THE LOCAL COMMUNITIES AND NILE CROCODILE IN LAKE RUKWA SOUTHERN TANZANIA: CAN THEY CO-EXIST?

BY

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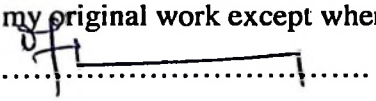
Human activities in Lake Rukwa

Nile crocodile in Lake Rukwa

CAN THEY CO-EXIST?

DECLARATION

I, Obed Festo Mbangwa, do hereby declare to the senate of the Agricultural University of Norway that this thesis has not been submitted for a degree award to any other university and that it is my original work except where acknowledged.



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DEDICATION

This work is dedicated to my parents, Festo Mbangwa and Tulalumba Mdeka for the gift of life and for opening my eyes to the world of academics; my wife Mrs Sarah Mbangwa; my daughters Zawad and Winnie Mbangwa and all my brothers and sisters.

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Finally, I humbly thank the Almighty God, from whom all the blessings come and special mention to my family for its support and patience during the entire period of my study.

ABSTRACT

Most local communities affected by problem animals are those in proximity to protected areas, lakes and rivers. Conflict exists between local communities living adjacent to Lake Rukwa and Nile crocodile (Crocodylus niloticus) in the lake. The objective of this study was to examine the nature and extent of conflict between local people and crocodile in Lake Rukwa. The major activities causing conflict were identified, the number of people and livestock killed by crocodile and number of crocodile killed were quantified. The attitude and perceptions of local communities towards crocodiles were also examined.

This study was conducted from August to November 2001 in local communities living adjacent to Lake Rukwa in southern Tanzania. Four villages and four fishing camps were surveyed with structured questionnaire. They were: Mtowisa, Uzia, Muze, Kalumbeleza, Malangali, Kichangani, Kwa Haule and Mtakuja respectively. Questionnaires were administered to 208 households, as well as District Game Officers, Fisheries Officers and crocodile ranchers. The Rukwa Game Reserve staff, key informants, hunting company and village leaders were also consulted. Secondary information was collected from libraries, local, regional and state archives.

Fishing activity in Lake Rukwa was shown to be a major cause of conflict between local people living adjacent to the Lake and crocodiles. Most damages to human life and peoples' property occurred during fishing (85%). Damage to fishing nets (38%), competition for fish (31%) and killing/wounding people (16%) were the most serious problems mentioned and are suggested here as the main sources of the existing conflict between local people and crocodiles in Lake Rukwa.

The results reveal no significant relationships between number of people killed/wounded and crocodiles killed /wounded in defence. More people were killed than crocodiles killed in defence during the period of 1996-2001. In the study area, an average of 11 people were killed or wounded by crocodiles each year during the period of 1996-2001, but less than an average of four people per year were reported to the District Game officers. The results also show that data on number of people, livestock and crocodiles killed or wounded in the study area held by Wildlife Division headquarters are far less than those revealed by both survey and interviews of District Game Officers and of data collected from local people. The difference in records is believed to be due to the difficult in reporting and poor response by the wildlife authority; both problems reflecting the remoteness of the areas.

The majority of respondents perceived wildlife as a source of benefit to the nation but not to themselves (66%). They perceived the government, the wildlife management authority and foreign tourists as the principle beneficiaries of wildlife. They complained that government officials do not visit them, solve their problems or explain to them the benefits of wildlife. However, the hunting company and ranchers reported benefiting from crocodiles.

It has been proposed by this study that Lake Rukwa continue as a multiple land use area. Ongoing activities such as hunting and fishing could then continue. However, in order to meet the dual objectives of the state of both conserving wildlife and enhancing local livelihoods these activities must be carried out at a level that ensures a sustainable population of crocodile. Local people should also benefit directly from conservation of crocodile in Lake Rukwa. The present set up of channelling back 25% of the revenue accrued from tourist hunting to the local communities does not seem to be reaching the target group and may not be adequate. It is suggested that mechanisms be introduced and monitored to ensure that the benefits reach the affected local people and directly offset wildlife costs incurred on local communities. It is also suggested that locals actively participate in management of crocodiles.

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LIST OF ACRONYMS

ADMADE	Administration Design for Game Management Area
ANOVA	Analysis of Variance
ASL.	Above Sea Level
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CBD	Convention on Biological Diversity
CBNRM	Community-based natural resource management
COP	Conference of the Parties
DGO	District Game Officer
DNPWLM	Department of National Parks and Wildlife Management
FAO	Food and Agriculture Organisation of United Nations
GTZ	Deutsche Gesellschaft Fur Technische Zusammenarbeit
IIED	International Institute for Environment and Development
KM	Kilometre
LIRDP	Luangwa Integrated Rural Development Project
M	Meter
MNRT	Ministry of Natural Resources and Tourism
NCA	Ngorongoro Conservation Area
OA	Open area. That is area settled by villagers
PA	Protected area. That is National Park and Game reserve
P- Value	Statistical Probability
RMAD	Rocky Mountain Animal Defence
R- Square	Regression Square
RGR	Rukwa Game Reserve
Spp	Species
TAWIRI	Tanzania Wildlife Research Institute
Tshs.	Tanzanian Shillings
WCA.	Wildlife Conservation Act

CHAPTER ONE: INTRODUCTION

1.1 General overview

Conservation in many indigenous societies, especially of hunters and gatherers in Africa and Tanzania in particular was closely tied to the co-existence of humans and wildlife (Gray 1993). Not all indigenous groups lived in harmonious co-existence with wildlife, and many agricultural and cattle-herding people actively controlled wildlife. When man and wild animals came into conflict over the occupation of land and/or use of habitats, the wild animals were driven out (Kjekshus 1977). Tchamba (1996) points out that in a world in which biophysical environments and socio-cultural systems are changing rapidly, conflicts between human and wildlife are likely to occur. Conflicts occur as a result of competing interests to resources between interacting actors. Such clashes of interest can be caused by both material and ideational factors. Material conflicts are linked to how the society is organized in terms of access rights and duties to resources, as well as to distribution of power and authority. Ideational conflicts are linked to competing values and norms, beliefs and cognitive understandings (Knight 2000). Conflicts are primary and internal if their causes are located within the same area and actors practice the same kind of activities. They are secondary or shifted if causes are located outside the area where they take place and actors practice different kinds of activities. Land as an object is central to many forms of conflicts (Gamassa 1989). With respect to wildlife, land may be claimed by some actors as habitat while others claim it for agriculture. This is a basis of difference and conflicting livelihoods. Human conflicts with wildlife assume a variety of forms, take up much time and energy and are often multifaceted in character. While on the one hand the state is responsible for the conservation of wildlife, on the other hand it has a responsibility to promote development and to protect its citizens. Wildlife depredations may be experienced as impediments to rural development as they cause damage to people, livestock and agricultural products. As a consequence, also this is an area of state concern and a possible area of expert intervention ("wildlife control") (Knight 2000).

Conflicts between conservation and human interests have centred on local peoples' demands to have access to land and/or resources in protected areas and as a result of damage to peoples' life

and property caused by wild animals to local people. The government however, has been striving to maintain protected areas for generation of foreign exchange for development and for future generations. With its wide-spread population of Nile crocodiles in Tanzania, and expanding population of humans and their activities in lakes and rivers, there are an increasing number of serious conflicts between man and crocodile (Wildlife Division 1993). The understanding of causes of conflicts between human and wild animal species such as Nile crocodile can enhance the chances for developing more successful policies, as well as increase the opportunities for greater professional effectiveness and a sense of control over the problem animals to the citizens.

1.2 Sources of people-wildlife conflicts

People-wildlife conflicts are relations of rivalry or antagonism between human beings and wild animals typically arising from territorial proximity. Rivalry or antagonism may involve reliance on the same resources, and/or create a threat to human well-being or safety (Knight, 2000). People-wildlife conflicts may thus include both competition and predation: competition for food between humans and wild animals and predation by wildlife on livestock and sometimes on people. In the first case, the conflict is indirect in character and between two species (with respect to the object of competition) sharing the same trophic level. In the second case, the conflict takes the form of direct antagonism between species at different levels of the food chain (ibid). Logically, competition works both ways: if wild animals are rivals for human (or human-claimed) foods or territory, human beings are also rivals for the food and territory of wild animals. Predation likewise works in both directions involving not just wildlife attacks on people, but also human attacks on wildlife that is hunting. However, with respect to human livelihood, human hunting represents a different, inverse relation to wildlife in which the prey animal forms a part of (rather than a threat to) human subsistence. This means that the reason for most, if not all, human-wildlife conflicts can be better understood through an appreciation and understanding of biological and ecological relationships (Messmer 2000). In addition, damage to peoples' property may be a source of human-wildlife conflicts (Kellert 1994; Newmark *et al* 1993, 1994). Transmission of diseases such as East Coast Fever and Malignant Catarrhal Fever between livestock and wildlife has also been reported as another source of conflict (Runyoro 1994).

1.3 Justification of the study

Complaints regarding damages caused by wildlife to the communities living adjacent to protected areas, lakes and rivers in Tanzania are one of the topics discussed during parliamentary sessions (MNRT 1997). Many studies of human-wildlife conflicts have been confined to the interactions between local people and protected areas (Kapela and Moe, 1988; Mbaruka 1996; Mtoni 1999; Newmark *et al*, 1993, 1994; Severre and Tibanyenda, 1988). A review of available literature has revealed that within Tanzania no studies have been carried out to quantify damages to human lives, livestock and fishing gear by wild animals within local communities situated adjacent to lakes/rivers outside protected areas. The only data found to be available on wildlife damages in these areas are those from regional and district game officers. These data are regarded as underestimates because complaints from members of parliament and local people have shown that most incidences are not reported (MNRT 1997). Complaints registered by members of parliament and local people seem to indicate much higher levels of damage than those being officially reported. Differences between the reported numbers of incidences and those talked about by members of parliament and locals and actual numbers are unknown (ibid). One of the species of great concern to local communities living adjacent to lakes and rivers is crocodile. According to Wildlife Conservation Act (WCA) No. 12 of 1974 and Wildlife Policy of 1998 (MNRT 1998), wild animals causing damage to human life and/or property are subject to control by killing. Lack of accurate data on people and property damaged by crocodile may pose a problem to their effective control and management.

There have been reports that both people and their livestock are killed by Nile crocodiles (*Crocodylus niloticus*) in or nearby Lake Rukwa. Villages which are most affected are Muze, Kalumbeleza, Uzia, Mtowisa, Nankanga, K'matundu and Maleza (Mwanakusha 2000). Adult crocodiles also damage fishing nets while juvenile crocodiles become entangled in the fishing nets, and drowned (ibid). When people or their livestock have been reported attacked by crocodile, the official response by the wildlife authority has been to kill the crocodile (MNRT 1997).

According to the wildlife policy of Tanzania, people who are affected by wild animals are supposed to be the main beneficiaries of revenue earned from wildlife (MNRT 1998). Reports from locals indicate that they are not receiving such benefits.

Surveys of existing literature and experience from wildlife officials suggests that, a detailed study on the nature and extent of the damages caused by crocodile in Tanzania has not been carried out. Deficiencies in knowledge and understanding about the nature and extent of social impact and economic losses caused by crocodiles to local communities living adjacent to Lake Rukwa must be addressed as a basis in developing proactive programs to address human-crocodile conflicts in Tanzania.

1.4 Objective of the study

The aim of this study is to examine the nature and extent of the human-crocodile conflicts in Lake Rukwa and its adjacent local communities in southern Tanzania. The results are expected to enhance both the understanding of the levels of damage caused by crocodiles and of the attitudes of local communities towards conservation of crocodiles in Lake Rukwa.

1.4.1 Specific objectives

1.4.1.1 Identify the cause or predictor of the human-crocodile conflict in Lake Rukwa.

1.4.1.2 Quantify human and stock losses due to crocodile depredation in villages/camps adjacent to the Lake and adult crocodiles killed/wounded in defence of human life and/or peoples' property.

1.4.1.3 Investigate the attitudes and perceptions of local communities living adjacent to Lake Rukwa towards crocodile conservation.

1.4.2 Hypotheses

1.4.2.1 Fishing activity is the major cause or predictor of human-crocodile conflict in Lake Rukwa.

1.4.2.2 There is a relationship between the number of people and livestock killed/wounded by crocodiles and the number of crocodiles killed/wounded in the course of human/ livestock defence.

1.4.2.3 Local communities living adjacent to Lake Rukwa have negative attitudes and perceptions towards crocodile conservation.

CHAPTER TWO: LITERATURE REVIEW

2.1 An overview on human–wildlife interactions

Many studies on human–wildlife interactions and conflict management have been carried out in Tanzania and other countries in the world. Conflicts between human and wildlife have been either real or perceived, economic or aesthetic, social or political (Messmer 2000). Those studies on the subject of people – wildlife conflicts have been concerned with the measurement of wildlife damage, the assessment of wildlife pest numbers and population dynamics, the determination of the causes of pestilence and the development of technologies of pest control (Knight 2000).

Conflicts between people and wildlife are found on land and in rivers and lakes, in the north and south and in city and countryside (Knight 2000). However, conflict is found to be at its sharpest among the local people living in proximity to protected areas. Gray (1993) pointed out that despite the prevalence of such occurrences, studies related to human dimensions of wildlife lagged behind research on wildlife populations and habitats. The case studies which have been reviewed indicate that causes of human-wildlife conflicts are many and varied in their nature and extent ranging from killing people and livestock to crop damage. Examples of case studies include, Jnawali (1989) in the study of damages caused by wildlife who reported rhinoceros to be killing people and as one of the source of human – wildlife conflict in Nepal. Elephant have been reported to kill people during migration in Far North province, Cameron and resulted into conflict between people and wildlife (Tchamba 1992). O' Connell- Rodwell *et al.* (2000) found that people and livestock were being frequently killed by lion, hyena and crocodile in East Caprivi, Namibia. Creek (2000) reported crocodiles being a major source of human – wildlife conflict because of killing people and taking livestock such as horses and cattle in Australia. Britton (2000) points out that human mortality due to Nile crocodiles has been frequently reported in Tanzania.

Crop damage by elephants have also been reported by O'Connell- Rodwell *et al.* in East Caprivi, Namibia. Villages which were most affected by elephants were those in the border areas to national parks. Similar findings were reported by Akama *et al* (1994) in Kenya where crop

damage often occurred in farmlands in proximity to national parks during the dry season when wild animals such as elephants, buffalo and antelopes had scarce resources in the park and as a consequence were attracted to the crops outside the parks. Morris (2000) noted that man-eating lion was a major problem to local people in Fort Manning district in Malawi. It attacked people during daytime while people were working in their field or fetching water and most victims were women. Knight (2000) reported that leopard and hyena are also known as man-eaters, particularly of young children. Cozza *et al* (1996) found that predation on domestic livestock by wolves and bear were the common complaints in the parts of Abruzzo region in Italy where extensive grazing of livestock is practiced. Wolf is also a source of fear to local people and a risk to domestic animals such as sheep in Norway (Bergstrøm 2002). Crop raiding by bush pigs, red tail monkey, baboon, hippos and chimpanzees have been reported by many authors (Mbaruka 1994; Naughton 1998; Knight 2000; Hill 2000). Hill (2000) found that baboons were responsible for 70% of the crop damage events caused by wild animals in the areas around the southern edge of the Budongo Forest Reserve in Uganda. Kapela and Moe (1988) reported that killing of human, livestock and crop damage by wild animals were the most critical problems confronting local people around Lake Burungi area in northern Tanzania. Similar findings were reported by Newmark, *et al* (1993) from surveys of conservation attitudes of local people living adjacent to five protected areas in Tanzania. Mtoni (1999) and Runyoro (1994) reported that disease transmission and loss of people's lives caused by wildlife attacks were the most serious problems to local communities surrounding Serengeti National Park and Ngorongoro Conservation Area.

Studies of human-wildlife conflicts reveal that it is a two-way conflict and that local perceptions are not necessarily supported by empirical evidence. Direct conflicts between wildlife and local communities, are also caused by blocking of traditional migratory routes of wild animals by various forms of human development activities. This interferes with seasonal migrations essential for their survival (Mmari 1989). A study carried out by Onesmo (1990) revealed that politics and management policies can cause resource conflicts between wildlife and local communities. A study of perceived human–wildlife conflicts in Zanzibar, Tanzania, concerning the red colobus *Procolobus kirkii* and coconut, showed that despite local beliefs to the contrary, red colobus had no significant negative impact on coconut harvest and were actually a source of tourist revenue to the region (Siex and Struhsaker 1999).

Injury and loss of people's lives through attack by Nile crocodile is one of the serious problems caused by wildlife which leads to human-wildlife conflict in Tanzania (Wildlife Division 1993). Nile crocodile reportedly kill more than 150 people each year (MNRT 1997). These data have been shown to be an underestimate as a consequence of most of the areas where attacks occur being so remote. Therefore, information on various incidences does not reach the appropriate authorities and/or is not reported at all (ibid). An investigation carried out by the Wildlife Division in 1997 in Mtera dam, Ruvuma and Ruvu rivers indicated that the conflict between people and crocodiles was particularly high in areas where fishing was practised (MNRT 1997). This could imply that overlapping habitats between fishermen and crocodiles is a major cause of conflict. Evidence from the studies reviewed suggests that human-wildlife conflicts reinforce the attitudes among local people that conservation programs and conservation areas contribute to their subsistence problems rather than benefits them.

2.1.1 Conflict management and resolutions

To minimize negative attitudes perceived by local people towards wildlife due to damages to human lives and/or peoples' property, many authors have pointed out the necessity of involving local communities in natural resource management and benefit sharing arrangements (Emerton 1998, Infield 1988, Kapela *et al* 1990, Kiss 1990 Mishra et al. 1992, Murphree 1997, O'Connell-Rodwell 2000, Tchamba 1996, Weladji 1998). Numerous attempts have been made through participatory approaches involving local communities in wildlife management and compensation schemes of damages caused by wild animals (IIED 1994). Participatory approaches are meant to involve people in the process of wildlife management. However, participation has come to mean different things to different people/programs (ibid). Local participation described by Cernea (1985) as "empowering people to mobilize their own capacities, be social actors, rather than passive subjects, manage the resources, make decisions and control the activities that affect their lives". IIED (1994) points out that many of the approaches to wildlife management are combinations of or ranges from 'passive' to 'active'/self-mobilization. These approaches have involved compensation schemes, income-generating projects, substitution of traditional techniques and management practices, and environmental education programmes (ibid). The current participation approach of local people in wildlife conservation in Tanzania include

provision of services to local people living adjacent to national parks through Community Conservation Services run by Tanzania national parks and sharing of revenue accrued from tourist hunting by the Wildlife Division (Mtoni 1999). Emerton (1998) points out that benefit sharing is just one of the range of economic factors which need to be incorporated into benefit based approaches to community wildlife conservation. Other factors include, consideration of the costs associated with wildlife and their distribution, the level and form in which community benefits are received, the degree to which communities have economic choice and control over wildlife management, use and benefit generation and wider policy factors (ibid). Barrow and Murphree (1998) recognize that community conservation is not a panacea to all environmental and conservation problems that nations and rural people may face. The notion and practice of community conservation needs to be strategically linked to the conservation of a nation's biodiversity and its land use planning (ibid).

2.1.2 Compensation

Compensation is made in many forms, basing on the principle that people will protect wildlife because they realize benefit from protecting them. Creek (2000) points out that in Australia crocodile eggs from the wild are collected and incubated. Hatchlings are then sold to crocodile farms for Australian dollars $50.00 each. Some of this money goes back to the landholders giving them a financial reward for protecting crocodiles and wetlands on their property, compensating for the occasional loss of livestock to crocodiles. A report presented by IIED (1994) points out that in order for compensation schemes be effective they should be designed so that the amount of compensation is proportionate to the amount of income foregone.

2.1.3 Experiences of local communities conservation schemes/projects

Many African countries have initiated local community participation schemes in natural resource management as a strategy toward resource management (Murphree 1997; Barrow and Murphree 1998). Projects include both those centred on protected areas and those not centred. These schemes/projects recognizes the importance of involving local people in natural resource management. They also raise problems likely to be encountered in designing strategies of involving local people in natural resource management. Examples illustrating include:

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2.1.3.1 Protected area centred Programmes

Amboseli National Park, Kenya

The Amboseli region has been used by the Maasai for many years as the main area where water and pasture could be found during dry season. The establishment of the Amboseli National Park resulted in Maasai loose their grazing rights and access to the area. Major benefits from tourism went to the central government. A small part of these benefits was given to district council. A programme was then established to settle the conflicts between the local people and the management, and promised to provide some facilities and compensate the Maasai for lost access to water and forage for their livestock. The project did not live up to its promises, compensation was never paid and some facilities were not repaired or provided, with the consequence that it began to break down in 1991. Conflicts between park management and the Maasai re-emerged and Maasai continued to enter the park for grazing and watering their livestock (IIED 1994, Weladji 1998).

Waza National Park in Cameroon

The colonial Government set up a forest/hunting reserve in 1936. Settlement and herding activities were allowed within the reserve, but with restrictions on logging of trees and hunting. In 1968, the forest/hunting reserve was transformed into a park in which settlements and herding were no longer permitted (IIED 1994; Weladji 1998)).

The establishment of the park has contributed to the conserving the rich variety of wildlife in the park. The major threat to the park however, is poaching. Local people hunt for subsistence purposes, mainly using traditional methods and with limited off-take. A more substantial threat is posed by modern poachers who use modern weapons to shoot groups of animals and transport them by trucks for sale in Nigeria using local people as guides or informants (Weladji 1998). The majority of local people feel little motivation to promote the survival of the park and its wildlife because its establishment has not resulted in any improvement of their livelihood. Instead their rights of access to pasture, agricultural land and forests have been lost. At the same time local people are suffering from attacks by wild animals on livestock and crop destruction (IIED 1994,

Tchamba 1996, Weladji 1998). The report presented by IIED (1994) points out that only a limited number of locals have benefited from the park, through employment as guides, craftsmen and waiters. Other projects which are protected area centred include; Community Conservation Services (CCS) under Tanzania National Parks in Tanzania, Queen Elizabeth National Park in Uganda and Air-Tenere National Park in Niger (IIED 1994).

2.1.3.2 Programmes not centred on protected areas

CAMPFIRE Project, Zimbabwe

The Communal Area Management Program For Indigenous Resources (CAMPFIRE) is one of the programmes not centred on Protected areas. It is one of the community based resource management programs cited as most successful in Africa. This project was initiated by Department of National Parks and Wildlife Management (DNPWLM) aimed at reducing conflicts between local communities and wildlife, and improve attitudes towards conservation in communal areas (IIED 1994). CAMPFIRE is based on creating appropriate institutions under which resources can be legitimately managed. Empowerment of local communities through access and control of natural resources and rights to make decisions and receive benefits from the exploitation of natural resources are the main underlying principles of CAMPFIRE. The major focus is on economic motivation under changing market and trade conditions, resource appropriation, and centre-periphery relationships in governance (Murphree 1997). Despite some successes, the program has also faced some constraints including the unwillingness of council to develop real responsibility and power, and to pass to local communities full amounts of revenue generated from wildlife management (ibid). Murphree (1997) points out that while it is true that CAMPFIRE has achieved a high regional and international profile and has contributed to the shape of community-based natural resource management (CBNRM) programmes in the Southern African region, there is good reason to be cautious about regarding it in its specifics as a "model" for the generality of CBNRM projects and programmes.

Selous Conservation Project, Tanzania

The Selous Conservation Programme was started in 1988, funded by the government of Germany through Deutsche Gesellschaft Fur Technische Zusammenarbeit (GTZ) and now under Community Based Conservation (CBC) programme operated by the Wildlife Division in Tanzania. It aims at involving local communities in conserving the ecological integrity of the Selous Game Reserve in Tanzania (IIED 1994). The community wildlife management component is directed towards the villages in the buffer zone surrounding the reserve. Some successes have been recorded in the project, however, IIED (1994) points out that in 1990 the Government of Tanzania failed to address the key policy issues of decentralization of control over resources and revenues in order to retain some revenues in the areas/villages.

Other African projects which are not centred on protected areas but having intention of involving people in wildlife management include; Luangwa Integrated Rural Development Project (LIRDP) under Administration Design for Game Management Areas (ADMADE) in Zambia (Bergstrøm 2000, Emerton 1998, IIED 1994), Serengeti Regional Conservation Strategy (SRCS) in Tanzania (Mtoni 1999) and Fishing and hunting management systems in the inland Niger Delta of Mali (IIED 1994).

The basic argument of the outlined participatory approaches is that the comparative value of wildlife resources to local people is crucial in determining options for community wildlife management. However, the major challenge facing community wildlife management as seen in the above case studies is, "How can wildlife conservation be made sufficiently attractive to local people for them to adopt the practice as a long-term livelihood strategy?"

2.2 Classification of Nile crocodile (Mamba)

Nile Crocodiles belong to the class reptilia, order Crocodilia and in the family crocodylidae (Britton 2000; Comb 2000). This family consists of 23 species, 8 species of alligators and caimans, 2 species of gharials and false gharials and 13 species of true crocodiles (Britton 2000;

Ross, 1998). The Nile crocodile is called "Mamba" in Swahili (the national language of Tanzania) and *Crocodylus niloticus* in Latin (Britton 2000).

2.3 Distribution and status of Nile crocodile in Africa

Nile crocodile is widely distributed. It occurs in, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Congo, Egypt, Ethiopia, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea Bissau, Ivory Coast, Kenya, Liberia, Madagascar, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zaire, Zambia and Zimbabwe (Uetz 2002). Nile crocodile is listed in CITES Appendix I (Appendix I lists the most endangered species and imposes an almost complete ban on international trade in any species so listed, see also section 2.6.1), except the populations of Botswana, Ethiopia, Kenya, Madagascar Malawi, Mozambique, South Africa, Tanzania, Uganda, Zambia and Zimbabwe which are listed in Appendix II subject to ranching and/or annual quota (Britton 2000).

2.4 Breeding of Nile crocodile

During breeding period Nile crocodile dig holes up to 50 cm deep in sandy banks, several metres from the water. These may be in close proximity to other nests. Timing of nesting behaviour varies with geographic location - it takes place during the dry season in the north, but at the start of the rainy season further south, usually from November through to the end of December. In Zimbabwe eggs are laid in September (Hutton, 1984). This finding is similar to what local people observed in this study for crocodiles in Lake Rukwa, Tanzania. Hutton (1984) noted that crocodiles enter a dispose phase when approximately 1.2 m long. He also pointed out that, in the wild, sexual maturity is reached when the total length is 2.9-3.3 m for males and 2.4-2.8 m for females, usually lasts between the age of 12-25 years depending on the ambient temperature (see also Britton 2000). Females lay around 40 to 60 eggs in the nest, although this number is quite variable between different populations (Hutton 1984). Incubation time averages 80 to 90 days (ranges from 70 to 100 days), after which females open the nest and carry the juveniles to the

water. The incubation temperature determines sex. An average temperature of 34°C produces males, while females are produced with a constant temperature of 30° C (ibid). Both males and females have been reported to assist hatching by gently cracking open eggs between their tongue and upper palate (Games, 1990). As with many crocodilians, older juveniles tend to stay away from older, more territorial animals. Nile crocodiles grow fast for the first years of their life, then slow down progressively (Cott, 1961).

2.5 Habitats, threats, diet and role of Nile crocodile in its ecosystem

2.5.1 Habitats and threats of Nile crocodile

Nile crocodile has wide habitat preferences which reflects their success and distribution. Their habitats include lakes, rivers, freshwater swamps and brackish water (Britton 2000). Sub-adults disperse into different habitats, away from breeding areas, when they reach a length of approximately 1.2 m (Hutton 1984). Nile crocodiles modify their habitat by digging dens (usually with their snouts and feet) into which they retreat from adverse conditions such as temperature extremes (Britton 2000).

Despite the vigilance of the female during the incubation period, a high percentage of nests are raided by a variety of animals, from hyenas and monitor lizards to humans (Britton 2000, MNRT 2000). This predation usually occurs when the female leaves the nest temporarily in order to thermo-regulate by cooling off in the water (Britton 2000).

Colley *et al* (1996) reveals that worldwide crocodiles are being threatened by alteration of wild habitat. Creek (2000) points out that habitat loss and pollution of aquatic habitats also has a detrimental effect to crocodile populations. Threats to crocodiles in Tanzania are limited (MNRT 2000). The primary threat appears to be illegal disturbance and/or killing in response to real or perceived threat to rural dwellers (MNRT 1997).

2.5.2 Diet and feeding behaviour of Nile crocodile

Hutton (1984) and Engel and Bassanezi (1997) observed that the juvenile crocodiles are generally restricted to eating small aquatic invertebrates and insects, and soon move to larger vertebrates such as fish, amphibians and reptiles. Adults, however, can potentially take a wide range of large vertebrates, including antelope, buffalo, young hippos and large cats (Britton 2000; Comb 2000). Osborne (2000) points out that Nile Crocodiles can feed even on large mammals like Wildebeest especially when wildebeest are crossing rivers. Fish and smaller vertebrates often form the greatest part of their diet, however. Britton (2000) points out that Nile crocodile can scavenge from carcasses and also when feeding as a group dominant crocodiles feed first. Nile crocodiles also kill and eat human and other crocodiles (Britton 2000, Creek 2000).

2.5.3 Role played by Nile crocodile in its ecosystem

Nile crocodiles are the largest predator in their habitats and play a valuable role in wetland ecosystems (Creek 2000). They enrich ecosystems by increasing nutrient recycling, maintaining aquatic refugee for other wetland species during droughts and keeping water ways open (Creek 2000; Ross 1998). Nile crocodiles maintain ecosystem structure and function through their activities and are hence regarded as keystone species (Pooley 1982). A keystone species is a species whose very presence contributes to a diversity of life and whose extinction would consequently lead to the extirpation of other forms of life. Keystone species help to support the ecosystem (entire community of life) of which they are part (RMAD 2002). From a management point of view, it is important to maintain the population of Nile crocodile in ecosystems and that removal of fish by fishing must also account for removal by Nile crocodile to prevent over-fishing.

2.6 Legal and institutional frameworks for crocodile conservation in Tanzania

Tanzania has created a system of protected areas through conservation policies and Acts/Ordinances. The major objectives of conservation of natural resources are:

- Promote conservation of biological diversity.
- Administer, regulate and develop wildlife resources.
- Involve all stakeholders in wildlife conservation and sustainable utilization, as well as in fair and equitable sharing of benefits.
- Promote sustainable utilization of wildlife resources.
- Contribute to poverty alleviation and improve the quality of life of the people of Tanzania.
- And; or Promote exchange of relevant information and expertise nationally, regionally and internationally (MNRT 1998).

A separate Ministry of Natural Resources and Tourism has been created in order to develop and execute a national comprehensive strategy aiming at reaching the above objectives. However, the effective implementation of the ministries' plans requires input and support from other ministries, countries, NGO's, private sector and the public (MNRT 1998).

2.6.1 International legislation

The Nile crocodile is one of the species which has been listed on CITES Appendix I since 1973 without reference to any criteria. Appendix I lists the most endangered species and imposes an almost complete ban on international trade in any species so listed (Hutton and Dickson 2000). The main goal of CITES is to protect species of wild fauna and flora against over-exploitation through international trade. CITES, as originally conceived, took a lead from western, protectionist approaches to wildlife and has not historically recognized a role of sustainable use in conservation (ibid). However, Nile crocodile have not attracted the sort of attention that western environmentalists have to other species such as elephants. This has made it easier to establish a policy based on sustainable use (ibid). Nile crocodile as a species is still included in Appendix I but a number of national populations have been transferred to Appendix II, the first one at the fourth meeting of the Conference of the Parties (COP), Gaborone in 1983. The

population of Nile crocodile of Zimbabwe was the first to be transferred to Appendix II, in accordance with Resolution conference 3.15 on ranching, which was later replaced by Resolution Conference 10.18 on Ranching and Trade in Ranched Specimens (MNRT 2000).

The population of Nile crocodile of Tanzania was transferred to Appendix II at the fifth COP meeting (Buenos Aires, 1985), together with the populations of eight other African states. These transfers were made in accordance with ranching criteria and annual export quotas. However, ranching programmes in Tanzania have not been successful due to lack of funds and technical expertise (Mulokozi 2000). During this same period, wild populations of Nile crocodile in Tanzania were increasing. In view of generating funds to support the ranches Tanzania requested the Conference of the Parties to allow the harvest of wild crocodiles and to export skins. It was at this point found that population of Nile crocodile of Tanzania did not qualify for being listed in Appendix I. As a result, the Conference of the Parties acceded to the request at its sixth meeting in Ottawa in 1987 to allow for controlled harvest and export of skins (MNRT 2000). Since then Tanzania has been exporting crocodile skins from the wild under quota agreed to by COP. At the 11th meeting of the COP (Gigiri, Kenya 2000) it was agreed that Tanzania continue maintaining its populations of Nile crocodile on Appendix II in accordance with criteria for amendment of Appendix I and II, in particular with relevancy to precautionary measures (ibid).

2.6.2 National legislation

Tanzania became a party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in the 1980s. It is also a signatory of other international conventions including Convention on Biological Diversity (CBD) and recently (2000) it became signatory to convention on wetlands (Ramsar convention). Ramsar convention provides frameworks for the coordinated designation and conservation of internationally important wetlands (Heywood and Watson 1995).

The legal framework for conservation of crocodiles and other species of wildlife is laid down in Wildlife policy, Wildlife Conservation Act (WCA) No. 12 of 1974, National Parks' Ordinance Cap. 418 and Ngorongoro Conservation Area (NCA) Ordinance Cap. 419 of 1959. The act and ordinances differ in their areas of jurisdictions. The WCA No.12 of 1974 is concerned with the

conservation of crocodiles and other species in Game reserves, Game Controlled Areas and Open Areas. 15% of Tanzania's surface area (946,000 km^2) is covered by 31 Game Reserves. Game Controlled Areas cover 8%. Forest Reserve covers 15% of which 3% overlap with wildlife conservation areas. Regulated hunting for trophies is allowed in Game Reserves, Game Controlled Areas and Open Areas. In addition to the WCA and general wildlife policy for Tanzania there is a specific Policy and Management Plan for Crocodiles in Tanzania. The policy seeks the protection, utilization and control of crocodiles as appropriate in various areas where it conflict with legitimate human activities and to derive community benefit from crocodiles where possible. The Management plan provides specific regulations for the control of ranching and sport hunting (Wildlife Division 1993). In accordance with the Wildlife Conservation Act, Nile crocodiles from the wild may be hunted or otherwise utilized under license issued by the Director of Wildlife. The only exception is that crocodiles may be killed in defence of human life and property (ibid).

The National Park Ordinance is the law governing all operations in National Parks in Tanzania. No consumptive utilization may take place within National Parks under the National Parks Ordinance No. 412 of 1959. National parks covers 5% of Tanzania's surface area and are utilized for purposes of eco-tourism and research. Thus crocodile utilization for eggs, hatchlings and legal hunting and human settlement is strictly prohibited in National parks. National parks and Game Reserves, which cover a total of 25% of the total land surface, provide protection for a large part of Tanzania's Nile crocodile population (MNRT 1997).

2.6.3 Nile crocodile values at local level

The habitat of crocodiles outside protected areas is protected through local conservation regulations (MNRT 1998). There are different attitudes among different groups of actors. Local people living adjacent to lakes and rivers view crocodile as a detriment instead of an asset or property. To local fishermen and livestock keepers, it is the fish, their nets their livestock, and other property that are valued (MNRT 1997). Members of parliament from rural constituencies support the local people that crocodile should be reduced or eliminated because of the risk it poses to people and because no benefit is realised by them (ibid). Crocodile ranchers perceive crocodile as an asset since crocodile ranching begins when eggs or juveniles are collected from

the wild. They also benefit from wild harvest quota of problem crocodiles (ibid). Hunting companies also receive direct benefits from crocodiles through sport hunting and export of skins and other crocodile products. Hanna *et al* (1996) write that direct use values are easiest to observe and measure because they are expressed in monetary terms. Elliot (1997) and Creek (2000) point out that other direct values of crocodiles include recreational, tourism, research and educational programmes. Nile crocodile like any other animal also has a non-use value, that is the intrinsic value and that its conservation in this respect may be seen as an investment in the future. This shows the divergent values that different people attach to crocodiles.

2.7 Population status and distribution of the Nile crocodile in Tanzania

Numerous aerial surveys have been conducted in specific areas of Tanzania with the aim of estimating the density of Nile crocodiles. MNRT (1997) indicates that Tello in 1985 estimated a total population of 74,000 Nile crocodiles in the country. Katalihwa and Lema (1988) estimated the population to 76,000 animals on the basis of Tello's data.

Aerial surveys to estimate the density of Nile crocodiles in specific areas were started in 1988 by the Wildlife Division (Hutton & Katalihwa, 1988). They were followed by surveys in 1989, 1990, 1993 1995, 1996 and 1999 (Games and Severre 1999). The total physical length of rivers and lakes of Tanzania is 7445 km and the area covered by dams is 6850 km^2. The minimum known Nile crocodile habitat is a length of 2163 km of lakes and rivers and the whole area of dams (6850 km^2) (Games and Severre 1995).

Table 2.1a: Density of crocodile populations in Protected Areas for the years 1990, 1993, 1995, 1996 and 1999 in Tanzania estimated from aerial surveys

Area/River/Lake	Year surveyed	Sample length (km)	Density (animals/km)
Kilombero (PA)	1990	**	2.86
	1993	131	3.54
	1995	116	2.84
	1996	93	5.60
	1999	98	6.1
Rubondo Island (PA)	1990	**	0.62
	1993	119	0.82
	1995	125	0.70
	1996	124	2.50
	1999	124	0.60
Grumeti (PA)	1990	*	0.83
	1996	137	2.04
	1999	70	1.24

Source: Modified from MNRT 2000. ** = Length not recorded
PA = Protected Area (National Park/Game Reserve)

Table 2.1b: Density of crocodile populations in Protected and Open Areas for the years 1990, 1993, 1995, 1996 and 1999 in Tanzania estimated from aerial surveys

Area/River/Lake	Year surveyed	Sample length (km)	Density (animals/km)
Rufiji (PA & OA)	1990	**	7.36
	1993	152	6.38
	1995	164	6.32
	1996	163	11.90
	1999	134	10.40
Ruaha (PA & OA)	1990	**	1.57
	1993	79	1.68
	1995	105	1.59
	1996	116	1.67
	1999	106	2.27
Ugalla (PA & OA)	1990	**	0.67
	1993	148	0.61
	1995	205	0.21
	1999	150	1.5
Upper Ruaha (PA &OA)	1990	**	0.86
	1993	94	1.36
	1996	117	2.66
	1999	100	2.42

Source: Modified from MNRT 2000. ** = Length not recorded

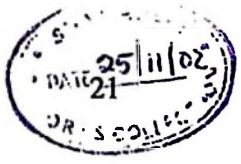

Table 2.1c Density of crocodile populations in Open Areas for the years 1990, 1993, 1995, 1996 and 1999 in Tanzania estimated from aerial surveys

Area/River/Lake	Year surveyed	Sample length (km)	Density (animals/km)
Malagarasi (OA)	1990	*	0.50
	1995	98	0.19
Mara (OA)	1990	**	0.88
	1996	111	0.62
	1999	61	0.32
Rukwa (OA)	1995	30	1.7
	1999	44	0.61
Rungwa (OA)	1990	**	0.46
	1993	76	0.20
	1995	119	0.40
	1999	97	0.31

Source: Modified from MNRT 2000. * = Length not recorded
OA = Open Area

The distribution and densities of crocodile population in Tanzania do not appear to be evenly distributed (Table 2.1a,b,c). There are large differences between lakes and rivers. A large proportion of the total crocodile population is located in protected areas (Table 2.1a). The highest density of crocodiles in Tanzania is found within the Rufiji lakes which are inside Selous Game Reserve. Among these lakes is Lake Tagallala where it was reported to have fifty crocodiles per kilometre of shoreline (Games and Severre, 1996). The reason for such high density is not well understood. The Upper Ruaha River density estimates indicate increases of crocodile populations in the period 1990-1999. The Ruaha density in the open area remained basically constant over the survey period with slight increase in 1999. The Kilombero River population show an increase in average density (Table 2.1a, MNRT 2000). Games and Severre (1996) reported that while there is certainly a real increase in the number of crocodiles, results also reflect the greater experience among survey crews which led to an improved performance.

The populations of Nile crocodile in Lake Rukwa, Malagarasi, Grumeti and Mara appear to be declining (Table 2.1c). The reason for the decrease in density of crocodile in those areas is not clearly known. These areas are open to human activities such as fishing except Grumeti, which has Game Reserve status (Table 2.1a). The sample length, however, for Lake Rukwa in 1999 increased by 50% to that of 1995. According to Games and Severre (1995) most crocodile

counted in 1995 were clumped together in a single pool. This may mean that the increased area had no crocodiles which would consequently lower the overall density of the increased sample. Nonetheless, it can be concluded that the area has not experienced an increase of crocodile density.

As indicated in Table 2.1a,b,c all the crocodile populations in Tanzania during the period of 1990-1999 were at stable or increasing levels of density. Table 2.1a,b,c also indicates that sample lengths differed from year to year which may make direct comparison difficult, as crocodiles are not evenly distributed in waters. Nonetheless, the statistics are believed to give an approximation of the current situation. Dasmann (1981) wrote that populations at stable level have adequate food, water and other necessities to meet their needs. However, since essentially no factor is limiting, this is not a point at which the populations will level off, unless it is held there by human hunting or the behavior of the crocodiles themselves which could prevent any further increase. As noted by MNRT (1997) the threats to crocodiles in Tanzania are limited and/or localized and hence affect small numbers of animals.

Despite the data provided in Table 2.1a,b,c aerial surveys to estimate crocodile numbers should be regarded as conservative, as surveys are fraught with scientific and statistical difficulties. However, Games and Severre (1999) reported that attempts were made to standardize the time of the year of the surveys, the water levels, the pilots and the observers. Time of the day will affect the number of crocodiles basking and diving bias and concealment bias may lower the densities. Games and Severre (1999) points out that night counts were also carried out in some rivers to try and measure the extent of bias caused by the size of the crocodiles (crocodiles smaller than 1.2 meters total length are seldom seen from the air).

2.8 Utilization of Nile crocodile in Tanzania

The forms of Wildlife utilization currently practiced in Tanzania include; game viewing, tourist or sport hunting, resident hunting, ranching and farming (MNRT 1998). Nile crocodile is utilized through sport hunting and ranching/farming within the premises of Resolution Conf 3.15 of CITES (MNRT 1998, Wildlife Division 1993).

During the eleventh Conference of the Parties to CITES (COP 11; see also section 2.6.1) Tanzania was allowed to export an annual quota not to exceed 1600 wild specimens, including 100 crocodiles for trophy hunting (MNRT 2000). Tanzania was allowed to harvest 1500 crocodiles per year designated as problem animals and to be able to generate revenue from export of skins. The revenue generated from this programme is intended to support development activities in communities living adjacent to areas with "problem" crocodiles and also to support conservation activities. However, there are no clear guidelines on community involvement and benefit sharing from revenues generated from both trophy hunting and problem crocodiles. Priorities of harvesting of 1500 crocodiles is given to areas where records in the Wildlife Division headquarters indicate incidences of human-crocodile conflict. This policy appear to bias areas which submit reports on incidences to the Wildlife Division headquarters with the consequence that remote areas such as Lake Rukwa may be overlooked. The issuance of permits to hunt problem crocodiles is undertaken in accordance with the WCA No.12 of 1974, principles and conditions set by the Wildlife Division for crocodile hunting in Tanzania.

2.8.1 Tourist hunting of Nile crocodile

Nile crocodile is hunted for export of skins. Currently Tanzania has a quota of 100 wild specimens to be hunted under tourist hunting quota. Hunting is conducted in Game Reserves, Game Controlled Areas, Open Areas and Forest Reserves. At present tourist hunting in general is economically viable and lucrative (MNRT 1998). Export of skins of crocodile is undertaken by following CITES regulation of Appendix II species, which among other things requires issuance of CITES permit and tagging of skins with special plastic tags.

2.8.2 Ranching of Nile crocodile in Tanzania

Ranching and farming of Nile crocodile are not well developed forms of wildlife utilization in Tanzania. Ranching is defined as rearing in a controlled environment of specimens, usually of young, taken from the wild with the intention of engaging in wildlife trade (MNRT 1998). Currently there are seven crocodile ranches in Tanzania. These ranches operate under regulations laid down in WCA, Policy and Management plan for crocodiles in Tanzania (ibid; see also 2.6). Ranches begin by being issued permit to collect eggs or capture juveniles in the wild. Wildlife

Division (1997) points out that the wild quota of eggs for ranches is 28,000, but less than 20% of this quota is collected per year (Jelden, et *al.* 1994). Creek (2000) who owns a crocodile ranch in Australia writes that ranching is an extremely safe method of exploiting the wild population with very little risk of over harvesting. It provides a strong incentive to conserve animals of breeding age in the wild. For example, the fledgling Australian industry currently generates Australian dollar $6 million per annum in skin and meat sales (ibid). This could be an opportunity for Tanzania to learn from Australia and other countries like Zimbabwe and South Africa where viable crocodile farming industries are to be found.

Creek (2000) also writes that, promoting public education, through teaching people how to live safely with crocodiles is an important component of any Crocodile Management Plan, because if people are injured or killed by crocodiles the public will be less supportive of crocodile conservation.

2.9 Reported cases of human–Nile crocodile conflict in Tanzania, 1997-2000

An overall assessment of the human-crocodile conflict in Tanzania reveals that on average, sixty-three people and one hundred seventy-four livestock were killed by crocodiles per year during the period of 1997-2000 (Table 2.2). During this period an average of thirty-nine crocodiles involved in damage of human life and livestock were also killed per year.

Table 2.2 shows that Morogoro region had many more incidences of livestock being killed by crocodiles than other regions. No incidence of people or livestock was reported from Lindi region during the period of 1997-2000. The reasons for such observations are not given in the report.

Table 2.2. Number of people and livestock reported killed/wounded by crocodiles and number of crocodile killed/wounded in defence by Wildlife Division in Tanzania during the period of 1997-2000.

Region	People killed	People wounded	Livestock killed	Livestock wounded	Crocodile killed	Crocodile wounded
Arusha	20	15	125	0	0	0
Coast	59	24	0	0	10	2
Iringa	2	6	0	0	0	0
Kagera	15	3	37	12	14	5
Kigoma	1	4	0	0	0	0
Kilimanjaro	6	19	58	97	3	15
Lindi	0	0	0	0	0	0
Mara	4	2	37	1	14	4
Mbeya	9	16	32	15	2	5
Morogoro	69	71	297	26	49	11
Mtwara	10	17	0	0	0	0
Mwanza	23	45	65	38	40	24
Rukwa	19	17	3	4	10	4
Ruvuma	1	4	0	0	0	0
Shinyanga	0	0	0	0	11	0
Tabora	6	1	0	0	2	1
Tanga	7	7	43	18	3	0

Source: Data has been compiled from Wildlife Division Headquarters' archives in Dar es salaam

2.10 Problem animals in Tanzania

A "problem animal" in Tanzania can be defined as an individual animal or species which poses a potential threat or causes actual damage to human life and/or property (WCA 1974; MNRT 1998). Different terms are used to define problem animals such as 'Pests', 'Vermin', 'varmints', 'nuisance animals', 'problem species'. These terms suggest the wildlife pest being defined in anthropocentric, utilitarian terms.

According to these definitions, problem animals in Tanzania are not limited to crocodiles. Many species of wildlife cause damages to human lives and/or their property. These species include both herbivores and predators. The most common "problem animal species" in Tanzania other than crocodile include, elephant, baboons, bush pig, lion, leopard, hippo, hyena, zebra, buffalo, leopard, monkey and cheetah. The overall damages caused by wild animals during the period of 1996-2000 included people killed/wounded (976), livestock killed/wounded (5,321) and 9,862.3 hectares of different crops destroyed. During the same period, 3,808 wild animals of different

species were involved in the damage of human life and/or property were killed or wounded (Table 2.3).

Table 2.3. Overall damages caused by wild animals in Tanzania during the period of 1996-2000.

Region	People killed	People wounded	Livestock killed	Livestock wounded	Wild animal killed	Wild animal wounded	Crop damaged (hectares)
Arusha	46	70	1335	410	329	119	4872
Coast	59	24	0	0	203	91	33
Dodoma	10	11	592	26	131	42	181.4
Iringa	3	18	166	35	110	61	89.5
Kagera	37	47	238	109	162	71	204
Kigoma	3	37	52	29	202	70	325.5
Kilimanjaro	11	31	95	105	141	38	679.5
Mara	13	18	37	36	47	24	112
Mbeya	1	4	32	3	20	0	20
Morogoro	73	75	319	26	516	184	1320
Mtwara	31	52	65	178	10	7	308.8
Mwanza	23	48	138	85	416	217	432.25
Rukwa	41	44	63	23	53	20	64.5
Ruvuma	16	35	219	0	33	0	116
Shinyanga	4	6	138	0	223	0	180.5
Singida	11	18	373	71	58	35	496.3
Tabora	20	18	251	2	104	57	415.5
Tanga	9	9	54	16	14	0	11.5
TOTAL	411	565	4167	1154	2772	1036	9862.3

Source: Data has been compiled from Wildlife Division Headquarters' archives in Dar es salaam.

CHAPTER THREE: STUDY AREA

3.1 Location of the study area

Lake Rukwa is located in Rukwa region in southern Tanzania. It covers an area of 2,300 km^2. Rukwa region covers an area of 68,635 km^2 (8% of Tanzania land area). Rukwa region is bounded by Lake Tanganyika in Kigoma region in the north and by Tabora and Mbeya regions in the northeast and southwest respectively and across the Lake by the national borders of Zaire on the west and Zambia on the extreme southwest (Figure 3.1). The Lake also passes across Mbeya region in Chunya district to Mpanda district in Rukwa region (Hughes and Hughes 1992).

Reconnaissance survey showed that among the seven villages and fifty-one fishing camps adjacent to Lake Rukwa, four villages and four camps were more close to the Lake (approximately 4 and 1.5 kilometres respectively). These were perceived to have more conflicts with crocodiles than the others. The villages and camps were: Mtowisa, Uzia, Muze Kalumbeleza, Malangali, Kichangani, Kwa haule and Mtakuja respectively. Therefore, these villages and camps were selected for study. The geographical positions of the fishing camps on the Lake shore of Rukwa is between 07degrees, 24' 14.8" and 27' 41.5" South and 31 degrees 35' 24.1" and 48' 20.0" East (Mbano 2000).

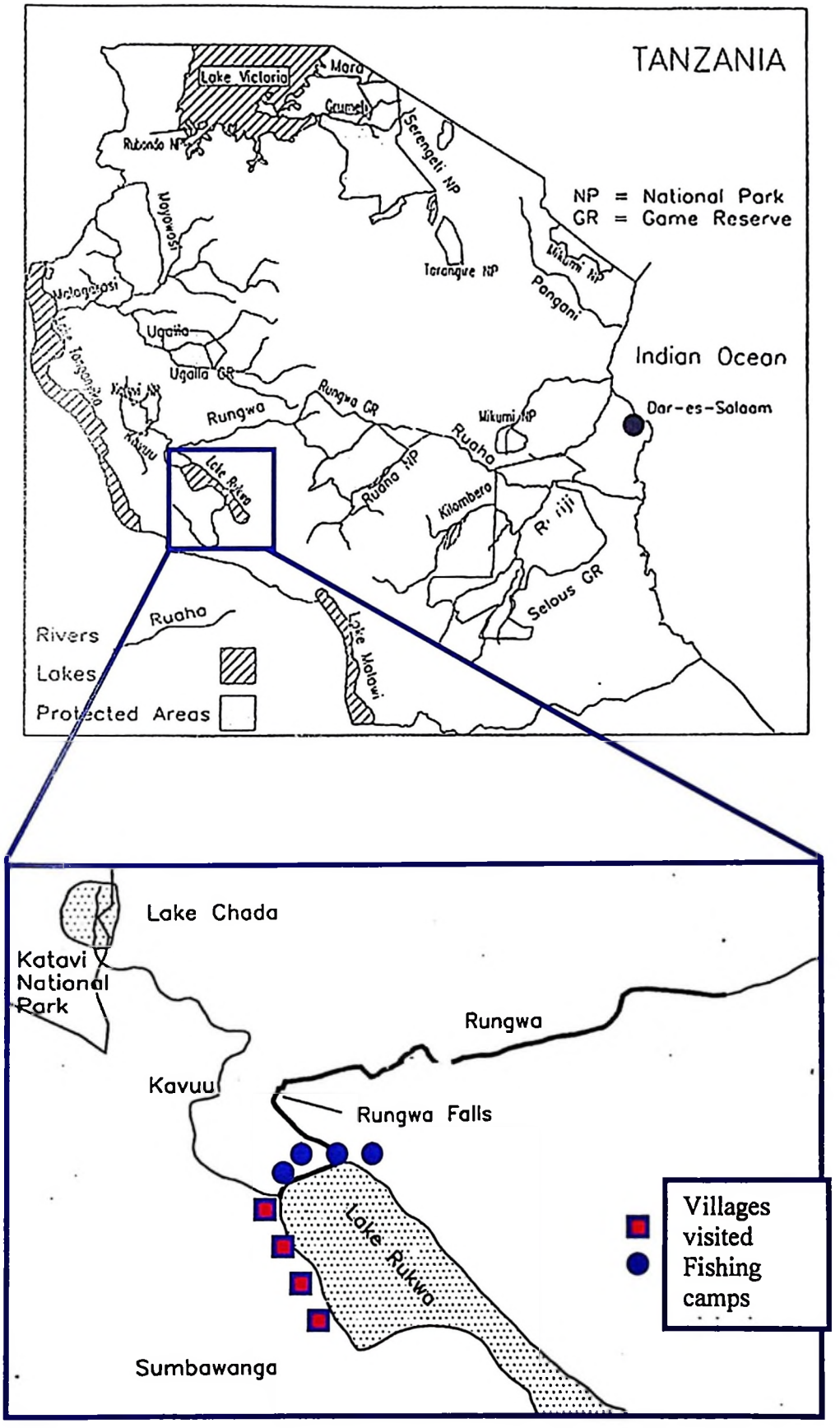

Figure 2. Map of Tanzania showing Lake Rukwa and the villages/camps visited during the study (source: modified from Games and Severre, 1995)

3.2 Hydrology and Water quality

The diversity of wetland ecosystem is particularly affected by changes in hydrological regimes and water quality (Heywood and Watson 1995). Water levels and periodicity of low and high water are vital to the survival of many species. The level of Lake Rukwa varies over time. During very dry periods it can almost become two lakes. The Lake floor slopes from west to east so that maximum depths occur close to the eastern shore. The north basin is shallow and may dry completely in some years, while the south basin has maximum depths of about 6.5 m, reducing to 3 m in dry cycles. At high water the two basins become continuous but the water depth over the barrier seldom exceeds 1 m (Hughes and Hughes 1992). The eastern side is steeply sloping because it is against the wall of the Rukwa rift valley. The catchments of Lake Rukwa exceeds 85 000 km^2, and direct precipitation over the Lake is close to 930 mm/year. Lake Rukwa is unusual in that it has no outlet. The principal inflows to the south basin are from the Lupa and Songwe Rivers, both of which drain the Rungwe Volcanoes, although the Lupa also has extensive catchments on the plateau to the east. The Mfafia River, which drains part of the western escarpment, enters the central swamps between the two basins, while the Kafufu enters at the northern extremity. These are all perennial rivers, but the other inflows are seasonal, or seasonal in most years. The water in those rivers have comparatively high levels of sodium and carbonate (Hughes and Hughes 1992).

3.3 Flora and Fauna

The floodplain grasslands around Lake Rukwa are short, and are dominated by species of grass such as *Panicum maximum*; *Andropogon* sp.; *Diplachne fusca and Sporoboius spicatus*. Common tree and shrub species include, *Tamarindus indica; Adansonia digitata; Combretum* sp; *Acacia* sp. and *Albizia* sp. (Mbano 2000). Papyrus grows in the permanent swamps around the Lake, where there is a supply of fresh water from affluent streams, and papyrus is dominant in the swamps on the Kafufu River. In most sites papyrus is associated with sedge, *Phragmites* sp. and other typical species. The small Lakes Chada and Kavuu, have a dense submerged flora and support carpets of water lilies inside the fringe of emergent macrophytes. (Hughes and Hughes 1992).

Hughes and Hughes (1992) identified twenty-four species of fish in Lake Rukwa, the most important species included *Tilapia rukwaensis* and *Clarias mossambicus. Tilapia rukwaensis* is endemic to the Lake and the most abundant species. Mammal species include Nile crocodile, *Crocodylus niloticus*; Hippos, *Hippopotamus amphibius;* Elephant, *Loxodonta africana;* Warthog, *Phacochoerus aethiopicus*, Puku, *Kobus vardonii,* Waterbuck, *Kobus ellipsiprymnus;* Greater kudu, *Tragelaphus spekei;* Giraffe, *Giraffa camelopardalis,* Cape Buffalo, *Syncerus caffer;*. Baboon, *Papio anubis* and Leopard, *Panthera pardus*. Among the birds, large numbers of White pelican, *Pelecanus onocrotalus* are present. Other birds include Herons, *Ardea melatiocephala* and *Nycticorax leuconotus,* Wattled crane, *Grus carunculatus;* Grey Crowned crane, *Balearica regulorum;* Egyptian Goose, *Alopochen aegyptiacus;* Ducks, Anatidae spp. and Glossy ibis, *Plegadis falcinellus* (Hughes and Hughes 1992; Mbano 2000).

3.4 Human impact and utilization

The human population along the lakeshore is sparse but has been increasing in recent years (Sabuni 1991). There are seven wards with a population of about 7,250 people living adjacent to the Lake that is, 3-10 km from the lake (Mwanakusha 2000). There has long been artisan fishery using dugout canoes in shallow water, but commercial fisheries have had a chequered history, having been started and abandoned on several occasions. *Tilapia* sp. has always been the principal species in the commercial catches (Photo 3.1).

Photo 3.1a. Preservation of fish by smoking. Kichangani camp. September 2001.

Photo 3.1b. Preservation of fish by sun-drying. Kichangani camp. September 2001

3.5 Conservation Status

The Uwanda Game Reserve, established in 1971, protects much of the south-western and central shores of the north basin and is contiguous with the North Rukwa Game Controlled Area, which covers the north end of the Lake. Some 50% of these areas, that is, about 250,000 hectares, are subject to seasonal inundation. The North Rukwa Game Controlled Area was upgraded and declared as Rukwa Game Reserve in 1995 (Wildlife Conservation Order 1995). Rukwa Game Reserve covers an area of 4,194 km^2. It is contiguous with the Katavi National Park, which was gazetted in 1974. This contains most of the Katavi Plains wetlands including Lake Chada and

Kavuu river. The lake covers an area of about 150 km^2 of the Rukwa Game Reserve (Mwanakusha 2000). This area was conserved in order to safeguard the biological diversity of the Lake including Nile crocodiles and fish, and also to prevent spill-over (buffer zone) effects of degradation of the Lake to Katavi National park. During the gazettement of Rukwa Game Reserve, a concession was made by the Ministry of Natural Resources and Tourism that local fishermen be allowed to stay in camps along the shore of Lake Rukwa within the Game Reserve (Mbano 2000).

3.6 Main resource users of Lake Rukwa, their interests and relationships

There are four main categories of users of Lake Rukwa. These are Game Reserve management who work for the Game Reserve; Tourist hunting company who use Lake Rukwa as a hunting concession; Crocodile ranchers who collect hatchlings/juvenile and hunt adult crocodiles and local communities who live adjacent to the Lake especially fishermen (Figure 3.2). Other stakeholders included District Game and Fisheries officers.

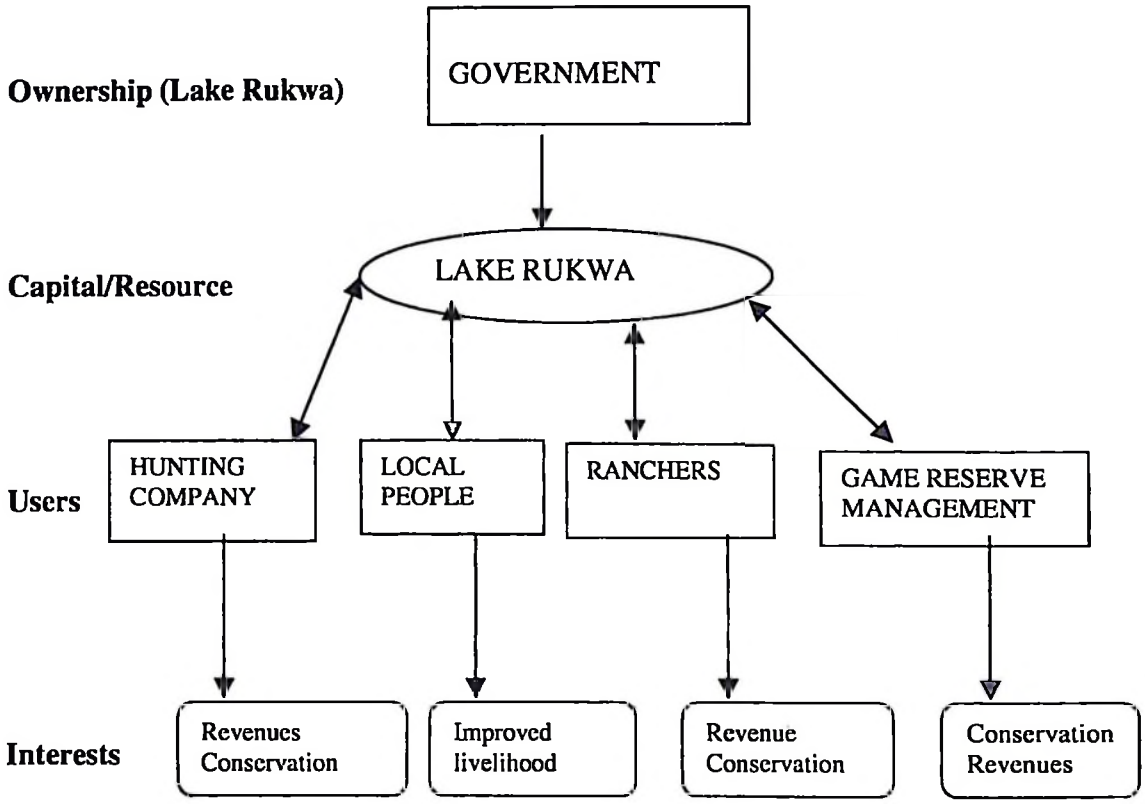

Figure 3.2. Scheme showing main resource users of Lake Rukwa, their interests and relationships.

Lake Rukwa resources are being used in accordance with the interests of the users. While local communities are interested in improving their livelihoods, the tourist hunting company is interested in maximizing profit through exploitation of crocodiles. However, in order to secure long-term benefits to hunting activity, the hunting company needs to ensure that crocodiles in Lake Rukwa are conserved. While conservation is the priority to the Reserve, its management includes the realization of revenues through tourist hunting. District Game officers are interested in earning revenues from tourist hunting and fishing. District Fisheries officers are interested in earning revenues from fishing activities. Since interests are different among users of the same resource, interaction is inevitable (Figure 3.2).

The relationship among the three stakeholders that is, the hunting company, fishermen and wildlife authority was said to be good (Mbano 2000). The hunting company is given a hunting quota and license by the Wildlife Division to kill a certain number of crocodiles and hippos from Lake Rukwa. Crocodile ranchers (Muze and Cossam crocodile) also are given permits from Wildlife Division to kill problem crocodiles and collect eggs and/or juveniles for their ranches.

Discussions with Rukwa Game Reserve staff revealed that illegal entry to the reserve by fishermen and livestock keepers was among the problems facing reserve management. During the study, cattle were seen inside the reserve (Photo 3.2). Also the deliberate felling of trees to obtain firewood for fish smoking (Photo 3.1a) and building materials was another problem to the reserve management. The hunting company expressed concern about the poaching activities said to be happening on the shore of Lake Rukwa. The illegal activities by local people inside the reserve are likely to ruin their good relationships with the reserve management and create tensions in future.

Photo 3.2. Livestock in Rukwa Game Reserve- near Malangali camp. 2001.

CHAPTER FOUR: METHODOLOGY

4.1 The survey process

Data were collected from August 2001 to November 2001. Sources of information were Wildlife Division in Dar es salaam, District Game and fisheries officers, ranchers, hunters, local communities living in villages and fishing adjacent to Lake Rukwa and Libraries. Four villages adjacent to the Lake and four fishing camps were sampled. These villages are: Mtowisa, Uzia, Muze and Kalumbeleza. Camps are: Malangali, Mtakuja, Kichangani and Kwa Haule. Village chairmen were consulted in advance in order to inform people about our presence as well as to avoid missing people. The purpose of the mission was clearly stated by the principle researcher prior to the interview and a letter introducing the principle researcher written by District Game officer of Sumbawanga district, was presented to each village chairmen.

4.2 The interview procedure

Four structured and semi-structured questionnaires were used to collect primary data. One questionnaire was for local people living in villages/fishing camps adjacent to the Lake (Appendix 1), one for Ranchers (Appendix 2) one for Game officers (Appendix 3), and one for Fisheries Officers (Appendix 4). The questions were designed to facilitate quantifying the numbers of people and livestock killed/wounded by crocodile per year. Respondents in villages and fishing camps were randomly selected. A total of 208 respondents representing 10% of the population were interviewed in total from all villages and fishing camps.

In this study a household was defined according to Ellis's (1993) concept of household which states that " the household is a social unit defined by the sharing of the same abode or hearth. It is a sub-set of a family within which household resources are pooled, income is shared and decisions are made jointly by adult household members." Houses with divorced women or widows who are heads of their houses and living with children were also considered as households.

The interviews together with physical observations were carried out by the principal researcher together with two field assistants. The surveys were preceded by a pilot survey which allowed for improvement on the original questionnaires, determined the duration of administering one interview (approximately 45 minutes), terminology, translation of questions into kiswahili (the national language of Tanzania) and practical training of the research team (Gamassa 1989).

Two types of questions were addressed: structured and closed questions with a list of possible answers to each question and broad, open-ended questions giving the respondent an opportunity to express views freely. Structured interviews were used essentially to assess both quantitative data and qualitative information. Open interviews were used to obtain mainly qualitative information related to historical and local knowledge and understandings concerning the human-crocodile conflict in villages adjacent to the Lake.

Key informants were also used. Informal interviews and discussions were carried out with village chairmen, teachers, elderly people, some professional hunters and Rukwa Game Reserve staff. This information has mainly been used to supplement the responses from formal questions.

Field observations and living in the area facilitated the team to cross-check the information given by local people especially with regard to damages of fishing nets and boats. Illegal activities in the areas visited, particularly fishing camps were observed.

Secondary data were obtained from existing reports and records in the archives of Wildlife Division, the District Game officers and discussion with different parties from relevant institutions. The libraries of both the University of Dar-es salaam and Agricultural University of Norway were searched for relevant data in relation to the study.

4.3 Data analysis

Data collected during fieldwork were entered into the computer and analysed statistically by using the statistical programs Minitab and Excel. All tests were performed at 0.05 (5%) level of confidence. The following statistical tools were used in accordance with Johnson and Bhattacharyya (1996):

Two sample t-tests in a matched pair situation were used to determine whether fishing activity was the primary source of conflict.

Regression Analysis was performed to measure the relationship between the number of people and livestock killed/wounded and number of crocodiles killed as a consequence in defence.

Analysis of variance (ANOVA) was performed to show if there was significance difference in the number of people and/or livestock killed/wounded among the villages and fishing camps adjacent to the Lake. Correlation among various attributes was also determined.

Frequency distribution tables and computation of proportions in percentages were used to investigate the most dominant response among several choices given to respondents.

Qualitative data were used to confirm questions and supplement both existing records and data from questionnaires. They were also used to understand the context of the conflict, historical and underlying values of different involved actors.

The survey methodology had some limitations as follows:

The principal researcher is an employee of the Ministry of Natural Resources and Tourism, Department of Wildlife, in Tanzania. He has been working with the Ministry for eleven years. As this was known and the vehicle used belonged to the Wildlife Division, this could have biased the responses given by local communities and District Game and Fisheries officers.

Most of the questions were the recall type which required respondents to remember years of the incidences, whether the incidences were reported or not, action taken by wildlife officers, number of people, livestock and crocodile killed/wounded. This means that the quality of the data depends on the ability and interest of the respondents to recall events. This problem was reduced

by involving all members of the household present at the time, so that among them some could remember and/ or correct one another (Photo 4.1) (Mbaruka 1994;Weladji 1998).

Women in the studied communities had little opportunity to express their views, since most responses were dominated by men. Only 12 out of 208 respondents were women. Most of the women were shy and/or feared their husbands.

The team did not actually witness any conflict with respect to crocodile apart from seeing fishing nets which were said to be destroyed by crocodiles. The limited period in the field (August-November) could be a possible explanation for the lack of observations.

Photo 4.1.The principal researcher interviewing a woman with her children to assist her recall of events. Mtowisa village. September 2001.

CHAPTER FIVE: RESULTS

5.1 Socio- economic conditions of local communities living adjacent to Lake Rukwa

5.1.1 Characteristics of the households

Sixty-one percent of the surveyed households were composed of five or less individuals and twelve percent between six and ten individuals. Twenty-six percent had eleven to fifteen individuals. The highest number of members of the household was more than fifteen individuals (1%). The dominant tribe in the study areas was Fipa (55%). Other tribes included Waha, Wangoni, Wanyamwanga, Wakinga, Wapimbwe and Warungu. The majority of respondents (49%) had lived in the area between one and five years. Thirty-nine percent had lived in the areas for more than fifteen year (Table 5.1). One of the key informants had lived in Muze village for 68 years. This old man had a wealth of information associated with the events occurring in the village and in Lake Rukwa. Results also revealed that duration of stay in villages/camps of respondents and benefits of conserving crocodiles at individual and national level were negatively correlated ($r = -0.090$, $P = 0.194$ and $r = -0.091$, $P = 0.191$ respectively).

With regard to education, eighty-one percent of the respondents attained primary school education. Only nine percent had secondary school education and eleven percent did not attend school at all (Table 5.1). Education attainment was positively correlated to the perception of benefits of conserving crocodiles at both individual and national level ($r = 0.091$, $P = 0.189$).

5.1.2 Resource endowments

The endowment in the studied villages comprised family labour, land, livestock and capital. Everyone among the surveyed villages and camps had access to land whether through ownership or renting. Renting land was not common in the study area as there were few people from outside the area who came to farm. Most of the people from outside came for fishing or employment.

5.1.3 Capital

Most local people in the study area got their cash income from farming and fishing. Access to loans and credits were limited due to complicated procedures. Fishing was found to be the most important economic activity of the households after agriculture. It was said to be a major source of employment since it does not require major capital investments unlike farming. 54% of respondents were farmers and 46% were fishermen.

5.1.4.Constraints to crop and livestock production and fishing

Crop loss from wild animals and predation of their livestock were the major constraints and hence caused entitlement failures. Most species of wild animals mentioned included baboon, crocodiles and hippos. Access to markets, diseases to crops and livestock were also problems limiting farms' production and causing entitlement failures. Fishing was found to be constrained by damage to fishing gear and threat to fishermen caused by crocodile and hippos as well as lack of capital to buy modern fishing gear and access to good markets.

5.1.5 Households diversification

Diversification of households' activities was found to be mainly in terms of cultivation, livestock keeping and fishing. Diversification was also in terms of farming systems and types of crops grown. Mixed cropping was preferred to mono cropping to avoid risks caused by rainfall, crop diseases and problem animals. Maize, paddy and beans were most grown crops in the study area. Fishing was another important activity in income generation and risk avoidance in agriculture.

Table 5.1. Characteristics of the households in each village/camp and their percent responses to education level, duration of stay and economic activities.

Variable	Category	Mto n = 28	Uzi n= 26	Muz n = 29	Kal n = 24	Mal n = 32	Kicha n = 25	Kwa n = 16	Mta n = 28	Total n = 208
Gender	Male	82	92	83	83	78	96	100	100	88
	Female	18	8	17	17	22	4	0	0	12
Education	Informal	25	8	4	17	6	16	0	7	10
	Primary	75	92	79	63	88	60	100	93	81
	Secondary	0	0	17	21	6	24	0	0	9
Duration	1-5Years	7	0	4	0	97	92	100	100	49
of stay	6-10Years	0	15	38	17	0	8	0	0	10
	11<Years	93	85	59	83	3	0	0	0	41
Economic	Farming	100	100	100	100	9	4	0	7	54
activity	Fishing	0	0	0	0	91	96	100	93	46

Mto=mtowisa, Uzi=Uzia, Muz=Muze; and Kal=Kalumbeleza: villages

Mala=Malangali, Kicha= Kichangani, Kwa=Kwa Haule and Mta=Mtakuja: Fishing camps

Source: survey and interview data, 2001.

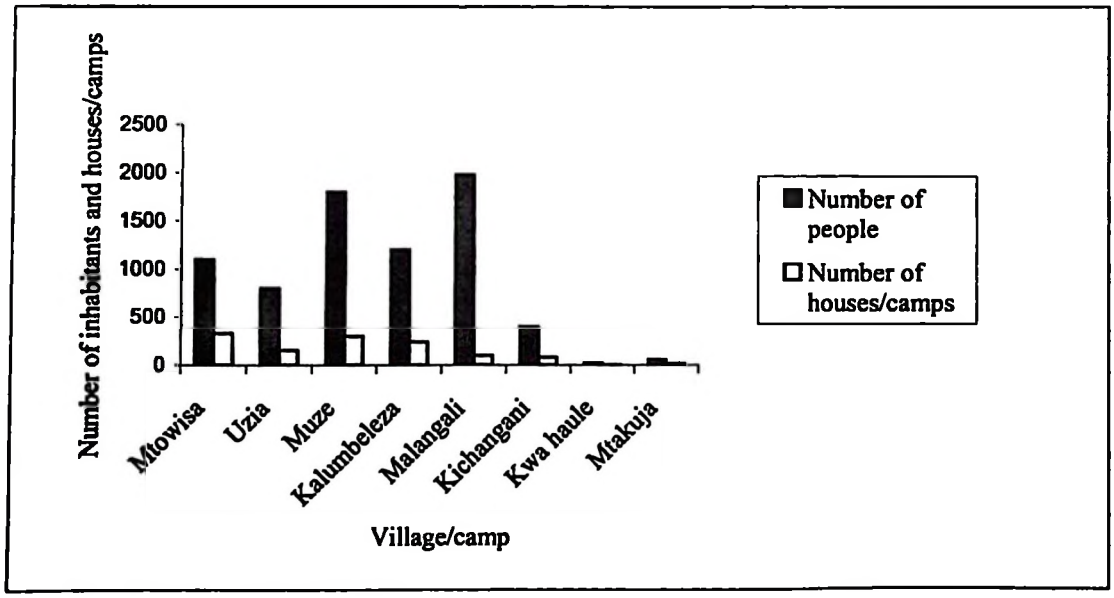

Figure 5.1. Number of people and houses in the surveyed villages/camps.

Among the villages and camps visited during this study, Malangali fishing camp appeared to have many people (1980) but few houses (100) (Figure 5.1). Kwa haule fishing camp was a relatively small camp with only sixteen fishermen and two big houses. Among the four villages visited, Muze village had many inhabitants (1800 people) and about three hundred households. Many houses in fishing camps were males living on their own. Their wives and children were in Mpanda and Sumbawanga districts and in adjacent villages.

5.1.6 Socio-economic aspects of fishing in Lake Rukwa

The study revealed that people who lived in the fishing camps included both those with permits (about 5 people per each camp) and those without permits (about 20 in each camp). The fishing camps were found to include both traders and criminals hiding from the law.

The results show that 46% of surveyed households had members who fish. These numbers attests to the contribution which the fishery makes to household food security, both as a food source and as cash income. However, the data on the contribution of fishery in food security and cash income were not obtained.

Table 5.2. Fishing activity in Lake Rukwa as source of employment to local people for 1996-2001, Sumbawanga District. Data not available for 1999.

Year	Fish species Caught	Annual Catches (kgs)	Value of catches (Tshs)	Number of fishermen
1996	Tilapia sp.	3534	405,100	235
1997	Tilapia sp.	1982	198,200	206
1998	Tilapia sp.	1264	126,400	340
2000	Tilapia sp.	1502	269,000	420
2001 (January-September)	Tilapia sp.	790	179,602	484
Total		9,072	1,578,302	1,685

Source: Survey and interview data from District Fisheries Officer of Sumbawanga District

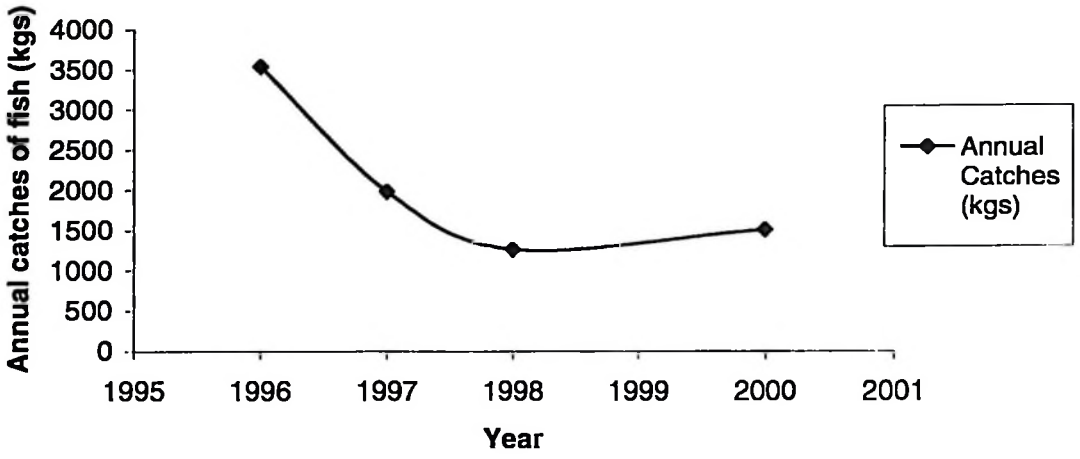

Figure 5.2. Dynamics of fish catches from Lake Rukwa in four years period

5.1.7 Perceptions of local people towards status of fish stocks in Lake Rukwa

Local communities living adjacent to Lake Rukwa show divergent views on the fish stocks in Lake Rukwa (Figure 5.3). Respondents perceiving fish stocks as being on the decline and on the increase are about equal (Figure 5.2). The main reasons given by local communities for decline in fish stocks were changing water levels (12%) and more people fishing as there were no employment (25%). The reason for the suggested increase of fish stock was catch per unit effort. That is respondents reported that large quantities of fish were caught in shorter time than it used to be in previous years due to expansion of Lake Rukwa. Other respondents (15%) mentioned increase in number of crocodiles being one of the contributing factor to the decline in fish stocks. Survey and interview data from District Fisheries Officer of Sumbawanga district (Table 5.2, Figure 5.2) also shows that fish catches have declined since 1996.

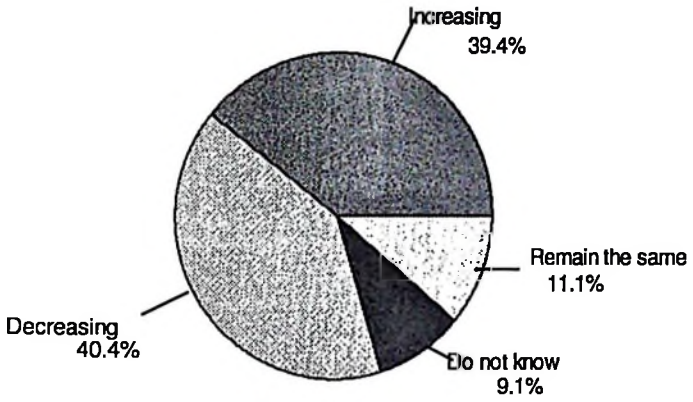

Figure 5.3. Perceptions of local people towards fish stocks in Lake Rukwa

During discussions and interviews with the Fisheries officer it was reported that some fishermen used illegal methods of fishing in Lake Rukwa. The most common is called "katuli" which involves beating water to produce sound to scare fish and get them entangled in the fishing nets. The method tends to kill fingerings and even destroy eggs of fish. Key informants in Muze village also gave an indication of "katuli" being used by some fishermen. Key informants suggested that the government should use its power to control such behaviour so that future generations will have the opportunity to continue fishing in Lake Rukwa. They further noted that the interest of fishermen, especially those coming from outside, is to maximize short-term profit without consideration for the long-term implications.

5.2 Fishing as a cause/predictor of human-crocodile conflict

Responses from interviews of local people living adjacent to Lake Rukwa (Appendix 1) revealed that eighty-six percent of the respondents (Figure 5.4; N=208) stated that they have conflicts with crocodiles mainly in the form of destruction of fishing nets (38%), competition for fish (30.8%), and/or deaths and injuries to people (15.9%) and livestock (1%). They responded that these conflicts were increasing.

Two sample t-tests in a matched pair situation show a significant difference between people killed by crocodiles while fishing and those killed outside the Lake (t =3.78, P =0.007). This indicates that more people were killed in the act of fishing than on land during other activities.

Responses from two professional groups on the cause of conflict between people and crocodiles were also analyzed by chi-square test (Table 5.3). The data provide statistical evidence of association between professions and human-crocodile conflict in the surveyed villages/camps ($\chi 2$=10.089, P-value =0.001, DF =1). High value of chi-square shows that there is a strong statistical association between fishing activity and human-crocodile conflict. This provides a probable basis for widespread negative opinion fishermen hold towards crocodiles.

Table 5.3 Assessment of fishing activity as a cause of conflict from responses of two professional groups of Farmers and Fishermen (N=208).

Professional group	Response Yes	Response No	Total
Farmers	90	23	113
Fishermen	90	5	95
Total	180	28	208

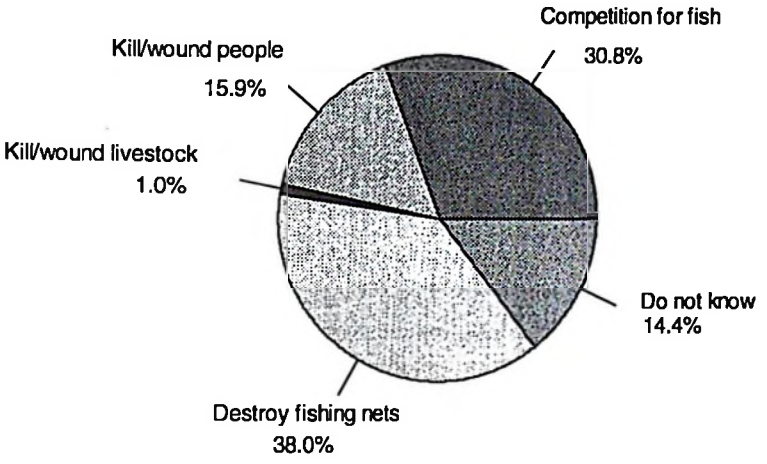

Figure 5.4. Causes of conflict between local people and crocodiles in Lake Rukwa.

These questions were also followed up in interviews with key informants and District Game officers. The interviews revealed that local people expressed fear of crocodile more than the actual damage it causes. The fear was more pronounced in fishing camps than in villages.

5.3 Number of people and livestock killed/wounded by crocodiles and crocodiles killed in defence and their relationships

Results from survey and interviews on the number of people and livestock killed/wounded by crocodiles and number of crocodiles killed/wounded in defence in villages/camps adjacent to Lake Rukwa for the period of 1996-2001 are shown in Table 5.4a, b and c. As discussed in the method section, the four villages and four fishing camps were chosen with the belief that they were all relatively highly affected.

Table 5.4a: Number of people and livestock killed/wounded by crocodiles and crocodiles killed/wounded in defence in villages/camps adjacent to Lake Rukwa for 1996-2001 as reported by local people living adjacent to the Lake.

Village/camp	People killed/wounded	Livestock killed/wounded	Crocodile killed/wounded
Mtowisa	7	1	9
Muze	7	2	2
Uzia	8	4	5
Kalumbeleza	7	0	10
Malangali	15	0	2
Kichangani	2	0	0
Kwa haule	6	0	0
Mtakuja	8	0	0
Total	60	7	28

Mtowisa, Muze, Uzia and Kalumbeleza: Villages
Malangali, Kichangani, Kwa Haule and Mtakuja: Fishing camps

Source: survey and interview data, 2001.

A test of One way Analysis of Variance (ANOVA) confirms that there was no significant difference in number of people killed or wounded by crocodiles in the four villages and four fishing camps (Table 5.4a) during the period of 1996-2001 (P-value = 0.074, F = 1.88, DF =7). Due to limited time and financial resources, no data was obtained to compare these villages/camps to villages located further away. However, given the limited range of crocodiles on land it seems safe to assume that villages without direct access to water would be less affected.

To determine the relationship between number of people, livestock and crocodile killed or wounded in the study area a regression analysis was run. With respect to the data provided by local people in Table 5.4a, the regression analysis shows no relationship exists between number of people and livestock killed/wounded and number of crocodiles killed (P = 0,075 for people and P= 0,458 for livestock) during the period of 1996-2001. Table 5.4a shows that more crocodiles (9 and 10) reported killed/wounded in both Mtowisa and Kalumbeleza villages than the number of people and livestock killed/wounded in either of them (7 people in each village and one livestock in Mtowisa). Malangali fishing camp reported the highest number of people killed/wounded (15) by crocodiles during the period of 1996-2001.

Table 5.4b: Number of people and livestock killed/wounded by crocodiles and crocodiles killed/wounded in defence from Lake Rukwa for 1996-2001 as reported by District Game officers during survey.

Year	People killed	People wounded	Livestock killed	Livestock wounded	Crocodile killed	Crocodile wounded
1996	9	8	5	4	5	2
1997	3	8	3	0	1	2
1998	4	7	3	1	2	1
1999	3	8	4	2	0	0
2000	5	5	1	4	1	2
2001	2	1	1	0	0	0
Total	26	37	17	11	9	7

Source: Survey and interview data, 2001, DGOs – Mpanda and Sumbawanga Districts

The data in Table 5.4b is that reported by District Game officers. A regression analysis was performed to determine the relationship between reported number of people/livestock killed or wounded and crocodiles killed/wounded in defense. From this analysis, the data shows that the factor people killed has strong relationship to the number of crocodile killed in response (P = 0,005, R-square = 88.3%). No significant relationship is observed between livestock killed and crocodile killed (P =0,176, R-sq =40,2%). One way analysis of variance of data in Table 5.4b also shows no significant difference in number of people and crocodile killed among years 1996-2001 (P= 0,251, DF =4). District Game Officers revealed that out of sixty-three people killed/wounded from Lake Rukwa (Table 5.4b), only twenty-three people reported from the study area mainly kichangani and malangali fishing camps. District Game officers also reported that only twelve livestock killed/wounded shown in Table 5.4b were from the study area.

Table 5.4c. Number of people and livestock killed/wounded by crocodiles and crocodiles killed/wounded in defence from Rukwa region for 1996-1999 from Wildlife Division headquarters. Data not available for 2000 and 2001.

Year	People killed	People wounded	Livestock killed	Livestock wounded	Crocodile killed	Crocodile wounded
1996	7	7	5	4	5	2
1997	4	6	0	0	2	2
1998	4	3	0	0	3	0
1999	6	3	2	1	0	0
Total	21	19	7	5	10	4

Source: Wildlife division, Headquarters archive and survey data, Dar es salaam

The data in Table 5.4c has been collected from Wildlife Division archives. As of November 2001 the Districts of the study area had still not reported data for the year 2000. The data in Table 5.4c reveals that forty people and twelve livestock were reported killed/wounded by crocodiles during the period of 1996-1999. Regression analysis was performed to determine the relationship between reported number of people/livestock killed and crocodile killed in defense. A regression analysis shows no significant relationship between people/livestock killed and crocodile killed in defense (P=0.174 for people, P=0.268 for livestock; R-square 95.9%). This suggests that more people/livestock were killed by crocodiles than crocodiles killed in defense.

5.4 Attitudes of local communities towards crocodile conservation

Local people interviewed on their attitude towards crocodile conservation included local people living/fishing adjacent to Lake Rukwa and ranchers who collects eggs/juveniles and hunt adult crocodiles from Lake Rukwa (Appendix 1, 2).

5.4.1 Local people living/fishing adjacent to Lake Rukwa

Table 5.5a. Percentage response frequencies to open questions concerning crocodile as a source of benefits to individual/household and nation levels (n =number of sample) by villages/camps

Variable	Responses	Mto n = 28	Uzi n= 26	Muz n = 29	Kal n = 24	Mal n = 32	Kicha n = 25	Kwa n = 16	Mta n = 28	Total n = 208
Benefit individual/household	Yes	25	19	14	13	12	4	0	14	13
	No	68	77	79	79	88	88	100	64	80
	DN	7	4	7	8	0	8	0	22	7
Benefit nation	Yes	61	88	69	50	84	88	19	50	64
	No	25	8	17	33	0	4	50	14	19
	DN	14	4	14	17	16	8	31	36	17

Mto=mtowisa, Uzi=Uzia, Muz=Muze; and Kal=kalumbeleza villages
Mala=Malangali, Kicha= Kichangani, Kwa=Kwa Haule and Mta=Mtakuja Fishing camps
*DN =Do not know
Source: survey and interview data, 2001.

The overall majority of respondents in the study areas do not report the realization of benefits of conserving crocodiles at the individual or household level (80%). However, the results show that 64% of the respondents indicated that the nation was receiving benefits from conservation of crocodiles in Lake Rukwa.

5.4.2 Nile crocodile ranchers

Two crocodile ranches are in Rukwa region and collect eggs/juvenile and hunt adult crocodiles from Lake Rukwa and provide employment to local people (Table 5.5b). The ranch is Cossam and Muze crocodile ranches. Both ranch owners were asked whether they benefited from crocodile conservation. Both answered affirmatively. The reasons given for their answers were that crocodiles are source of hatchlings for their ranch and income from sale of skins.

Both ranches indicated that the reasons for conflict between local people living adjacent to Lake Rukwa and crocodile were destruction of fishing nets, killing /wounding people and/or livestock.

Table 5.5b. Ranches and local people employed, hatchlings and adult crocodiles collected/killed from Lake Rukwa and people killed by crocodile in each ranch for 1996-2001.

Name of ranch	People employed	Hatchlings of crocodiles captured	Adult crocodiles Killed	People killed by crocodiles
Cossam	15	60	459	0
Muze (started in year 2000)	7	128	207	2

Source: survey and interview data, 2001.

Photo 5.1 Ranch and crocodiles in very poor condition. Muze crocodile ranch. September 2001.

5.5 Perceptions of local communities towards wildlife in general

Perceptions of local communities living adjacent to and/or fishing in Lake Rukwa towards conservation of wildlife in general was examined by two open questions (Appendix 1). The results show that most respondents considered wildlife in general as resources worth conserving (55%). 38% of respondents were unsure and 7% did not perceive any benefit from wildlife (Figure 5.5).

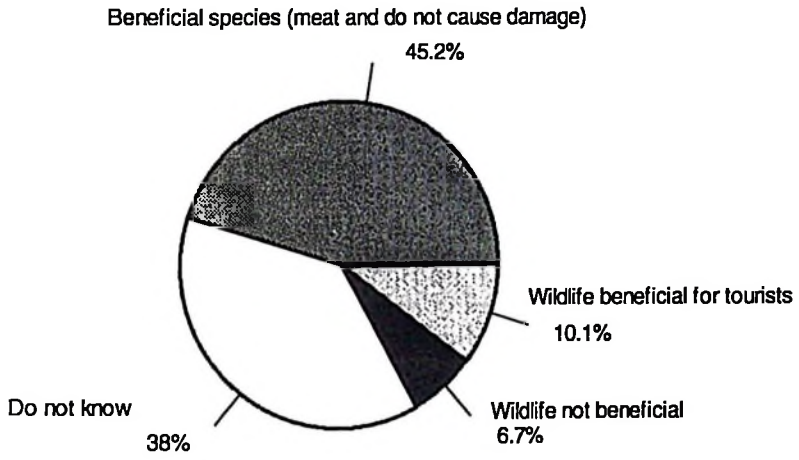

Figure 5.5.Responses of local communities on perceptions towards benefits from wildlife conservation.

In response to the question on policy reform to enable that wildlife generates more benefits to the nation and to themselves/their communities, majority (66%) of respondents reported not knowing how could wildlife in general and crocodile in particular in Lake Rukwa could bring more benefits to the nation and to themselves/communities if there was policy reform. Only 23% of the respondents proposed hunting and ranching of wildlife, particularly crocodiles to be the best options for generating revenues o the communities and to the nation (Figure 5.6).

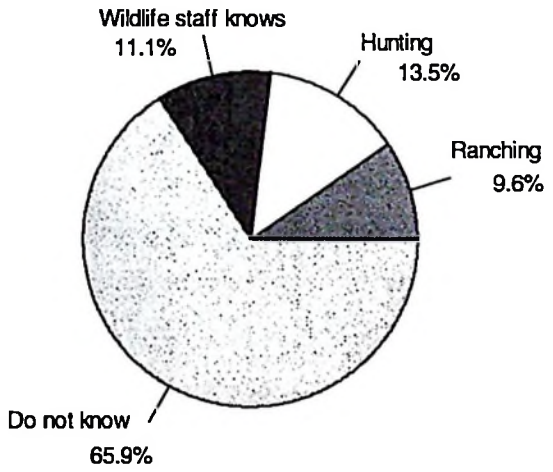

Figure 5.6. Suggestions of local people on options of making wildlife more beneficial to themselves/communities and to the nation

5.6 The role of wildlife management authority to the local people living adjacent to Lake Rukwa

When local people were asked about the role of Wildlife Division in controlling problem animals, the majority (84%) of the respondents perceived no role played by the Division either positively or negatively (Table 5.6). A positive correlation was found between duration of stay of respondents in the villages/camps and the attitudes towards the role of Wildlife Division in controlling problem animals ($r = 0.269$, $P = 0.000$). There was a limited indication of the staff harassing local people (2%).

Table 5.6. Responses of local people to the role of Wildlife Division (n=208)

Variable	Response	Frequency	Relative Frequency
Role of Wildlife Division in controlling problem animals	Help in case of crocodiles and hippopotamus	30	14
	Harass people	4	2
	Do nothing	151	73
	Do not remember	23	11

Source: survey and interview data, 2001.

5.7 Opinions on remedies to the problem crocodiles

Respondents were asked to provide suggestions as remedies to problems and conflicts with crocodiles in Lake Rukwa. 17.3% wanted crocodiles to be harvested; 2.9% indicated the need to harvest both crocodiles and hippos; 16.3% urged government to find solution to the problem crocodiles and 63.5% had no opinion (Figure 5.7).

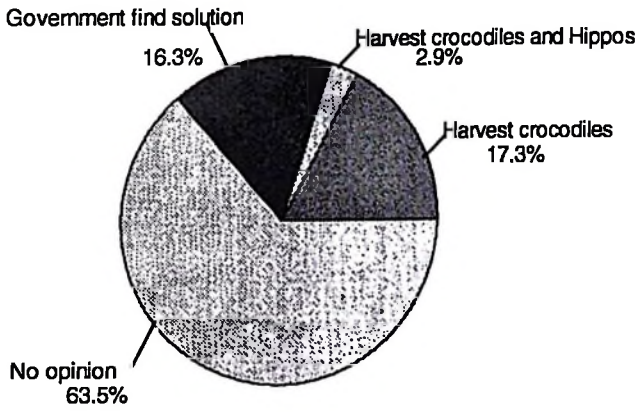

Figure 5.7. Households opinions on the possible remedies to problem crocodiles.

CHAPTER SIX: DISCUSSION

6.1 Socio economic aspect of fishing in Lake Rukwa

Local people living adjacent to Lake Rukwa are among the people who benefit from fishing activity in Lake Rukwa through both employment and as a source of protein. More than three hundred people per year are full time fishermen (Table5.2). The number of fishermen with permits in Lake Rukwa has been reported to be increasing. It is difficult to know actual changes in numbers as the number of fishermen with permits at the time of the study was a fraction (20%) of the total number of fishermen in the area. It is unknown if this reflected the situation of the past five years or if it is a new phenomenon. It was revealed that some of those fishermen own boat engines rather than the common dugout canoes to increase their individual capacities. It was also reported that good markets of fish exist in neighbouring countries including, Zambia, Democratic Republic of Congo and Malawi. Similar findings concerning good markets in those countries have been reported by Mbano (2000) during his survey of sustainable fishing in Lake Rukwa. During the period of 1996-2000 the fish catches have been rather moderate. In 2001 reported fish catches was low at least part because only nine months were recorded (Table 5.2; Figure 5.2).

Berkes (1985) adapted Hardin's (1968) common property approach (what is today refer to as open access) in analysing the world-wide interest in traditional management practices of natural resources focusing on fisheries. Berkes (1985) points out that with increase in numbers of fishermen with new, more effective gear or use of illegal fishing methods and increased fishing effort, individual catches of fishermen per unit of fishing effort expended will fall. At some point over-fishing will occur inevitably when the total yield exceeds the natural ability of the fish populations to renew themselves on a sustained basis. He explained this as a "Fishermen and the Tragedy of the commons." Commercialisation of subsistence fishery, he claims, is one of the conditions that lead to the tragedy of the commons (ibid). Commercialisation of subsistence fishery has been reported in Lake Rukwa by Mbano (2000) and confirmed during this study.

FAO (2001) report on fishing in Southern African Region reveals that experience in the more heavily fished Malawian waters has shown that the over-fishing threshold is crossed in a very

short time. Breen *et al* (1997) point out that in parts of Zambia fish populations have declined to the extent that in 1996 a ban on fishing during the spawning season was imposed. The decline in fish stocks was attributed to both an increase in the number of fishermen and the frequency of fishing. However, in order to maintain the same catch levels fishermen had to resort to changes in fishing methods by reducing the mesh size of nets or through catching fish by illegal methods such as poisoning or dynamiting (*ibid*). Mbano (2000) reported that fishermen in Lake Rukwa used illegal fishing method known as "Katuli" (see also 5.1.8). District Fisheries Officers and key informants confirmed that "katuli" was practiced to maximize catches.

The results of the current study reveal that fishing is the second most important activity for the local communities living adjacent to Lake Rukwa after agriculture. This may suggest that the health and nutrition of the local people living adjacent to Lake Rukwa is dependent, in part, on the fishery as a source of protein and income. Key informants reported that less visibly, but equally as important, the fishery also helps to sustain the social and cultural fabric of communities along the Lake as people help one another during attacks by crocodiles, carry sick persons from the fishing camps to the hospital and even take disciplinary actions to members of the fishing community who misbehaves.

Despite the importance of fishing to the local communities living adjacent to Lake Rukwa, literatures which have been reviewed appears to lack data on social, biological and ecological data in Lake Rukwa Fisheries. This may negatively affect development of sound management policies.

6.2 Fishing as a cause/predictor of human-crocodile conflict

Fishing activity in Lake Rukwa appears to be the major cause/predictor of the existing conflict between local communities living adjacent to Lake Rukwa and crocodiles as expected. The majority (86%) of fishermen view crocodile as causing problems to them (Figure 5.5). The major problems are destruction of fishing nets (38%), competition for fish (31%) and killing/wounding people (16%). It was also reported that crocodiles were killing/wounding livestock (1%). Britton (2000) wrote that attacks on humans by crocodiles are not uncommon. He also indicated that a

significant number of attacks occur during the nesting season. During the nesting season, females are exceptionally vigilant around their nest, and will act aggressively towards any approaching animals they perceive as a threat to their eggs (comb 2000). Therefore, nesting areas should be avoided at this time in order to avoid such encounters.

It was reported by local people that frequent destruction of fishing nets forces fishermen to buy fishing nets more often. This is costly, and sometimes fishermen sell their livestock in order to get money to buy fishing nets. In a way this may contribute to poverty among local communities living adjacent to Lake Rukwa as a result of entitlement failures (Sen 1981; see also section 5.1.5). Similar findings were reported by Games (1990) and Fergusson (1998) who showed that the damage to fishing gear was frequently caused by crocodiles extracting fish from gill-nets.

In the current study, thirty one percent of those interviewed mentioned competition for fish as another cause of conflict between fishermen and crocodiles. Local perceptions may reflect their own interests. For example this observation differs from what Games (1990) found in a study on the ecology of Nile crocodile in Zimbabwe where apparent competition for fish between crocodile and fishermen was not observed. It may also reflect a higher level of fishing activity in the study area.

District Game Officers, Fisheries officer and Ranchers reported that fishing in crocodile habitats is a major contributing factor towards attack by crocodile. It was also reported that problem with crocodile is more serious during rainy season/ November-March (see also section 2.5), when the Lake expands covering the shoreline with tall grasses which are being used by crocodiles as a hideout (62% of respondents). Fishermen are aware of the danger to themselves of fishing in habitats occupied by crocodiles. Most crocodiles concentrate in areas where the rivers enter the Lake. This means that fishing could be restricted in those areas through seasonal zoning to avoid or reduce conflicts.

Local people claimed that an increase in the number of crocodiles was escalating the conflict. Contrary to this, the key informants, Rukwa Game Reserve staff, District Game officers and hunting company expressed concern on the decline on the number of crocodiles in the Lake.

Games and Severre (1999) reported that crocodile population in Lake Rukwa was on a decline however, their counts covered different lengths of the Lake in 1995 and 1999. In 1995 all the crocodiles were sighted in a single pool (see also section 2.7). There is a need for undertaking boat counts in successive years of crocodiles to determine their numbers and change over time or a boat count simultaneously with plane count to have basis for estimating differences in the techniques. Accurate number of crocodiles will facilitate allocation of realistic trophy hunting quota to hunting company and ranchers to capture juveniles and hunt adult problem crocodiles properly identified by experienced fishermen or other wildlife experts as crocodile causing problems (see also section 2.8). Tanzania's policy towards Nile crocodiles states that, "they will be conserved and encouraged where they do not conflict with legitimate human interests/activities" (Wildlife Division 1993). Fishing in Lake Rukwa (for permitted fishermen) is a legitimate human activity. This makes basis for control of crocodiles causing problems to local people fishing in Lake Rukwa (see also 2.6.2).

Interviews with key informants and District Game officers suggest that local people have fear on crocodiles in Lake Rukwa. Fear of crocodiles by local people should be followed up further, as this study was not designed for that kind of information.

6.3 Number of people and livestock killed or wounded by crocodiles and the crocodiles killed in defence and their Relationships

The results s indicate that more people/livestock were either killed or wounded by crocodiles than the number of crocodiles killed in response during the period of 1996-2001 (Table 5.4a, b and c). There is however, a clear discrepancy in comparison of the three sources of information: locals, Districts Game officers and the Wildlife Division. Local people reported twenty-eight crocodiles being killed in defence of human life and/or peoples' property while District Game Officers reported only sixteen crocodiles. This appears to suggest that some crocodiles are killed by local people and are not reported to the District Game Officers. The number of crocodiles reported killed/wounded by local people however, may be far less than the actual killed by them (there may be multiple reports of the same killing or they may reflect stories told, for example), as it is illegal to kill crocodile without permission from the Director of Wildlife (WCA 1974).

Interestingly, local people in Mtowisa and Kalumbeleza reported more crocodiles being killed/wounded than people and livestock killed/wounded (Table 5.4a).

Reasons for inefficiency in killing problem crocodiles given by Game officers were among others, remoteness of the areas, lack of transport and funds for purchase of ammunition, fuel and payment of night out allowances for scouts to immediately respond to the problem. Another reason was failure to identify and kill the particular problem animal. Fewer staff in the districts as a result of retrenchment by the government is another constraint. It was for example reported that Sumbawanga district had less than six staff. In addition to the number of staff being few there was not a single car available for the district wildlife related activities. Nonetheless, response by game officers to kill crocodile is more pronounced when crocodile kill a person than when kill/wound livestock.

The differences in numbers of people, livestock and crocodiles killed/wounded revealed in the results may also reflect difficulties of local people to reach the Wildlife District authorities to report the incidences. Another explanation given by local people was that they do not bother to report because they do not expect any benefits in terms of help from reporting. The same type of explanation may represent the differences in records between District Game Officers and Wildlife Division headquarters (Table 5.4 b and c). The Wildlife Division headquarters gets reports on the damages to people and property caused by crocodiles from the District Game officers. The Director of Wildlife must ask the DGOs to submit the reports or send staff from headquarters to collect the data. At extreme cases, radio calls may be used to communicate messages to DGOs and also receive data through radio calls. Experience shows long lags in submission of reports as evidenced by the lack of data for the area in both years 2000 and 2001 (see also Table 5.4c).

To minimize problems caused by crocodiles (and other wild animals), the district wildlife authorities must be well equipped with appropriate facilities, equipment manpower and funds. Moreover, record keeping should be improved through computerized system at the level of district and Wildlife Division headquarters. Accurate data will facilitate decision-making by

Wildlife Division at headquarters particularly with regard to problem crocodiles' quota to be requested from Conference of the Parties to CITES (see also section 2.8).

6.4 Attitudes of local communities towards crocodile conservation

Local people interviewed during this study indicated substantial differences in attitudes towards conservation of crocodiles in Lake Rukwa (Table 5.5a and b). Most local people who had lived in the villages and camps for ten or more years expressed a more negative attitude towards crocodiles than newcomers. More negative attitudes have also been described, particularly among fishermen and livestock keepers who often experience damage to their property by crocodiles. Kellert (1994) in his paper on the public attitudes towards bears and their conservation focusing on importance of values in bear policy noted that the capacity of brown bears to inflict injury fostered ambivalent and negativistic attitudes towards brown bears. This could be the case of crocodiles in Lake Rukwa. Moreover, interviews with key informants revealed that fear was another cause of the existing negative attitudes towards crocodiles in Lake Rukwa. There is a need to follow up this expression of fear reported by key informants in another study as the current study was not designed for this and therefore did not collect enough information to enable a clear understanding of the extent of fear among the local communities living adjacent to Lake Rukwa.

There was a positive correlation between perception of crocodile as a revenue earner through tourist hunting and level of education. The majority of respondents who had attained secondary education perceived crocodiles and other species of wildlife as resources worth conserving. This could be due to a greater opportunity of being employed by Wildlife authorities, hunting company and ranchers among educated persons. Similar findings on local people's perceptions towards baboons were reported by Hill (2000) and Naughton (1996) in their studies of crop raiding by wildlife around Kibale National Park, Uganda. Kellert (1994) also revealed that public attitudes towards brown bears and their conservation were influenced by knowledge and understanding of the bears. This suggests that the level of education and knowledge about crocodile is an important means through which to combat negative attitudes towards crocodiles

and to advance the cause of conservation. Generally the increase in education level provides general supports to wildlife conservation.

As compared with more negative attitudes by local people living adjacent and/or fishing, both ranchers (Muze and Cossam crocodile ranch) clearly indicated highly positive views of conservation of crocodiles. The ranches create employment to local people living in Rukwa region. They also help to minimize the problems caused by problem crocodiles through collection of eggs/juvenile and hunting of adult crocodiles (Table 5.5b). Both ranches also indicated that conflict between local people and crocodile do not affect the possibility of carrying out ranching operations in the area. Ranch and crocodiles were found to be in extremely poor condition, something also locals were aware of as they indicated that improved ranch management will lead to improved profits.

6.5 Perceptions of local communities towards wildlife in general

The majority (55%) of local people living adjacent to Lake Rukwa perceived wildlife species which are sources of meat and which do not cause damages/dangerous as beneficial species. The species most preferred include elephant, giraffe, wildebeest, impala and buffaloes. Crocodiles, hippos and baboons were mentioned as harmful species or problem animals. It is striking to note that local communities also recognise the role of wildlife in terms of generation of foreign exchange revenues and for future generations.

A number of people (23%) favoured hunting and ranching of problem animals particularly crocodiles as means of minimizing damages caused by those animals to local people. They also pointed out that hunting and ranching and export of their products of such species will generate more funds for conservation of wildlife. However, 77% of local communities living adjacent to Lake Rukwa is not knowing as to whether hunting or ranching of problem animals such as crocodiles could make the species more beneficial to them and to the nation.

6.6 The role of wildlife management authority to the local people living adjacent to Lake Rukwa

Many (73%) of local people living in the communities adjacent to Lake Rukwa do not recognize the Wildlife Division as having a role in controlling problem animals (Table 5.6). They complained that the wildlife staff do not visit them and listen to their problems. Few local people have consulted with wildlife officials. Those that have primarily done so reported damage to human life and or property caused by crocodiles. The trend of the results is similar to the findings obtained by both Mbaruka (1996) in communities surrounding Mikumi National Park in Tanzania, and by Gillingham and Lee (1999) among local people around Selous Game Reserve in Tanzania. The negative responses could be due to perceptions that Wildlife Division staff are considered as the bearers of authority and responsibility for wildlife management, and are privileged in terms of access to resources and decision-making which local people are denied (Haslerig 2000). Gillingham and Lee (1999) in the study of the impact of wildlife-related benefits on the conservation attitudes of local people around Selous Game Reserve, Tanzania, found that villagers perceived wildlife management as being to the villagers' disadvantage, and it was the domain of the state.

6.7 General opinion on what should be done as remedies of conflict between human and crocodile

Suggestions to remedy conflicts between local people and crocodile varied greatly. The most prevalent suggestions (20%) were to harvest crocodiles and/or both crocodile and hippos in Lake Rukwa. Local communities reported wanting to be granted hunting licences to crocodile to either individuals or to an association which could be authorized by the wildlife authority. The view of local people to demand authorization to hunt supports the plans of the Wildlife Division of linking the wild harvest to community based conservation programmes in order to channel benefits from the utilization schemes to local communities (MNRT 2000). The majority (67%) of local people suggested that it is the government staff who should look for solution to the problem crocodile. This may reflect what they see as the state's responsibility, but may just as well reflect that they are unfamiliar with possible options.

CHAPTER SEVEN: CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

As discussed in chapter two, various case studies suggest that in order to ensure co-existence between local people and wildlife, sources of conflicts must be explored and taken on board in the planning process. Results from this study demonstrate causes of conflict between local people adjacent to Lake Rukwa and Nile crocodiles. The relationships between number of people and livestock killed or wounded by crocodiles and number of crocodiles killed or wounded in defence have been presented by three different actors: local people, District Game Officers and Wildlife Division headquarters. Attitudes of local people towards wildlife in general and crocodile in particular in Lake Rukwa have also been investigated.

The findings of this study reveals that fishing activity appears to be the main cause or predictor of the existing conflict between local people and crocodiles in Lake Rukwa.
More people are killed/wounded by crocodiles while fishing in Lake Rukwa than while on land. Damage to fishing gear and competition for fish between fishermen and crocodile have also been reported.

In the study area more people were killed/wounded by crocodiles than crocodiles killed/wounded in defence during the period of 1996-2001. Reports on damages caused by crocodiles to local people living adjacent to Lake Rukwa differ among, local people, district wildlife authorities and national archives. Local people report more damages caused by crocodiles to them but not damages caused by them to crocodiles. District Game Officers and Wildlife Division at headquarters report a balance situation between crocodile killed as a response to human/livestock killed or wounded. Interestingly, although national records would be expected to simply reflect District reports, there are also discrepancies between these two groups. In collecting information interviews were used to augment written reports with District officers personal knowledge of local events.

Local people living adjacent to Lake Rukwa have negative attitudes and perceptions towards wildlife species causing damage particularly crocodiles. They do not report realizing benefits from conservation of crocodiles and species of wildlife in the reserve. They reported that currently no funds are reaching them. This may in part explain negative attitude towards conservation. In contrast, ranchers and the hunting company indicated a positive response toward crocodiles and other wild animals. Moreover, local people recommend the number of crocodiles to be reduced through hunting, ranching or other means which the Government may consider viable. However, if the local people continue fishing in habitats shared with crocodiles, it is likely that conflicts with crocodiles cannot be eradicated, only reduced. This supports the need to establish more sustainable-yield management programs involving local people in benefit sharing and management goals, together with educational programs to teach people the ecology and biology of crocodiles in order to create awareness to avoid attacks. Both scientific knowledge and local/indigenous knowledge from experienced fishermen should be included.

Finally, it is clear that despite some positive responses received during this study, managing conflicts between crocodiles and people still faces a number of challenges. These challenges include: managing crocodile numbers sustainably while meeting peoples' livelihood needs from Lake Rukwa; linking the poverty reduction strategies with gaining local and regional political commitment. Other challenges include ensuring that the allotted funds reach the local level, establishing transparent cost/benefit sharing arrangements among stakeholders; building capacity of local communities to manage crocodile and other species of wildlife in Wildlife Management Areas (WMAs).

7.2 Management Recommendations

The Wildlife Division through community-based conservation programs should work out mechanisms to ensure that the revenue accrue from crocodile harvesting reach the affected groups. The programs should be compatible with local social and biological conditions. Extension programmes should be designed to establish permanent lines of dialogue between Rukwa Game Reserve management (RGR) and local people as well as between the Wildlife Division and the RGR management. These programmes should be combined with those that are designed to educate local communities on the significance of conserving wildlife. While the general level of education is correlated to peoples' attitudes towards wildlife conservation, educational programs specifically designed to teach people about the benefits of wildlife rarely have the intended effect.

The Wildlife Policy and follow-up enabling legislation should be revised to create an institutional structure that reflect active participation of local communities living adjacent to Lake Rukwa in management of Lake Rukwa resources including crocodiles. Community rights to wildlife resources should be promoted and legally enforceable. Community participation should ensure interactive involvement in design, planning, implementation and evaluation of wildlife management activities in the Lake. The legislation should also include effective mechanisms for the sharing of benefits from wildlife resources with communities living adjacent to Lake Rukwa. Differing stakeholder values, attitudes and beliefs should be recognized, embraced and incorporated in the policy-making process and management plan. This may improve relationships among users and reduce the existing conflict.

Documentation at the level of Wildlife Division, District Game offices and local communities of the extent of damages caused by crocodiles should be encouraged and improved. Accurate data on the number of people and their property damaged by crocodile and number of crocodiles killed in defence will facilitate the Wildlife Division to make decisions on the number of crocodile to be harvested, where and when the problem of crocodile more serious. Sound scientific and technical data is essential for creating workable solutions especially in view of requesting quota of crocodile from Conference of the Parties to CITES where survey data and

incidences of human fatalities from crocodiles have to be presented. Improved reporting will also provide a more sound basis for distribution of licenses to kill problem animals.

It was learnt during this study that long experienced fishermen know where and when do crocodile nest and breed. Where egg/hatchling collection for ranching or similar establishment is carried out, local communities especially long experienced fishermen should be involved in order to use their local ecological knowledge in locating breeding and nesting sites. Where shooting of problem crocodiles is conducted, local fishermen should also be involved in identification of problem crocodile to be shot.

The Wildlife Division should establish simple and clear guidelines and procedures for obtaining entry permits to the reserve for fishing by local communities living adjacent to Lake Rukwa. Entry permits to Rukwa Game Reserve should also be checked thoroughly to control the number of fishermen and illegal entry. This will reduce illegal entry which was reported during this study. Limiting the number of fishermen with access rights to fish will benefit local fishermen, fish stocks and crocodiles as disturbances to crocodile habitats will be minimized and presumably reduced competition for fish. This could also be achieved through formation of local association of fishermen in Lake Rukwa. The association could enable them improve their fishing activities, markets and get loans from Government and NGOs for purchasing fishing gears and make their voice heard. Given that the highest incidences of problems with crocodiles is reported among fishermen, this group could be especially targeted both with respect to educational programs and benefits.

The Fisheries Division should collaborate with wildlife division to develop a proper resource management plan for fisheries in Lake Rukwa. The Management plan should provide the fishermen with the opportunity to manage their own fishery and to maintain communal control of access to the stocks. Included in the plan may be the establishment of property rights to the fishery resource by granting limited numbers of fishing licenses and assigning catch quotas to those licenses.

Management of the fishery must be part of a holistic natural resource management strategy. Central to the management of fisheries resource should be understanding the causes of changes in its use. Management must include condition of the social and economic empowerment of local communities. If this is achieved and directly associated with wildlife, it will offset the costs caused by crocodiles and hippos to the local people living adjacent to Lake Rukwa.

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APPENDICES

Note: The questionnaires were also prepared and administered in the national language "Swahili".

Appendix 1: Households questionnaire administered to local communities and fishing camps living adjacent to Lake Rukwa

1. Sex of respondent
2. Occupation
3. Tribe
4. Village/camp
5. District
6. How many people live in this house?
7. How long has the family lived in this village?
8. What is your education level?

No education	Elementary/primary	Secondary	Post-secondary
1	2	3	4

9. What benefits do you get by living near to Lake Rukwa? Please explain the reason for your answer.
10. Does living next to Lake Rukwa cause problems to you and your family?
11. Please explain the reason for your answer in 10 above.
12. Do you fish in Lake Rukwa?
13. If the answer for question 12 is yes, for how long have you been fishing ?
14. Do you think the number of fishermen is increasing or decreasing?
15. Please explain your answer in 14 above
16. Do crocodiles cause problems to you and your family?

Yes	No	Don't know
1	2	3

17. If the answer for question number 16 is yes, what problems?

Kill people	Wound people	Kill livestock/wound	Damage property/nets	None
1	2	3	4	5

18. What other problems caused by crocodiles?

19. How many people have been killed/wounded by crocodiles in your household from 1996 to 2001?

20. What was/were the victim(s) in question 19 doing during the incidence?

Fishing	Herding livestock	Washing	Fetching water	Other
1	2	3	4	5

21. Did you report the incidence in question 19 to the game officials?

22. If the answer for question 21 is yes, what action did they take?

23. How many livestock killed/wounded by crocs from 1996 to 2001?

24. Did you report the incidence in question 23 to the game officials?

25. If the answer for question 24 is yes, what action did they take?

26. Where did the incidences in 16 and 19 above happen?

Inside the lake	Outside the lake	Do not know
1	2	3

27. What do you do if crocodile attack or kill a person/livestock?

Kill the croc	Report to Authority	Do nothing
1	2	3

28. How many crocodiles have been killed/wounded in defence of human life and /or property from 1996 to 2001?

29. At what time of the year is problem crocodile most serious. Why?

30. Do you think there is a conflict between you and crocodiles?

Yes	No
1	2

31. If the answer for 30 is yes, specify the type and cause of conflict.

32. Do crocodiles benefit you and the people in your household?

Yes	No	Do not know
1	2	3

If yes, specify how ?

33. Do crocodiles benefit Tanzania?

Yes	No	Do not know
1	2	3

If yes, specify how?

34. Which species of wildlife are beneficial to you and which species are not? Why?

35. If there is a policy reform, how can crocodile and other species of wildlife be more beneficial to you and to the nation?

36. What does the Department of Wildlife do for the people of this village?

37. What do you suggest as means to remedy the conflict and damage caused by crocodile

Thank you very much for taking your precious time to answer my questions.

Note: The questionnaire was also prepared and administered in the national language "Swahili".

Kiambatisho 1: Maswali kwa wanavijiji na wavuvi waishio kando kando ya Ziwa Rukwa ("Swahili"version)

.1. Jinsia:.....Mwanamke/Mwanaume
2. Kazi/Shughuli zako:.....
3. Kabila lako:.....
4. Kijiji unachoishi:.....
5. Wilaya:.....
6. Je, ni watu wangapi wanaishi katika nyumba yako?.....
7. Ni muda gani familia yako imeishi kwenye kijiji hiki?.....
8. Je, una elimu gani?

Sina elimu yeyote	Elimu ya msingi	Sekondari	Elimu ya juu
1	2	3	4

9. Ni faida gani unapata kwa kuishi karibu na ziwa Rukwa? Tafadhalieleza sababu ya jibu ulilotoa.....
10. Je, kuishi kwako karibu na ziwa kinakuletea matatizo gani? Wewe na familia yako?
11. Tafadhali toa sababu kwa jibu lako katika swali namba 10
.....
12. Je, unavua katika ziwa Rukwa?
13. Kama ndiyo, ni kwa muda gani umekuwa ukivua ziwani?
.....
14. Je unafikiri idadi ya wavuvi inaongezeka au inapungua?
15. Tafadhali eleza sababu kwa jibu ulilotoa katika swali namba 14
.....
16. Je, mamba wanaleta matatizo kwako na familia yako?

Ndiyo	Hapana	Sifahamu
1	2	3

17. Kama jibu la swali namba 16 ni ndiyo ni matatizo gani?

Kuua watu	Kujeruhi watu	Kuua mifugo/Kujeruhi	.....Kuharibu mali/nyavu/mitumbwi
1	2	3	4

18. Je, ni matatizo gani mengine yanayosababishwa na namba?

.....

19. Je, ni watu wangapi katika nyumba yako wameuawa au kujeruhiwa na mamba tangu mwaka 1996 hadi 2001.

.....

20. Je, ulitoa taarifa kwa afisa wanyamapori kuhusu tukio la swali nambari 19?

21. Kama jibu la swali nambari 20 ni ndiyo, je, afisa wanyamapori alichukua hatua gani?

.....

22. Je, ni mifugo mingapi imeuawa au kujeruhiwa na mamba tangu 1996 hadi 2001

Mwaka	Mifugo uawa	Mifugo jeruhiwa
1996		
1997		
1998		
1999		
2000		
2001		

23. Je, ulitoa taarifa kwa afisa wanyamapori kuhusu tukio hilo la swali nambari 22?

24. Kama jibu ni ndiyo, je, afisa huyo alichukua hatua gani?

.....

25. Ni mahali gani ambapo tukio la swali nambari 19 lilipotokea?

Ndani ya ziwa	Nje ya ziwa	Sifahamu
1	2	3

26. Wakati wa tukio hilo la swali nambari 19 mtu huyo alikuwa anafanya nini?

Anavua samaki	Anachunga mifugo	Anafua nguo	Anachota maji
1	2	3	4

27. Je, ni hatua zipi mnachukua endapo mtu amekamatwa na mamba?

Ua mamba	Toa taarifa kunakohusika	Sifanyi kitu
1	2	3

28. Je, ni mamba wangapi wameuawa katika kulinda maisha yenu na mali zenu tangia mwaka 1996 hadi 2001?

Mwaka	Mamba uawa	Mamba jeruhiwa
1996		
1997		
1998		
1999		
2000		
2001		

29.Ni wakati gani wa mwaka ambapo tatizo la mamba ni kubwa zaidi? kwa nini?

.....

30. Je, unafikiri kuna migogoro na migongano kati yako na mamba?

Ndiyo	Hapana
1	2

31. Kama jibu ni ndiyo katika swali namba 30 taja aina na chanzo cha migogoro/migongano hiyo.....

32. Je, mamba wanafaida kwako na familia yako?

Ndiyo	Hapana	Sifahamu
1	2	3

Kama ndiyo eleza ni vipi unafaidika na mamba hao?

.....

33. Je, mamba wanafaida yoyote kwa nchi ya Tanzania? .....

Ndiyo	Hapana	Sifahamu
1	2	3

Kama jibu ni ndiyo, eleza ni vipi Tanzania inafaidika na mamba

.....

34. Ni aina zipi za wanyamapori ni za manufaa kwako na aina zipi siyo za manufaa kwako. Eleza kwa nini?

.....

35. Ni jinsi gani mamba na wanyamapori wengine wanaweza kuwa wa manufaa kwako

.....

36. Je, Idara ya wanyamapori imewafanyia nini watu wa kijiji hiki?

.....

37. Toa maoni yako mengine kuhusu tatizo la mamba na uhifadhi wanyamapori kwa ujumla .....

Ahsante kwa kutumia muda wako muhimu katika kujibu maswali yangu.

Appendix 2: Questionnaire administered to crocodile ranchers

1.What is the name of your company?

2. How many people employed by your company?

3. Do you employ people from the local communities? If yes, how many?

4.What made you get involved in crocodile ranching?

5. Do you think wild crocodiles are beneficial to you? How?

6.What benefits do you contribute to the conservation of wild crocodiles?

7. How many hatchlings /eggs have you captured /collected from 1996 to 2001?

8. How many wild adult crocodiles have you killed as problem animals from 1996 to 2001? Can you identify a problem crocodile? If yes, explain how.

9. How many people have been killed/wounded by crocs in your company from 1996 to 2001?

10. Do you think hunting of wild crocodiles and collecting of hatchlings reduce problem crocodiles in the Lake?

11. What are the reasons for the conflict between local people living adjacent to the lake and crocodiles in Lake Rukwa?

12. Does this conflict affect the possibility to carry out ranching in the area?

Thank you very much for taking your precious time to answer my questions.

Kiambatisho 2: Maswali kwa wafugaji wa mamba mkoani Rukwa ("Swahili" version)

1. Jina la kampuni
2. Je kampuni yako imeaajiri watumishi wangapi?
3. Je, unaajiri watumishi kutoka katika jamii ya wenyeji? Kama jibu ni ndiyo ni wangapi umeajiri?
4. Ni kitu gani kilikufanya ujishughulishe na ufugaji wa mamba?
5. Je unafikiri mamba wana faida kwako? Kwa jinsi gani?
6. Je, unachangia vipi katika uhifadhi wa mamba wa porini?
7. Ni kiasi gani cha vifaranga/mayai ya mamaba umekusanya kutoka porini kutoka mwaka 1996-2001?
8. Ni mamba wangapi wakubwa ambao wanasababisha uharibifu wa maisha ya binadamu na mali zao umeua/vuna kutoka mwaka 1996-2001. Je, unaweza kutambua mamba anayeleta uharibifu? Kama jibu ni ndiyo eleza ni vipi?
9. Ni watu wangapi wameuawa/jeruhiwa na mamba katika kampuni yako kutoka mwaka 1996-2001?
10. Je unafikiri uwindaji wa mamba waharibifu na ukusanyaji mayai/vifaranga unasaidia kupunguza tatizo la mamba waharibifu katika Ziwa Rukwa?
11. Taja aina na chanzo cha migogoro/migongano kati ya wanavijiji waishio kando kando ya Ziwa Rukwa na mamba.
12. Je, migogoro/migongano iliyopo kati ya wanavijiji waishio kando kando ya Ziwa Rukwa na mamba inaathiri shughuli zako za ufugaji mamba?

Ahsante kwa kutumia muda wako muhimu katika kujibu maswali yangu.

Appendix 3: Questionnaire administered to District Game Officers

1. Name of the District
2. Is crocodile a problem in your district? If yes, what problems?
3. What are the causes of human-crocodile conflict in Lake Rukwa?
4. How many people have been killed/wounded by crocodiles in your district from 1996 to 2001?

5. Did they report the incidence in question number 4 to you? If yes, what action did you take?

6. How many livestock killed/wounded by crocs from 1996 to 2001?

7. Did they report the incidence in question number 6 to you? If yes, what action did you take?

8. Where did the incidences in 4 and 6 above happen?

Inside the lake	Outside the lake	Do not know
1	2	3

9. What was the victim doing during the incidence?

Fishing	Herding livestock	Washing	Fetching water	Other
1	2	3	4	5

10. What do you do if crocodile attack or kill a person/livestock?

Kill the croc	Compensate	Do nothing
1	2	3

11. How many crocodiles have been killed/wounded in defence of human life and /or property from 1996 to 2001?

12. How do you identify a problem crocodile?

13. At what time of the year is problem crocodile most serious. Why ?

14. Do you think the population of crocodiles is increasing or decreasing? Please explain your answer

15. Do you think the number of fishermen is increasing or decreasing? Please explain your answer

16. Do you think there is a conflict between local communities adjacent to Lake Rukwa and crocodiles?

1	2
Yes	No

If yes, specify the type and cause of conflict.

17. What is your opinion about human-crocodile conflict in your district?

18. How do local communities benefit from conservation of crocodiles in Lake Rukwa?

Thank you very much for taking your precious time to answer my questions.

Kiambatisho 3: Maswali kwa maafisa wanyamapori wa wilaya ya Mpanda na Sumbawanga ("Swahili" version)

1. Jina la wilaya
2. Je, mamba wanaleta matatizo katika wilaya yako? Kama ndiyo ni matatizo gani?
3. Nini chanzo cha migogoro/migongano kati ya binadamu na mamba katika Ziwa Rukwa?
4.Je, ni watu wangapi wameuawa/jeruhiwa na mamba katika wilaya yako kutoka mwaka 1996-2001?
5.Je, wanajiji walitoa taarifa ya tukio hilo la namba 4 kwako. Kama jibu ni ndiyo ulichukua hatua gani?
6.Je, ni mifugo mingapi imeuawa/jeruhiwa na mamba katika wilaya yako kutoka mwaka 1996-2001?
7.Je, walitoa taarifa kwako? Kama jibu ni ndiyo je, ulichukua hatua gani?
8. Ni mahali gani ambapo tukio la swali nambari 4 na 6 lilipotokea?

Ndani ya ziwa	Nje ya ziwa	Sifahamu
1	2	3

9. Wakati wa tukio hilo la swali nambari 4 mtu huyo alikuwa anafanya nini?

Anavua samaki	Anachunga mifugo	Anafua nguo	Anachota maji
1	2	3	4

10. Je, ni hatua zipi unachukua endapo mtu ameuawa/jeruhiwa na mamba?

Ua mamba	Toa fidia	Sifanyi kitu
1	2	3

11. Je, ni mamba wangapi wameuawa/jeruhiwa katika kuokoa maisah ya binadamu na mali zao kwa kipindi cha mwaka 1996-2001?
12. Je, ni jinsi gani unavyomtambua mamba mharibifu wa maisha ya binadamu na mali zao?
13. Ni wakati gani wa mwaka ambapo tatizo la mamba ni kubwa zaidi? Kwa nini?
14. Je, unafikiri idadi ya mamba katika Ziwa Rukwa inaongezeka au inapungua? Tafadhali eleza sababu za jibu ulilotoa.
15. Je, unafikiri idadi ya wavuvi katika Ziwa Rukwa inaongezeka au inapungua. Tafadhali eleza sababu za jibu ulilotoa.
16. Je, unadhani kuna migogoro/migongano kati ya wanajiji waishio kando kando ya Ziwa Rukwa na mamba?

Ndiyo	Hapana
1	2

Kama jibu ni ndiyo taja aina na chanzo cha migogoro/migongano hiyo.
17. Nini maoni yako kuhusu migogoro/migongano kati ya wanajiji hao na mamba katika Ziwa Rukwa.
18. Ni jinsi gani wanavijiji waishio kando kando ya Ziwa Rukwa wanavyofaidika na uhifadhi wa mamba?

Ahsante kwa kutumia muda wako muhimu katika kujibu maswali yangu.

Appendix 4: Questionnaire administered to District Fisheries Officers concerning fishing activities in Lake Rukwa (English version)

1 Name of district

2. Do you think the number of fishermen is increasing or decreasing? Please give reasons for your answer.

3 Do you think the fish stocks are increasing or decreasing? Please give reasons for your answer.

4. Which fish species are commonly caught from Lake Rukwa?

5. How many tonnes/kilograms of fish have been caught from Lake Rukwa during the period 1996-2001?

6. What was the value of the fish caught in question 5 above?

7. What amount of money was collected as Government tax from the fish caught in question 5 above?

8. How many people/fishermen were granted licenses and involved in fishing in Lake Rukwa during the period 1996-2001?

9. What are the problems fishermen encounter in your district? How do you help them in solving those problems?

10. Give opinions on how to improve fishing industry in Lake Rukwa in order to make it sustainable.

Please fill in this Table for questions number 4, 5, 6, 7,and 8 above.

Year	Fish species Caught	Annual Catches (kgs)	Value of catches (Tshs)	Tax paid to Governme nt (Tshs)	Number of fishermen
1996					
1997					
1998					
1999					
2000					
2001					

Thank you very much for taking your precious time to answer my questions.

Kiambatisho 4: Maswali kwa Maofisa uvuvi wa wilaya kuhusu shughuli za uvuvi katika Ziwa Rukwa ("Swahili" version)

1. Wilaya.....
2. Je, unafikiri idadi ya wavuvi katika ziwa Rukwa inaongezeka au inapungua? Tafadhali eleza sababu kwa jibu ulilotoa.
3.Je, unafikiri idadi ya samaki ziwani inapungua au inaongezeka? Toa sababu kwa jibu lako.....
4. Ni aina zipi za samaki zinazovuliwa kwa wingi kutoka katika ziwa Rukwa? (Tafadhali jaza jedwali hapo chini).
5. Je, ni kiasi gani cha samaki kimevuliwa kutoka ziwani kwa kipindi cha mwaka 1996 hadi 2001? (Tafadhali jaza jedwali hapo chini).
6. Je, samaki waliovuliwa katika swali namba 5 wanathamani ya shilingi ngapi za kitanzania kwa kila mwaka? (Tafadhali jaza jedwali hapo chini).
7. Je, ni kiasi gani cha fedha kimekusanywa na serikali kama ushuru kutokana na uvuvi kwa kipindi cha mwaka 1996 hadi 2001? (Tafadhali jaza jedwali hapo chini).
8. Je, ni watu wangapi waliojishughulisha na uvuvi kutoka katika wilaya yako kwa kipindi cha mwaka 1996 hadi 2001? (Tafadhali jaza jedwali hapo chini).
9. Je, ni matatizo gani yanayowapata wavuvi katika wilaya yako? Je, Unawasaidia vipi katika kuyatatua?

.....

10. Toa maoni yako kuhusu namna ya kuboresha shughuli za uvuvi katika ziwa Rukwa ili kuufanya uwe endelevu.

.....

.....

Tafadhali jaza jedwali hili kwa swali namba 4,5,6,7 na 8 hapo juu.

Mwaka	Aina ya samaki	Kiasi kilichovuliwa/tani	Thamani (Tshs.)	Ushuru serikalini	Idadi ya wavuvi/watu
1996					
1997					
1998					
2000					
2001					

Ahsante kwa kutumia muda wako muhimu katika kujibu maswali yangu.