

**HUMAN-CROCODILE CONFLICTS IN AREAS ADJACENT TO LAKE RUKWA
AND MOMBA RIVER, MOMBA DISTRICT, TANZANIA**

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**A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE
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ABSTRACT

Conflicts between human and crocodiles are increasing due to increase in human population. The conflicts have significant impacts on both human and crocodile populations. The study focused on assessment of human-crocodile conflicts in areas adjacent to Lake Rukwa and Momba River, Momba District, Mbeya Region Tanzania, for the period of 2003 to 2012. Cross-sectional research design and purposive sampling of villages were used in data collection. A total of 120 households were randomly sampled from four villages of Kamsamba, Senga, Muuyu and Samang'ombe. Data were collected using direct observation, structured interviews, focus group discussions and key informants interview. Simple descriptive statistics, cross tabulations and Chi-square test were used to analyze data. The causes of human-crocodile conflicts identified include: - fishing, crossing rivers, water for domestic use, and bathing/swimming. The main crocodile damage reported were:- killing of people, livestock depredation, injury/deformity to people, damages on fishing nets and crocodiles were blamed to cause threats to people's life. During the period of 2003 to 2012, a total of 32 people were killed and 19 were injured by crocodiles. On the same period, crocodiles were reported to have killed 52 cattle, 10 dogs and 23 goats. It was found that most crocodile attacks occurred during the wet season from the period of January to March. Overall, many crocodiles attacks on people occurred while they were fishing or crossing rivers. The methods used in solving human-crocodile conflicts involved killing harmful crocodiles, avoiding going near the lake/rivers, digging water wells and providing education to communities on ways of avoiding crocodiles. The study recommends the supply of clean water to villagers of Kamsamba, Senga, Muuyu and Samang'ombe, and bridges to be constructed across rivers where most people pass when going to either side of the rivers.

DECLARATION

I, ZAKAYO FRANK, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

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The above declaration is confirmed

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Date

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DEDICATION

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TABLE OF CONTENTS

ABSTRACT	ii
DECLARATION	iii
COPYRIGHT	iv
ACKNOWLEDGEMENTS	v
DEDICATION	vi
TABLE OF CONTENTS	vii
LIST OF TABLES	xi
LIST OF FIGURES	xii
LIST OF APPENDICES	xiii
LIST OF ABBREVIATIONS	xiv
CHAPTER ONE	1
1.0 INTRODUCTION	1
1.1 Background Information	1
1.2 Problem Statement And Justification of the Study.....	2
1.3 Objective.....	4
1.3.1 General objective.....	4
1.3.2 Specific objectives.....	4
1.4 Research Questions	4
1.5 Conceptual Framework	5
CHAPTER TWO	7
2.0 LITERATURE REVIEW	7
2.1 Human-crocodile Conflicts	7
2.2 Human-crocodile Conflicts Worldwide	8

2.3	Human-crocodile Conflicts in Tanzania.....	10
2.4	Crocodile Distribution in Tanzania	10
2.5	Abundance of Crocodiles in Tanzania	11
2.6	Damages Caused by Crocodiles	12
2.7	Threats Facing Crocodiles.....	13
CHAPTER THREE.....		14
3.0 MATERIALS AND METHODS.....		14
3.1	Study Area.....	14
3.1.1	Location.....	14
3.1.2	Topography and climate.....	14
3.1.3	Lake Rukwa.....	16
3.1.4	Momba River.....	16
3.1.5	Wildlife.....	17
3.1.6	Human population	17
3.1.7	Economic activities	18
3.2	Methods	18
3.2.1	Research design.....	18
3.2.2	Reconnaissance survey.....	18
3.2.3	Sampling procedure.....	19
3.2.4	Data collection.....	19
3.2.4.1	Primary data	19
3.2.4.2	Secondary data	21
3.3	Data Analysis.....	21
3.3.1	Qualitative data	21
3.3.2	Quantitative data	22

3.4	Potential Sources of Bias	22
CHAPTER FOUR.....		24
4.0	RESULTS AND DISCUSSIONS.....	24
4.1	Social Economic Characteristics of the Respondents	24
4.1.1	Age and sex distribution.....	24
4.1.2	Education level	25
4.1.3	Marital status and household size of the respondents	25
4.1.4	Ethnicity and residency	26
4.1.5	Occupation and household income of the respondents	27
4.1.6	Land use and ownerships	28
4.1.7	Livestock ownership	28
4.2	Dependence on Water Bodies	29
4.3	Human-crocodile Conflicts Analysis	31
4.4	Factors Causing Human-crocodile Conflicts.....	35
4.5	Damages Caused by Crocodiles to Communities	36
4.5.1	Crocodiles damage to livestock.....	37
4.5.2	Crocodiles damage to fishing nets	39
4.5.3	Experience of households on crocodile attacks.....	40
4.5.3.1	Distribution of crocodile attacks between men and women....	41
4.5.3.2	Crocodiles attacks by age groups	42
4.6	Time for Most Crocodile Attacks on People and Livestock	43
4.7	Seasonal Pattern of Crocodile Attacks	44
4.8	Months in which the problem of crocodiles is serious	45
4.9	Intensity of Crocodile Damages to Communities	46
4.9.1	Intensity of crocodile damages to humans	46

4.9.2	Intensity of crocodile damages on fishing gears	47
4.10	Extent of Crocodile Damage to Communities.....	49
4.10.1	Crocodile predation on livestock.....	49
4.10.2	Crocodile attacks on human beings.....	51
4.10.3	Trends of crocodile attacks on human beings	52
4.10.4	Opinions of people on trends of crocodile attacks	52
4.11	Current Situation of the Human-crocodile Conflicts in the Study Area	53
4.12	Methods Used to Solve Human-crocodile Conflicts	54
4.12.1	Methods used by people to protect themselves from crocodile attacks	55
4.12.2	Methods used to protect livestock from crocodile attacks	56
4.13	General Opinions on Minimizing Human-crocodile Conflicts	57
CHAPTER FIVE		59
5.0 CONCLUSIONS AND RECOMMENDATIONS		59
5.1	Conclusions	59
5.2	Recommendations	61
REFERENCES.....		63
APPENDICES		72

LIST OF TABLES

Table 1:	Social economic characteristics of respondents	24
Table 2:	Residence and ethnicity of respondents	26
Table 3:	Occupation and income of respondents	27
Table 4:	Responses on land ownership and location.....	28
Table 5:	Responses on ownerships of livestock and location of grazing areas.....	29
Table 6:	Responses on water dependencies on different water sources.....	30
Table 7:	Responses on human-crocodile conflicts according to age groups.....	31
Table 8:	Responses on various issues of crocodiles conflicts.....	32
Table 9:	Responses on certain lake/river places being dangerous than others.....	34
Table 10:	Responses on fear for crocodiles when swimming.....	35
Table 11:	Responses on factors causing human-crocodile conflicts.....	36
Table 12:	Responses on livestock losses from crocodiles attacks	38
Table 13:	Responses on crocodile damage to fishing nets.....	39
Table 14:	Responses on experience of households on crocodiles' attacks from the year 2003 to 2012.....	40
Table 15:	Responses on intensity of crocodile damages to humans	47
Table 16:	Number of people killed/injured from crocodile attacks	51
Table 17:	Responses on current situation of the human-crocodile conflicts.....	54
Table 18:	Responses on methods used to solve human-crocodile conflicts	54
Table 19:	Responses on people's ways of protection from crocodiles attacks	56
Table 20:	Responses on ways of protecting livestock from crocodiles	56
Table 21:	Responses on opinions of minimizing human-crocodile conflicts	58

LIST OF FIGURES

Figure 1: The conceptual framework for the study of human-crocodile conflicts	5
Figure 2: A map of momba district showing locations of the study villages	15
Figure 3: Responses on damages caused by crocodiles.....	37
Figure 4: Responses on the distribution of crocodile attacks between men and women	41
Figure 5: Responses on crocodiles attacks by age groups	43
Figure 6: Responses on time for most crocodiles' attacks on people and livestock.....	43
Figure 7: Responses on seasonal pattern of crocodiles attacks.....	45
Figure 8: Responses on months in which the problem of crocodile is serious	46
Figure 9: Responses on the intensity of crocodiles in damaging fishing gears	48
Figure 10: Number of livestock species lost from crocodiles attacks for the period of 2003 to 2012	50
Figure 11: Trends on the number of people killed/injured by crocodiles.....	52
Figure 12: Opinions on the trend of crocodile damages from 2003 to 2012	53

LIST OF APPENDICES

Appendix 1: Household interview schedule 72

Appendix 2: Checklist for focus group discussion 78

Appendix 3: Checklist for key informants 79

LIST OF ABBREVIATIONS

BBC	British Broadcasting Corporation
CITES	The Convention on International Trade in Endangered Species of Wild Fauna and Flora
E	East
FAO	Food and Agriculture Organization
HCC	Human-Crocodile Conflicts
IUCN	International Union for Conservation of Nature
S	South
SPSS	Statistical Package for Social Sciences
Tshs	Tanzania shillings
UNEP-WCMC	United Nations Environment Programme - World Conservation Monitoring Centre
URT	United Republic of Tanzania

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Crocodiles belong to the Phylum Chordata and Class Reptilia. They are carnivorous reptiles of the order Crocodylia. These animals are the largest among the principal group of reptiles called Squamata which comprises of lizards, crocodiles and snakes (Ross, 1998). The order Crocodylia is arranged in three families including Alligatoridae, Crocodylidae and Gavialidae (Ross, 1998). Crocodiles are found in tropical and subtropical regions. They play an important role in maintaining the structure and function of freshwater ecosystems (Ross, 1998). They are considered as keystone species (Thorbjarnarson, 1992) that maintain ecosystem structure and function by selective predation on fish species (Pooley, 1982), recycling nutrients and maintenance of wet refugia (Thorbjarnarson, 1992).

Three species of crocodylians occur in Africa, the slender-snouted crocodile (*Crocodylus cataphractus*), the dwarf crocodile (*Osteolaemus tetraspis*) and the Nile crocodile (*Crocodylus niloticus*) (Bourquin, 2007). The Nile crocodile is the most widely distributed crocodile species in Africa occurring in virtually all sub-Saharan countries (CITES, 2010; Ross, 1998).

Crocodiles are found in a wide variety of habitat types in Africa including lakes, rivers, and freshwater swamps. They can tolerate a broad range of habitats including small brackish streams, fast flowing rivers, swamps, dams, tidal lakes and estuaries (Leslie, 1997). These animals are efficient colonizers of suitable habitat and are one of the few dangerous predators commonly found outside protected areas in Tanzania.

Their amphibious nature and cryptic behavior enable them to move relatively freely and remain undetected even in densely populated areas (Pooley, 1982) thus making surprise attacks to humans and livestock.

Crocodiles are blamed to cause problems to humans and livestock. They probably cause more human deaths than any other wild animal in Africa (Kyalo, 2008). Little is known about the conflicts between human and crocodiles in areas adjacent to Lake Rukwa and Momba River in Momba District, Tanzania. This study attempted to gain a better understanding of the conflicts, explore information on factors causing human-crocodile conflicts, damages caused by crocodiles to communities, extent of crocodile damages to communities, trends in human-crocodile conflicts, seasonal pattern of crocodile attacks on people and livestock, and measures used by communities and institutions to resolve the conflicts. By understanding these scenarios, it was easier to give concrete suggestions on ways to minimize the conflicts and thus develop more effective long-term solutions to the problem of human-crocodile conflicts in areas adjacent to Lake Rukwa and Momba River and Tanzania in general.

1.2 Problem Statement And Justification of the Study

Human-wildlife conflict is a growing global problem. It is a major concern of most people living near protected areas in Africa. It is not restricted to a particular geographical region or climatic condition, but is common to all areas where wildlife and human populations coexist and share limited resources (Distefano, 2004). The February 2010 meeting of the Southern African Development Community Technical Committee on Wildlife pronounced that wild animals represent the number-one problem for Africa's rural populations in terms of both personal security and economic loss and the situation is getting worse (Le Bel *et al.*, 2010).

The problem is more common around protected areas like national parks, game reserves and game controlled areas where wild animals are blamed to cause crop damage, animal death, property damage, habitat destruction, and injuries and death to people (Magige, 2012). A similar problem occurs in areas outside protected areas such as lakes and rivers which harbor a considerable number of wild animals like crocodiles and hippopotamuses (*Hippopotamus amphibious*). This has created an increasing concern among conservationists and researchers who carry out wildlife research in places where people live nearby protected areas (Miller and Hobbs, 2002).

Despite the rise in human-crocodile conflict, the international community has indicated the recovery of crocodylians populations as a conservation success story (Aust, 2009). This is due to lack of information on trends in human-crocodile conflict especially outside protected areas like in areas adjacent to Lake Rukwa and Momba River where crocodiles are considered to be a problem to communities. In the absence of this information, crocodile conservation and management policies have continued to be directed by international attitudes with limited respect for current local opinion. Aust (2009) suggested that, the recovery of Nile crocodile populations has resulted in substantial levels of human-crocodile conflicts. In particular, the effects on subsistence communities are acute and could potentially undermine both development and conservation initiatives.

This study managed to assess human-crocodile conflicts in areas adjacent to Lake Rukwa and Momba River in Momba District for the period of 2003 to 2012. Its findings helped to explore the existing conflicts between human and crocodiles, the opinions of the people about the conflicts and provided suggestions to efforts towards reducing the human-crocodile conflicts in these areas. Such information is important in programs intended in controlling problem animals like crocodiles and it will provide a baseline against which

the level of future conflict can be compared. Policy and decision makers will make use of these findings to develop consolation strategies for people affected negatively with crocodiles and other wildlife in particular. The public will also be made more aware of the prevailing situation and thus change their risk behaviors exposing them crocodile attacks.

1.3 Objective

1.3.1 General objective

The general objective of this study was to assess human-crocodile conflicts in areas adjacent to Lake Rukwa and Momba River in Momba District.

1.3.2 Specific objectives

The specific objectives of the study were to:-

- i. Identify factors that lead to human-crocodile conflicts in areas adjacent to Lake Rukwa and Momba River.
- ii. Assess the extent and trend of damage caused by crocodiles to the communities adjacent to Lake Rukwa and Momba River.
- iii. Identify measures used by communities and institutions to resolve the human-crocodile conflicts.

1.4 Research Questions

- i. What factors lead to human-crocodile conflicts in areas adjacent to Lake Rukwa and Momba River?
- ii. To what extent is the damage caused by crocodiles affects the local communities in areas adjacent to Lake Rukwa and Momba River?
- iii. What is the trend of these damages for the period of 2003-2012?
- iv. What are the measures taken so far to resolve the conflicts?

1.5 Conceptual Framework

The study was based on the concept that dependence of human activities on water resources for economic and social activities leads to interactions with crocodiles living inside the water bodies (Fig. 1). The interactions increase as human population increases leading to high demand for fishing, farming (agriculture and livestock keeping), water for domestic use, navigation and swimming. These activities are considered as the main drivers of human-crocodile conflicts in areas adjacent to Lake Rukwa and Momba River.

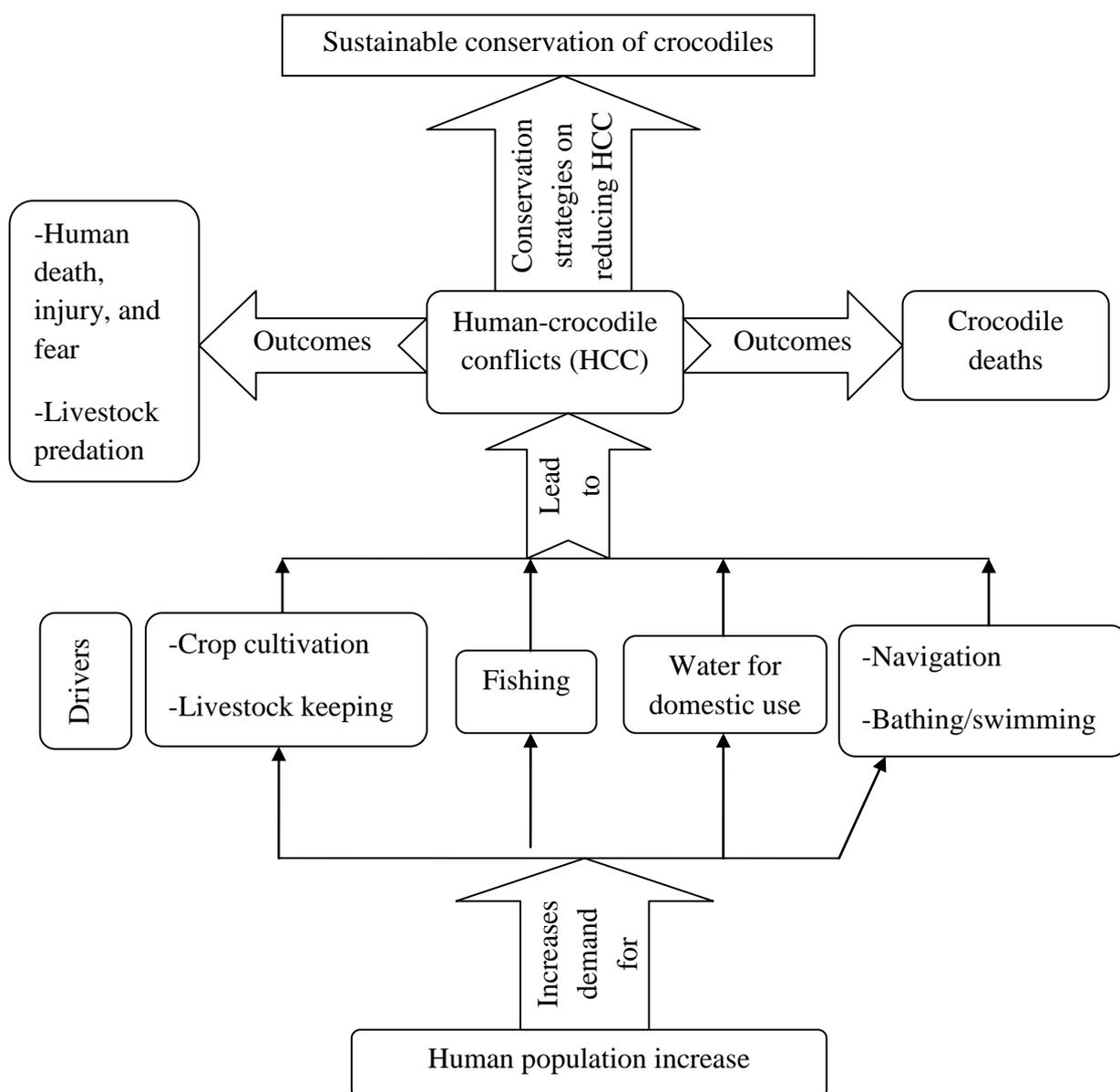


Figure 1: The conceptual framework for the study of human-crocodile conflicts

The outcomes of human-crocodile conflicts are negative to both human and crocodiles, and they include fear, injury/death to human, livestock predation and reduced population of crocodiles. Crocodile attacks on local people and livestock creates negative incentives for local communities to oppose ongoing conservation efforts and thus destroy crocodiles in the interests of public safety, regardless of national laws. In order to reduce the negative effects to humans and crocodile conservation, strategies should consider reducing human-crocodile conflicts so as to attain sustainable conservation of crocodiles.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Human-crocodile Conflicts

People and crocodiles are increasingly coming into conflicts over living space and food as human populations continue expanding and natural habitats shrink. Human-crocodile conflicts occur when the needs and behavior of crocodile impact negatively on the goals of humans or when the goals of humans negatively impact the needs of crocodiles. These conflicts may result when crocodile injure or kill domestic animals, threaten or kill people (IUCN, 2004). The conflicts can be real or perceived, economic, social or political and may be associated with some ecological, social, economic and political factors. Human-crocodile conflicts may arise when humans and crocodiles share some physical space in the landscape. This happens when surrounding communities use resources from wildlife territories. In using these resources the community members cause disturbance to crocodiles leading to conflicts between humans and crocodiles. The ignorance on the general behavior of crocodiles coupled with the inability to detect crocodiles in water compared to, for instance, elephants on land which can easily be detected by their large size, noise or droppings aggravate the conflicts (Chomba *et al.*, 2012).

In order to manage crocodiles living in a human dominated landscape there is a need to strike a balance between conservation priorities and the needs of people who live with crocodiles. The problems they cause to humans and livestock need to be known. Understanding the causes, timing and distribution of attacks on people and livestock is a step toward reducing the problem and hence prevent it. Conservation of wildlife outside protected areas cannot be achieved merely by protecting animals and avoiding the issues of people's needs and rights and their conflict with wildlife (FAO, 2009).

2.2 Human-crocodile Conflicts Worldwide

The conflicts between human and crocodiles exist in one form or another all over the world. It can be direct when humans are injured or killed by crocodile or indirect when crocodile kills livestock. The conflict has increased worldwide due to growing human populations and associated land use changes. Conflicts between humans and crocodiles, for example, have been reported in 33 countries spanning the tropics and subtropics, and the problem probably exists in many more (FAO, 2009). While most crocodiles' attacks occur in Africa and Asia, but these powerful reptiles are also found in parts of South America, Australia and the Southern United States (Chomba *et al.*, 2012). Crocodilians attacks on humans have been reasonably well documented in developed countries in the last few decades (Sideleau and Britton, 2013).

The attacks involving different crocodilian species have been highlighted in several scientific publications. The analysis of 1237 crocodilian attacks which resulted into 674 fatalities worldwide for the period of January 2008 to July 2013 showed that, 15 crocodilian species were responsible for attacks and 7 of those species were fatal attacks (Sideleau and Britton, 2013). *Crocodylus porosus* caused 494 attacks which resulted into 285 fatalities in areas of east Timor, Sumatra, east Kalimantan of Indonesia, Sarawak of Malaysia, Orissa of India and coastal Sri Lanka. *Crocodylus niloticus* caused 428 attacks of which 309 attacks were fatal. *Crocodylus palustris* was reported as a problem in India especially within Gujarat state, caused 98 attacks of which 50 were fatal. Other attacks were reported as follows:- 69 attacks resulting in 13 fatalities for *Crocodylus acutus* (problem areas were the Pacific coast of Mexico, Costa Rica and Panama), 36 attacks resulting in 9 fatalities for *Melanosuchus niger* (mostly from the Amazonas state of Brazil), 8 attacks resulting in 4 fatalities for *Tomistoma schlegelii*, 16 attacks resulting in 2 fatalities for *Crocodylus moreletii* (with the most severe cases coming from the

Tamaulipas state of Mexico), 47 attacks resulting in no fatalities for *Alligator mississippiensis*, and 33 non-fatal attacks for 7 other species (*Crocodylus johnstoni*, *Crocodylus siamensis*, *Crocodylus mindorensis*, *Crocodylus intermedius*, *Caiman yacare*, *Crocodylus latirostris* and *Crocodylus crocodilus*) (Sideleau and Britton, 2013).

Conversely, attacks in developing countries are typically poorly documented despite holding the highest frequencies of crocodylian attacks (Sideleau and Britton, 2013). Available reports suggest that human-crocodile conflicts in Africa are not only more prevalent than elsewhere but in some cases may represent a growing threat to rural livelihoods and development (McGregor, 2005). During the period of 2002 to 2008, a total of 347 people in Zambia were killed by five species of wildlife; crocodile, elephant, hippo, lion and buffalo (Chomba *et al.*, 2012). Nile crocodile killed the largest number of people 185 (53%) and was the most significant cause of human fatalities (Chomba *et al.*, 2012). In Mozambique, many deaths go unreported, simply because of the difficulty for many people of getting to government offices. A rough estimate would be around 300 people killed by crocodiles per year countrywide (FAO, 2009). With most crocodile attacks occurring in district bordering Lake Cabora Bassa and the Zambezi River (Dunham *et al.*, 2009). In Namibia, 157 crocodile attacks on humans and cattle were recorded in 2005 by community rangers in registered conservancies in the Caprivi region (FAO, 2009). Crocodile bites are also a major threat to the Southern Malawian population especially amongst those who live near the Shire River. In 1998, 60 patients over 4 years of age were admitted at Trinity hospital in the Nsanje District of Southern Malawi after sustaining crocodile bites (Wamisho *et al.*, 2009). BBC news reports and local statistics stated that two Malawians died each day during the rainy season in 2000, and there were 250 reported bites in the lower Shire area during 2001 (Wamisho *et al.*, 2009).

2.3 Human-crocodile Conflicts in Tanzania

Human-crocodile conflicts in Tanzania occur because many rivers are seasonal and dry up to a few remaining pools between August and January. Crocodiles and hippopotamuses living in these rivers are forced to concentrate in these pools. Similarly, rural people are also forced to use the same pools to water their livestock, wash themselves, their clothes and collect water for domestic uses. On the other hand during the rainy season many rivers and lakes floods up making crocodiles move freely in different flooded areas. In so doing crocodiles interact with humans as they venture some areas which are used by humans for different activities. These interactions of humans and crocodiles in lakes, rivers, pools and flooded areas have resulted into negative effects to both human beings and crocodiles. Crocodiles for example were responsible for 51 deaths in the 52 months from January 1990 to April 1994 in Korogwe District in Tanzania (Scott and Scott, 1994). Of these, 18 deaths occurred in the first four months of 1994. From 1999 to 2004, crocodiles killed at least 28 people and injured 57 others in Ukutu area, an area of about 500 km² comprising 22 villages located in the northern buffer zone of the Selous Game Reserve (Baldus, 2005). In one village alone 11 people were killed in a single year.

2.4 Crocodile Distribution in Tanzania

Tanzania has two species of crocodile namely, the Nile crocodile (*Crocodylus niloticus*) and the African slender-snouted crocodile (*Crocodylus cataphractus*) (URT, 1993; Ross, 1998). Among the two species, the Nile crocodile occurs in many parts of Tanzania where there is permanent fresh water. It is found in big rivers such as Grumeti, Kagera, Kizigo, Malagarasi, Mara, Moyowosi, Pangani, Ruaha, Rufiji, Rungwa, Ruvu, Ruvuma and Ugalla, and in lakes such as Burigi, Nyasa, Rukwa, Tanganyika and Victoria. The wide distribution of crocodiles population in Tanzania has led it to be down-listed from Appendix I to Appendix II of the CITES so as to allow utilization of crocodile through

ranching and trade (URT, 1993). While the Nile crocodile is common, the African slender-snouted crocodile is uncommon and occurs in Lake Tanganyika and is fully protected by law (URT, 1993, 2008). Its range is thus limited to Lake Tanganyika. The factors which determine the distribution of crocodile in many areas of Tanzania include food and water.

2.5 Abundance of Crocodiles in Tanzania

Numerous surveys have been conducted with the aim of estimating the abundance of crocodiles in specific areas of Tanzania but there is little recent information on the total number of crocodiles in the country. Tello (1985) estimated a total population of 74 000 crocodiles in Tanzania. Crocodile survey in Lake Rukwa was done by Hirji in 1986, with very little evidence it was recommended that an annual cropping of 10 000 crocodiles can be carried out in the lake (Hirji, 1986). Katalihwa and Lema (1988) made an estimate of 76 000 crocodiles in Tanzania by using information from Tello (1985). Aerial surveys of crocodile densities were made in the Selous Game Reserve and surrounding game controlled and open areas in 1988 and 1989 indicating that the population appears not only stable but also increasing (Hutton and Katalihwa, 1998).

Games and Severre (1990) made a country wide survey of crocodile densities, and found a reasonable distribution of crocodiles in all natural habitats of the country regardless of the number of crocodiles which were harvested as result of CITES permission of reducing crocodiles population that are conflicting with human. Crocodiles were not hunted in the game reserves and national parks. Games and Severre (1990) came up with an average density of 2.47 crocodiles per square kilometer of water bodies estimating 16 905 crocodiles. With a correction factor of 4.5, Tanzania had a crocodile population of 76 071 crocodiles, indicating a stable population over time.

2.6 Damages Caused by Crocodiles

Nile crocodiles are one of the most dangerous crocodylians to humans (Revol, 1995). These animals have several potential damages. The damages associated with crocodiles include death or injury to people which causes trauma to families and communities. Safety and freedom of movement are constrained in areas with crocodiles. These prohibit people from accessing resources found in areas where crocodiles live. Crocodiles kill livestock leading to lack of meat, milk, and draught power, social and cultural activities relating to prestige, bride wealth, and social status to the households involved (FAO, 2009). Crocodiles utilize a prey population that could be harvested by humans leading to reduced fish harvest. They destroy valuable fishing equipment and interfere with fishing efforts leading to reduced income from fishing activities. Fish caught in nets or on fishing lines are known to attract crocodiles which often end up destroying the fishing gear whilst attempting to feed on the ensnared fish (Boyle, 2007; McGregor, 2005). Fishing equipment is considered a valuable asset to developing fisheries and any losses can impact heavily on livelihoods (McGregor, 2005). These factors definitely contribute towards people's negative attitude to crocodiles and they undermine the political support for conservation in protected areas and may call for eradication of the problem animal.

People often respond to these damages by actions such as injuring or killing animals and by creating conflict with wildlife authorities (Woodroffe *et al.*, 2005). As a consequence many species of large 'fierce' animals are in rapid decline (Woodroffe and Ginsberg, 1998). The management of human-wildlife conflicts is perhaps the greatest challenge for the future survival of many species of large mammals (Graham *et al.*, 2010) such as carnivores. This is particularly true for crocodiles found outside protected areas of Tanzania.

2.7 Threats Facing Crocodiles

The main threats to the population of Nile crocodile are habitat loss, direct conflict with people, poaching, uncontrolled hunting (Fergusson, 2010), pollution associated with increasing human population density (Pooley, 1982; Thorbjarnarson, 1992; Shacks, 2006; Thomas, 2006) and entanglement in fishing nets. The growing problem on freshwater scarcity, threatens all the important Nile crocodile range states in Southern, Eastern and Sudano-Sahelian Africa (UNEP-WCMC, 2008). The increased dependence on freshwater resources for poverty alleviation in Africa has led to restrictiveness in crocodile specific habitat. Also, the vast majorities of people living alongside crocodiles in Africa derive minimal benefit from them and see crocodiles only as dangerous problem animals (McGregor, 2005; Pooley, 1982; Ross, 1998; Thomas, 2006).

The main threats facing crocodiles found in Lake Rukwa and Feeder Rivers are hunting/exploitation and entanglement in fishing nets. Human have been killing crocodiles for skin and human consumption. The Nile crocodile is one of the most commercially utilized crocodilians, the skin being acknowledged as one of the “classics” (Fergusson, 2010). In the need of crocodile skins hunting of crocodile in Lake Rukwa started to be implemented in 1998. Cossam Building and Civil Engineering Cooperation was the only licensed company involved in crocodile hunting process and crocodile farming in Lake Rukwa (Mbozi District, 2013). Hunting activities were conducted in different areas of the lake and its feeder rivers. It was mainly done during the night by using flashlights because it is very difficult to locate crocodiles during the day time due to their amphibious nature and cryptic behaviors. Important years of hunting included 2003, 2004, 2007, 2008, 2009 and 2010 with no any hunting done in years 2005, 2006, 2011 and 2012 (Mbozi District, 2013). Hunting process has reduced the number of crocodiles in the lake.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

3.1.1 Location

The study was carried out in four villages of Momba District, i.e. Kamsamba, Muuyu and Senga villages of Kamsamba ward and Samang'ombe village of Ivuna ward. Momba District is located at the south western part of Mbeya Region, between 8⁰10' and 9⁰ 15" S and 32⁰ 5' and 32⁰ 45" E (Momba District, 2013). It shares borders with Rukwa Region and Republic of Zambia to the west, Mbozi District to the east, Chunya District to the north and Ileje District to the south (Fig. 2).

3.1.2 Topography and climate

Momba District lies between 900 - 2750 m above sea level. On average it receives rainfall between 1350 mm and 1550 mm per annum (Momba District, 2013). The average temperature ranges between 20⁰C to 28⁰C (Momba District, 2013). The district is divided into two main zones which are high plateau and rift valley zones. The high plateau zone covers a small portion of Ndalambo division where its altitude ranges from 1400 - 2750 m above the sea level (Momba District, 2013). The topography of this area is characterized by several hills with rivers and a valuable valley for irrigation. In this zone, two types of soil are observed which include the volcanic soil and clay soil. Though the vegetation cover has been widely removed by human beings through agricultural activities, some natural vegetation is still observed especially along the river valleys, mountains and hills. Its climate is relatively of moderate temperature and high rainfall compared to the other zone.

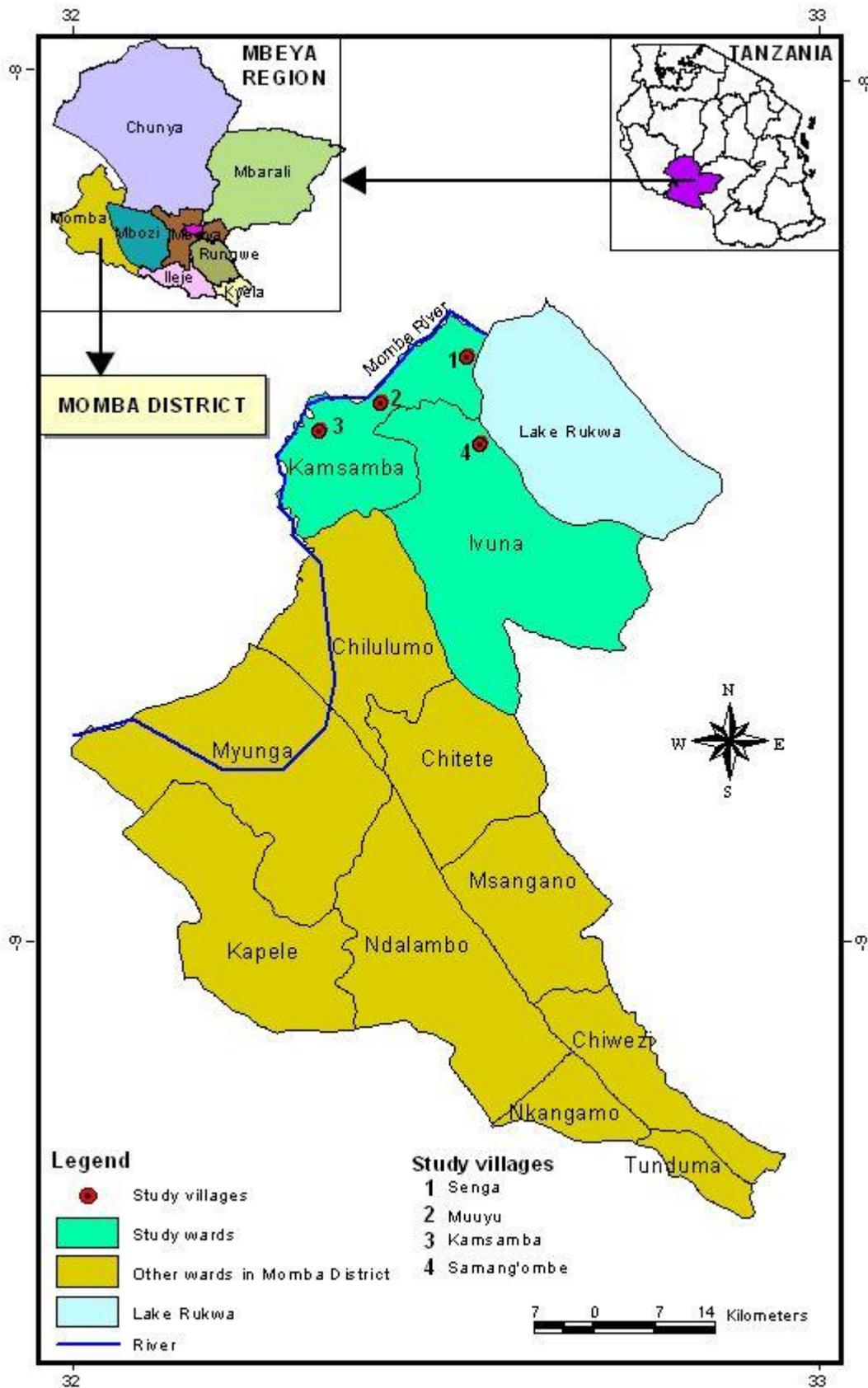


Figure 2: A map of Momba District showing locations of the study villages

The rift valley (low land) zone is located in the western part of the district, covering the large parts of Ndalambo, Msangano, Ivuna and Kamsamba divisions. This area is relatively hot with temperature ranging between 25 °C - 28° C (Momba District, 2013). The zone is characterised by relatively flat areas with clay, loam types of soils and silt soil predominating over a large area. Potential rivers cut across some parts of the zone areas. These rivers are associated with valleys favourable for paddy, beans, vegetables, fruits and other crops production. The vegetation cover in this zone is mainly composed of species of *Acacia*.

3.1.3 Lake Rukwa

Lake Rukwa is a large, shallow, closed-basin lake which borders three regions of Rukwa, Katavi and Mbeya on the south-western part of Tanzania and is part of the Rift Valley with Lake Tanganyika on the northwest and Lake Nyasa on the southwest. It covers a total area of 85 000 km² and it is 790 m above sea level. Of 85 000 km², 292 km² form part of Momba District where fishing activities are carried out (Momba District, 2013). The lake is endorheic, with no external drainage (Hughes and Hughes, 1992). The lake provides a habitat to different number of fish species and wildlife like crocodiles, hippopotamuses and terrapins. The long term existence of this lake is threatened by silting which is caused by intensive agricultural cultivation at the upper river streams and catchment areas which feed the lake and intensive cattle grazing around the lake.

3.1.4 Momba River

Momba River is a permanent flowing river which originates from several small rivers in areas of Myunga ward at Mfuto village. The rivers which form Momba River include Masanyinta River, Mtavya River, Mtonta River, Saesi River and Halungu River.

Apart from different fish species present in Momba River, crocodiles are the only important wild animals present in the river. The river provides water supply to different communities in Momba District.

3.1.5 Wildlife

Prominent wildlife found in the Miombo woodlands, grasslands around the lake, in the lake and neighbouring swamps include hippopotamus (*Hippopotamus amphibious*), hare (*Lepus capensis*), hyena (*Crocuta crocuta*), spotted necked otter (*Lutra maculicollis*) and crocodiles (*Crocodylus niloticus*). The bird fauna is also very diverse with at least 360 species, including among the most important ones, cattle egret (*Bubulcus ibis*), marabou stork (*Leptoptilos crumeniferus*), brown-necked parrot (*Poicephalus robustus*), doves (*Sterptopelia* spp), francolin (*Francolinos* spp), African skimmer (*Rynchops flavirostris*), southern carmine bee-eater (*Merops nubicoides*) and malachite kingfisher (*Alcedo cristata*).

3.1.6 Human population

According to the 2012 population and housing census, Momba District had a population of 196 818 of which 94 257 are males and 102 561 are females. The average number of people per household in the district is 4.6 (URT, 2013). Kamsamba ward had a population of 17 055 of which 8297 were males and 8758 were females with the average household size being 4.8 while the population of Ivuna ward was 31 254 of which 14 883 were males and 16 371 were females with the average household size of 5.0 (URT, 2013). Kamsamba and Ivuna are wards bordering Lake Rukwa where the four study villages of Samang'ombe, Senga, Muuyu and Kamsamba are found.

3.1.7 Economic activities

People in Momba District rely entirely on their environment for food, energy, shelter and medicine. The life in rural areas of the district especially near Lake Rukwa and Momba River is heavily dependent on the river and lake resources for their domestic purpose. Some rural people gain financially by exploiting natural resources such as fish. Agriculture is the main economic activity in the district and is based on wetland cultivation of paddy. A number of rural people involved in agriculture are also involved in fishing activities. Livestock keepers are highly depended on water from rivers or lake for their animals to drink. During the dry season they graze their livestock on wetlands available along the rivers or lake. Depending on scale, these activities may either attract or repel crocodiles present in the lake or river. In order to strike a balance between the needs of people and other wildlife like crocodiles in these areas, it is very important to address the problems which crocodiles cause to human beings.

3.2 Methods

3.2.1 Research design

The study used cross-sectional research design for data collection. The design allowed data collection at one point in time from a sample selected to represent the larger population. The design used is quick and appropriate for descriptive and interpretation as recommended by Babbie (1990).

3.2.2 Reconnaissance survey

A preliminary survey of the study area was conducted in order to familiarize with the study area and collect general information about the existing human-crocodile conflicts, terrain and accessibility of the study area. The survey also involved the selection of four

study villages. During the reconnaissance survey, questionnaires were pre-tested in one of the villages and necessary modification made to suit the prevailing local circumstances.

3.2.3 Sampling procedure

The study used purposive sampling for selecting four villages out of eight available villages; two villages of Samang'ombe and Senga along Lake Rukwa and the other two villages of Kamsamba and Muuyu along Momba River. Households were randomly selected from the lists provided by the respective village government officers for each village. If nobody was available for the interview in the selected house then the nearest house with an available respondent was chosen. Communities surrounding Lake Rukwa and Momba River formed the study population whereby households were used as basic sampling unit in each village. The sampling frame used was the list of available population in each village. The sampling intensity involved taking 30 households in each village and a total of 120 households were sufficient for the study. Bailey (1994) reported that, for studies in which statistical analysis is to be done, a sample size of ≥ 30 is required regardless of the population size.

3.2.4 Data collection

Data collection involved both primary data collection and secondary data collection in the study area.

3.2.4.1 Primary data

Primary data were collected from the field through direct observation, household interview, focus group discussion and key informants interview. Both quantitative and qualitative data were collected.

Direct observation

Direct observation was used in collecting information relating to human behaviors on the use of river and lake resources. Observation involved observing activities like washing clothes, swimming, fetching water for domestic use, farming and grazing animals around the river or lake. The direct observation method was basically used to bind together the more separate elements of data collected by other methods.

Household interview

Structured interviews were used to the household heads by using questionnaire (Appendix 1). This method allowed collection of information relating to causes and types of human-crocodile conflicts. Direct personal investigation using structured interview provided uniform information which ensured comparability of data. Collection of data using questionnaire allowed villagers with minimum level of education to comfortably participate during the exercise.

Focus group discussions

Focus group discussions were conducted with people who were knowledgeable and had experience on human-crocodile conflicts. The focus group discussion involved six to twelve people. A checklist was used to guide focus group discussion (Appendix 2). Three focus groups discussions were conducted in three villages of Kamsamba, Samang'ombe, and Senga, the first involved females only; the second males only and lastly combined both males and females in equal proportion. This is because males and females have different ways of using water resources. Focus group discussions were conducted in order to complement, supplement and crosscheck information given by other methods. Focus group discussions were used to get more in-depth information on perceptions, attitudes, experiences and beliefs on human-crocodile conflicts.

Focus group discussion was not conducted at Muuyu village because Senga village was previously a hamlet of Muuyu and thus the people of two villages shared a great common understanding of human-crocodile conflicts.

Key informants interview

Interview with key informants were used to collect data on various issues on human-crocodile conflicts. The key informants in this study included District Game Officer, Senior Assistant Game Officer, District Fisheries Officer, Assistant Fisheries Officer, Councillors and Ward Executive Officers present in the study area. Checklist of questions was used to obtain information from key informants (Appendix 3).

3.2.4.2 Secondary data

Secondary data were obtained from official documents of Mbozi District Council, Momba District Council, Kamsamba ward, Ivuna ward and village records. The data collected from these records included the number of past human-crocodile damages and measures taken to resolve the conflict. Information on the number of people and livestock attacked by crocodiles in the study area were collected.

3.3 Data Analysis

3.3.1 Qualitative data

Qualitative data were analyzed by the use of content analysis. Content analysis was used to analyze the components of verbal discussions held with different respondents. In this way the recorded dialogue with the respondents was broken down into smallest meaningful units of information, values and attitudes of respondents (Kajembe, 1994). Data from focus group discussions were summarized by picking the main points and conclusions reached by the group members themselves (Cooksey and Lokuji, 1995).

3.3.2 Quantitative data

Quantitative data were organized, edited, coded and entered in a computer and the Statistical Package for Social Science (SPSS) software version 16.0 spread sheet was used for the analysis. Descriptive statistics were run to give frequencies, percentages and then cross-tabulation was undertaken. Tables and bar charts were used to present different variables. Cross-tabulation allowed a comparison of different study parameters in the four villages. Chi-square test was used to determine significance of differences between data sets at the 0.05 significance level. Data for crocodile damages on human and livestock were analyzed using Microsoft Office Excel 2007 to present patterns and trends of crocodile damages on humans and livestock in the form of graphs.

3.4 Potential Sources of Bias

The main potential source of bias was in the collection of data on livestock losses due to crocodile attacks. This was the problem because the Tanzanian government does not compensate for losses on livestock predation, so livestock keepers lack incentive to report livestock losses, leading to a likely underestimate of the true extent of predation. Another source of bias was that survey respondents lacked memory of past events on crocodile threats, injuries and sometimes the year when the death occurred. This was minimized by asking the same question to other members of the household. Furthermore, key informants interviews and focus group discussions helped in updating different key issues in the study by so doing biases were reduced and further improved the quality and reliability of the data collected for this study.

During the study period, there were two programs going on the field. One of the programs was poaching eradication operation which was implemented in all villages bordering the lake, but the effect was apparent in all nearby villages. Another operation involved

evacuating all livestock keepers and their livestock in all areas of the lake covering Momba District. The two programs created negative attitudes towards the study because it was also touching some aspects of wildlife. This was reduced by involving village chairpersons or village executive officers in giving clarifications of the aim of the study and its importance to their communities.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

4.1 Social Economic Characteristics of the Respondents

4.1.1 Age and sex distribution

The study population comprised of males and females with different ages, family size and education backgrounds. Of the household heads interviewed, 69.2% of the respondents were males and 30.8% females (Table 1). Male respondents were many compared to females because the majority of households in the study area were headed by males than females.

Table 1: Social economic characteristics of respondents

Parameter		Frequency (n=120)	Percent
Sex	Males	83	69.2
	Females	37	30.8
Age (years)	20-29	16	13.3
	30-39	36	30.1
	40-49	37	30.8
	50-59	22	18.3
	60-69	7	5.8
	70-79	2	1.7
Level of education	No formal education	46	38.3
	Primary education	70	58.4
	Secondary education	3	2.5
	Tertiary education	1	0.8
Family size	1-2	22	18.3
	3-5	50	41.7
	6-8	42	35.0
	≥9	6	5.0
Marital status	Single	3	2.5
	Married	95	79.2
	Divorced	7	5.8
	Widows/widowers	15	12.5

The age of respondents was an important parameter since different age groups perform different sets of activities in most African societies. The age distribution varied greatly among the respondents. The study depicts that 30.8% of the respondents had an age range of 40-49, 30.1% had an age range of 30-39, where as 18.3%, 13.3%, 5.8% and 1.7% had age ranges of 50-59, 20-29, 60-69 and 70-79, respectively (Table 1). Overall, it shows that 56.6% of the respondents were above 40 years old. This was important because they had a clear understanding of the historical trends of crocodile damages/threats in their areas. On other hand the group aged 39 years and below (43.4%) was also important because many of them were involved in different activities like crop cultivation, tending livestock and fishing, so they had a clear understanding of the current situation of crocodile damages on fishing gears and threats posed by crocodiles in fishing activities.

4.1.2 Education level

Understanding the education level of respondents is the key important aspect in assessing their skills and knowledge in judging and reasoning about different issues. The results show that, majority of the respondents 58.4%, had primary education, 38.3% had no formal education, 2.5% acquired secondary education and 0.8% had tertiary education (Table 1).

4.1.3 Marital status and household size of the respondents

Table 1 show that 79.2% of the respondents were married, 12.5% were widows/widowers, 5.8% were divorced and 2.5% were single. The large numbers (79.2%) of families which have married couples are likely to do better in different economic activities compared to the rest categories. With respect to family size, results indicate that 41.7% had 3-5 family members, 35.0% had 6-8 family members, 18.3% had 1-2 family members and 5.0% had 9 or more than 9 family members.

4.1.4 Ethnicity and residency

The study found a number of ethnic tribes living adjacent to Momba River and Lake Rukwa. The respondents' tribes include: - Nyamwanga (40.0%), Nyiha (13.3%), Nyakyusa (11.7%), Ngoni (6.7%), Bungu (5.8%), Kinga (5.0%), Fipa (0.8%), Maasai (4.2%), Mambwe (0.8%), Ndali (4.2%), Waha (1.7%), Nyamwezi (0.8%), Sukuma (2.5%) and Wanda (2.5%) (Table 2). Nyamwanga (40.0%) formed a large number of the total respondents because it is the major ethnic group in terms of their number and it forms 50.0% of the total population found in Momba District (Momba District, 2013). There are many tribes in the study area because of fishing activities which tend to attract a large number of people from different areas of the country. Of all the respondents, 99.2% were permanent residents and only 0.8% being temporary residents (Table 2). The involvement of a large number of permanent respondents was very important because they have a good experience in all matters relating to crocodiles.

Table 2: Residence and ethnicity of respondents

Respondent's ethnicity		Frequency (n=120)	Percent
Bungu		7	5.8
Fipa		1	0.8
Kinga		6	5.0
Maasai		5	4.2
Mambwe		1	0.8
Ndali		5	4.2
Ngoni		8	6.7
Nyakyusa		14	11.7
Nyamwanga		48	40.0
Nyamwezi		1	0.8
Nyiha		16	13.3
Sukuma		3	2.5
Waha		2	1.7
Wanda		3	2.5
Residency	Permanent	119	99.2
	Temporary	1	0.8

4.1.5 Occupation and household income of the respondents

In the study area it was found that people engage in different economic activities. It was found that 34.2% of the respondents were involved in crop production, 28.3% in crop production and livestock keeping, while 15.8%, 11.7%, 5.8% and 4.2% of the respondents were involved in crop production and fishing, fishing, livestock keeping, and crop production and business, respectively (Table 3). Agriculture involving crop cultivation is the main economic activity in the study area and is mainly done by small scale farmers who use hand hoes and animals in their daily agricultural productions. A Chi square test for the difference between occupation of respondents and age showed significant differences ($\chi^2 = 48.992$, $df = 25$, $p = 0.003$). Respondents with age ranging from 20 to 49 years were involved in more than one economic activity while that with age ranging from 50 to 79 years were more specialized on either crop cultivation or livestock keeping.

Table 3: Occupation and income of respondents

Parameter	Response	Frequency (n=120)	Percent
Occupation of respondents	Crop production	41	34.2
	Livestock keeping	7	5.8
	Fishing	14	11.7
	Crop production and business	5	4.2
	Crop production and livestock keeping	34	28.3
	Crop production and fishing	19	15.8
Household income (Tshs)	Less than 500 000	44	36.6
	500 001 - 800 000	50	41.7
	800 001 - 1 000 000	17	14.2
	Above 1 000 000	9	7.5

The income of different respondents in households varied from one household to another. The study shows that 41.7% had income between the range of 500 001-800 000 Tshs per annum, 36.6% with income less than 500 000 Tshs, 14.2% income between 800 001-1000 000 Tshs and 7.5% with income above 1 000 000 Tshs per annum

(Table 3). The variation in household income was the driving factor towards the dependence of people on natural resources such as fish. People with low income tend to depend more on natural resources than people with high income.

4.1.6 Land use and ownerships

With respect to the ownership of land, the study indicates that 88.3% of the respondents reported to have their own land for agriculture while only 11.7% do not own land for agriculture (Table 4). This shows that many individuals are involved in agriculture. The major crops grown in this area are maize, paddy, sorghum, finger millet, cassava, sweet potatoes, simsim and sunflower. The results also indicate that 56.6% of the respondents who own land had their land located near the river or lake while 43.4% of the respondents owning land had their land located far from the river or lake. Many people prefer to carry out their agricultural activities along the lake/river because of the availability of water for growing paddy.

Table 4: Responses on land ownership and location

Parameter	Response	Frequency (n=120)	Percent
Land ownership	Own land	106	88.3
	Not own land	14	11.7
Land location	Near the lake/river	60	56.6
	Far from the lake/river	46	43.4

4.1.7 Livestock ownership

Livestock keeping is one of the activities performed by people in areas along Momba River and Lake Rukwa. The results indicate that 53.3% of the respondents own livestock and 46.7% do not have any livestock (Table 5). During the study period it was observed that a number of people keep livestock like cattle, goat, sheep, dog, pigs and donkey.

It was found that 78.1% of the respondents who keep livestock graze their livestock near the river or lake while 21.9% reported to graze their livestock far from the river. Livestock keepers prefer to herd their livestock in wetland areas of the lake or river because of the presence of plenty green grasses. The livestock fodders growing in wetlands along the river or lake attract a number of livestock to feed on them eventually exposing them to crocodiles.

Table 5: Responses on ownerships of livestock and location of grazing areas

Parameter	Response	Frequency (n=120)	Percent
Livestock ownership	Own livestock	64	53.3
	Not own livestock	56	46.7
Grazing area for livestock owners	Near the lake/river	50	78.1
	Far from the lake/river	14	21.9

4.2 Dependence on Water Bodies

Access to water is an essential human requirement and many developments of permanent settlements are always close to a source of water. During the study period it was found that majority of respondents depend on the river or the lake for different activities in their daily life. Such activities include fetching water, washing clothes, bathing, swimming, fishing, irrigation, navigation and watering livestock (Table 6). Most of these activities are either done in or near the lake and river where crocodiles live and therefore expose people to the risk of crocodiles' attacks.

With respect to fetching water it was shown that 50.0% of the respondents depend on the river, 23.3% the lake, 7.5% the lake and the river and 19.2% well/dam/spring (Table 6). For washing clothes it was found that 50.0% of the respondents depend on the river, 25.9% the lake, 16.7% well/dam/spring and 7.5% both on the lake and the river. Other

responses on bathing, swimming, fishing, irrigation, navigation and water for livestock are as shown in the Table 6.

Table 6: Responses on water dependencies on different water sources

Item of dependence	Activity area	Frequency (n=120)	Percent
Fetching water	Lake	28	23.3
	River	60	50.0
	Lake and river	9	7.5
	Well/dam/spring	23	19.2
Washing clothes	Lake	31	25.9
	River	60	50.0
	Lake and river	9	7.5
	Well/dam/spring	20	16.6
Bathing	Lake	28	23.3
	River	58	48.3
	Lake and river	8	6.7
	Well/dam/spring	26	21.7
Swimming	Lake	26	21.7
	River	22	18.3
	Lake and river	10	8.3
	Well/dam/spring	3	2.5
	No opinion	59	49.2
Fishing	Lake	29	24.2
	River	8	6.6
	Lake and river	20	16.7
	No opinion	63	52.5
Irrigation/cultivation	Lake	18	15.0
	River	34	28.3
	Lake and river	5	4.2
	Well/dam/spring	2	1.7
	No opinion	61	50.8
Navigation	Lake	36	30.0
	River	35	29.2
	Lake and river	17	14.2
	Well/dam/spring	1	0.8
	No opinion	31	25.8
Water for livestock keeping	Lake	30	25.0
	River	32	26.7
	Lake and river	36	30.0
	No opinion	22	18.3

4.3 Human-crocodile Conflicts Analysis

The results in Table 7 indicate that 99.2% of the respondents said that there are human-crocodile conflicts in their villages, while 0.8% reported that there is no any problem relating to crocodiles in their villages. The reports on the presence of human-crocodile conflicts in the villages varied significantly among age groups ($\chi^2 = 59.496$, $df = 5$, $p = 0.0001$), with more responses from age group 40-49 (30.08%) and 30-39 (30.0%). Results on other age groups show that 18.3% (50-59), 13.3% (20-29), 5.8% (60-69) and 0.8% (70-79) indicated the presence of human-crocodile conflicts in their villages. The absence of human-crocodile conflicts were reported by respondents (0.8%) with ages ranging from 70 to 79 years. The variation on the reporting of human-crocodile conflicts among age groups was due to their involvement in different economic activities and hence having different knowledge about the crocodile problems.

Table 7: Responses on human-crocodile conflicts according to age groups

Age of respondents (years)	Presence of human-crocodile conflict in the village	
	Yes	No
20-29	16 (13.3)	0 (0.0)
30-39	36 (30.0)	0 (0.0)
40-49	37 (30.8)	0 (0.0)
50-59	22 (18.3)	0 (0.0)
60-69	7 (5.8)	0 (0.0)
70-79	1 (0.8)	1 (0.8)
Total	119 (99.2)	1 (0.8)

The results show that a number of people know that there is a problem of crocodiles to humans and livestock. This may be attributed to the threats which crocodiles pose to the communities and thus making a number of people aware of the problem. It was observed that communities in the study area suffer indirectly from a sense of insecurity due to problems associated with crocodiles to their lives and property. This might be due to the possible losses that they can experience or from the worry of physical threat to their lives

and property. The indirect costs of human-crocodile conflicts are generally associated with the physical threat of living with crocodiles. This has effects on restricting people's freedom of movement, for fear of running into such animals, or restricts their access to resources such as water and fish.

When respondents were asked on whether they had faced any threat from crocodiles for the period of 2003-2012, 58.3% said yes, while 41.7% had not faced any threat from crocodiles (Table 8). Responses to whether any family member experienced attack from crocodiles indicated that 82.5% had not experienced any attack, 15.8% said yes and only 1.7% had no opinion on that. With regards to witchcraft beliefs associated with crocodile attacks on human beings it was found that 66.7% said no, 32.5% said yes and 0.8% had no opinion (Table 8).

Table 8: Responses on various issues of crocodiles conflicts

	Experience on crocodiles conflicts	Response	Frequency (n=120)	Percent
i.	Fishing nets damaged by crocodiles	Yes	66	55.0
		No	53	44.2
		No opinion	1	0.8
ii.	Faced crocodile threat for the period of 2003-2012 years	Yes	70	58.3
		No	50	41.7
iii.	Experience of family members on crocodile attacks from 2003-2012	Yes	19	15.8
		No	99	82.5
		No opinion	2	1.7
iv.	Traditional beliefs associated with human-crocodile conflict	Yes	39	32.5
		No	80	66.7
		No opinion	1	0.8
v.	Livestock killed by crocodiles	Yes	48	40.0
		No	69	57.5
		No opinion	3	2.5
vi.	Protecting fishing nets from crocodiles	Yes	4	3.3
		No	106	88.4
		No opinion	10	8.3

Despite the large number (66.7%) of respondents who do not agree on the association of crocodile attacks on human beings with traditional beliefs, focus group discussion revealed that there is some traditional beliefs associated with crocodile attacks on humans. It was reported that at Mchangani area there is a crocodile which kills and eats people and livestock. The livestock mostly killed include cattle, goats, sheep and ducks. The crocodile involved is believed to be a human crocodile with a name Nangoya. It is attributed to witchcraft and not crocodile as a species, it is suspected to wizards and witches in the village. Participants of the focus group discussion highlighted that efforts have been made to search for the crocodile and kill it but without success. Interviews with key informants found that the problem of Nangoya crocodile that is believed to be a human crocodile is well known to the villagers of Senga and other people who go to Mchangani fisheries camp several times to buy fish. Results on protecting fishing nets from crocodiles damages indicates that the majority of respondents (88.4%) do not protect their fishing nets from crocodiles damages while 3.3% reported that they protect their fish nets from crocodiles and 8.3% had no any opinion (Table 8).

The respondents' views on certain places in the river/lake being more dangerous to human and livestock visits due to presence of crocodiles, results show that 96.7% of all respondents were aware that some places are more risky than others (Table 9). It was noted that these places are not visited at all in some periods of a year especially during the wet season. Their distribution according to age was 30.0% (30-39), 29.2% (40-49), 17.5% (50-59), 13.3% (20-29), 5.8% (60-69) and 0.8% (70-79). The results show that, respondents with ages ranging from 20 years to 49 years (72.5%) reported significantly many responses than respondents with ages above 50 years (24.1%) ($\chi^2 = 62.681$, $df = 10$, $p = 0.0001$). This implies that respondents with 49 years of age and below had a better understanding of crocodiles' locations than those with 50 years and above ages.

This is due to their activeness in the various activities carried out in a lake/river or nearby places. The remainder had mixed views, for example 29.2 % (40-49) and 0.8% (70-79) didn't agree on whether certain areas of lake/river are more dangerous than others with respect to human and livestock safety while 0.8% (70-79) had no any opinion.

Table 9: Responses on certain lake/river places being dangerous than others

Age of respondent (years)	Certain lake/river places dangerous than others (n=120)		
	Yes	No	No opinion
20-29	16 (13.3)	0 (0.0)	0 (0.0)
30-39	36 (30.0)	0 (0.0)	0 (0.0)
40-49	35 (29.2)	2 (1.7)	0 (0.0)
50-59	21 (17.5)	1 (0.8)	0 (0.0)
60-69	7 (5.8)	0 (0.0)	0 (0.0)
70-79	1 (0.8)	0 (0.0)	1 (0.8)
Total	116 (96.7)	3 (2.5)	1 (0.8)

Table 10 indicates the responses from households regarding their swimming habits towards crocodiles. Most of the residents interviewed (87.5%) said that they are afraid of crocodiles when swimming in the lake or the river. They believed that crocodiles can attack them at any time but they tended to ignore them when swimming because the selected areas were believed to have no crocodiles. The results also show that 5.8% of all respondents said that they are not afraid from crocodiles when swimming. They also show significant differences on the responses of respondent's age towards crocodiles when swimming ($\chi^2 = 19.931$, $df = 10$, $p = 0.030$). Many respondents (69.1%) who said they fear for crocodiles when swimming were of ages ranging from 20 to 49 years and only 18.3% were of ages above 50 years. This is because young people prefer swimming than older people.

Table 10: Responses on fear for crocodiles when swimming

Age of respondents (years)	Fear from crocodiles when swimming (n=120)		
	Yes	No	No opinion
20-29	15 (12.5)	1 (0.8)	0 (0.0)
30-39	34 (28.3)	0 (0.0)	2 (1.7)
40-49	34 (28.3)	2 (1.7)	1 (0.8)
50-59	17 (14.2)	3 (2.5)	2 (1.7)
60-69	4 (3.3)	1 (0.8)	2 (1.7)
70-79	1 (0.8)	0 (0.0)	1 (0.8)
Total	105 (87.5)	7 (5.8)	8 (6.7)

4.4 Factors Causing Human-crocodile Conflicts

In finding out factors that are responsible for causing human-crocodile conflicts, different views were obtained. The views were distributed such that 40.0% of all the respondents said fishing, 30.8% mentioned crossing rivers, 16.7% said fetching water for domestic use, 7.5% said agriculture/livestock keeping and 5.0% of the respondents interviewed said bathing/swimming (Table 11). The results show that fishing is the main factor causing human-crocodile conflicts. It was noted during focus group discussion that fishing activities in the lake/river were formally conducted in places where the rewards in terms of fish catch are highest and where there were no crocodiles, thus crocodiles become concentrated in areas less heavily fished or disturbed. Due to the growing demand for fish, these areas become ultimately subjected to fishing pressure. This, consequently, increases the chances of contact between people and crocodiles resulting into conflict with humans. The over fishing of the crocodiles' primary food source has caused crocodiles to switch to other prey including humans and has been sometimes mentioned to explain the human-crocodile conflicts (FAO, 2005).

Table 11: Responses on factors causing human-crocodile conflicts

Factors causing human-crocodile conflicts	Frequency (n=120)	Percent
Crossing rivers	37	30.8
Fishing	48	40.0
Water for domestic use	20	16.7
Swimming/ bathing	6	5.0
Agriculture/Livestock keeping	9	7.5

Agriculture exposes people to crocodile attacks when they are working in wetland areas or when they are going or coming from their fields. It was highlighted during focus groups discussion that many crocodile attack victims were either going or coming from agricultural fields. On the other hand livestock keepers prefer to graze their livestock in wetland areas of the lake or the river. Wetland resources along the river or the lake attract a number of livestock eventually exposing them to crocodiles.

The present study on human-crocodile conflicts concurs with the study conducted by Fergusson (2004), who reported that most of the Nile crocodile attacks victims were through swimming, bathing, or crossing a river with cattle. Other activities included fetching water, drinking, or fishing at the water's edge. Similar factors were reported by Kalowekamo (2000).

4.5 Damages Caused by Crocodiles to Communities

In an attempt to find out the crocodile damages to the communities, the study found that killing of people (34.2%) was the serious damage that crocodile caused to the communities, 21.7% indicated killing of livestock, 18.3% said crocodiles pose threats to people's life and thus prohibiting them to have access to water resources, 15.0% of the respondents indicated injury/deformity to people and 10.8% of the respondents reported on the damages on fishing nets (Fig. 3). These damages affect communities socially and

economically, and they create negative awareness to the communities living in areas adjacent to Lake Rukwa and Momba River about conservation of crocodiles. This can be a hindrance to the crocodile conservation initiatives in the future.

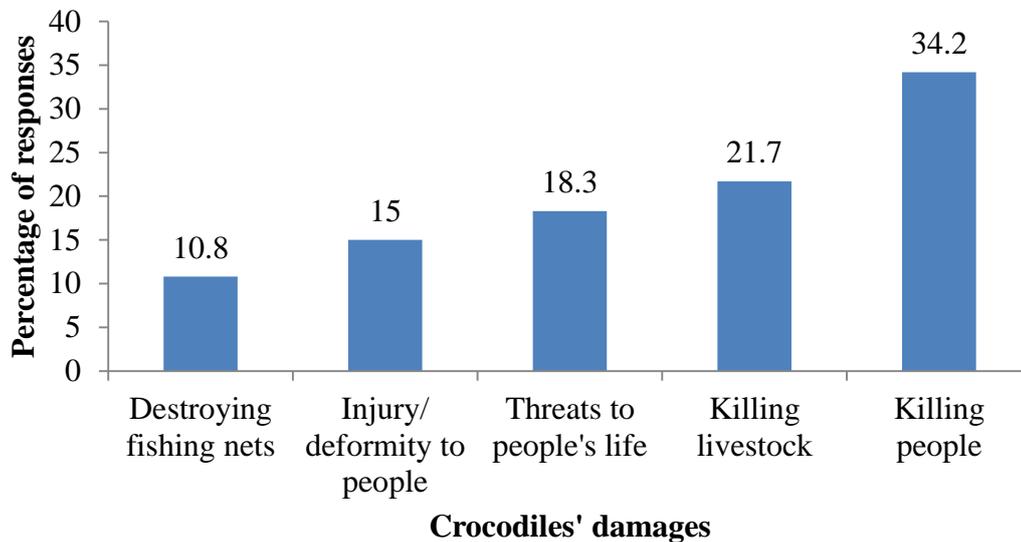


Figure 3: Responses on damages caused by crocodiles

4.5.1 Crocodiles damage to livestock

Regarding crocodile damages to livestock, different responses were noted as follows: - 17.5% of the respondents had lost cattle, 12.5% reported loss in goats, 6.7% lost dogs and 63.3% of the respondents didn't lose any livestock for the period of 2003-2012 (Table 12). Despite few responses on livestock losses due to crocodile attacks, this creates conflicts with communities. Crocodile attacks on livestock cause economic problem for rural population who depend on domestic animals for manure, milk and meat. The impact of crocodile predation on domestic animals depends on the scale of the livestock husbandry system. It can be devastating for small traditional farmers who depend on a few livestock and can thus become a significant problem at the local level and induce drastic human retaliation (FAO, 2010). The loss of livestock such as oxen which are used in farming activities in a family with low income may result in adverse effects on food

security. Humans usually react with retaliation killings, where no distinction is made between the animal that actually caused the damage and other non-culpable individuals (FAO, 2010).

Table 12: Responses on livestock losses from crocodiles attacks

Livestock lost	Name of villages (n=120)				Total
	Samang'ombe	Senga	Muuyu	Kamsamba	
Cattle	9 (7.5)	4 (3.3)	6 (5.0)	2 (1.7)	21 (17.5)
Goat	2 (1.7)	3 (2.5)	3 (2.5)	7 (5.8)	15 (12.5)
Dog	0 (0.0)	1 (0.8)	0 (0.0)	7 (5.8)	8 (6.7)
None	19 (15.8)	22 (18.3)	21 (17.5)	14 (11.7)	76 (63.3)

In a focus group discussion it was stressed that there was large number of domestic animals which were killed by crocodiles but their values were generally poorly recorded. Goats are much more frequently killed than cattle but the economic loss associated with the death of a cow is considerable. Dogs were also reported as frequent victims although their value is difficult to quantify. An interview with the Senior Assistant Game Officer revealed that communities lack motivation in reporting the death of small animals to government officials as there is no consolation made for such damage. This is contrary to the Wildlife Conservation Act No. 5 of 2009 of the United Republic of Tanzania. The consolation for loss of life, crops or injury caused by dangerous animals (section 70) is under part four of the act dealing with human wildlife conflict. Section 71 subsection one states that “The Minister may, in the public interest and after consultation with the Minister responsible for finance, make regulations specifying the amount of money to be paid as a consolation to a person or groups of persons who have suffered loss of life, livestock, crops or injury caused by dangerous animals.” It is further stated in subsection two that “Without prejudice to the provisions of subsection one, the Minister shall make regulations prescribing the payment of consolation money to any person for injury

sustained, death or destruction of his crops caused by dangerous animals, provided that in relation to destruction of crops, no payment shall be made in excess of five acres” (URT, 2008).

4.5.2 Crocodiles damage to fishing nets

In respect to the crocodile damages on fishing gears, results revealed that 55.0% of the respondents claimed that crocodiles had caused damages to their fishing nets for the period of 2003-2012, 44.2% of the respondents had not experienced any damages from crocodile on their fishing nets and the remaining 0.8% had no opinion on crocodile damages on fishing nets (Table 13). The response differs among respondents because they engage in different activities and had different experiences on crocodiles for the past ten years (2003 - 2012). Male respondents reported larger number of responses (45.8%) than females (9.2%) ($\chi^2 = 15.087$, $df = 2$; $p = 0.001$). This is because fishing activities in Lake Rukwa and Momba River are mainly done by men while females remain in fishing camps for fish processing activities like salting, removing fish scales and in drying processes. Crocodile damages on fishing gears may lead to people involved in fishing activities to have negative attitudes towards crocodiles. This conflict could often undermine the objectives of wildlife conservation and initiatives for sustainable use of wildlife resources like crocodiles.

Table 13: Responses on crocodile damage to fishing nets

Sex of respondents	Fishing nets damaged by crocodiles		
	Yes	No	No opinion
Males	55 (45.8)	28 (23.3)	0 (0.0)
Females	11 (9.2)	25 (20.8)	1 (0.8)
Total	66 (55.0)	53 (44.2)	1 (0.8)

4.5.3 Experience of households on crocodile attacks

The experience of households to crocodile attacks in their families from 2003 to 2012 revealed that 68.3% of all the respondents had no any experience on crocodile attack on humans, 25.8% reported to had a family member who faced threat/attack from crocodiles, 4.2% had experienced death and 1.7% experienced injury/deformity (Table 14).

Table 14: Responses on experience of households on crocodiles' attacks from the year 2003 to 2012

Household experience on crocodiles' attacks	Frequency (n=120)	Percent
Threat/attack	31	25.8
Injury/deformity	2	1.7
Death	5	4.2
None	82	68.3

Despite the few responses on human deaths and injuries at the family level, the cases reported by respondents in Table 14 manifest human-crocodile conflicts and are commonly regarded as intolerable. The loss of human life often draws attention of the public media and politicians who demand action from the government. In general, the death of a family member due to a wild animal is a very traumatic experience. In focus group discussion it was highlighted that physical injury or even death caused by crocodile attacks have high financial costs for individuals and society in the form of medical treatments to cure and prevent infections transmitted from the animal. One crocodile attack victim known as Alinani Nzunda (42) who lost his arm while fishing at Chafundika River with his friend in November 2011, said that he stayed more than two months at Mbeya Referral Hospital for treatment of his wound. During treatment time his family spent a lot of money for transport, food, house rent and treatment.

The death or injury of the bread winner to a poor peasant family in a developing country can mean the difference between a secure life for all and one of destitution where day to day survival becomes life's priority. The loss of the mother of a family will mean that a child has to take her place doing family chores and that the opportunity of an education for that child is lost (FAO, 2009). In time, this will have consequences for her children and their future.

4.5.3.1 Distribution of crocodile attacks between men and women

On examination of how the problem is distributed between men and women, the results show that 43.3% of the respondents reported that men are more affected, 30.8% said women are more affected than men, 24.2% both men and women are equally affected, while only 1.7% of the respondents had no opinion on who are more affected between men and women with the crocodile problems (Fig. 4). A χ^2 test to examine the difference between respondent's sex and their opinions on crocodile problem distribution between men and women showed a significant differences ($\chi^2 = 11.332$, $df = 3$, $p = 0.010$). A large proportion of respondents know that men are more affected with crocodiles than women. It was noted during focus groups discussion that there were more crocodiles attacks on men than females.

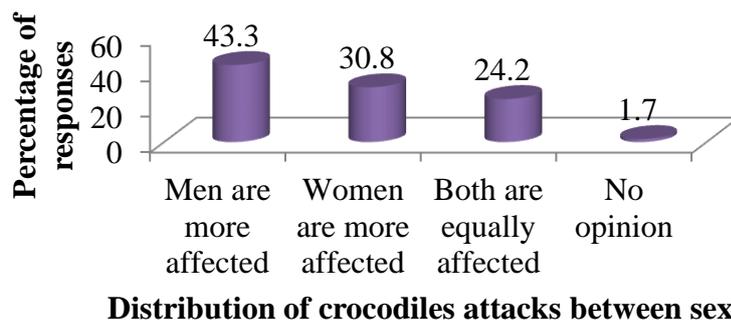


Figure 4: Responses on the distribution of crocodile attacks between men and women

During the study period, it was observed that men are more involved in fishing activities, tending livestock and doing many agricultural works than women. On other hand women were more involved in home care activities such as collecting water for domestic use, washing activities and firewood collection. Activities performed by men and women expose them differently to crocodile attacks depending on the nature of the activity, its frequency, area where it is done and time at which the activity took place. This study is in line with the study done by Manolis and Webb in 2013 who reported that the majority of people attacked by crocodiles were males (74.5%) with an average age of 33.7 years. It was also reported by Silva *et al.* (2013) that of the 177 victims of crocodile attacks in Sri Lanka, 84.0% were males and 15.0% were females. The remaining 1.0% was missing from the record.

4.5.3.2 Crocodiles attacks by age groups

The results on identifying which age group is more affected by crocodile problems indicated that 36.7% of the respondents said 16-35 years old, 30.0% indicated 36-50 years old, 18.3% said all age groups, 12.5% said below 15 years and 2.5% of the respondents said above 51 years (Fig. 5). People with age group ranging from 16 to 35 years were more affected with crocodile attacks than the rest age groups ($\chi^2 = 44.583$, $df = 4$, $p = 0.0001$). This is because many people in this age group category are more involved in different activities such as fishing, tending livestock, water collection and many of them prefer to go for swimming or taking a bath in either the river or the lake, thus exposing themselves to crocodile attacks.

The study concurs with the study done by Caldicott *et al.* (2005) on crocodile attack in Australia, who reported that most crocodile attack victims in northern Australia have been males (75.0%), and the average age of all victims was 31.2 years. A similar trend is

apparent with American alligator attacks (1948 to 1995), where 84.0% of victims were males, and the average age of victims was 31.8 years (Conover and Dubow, 1997).

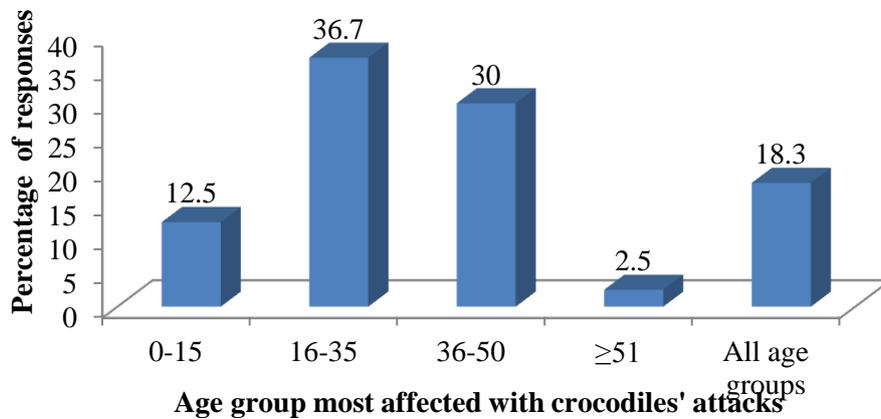


Figure 5: Responses on crocodiles attacks by age groups

4.6 Time for Most Crocodile Attacks on People and Livestock

People had different views on when most crocodile attacks occur on people and livestock. The results show that 58.3% of the respondents said all the time of the day, 29.2% said evening time, 10.0% said afternoon and 2.5% said morning time (Fig. 6).

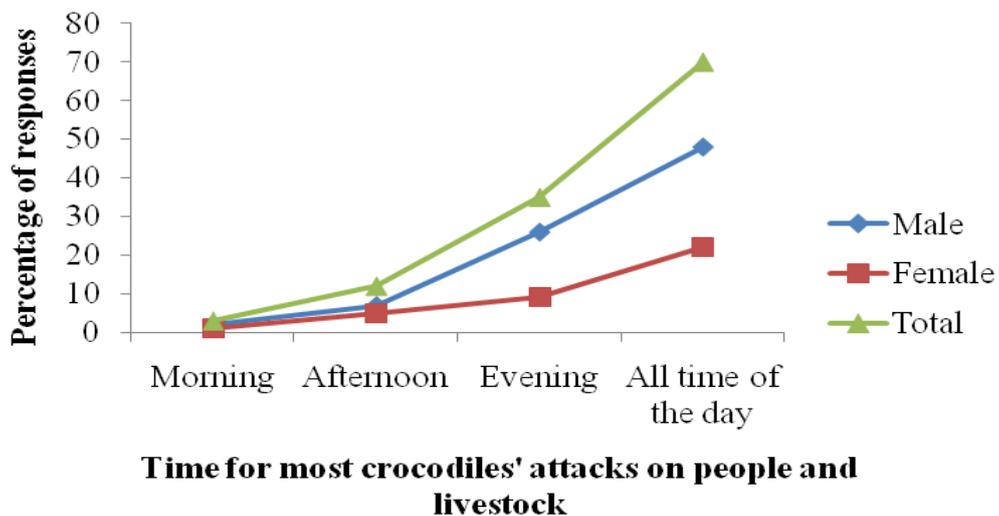


Figure 6: Responses on time for most crocodiles' attacks on people and livestock

The results indicate that most crocodile attacks on people and livestock can occur at any time of the day followed by evening. Both male and female graphs show a similar pattern on time for most crocodile attacks, despite male having many responses than females. Attacks from crocodiles normally reflect people's activities. Fergusson (2004) reported that 86.0% of Nile crocodile attacks occurred during daylight hours, reflecting human activity patterns. The current study concurs with Manolis and Webb (2013) who found that most attacks by saltwater crocodiles occur during the day reflecting the timing of activities by victims, rather than any specific preference by crocodiles.

4.7 Seasonal Pattern of Crocodile Attacks

With respect to the seasonal pattern of crocodile attacks on human and livestock, the results show that 80.8% of the respondents indicated wet season, 15.0% both wet and dry season and 4.2% dry season (Fig. 7). The results show that wet season is when crocodiles become a serious problem in the study area. In the rainy season many areas of the rivers, streams, swamps, lagoons, lake and floodplains become flooded with water making crocodiles free to move in different water bodies. Fishing activities are also very active during the rainy season than during the dry season making fishermen victims to crocodiles. Many people are also very busy with agricultural activities, for example paddy growers have to walk several distances within the shallow water to reach their areas for cultivation. In so doing they become victims to crocodile attacks. In general fishing and agriculture activities are at peaks during the wet season. Mshale (2008) reported similar results at Ukutu areas near Selous Game Reserve.

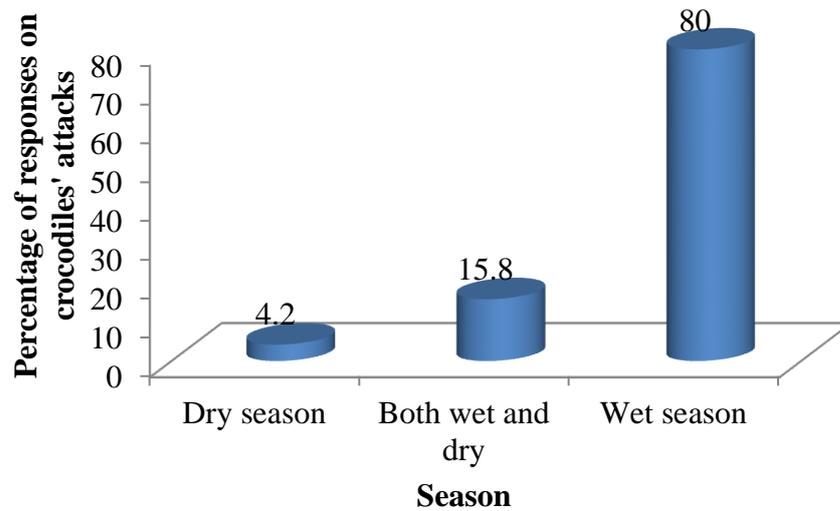


Figure 7: Responses on seasonal pattern of crocodiles' attacks

4.8 Months in Which the Problem of Crocodiles Is Serious

Regarding the months in which the problem is more serious, 46.7% of the respondents said from January to March, 30.5% from April to June, 15.0% from October to December and 5.8% from July to September (Fig. 8). Based on these results it is clear that many crocodile attacks on humans and livestock occur mainly during the period of January to March. This is the period of rain season in which many economic activities are done. Pooley *et al.* (1989) reported that 91.0% of 43 attacks by Nile crocodiles in northern Zululand and southern Mozambique occurred between November and early April, when weather conditions are warm, and coincided with the mating and breeding season. Fergusson (2004) reported similar results in attacks from Namibia and Kenya, where 78.0% of attacks occurred in November to May. Few attacks are reported during the period of July to September because it is a dry season where fishing activities are very low and it is normally done in deeper areas of the lake unlike the period of rainfall where fishing can be done even in shallow areas of the lake.

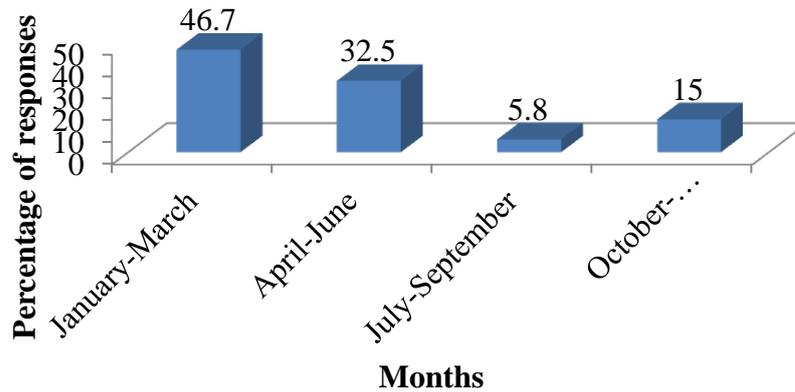


Figure 8: Responses on months in which the problem of crocodile is serious

4.9 Intensity of Crocodile Damages to Communities

4.9 1 Intensity of crocodile damages to humans

Table 15 shows the responses on the intensity of crocodile damage to the human beings. The study found that 54.2% of the respondents said it is a serious problem, 39.2% moderate problem, 5.8% minor problem and 0.8% not at all a problem. A Chi-square test for the difference between respondent's marital status and the intensity of crocodile damages to communities showed a significant difference ($\chi^2 = 42.514$, $df = 9$; $p = 0.0001$). Married respondents reported more responses (42.5%) that the intensity of crocodiles damage to communities is serious compared to widows/widowers (7.5%), divorced (2.5%) and single (1.7%). This is because crocodile damage to communities is more apparent in households with many family members compared to those with few family members. A number of respondents (54.2%) said the loss of human life in a family or any part of the body is a very great harm because in any way no compensation can be made for such damage. The impact of crocodile killing people is huge, whatever the scale. In terms of direct impact, the death of a single person is a major hardship for a family, but indirect impacts affect entire communities in terms of psychological stress and disorders,

which are considerable but difficult to assess. The investigation of the intensity of damage was important because it is the one among other factors that affect people's attitude towards conservation of wild animals found in protected areas or outside protected areas. Graham *et al.* (2005) reported that wildlife damage represents a very real and tangible threat to livelihoods in terms of personal injury, crop and livestock losses, and property damage.

Table 15: Responses on intensity of crocodile damages to humans

Respondent's marital status	The intensity of crocodile damages to humans (n=120)			
	Serious	Moderate	Minor	Not at all
Single	2 (1.7)	0 (0.0)	0 (0.0)	1 (0.8)
Married	51 (42.5)	38 (31.7)	6 (5.0)	0 (0.0)
Divorced	3 (2.5)	3 (2.5)	1 (0.8)	0 (0.0)
Widow/widower	9 (7.5)	6 (5.0)	0 (0.0)	0 (0.0)
Total	65 (54.2)	47 (39.2)	7 (5.8)	1 (0.8)

4.9.2 Intensity of crocodile damages on fishing gears

The responses on the damages caused by crocodiles in fishing nets and other traditional fishing gears varied significantly among respondents ($\chi^2 = 99.100$, $df = 5$, $p = 0.0001$). The results show that 42.5% of the respondents indicated that the problem is moderate, 32.5% said the problem is serious, 10.0% replied that there is no problem at all, 6.7% had no opinion about crocodile damaging fishing nets, 5.0% did not know anything about the problem while 3.3% said that the problem is negligible (Fig. 9). Many of the respondents who reported on the problem of crocodile damaging fishing gears said that crocodiles do steal live fish from fishing nets. The damages that crocodiles cause to fishing nets has an impact on food security, particularly thin monofilament gill nets with small to medium mesh size frequently used by artisanal fishermen. This is because fishing nets are considered as very valuable assets in the fishing industry. On the other hand crocodile

damages on fishing gears creates negative attitude towards conservation of crocodiles found in the river or the lake. Negative attitudes also result if the presence of crocodile species is believed to restrict private property rights (Drake and Jones, 2002) or limit access to and use of natural resources (Reading and Kellert, 1993). If anti-conservation attitudes prevail, measures to protect or enhance the species could become difficult.

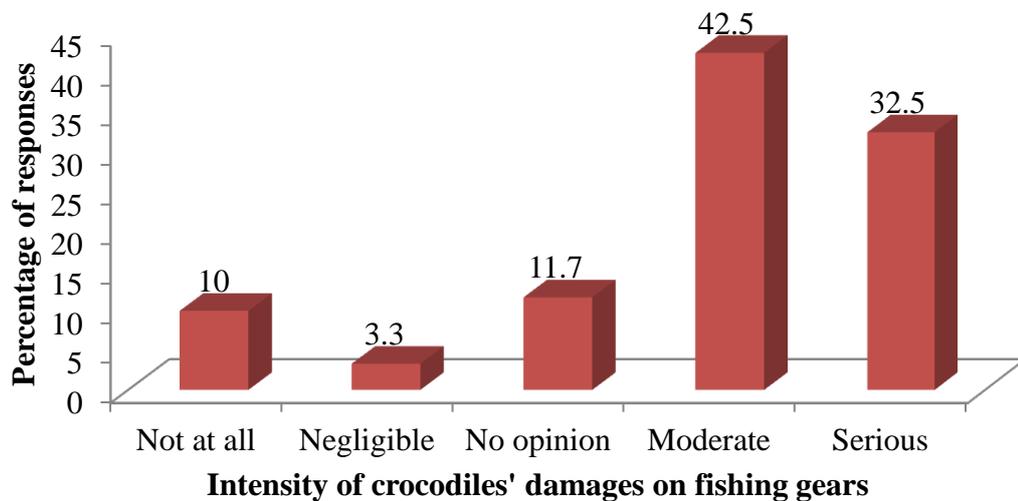


Figure 9: Responses on the intensity of crocodiles in damaging fishing gears

The study concurs with McGregor (2005) who reported that over 80.0% of sample of fisherman's nets were damaged by crocodiles at Lake Kariba, Zimbabwe. The holes torn in the nets were often extensive up to several meters in diameter. This reduces the fish catch for the fishermen and requires significant amounts of time, effort and resources to repair or replace the damaged sections (McGregor, 2005). Aust (2009) reported that approximately half (55.0%) of the nets damaged by crocodiles were destroyed beyond repair. In addition, the replacement costs of fishing gear damaged by crocodiles were significant in the economy of subsistence fishermen. On other hand crocodiles found entangled in the fishing nets were normally killed for consumption. An interview with

key informants revealed that one crocodile measuring 4.5 meters was killed on 25 November, 2013 at Samang'ombe village after being found entangled in the fishing nets and the meat was distributed equally among the fishermen who were there to assist in killing the crocodile.

Comparison of responses on the fishing nets damaged by crocodiles in four villages showed a significant variation. There were more responses on crocodile damages on fishing nets from villages of Samang'ombe ($\chi^2 = 8.777$, $df = 2$, $p = 0.012$) and Senga ($\chi^2 = 6.212$, $df = 1$, $p = 0.013$) than from the villages of Muuyu ($\chi^2 = 1.875$, $df = 1$, $p = 0.171$) and Kamsamba ($\chi^2 = 1.094$, $df = 1$, $p = 0.296$). The reason in their variation is that Samang'ombe and Senga villages are located along the Lake Rukwa where more fishing activities are being done while the other two villages of Muuyu and Kamsamba are villages located along Momba River where fishing activities are limited to small scale.

4.10 Extent of Crocodile Damage to Communities

A focus on assessment of the extent of crocodile damages was based on the number of livestock reported to be lost from crocodile attacks, reported cases of people injured or deaths from crocodile attacks and on the opinions of people about the current situation of crocodile damages.

4.10.1 Crocodile predation on livestock

The findings on livestock predation incidences showed that crocodile killed 52 cattle, 10 dogs and 23 goats from the period of 2003 to 2012 (Mbozi District, 2013). Fig. 10 shows cattle loss decrease in the number of cattle lost in the years from 2003 to 2005, but it shows an increase in number of cattle lost in the year 2006 and then shows a general decrease. The loss of dogs shows a general decrease from year to year unlike that of goat

which shows the increase in the number of goat lost from 2006 to 2009 and then decreased. The variation on the number livestock loss may be attributed to the changes in the amount of rainfall. It was noted during key informants interviews and focus groups discussion that many attacks on livestock and people occur in the year with high rainfall where crocodiles tend to venture into different flooded areas.

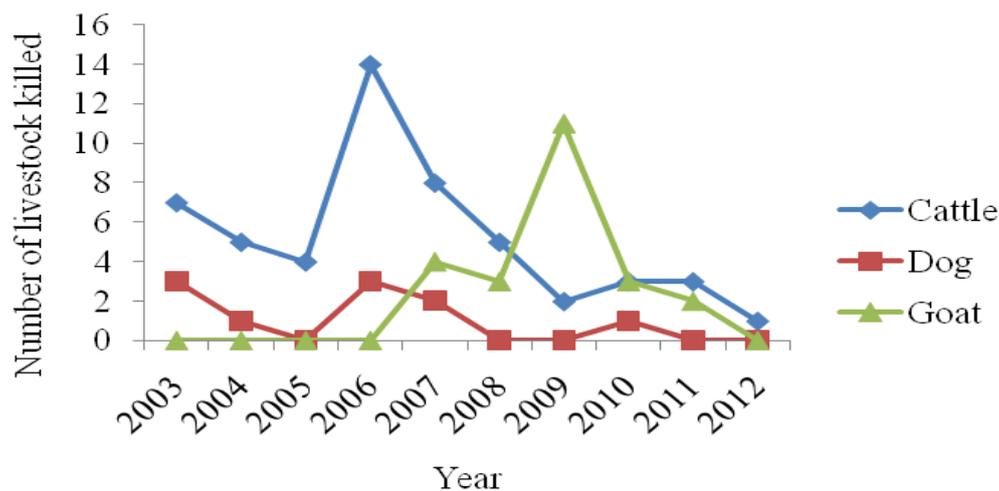


Figure 10: Number of livestock species lost from crocodiles attacks for the period of 2003 to 2012

A χ^2 test for the difference between livestock killed by crocodiles and the location of grazing areas showed a significant variation ($\chi^2 = 31.667$, $df = 4$, $p = 0.0001$). More crocodile attacks on livestock occurred while livestock are being grazed near the lake or the river. On the other hand very few crocodile attacks on livestock occurred for those being grazed far from the lake or the river. The attacks were said to occur while livestock are going to drink water into the lake or the river.

4.10.2 Crocodile attacks on human beings

Records on crocodile attacks on human beings in Momba District show that crocodiles have killed 32 people and 19 were injured during the period of 2003 to 2012 (Mbozi District, 2013) (Table 16). During the same period, 15 crocodiles were killed and four were injured. Most people who were killed and injured by crocodiles were fishing in Lake Rukwa or in Momba River or were crossing rivers. Most crocodile attacks occurred during the wet season. All crocodiles that were killed and injured were attacking humans. It was reported through key informants interview that some of crocodiles escaped after attacking humans or livestock.

Table 16: Number of people killed/injured from crocodile attacks

Year	Number of people		Number of crocodile	
	Killed	Injured	Killed	Injured
2003	6	0	4	1
2004	4	7	2	0
2005	7	4	3	2
2006	7	2	3	1
2007	6	3	1	0
2008	1	0	1	0
2009	0	0	0	0
2010	1	2	0	0
2011	0	1	0	0
2012	0	0	1	0
Total	32	19	15	4

Source: Mbozi District (2013)

Despite these records it was noted during focus groups discussion that minor injuries that do not require medical attention are ignored and were not reported to the government officials. It was also highlighted that attacks on an individual who was alone in most cases was not reported because no one was sure whether the person is somewhere alive or is dead. For example Mr. Chapasi Mpauka reported that his father Mpauka Mtali was killed by crocodile in 2003 at Mchangani areas in Senga village while he was fishing alone. The incident was not reported because it took several weeks up to when the remains of body parts (legs) were found.

4.10.3 Trends of crocodile attacks on human beings

On examining the trend of crocodile attacks on human beings, the study results show that there is a general decrease in the number of people killed by crocodiles and who were wounded by the problem animal from 2003 to 2012 (Fig. 11). The main reason for the decrease in the number of crocodiles' attacks on humans was crocodile harvesting program which had reduced the population of crocodiles in the lake/river. It was also noted that crocodile entanglement in fishing nets was another factor which contributed to their decrease. Key informants interviews and focus group discussions highlighted that the entangled crocodiles were killed for meat consumption. The decrease in crocodile population has lead to the decreased interaction between crocodiles and humans hence reduced crocodile attacks on humans.

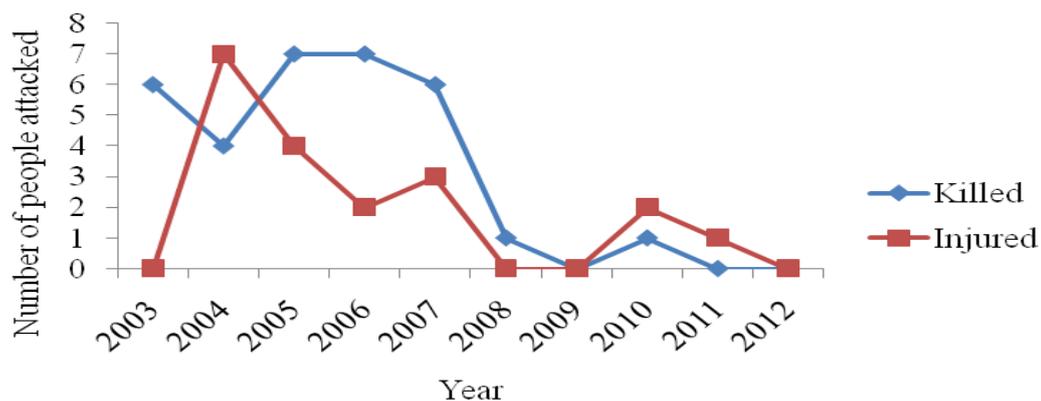


Figure 11: Trends on the number of people killed/injured by crocodiles

4.10.4 Opinions of people on trends of crocodile attacks

On assessment of the people's opinions about the damages caused by crocodiles to their families and property from 2003 to 2012, it was found that 72.5% of the respondents indicated that the attacks are decreasing, 23.3% reported that the attacks are constant, 3.3% said they are increasing and 0.8% didn't know whether the attacks are increasing or decreasing (Fig. 12). An interview with Kamsamba Ward Executive Officer also confirmed that the reported number of crocodile cases on humans and livestock attacks

has been decreasing year to year for the period of 2003 to 2012. The reasons for the decrease on crocodile attacks on humans and livestock were due to decreased crocodile population as a result of trophy hunting, entanglement in fishing nets, human consumption and uncontrolled killing in response to attacks on humans and livestock.

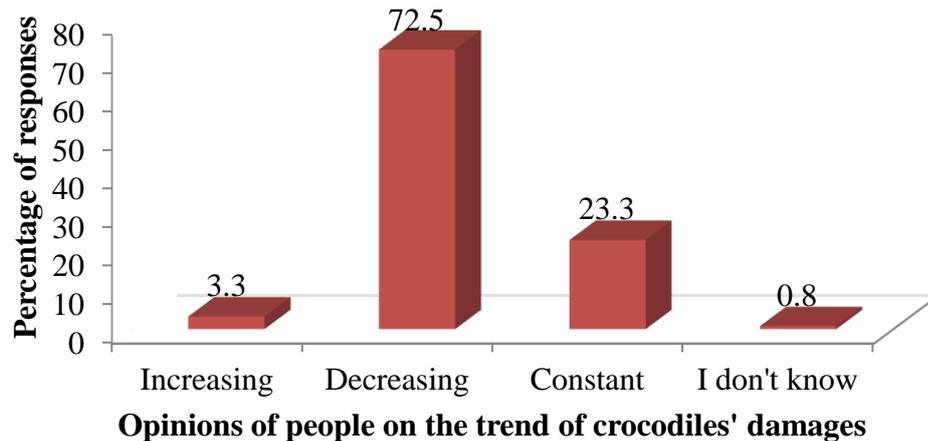


Figure 12: Opinions on the trend of crocodile damages from 2003 to 2012

4.11 Current Situation of the Human-crocodile Conflicts in the Study Area

In evaluating the current situation of the human-crocodile conflicts in the study area, respondents were required to provide answers on how often do they hear about the problem and how they see the problem now. The results show that 48.3% hear the problem often, 24.2% replied always, 14.2% sometimes and 13.3% said rarely (Table 17). The large number of responses (48.3%) on hearing human-crocodile conflicts often was due to fearfulness of being attacked by crocodiles. This has created awareness among the people living in the area in such a way that new comers visiting the area are alerted on the presence of crocodiles in the lake/river before they visit or pass some areas believed to harbor crocodiles. My personal observation during the study revealed that the number of

crocodiles' attacks cases has been decreased but the risk of being attacked is still high especially in areas where crocodiles are easily seen at different times of the day. Their presence in those areas poses threat to people hence limiting people's movement.

Table 17: Responses on current situation of the human-crocodile conflicts

Hearing about crocodile conflicts	Frequency (n=120)	Percent
Rarely	16	13.3
Sometimes	17	14.2
Often	58	48.3
Always	29	24.2

4.12 Methods Used to Solve Human-crocodile Conflicts

Table 18 show results of responses on the way which communities use to solve human-crocodile in the study area. The most popular methods employed in dealing with human-crocodile conflicts were killing of harmful crocodiles (35.1%), reporting the events to the District Game Officer (25.0%), educating communities on how to avoid the problem crocodiles (15.8%), avoiding going near the lake or rivers (12.5%), digging water wells (8.3%) and using large canoes for transport and for fishing activities (3.3%).

Table 18: Responses on methods used to solve human-crocodile conflicts

Methods used to solve human-crocodile conflicts	Frequency (n=120)	Percent
Educating communities	19	15.8
Killing harmful crocodiles	42	35.1
Reporting the events to District Game Officer	30	25.0
Avoiding going near the lake or rivers	15	12.5
Digging water wells	10	8.3
Use of large canoes for transport and fishing	4	3.3

Focus groups discussions and key informants interviews highlighted that when an incident of crocodile attack occurred, a report is sent to the government officials, whereby the Game Officers with the help of villagers, especially men, search the crocodile involved and kill it. Many of the respondents said that killing the problem animal is

beneficial especially when some crocodiles became extremely disturbing in an area. Killing of problem animal in the public interest is legally allowed under the Wildlife Conservation Act No. 5 of 2009 of the United Republic of Tanzania. This is shown in Part IV of the Act under human wildlife conflicts. The authority comes from section 69 subsection 1 which states that “The Director may deploy authorized officers for the purpose of controlling problem animals that cause or have caused damage to property or injury or loss of human life.” Subsection 2 states that “Any Park Warden, Park Ranger or Ranger may, in the public interest, kill any problem animal in any place other than in a National Park or the Ngorongoro Conservation Area” (URT, 2008). According to Hoare (2001), killing has the advantage that it does have some effect (even if short-term). It is relatively cheap and quick, and it has good public relations value in the affected community. However, shooting ‘problem’ animals often has a short term effect and it is difficult to identify the culprit animals (Ocholla *et al.*, 2013).

4.12.1 Methods used by people to protect themselves from crocodile attacks

Respondents in the study area had different views on how they protect themselves from crocodile attacks (Table 19). Many respondents (33.3%) claimed that they avoid swimming in the lake/river, 30.9% said they avoid crossing rivers during the rainy season, 21.7% avoid bathing along the rivers, 7.5% avoid fishing in areas where rivers enter the lake (estuary), 3.3% avoiding fetching water in rivers and 3.3% said they use modern fishing gears in their fishing activities.

Table 19: Responses on people's ways of protection from crocodiles attacks

People's ways of protection from crocodile	Frequency (n=120)	Percent
Avoid swimming in the lake/river	40	33.3
Use of modern fishing gears	4	3.3
Avoid fishing in estuary	9	7.5
Avoid fetching water from the rivers	4	3.3
Avoid crossing rivers during the rainy season	37	30.9
Avoid bathing along the rivers	26	21.7

Despite the large number of responses on avoiding swimming in the lake/river, it was observed during the study period that many youths especially boys and girls like prefer swimming to bathing in the lake and river. They normally go for swimming in the lake or the river as a group. Children normally go for swimming with their elders, they swim while their elders are washing clothes. On the other hand many fishing activities were done by using traditional methods with low technology such as the use of passive fishing gears like dugout canoes, fish hooks and wickerwork fish traps. Fishermen were observed swimming or bathing in the lake or the river after they have finished their activities.

4.12.2 Methods used to protect livestock from crocodile attacks

The study revealed that, the majority of local communities (61.7%) are aware that avoiding livestock to wander around the river or the lake helps to protect livestock from predation by crocodiles (Table 20). On the other hand 21.6% of the respondents had no opinion on how they can protect their cattle from predation because they did not own livestock while 16.7% said that digging water ponds for livestock drinking is the way which they use to protect their cattle from crocodiles.

Table 20: Responses on ways of protecting livestock from crocodiles

Ways of protecting livestock from crocodiles	Frequency (n=120)	Percent
Remove livestock wandering around the lake/river	74	61.7
Digging water ponds for livestock	20	16.7
No opinion	26	21.6

4.13 General Opinions on Minimizing Human-crocodile Conflicts

In the opinion of the local people, supply of clean water (45.8%) through pipes is the most suitable solution to the problem (Table 21). In addition 24.2% of the respondents preferred bridge construction across rivers, 11.7% called for digging water ponds for livestock use, 7.5% mentioned the use of modern fishing gears, 6.6% suggested harvesting the crocodiles and 4.2% said provision of education to communities. There were significant differences in opinions in different villages ($\chi^2 = 25.466$, $df = 15$, $p = 0.044$). The results show that supply of clean water had large number of responses in the villages of Samang'ombe (10.8%), Muuyu (15.0%) and Kamsamba (12.5%) while in Senga the priority was on construction of bridges across rivers (9.2%) (Table 21). These responses varied from one village to another due to differences in the experiences of crocodile attacks in each village. It was further stressed in the focus groups discussions that provision of clean water, construction of bridges, supply of modern fishing gears and digging water ponds for livestock use can help to minimize the conflicts.

Table 21: Responses on opinions of minimizing human-crocodile conflicts

Opinions on minimizing human-crocodile conflicts	Name of villages				
	Samang'ombe	Senga	Muuyu	Kamsamba	Total
Government should provide modern fishing gears	5 (4.2)	3 (2.5)	0 (0.0)	1 (0.8)	9 (7.5)
Government should provide clean water	13 (10.8)	9 (7.5)	18 (15.0)	15 (12.5)	55 (45.8)
Harvesting/killing harmful crocodiles	3 (2.5)	1 (0.8)	1 (0.8)	3 (2.5)	8 (6.6)
Provision of education to communities	2 (1.7)	2 (1.7)	1 (0.8)	0 (0.0)	5 (4.2)
Bridge construction across rivers	3 (2.5)	11 (9.2)	10 (8.3)	5 (4.2)	29 (24.2)
Digging water ponds for livestock drinking	4 (3.3)	4 (3.3)	0 (0.0)	6 (5.0)	14 (11.7)

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The study aimed at assessing the human-crocodile conflicts in areas adjacent to Lake Rukwa and Momba River in Momba District. It highlights the costs of living with crocodiles outside protected areas. The analysis on the damages caused by crocodiles in a household has shown that human-crocodile conflicts are perceived to be severe problems resulting into loss of life, injury/deformities, loss of livestock and fear of the presence of crocodiles. The study has shown that crocodile attacks can occur at any time of the day. Wet season was identified as a very risky period for crocodile attacks on people and livestock.

The findings identified some of the important factors responsible for the causing human-crocodile conflicts. It was observed that the major driving forces for human-crocodile conflicts are crossing rivers, fetching water for domestic use, fishing, livestock keeping and agriculture. These factors attract people towards the lake or the river exposing them to crocodile attacks. They are the main causes of human-crocodile conflicts in the study area. Furthermore the increase in human population has increased pressure on the utilization of natural resources found in the lake and the river and hence exacerbates the conflict.

The study found that many people were attacked by crocodiles while they were fetching water for domestic use, bathing or swimming at the edge of the river or the lake. Women for example wash clothes at the edge of the river or lake exposing themselves to the risk of attacks. A number of people were reported to prefer swimming/bathing in the river or

shallow areas of the lake. It was found that swimming in a group reduces the risk of crocodile attacks than swimming alone in the river or the lake.

Fishing activities employ a significant number of people in the areas of Lake Rukwa and are viewed as the quickest way of earning income. The increase in fishing activities has led to the expansion of fishing areas and establishment of new fishing grounds. These practices have caused invasion to crocodile home ranges which are now causing a lot of damages to the fishing nets. Fishing was among an important factor causing human-crocodile conflicts because many people reported to be attacked by crocodiles were being involved in fishing activities. Key informants interview with the Senior Assistant Fisheries Officer acknowledged that people using fish dragnets in rivers, streams, lagoons, pools or at the edge of the lake are normally attacked by crocodiles while fishing. This occurs because they fish while partially submerged in water controlling their nets disregarding the risk of crocodile attacks to which they are subjecting themselves. It was also noted that many attacks on fishermen occurred when they were removing anchors used in supporting fish nets.

Livestock keeping formed an important driver of human-crocodile conflicts because livestock keepers prefer to tend their livestock in wetland areas of the lake or the river. Grasses which are eaten by livestock grow in wetlands along the river or the lake attracts a number of livestock to feed on, eventually exposing them to crocodiles. It was found that a number of crocodile attacks on livestock occurred when they were crossing the river or they were drinking water at the edge of the lake or the river. The livestock that were attacked more by crocodiles were cattle, goats and dogs.

Agricultural land formed another important driver of human-crocodile conflicts because many people prefer to cultivate along the river or the lake during the dry season when these areas are dry but during the wet season the areas become flooded with water and it attracts a number of crocodiles which come to feed on the breeding fish. Many areas which were previously used as wetlands are now under cultivation. This is posing a threat for the survival of crocodiles and hippopotamuses because the areas have now been turned into agricultural land, and it is a form of human-wildlife conflicts.

5.2 Recommendations

Based on the findings of the study, the following recommendations aim at minimizing human-crocodile conflicts in areas adjacent to Lake Rukwa and Momba River.

- i. It is recommended that the people of Kamsamba, Muuyu, Senga and Samang'ombe villages need to be supplied with clean water through construction of water infrastructures such as water taps, wells and water ponds for livestock use. This will help people not to go to rivers or lake searching for water for domestic use and livestock will be taken to the water ponds for drinking instead of going to the lake or the river.

- ii. On other hand there is a need of constructing bridges across rivers in important areas where most people cross when they are going to and from their working areas. These areas include Chafundika, Chafundika-Ming'ongo, Chafundika-Chang'ombe, and Chafundika-Ngala for Samang'ombe village and for Senga village bridges should be constructed at Toba ditch, Ming'ongo, Chafundika and Chang'ombe.

- iii. Conservation education should be provided to all communities living adjacent Lake Rukwa and Momba River. This should include educating people on how to avoid crocodile attacks by knowing the behaviors of crocodiles. It should also involve changing people's behaviors on avoiding swimming and bathing in Lake Rukwa and Momba River.

- iv. There is a need for wildlife managers to have clear understanding of the causes, consequences and people's attitudes towards crocodile attacks. This will enable them to set good management plan that considers important issues of both human and crocodile leading to sustainable conservation of crocodiles. It will also help in winning community support in crocodile conservation and other wildlife in particular.

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APPENDICES

Appendix 1: Household interview schedule

1.0 General information

1.1 District name 1.2 Ward name.....1.3 Name of
village..... 1.4 Respondent number..... 1.5 Age 1.6
Sex..... 1.7 Date.....

1.8 Marital status

- | | |
|---------------------|-----------------------------|
| (1) Single (.....) | (3) Divorced (.....) |
| (2) Married (.....) | (4) Widowed/widower (.....) |

1.9 Total number in the household (.....)

- | | |
|-------------------|-------------------------|
| (1) 1 - 2 (.....) | (3) 6 - 8 (.....) |
| (2) 3 - 5 (.....) | (4) 9 and above (.....) |

1.10 Household income per annum in Tshs.

- | | |
|-------------------------------|--------------------------------|
| (1) Less than 500 000 (.....) | (3) 800 001 - 1000 000 (.....) |
| (2) 500 001 - 800 000 (.....) | (4) Above 1000 000 (.....) |

1.11 Education level of respondents.

- | | |
|---------------------------------|---------------------------------|
| (1) No formal education (.....) | (3) Secondary education (.....) |
| (2) Primary education (.....) | (4) Tertiary education (.....) |

1.12 Residence

- | | |
|-----------------------|-----------------------|
| (1) Permanent (.....) | (2) Temporary (.....) |
|-----------------------|-----------------------|

1.13 If the answer for the above is No, When did you come to this area?

1.14 Ethnicity: What is your tribe

1.15. Duration of residence (years)

- (1) 0 - 5 years (.....) (4) 21 - 30 years (.....)
- (2) 6 - 10 years (.....) (5) 31 and above years (.....)
- (3) 11 - 20 years (.....)

1.16 What is your occupation/Source of income?

- (1) Crop production (.....)
- (2) Livestock keeping (.....)
- (3) Fishing (.....)
- (4) Crop production and livestock keeping (.....)
- (5) Crop production and business (.....)
- (6) Crop production and fishing (.....)

2.0 Land use and ownership

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

2.2 If the answer in (Qn 2.1) is yes, where is it located?

- (1) Near the lake/river (.....) (2) Far from the lake/river (.....)

2.3 Do you own livestock? (1) Yes (.....) (2) No (.....)

2.4 If the answer in Qn 2.3 is yes, where do you graze your livestock?

- (1) Near the lake (.....) (3) Others (specify)
- (2) Near the river (.....)

3.0 Dependence on water body

3.1 The following is a list of some activities that bring people into contact with water resources. Please indicate where each of the following activities is done (Tick where applicable).

No.	Activity	Lake	River	Both Lake and River	Well/dam/spring
i.	Fetching water				
ii.	Washing clothes				
iii.	Bathing				
iv.	Swimming				
v.	Fishing				
vi.	Irrigation/Cultivation				
vii.	Watering livestock				
viii.	Navigation				

3.2 Do you go for swimming in a lake or river? (1). Yes (.....) (2). No (.....)

3.3 Do you swim in one place or in different places?

(1) One place (.....)

(2) Different places (.....)

3.4 Are you afraid of crocodiles when swimming? (1). Yes (.....) (2). No (.....)

3.5 Are certain areas of the Lake/river more dangerous than others? (1). Yes (..) (2). No

3.6 Are you involved in fishing? (1). Yes (....) (2). (....)

3.7 Have you had any fishing nets/gears damaged by crocodiles? (1). Yes (....) (2). No

3.8 To what extent is crocodile damaging fish nets a problem?

(1) Is not at all a problem (.....)

(3) Moderate problem (.....)

(2) Minor problem (.....)

(4) Serious problem (.....)

3.9 Do you do anything to protect your nets from crocodiles? (1). Yes (....) (2). No (.....)

4.0 Human-crocodile conflict

4.1 Please tick the answer that you believe is correct for each of the following questions.

No.	Question	Yes	No
i. 1	Are there any human-crocodile conflicts in your village?		
ii. 3	Have you ever faced an attack/threat from crocodiles for the past ten years?		
iii. 4	Has anyone in your family been attacked by a crocodile?		
iv. 5	Is there any witchcraft belief associated with crocodile conflicts?		
v. 6	Have you ever had any of your livestock killed by crocodiles?		

4.2 What are the major factors causing human crocodile conflicts in your village?

(1) (3)

(2) (4)

4.3 What are the damages caused by crocodiles in your village?

(1) (3)

.....

(2) (4)

4.4 At what time of the day do crocodile most often attack your livestock?

(1) Morning (.....)

(2) Midday (.....)

(3) Afternoon (.....)

(4) Evening (.....)

(5) Throughout the day (.....)

4.5 When was the last time you had livestock killed by crocodiles?

4.6 How many livestock have you lost to crocodiles for the period of 2003-2012?

- (1) Cattle (3) Goat
 (2) Sheep (4) Others (specify)

4.7 How many in your household have experienced the following from crocodile.

- (1) Injury (.....) (2) Deformity (.....) (3) Death (.....) for the period of 2003-2012

4.8 What is your opinion about crocodile problems now?

- (3) Is not at all a problem (.....) (3) Moderate problem (.....)
 (4) Minor problem (.....) (4) Serious problem (.....)

4.9 In which season is crocodile a real problem?

- (1) Dry season (.....) months (3) All seasons (.....)
 (2) Wet season (.....) months (4) I don't know (.....)

4.10 Which age group of people is more affected by crocodiles?

- (1) 0-5 years (.....)
 (2) 6-15 years (.....)
 (3) 16-35 years (.....)
 (4) 36-50 years (.....)
 (5) 50 and above years (.....)

4.11 Which activity makes people more vulnerable to crocodile attacks?

- (1) Fetching water (....) (5) Cultivating (....)
 (2) Bathing (.....) (6) Fishing (.....)
 (3) Swimming (....) (7) Crossing rivers (....)
 (4) Washing clothes (.....) (8) Others (specify)

4.12 What is the trend of crocodile damage for the period of 2003-2012?

- (1) Increasing (.....) (3) Constant (.....)
 (2) Decreasing (.....) (4) I don't know (....)

4.13 How is the problem distributed between men and women?

- (1) Men are more affected (.....) (3) All are equally affected (.....)
- (2) Women are more affected (.....) (4) I don't know (.....)

4.14 To what extent is the damage caused by crocodiles affect the local communities?

- (1) To a great extent (....) (3) Very little (.....)
- (2) Somewhat (.....) (4) Not at all (.....)

4.15 How often do you hear about crocodile conflicts in your village?

- (1) Rarely (.....) (3) Often (.....)
- (2) Sometimes (.....) (4) Always (.....)

4.16 What are the methods used by communities to settle human-crocodile conflicts?

- (1)
- (2)
- (3)

4.17 How do you protect your cattle from crocodiles?

- (1)
- (2)

4.18 How do you protect yourselves from crocodiles?

- (1)
- (2)

4.19 How can we minimize the human-crocodile conflict?

- (1)
- (2)
- (3)

THANK YOU FOR YOUR COOPERATION AND TIME!

Appendix 2: Checklist for focus group discussion

1. Major problems related to crocodiles in your village
2. Factors that lead to human-crocodile conflicts
3. Farming (Agriculture and livestock keeping)
4. Resources that are involved in human-crocodile conflicts
5. The extent of damages caused by crocodiles to the local communities
6. Trend of damages caused by crocodiles for the period of 2003-2012.
7. Measures used by communities and institutions to settle the human-crocodile conflicts
8. What should be done to reduce the conflict
9. Witchcrafts associated with crocodiles attacks
10. Navigation and safety in water
11. Consolation for loss of life, crops or injury caused by dangerous crocodiles

THANK YOU FOR YOUR COOPERATION AND TIME!

Appendix 3: Checklist for key informants

1. What type of human-crocodile conflict occurs in this area?
2. What factors lead to human-crocodile conflicts?
3. To what extent the damage caused by crocodiles affect the communities?
4. What is the trend of these damages for the period of 2003 to 2012 years?
5. How are these conflicts mitigated/ minimized?
6. Can you suggest other alternative ways of solving the conflict?
7. What is the record of human-crocodiles for the period of 2003-2012 years?
8. What other problem animals do the communities encounter?
9. In which season is the problem more serious?
10. Which years was the problem more serious?
11. Can you remember the number of human injuries and deaths?
12. Which livestock are attacked by crocodiles? List them
13. Suggestions on consolation for loss of life or injury caused by dangerous crocodiles

THANK YOU FOR YOUR COOPERATION AND TIME!