependent factors Litoro (2012). To cope with the conflicts that may result in altered environments, the density or numbers of offending species are often regulated. The offending species are

managed or controlled to protect the other species and reduce the damage to the desired resources.

2.6.1 Retaliatory killings

Northern Kenya, the number of predators killed by farmers has been reported to be equal to the number of livestock killed by lions, hyenas and leopards (Ogada *et al.*, 2003). Kenyan pastoralists poisoned all the lions in Amboseli Reserve in 1990 and speared 27 out of 40 lions in Nairobi National Park in 2003. Pastoralists in Chad and in several districts of the United Republic of Tanzania also poison lions (Packer *et al.*, 2006). In Namibia, an average of about 60 lions was killed each year outside Etosha National Park over a 20-year period, almost always by communal or commercial farmers (Government of Namibia, 2007).

Crocodiles attack from the water and retreat underwater with the victim immediately after the attack. For this reason it is unlikely that a particular individual is ever identified as being responsible for attacks. In general more crocodiles are killed in retaliation than the number of people attacked (Wanjau, 2002). Smaller crocodiles are sometimes trapped by nets if they are unable to tear away the netting which holds them beneath the water surface, and will eventually drown. Alternatively, fishermen who find live crocodiles trapped in their nets will typically dispatch the animal with a blow to the head. Elephants are often killed in retaliation for human deaths. Kenyan Wildlife authorities shoot between 50 to 120 problem elephants each year WWF, (2007a). In the surroundings of Virunga National Park (Democratic Republic of the Congo), habitat destruction and human population growth mean that the mountain gorilla and other forest animals, such as elephants and buffalo, are increasingly coming into contact and conflict with people. For mountain gorillas, interactions with local people are a source of stress, can result in the transmission of human diseases, and can lead to direct physical attacks, disabilities such as loss of limbs from snares, and even death: 18 mountain gorillas were killed between 1996 and 2003 in Virunga and Bwindi (MacFie, 2003; Woodford, Butynski, and Karesh, 2002).

2.7 Theoretical framework

This study will be guided by the theory of human wildlife conflicts.

2.7.1 Human Wildlife Conflicts Theory

Wildlife is a critical component of protected areas worldwide. It can serve not only as a primary attraction or an enjoyable part of the visitor experience but also as a source of conflict. Managing wildlife in this context requires a broad based approach that can account

for the myriad factors underlying conservation effectiveness, including the nature of people's relationships with wildlife. These relationships stem from the cognitive foundation that shapes human behavior toward wildlife, (Okello *et al.*, 2006). The theory of wildlife value orientations contends that, at an individual. Wildlife is a critical component of parks and protected-area management worldwide. It often serves as a primary attraction for visitors or an enjoyable part of the visitor experience. In the United States, for example, visitors rank opportunities to view wildlife as a top reason for their attendance at national parks, a finding that is likely to apply to many of the world's protected areas (Manfredo, 2000).

Numerous studies highlight the significant economic impacts of these experiences, including benefits to local communities bordering protected areas, and in some cases show that visitor expenditures fall considerably short of willingness to pay (Graham *et al.*, 2009). At the same time, wildlife can be an obvious source of conflict in protected areas. While these areas offer refuge to wildlife and are vital for wildlife conservation, many are of insufficient size to contain viable populations of wide-ranging species, such as large carnivores, that can pose serious threats to human safety (Woodroffe and Ginsberg 1998) In addition; wildlife often finds easy food sources in areas of human settlement bordering reserves. As a result of these circumstances, human– wildlife conflict (HWC) tends to be more common in and around protected areas, where wildlife abundance is greater and where animals often stray into adjacent cultivated fields (Kioko *et al.*, 2006). Concerns about this situation have spawned an interest in coordinated efforts aimed at understanding and addressing HWC issues on a global scale. Such interest is reflected in a recent International Union for Conservation of Nature (IUCN) recommendation, resulting from the World Parks Congress 2003, that prioritizes cooperation and action to prevent and mitigate HWC. According to the recommendation, failure to address HWC not only is likely to result in significant ecological and social costs but also could lead to declines in local support for conservation of parks and wildlife.

Developing effective solutions to HWC begins with an understanding of its underlying causes as well as what are likely to serve as constraints to successful conflict mitigation. HWC is driven largely by human factors, including population growth, land-use transformation, habitat loss and fragmentation, increasing wildlife populations due to conservation initiatives, and growing interest in access to nature reserves and nature-based activities (Litoro, 2004).

Human factors also affect the success of HWC mitigation efforts, which are often dependent on public support. Growing public concerns about the use of certain practices to address HWC (Ogodo, 2003) and increased conflict among stakeholder groups regarding appropriate strategies have created significant challenges to HWC alleviation. Dealing with such social challenges that increasingly define the context of wildlife management in and around protected areas requires a broad-based approach, one that can account for the myriad factors that underlie conservation effectiveness (Lucy *et al* 2009). Among these are the needs and interests of people, including both residents and visitors, and the nature of their relationships with wildlife. Root causes of these relationships stem from the cognitive foundation that shapes human thought and behavior toward wildlife. In particular, our theory of wildlife value orientations contends that, at an individual level, broad cultural ideals or value orientations form the basis for more specific cognitions, which in turn drive individual action. Drawing upon theory from cultural ecology, we extend this “cognitive hierarchy” framework to account for the role of societal forces that give rise to cultural values and their orientations over time (Lambrechts *et al* 2003).

This theory clearly spells out that there is an interconnection between wildlife and humans and it reflects the causes based on both parties. However the emphasis is on humans where they have taken up the space for wildlife and this brings out the understanding of the study as it's a reflection to the people and the interventions thereof.

2.7.3 Alternative development theory

This paradigm rejects economic growth as an end in itself, and instead emphasizes welfare and human development with increased choices (Martinussen, 1999). It emerged in 1970's as a critique to mainstream economic model of modernization that failed to address the problem of massive poverty and environmental sustainability. It was inspired by the works of John Friedman who saw the previous attempts to development as ‘failure’ and alternative development as ‘hope’. As a new approach, alternative development hoped to improve the living conditions of the poor especially in the rural areas and at the same time be compatible with emerging environmental concerns.

The main idea about alternative development was not to replace mainstream development path of modernization through the state but rather to transform them so that the disempowered poor are included in political and economic processes and have their rights as

citizens and human beings acknowledged. It therefore becomes a bottom-up approach. This has increasingly been used to mean increasing people’s capacities so that they become self-sustaining, independent and able to make decisions that affect their lives. The theory points out that its only through people-centered and bottom-up approaches to development through which people are empowered; socially, economically as well as psychologically. Through the ‘basic needs approach’ of alternative development, use of their forms of energy for fuel than depending on the forest is imperative. It is important to note that the use of Alternative Development Theory in this study helps to understand the factors influencing human elephant conflicts in the study area as dependency to wildlife resources will end up depleting these resources in Embu North Sub County

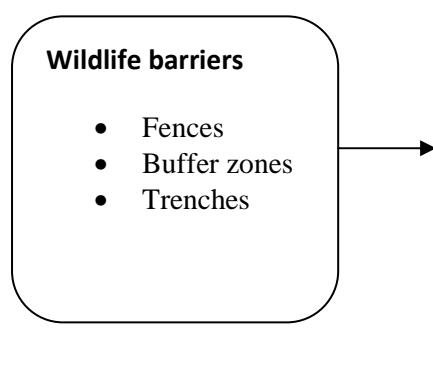
2.8 Conceptual framework

According to Bogdan and Biklen, 2003 , a conceptual framework is a basic structure that consists of certain abstract blocks which represent the observational, the experiential and the analytical or synthetically aspects of a process or system being conceived. The interconnections of these blocks complete the framework for certain expected outcomes. An independent variable is a variable which is presumed to affect or determine a dependent variable. It can be changed as required and its values do not represent a problem requiring explanation in an analysis, but are taken simply as given (Dodge, 2003).

2.9 Conceptual Framework of the study

This is a figure that shows independent, dependent, intervening and moderating variables and how they are related or affect themselves. The independent variables in this study are: to establish how infrastructure influences human elephant conflicts, to know the extent to which human encroachment influences human elephant conflicts and to know the extent to which socio economic factors influences human elephant conflicts in Embu North Sub County. A dependent variable is what is measured in the experiment and what is affected during the experiment. The dependent variable responds to the independent variable. The dependent variable in this study is human elephant conflict.

Independent variables



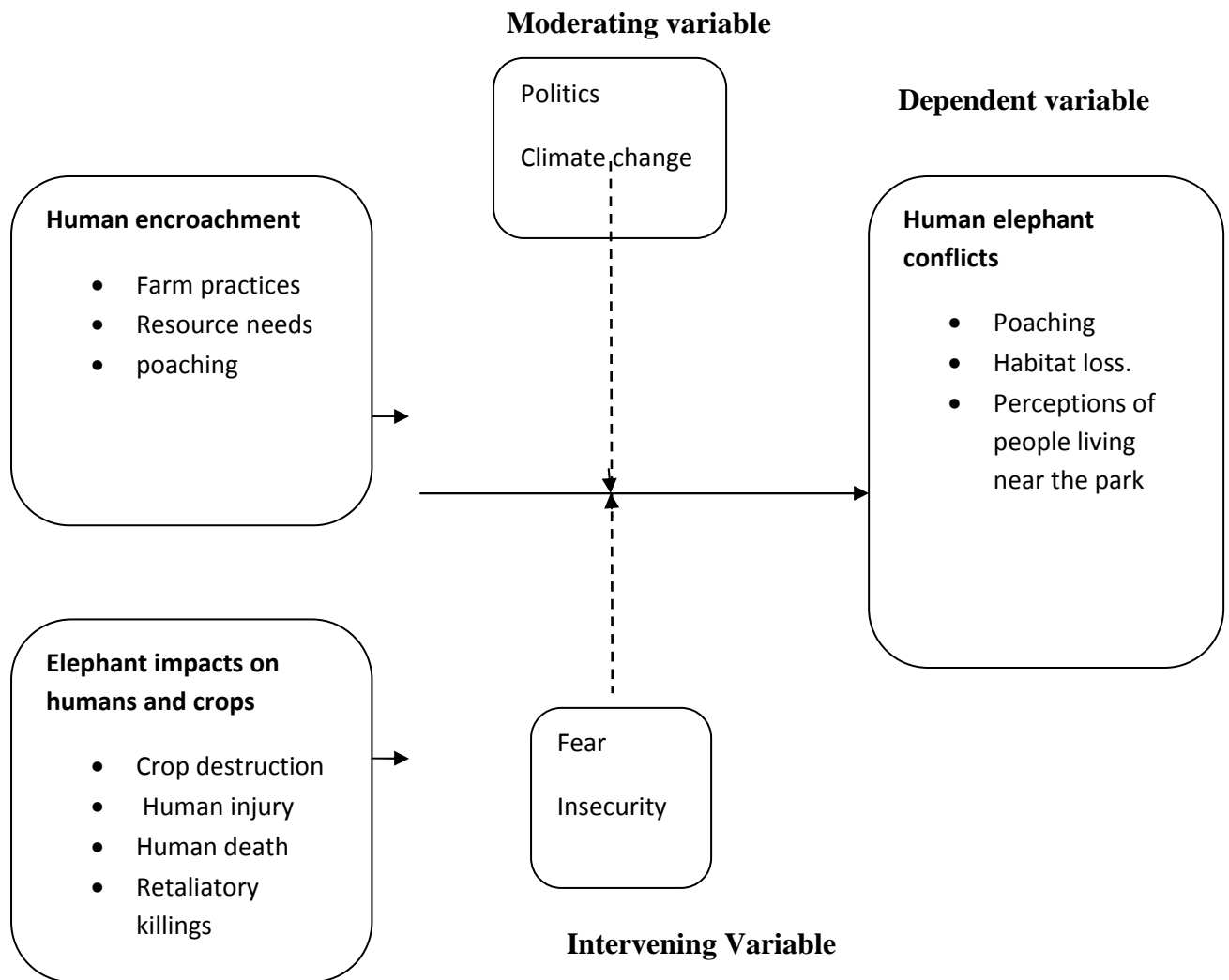


Figure 1 Conceptual Framework

2.10. Knowledge gap

The literature review of this study shows that human elephant conflicts are real in Kenya but tackling the issue has been underestimated where the communities wait for the government to act but not by their own initiatives. The study reflects the wildlife barriers influencing human elephant conflicts, human encroachment as an influence to human elephant conflicts and the impacts by elephants on humans and crops in relation to human elephant conflicts. This study did not consider about how technology can be used as a solution or a factor of consideration to tackle human elephant conflicts. There is therefore need for further research on determinants of human elephant conflicts.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the research design, target population, sampling techniques, sampling size, data collection methods, data collection instruments, reliability and validity of the data collection instruments. It finally presents an operation of variables table.

3.2 Research Design

For the purpose of this study, the researcher employed descriptive research design. A descriptive design is concerned with determining the frequency with which something occurs or the relationship between variables (Bell and Bryman, 2003). Descriptive research design was used in researching factors influencing human elephant conflicts in Embu north Sub County and a precursor to quantitative studies and analysis. This design was preferred because of the nature of the study area and the objectives of this study

3.3 Target Population

Mugenda and Mugenda (2003) reported that target population should have some observable characteristics to which the researcher intends to generalize the results of the study. The sub county has seven locations and twenty two sub locations, as shown in Appendix 10, with a total population of 73841 inhabitants who will form the population of the study.

3.4 Sampling Procedures and Sample Size

Based on Krejcie and Morgan's (1970) table for determining sample size, for a given population of 73841, a sample size of 382 respondents was appropriate to adequately represent a cross-section of the population at 95% confidence level, as shown in appendix 9. Stratified random sampling was used basing the strata on the communities closer to the forest ecosystem. This was then put on a sampling frame as shown in Table 3.1, and from this the sub samples were chosen at random. The sum of each of the sub samples gave the total sample size, (Jankowicz, 2002).

Table 3. 1 Sampling technique.

Location	Population	Sample
1.Mbuvori	9223	48
2.Kathangariri	9201	48
3.Kibugu	10087	52
4.Ruguru	9399	49
5.Ngandori West	10039	52
6.Gaturi North	12892	67
7.Ngandori East	13000	66
TOTAL	73841	382

Sample Size= (target population/total population)× sample size

3.5 Data Collection Methods

This research used both primary and secondary data. According to Kothari (2003) primary data is data collected from immediate source for the purpose of the study while secondary data is by a person or organization other than a researcher. Data was collected using both close ended and open ended questionnaires. Interviews were also conducted.

3.6 Instrument validity

‘Validity is the accuracy and meaningfulness of inferences, which are based on research results, it is the degree to which results obtained from the analysis of the data actually represent the phenomenon under study’, Mugenda and Mugenda (2004). Put differently, validity is the degree to which a test measures what it purports to measure. The instrument was availed to experts from the Department of Extra Mural Studies and peers who established its content and constructed its validity in order to ensure that the questionnaire included an adequate and representative set of items which contain the dimension and elements of

concepts under study. To enhance validity of instrument in this study, the questionnaire was reviewed by experts in the subject matter, particularly my supervisor.

3.7 Reliability of the instruments

Pilot/ pre-test was done to ensure that questions in the questionnaire are stated clearly and have the same meaning to all respondents. The respondents in which they are tested were not part of the selected sample (Mugenda and Mugenda, 2003). This test was done to Community Forest Association, CFA Executives and the chiefs of the seven locations. Computation of scores was done using Pearson Product-Moment correlation coefficient Formula and Table 3.1 shows the results.

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$$

Where,

r = Pearson correlation coefficient

x = Values in first set of data

y = Values in second set of data

n = Total number of values.

Table 3.1 Illustration of Pearson correlation coefficient results

Correlations for Poaching areas versus Human Elephant Conflict			WHERE POACHING OF WILDLIFE IS COMMON	Respondents with conflict elephants
WHERE POACHING OF WILDLIFE IS COMMON	Pearson Correlation	12	.702	
	Sig. (2-tailed)		.638	
	N	12	12	
Respondents with conflict elephants	Pearson Correlation	.702	12	
	Sig. (2-tailed)	.638		
	N	12	12	

A correlation coefficient of above 0.7 was deemed to mean that the instrument was reliable and measurable

3.8 Data Analysis Techniques

The questionnaires were edited with the aim of checking on completeness, clarity and consistency in answering research questions. The data was coded, tabulated and analyzed using Statistical Package for Social Sciences and MS Excel based on study objectives. Descriptive statistics was computed and study findings presented using percentages and tables and interpretations made

3.9 Ethical considerations

All the respondents were treated with respect and research assistants employed in this exercise was taught on the essence of ethics and assisted the researcher in data collection and analysis. The enumerators and the respondents were informed clearly on the purpose of the study where each respondent was politely requested to fill the questionnaire and assured of confidentiality on any information that he or she provided in the questionnaire.

3.10 Operationalization of variables

Table 3.2 presents the operational of variables that were the basis of field work

Objectives	Types of variables	Indicator(s)	Measurements	Measurement scale	Tools of analysis	Data analysis
To establish how wildlife barriers influence human elephant conflicts in Embu North Sub County	Independent Wildlife barriers	Fences	Type of fence ever known	Ordinal	Percentages means	Descriptive
		Trenches	Type of trenches	Ratio	Percentages means	Descriptive
		Buffer zone	Number of farms within the forest buffer zone Types of buffers bordering the forest	Ratio	Percentages means	Descriptive
To determine the extent to which human encroachment has influenced human elephant conflicts in Embu North Sub	Human encroachment	Farm practices	Zero grazing, mixed farming, forest grazing, shift cultivation	Ratio	Percentages means	Descriptive
			Content of fertility	Ratio	Percentages	Descriptive

			are cut from the forest	
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			Hotspots for poaching	
To determine the extent to which elephant	Elephants Encroachment	Crop destruction	Number of crop damage cases	Ratio

<p>Human Elephants Conflicts</p>	<p>Dependent Variable Human elephant conflicts</p>	<p>-Poaching -Habitat loss -Perceptions of people living near the park</p>	<p>Poaching incidences People's feelings about conflicts with elephants. Positions of park beacons and human settlements</p>	<p>Ordinal</p>
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CHAPTER FOUR
DATA ANALYSIS, PRESENTATION AND DISCUSSION OF FINDINGS

4.1. Introduction

This section presents the data as summarized from the respondents. The study aimed at determining the factors that influence human elephant conflict in Embu County and was interested in three major issues: how wildlife barriers influences human elephant conflict, the extent to which human encroachment in the forest ecosystem influences human elephant conflicts and to determine how elephants impact on crops and humans thus influencing human elephant conflicts. The data is thus presented based on the study objectives.

4.2. Demographic data

4.2.1. Response rate of sampled data

The respondents were drawn from each location as shown in the Table 4.1 against the target sample

Table 4.1 Response rates based on sampled villages in Embu County

Area	Population	Number sent	Returned	Response (%)
1.Mbuvori	9223	48	28	7.34
2.Kathangariri	9201	48	33	8.64
3.Kibugu	10087	52	24	6.28
4.Ruguru	9399	49	30	7.85
5.Ngandori West	10039	52	26	6.81
6.Gaturi North	12892	67	35	9.16
7.Ngandori East	13000	66	20	5.24
Total	73841	382	196	51.32 %

The study targeted 382 respondents in order to form its final sample size. This similar number of questionnaires was sent out to the seven villages as indicated in Table 3.1 using selected KWS officers as research assistants. Out of these, 196 questionnaires were returned

representing a 51.3% response rate. Mugenda and Mugenda (2003) observe that a response of over 50% is good. There were twelve key informants in the study who also provided relevant data in the study which has been used to confirm some of the results given by the other respondents

4.2.2. Distribution of Respondents by Gender

Samples on gender were established as shown in Table 4.2 to ensure fair contributions

Table 4.2: Respondents by Gender

Respondents' Gender	Frequency	Percentage response
Male	146	49.13
Female	50	50.87
Totals	196	100

Table 4.2 indicates that there was a balanced gender of males and female participation in the study, hence no bias.

4.2.3. Respondents by age

The ages of respondents were tabulated as indicated in Table 4.3 to know the which of these age brackets influence human elephant conflicts in Embu North Sub County

Table 4.3 The Ages of Respondents

Classification of respondents by age	Frequency	Percentage response
Less than 16 years	4	2.05
16-30 Years	8	4.08
31-45 Years	70	35.71
46-60 Years	96	48.98
61-90 Years	17	8.67
More than 90 Years	1	0.51
Total	196	100

The age of the respondent has an influence on human elephant conflict as not all the respondents are affected by the conflict as shown in Table 4.3. This reveals that over 90% of the respondents are 30 years and above. This is the productive age that would likely be actively involved in the life of the community and which would feel the effects of wildlife more than the other populations.

4.2.4 Distribution of the respondents by their level of education

Sampling on education level was undertaken and from the respondents, Table 4.4 indicated the results for the purposes of understanding the literacy level of the respondents.

Table 4.4 Education levels of Respondents

Highest level attained	Frequency	Percentage response
University	6	3.08
Tertiary	42	21.43
Secondary	49	23
Primary and below	107	54.59
Totals	196	100

Table 4.4 shows that most of the respondents had secondary education and below, with the highest populations drawn from those with primary education. This is understandable, given that the area is quite remote and it can be assumed that the educated populations may have moved into urban areas in search of jobs.

4.3 Wildlife barriers as an influence to human-elephant conflicts.

Wildlife barriers like fences, buffer zones and trenches have an influence on human elephant conflicts in the study area.

4.3.1 Known wildlife barriers by respondents

Wildlife barriers known to the respondents were got from the answers they gave as shown in Table 4.5 to establish if they have an influence to human elephant conflicts in the area.

Table 4.5: Known wildlife barriers by respondents

Known barriers	Frequency of responses	Percentage responses
Trenches	31	15.81
Moats	16	8.16
Electric fences	89	45.41
Beehive fences	60	30.62
Total	196	100

The study established that the population is aware of different types of barriers and fences are the most known to them at 76%.

4.3.2 Proximity of residents to the protected area

A sample on the proximity was got as shown in Table 4.6 where the respondents' indicated the distance between them and the forest boundary.

Table 4.6 The distance between residents and forest edge

Distance from forest	Frequency of responses	Percentage response
Within 20 Metres	3	1.53
Within 30 Metres	7	3.57
Within 100 Metres	31	15.82
More than 100 Metres	155	79.08
Total	196	100

80% of the respondents stay at 100 metres and over. This shows that the distance between their residential and forest boundary is relatively far. Only 20% are in the vulnerable zone. With the tea zone as a buffer, the 20% are in hotspots.

4.3.3 Buffer Zones

Table 4.7 below presents the main responses given by the people on what separates the forest from them

Table 4.7 Forest Buffer Zones

Separating elements from forest	Frequency of responses	Percentage response
Tea zones	73	37.42
Eucalyptus trees	46	23.49
Roads	23	11.74
Fences	54	27.35
Totals	196	100

In some areas, what separate the forest boundary with human settlement have been porous situations and barriers that themselves do not adequately protect the residents. 60% of the respondents say they are separated from the forest by vegetation cover. This is an easy way for elephants that roam to farms and destroy crops in addition to being a threat to humans too.

4.3.4 Indicators of human elephant conflicts

The study used the three questions to determine the extent to which they contribute to human elephant conflict in Embu North Sub County as shown in Table 4.8.

Table 4.8: Major Indicators of Human Elephant conflict

Indicators	Not at all	Low	Moderate	High	Very High	Totals
	1	2	3	4	5	
Human Injuries by elephants	74(37.76%)	71(36.22)	34(18.37%)	14(7.14%)	3(1.53%)	196 (100%)

Poaching of elephants	2(1.02%)	18(9.18%)	23(11.73%)	67(34.18%)	86(43.88%)	196 (100%)
Unemployed people	7(3.57%)	20(10.20%)	28(14.29%)	58(29.59%)	83(42.35%)	196 (100%)

It was noted that the respondents did not necessarily attribute injuries caused to humans by elephants as a source of human wildlife conflict in the area. Only a combined average of 8.67% affirmed that the injuries either influenced the conflicts highly or very highly. This is a contrast to other animals that are perceived to cause more injuries to humans such as crocodiles or snakes.

4.3.5 Poaching hotspots in and out of the park

A sample on poaching was undertaken as shown in Table 4.9 and results obtained as shown for analysis of factors influencing HEC in the project area.

Table 4.9 Common areas of poaching in the area

Places where poaching occurs	Frequency of responses	Percentage response
At the boundary of the park	51	26.02
Inside the park	115	58.67
Both at the boundary and inside the park	30	15.31
Totals	196	100

Poaching was particularly rampant inside the park as is attributed by the responses as shown in Table 4.9. Poaching inside the park accounted for approximately 84% of the total poaching activities in the area.

4.3.6. Instruments used by poachers

The people use a number of crude means to carry out poaching activities in the park in this area as shown in Table 4.10

Table 4.10: Instruments used by poachers to carry out activities

Poaching instruments	Frequency of responses	Percentage responses
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Poisoned arrows	96	48.98
Rifles	20	10.20
Snares	66	33.67
Poisoned fruits	14	7.15
Totals	196	100

The respondents know what poaching is and they tell of the main weapons used by poachers. More than 80% say snares and poisoned arrows are used; these two kill the animals slowly as compared to rifles of which the shots may be heard and this can threaten their activities, poachers.

4.3.7 Fuel types used in the area that promote human wildlife conflict

Types of fuel used by respondents mean a lot in establishing access to forest products as shown in Table 4.11. Respondents gave their feedback according to what type of fuel they used in their homesteads

Table 4.11: Fuel types used in the area that promote human wildlife conflict.

Type of fuel used by respondents	Frequency of responses	Percentage response
Firewood	147	75
Gas	7	3.97
Kerosene	43	21.03
Totals	196	100

Firewood dominates source of fuel that the respondents use, 75%. This shows how the communities around the park rely heavily on trees which are the habitats for wildlife. The fact that women can get permits to go collect firewood in the forest explains why this is on a high response however alternative methods can be used to substitute this practice.

4.3.8 Discussion of findings on Human Elephant Conflicts

The findings also reveal that a huge proportion of conflicts have been due to poaching, 78% and the number of unemployed people, 72%, in the area who would have the tendency of

competing for same land resource with the elephants to collide with wildlife. Although the reasons for this are not explicitly given, more attention would need to be focused in this area in order to determine the real issues. Kioko *et al.*, 2006 iterated that elephant habitats are gradually reducing and this has a negative impact to humans. These findings are in line with Kioko *et al.*, 2006 finding and human encroachment to elephant habitats due to population increase and demand for land leading to human elephant conflicts.

4.3.9 Discussion of the findings on Wildlife Barriers

This study established that the communities around the national park are aware of fences as wildlife barriers. In Maputo Elephant Reserve in Mozambique, 81% of farmers believed that electrified fences would control crop-raiding elephants (De Boer & Ntumi, 2001). In Indonesia, Way Kambas National Park, Sumatra trenches have been effective as buffer zones, (Nyhus *et al.*, 2002), in northern Kenya and some parts of Laikipia studied and concluded that electric fences have been the most effective (Lucy *et al.*, 2009). In this study this is very possible too though there are areas where trenches can be most effective as barriers since the terrain is not uniform. This will then mitigate human elephant conflicts.

4.4 Human encroachment in the forest ecosystem

The study also aimed to determine the ways in which human invasion of forests has resulted in increased conflict with elephants. When asked about the farming methods used by the people in the area, a huge per cent of the respondents were engaged in mixed agriculture where they both keep animals in engage in different forms of farming. The table below illustrates the responses.

4.4.1 Farming methods used by residents around the forest.

Farming methods around the forest boundary has an influence to human elephant conflicts since when it comes to crop destruction or livestock injuries it depends on the kind of farming being practiced. Table 4.12 illustrates the different types of farming methods as given by respondents

Table 4.12: Methods of farming adopted by residents

Type of farming	Frequency of responses	Percentage response
Mixed farming	133	67.86

Shift cultivation	8	4.08
Livestock keeping	49	25
Zero grazing	4	2.04
Other forms of farming	2	1.02
Total	196	100

96% of the respondents are sedentary farmers, farm in open fields; this exposes their farms to risk of attack by elephants which end up fueling human elephant conflicts. Coupled with these, the respondents also observed that they grow a variety of crops around the year. These include tea (6%), coffee (8%), maize (16%), cabbages (53%), irish potatoes (11%), and other crops (16%).

4.4.2 Sources of water in the region

Table 4.13 below describes the main water sources in the ecosystem which establishes access to the water used by respondents in their homes

Table 4.13: Major sources of water in the region

Source of water	Frequency of responses	Percentage responses
Piped water from the county government	11	5.61
Forest streams	137	69.90
Both piped and stream water	48	24.48
Total	196	100

It's clear that 70% of the water is got direct from the forest ecosystem. Source of water was another potential source of conflict since most of the water for usage here is drawn from the forest streams either directly into the forests or downstream once it flows out of the forests.

4.4.3 Discussion of the findings on Human Encroachment

This study has established that 96% of respondents are sedentary farmers in Embu North Sub County. Kioko (2006) suggested that the major conditions which must be satisfied before rural people will plant trees are economic, cultural, and environmental and land ownership. Planting trees in farms is agro forestry which Burley (1989) suggests as an alternative. This is in line with this study as a recommendation to mitigate too much dependency to forest products mainly firewood. This study also indicates that many sedentary farmers have grown maize. Access to the forest by the community members in search of pure drinking water poses a threat since its from the accessibility that exposes them to attack due to resource use. Rheker (2002) puts it that poor enforcement and inadequate supervision has resulted to even degradation of water resources which are essential for habitat restoration. With monitoring and maintenance of protected areas the issue of access to the natural resources in risky ways would be manageable.

4.5 Encroachment of elephants on crops and humans

4.5.1 Frequency of crop raids by elephants

Asked whether their crops have been damaged by elephants the respondents answered as Table 4.14 illustrates.

Table 4.14: Whether crops have been destroyed by elephants

Crops have been damaged by elephants?	Frequency	Percentage response
Yes	166	84.69
No	30	15.31
Totals	196	100

The very fact that elephants have destroyed farms and other human property has been a source of conflict itself, 85% responded in the affirmative, meaning that the impact of elephants has been felt tremendously in the region.

4.5.2 Actions taken by residents when elephants destroy crops

The questioned asked to respondents in Table 4.15 was clear on the uniformed service who are frequent in the forest ecosystem

Table 4.15: Presence of uniformed officers around the forest area

Visible uniform patrol in the area	Frequency of responses	Percentage response
KWS Rangers	61	31.12
KFS rangers	48	14.46
Both KWS and KFS	89	45.41
Administration police	23	1.73
Kenya police	18	7.18
Total	196	100

The most noticeable uniformed forces are indicated by the responses in table 4.15 as both KWS and KFS at over 90%. This question meant to determine the mechanisms adopted by farmers and the residents in dealing with crop destruction menace from elephants. Some respondents noted that they would simply chase them away and then report to the Kenya Forest Service (KFS) guards who lived nearby. These residents either chased them away using traditional methods such as drumming or by using sticks and noise to scare the animals away. Others reported to KWS rangers depending on which guards were closest to the residents. Others noted that no actions were taken even when issues were reported.

4.5.3 Coping mechanisms when elephants raid farms

Dealing with elephant encroachment was respondent to as illustrated in Table 4.16. This would explain different methods that communities use to ensure the elephants stayed away from them.

4.16: Methods of mitigating raids by elephants

Means of reducing raids by elephants	Frequency of responses	Percentage response
Planting crops with less attraction to elephants	65	33.16
Improved fencing for homesteads	68	34.69
Scaring the animals away	19	9.61
Planting of trees along the forest boundary	18	9.18

Lighting fires in homesteads	20	10.20
Other methods	6	3.26
Total	196	100

As illustrated by table 4.16, 33% respondents chose to change the crops they plant from what elephants love feeding on to something unpalatable. Long term adaptation mechanisms that are long term by community members at 86% shows the community members have ways of dealing with the conflicts. The most commonly adopted crop was tea while bananas were largely abandoned by the farmers. This means that the elephants have forced residents to abandon their staple foods and change their feeding patterns for the sake of reducing conflicts between them and the animals.

4.5.4 Injuries and damages by elephants

One of the questions posed was on injuries to humans and crops destruction, Table 4.17 illustrates to establish if the destruction to crops is the issue or the injuries to humans.

4.17 Injuries to humans and destruction to crops

	Yes	No	Percentage response
Injuries to humans by elephants	55 (28.06%)	141(71.94%)	196 (100%)
Damage to crops by elephants	117 (59.69%)	79 (40.31%)	196 (100%)

Table 4.17 shows that humans have experienced less injuries, 28%, from elephants compared to having had more damages, 59%, from the elephants. This means that they have attempted to take precautions over their bodies by keeping off the animals path but their crops have not been equally lucky given that the animals access farms when least expected and given their strength over humans.

4.5.5 Discussion of findings on Elephant Impacts

This study has revealed that 85% of crop destruction by elephants is to the people who stay at 100 meters from the park. Parker and Osbon (2001) studied that elephant raids in farms is quite severe especially those who boarder forested areas in Krugler National park. According

to study carried out in Lake Nakuru National Park, crop destruction by elephant raids has serious implications on management and conservation of elephants because it has created hostility of adversely affected communities towards elephants, (Kamweya, 2002) this is contradicts this study since with the new Wildlife Conservation and Management Act no 47 of 2013 in the laws of Kenya has allowed compensation, this has been a legislative solution to the perennial problem which initially it was not possible. In Mount Kenya rural residents, especially agricultural producers and forest landowners have typically borne the brunt of wildlife damage. The terms predator control, animal damage control, animal damage management, vertebrate pest control, vertebrate pest management, and wildlife damage management have been used to describe economic losses directly caused by wildlife (Chira, 2003). As a result the communities have been able to cope with ensuring their crops are protected. This is in line with this study as community members, 86%, have had to use adaptive means to cope. While it is widely recognized that in most cases elephants do not inflict the most damage to subsistence agriculture, they are generally identified as the greatest threat to African farmers (Parker *et al.*, 2007) The residents' apathy can be attributed to the previous lack of compensation policy for injuries and damages incurred from animal threats. However, this has now changed with the signing into law of the wildlife act. It remains to be seen how this will help in solving the exiting problem of human animal conflict.

4.6 Summary of the Chapter

The data collected was analyzed using Statistical Package for Social Sciences and tables were used to present data in APA table format. The response rate was 51.32% (196 questionnaires). The data interpretation focused on wildlife barriers, human encroachment and elephant impacts on crops and humans and how they influence human elephant conflicts in Embu North Sub County.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter focuses on the summary of findings and discussions from which conclusion and recommendations were advanced to address factors influencing human elephant conflicts in Embu North Sub County. It also includes suggested areas for further research and contributions made to the body of knowledge

5.2 Summary Findings

Summary of findings was based on the three objectives of the study.

5.2.1 Assessment of wildlife barriers influencing human elephant conflicts

The summary of the first objective sought to assess wildlife barriers and their influence to human elephant conflicts in Embu North Sub County, the study showed that majority of the respondents were aware of existence of fences particularly electric type and beehive type. Electric fence is durable and in efforts to erecting an electric fence would enable peaceful coexistence between the community members and wildlife hence mitigating human elephant conflicts.

5.2.2 Assessment of human encroachment factor influencing human elephant conflicts.

The summary of the findings based on objective two which was to assess human encroachment factors that influence Human elephant conflicts in Embu North Sub County. The study findings indicated that majority of the farmers are sedentary farmers who plant their crops and keep their livestock in open range. This makes them vulnerable to mammoth attacks. It is through these raids and human elephant conflicts occur. Its only 3% of the respondents that do zero grazing and other methods of farming. 3 % shows that a small number, so out of 196 of the populations are safe from elephant raids. When farmers get in forest to do shamba system type of farming, it makes them vulnerable of elephant and other mammals attack due to encroachment to their habitat. Poaching using poisoned arrows and snakes scored 82%. This indicated that communities know what poaching is and are aware of the type of weapons being used. Use of Rifles scored 10% this indicates that probably the fear of the bullets to be heard or very few use it as a means. Interviews indicated they use poisoned water melons to poison the elephants.

5.2.3 Assessment of elephant encroachment on humans and crops and its influence to human elephant conflicts.

The summary of the findings based on objective three was to determine how elephants impacts on crops and human influence human elephants conflicts in Embu North Sub-county 85% affirmed that elephant raids on crops is severe. Its only 20% who said their crops had never been damaged probably because they stay far away from the forest or they've fenced their crops appropriately. Through interviews, the study established there are farmers who fenced their farms with trees agro forestry hence safe from elephant raids. No retaliatory killings were reflected but adaptive mechanisms came out clearly. Long term solution of planting crops e.g. Irish potatoes, fencing of homesteads and planting more trees along the forest boundary scored 80%. This shows the community users many alternatives to ensure they are safe from the elephants hence reducing human elephant conflicts. The study concludes that there are more conflicts when crops are damaged than when a person is injured or killed by an elephant.

5.3 Conclusion

The study has established that competition for scarce resources including land and water have been the main cause for human/wildlife conflict with not only the elephants moving out of protected areas to reach out to farmlands but also humans intruding into the elephant habitats. Under such circumstances, the resulting human-elephant conflict has been inevitable with crop destruction, human injuries and human deaths and also retaliatory killings of the elephants. To reduce such a conflict, it is important that appropriate electric fences and beehive fences be erected and also the humans be sensitized on the new wildlife legislation/Act and also that security/ranger do all the can to reduce management error so as to reduce unnecessary killing of elephants.

5.4 Recommendations.

The following recommendations are made from the findings of this study.

1. The county government should take the initiative of erecting an 8 strand electric fence with man gates at appropriate distances. This will be one of the measures to reduce human-elephant conflicts to avoid the issues of easy access to and from the forest.
2. Kenya Wildlife Service should step up community sensitization programs to ensure communities are aware of new wildlife conservation and management Act No.47 of 2013.
3. Law enforcement especially on use of natural resources is necessary. Human encroachment in protected areas should be stopped and people accessing forests be screened to ensure intentions are clear.
4. Government with private partners should come up with many institutions for research and development on wildlife to come up with many methods of mitigating human-elephant conflicts.

5.5. Suggested areas for further research.

The following are the suggested areas for further studying.

1. A study to establish why elephants are most notorious in human wildlife conflicts than any other animal in Embu North Sub County so that more scientific solutions can be sort to mitigate the conflict
2. Also a study on assessment of other factors that influence human wildlife conflicts such as technology and use of alternatives like elephant monitoring using satellite so that communities can be updated regularly to avert conflicts.

2. A similar study in other countries with similar problems in Kenya and the globe can be carried out for more understanding of human elephant conflicts.

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APPENDICES

APPENDIX 1: INTRODUCTION LETTER

Dear Respondent,

RE: TRANSMITTAL LETTER FOR RESEARCH INSTRUMENTS

I am currently taking a Masters of Arts degree in Project Planning and Management at the university of Nairobi Embu campus. As part of the requirement for the award of the degree for graduation, I am undertaking a research to determine the factors that influence human elephant conflicts in Embu North Sub County.

In this regard I am kindly requesting for your support in terms of time and by responding to the attached questionnaire. Your accuracy and candid response will be appreciated

Please note that the information received will be treated with utmost confidence and you have a choice of not writing your name. In addition, the findings of the study will solely be used for academic research purposes and to enhance knowledge in the field of conservation

Thank you for your valuable time

Yours faithfully,

Francis Bisuche Wenyaa

L50/66329/2013

APPENDIX 2: QUESTIONNAIRE FOR FARMERS.

This Questionnaire is meant to collect data from the residents of Embu County. Any information provided in this questionnaire will be used for the purposes of research only and will not be divulged or availed to unauthorized persons

Tick the correct answer in the boxes provided against the question where provided

You need not write your name on the questionnaire

Please answer the questions as accurately as possible

SECTION A: RESPONDENT'S DEMOGRAPHICS

1. Please indicate your village _____

2. Please indicate your sex

Female []

Male []

3. Please indicate your age groups position by ticking (✓) in the appropriate box

Less than 16 years	
16-30 years	
31-45 years	
46-60 years	
61-90 years	
Over 90 years	

4. How long have you lived in mount Kenya region? Indicate with (✓)

Less than 6 years	
6-10 years	
11-15 years	
16-20 years	
Over 20 years	

5. Level of education. Tick (✓) where appropriate

Primary level ()

Secondary level ()

Tertiary level ()

University level ()

None ()

6. Marital status

Married ()

Single ()

Divorced ()

Widow ()

Widower ()

7. Kindly state your source of income.

SECTION B: HUMAN ELEPHANT CONFLICTS

8. Please indicate in your opinion, your evaluation of each of the following indicators of human elephant conflicts. Tick(√) the correct answer in the space corresponding to the answer

Scale: Not at All=0; Low=1; Moderate=2; High=3; Very High=4

Indicator	Not at All	Low	Moderate	High	Very High
Human injuries by elephants					
Poaching of elephants					
Unemployed people in the area					

9. Poaching of wildlife is common where
- I. At the boundary of the park ()
 - II. Inside the Park ()
 - III. Both at the boundary and inside the park ()
10. What do the poachers use to do this illegal activity?
- I. Poisoned arrows ()
 - II. Rifles ()
 - III. Snares ()
 - IV. Poisoned fruits ()

11. What type of fuel do you use in your home?

Firewood ()

Gas ()

Kerosene ()

12. In your opinion what are some of the main causes of human elephant conflicts?

13. Suggest mitigation measures to reduce human elephant conflict

SECTION C: WILDLIFE BARRIERS

14. What wildlife barrier do you know of: Tick any that you know of?

- I. Trenches ()
- II. Moats ()
- III. Electric Fences ()
- IV. Beehive fence ()

15. The ranger houses or outposts you've ever seen belong to which forces. Tick any that you know of.

- I. KWS ()
- II. KFS ()
- III. Both KWS and KFS ()
- IV. AP ()
- V. KENYA POLICE ()

16. Patrols that are always carried along the forest boundary are done by which uniformed service () appropriately

- KWS ()
- KFS ()
- Kenya police ()
- Administration police ()

17. Approximately how far do you stay from the forest boundary?

- More than 20 meters ()
- More than 30 meters ()
- More than 50 meters ()
- More than 100 meters ()

18. What separates the forest boundary with the human settlement? Tick any that you know of.

- I. Tea Zone ()
- II. Eucalyptus trees ()

- III. Roads ()
- IV. Fence ()
- V. None ()

SECTION D: HUMAN ENCROACHMENT

19. What are some of the farming methods you undertake in your farm?

- Mixed farming ()
- Shift cultivation ()
- Livestock keeping ()
- Zero grazing ()
- If it is not listed please state _____

20. What some of the crops that you grow seasonally?

- Tea ()
- Coffee ()
- Maize ()
- Irish potatoes ()
- Cabbages ()

21. Do you use fertilizers in your farm?

- Yes ()
- No ()

22. Where does the water you consume come from?

- Piped from the county government ()
- Forest streams ()

SECTION E: IMPACTS AS A RESULT OF HUMAN ELEPHANT CONFLICTS

23. Have your crops ever been damaged by elephants?

- Yes ()
- No ()

24. What action did you take?

25. What have you done to reduce the crop raid by elephants in your farm?

26. Have you ever been injured by wild animals?

Yes ()

No ()

If yes which one? Did you report the matter to authorities?

27. Have your properties ever been destroyed by wildlife?

Yes ()

No ()

If yes, which one? Did you report the matter to authorities?

Thank you for participation

APPENDIX 3: QUESTIONNAIRE FOR KEY INFORMANTS

This Questionnaire is meant to collect data from the residents of Embu Sub County. Any information provided in this questionnaire will be used for the purposes of research only and will not be divulged or availed to unauthorized persons

Tick the correct answer in the boxes provided against the question where provided

You need not write your name on the questionnaire

SECTION A: RESPONDENT'S DEMOGRAPHICS

1. Please indicate your village _____

2. Please indicate your sex

Female []

Male []

3. Please indicate your age groups position by ticking (√) in the appropriate box

Less than 16 years	
16-30 years	
31-45 years	
46-60 years	
61-90 years	
Over 90 years	

4. How long have you lived in mount Kenya region? Indicate with (√)

Less than 6 years	
6-10 years	
11-15 years	
16-20 years	
Over 20 years	

SECTION B: HUMAN ELEPHANT CONFLICTS

5. Please indicate in your opinion, your evaluation of each of the following indicators of human elephant conflicts. Tick(√) the correct answer in the space corresponding to the answer

Scale: Not at All=0; Low=1; Moderate=2; High=3; Very High=4

	Indicator	Not at All	Low	Moderate	High	Very High
Human injuries by elephants						
Poaching of elephants						
Unemployed people in the area						

SECTION C: WILDLIFE BARRIERS

6. How many rangers' outposts or stations do you know of located around or in the forest?

7. Do you know the people who stay in those outposts or stations and how do they react when elephants come out of the forest and go in people's farms?

8. Have you ever seen trenches or moats along the forest line, what were they used for?

9. What is the main cash crop grown?

10. How do the rainy seasons affect wildlife patterns in your area of stay?

11. When a person is injured by wildlife like elephants what is the action taken to save the situation?

12. What about your crops that you grow, when they are destroyed by elephants what do you normally do?

THANK YOU

**APPENDIX 4: INTERVIEW SCHEDULE FOR COMMUNITY FOREST
ASSOCIATION MEMBERS(CFA's)**

INTRODUCTION

All the items will be verbally transmitted to CFA members with the aim of gathering useful responses to be used in investigating the factors influencing human elephant conflicts in Embu North Sub County. Responses will be gathered from the sampled members

1. Gender: _____

2. Which crops do you grow

3. State your approximate monthly income
4. How regular do elephant attack you as a person or your farm?
5. What remedies do you put in place to deal with the situation?
6. Are you a native or a settler?
7. Poachers are responsible for most of deaths of wildlife within and without the protected areas, what measures should the government put in place to ensure the poaching menace is reduced?
8. What part can you play in ensuring that humans live peaceful with elephants?

APPENDIX 5: OBSERVATION SCHEDULE

1. What kind of infrastructure in at the forest or in the boundary between the forest and settlements?
2. Are there elephant spoor?
3. What is the vegetation type
4. What is the dominant cash crop?
5. What barriers that farmers have put in their farms to protect their crops
6. Are there elephant foot paths seen?
7. What are the common economic activities
8. Any anthropogenic activities in the forest?

9. Are there ranger's houses or outposts?
10. Any other unique substance relevant to the study?

**APPENDIX 7. TABLE FOR DETERMINING SAMPLE SIZE FROM A GIVEN
POPULATION.**

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	180	118	400	196	1300	297	7000	364
50	44	190	123	420	201	1400	302	8000	367
55	48	200	127	440	205	1500	306	9000	368
60	52	210	132	460	210	1600	310	10000	373
65	56	220	136	480	214	1700	313	15000	375
70	59	230	140	500	217	1800	317	20000	377
75	63	240	144	550	225	1900	320	30000	379
80	66	250	148	600	234	2000	322	40000	380
85	70	260	152	650	242	2200	327	50000	381
90	73	270	155	700	248	2400	331	75000	382
95	76	270	159	750	256	2600	335	100000	384

Note: "N" is population size.

"S" is sample size.

Source: Krejcie et al, 1970

