ASSESSMENT OF APPROACHES FOR MANAGING HUMAN-ELEPHANT CONFLICTS IN WESTERN SERENGETI ECOSYSTEM, TANZANIA

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CERTIFICATION

The undersigned certify that she has read and hereby recommends for acceptance by the Open University of Tanzania, a dissertation titled: "***Assessment of Approaches for Managing Human-Elephant Conflicts in Western Serengeti Ecosystem, Tanzania"***, in partial fulfillment of the requirements for the Degree of Master of Natural Resources Assessment and Management (MA-NRAM) of the Open University of Tanzania.

…….…….

Dr. Anna I. Wawa

(Supervisor)

……..……

Date

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DECLARATION

I**, Theresia James Urio,** do hereby declare that, this piece of work is my own original work and that it has not been presented and will not be presented to any other University for similar or any other award.

…….

Signature

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Date

DEDICATION

This work is dedicated to my Beloved Parents Mr. and Mrs. James Urio, my Sweet Husband Virgil Mtui and my Lovely children, Fragrancia, Renaissancia and Valdo.

ACKNOWLEDGMENT

I would like to express my sincere thanks to my Parents Mr. and Mrs. James P. Urio for devoting their wealth to sponsor my Master degree course at the Open University of Tanzania. My gratitude thanks are also to my best friend Peter Maiga for his positive psychological contribution during my study time as well as his support in various circumstances.

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ABSTRACT

Human-elephant conflicts (HEC) have been persistent in Western Serengeti Protected Areas (PAs) and the adjacent communities of Bunda and Serengeti districts, Mara region. This study aimed to identify factors that lead to human-elephant conflicts, examine approaches applied for prevention and mitigation of human-elephant conflicts and to identify barriers toward applied approaches and techniques for managing human-elephant conflicts in western Serengeti area. Data collection involved direct observations, key informant interviews and household survey using questionnaires. The analysis was done using IBM SPSS and MS Excel computer soft wares. Results showed that factors that significantly influenced human elephant conflict occurrence were crop raiding incidences, increasing elephant population, encroachment, and lack of clear buffer area, lack of compensation plan, infrastructure damages and direct elephant attack. The major effects of HEC in the study villages were crop damage, increased elephant population, encroachment due to lack of buffer zone. The major barriers to HEC mitigation measures included long distance between rangers' camp, use of poor tools like handheld torches and inadequate manpower in HWC mitigation units. A number of non- conventional mitigation measures were identified and recommended; namely construction of trenches, establishment of buffer zone management units (BZMUs) and geo-fencing system. Generally, no single solution is effective, as different approaches need to be integrated to address the problem proactively. Community involvement in decision-making and policy formulation should be emphasized for effective implementation of proposed mitigation measures.

Keywords: Conflict, protected areas, conservation, management approaches and community livelihood.

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LIST OF ABBREVIATIONS AND ACRONYMS

BZMUs	Buffer Zone Management Units
CBNRM	Community Based Natural Resource Management
CDR	Conflict Detection and Resolution
COP	Community Outreach Programs
COSTECH	Tanzania Commission for Science and Technology
CPU	Central Processing Unit
CRT	Conflict Resolution Theory
DGO(s)	District Game Officer (s)
FZS	Frankfurt Zoological Society
GPS	Global Positioning System
GSM	Global System for Mobile Communication
Ha	Hectares
HEC	Human-elephant Conflict (s)
HH	Household
HNT	Human Needs Theory
HWC	Human-wildlife Conflict (s)
HWCMU(s)	Human-wildlife Conflict Mitigation Unit (s)
IGKGRs	Ikorongo, Grumeti and Kijereshi Game Reserves
NBS	National Bureau of Statistics
PAC	Problem Animal Control
PA	Protected Areas
RDB	Rwanda Development Board
SENAPA	Serengeti National Park

SMS	Short Message Service
SPGSC	Senate Postgraduate Studies Committee
SPSS	IBM Statistical Package for Social Science
TANAPA	Tanzania National Parks Authority
TZS	Tanzanian Shillings
URT	United Republic of Tanzania
USD	United States Dollar
VEO(s)	Village Executive Officer(s)
VHF	Very High Frequency
WCA	Wildlife Conservation Act
WD	Wildlife Division
WMA	Wildlife Management Area
WSN	Wireless Sensing Network

CHAPTER ONE

INTRODUCTION

1.1 Overview

One of the most challenging aspects in conservation of wildlife is human-wildlife conflict. Expansion of human settlements and agricultural fields adjacent to protected areas has resulted in widespread loss of wildlife habitat, degraded forage, reduced landscape connectivity, and a significant decline in wild animals' populations relative to their historical size and overall range. As their habitats shrink, wild animals are progressively forced into closer contact with people, resulting in more frequent and severe conflict over space and resources with consequences ranging from crop raiding to reciprocal loss of life.

1.2 Background to the Research Problem

Primack (2014) reported that animals such as elephants, birds and primates are known to raid crops. It has been found by Teel *et al*. (2010) that lack of consensus on the main cause of human-wildlife conflicts has intensified negative attitudes among people towards wildlife conservation. Generally, human-wildlife conflict results when wild animals from protected areas damage crops, infrastructure, human properties and attack people where they cause injuries, or deaths. The conflicts can inculcate revenge behaviour among the people and thus threaten wildlife in return (Okello, 2005; Røskaft *et al*. 2012).

In particular, human-elephant conflict (HEC) affects human socio-economically and culturally as they spend much of their time in crop fields guarding their farms from raiding elephants while threatens survival of elephants (AfESG, 2007; Fungo, 2011;

Kumar *et al*. 2011; Jadhav and Barua, 2012). Human-elephant conflict marks one of the greatest challenges of conservation in many countries around the world (Burn *et al*., 2011). Asian elephants (*Elephas maximus*) are one of the principal sources of human-wildlife conflicts in some of Asian countries as they have consistent impact on the livelihoods of local populations (Nyhus and Tilson, 2004). In Indonesia 12 elephants were poisoned to death by workers as they were trying to enter and feed on oil palm plantations (Nyhus and Sumianto, 2000). In China, in the mountainous area of Simao, near to Xishuang Banna Nature Reserve, property damages and crop raiding by Asian elephants has been reported to be done by a group of about 19 to 24 elephants (Chen *et al*. 2016; Distefano, 2005).

Moreover, in African countries such as Cameroon, Zimbabwe and Namibia, elephants were seen to be the most aggressive animals once they enter into communal lands compared to lions and other predators, as they attacked a large area and raided crops (Hedges and Gunaryadi, 2010; O'Connel-Rodwell *et al.* 2000; Sarker and Røskaft, 2010a; Sukumar, 1991). Human-elephant conflicts have impacts on elephant population (Archie and Chiyo, 2012; Estes *et al*. 2012). In Kenya about 50 to 120 problematic elephants are shot dead by wildlife authorities each year as a measure to control them from killing human beings. As a result, HEC together with other factors such as poaching and habitat degradation, have caused decline in African elephant population from around 3-5 million to between 470,000 and 690,000 in the last 100 years (WWF, 2014b).

Management of wildlife in Tanzania is done under the Ministry of Natural resources and Tourism (Nelson *et al*., 2007). There is a descending approach on the

administrative organizations with different jurisdiction over management of wildlife in different areas (Hoare, 2007). Tanzania wildlife policy established a community based natural resource management (CBNRM) approach under section 3.2.1 to promote the management of wildlife resources outside the protected areas by establishing Wildlife Management Areas (WMAs). The approach aids in enforcing wildlife law and facilitates the application of various techniques for protecting wildlife resources such as elephants against illegal uses (MNRT, 1998). WMAs aid in mitigation and prevention of conflicts between human and wildlife as the approach enables the local communities to have authority over managing wildlife in their land (Wilfred, 2010).

This makes it easier to implement strategies such as awareness raising, chili fencing, human-wildlife conflict mitigation units and other. Tanzania's Wildlife Conservation Act (Cap. 283) of 2009 at Part VIII, describes the management of human-wildlife conflict by suggesting a number of approaches including problem animals control (PAC), consolation for loss of life, crops or injury caused by wild animals (WCA, 2009). Although not to a point where there are no more conflicts, these approaches have been reducing the intensity of human-wildlife conflicts and especially human-elephant conflicts to many local communities around protected areas within the country (Benjaminsen *et al*. 2013).

Every year, Tanzania loses its elephants due to poaching, human-elephant conflicts and habitat degradation. For example, a census survey conducted across six ecosystems across the country in 2009, namely Tarangire- Manyara, Serengeti, Selous-Mikumi, Ruaha-Rungwa, Katavi- Rukwa and Moyowosi- Kigosi covering

229,318 km^2 showed that, the elephant population fell from 142,788 by 2006 to 109,051 in 2009 (CITES Secretariat, 2010; TAWIRI, 2010). In the past five years from 2014, Tanzania has lost 60% of its elephants, as the population fell from an estimated 109,051 in 2009 to about 43,330 in 2014 (EIA, 2014; WildAid, 2014).

Results from an aerial survey conducted in the Serengeti-Mara ecosystem in 2014, showed that about 192 elephant carcasses were counted, of which 117 were found in the northern part while 75 in the southern part of the ecosystem with 84% and 27% of it outside the protected area respectively (WWF, 2014a). There is an ongoing dissatisfaction among local communities, farmers and herders on the way wild animals are managed, and the way destruction and loss are poorly compensated and treated. This dissatisfaction has resulted into the human-elephant conflicts (Shemwetta and Kideghesho, 2000; Fernando *et al.* 2008; WWF, 2014a).

1.3 Statement of the Research Problem

Absence of an effective buffer between protected areas and human settlements or farmlands in Western Serengeti is a major source of conflicts (Kideghesho *et al.* 2006; Nelson, 2012; Fridolin, 2014).

Despite the rise in human-elephant conflicts, there is little information that is known on the approaches to be applied in solving the problem. This is because most of traditional techniques such as chili essence, guarding farms, scaring elephants using noise and, planting alternative crops, buffer crops around fields have shown short-term impacts leaving a gap to be filled.

This study aims to come up with approaches with long-term impacts required to prevent and mitigate human-elephant conflicts in Game Reserves. Results obtained from this research will add to the understanding of long-term measures, opening the chance of preventing and combating existing human-elephant conflicts in western Serengeti area and other protected areas having similar problem. Moreover, the study will add knowledge on the management of socio-ecological systems.

1.4 Objectives

1.4.1 Main Objectives

The main objective of the study is to investigate the approaches for managing human-elephant conflict in Tanzania.

1.4.2 Specific Objectives

The specific objectives of the study are:

(i) To assess factors that lead to human-elephant conflicts in western Serengeti area

(ii) To examine approaches applied for prevention of human-elephant conflicts in western Serengeti area.

(iii) To examine barriers for managing human-elephant conflicts in western Serengeti area.

1.5 Research Questions

(i) What are the factors that lead to human-elephant conflicts in Western Serengeti area?

(ii) How are the new approaches applied for prevention of human-elephant conflicts in Western Serengeti area?

(iii) What are the barriers for managing human-elephant conflicts in Western Serengeti area?

1.6 Significance of the Study

The research findings are of important to policy makers in considering that elephants are ecologically very important in modifying the environment for other wildlife. Elephants are also economically important as they catalyze the National Tourism industry, which is one of the major countries source of income. Findings can be used by Government administrators, Wildlife managers, agriculturalists, environmentalists and all stakeholders as conservation yardstick and tool in formulating policies for balancing the conservation of elephant and human hood. Study findings also act as reference when mobilizing support from the community to support elephant conservation.

1.7 Scope of the Study

The research was conducted in Western Serengeti Ecosystem and the nearby villages allocated in Serengeti and Bunda Districts in Mara region, Tanzania. The study was delimitated to the allocation and selection of villages where, not all villages were directly involved in the study rather few (6) selected were considered. These were enough to represent others.

1.8 Organization of the Study

This study is organized in to five chapters. Chapter one consists of Background to the Research Problem, Statement of the Research Problem, Objectives, Research Questions, Significance of the Study, Scope and Organization of the study. Chapter two is Literature review, which includes theories on Human elephant conflict,

empirical framework, conceptual framework and research gap. Chapter three is about research design, study area, types of data, data collection methods, data analysis, validity and variability, and ethical issues. Chapter four contains the results and discussions of the research. It presents a conflict analysis and strategy design that describes various causes of conflicts between human and elephants. Lastly, is chapter five, which includes conclusions and recommendations on the long term approaches to minimize human elephant conflict.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

Human-elephant conflict is a major conservation concern in elephant range countries. A variety of management approaches have been developed and are practiced at different scales for preventing and mitigating human-elephant conflict. However, human-elephant conflict remains pervasive as the majority of existing prevention approaches are driven by site-specific factors that only offer short-term solutions, while transferring conflict risk from one place to another. Here is the review of current human-elephant conflict management approaches that describe an interdisciplinary conceptual approach to manage the existing conflict over the long-term.

2.2 Conceptual Definition

A conceptual definition tells what constructs are by explaining how they are related to other constructs. This was done by observing and analyzing present information on human elephant conflict analysis and resolution. The study reviewed current human elephant conflict in sharing resources at different spatial and temporal scales for management strategies and describe conceptual approaches to manage species coexistence over the long term.

2.3 Theoretical Framework

Conflict refers to a situation arising from two or more parties that have incompatible goals about something (Mwagiru, 2000). In understanding sources of conflicts that occur within socio-ecological systems and conflict management techniques a

theoretical framework is developed. The framework is bases on two theories, Human Needs Theory (HNT) and Conflict Resolution Theory (CRT).

2.3.1 Human Needs Theory

Abraham Maslow through his Maslow's hierarchy of needs applied human needs theory by urging that, in order to live and attain well-being, humans need certain essentials. These are called human needs or basic human needs. Humans will struggle to ensure they meet these needs. On the base of the pyramid he places food, water, and shelter followed by need for safety and security. Human needs theorists argue that conflicts and violent conducts are caused by unmet human needs. In socio-ecological systems wild animals damage human properties, and cause injury and deaths to people when their ability to meet needs is compromised resulting into conflicts with human beings (Danielsen, 2005).

2.3.2 Conflict Resolution Theory

Morton Deustch, (1949) on solving conflicts, he developed a theory of Conflict Resolution. He urged that in order to solve an existing conflict the two parties involved should cooperate in solving the conflict. They should work together in finding the constructive measures rather than working separately and come up with destructive ideas. It is considered to be "Cooperation-Constructive; Competition-Destructive" theory (Hansen, 2008).

For this case, HEC is cutting across the whole community, it is not an issue to be solved by the Wildlife Department alone. It requires multi-sectorial action from Ministries responsible for managing natural resources, agriculture and social welfare

to local communities adjacent to protected areas. This means that, in any human elephant conflict resolution both parties must sit together in order to reach mutual conclusion.

2.4 Empirical Framework

2.4.1 Causes of Human-elephant Conflicts

Human-elephant conflict refers to any human-elephant interaction which results into negative effects on human social, economic or cultural life, on elephant conservation or on the environment (AfESG, 2007) Invasion of human beings and conversion of natural habitats to human dominated land use causes fragmentation and loss of elephant habitat (Chartier *et al*. 2011). With increased contact, elephants progressively raid crop fields and break down houses to get stored crops (Fungo, 2011; Webber *et al*., 2011). Chance encounters between elephants and people living to areas adjacent to protected areas, as well as efforts of people guarding food crops in their farms against raiding elephants result in injury and death of humans (DeMotts and Hoon, 2012; Pant *et al*. 2016). Harmful methods employed by people in the process result in death and injury of elephants thereby escalating human-elephant conflicts (Mijele *et al*. 2013; Fernando *et al.* 2005; Wittemyer *et al*. 2014).

In Africa, human population growth has led to encroachment into wildlife habitats, constriction of species into marginal habitat patches and direct competition with local communities (Barua *et al*. 2013; Siex and Struhsaker, 1999). Crop damage by elephants is one of the most common causes of human-elephants conflicts in southern Africa, where rural people are dependent on traditional agriculture for their livelihoods (Osborne and Parker, 2003; Barnes *et al*. 2005; Malima *et al.* 2005).

The study done at Arabuko Sokoke forest (2001) in Kenya found that there was a correlation between water availability, rainfall, food availability and crop raiding by elephants. Occurrence of crop raiding was due to the movement of elephants from one area to another area in search of suitable habitats having enough water and food, particularly during dry seasons (Muoria, 2001).

2.4.2 Human-elephant Conflicts Intensity

The intensity of human-elephant conflict varies among different protected area segments such as inside, edge and outside the protected areas (Hartter *et al*. 2011). In addition, roads and settlements close to protected areas are mostly affected by elephant attacks (Saaban *et al*. 2011). Intensity of deaths and injuries were highest in settlements close to protected areas, corridor enclosed settlements, and protected areas' edges. This is due to the short distances between settlements which have been constructed illegally and forests or other protected areas, food scarcity inside the forest and extreme disturbances by people (Beyers *et al*. 2011). The human-elephant conflicts intensity rate is remarkable high near the edges of protected areas because of more agriculture related practices and illegal settlements (Joshi *et al*. 2011).

In addition, human-elephant conflict intensity is high inside the protected areas due to illegal human entrances. According to Sukumar (1989), 55% of human deaths which occurred in the forests comprising the Biligirirangans of Tamil Nadu were during the day, while 45% of the deaths occurred in settlements at night from a total of 123 human deaths caused by elephants in India. Moreover, factors which are more responsible for the increased deaths and injuries among the people inside the forests are weak forest management system and lack of awareness to most local people

adjacent to protected areas (Ramkumar *et al*. 2014). Human-elephant conflicts are increasing outside the forests due to crop raiding in the crop fields and raiding for stored grains in houses (Sarker and Røskaft, 2011; Sukumar, 1990).

In India around 300 humans are killed by elephants and around 200 elephant deaths are found every year (Bist, 2002). Similarly, in Sri Lanka around 150 elephant deaths are found every year due to human and elephant conflicts (Perea, 2009). According to Lee *et al.* (1986) negative interactions between humans and elephants have escalated dramatically over the last 30 years. Encroachments of forest land and establishment of new illegal settlements are the dominant causes behind the increasing intensity of human-elephant conflicts. Poor people are being driven out from their original land to forest land due to financial crisis, lack of livelihood opportunity and excess of land cost. Human-elephant conflicts intensity also varied significantly between different seasons, which mainly are due to crop availability in the fields (Bal *et al*., 2011; Gunn *et al*. 2014). The conflicts seem to increase at extreme levels during the winter and rainy seasons, when crops cultivated by local people living adjacent to the protected areas are in harvesting stage (Sarker and Røskaft, 2010b; Sukumar, 1990).

2.4.3 Control, Prevention and Mitigation Measures for Human-Elephant Conflicts

Mitigation and prevention of human-elephant conflicts require a complete understanding of the problem, its locality, specific causes and attempts to solve it, in order to develop effective management strategies for local communities (Redpath *et al*. 2013; Sitati *et al*. 2003). Various techniques employed in mitigation of human-elephant conflicts range from chasing elephants by shouting, drum-beating, noise-

making, use of fire crackers, lights, use of chili pepper and torches (Hilland Wallace, 2012; King, 2011).

Furthermore, engaging approaches such as koonkies (trained elephants), specially trained and equipped teams of people, construction of elephant barriers such as rubble walls, ditches and canals, biological and electric fences have been employed in various countries (Joshi, 2010). According to Bandara (2010) and Fernando *et al.* (2005) deployment of alarms, development of communication systems, capture, translocation and culling of problem animals, use of highly sophisticated technology such as satellite telemetry, and compensation and insurance schemes have been suggested.

In Ontario, Canada different ways to mitigate the problem of human-wildlife conflicts such as involvement of stakeholder especially local community in the development and implementation of management tools are used (Estévez *et al*., 2015). Promoting conservation of biodiversity among people through community based conservation (CBC), where local communities own and manage the area (Derocher *et al*. 2013). Encouraging local communities to initiate discussions on conflict issues tend to increase public understanding and awareness about human-wildlife conflicts (OMNR, 2005).

The study suggesting the killing of elephants as a routine method of problem animal control (PAC) was illustrated by Hoare (2001) who showed experimental data on a crop-raiding group of bull elephants. In 2011 the wildlife authorities of Botswana stated that the legal hunting quota for elephants (27 animals) was to be made up

entirely of male crop raiders, believing that, this would help control these problem animals (Bungu, 2011). Use of bees as an elephant deterrent is the other way of preventing elephants from entering the villages. Kenya uses African honey bees (*Apis mellifera*) as a deterrent to crop-raiding elephants where the sound of bees had previously caused elephant groups to either apparently retreat from the source of sound or make alarm calls (King *et al*. 2010, 2011).

Monetary compensation has been used as another way of mitigating human-elephant conflicts where it was tried at many scales but has never been successful in practice (AfESG, 2000). Botswana remains the only African country, which is still paying across the board wildlife damage compensation to local communities surrounding protected areas (DeMotts and Hoon, 2012). But it is agreeable by the government that the main triggering factor is to maintain the public relations rather than addressing the problem (Hoare, 2012). Recently in Uganda, a study conducted suggested that the actual compensation of crops and properties damaged by elephants and other wildlife species is not affordable by protected area authorities (Babaasa *et al*., 2013).

Furthermore, insisted that it is not sustainable towards conservation as the conflict seems to increase. In turn, Mackenzie and Ahabyona (2012) suggested the best way of using obtained funds to prevent and mitigate the human-elephant conflicts among local people living adjacent to protected areas, is through promotion and increase awareness on crop raiding control measures.

O'Connell-Rodwell *et al*. (2000) found that, electrical fencing was effective in controlling crop damage caused by elephants, hence reducing costs at the community

level in the East Caprivi Region of Namibia. The large number of crop raiding incidences was due to high population densities of both people and elephants in an area, resulting into an increased human-elephant conflict compared to other areas within the country (Lindeque, 1995). Local communities were encouraged to use chili-based olfactory repellents to deter elephants from entering crop fields or human habitats (Hoare, 2015; Le Bel *et al*. 2015).

Although large quantity of chili aerosols was needed in order to reach elephants to some distance where they are, once reached them the chili started to make them hot hence deter from an area (Osborn, 2002). Example. Four years of monitoring the use of chili in western Serengeti, showed increasing uptake by farmers reduced the total elephant crop raids in 22 villages by 89% (Malugu, 2010).

2.5 Conceptual Framework

The study is based on the concept that conflict analysis and resolution is the systematic study of identifying the profile, causes, and actors, dynamism of conflict and effective measures that can be applied to manage the existing conflicts. It helps conflict managers to get a clear insight on understanding the context of management of both social and ecological systems.

Conflict management is thus a central component of managing the contradicting parties or systems, as it provides the foundation to inform managers on the consideration of needs to both social and ecological systems.

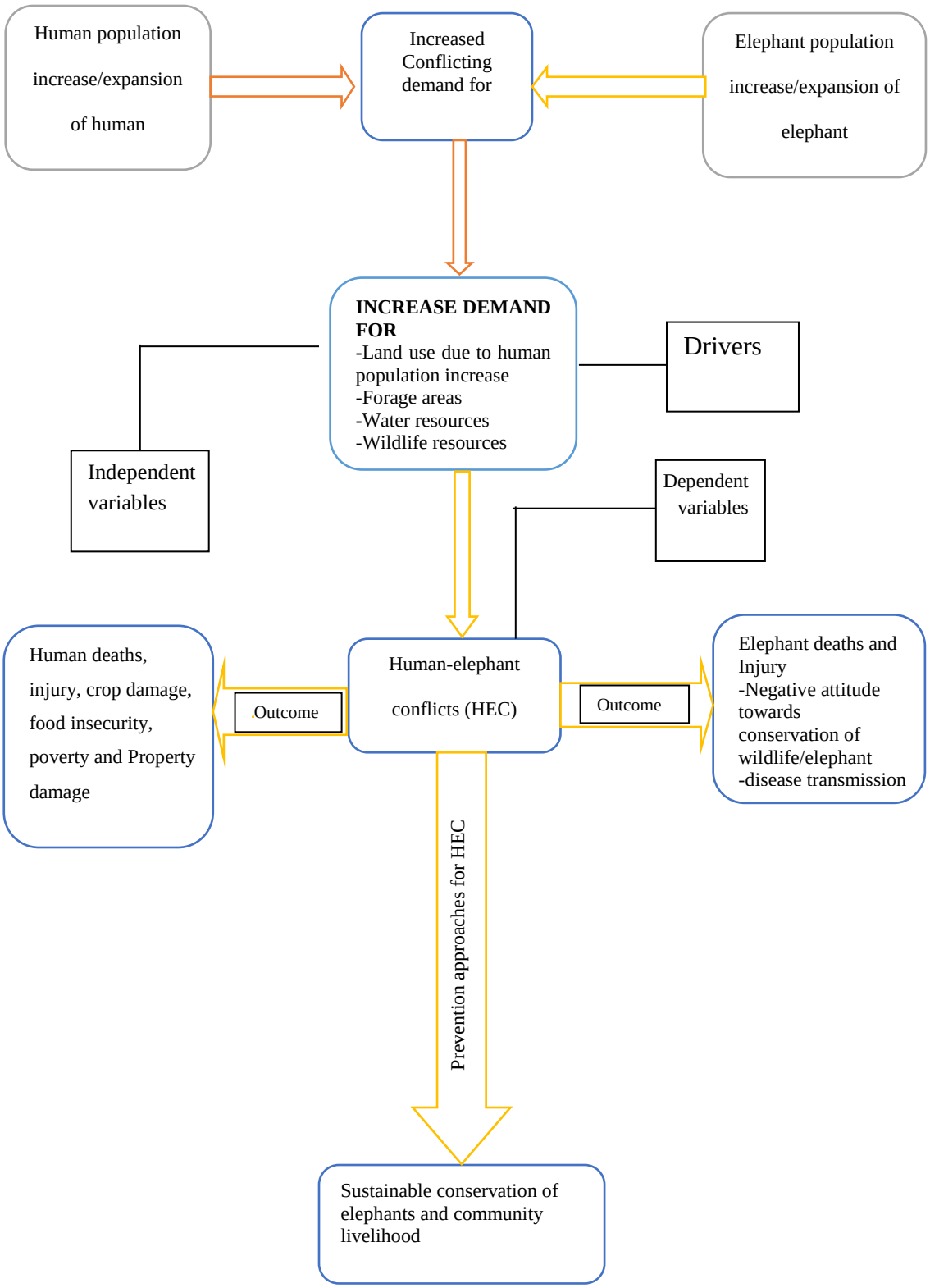

Figure 2.1: Conceptual Framework of the Study Based on Human Needs Theory (HNT) and Conflict Resolution Theory (CRT)

Source: (Modified from Mwagiru, 2000)

2.6 Research Gap

Despite the rise in human-elephant conflicts, there is little information on the approaches to be applied in solving the problem. This is because most of the traditional techniques such as chilli essence (Malugu, 2010), guarding farms (Walpole *et al.*, 2004), scaring elephants using noise and pungent materials (Pittiglio *et al*. 2014), planting alternative crops and buffer crops around fields (Hoare, 2012), and benefit sharing (Gross *et al*. 2016; RESOLVE *et al.* 2016) have shown short-term impacts leaving a gap to be filled. This study therefore, aims to assess on the long-term resolution of human-elephant conflict and promotion of peaceful co-existence for a simultaneous focusing on management efforts as well as the understanding application of approaches that directly address human-elephant conflict and the processes that link them together, within a coupled natural and human system.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Overview

Western Serengeti was chosen as a study area, because it has been reported recently to have the challenge of human-wildlife conflict. So there is a need to keep an eye in that area as well as to think on approaches that will be helpful in minimizing the magnitude of the conflict.

3.2 Research Design

A cross-sectional research design was used in collecting primary data from the study area. According to Olsen and George (2004), this type of research design covers the entire population or a sample is selected, and from these individuals, data are collected to help to answer research questions of interest. Furthermore, it is clarified that it is called a cross-sectional because the information about the subject is gathered only at one point in time. This research design is chosen because it is more flexible and less costly (Babie, 1990; Bailey, 1994). Individuals' views and opinions concerning new approaches for prevention and mitigation of human-elephant conflicts in Western Serengeti concessions, were collected through direct observation, key informants in-depth interviews household survey and questionnaires (Polit *et al*. 2001).

3.2 Description of the Study Area

Western Serengeti includes Part of Serengeti National Park, and Ikorongo, Grumeti and Kijereshi Game Reserves.

3.2.1 Location

The study area lie between latitudes 1º30' and 2º45' S and longitudes 33º00' and 35º30' E. The area is covered by Ikorongo, Grumeti and Kijereshi Game Reserves is 563km^2, 416 km^2 and 66 km^2 respectively (Chamba, 2017).

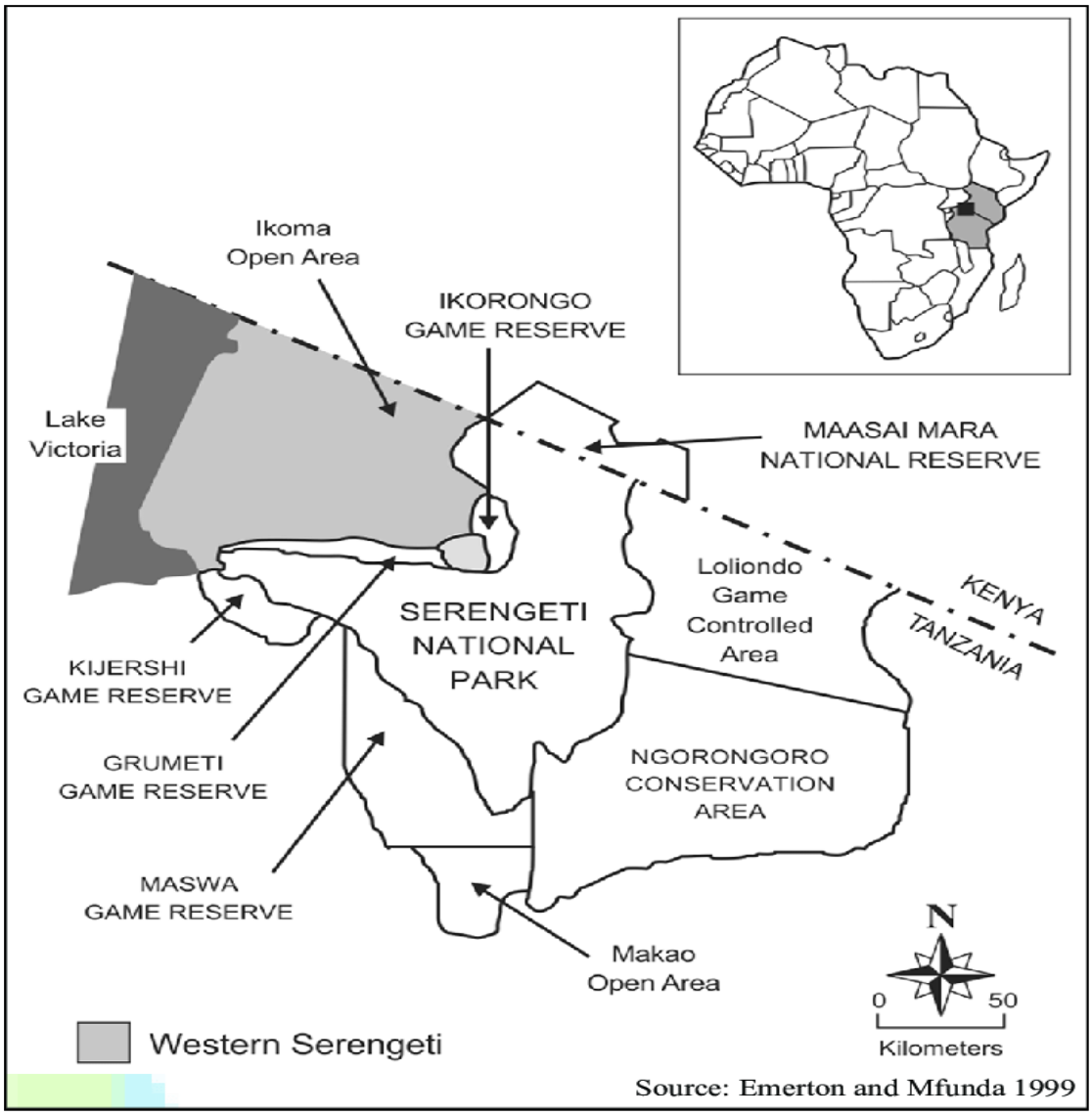

Figure 3.1: Map of Serengeti Ecosystem, with the Study Area of Western Serengeti

3.2.2 Climate

The climate of the area is sub-tropical with a dry and relatively cool seasons from May to August, a warmer and still quite dry season in September and October, and a

rainy and quite hot season from November to April. The area is characterized by an average annual rainfall approximated to range between 900 mm and 1,000 mm declining towards the park boundary and increasing towards Lake Victoria and an annual temperature range of between 21°C and 27°C (Climatestotravel.com, 2019).

3.2.3 Vegetation

Vegetation cover of an area is a highland savannah with thorny tree woodlands and plains ranging from approximately 1,100 to 2,000 meters above sea level. Western Serengeti is an integral part of the Serengeti-Mara ecosystem, known as the home of the Great Migration as it protects the path of the annual wildebeest migration (Kideghesho *et al*., 2006).

3.2.4 Human Population

Western Serengeti bordered by a diverse of ethnic groups which are approximately to be more than 20 tribes in the area and the major areas are Ikoma, Taturu, Ikizu, Nata, Isenye, Zanaki, Sukuma, Kurya, Zizaki, Ngoreme and Jita. Most of them engage into crop cultivation as well as livestock keeping for sustaining their livelihood. Crops cultivated are maize, cassava, millet and sorghum as food crops and cotton as a cash crop. Livestock include goats, donkeys, cattle and sheep (Kideghesho, 2006; Galvin *et al.*, 2008).

3.3 Sampling Procedures

The study was conducted within villages bordering Western Serengeti. The research used three stages sampling technique, at the first stage, 6 villages were selected purposively based on the nearest distance from the protected area boundary and

intensity of human-elephant conflicts reported. In the second stage, from selected villages the researcher used random sampling to select the blocks. The last stage involved simple random sampling to sample households from the sampled blocks. The sampling frame was the village registry books containing list of households that served as sampling units.

3.3.1 Sample Size

In order to ensure equal chance of being included in the sample a simple random sampling technique was adopted, while a purposive sampling technique was used for key informants (Parahoo, 1997).

Table 3.1: Sample Size

S/No	Strata	Sample responded	Percentage%
1	TAWA Staff	30	20.00
2	SENAPA Staff	10	6.66
3	Private Partners	30	20.00
4	Districts Leaders	10	6.66
5	Village leaders	20	13.33
6	Villagers	50	33.33
Total		**150**	**100.00**

Source: Research data, 2019

3.4 Types of Data

Data collected in this research were obtained from different sources i.e. Primary and Secondary data.

3.4.1 Primary Data

These are the data that are collected for the first time by an investigator for a specific purpose. Primary data are pure in the sense that no statistical operations have been performed on them and they are original (Kaswamila, 2004). Primary data used in this study were collected from sampled population through observation, questionnaires, focus group discussion and in-depth interviews.

3.4.2 Secondary Data

These are the data that has already been collected by some researchers or investigators in the past and available either in published or unpublished form. For examples of secondary data are information from reports, books, websites and journals (Kothari, 2004).

3.5 Data Collection Methods

3.5.1 In-depth Interview

Kothari, (2004) states that, “Interview method of collecting data involves presentation of oral – verbal stimuli and reply in terms of oral – verbal responses”. Interview was used to collect information mainly from the people with specific knowledge where the respondents’ answers were recorded directly. This method of data collection involved workers of game reserves and villagers adjacent to western Serengeti ecosystem who explained much on factors influencing human wildlife conflicts in western Serengeti.

3.5.2 Questionnaires

According to Kothari, (2004) a questionnaire consists of questions printed or typed in a definite order in a form or set of forms. Questionnaires were provided to TAWA,

and SENAPA staff, Private partners, District leaders and village leaders in order to get information about the magnitude of human elephant conflict and possible approaches to overcome it.

3.5.3 Focus Group Discussions

Focus group discussion was administered to people who are knowledgeable to the study area including group members of named Reserves and Serengeti National Park and selected members from the community. Data obtained through recording discussion using notebooks. The information from focused group was on the possible approaches, which will be used to minimize human –elephant conflicts in the area. Different groups of knowledgeable people about HEC were focused, groups had different number of people depending on their availabity since they are much occupied people. A large group being of forty (40) staff of wildlife sector who provided their professional views on suitable approaches to minimize HEC especially in translocation of problematic elephants.

3.5.4 Observation

Observation method was applied where appropriate especially on the physical assessment of overstocking effects to the environment or extensive cultivation blocking the wild animals' dispersal areas.

3.5.5 Literature Search

Literature search was used in order to accrue relevant information about human-elephant conflict. It gave information about other places with the same problem, approaches used and helped in suggestion on the new approaches which can possibly be used in the area to minimize the conflict.

3.6 Data Processing and Analysis

Data analysis was done using statistical techniques including Microsoft Excel and/ or Statistical Package for Social Scientists (SPSS) pack in giving the full report from the study area. For report and data interpretation and presentation, the computer Microsoft word and excel programs were applied to make text, tables and graphs for more understanding. Secondary data obtained from literatures also serve to give some baseline, benchmarks and cover for some gaps that may not have been covered adequately by the research.

3.7 Validity and Variability

According to Thatcher (2010) validity of a measuring instrument indicates its ability to measure what it is intended to measure. That is the extent to which the obtained variance in the measuring instrument imitates the true variance among the individuals being tested (Kothari, 2004). The validity test conducted to test the tool for accuracy and adequate coverage of the research.

3.8 Ethical Issues

All aspects of ethics regarding age, sex, religion and culture were considered respectively in order to avoid biasness and get correct information from the study area. This research is for academic purposes, whoever were consulted in the data collection, were requested to give information in his or her free willingly. All the information obtained from study area is confidential. Permission for data collection was sought from responsible authorities according to research approval from the Open University of Tanzania (Appendix 3)

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Overview

This chapter contains the results and discussions of the research. It presents a conflict analysis and strategy design that describes various causes of conflicts between human and elephants. It identifies factors that lead to human-elephant conflicts, examines the approaches applied for prevention and mitigation of human-elephant conflicts, and identify barriers toward applied approaches and techniques for managing human-elephant conflicts in western Serengeti area.

During data collection process, the researcher was able to interact with 150 respondents as indicated in Table 4.1. The Interviewees includes TAWA Staff (in Game reserves), Private Partners of Conservation and Tourism from different organizations, District Councils workers, village leaders and other selected villagers. Result and Discussion are basing on the objectives of the research.

4.2 Respondents Demographic Characteristics

Demography is the statistical study of populations especially of human beings based on the characteristics, which are easily to identify. These includes qualities such as age, sex, education and work experience (Kaswamila, 2004).

4.2.1 Respondents Gender

Since men and women do have different ideas and perceive things differently. It was important to include gender in order to get correct views from both men and women.

Table 4.1: Sex of Respondents

Sex	Respondents	Percentage%
Male	100	66.7
Female	50	33.3
Total	**150**	**100**

Source: Field Survey, 2019

Table 4.1 shows that, most of the respondents were male by 66.7% and 33.3% were females. This shows that both groups were fairly represented. The number of women was a bit lower because of the nature of the area that women are not participating much in other activities rather than taking care of families. Despite that, the combination gave clear perspective of both sexes regarding to the study.

4.2.2 Age of Respondents

Table 4.2: Age Range of Respondents

Age Group	Respondents	Percentage
21-30	20	13.33
31-40	30	20.00
41-50	50	33.33
51+	50	33.33
Total	**150**	**99.9**

Source: Field Survey, 2019

Table 4.2 shows the majority of respondents were of the age group 41 - 50 and 51+, this implies that their answers are accompanied with a good experience in human elephant conflict, and can trace back the history of conflict settlement and the appropriate approaches.

4.2.3 Respondents Educational Level

Table 4.3: Education Level of Respondents

Level of Education	Respondents	Percentage
Primary	80	53.33
Secondary	50	33.33
Tertiary education	20	13.33
Total	**150**	**99.99**

Source: Field Survey, 2019

Table 4.3 shows the percentage distribution of respondents according to their level of education, the majority were primary leavers (53.3%) followed by Secondary level education 33.33% and Tertiary education by 13.33% which implies their understanding and awareness of the matter of the study is high.

4.2.4 Respondents' Length of Stay in the Area

Table 4.4 indicates that 33.33% of respondents have been in the area for 20 to 27 years, which is similar to those who stay 16 to 19 years followed by, 12 to 15 years (20%.) This implies that they know and understand conservation disputes especially human elephant conflict, and suitable approaches of resolving them because they have a long experience.

Table 4.4: Respondents Length Stay in the Area

Length of Stay in the area	Respondents	Percentage
1 – 3 years	4	2.7
4 – 7 years	6	4.0
8 – 11 years	10	6.7
12 – 15 years	30	20.0
16 – 19 years	50	33.3
20 – 27 years	50	33.3
Total	**150**	**100.0**

Source: Field Survey, 2019

4.3 Factors Influencing Human-Elephants Conflicts in Western Serengeti Area

Direct factors are; crop damage, increased elephant population, encroachment, lack of clear buffer zone, infrastructure damage and lack of compensation plan. Fifty percent (50%) of all the respondents (n=150) contended that crop raiding by elephants was a serious problem (Table 4.5). The major crops which were destroyed are maize, cotton, millet, cassava, rice and sweet potatoes. This result concur with a study done in Kenya in 2009 by King *et al.* 2009 which showed that these major crops which were more affected by elephant raiding. This resulted into an increased sense of food insecurity among the people. The most intense conflict appeared to be on the boundary between protected areas and village land and within and around traditional wildlife movement routes.

Table 4.5: Factors Influencing Human Elephant Conflict

Factor	Frequency (n150)	Percentage
Damage of crops	75	50.0
Elephant population increase	30	20.0
Human population increase	18	12.0
Lack of buffer area	7	4.6
Basic structures damage	6	4.0
Lack of compensation plan	5	3.3
Human attack	5	3.3
Constant	4	2.6

Source: Field Survey, 2019

4.3.1 Damage of Crops

Findings from the survey (Table 4.5) showed that 50% of the respondents considered crop damage caused by elephants as one among the major factors influencing conflicts

between human and elephants. This is an indication that crop damage done by raiding elephants contributes to conflict between elephants and people of Western Serengeti area. The extent to which crop raiding incidences caused by elephants had an influence on the occurrence of HEC is presented in the Table 4.6.

Table 4.6: Extent to which Crop Raiding Incidences Enhanced HEC

Extent	Frequency (n=150)	Percentage	Rank
Very high extent	80	53.3	1
High extent	30	20	2
Moderate extent	25	16.7	4
Not applicable	15	10	3
Total	**150**	**100**	

Source: Field Survey, 2019

The majority of the respondents indicated that crop raiding by elephants contributed to HEC at a very high extent as it was ranked the first, then high extent and medium extent. This finding concurs with Naughton-Treves (1998) who found that encroachment of crop cultivation near protected area boundaries increases pressure on wild animals such as elephants forcing them to move outside the protected area into village land. Also, according to Bunda district Annual Report in 2017, approximately 8954.5 acres of crops were damaged by elephants in Serengeti district, whereas about 6438.5 acres were damaged in villagers from Bunda District leaving the majority of farmers without food.

On the other hand, Table 4.7 showed that, in 2019 cropping season about 1819 acres were cultivated of which 847.5 acres were raided by elephants that accounting to 46.6% of the cultivated land (Districts Reports, 2019).

Table 4.7: Crop Damage by Elephants in 2019

Village Name	Nyamatoke	Hunyari	Iharara	Makundusi	Nyichoka	Bonchugu	Total
Cultivated farms (Acres	286.5	292	218.5	391.5	315	315.5	**1,819**
Damaged farms (Acres)	140.5	138	124	166.5	112	166.5	**847.5**

Source: Serengeti and Bunda Districts Reports, 2019

4.3.2 Elephant Population Increase

From Table 4.5, 30 respondents equal to 20% indicated that elephant population has been increasing in the study area causing it to be one among the factors influencing HEC in their villages. In the past, they had never seen elephants in the village land but later on, few elephants started to invade and raid crops within the villages. They also added that, "*they had never seen elephants within the village until in the 2000S where the invasion started and has been increasing temporally"*. This was further evidenced by a report from WWF showing a general increasing trend in the elephant numbers within the Serengeti ecosystem (WWF, 2014a).

Furthermore, successful conservation initiatives implemented in protected areas, has resulted into massive increase in the population of elephants (Goodman, 2014). This increase in elephant population exerts pressure on grazing land within the protected areas resulting into the elephants to move in and out of the protected area boundary in search of resources such as food and water. Fig. 4.1 shows that elephant population in Ikorongo, Grumeti and Kijereshi Game Reserves has been changing substantially over ten years since 2009 to 2019. However, since 2011 onwards the trend has been increasing gradually suggesting the persistence of elephant invasions into the human dominated land around the reserves.

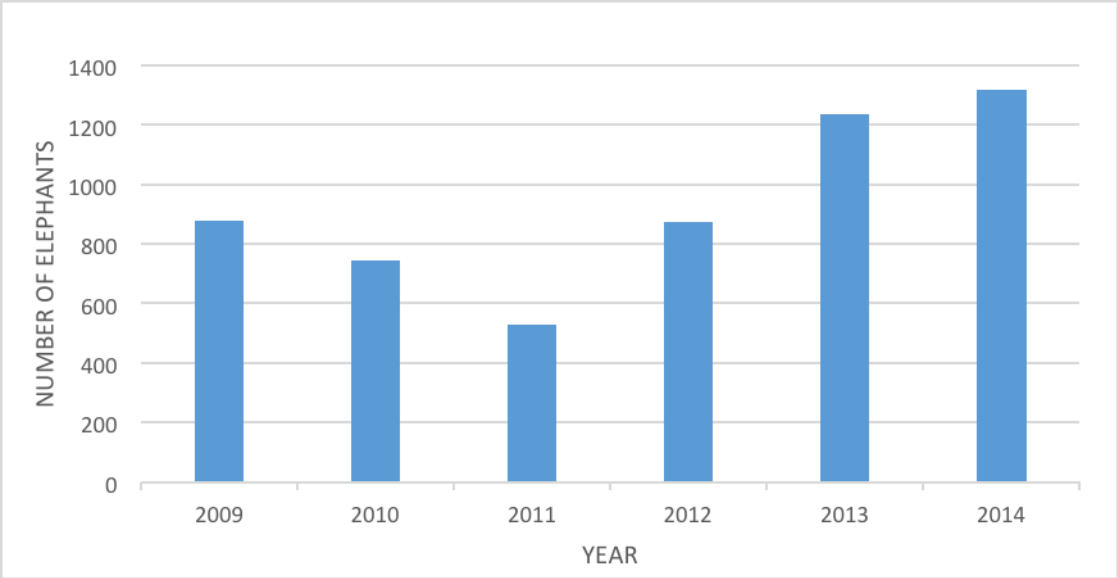

Figure 4.1: Trend in the Size of the Elephant Population in IGKGRs

Source: Goodman, (2014)

In addition, 73% of the respondents indicated that an increase in elephant population within the neighboring PAs contributed to the occurrence of HEC, (Table 4.8).

Table 4.8: Extent to which Increased Elephant Population Enhanced HEC

Extent	Frequency (n=150)	Percentage	Rank
Very high extent	109	72.7	1
High extent	20	13.3	2
Moderate extent	15	10	3
Not applicable	6	4	4
Total	**150**	**100**	

Source: Field Survey, 2019

4.3.3 Human Population Increase

The human population in Serengeti and Bunda Districts was over 249 420 and 335 061 in the 2012 national census, and has been rising at an annual rate of around 3.5% and 2.6% respectively (NBS, 2012). Ikorongo, Grumeti and Kijereshi Game Reserves

are encroached by human settlements and farms. This exerted more pressure on protected areas land for settlements and agricultural activities. In the sampled villages, about 3% of the surveyed households were found within 500 meters from the protected area boundary, where by these meters were supposed to be buffer zone. This increased vulnerability and exposure of human beings and crop fields to elephants once moving near or outside the protected areas. Areas that were highly encroached by human settlements and farms were considered to be high conflict zones.

As a whole, this was evidenced by the intensity of crop damage, which occurred in the surveyed households from the sampled villages. The intensity being higher in Makundusi village which had 166.5 acres damaged with an average distance of 1.6km from PAs boundary, followed by Bonchugu village (166.5 acres damaged with 1.7km average distance from PAs boundary), Nyamatoke village (140.5 acres damaged with 2.1km average distance from PAs boundary), Hunyari village (138 acres damaged with 3.6km average distance from PAs boundary), Iharara village (124 acres damaged with 4.7km average distance from PAs boundary) and Nyichoka village (112 acres damaged with 5.7km average distance from PAs boundary) (Figure 4.2).

Furthermore, about 18% of the respondents from the surveyed households considered the short distance from households to protected area boundary to be among the factors influencing the HEC (see Table 4.5). Although, the respondents observed that, the protected area boundary has been moving from the previously established boundary towards the village land, findings on the extent to which human population increase and encroachment contributed to the occurrence and increasing of the HEC are summarized in the Table 4.9. About 80.7% of 150 respondents suggested that

encroachment influenced HEC to a very high extent followed by 9.6 % who suggested that it influenced to a moderate extent.

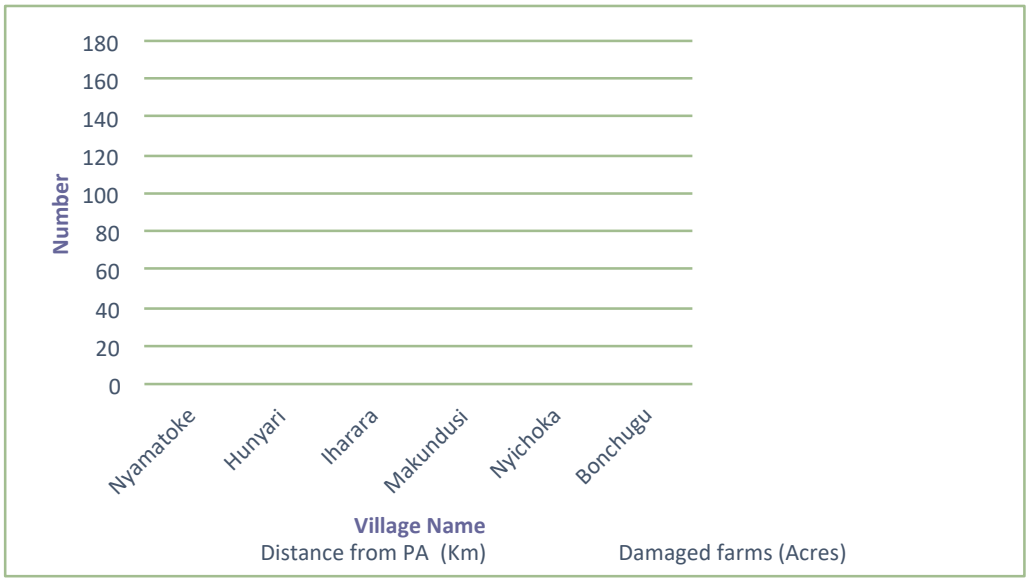

Figure 4.2: Crop Damage Against Village Average Distance

Source: Ikorongo Grumeti, Field Report, 2018

Table 4.9: Human Population Enhanced HEC

Extent	Frequency (n=150)	Percentage	Rank
Very high extent	121	80.7	1
High extent	12	8.0	3
Moderate extent	14	9.6	2
Low	3	1.6	4
Not applicable	0	0	
Total	**150**	**100**	

Source: Field Survey, 2019

4.3.4 Lack of Buffer Area

Absence of large enough and clear buffer zone is one among the long-term challenges facing IGKGRs. To the north of Grumeti Game Reserve is the Robana River forming the boundary between the reserve and surrounding villages, where at one side is the

protected area and the other side is the village land. It is also the same to Ikorongo Game Reserve and surrounding villages where the established boundary is made up of small pillars (beacons) without clear buffer area between the land of villagers and protected area.

From the surveyed households, 4.6% of the respondents (Table 4.5) perceived that lack of a clearly defined buffer area between game reserves and adjacent communities was among the factors escalating the HEC. Table 4.10 shows that lack of clear buffer area influenced the occurrence of HEC in very high extent was ranked the first, followed by those who ranked it to a high extent.

Table 4.10: Extent to which Lack of Clear Buffer Area Enhanced HEC

Extent	Frequency (n=150)	Percentage	Rank
Very high extent	90	60.0	1
High extent	30	20.0	2
Moderate extent	25	16.6	3
Low extent	3	2.0	4
Very low extent	2	1.3	5
Not applicable	0	0	6
Total	**150**	**100**	

Source: Field Survey, 2019

4.3.5 Basic Structures Damages

Basic structures damages caused by problem elephants are house breaking, paddock, fence break, and damage for various reasons when elephants are searching for food grains or to rescue their calves if they have ventured inside.

Findings in Table 4.5 showed that 4% of the respondents indicated that elephants destroyed their houses, food stores and water wells in the year 2017 only. Several cases were also reported where house fences made up by sisal were destroyed as elephants feed on sisal especially during the dry season where they acquire food as well as water from the sisal. From 2008 to 2014, 61 incidences of infrastructure and other damage were reported to occur in villages adjacent to IGKGRs (Field Survey, 2019).

Table 4.11 indicates that among the respondents who suggested that infrastructure damage had an influence on occurrence of HEC majority ranked higher extent first, moderate extent and very high extent was rank fifth. This implies that infrastructure damage caused by problem elephants influences the existing HEC in the area.

Table 4.11: Extent to which Infrastructure Damage Enhanced HEC

Extent	Frequency (n=150)	Percentage	Rank
Very high extent	10	6.6	5
High extent	75	50.0	1
Moderate extent	30	20.0	2
Low extent	20	13.3	3
Very low extent	10	6.6	4
Not applicable	5	3.3	5
Total	**150**	**100**	

Source: Field Survey, 2019

4.3.6 Lack of Compensation Plan

There is no compensation scheme for damages caused by wild animals in Tanzania as the approach seems to be more costly and challenging in its implementation. Instead

there is a consolation scheme titled "*The Wildlife Conservation (Dangerous Animals Damage Consolation) Regulations, 2011*" established under Section 121 of the Tanzania Wildlife Conservation Act of 2009 (URT, 2009). Absence of a clearly defined compensation plan for damages done by elephants and other wild animals facilitates and escalates the occurrence of HEC within the study villages. It causes dissatisfaction among the people as the existing consolation plan seems unsatisfactory to local people as the amount being paid does not match to total cost incurred or actual value of the destroyed property. This can be evidenced by 3.3% of the respondents who indicated that absence of well-defined compensation plan facilitated the conflict between them and elephants in their villages.

Table 4.12 shows that influence from lack of a compensation plan in the management of HEC to the occurrence of conflicts. 53.3% of respondents rank it at high level.

Table 4.12: Extent to which Lack of Compensation Plan Enhanced HEC

Extent	Frequency (n=150)	Percentage	Rank
Very high extent	50	33.3	2
High extent	80	53.3	1
Moderate extent	12	8	3
Low	2	1.3	5
Not applicable	6	4	4
Total	**150**	**100**	

Source: Field Survey, 2019

4.3.7 Elephant Attacks

Elephants have been threatening human being where by some have been injured and killed by the problematic elephants. Attacks have been occurring when elephants

invade in the villages in searching for food and water and meet with farmers in their farms or homesteads. 3.3% of the respondents from the surveyed villages who indicated that elephant attacks to humans that were reported to occur within their villages increased their hatred to problematic elephants.

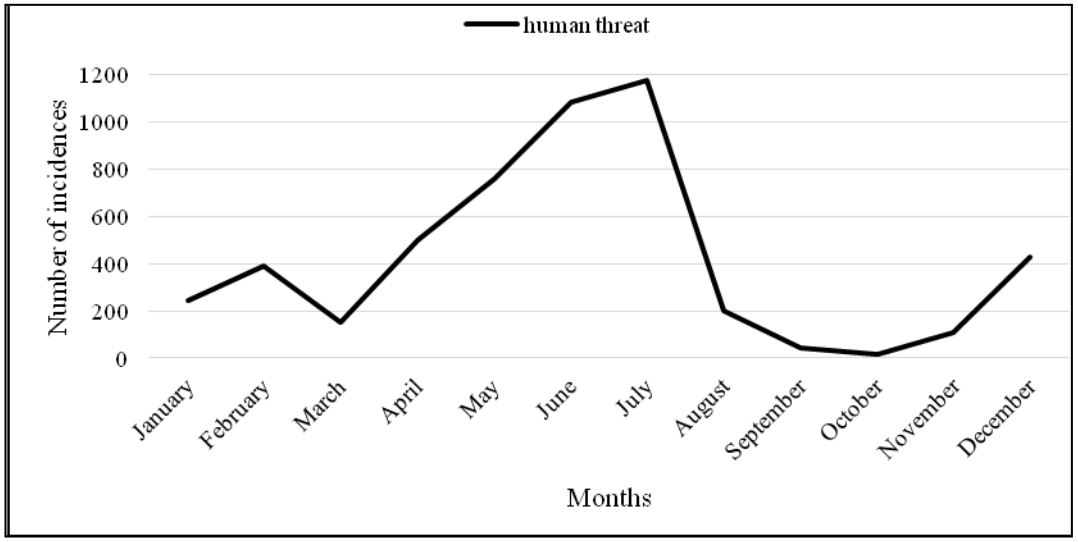

Figure 4.3: Trend line Showing Elephant Threats to Human in Serengeti District
Source: Serengeti District Council, Problem Animals Report, (2018)

According to data recorded from year 2008 to 2015 in villages of Serengeti and Bunda District, human threats were higher in the months of June, July when the crops are mature (Figure 4.3 and 4.4). This increase in threats from elephants was aligned with seasonal increase in crop raiding incidences within the villages because of availability of crops in farms during that time of the year.

Reported incidences where people killed and injured by problematic elephants were considered to have an influence to the occurrence of HEC by the majority of the respondents and ranked at a higher extent (1), followed by high extent (2) and moderate extent (3) (Table 4.13).

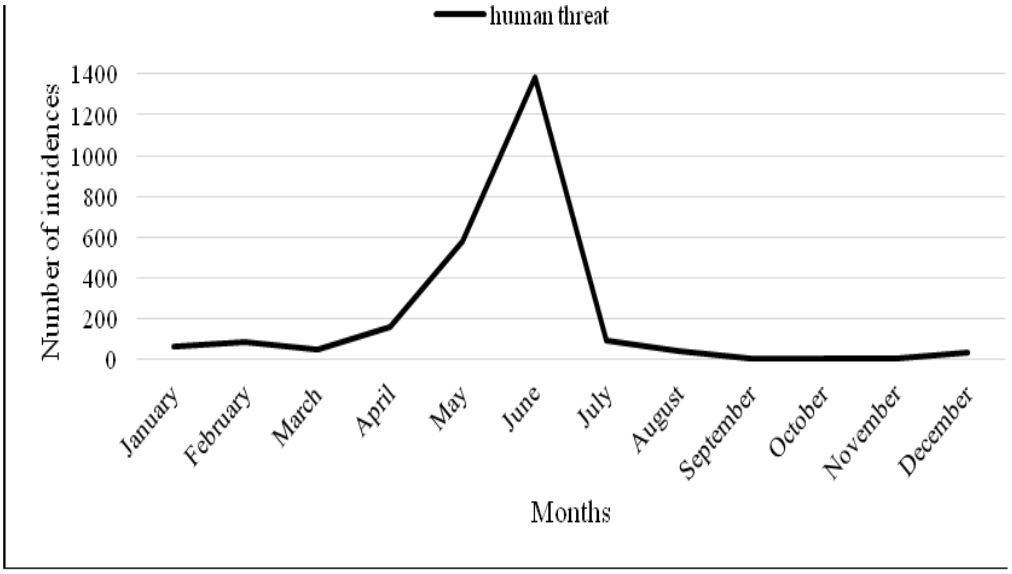

Figure 4.4: Trend-line Showing Elephant Threats to Human in Bunda District
Source: Bunda District Annual Report, (2018)

Table 4.13: Extent to which Elephant Attacks Human Habitats

Extent	Respondents (n=150)	Percentage	Rank
Very high extent	35	23.3	2
High extent	90	60.0	1
Moderate extent	15	10.0	3
Low	6	4.0	4
Not applicable	4	2.7	5
Total	**150**	**100**	

Source: Field Survey, 2019

4.3.7.1 Possible times for Conflict Occurrence

The study revealed that, most raiding happens at night. Of all 150 respondents, 76.7% indicated that elephant conflicts occurred at night (Table 4.14). Respondents further indicated that due to the nature of most of elephant invasions being in the night they are forced to spend most of their night time in farms guarding their crops against raiding elephants. This in turn increases risk of being injured or killed by elephants.

This concurred with the general notion that “elephants spend most of their time eating and sleep for about two hours a day” (Archie and Chiyo, 2012).

Table 4.14: Time when HEC Occurred

Time of Day	Respondents (n=150)	Percentage
During the Day	20	13.3
At Night	115	76.7
All the Time	15	10

Source: Field Survey, 2019

4.3.7.2 Time of the Year when Conflicts Occur

The highest number of incidents was recorded in June and July, 2019 with a mean of 130 incidences per month whereas the lowest recorded incidences were in September and October with a mean of 2 incidents per month.

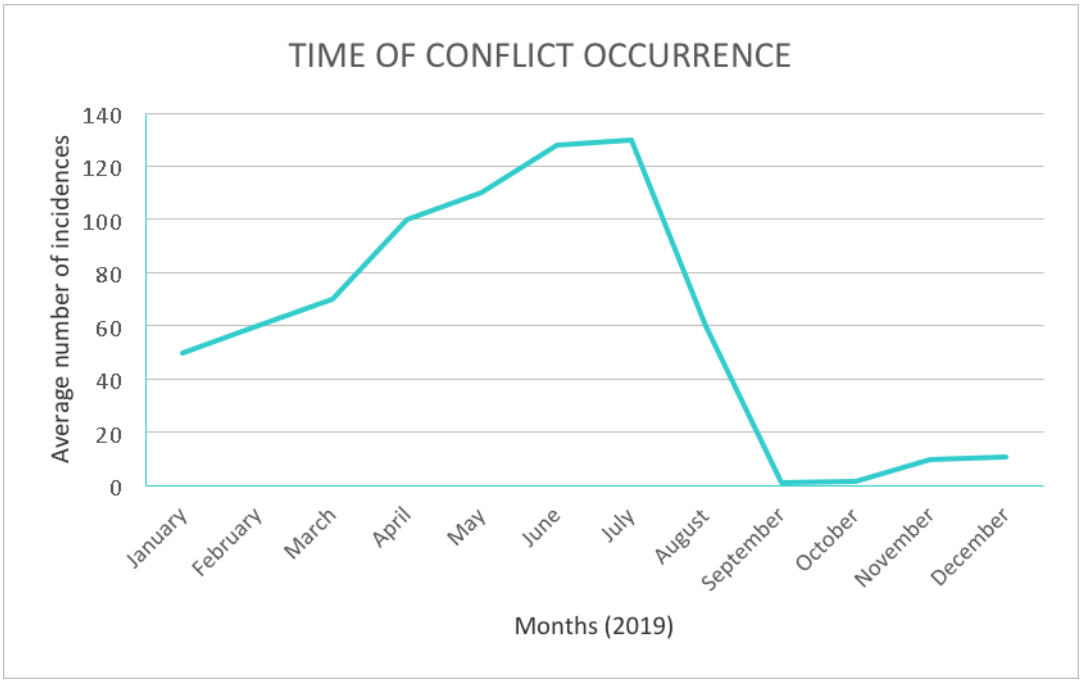

Figure 4.5: Monthly Number of HEC Incidences for Year 2019

Source: Serengeti District Council Profile Report, (2019)

Though there isn't a precise timing, mostly the farm incursions happen when most parts of the reserves and the Serengeti National Park are beginning to dry, and the elephants are looking for additional nutrition (Serengeti District Council Profile Report, 2019). There are certain times of the year when the elephants from IGKGRs begin moving into the farms (Malugu, 2011).

4.4 Approaches for HEC Mitigation

There is a demand for more effective measures with long-term impact to prevent and mitigate the HEC. Due to advancement of technology the use of un-conventional mitigation measures such as Construction of Trenches, Electric fencing, Buffer Zone Management Units (BZMUs), Geo-fencing system, Wireless Sensing Network (WSN), and Translocation of problem elephants together with traditional techniques showed fairly positive results in the management of HEC. According to Dhanaraj & Sangiah (2017) and Sheela *et al*. (2016) application of advanced techniques in the management of HEC across the global showed positive impacts with long-term results.

Following the study survey that was conducted in the sampled villages from Bunda and Serengeti Districts, respondents from the surveyed households suggested new six measures namely; Construction of Trench (95.3%), Electric fencing (95%), Buffer Zone Management Units (BZMUs) (92.7%), Geo-fencing system (92.3%), Wireless Sensing Network (WSN) (85.3%), Translocation of problem elephants (11.7%), and Evacuation of people near protected area boundary (22%) (Figure 4.6). Moreover, the proposed measures were ranked in regard to the number of respondents who opted

particular measures. In which the ones with large number of respondents who opted them were ranked higher, followed by those with small numbers (Figure 4.6).

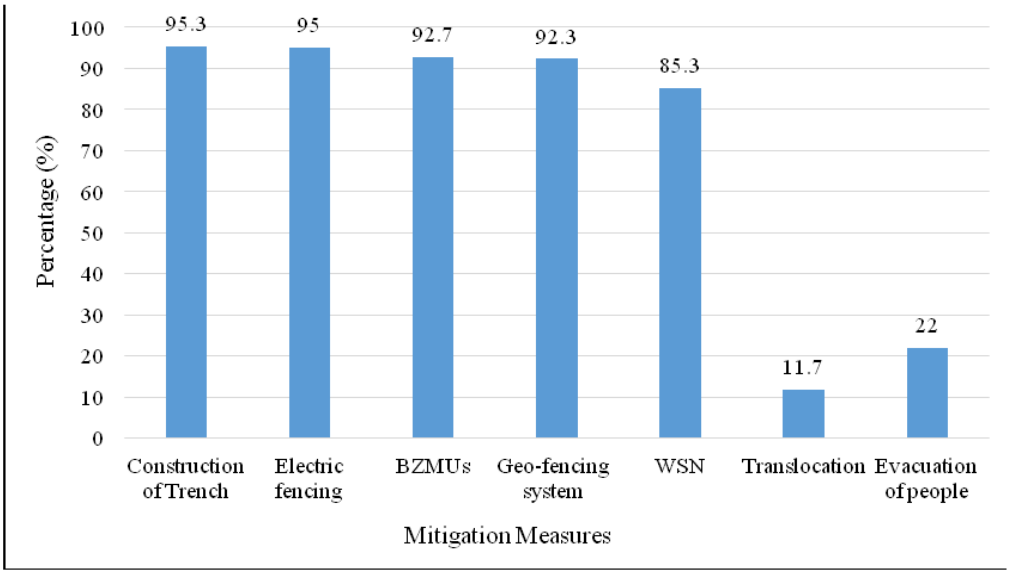

Figure 4.6: Unconventional HEC Mitigation Measures

Source: Field Survey, 2019

4.4.1 Construction of Trench

A trench, about 20ft wide and 8ft deep is excavated at the reserves edge (Fig. 4.7). It is a deterrent to non-jumping animals like elephants. The technique has been applied in majority of National parks in India, Sri Lanka and Uganda (Babaasa *et al*. 2013; Fernando *et al*., 2008; Mackenzie and Ainebyona, 2012).

95.3% of respondents in the surveyed villages indicated that trench construction could be applied as an unconventional mitigation approach to the HEC (Figure 4.6). It is more effective as a physical barrier that will prevent elephants moving out of the protected areas boundary into village land. It also shows that (46%) of the respondents indicated that construction of trench along the protected areas boundary was given a very high priority as a measure that will result into positive and long-term prevention

of elephant incursions into the village land (Table 4.15). This implies that construction of a trench along the PAs boundary will have a long-term impact on mitigating the HEC within the communities surrounding the IGKGRs.

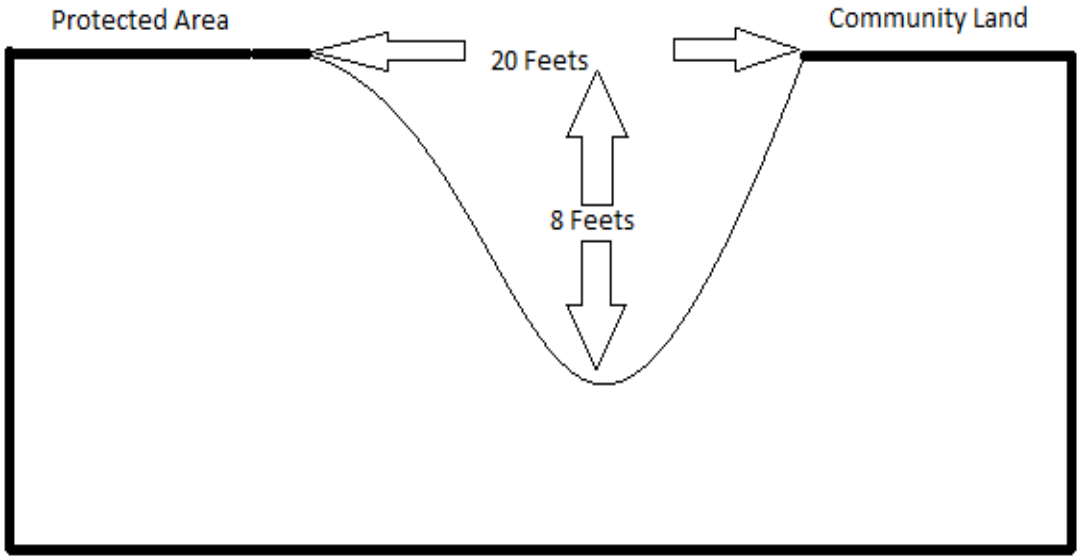

Figure 4.7: Example of Schematic Diagram of the Proposed Trench Construction
Field Observation, (2019)

Table 4.15: Prioritization of Trench Construction

Priority	Respondents (n=150)	Percentage
Very high	70	46
High	33	22
Medium	27	18
Low	15	10
Very low	5	3.3
Total	**150**	**100**

Source: Field data

4.4.2 Electric Fencing

Electric fences have been quite effective in preventing problem animals, particularly habitual raiding elephants in most countries facing the HEC (Babaasa *et al*. 2013).

The technique acts as the physical barrier preventing the elephants from invading farms in the village land bordering the protected areas. The erection of electric fence powered by solar energy was considered an alternative measure following the failure and short term effectiveness of the traditional measures (Figure 4.8).

Majority of the respondents in the surveyed villages (95%) indicated that erection of electric fence along the boundary between IGKGRs and villages will have a positive impact over the conflict as it will restrict elephants' movement from PAs into farmlands located along the reserves boundary. The technique was ranked the second (2) as a technique with long-term solution to elephant menace within the communities surrounding the IGKGRs.

Figure 4.8: Electric Fence at Gurmeti Game Reserve Limiting Elephants Crossing from PAs to Villages

Source: (Field Survey, 2019)

Respondents were asked about the priority to which the electric fencing was considered an alternative HEC mitigation measure and results are presented in Table

4.16. Results in Table 4.18 show that majority of the respondents (50%) presented high priority to electric fence as a mitigation measure with long-term impact followed by the ones presented a very high priority to the technique (33.3%) and medium priority (10%).

Table 4.16: Prioritization of Electric Fencing

Priority	Respondents (n=150)	Percentage
Very high	50	33.3
High	75	50
Medium	15	10
Low	7	4.6
Very low	3	2
Total	**150**	**100**

Source: Field Survey, (2019)

The same approach has been used in Amboseli – Tsavo – Kilimanjaro ecosystem. One of the ways the foundation works strategically to mitigate the issue is by building crop-protection fences to deter elephants from entering farmed areas in the first place. Since 2016, Big Life has been working with local communities and partners on an ambitious solution to crop-raiding in the areas with the most incidents: the construction of an electric fence that establishes a hard boundary between farmers' crops and hungry elephants. To date, 100 kilometers (about 62 miles) of the needed 120 kilometers (about 74 miles) have been constructed. The impact is nothing short of extraordinary. There has been a 90 percent decrease in the number of elephant crop-raids in areas protected by the fence. Of equal importance, there are signs that public opinion toward elephants has improved.

Before the fence, only 22 percent of local community members said that they thought positively of elephants. Today, that figure has risen to 77 percent, with 97 percent of people believing that the crop-protecting fences have been effective at eliminating human-elephant conflict.

“I can’t remember the last time I harvested this much," said a local farmer adjacent to the fence. "The fence is a life-saver for farmers. In the past, we invested a lot of money to stop the raids, but our efforts were in vain. In hindsight, this fence is exactly what we've been looking for” (Big Life Foundation, 2016).

Figure 4.9: Construction of Electric Fence at Amboseli, Tsavo and Kilimanjaro Ecosystem

Source: Big Life Foundation, (2016)

4.4.3 Buffer Zone Management Units (BZMUs)

Buffer Zone Management Units comprise of specialized personnel dedicated to respond quickly upon elephant’s invasion or when about to cross from PAs into

village land. About 92.7% from the surveyed villages suggested that a clearly delineated buffer zone should be established between the IGKGRs, boundary and its adjacent villages. It was ranked third (3) as the technique of choice among the respondents. They further indicated upon creation of a clearly defined buffer zone, there should be establishment of Buffer Zone Management Units (BZMUs) dedicated to the protection and management of the buffer zone. Moreover, establishment of the BZMUs should be in line with establishment of permanent ranger posts along the buffer zone across the villages.

The respondents were asked to indicate the level of prioritization on the establishment of BZMUs as an alternative measure to mitigate the HEC in the study site and results are presented in Table 4.17. The findings show that the majority of the respondents presented a very high priority (76.6%), whereas 19.8% indicated high priority to the approach. This indicates that the approach was considered effective to mitigate HEC by the respondents to a great extent.

Table 4.17: Prioritization on Establishing Buffer zone Management Units as a Desired Approach

Priority	Respondents (n=150)	Percentage
Very high	100	66.6
High	33	22
Medium	12	8
Low	5	3.3
Total	**150**	**100**

Source: Field Survey, (2019)

4.4.4 Geo–Fencing System

The system involves a virtual fence line within a computer GIS and programmed in GPS positions into the tracking collar of crop raiding elephants which creates a Geo-fence around the particular animal. When the elephant strays outside of its known range or tries to enter a local village to raid crops, GSM elephant collars with installed SIM cards send a SMS text message to the control center or BZMUs manager alerting them of the immediate problem, and the location of the elephant, enabling rangers, VGS and reserve staff to locate and drive back the elephant into the reserve boundaries. About 92.3% of respondents indicated that the approach is good with long-term impact to the mitigation of HEC in the conflict zones of IGKGRs. It was ranked fourth (4) as the approach of choice among the respondents.

Villagers indicated the level at which they prioritized the approach, whereas the majority of the respondents (53.3%) indicated a very high priority, followed by those who indicated a high priority to the technique (33.3%). This shows clearly that the approach believed to have a long-term and effective solution to the HEC within the IGKGRs and adjacent communities (Table 4.18).

Table 4.18: Prioritization of Geo-fencing System

Priority	Respondents (n=150)	Percentage
Very high	80	53.3
High	50	33.3
Medium	15	10
Low	5	3.3
Total	**150**	**100**

Source: Field Survey, 2019

4.4.5 Wireless Sensing Network

The system can also be effective to generate an early warning on the presence of elephant near the village land and thus can prevent potential human-elephant conflict scenarios. The proposed technique uses the Very High Frequency (VHF) transmitters embedded in the collar fitted on elephant body that are connected to track the location of the animal while approaching the restricted area. The VHF transmitters attached to the problem elephant emit a pulsed radio signals which when the animal is within the range the signals are detected by the receivers erected on poles or towers. The signals taped by receivers are sent to a gateway node having a signal processing unit to filter specific signal of particular frequency. Signals from gateway node will be received by a central processing unit (CPU) (Ramkumar *et al*., 2014; Sheela *et al*., 2016).

This processing unit will look for a pattern match of incoming signal with a reference signal to detect and confirm the presence of elephant within range. Once the CPU confirms the presence of an elephant it will generate warnings and send the information to the nearby HWCMU office with specific location codes through GPS. Various studies commented on the system functionality. “Wireless Sensing Network (WSN) is the systems widely used for various purposes such as warning system against different hazard scenarios and on detection of movement and distribution patterns of wild animals” (Dhanaraj and Sangiah, 2017).

Surveyed households results, shows that 85.6% of respondents considered this technique as a mitigation approach which upon implementation could have an effective to HEC within the western Serengeti. WSN considered as an alternative

solution to HEC scenarios, whereas majority of the respondents (78%) gave very high priority to the technique (Table 4.19).

Table 4.19: Prioritization on Establishing Wireless Sensing Network as a Desired Measure

Priority	Respondents (n=150)	Percentage
Very high	117	78
High	26	17.3
Medium	5	3.3
Low	2	1.3
Total	**150**	**100**

Source: Field Survey, 2019

4.4.6 Translocation of Problem Elephants

This is the removal of a problem animal by tranquilizing, transporting and release it to a new location where possibly the area is big enough and far away from human settlement using specially designed vehicles and specialists' expertise. This approach was proposed mostly by conservation organizations because it has a number of advantages, including saving elephants from being killed, stabilizing the elephant population within the habitat carrying capacity, and taking obvious action that satisfies local communities who are normally confronted with conflict. Preliminary studies of the social structure of the elephants need to be conducted so as to avoid disruptions that can affect family and other elephants should be undertaken before translocation. About 11.7% of the respondents in the surveyed villages indicated by Figure 4.6 that the approach could help in the reduction of problem elephants hence incursions and raiding pressure on crop fields from nearby villages.

Respondents were wildlife professionals, with medium priority (50%) as an alternative approach to mitigate HEC following the growing numbers of elephants in IGKGRs and other nearby PAs (Table 4.20). Translocation of animals has also been undertaken in Kenya (Litoroh *et al*., 2001; Njumbi *et al*., 1996) and South Africa (Garai and Carr, 2001).

Table 4.20: Prioritization of Elephants Translocation Approach

Priority	Respondents (n=40)	Percentage
Very high	5	12.5
High	10	25
Medium	20	50
Low	3	7.5
Very low	2	5
Total	**40**	**100**

Source: Field Survey, 2019

4.4.7 Evacuation of People

Results revealed that distance from PA to settlements showed a significant relationship with intensity of conflict. From the study, of crop damaged varied in the study villages with the change in the average distance of the surveyed households and farms in each village As the encroachment of PAs by settlements together with human cultivated land seemed fueling the damage of crops and increase in threats to both human and domestic animals, reallocation of people living near protected areas is inevitable as it was shown by Figure 4.2 above.

People should be evacuated in the areas, which are reported to be conflict zones and those, which are very close (<0.5km) to the IGGRs. In the study villages about 22% of

the respondents considered the approach as an alternative measure that will have effective and long-term solution to the conflicts. The approach was given a medium priority by majority of the respondents (40.9%) as a suggested measure of interest, followed by those who indicated a high priority (30.3%) and 7.6% indicated a very high priority (Table 4.21).

Table 4.21: Prioritization of Evacuation of People near Protected

Priority	Respondents (n=150)	Percentage
Very high	5	7.6
High	20	30.3
Medium	27	40.9
Low	13	19.7
Very low	1	1.5
Total	**150**	**100**

Source: Field Survey, 2019

Human-elephant conflict is cutting across the whole community, it is not an issue to be solved by the Wildlife Department alone. It requires multi-sectorial action from Ministries responsible for managing natural resources, agriculture and social welfare to local communities adjacent to protected areas. All parties interests' should be discussed together and reach consensus on the implementation of approaches to minimize the conflict between local communities, Ikorongo Grumeti and Kijereshi Game Reserves (IGKGRs).

4.5 Barriers to Human-Elephant Conflicts Mitigation Approaches

An increase of human-elephant conflict in the past few years has resulted in development of other approaches from wildlife authorities together with traditional methods to address the problem. Generally, traditional approaches are easy to use, have low costs and can be effective at low levels of conflicts. The following are various approaches and barriers to implementation in human-elephant conflict mitigation by farmers and PAs management in villages adjacent to Ikorongo, Grumeti and Kijereshi Game Reserves (Figure 4.10).

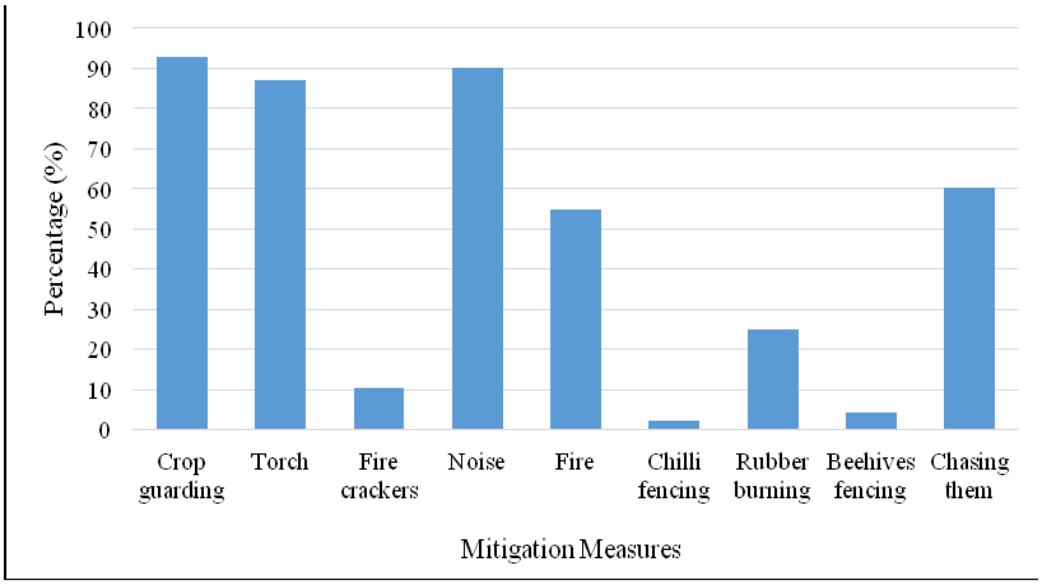

Figure 4.10: Prevalence of Current Human Elephant Conflict Mitigation Measures

Source: Field Survey, (2019)

4.5.1 Crop Guarding

Guarding of crops by farmers is conducted with different levels of organization ranging from guarding isolated fields by individual farmers to guarding the peripheries of contiguous fields by village societies. Farmers individually or collectively scare away elephants relying on the fear elephants have over people,

especially herds of females and young elephants. The mere presence of farmers in huts located within the crop fields may discourage elephants from raiding crops. According to respondents, 92% in the surveyed villages guarding is accompanied by several means (e.g. whistles and sling). Human effigies (scarecrows) are also used in places although elephants quickly become habituated (Figure 4.10).

However, the method seemed more of a risk as farmers spend their time outside while exposing themselves to the problem elephants hence they bear a risk of being killed. Moreover, the quickly habituation of elephants to the scarecrows reduce the effectiveness of the approach hence subjected to failure. The respondents indicated no permanent solution to enhance the effectiveness of this approach.

4.5.2 Noise

Noise-making which involves beating on drums, shouting and use motorcycle horns is one of the common used strategies by famers. Villagers (90.3%) living in communities adjacent to Ikorongo, Grumeti, Kijereshi Game Reserves, and Ikona WMA used noise made by drumming on tins and pots to frighten off elephants. They further indicated that the method seems to be less effective as it somehow works when the problem elephants are not in the crop fields as they usually refuse to come out once in the crop fields (Figure 4.10).

However, although the approach was considered somewhat effective in controlling the elephant incursions it was among the most dangerous approach as sometimes problematic elephants do charge back to people. The approach indicates less effectiveness in prevention of elephant's attack due to the fact that most farmers used

poor tools to frighten off the problem elephants (e.g. drumming on tins and pots). The use of more sophisticated tools such as non-lethal explosives was suggested as means to address the barriers to the technique.

4.5.3 Lights and Torches

Although elephants graze almost any time of the day they are partial to feasting by night, hence rigging up lights or use of torches might scare them off. Quiet number of farmers (87%) along the surveyed communities adjacent to IGKGRs were using torches and other light sources to scare the problem elephants trying to prevent the crop raiding and other damages associated with elephants' incursions in the village land.

Nonetheless**,** the strategy resulted into fairly less effective impacts due to a number of reasons such as use of poor torches having no capacity to flash very bright lights that can be sufficient to scare them off and change habituation of the strategies by problem elephants. Furthermore, majority of the people due to low income level cannot afford battery costs and repair of the tools when needed to do so. The possible solutions that were addressed by the respondents through interview were provision of torches with long range flashlight and other sophisticated equipments to enhance the approach.

4.5.4 Fire

Most wild animals avoid fire. Fires at crop field boundaries, or at elephant entry points to fields, serve as a short-term deterrent. The technique deters elephants hence reduces the intensity of elephants' attack especially when fire is lit at the entry points of the problem elephants into the crop fields or villages. Fairly moderate number of respondents (54.7%) in Figure 4.10, indicated that they were applying the strategy this

could be due to the fact that the strategy was unsustainable for any length of time without large amount of materials to be burnt to increase the deterrent effect of fire as it has seen in Hoare, 2001.

However, the unsustainability of fire without large amount of wood materials to be burnt so as to increase the effect of fire was one among the causes of its less effectiveness and application as it was considered not environmental friendly approach. Another reason could be the negative effect of using fire as sometimes elephants charge back in the direction of fire once frightened. No means to address the barriers as the approach was considered destructive.

4.5.5 Rubber Burning

Smoke from plastic and rubber burning is one among the elephants' deterrent used in communities surrounding IGGRs. Farmers may burn plastic and rubber to create noxious smoke that deter elephants from entering the crop fields (Fernando *et al*., 2008). About 25% of the respondents (Fig. 4.10) from the surveyed villages indicated that they have been using this technique for some time and the method seemed to become effective.

The noxious smoke that comes out of the burnt rubber or plastic materials had a chocking smell, which deter elephants and prevent them from raiding. Nonetheless, the respondents faced several challenges during application of the techniques as the noxious smoke affected the farmers as well causing them to not stay near or in the crop fields.

Furthermore, the burnt rubber or plastic material can start fire which can burn crops while in the crop fields as the crop raiding peaks were in the months of July,

November, December and January where the vegetation cover is almost dried. The respondents indicated no possible solution to improve the technique and increase its effectiveness as the method considered destructive and lethal.

4.5.6 Chasing Elephants Away

The official approach where elephants are chased by human-wildlife conflict mitigation unit or Rangers is for villages to request assistance from TANAPA or Ikorongo and Grumeti Game Reserves through Village Executive Officers (VEOs) and DGOs. The HWC mitigation unit is sent with Game Wardens or a person authorized to use gun loaded with ammunition. The HWC mitigation unit uses the vehicle to chase elephants, using its horn and firing ammunition to scare them away. About 60.3% of respondents (Fig.4.10) revealed that they have been received assistance from the HWC mitigation unit from IGKGRs in collaboration with TANAPA, and DGOs from both Bunda and Serengeti Districts through their VEOs.

Nonetheless, **t**he method had an effective impact although due to several challenges that has been limitations to its effectiveness. Respondents indicated that the barriers have been inhibiting the technique as there are times where the HWCMUs are not reached or when reached are already in other villages chasing the elephants back into the PAs.

4.5.7 Use of Firecrackers

Finding from Figure 4.10 shows that about 10.3% of the respondents from the six surveyed villages reported to use the fire crackers to deter elephants from incursions into farms. These results tally with the report by RESOLVE at el., 2016 who donated firecrackers from Frunkfurt Zoological Society (FZS) to the studied villages. The

report showed that, approach seemed more effective than other traditional approaches like shouting and the use of torches. The method seemed as the alternative to the HWC mitigation units who use guns loaded with ammunition as the firecrackers emitted fire, smoke and sound which scared the problem elephants as they confuse the technique with firearms.

However, the technique is fairly and newly employed in few villages within the western Serengeti area and most people seemed to not have knowledge over its application. Moreover, majority of the respondents didn't apply the technique as very few firecrackers were supplied among the community hence limited coverage and application. The only solution that could be employed to increase the efficiency of this technique is to promote and increase the supply of firecrackers among the people and provision of knowledge on its application for effective HEC mitigation.

4.5.8 Beehives Fencing

Very few respondents indicated that the beehives fencing had a positive impact towards deterring the elephants from crop field incursion. This was pinpointed out by 4.3 % of the respondents from the surveyed villages who were found applying the beehives fences supplied by SGF to prevent crop raiding by problem elephants in their crop fields (Figure 4.11). This is due to the facts that, the method is newly introduced by conservational partners and requires capital to implement, however local people were required to form groups in order to be given beehives (King et al, 2011).

Although the number of respondents, which indicate beehives fencing as deterring method, is negligible the method is gaining momentum from many conservational

points of view. Because the method considered among the biological deterrent of elephants as African honey bees (*Appis melifera*) produces chemical substance, which threaten elephant and stay away from sting. This concur with however study done at Udzungwa National park revealed than beehives methods is more efficiency in reducing crop field incursion done by elephant (Scheijen *et al*, 2018).

Figure 4.11: Protecting Crop Fields in Serengeti by Beehives Fencing
Source: Field Survey, (2019)

Figure 4.12: Beehives to Minimize HEC at Kilimanjaro Amboseli Ecosystem

Source: Big Life Foundation, (2016)

There is also evidence of the same practice in other protected areas. Taking example of Amboseli Tsavo and Kilimanjaro Ecosystem (Figure 4.12) the community adjacent with collaboration with wildlife management at the area have set beehives in order to protect elephants from moving outside protected area to land of communities. The community is also happy with the approach since is an income project to them and it is economically of benefit (Biglife Foundation, 2016).

4.5.9 Chili – based Deterrents

Chili-based deterrents have been used to prevent elephants from entering the crop fields across the global (Osborn & Parker, 2002; Parker & Osborn, 2006). The method can be applied through several ways namely; pepper grease (chili-grease), which is applied to rope fences around crop fields (Chang'a *et al*., 2016), pepper dung (chili-dung), which is burnt to produce a noxious smoke (Parker *et al*., 2007), and pepper plants, which are planted as buffer crop at the boundary of crop fields. Such uses of

chilies (*Capsicum frutescens*) were reported by the 2.3% (Figure 4.10) of the respondents in the surveyed villages adjacent to IGKGRs. The reason for few respondents to apply the method was due to its limited effectiveness over elephant deterrence as it was indicated by the respondents who happened to use the approach.

However, sisal rope fences covered in chili oil, pepper dung and pepper planted as buffer crop do not work all the time as some elephants have figured out how to walk into farms backwards or knock them down with branches and tolerate the hotness from pepper. The method was regarded to be a failure hence no solution that was depicted by the respondents.

4.6 Summary

Results showed that factors that significantly influenced human-elephant conflict occurrence were crop raiding incidences, increasing elephant population, encroachment, and lack of clear buffer area, lack of compensation plan, infrastructure damages and direct elephant attack. Local communities used traditional mitigation measures together with the efforts from HWCMUs and PAs authorities to control elephant attacks. Despite these efforts, there were several barriers needed to be addressed to make the mitigation measures more effective. These include; the use of local tools as the primary mean to chase the elephants, low income and education level and large distance between ranger posts and villages. Moreover, elephants showed very high adaptability to most of the applied deterrents. Several unconventional mitigation approaches were identified and recommended as mitigation measures with long-term impact to the HEC between local communities and elephants of the IGKGRs. The measures include; construction of trench, electric fencing, buffer

zone management units (BZMUs), geo-fencing system, Wireless Sensing Network (WSN), evacuation of people near protected area boundary and translocation of problem elephants.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Overview

Crop raiding incidences, increasing elephant population, encroachment, lack of clear buffer zone, infrastructure damage, lack of compensation plan and direct elephant attacks were significant predictors of human-elephant conflicts prevalence between local communities and elephants from IGKGRs. Majority of the villagers particularly farmers were the most affected in the HEC conflicts due to incidences like crop damage, human killings and injuries, domestic animal killings, and infrastructure and other damage, whereas very few corrupt leaders were the ones gaining from the conflicts.

5.1 Conclusions

The local communities used traditional mitigation measures together with the efforts from HWCMUs and PAs authorities to control elephant attacks. Despite these efforts,

there were several barriers needed to be addressed to make the mitigation measures more effective. These included the use of local tools as the primary mean to chase the elephants, low income and education level and large distance between ranger posts and villages.

Moreover, elephants showed very high adaptability to most of the applied detterents. Several unconventional mitigation approaches were identified and recommended as mitigation measures with long-term impact to the HEC between local communities and elephants of the IGKGRs. The measures were construction of trench, electric fencing, buffer zone management units (BZMUs), geo-fencing system, Wireless Sensing Network (WSN), evacuation of people near protected area boundary and translocation of problem elephants.

5.2 Recommendations

Basing on the study findings, it is evident that HEC is real a problem to communities living adjacent to IGKGRs. Hence, the following are recommendations:

5.2.1 Recommendations for Local Communities

The planting of palatable crops (maize, millet, among others) close to the reserves boundary by farmers has led to the hike in the incidence of elephant crop raids within the landscape. Therefore, farmers are advised to engage in cultivation of non-target crops like onions, chili, peanuts and sesame, which are mainly commercial crops (Ekanayaka *et al*. 2011). Also, in collaboration with PAs management and other

stakeholders, farmers would need to adopt new and sustainable techniques to deter elephants from raiding their crops as suggested in this study.

On other hand, livestock keepers should participate in bee keeping projects where they can get and sell honey and beeswax, whereas beehive fences can enhance crop production hence improved rural livelihoods (King *et al.* 2011). Local people are encouraged to improve village-based guarding efforts to detect and deter elephants prior to their entry into crop fields. This should be in line with the use of more sophisticated tools like long-range flashlight torches, among others as suggested in this study.

5.2.2 Recommendations for PAs management

For effective management of elephants and human-elephant conflicts it is important for local people to have conservation education and an understanding on scientifically-proven drivers of the conflicts particularly HEC. Hence it is recommended that the IGKGRs should put more emphasis on conservation education among local people at various levels and seek to address the economic aspects of the communities. Community involvement in conservation activities should be among the key and prioritized areas in the General Management Plan (GMP) of the IGKRRs. The approach increases sense of belonging in the conservation teams among the people hence is a sustainable way and therefore conducive to long-term conservation efforts.

HEC mitigation approaches suggested in this study should be put in place by IGKGRs in collaboration with Ministry of Natural Resources and Tourism for effective and long-term mitigation of HEC in western Serengeti. The IGKGRs management should

use GPS satellite telemetry to monitor and record the spatial and temporal distribution and movement patterns of elephants and their activities within and outside the PAs boundary. This should focus on identifying individuals and groups and monitoring their movement patterns in relation to crop raiding in order to obtain long-term information for effective operation of the new conflict mitigation measures identified in this study. Also, establishment of comparative conflicts mitigation trials within the conflict zones that can be monitored to assess for their effectiveness should be put in place.

Implementation of recommended mitigation measures requires a long timeframe, financial resources and more importantly, political will. It is essential that human-elephant conflicts mitigation becomes an integral part of the national wildlife conservation policy. Strengthening trans-border cooperation is needed to manage elephant populations across IGKGRs, Serengeti National Park, and other nearby PAs. Development of a rigorous decision-making framework will require the participation of various stakeholders such as government ministries responsible for management of natural resources, social welfare and land-use planners, PAs management authorities, natural and social scientists and economists and local people from communities adjacent to PAs.

There is a need for a clear policy and strategic planning. The current approach to dealing with conflict is largely ad hoc, and predisposed to failure because of inappropriate application of methods, limited involvement of local people, lack of effective monitoring of conflicts and conflict mitigation measures, and inadequate understanding of elephant ecology in deploying mitigation strategies. In the absence

of a new and improved wildlife conservation approaches, there will be more conflicts between people and wildlife particularly elephants due to their large home range and free ranging. No single solution is effective and different approaches need to be integrated to address the problem proactively.

5.2.3 Recommendations for the Government

The current Wildlife Conservation Policy of 2007 should be revised and amended to incorporate and put into action the potential and alternative long-term mitigation measures. Measures such as erecting electric deterrents, which are non-lethal to reduce the conflict between people and wildlife as suggested in Section 3.3.12 of the Tanzania Wildlife Policy of 1998. It is recommended that Tanzania Government should design and establish compensation and insurance scheme as 54% of the respondents indicated that they are willing to contribute in order to support the new interventions and a government-established trust fund to compensate a greater proportion of the elephant-caused damage. Government should put an emphasis on the greater local communities' involvement in the decision-making processes for HEC mitigation plans. Shared policy changes by the government would enhance people's perception towards and an ownership of those elephants being conserved. It is further recommended for the government to create a clear and well-defined buffer zone separating the IGGRs and the surrounding communities.

5.3 Suggested Further Research

In order to enhance the sustainability and effectiveness of human-elephant conflicts mitigation strategies, this study suggested several areas for further research. These areas included the following;

(i) Assessment of the spatial distribution patterns and movement of elephants in the Reserves and its surrounding using GPS radio telemetry for proper implementation of new HEC mitigation measures.

(ii) Collect and collate existing data and information to document change in land use and possible impact on elephant distribution.

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APPENDICES

Appendix I: Household survey questionnaire

I am a student from The Open University of Tanzania, studying Master of Art in Natural Resources Assessment and Management. The information collected will assist TAWA management, communities adjacent to protected areas and other future Wildlife Officers to plan on suitable approaches to deal with HEC issues. Please, assist me with your help in completing the following questionnaire:

DATE …… QUESTIONNAIRE NO. 1

PERSONAL PARTICULARS OF THE INTERVIEWEE

1. SEX ……
2. AGE ……
3. TRIBE……
4. OCCUPATION ……..
5. MARITAL STATUS……..
6. NUMBER OF PEOPLE IN THE HOUSEHOLD……..
7. PERIOD SERVED IN THE AREA ……...

8.0 Land use and ownership

8.1 Do you own land for agriculture? 1. Yes (…..) 2. No (…..)

8.2 If the answer in (Qn 8.1) is yes, what is the farm size …… (Acres) and how far it is from Game Reserve boundary …… (Meters/Kilometers)?

8.3 From your farm, what kind of crops are you producing in your farm?

1. …… 2. ……..

3. …… 4. ……..

9. Human-elephant conflicts

a. Are there human-elephant conflicts in your village? 1. Yes (…..) 2. No (…..)

b. If the answer is yes in Q a. above, what are the main reasons causing human-elephant conflicts in your area?

1. …… 2. ……..

3. …… 4. ……..

10. Please tick the activities that the elephants cause to your area.

Activities	**Village**
Crop damage	
House damage	
Attack to livestock	
Family member death	
Family member injury	
Any other……..	

11. Is there any incidence of crop raiding done by elephants in your farm?

1. Yes (….) 2. No (….)

12. If yes, how many incidences of crop raiding occurred in your farm in this cropping season? .....

13. What time of the day do elephants prefer most in raiding crops?

    1. Morning (…..) 2. Afternoon (……) 3. Evening (…..)

    4. Night (…..) 5. Throughout the day (…..)

14. What is the estimate of economic losses resulting from crop damaged caused by elephants in percentage (%) and Tanzania shillings (TSh.) in this cropping season?.....(%) and …….(TSh.)

15. Have you ever heard about elephant's conservation? 1. Yes (….) 2. No (….)

16. Do you think there is a need to conserve elephants? 1. Yes (….) 2. No (….)

    Give reasons why? .....

17. Has it ever happened an incidence of elephant being killed by human beings within your village?

    1. Yes (….) 2. No (….)

18. What are the possible reasons of elephant killings by people in this area?

    1 …… 2 …….

    3 …… 4 ……..

HEC prevention and mitigation measures

19. Is there a need to prevent elephants from entering communities' land?

    1. Yes (...) 2. No (….)

20. Are you aware about the HEC prevention and mitigation approaches?

    1. Yes (….) 2. No (….)

21. Mention any approach you know that can be applied to prevent crop damage by elephants?

    1 …… 2 …….

    3 …… 4 ……..

22. Are there any approaches applied by Ikorongo-Grumeti and Kijereshi Game Reserves/Any Protected Area Authorities to prevent and mitigate the existing human-elephant conflicts in your area? 1. Yes (….) 2. No (….)

23. Mention those approaches

1 …… 2 …….

3 …… 4 ……..

24. (a) Focus on the mentioned approaches, were they successful?

1. Very high (...) 2. High (...) 3. Moderate (...) 4. Little (….) 5. Not at all (….)

(b) Mention and explain possible barriers contributed to the failure of the approaches and means on how to overcome.

25. What approaches apart from the previously applied do you think should be applied in order to effectively prevent and mitigate human-elephant conflicts in the area? Mention…….

THANKS MUCH FOR YOUR TIME

Appendix II: Checklist for Key Informant Interviews

I am a student from The Open University of Tanzania, studying Master of Art in Natural Resources Assessment and Management, conducting a research to assess on how the management of Ikorongo, Grumeti and Kijereshi Game Reserves specifically deals with approaches to minimize human-elephant conflicts in adjacent communities. The information collected will assist TAWA management, communities adjacent to protected areas and other future Wildlife Officers to plan on suitable approaches to deal with HEC issues. Individual answers will not be disclosed to anyone. They will be combined with those of other respondents to guide in the evaluation process. Your experienced answers and are very important for resolution of the conflicts. Please, assist me with your help in completing the following questionnaire:

DATE …… QUESTIONNAIRE NO. 2

PERSONAL PARTICULARS OF THE INTERVIEWEE

I. SEX ……

II. AGE ……

III. TRIBE……

IV. OCCUPATION STATUS……..

V. MARITAL STATUS……..

VI. PERIOD SERVED IN THE AREA ……...

1. Is there any human-elephant conflicts in this area?

2. What are factors contributing to human-elephant conflicts?

3. Can you tell to what extent the damage caused by elephants brings conflict with the communities?

4. What is the trend of these damages for the period between years 2009 to 2019?

5. Which crops are mostly raided by elephants? List them (in a list of priority)

6. How many incidences of crop raiding have been reported to occur in your area for the period of the years 2009 to 2019?

7. What is the number of human injuries and deaths caused by elephants for the years 2009 to 2019?

8. Are there incidences of elephants were killed/injured as problem animals within or along your area for the period of years 2009 to 2019?

9. Tell approaches that have been applied to minimize the conflicts in this area?

10. Were the approaches successful? **Yes** or **No** Why……?

11. Please suggest and explain other approaches apart from the above mentioned, that can be used to minimize HEC in the area.

THANKS MUCH FOR YOUR TIME.

Appendix III: Research Clearance Letter

THE OPEN UNIVERSITY OF TANZANIA

DIRECTORATE OF POSTGRADUATE STUDIES

P.O. Box 23409
Dar es Salaam, Tanzania
http://www.openuniversity.ac.tz

Tel: 255-22-2668992/2668445
ext.2101
Fax: 255-22-2668759
E-mail: dpgs@out.ac.tz

Our Ref: PG201608703

10th October 2019

Chief Warden,
Serengeti National Park,
Serengeti ,
MARA.

RE: RESEARCH CLEARANCE

The Open University of Tanzania was established by an Act of Parliament No. 17 of 1992, which became operational on the 1st March 1993 by public notice No.55 in the official Gazette. The Act was however replaced by the Open University of Tanzania Charter of 2005, which became operational on 1st January 2007.In line with the Charter, the Open University of Tanzania mission is to generate and apply knowledge through research.

To facilitate and to simplify research process therefore, the act empowers the Vice Chancellor of the Open University of Tanzania to issue research clearance, on behalf of the Government of Tanzania and Tanzania Commission for Science and Technology, to both its staff and students who are doing research in Tanzania. With this brief background, the purpose of this letter is to introduce to you **Ms. URIO, Theresia James Reg No: PG201608703** pursuing **Master of Arts in Natural Resource Assessment and Management (MANRAM).**

We here by grant this clearance to conduct a research titled ***"Assessment of Approaches for Managing Human-Elephant Conflicts in Tanzania. Serengeti Ecosystem Western Part".*** She will collect her data at your area from 11th October 2019 to 11th November 2019.

In case you need any further information, kindly do not hesitate to contact the Deputy Vice Chancellor (Academic) of the Open University of Tanzania, P.O.Box 23409, Dar es Salaam.Tel: 022-2-2668820.We lastly thank you in advance for your assumed cooperation and facilitation of this research academic activity.

Yours Sincerely,

Prof.Hossea Rwegoshora
For:VICE CHANCELLOR
THE OPEN UNIVERSITY OF TANZANIA

Appendix IV: Plagiarism Report

ASSESSMENT OF APPROACHES FOR MANAGING HUMAN-ELEPHANT CONFLICTS IN WESTERN SERENGETI ECOSYSTEM, TANZANIA

ORIGINALITY REPORT

21%	19%	7%	8%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

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Our Ref: PG201608703

10th October 2019

Chief Warden,
Serengeti National Park,
Serengeti ,
MARA.

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Yours Sincerely,

Prof.Hossea Rwegoshora
For:VICE CHANCELLOR
THE OPEN UNIVERSITY OF TANZANIA