THE SOCIO–ECONOMIC IMPACTS OF LAND-USE AND LAND-COVER CHANGES IN LAKE RUKWA VALLEY, RUKWA REGION, TANZANIA

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN MANAGEMENT OF NATURAL RESOURCE FOR SUSTAINABLE AGRICULTURE OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

2021

ABSTRACT

Lake Rukwa valley is endowed with various natural resource such as wetland, Lake Rukwa, Ilemba and, Mbizi forest reserve, Rukwa and Uwanda game reserve with abundant helium gas which has been recently discovered. Presence of these natural resource leads to a number of challenging factors which underpin sustainable management and utilization of natural resources. The objective of this study was to identify land-use cover practice and socio-economic activities, to analyse the land-cover changes (LCC) and to determine the influence of LULCC on the socio-economic activities in Lake Rukwa Valley. Random sampling was employed in this study by interviewing 30 households in each village of the four chosen villages of Ilanga, Mtowisa B, Kisa and Ilemba B. Sampling frame were drawn from village book registry, key informant, focus group discussion and interviews with governments official and village leaders. Data were collected using semi-structured questionnaire with an open-ended question while land-use and land-cover changes were determined using satellite imagery for the two epoch of 1995 to 2020 years. The imagery downloaded were analyzed using computer Arc View program with a combination of GIS programs while socio-economic data associated with LULCC were analyzed using descriptive statistics was applied to obtain frequencies and percentages, then cross-tabulation was performed, chi-square test was used to determine the significance level between the data obtained and the trend of land use and land cover changes in Lake Rukwa Valley. The results revealed that there is significant changes in land-use classes at a study area as $p < 0.05$, therefore study concluded that there is a long term association between land-use and land-cover changes in Lake Rukwa Valley. Thus the study recommended that, there is a need of policy makers, district land planner's to take measure in maintaining sustainable resource utilization to minimize and maintain land cover changes in Lake Rukwa Valley.

DECLARATION

I, MCHOME NICHOLAUS do hereby declare to the senate of Sokoine University of Agriculture that this Dissertation is my own original work done within the period of registration and that it has neither been submitted before nor being concurrently submitted to any other institution.

_____   _____

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 (MSc. Candidate)

The above declaration is confirmed by;

_____   _____

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ACKNOWLEDGMENTS

I would like thanks the almighty Lord for granting me good health and energy that enabled me accomplishing this work. Secondly, I thank my supervisor Prof. G. C. Monela of Department of Forest and Environmental Economics for his support during the proposal writing and completion of my dissertation reports. Many thanks go to Dr. Greyson Z. Nyamoga, the Head of Department of Forest and Environmental Economics whose initiative and support as enables me through my dissertation during data analysis and report writing. Apart from their guidance, many thanks go to Dr. L. P. Lusambo who devoted his time and energy to assist me in accomplishing my work. I would like to express my gratitude for their constructive criticism with tireless encouragement during proposal writing and reports writing. Many thanks also go to Dr. Andrew Malekani and Mr Saimon Chidodo who assisted me in data analysis.

I am deeply grateful to the Rukwa Regional Administrative Secretary for allowing me to attend Master studies. Many thanks goes to Rukwa Regional Secretariat technical staff Mr. Ocran Chengula, the Assistance Administrative Secretary (AAS) of Economic and Productive Sector Section (EPSS), Dr. Rogathe Malabeja, and Mr. Kassim Shekilango without forgetting Mr. Dennis Maghala, Mr. Chande Juma and Hilda Mudu from Sumbawanga District Council for their assistance during my research. My sincere thanks should go to the Ward Executive Officer, Village Executive Officer and Village Chairperson of Muze (Ilanga), Mtowisa (Mtowisa B) Milepa (Kisa) and Ilemba (Ilemba B) for their assistance, guidance during field work and support by ensuring this work succeeded during data collection.

Lastly my special thanks should go to my wife and children's and my brothers for their moral support and patience during my studies and enables me to meet my goal.

DEDICATION

This work is dedicated to my mother who devoted her entire life in raising and educating me, my wife, beloved brothers for their endurance during my studies. May God bless them.

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LIST OF ACRONYMS AND ABBREVIATIONS

DAICO   District Agricultural and Irrigation Cooperative Officer

DC   District Council

DFsO   District Fisheries Officer

DGP   Gross Domestic Product

FAO   Food and Agriculture Organization

FDG   Focus group discussion

GIS   Geographical Information System

GLOVIS   Global Visualization Viewer

LGAs   Local Government Authorities

LULC   Land-use and Land-cover

LULCC   Land-Use and Land-Cover Changes

NAFORMA   National Forest Resources Monitoring & Assessment of Tanzania Mainland

NBS   National Bureau of Statistics

NEP   National Environmental Policy

NGO   Non –Government Organization

RAS   Regional Administration Secretary

RS   Regional Secretary

SPSS   Statistical Package for Social Science

SSA   Sub Saharan Africa

TZS   Tanzanian Shillings

UNDP   United Nations Development Programme

URT   United Republic of Tanzania

USAID   United States Agency for International Development

VEO   Village Executive Officer

WEO   Ward Executive Officer

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background information

Land-use and land-cover changes are the major key factors which associated with human activities and had impacts on the natural environment (Nkony*a et al*., 2016; Matano *et al*., 2015; Mngube *et al.,* 2019 and Rovani *et al.,* 2020) however the presence of various natural resources play an important role in people's livelihoods, however rapid growth, scarcity of land, the need for more food production and changing of technologies exert pressure on land-use and land-cover changes resulted in biodiversity loss and land degradation henceforth compromising the value of ecosystem services around the world (Kariuki*, et* al*.,* 2016 and Nicholas *et al.*, 2017). According to Misana, (2003); Seki *et al.,* (2017); Prins, (1987) and Bailey *et al.*, (2015), the decline in biodiversity is caused by removal of vegetation cover which associate with shift from one form of land-cover to another.

On the other hand, Mtu*i et* al. (2017) and Ninna (2017) shows that the presence of high densities of large herbivores, variation of precipitation, and high density of population causes an increase of human activities which in turn tends to have impacts in species fragmentation and degradation as a results of conversion of grassland to woodland or woodland to grassland. These changes have been identified as a major global challenge since the 20th Century and will continue to remain high on the International Agenda in the 21st Century (Lupal*a et al*., 2015; Matan*o et* al., 2015; Mtui *et al*., 2017). Bai *et al.,* (2008) described that land degradation is increasing in severity and extent in many parts of the world in association with various land-uses allocation. Empirical evidence indicates that more than 20% of all cultivated area, 30% of forest and 10% of grassland is

undergoing degradation. However, Alice *et* al. (2016) arguing that, based on available global data, approximately forest cover has been declining by 16.1 million hectares per year since 1990s due to expansion of villages and production particularly shifting cultivation and pastoralism.

However, over the last half – century in East African countries, there has been a rapid change of land-uses due to anthropogenic activities in expenses of natural vegetation (Maitim*a et al.,* 2009). Land transformation is fueled by high demand for agricultural products for the sake of improving food security in the households and generating income through land expansion for production to maximize the total yield gained per acre in a particular planting season (Ogechi and Hunja 2014; Kariuki *et al.,* 2016). These changes depend on population growth and density in a particular areas and differ in degree and magnitudes depending on the interactions with other factors.

In Rukwa region, human activities have notable effects and implications on the types of land cover (Sek*i et* al., 2017). The utilization of riparian land for economic development has significantly impacted critical catchment areas of Lake Rukwa Valley (Rizk and Rashed, 2015). Overutilization of resource in this areas with low production has altering the ecological system by threatening production capacity of the agro-ecological zone and undermine sustainable management and utilization of natural resource by affecting local communities residing in Lake Rukwa Valley (Paradzayi and Ruther, 2004). The Lake Rukwa Valley possesses a multiple resources for various socio-economic activities including culture, tourism, fishing, transportation, livestock keeping, and agriculture where the latter is the most important sector employing about 80% of the population and contributing about 70% of GDP (Charles, 2004). The ongoing human movement both

immigration and internal population growth has induced intensive resource utilization at unprecedented rate (Renny, 2012).

However, scant assessment of land-use and land-cover changes have been conducted specifically in Lake Rukwa valleys to quantify the extent of changes and the impacts it has on various ecosystems. Thus this research aims to assess the spatial and temporal dynamics of land-use and land-cover changes in Lake Rukwa Valley and provide remedies for sustainable management and conservation of natural resources.

1.2 Statement of the problem

Lake Rukwa Valley is endowed with various natural resources such as wetland, Lake Rukwa, Ilemba forest reserve, Uwanda game reserve and Mbizi forest reserve (URT, 2014; Mwinuka *et al.,* 2015). The existence of abundant natural resources has attracted likelihood exploitation of resources at various degree from high to low competitive area with the accessible resources like fishing, farming, livestock keeping and marine and road transport (Rizk and Rashed, 2015; Mulat*u et* al., 2019). About 80 % of the population from Lake Rukwa Valley derive their livelihood from agriculture through farming and livestock keeping (Mwinuka *et al*., 2015). Apart from depending from agriculture to derives their living but also off-farm activities such as transportation of produced goods, casual labour, fish vendors and small and medium enterprises.

The socio-economic activities practiced by people residing adjacent to Lake Rukwa Valley has affected resources utilization through various means including land modification (Mulatu *et al*., 2019). However, land-use and land-cover changes brought both positive and negative socio-economic and environmental consequences in the study area (Lambin, 2010 and Jama*l et* al*.,* 2020). Despite presence of various policy (land

policy, water policy, forest policy and environmental policy) and strategies in land management and utilization in the study area is still a problems and Reversing these conditions will require other means or techniques of land utilization in crop production to increase yields and sustainable land resource utilization. Thus this research aims at helping the land-use planners, policy makers, different practitioners and communities in the region to identify and execute site specific best management practices to bring sustainable land-use within the permissible limit at national and local environments.

1.3 Objectives of the study

1.3.1 Overall objectives

The main objective of this study was to analyse the pattern and drivers of land-use and land-cover changes, and its socio-economic impacts in Lake Rukwa valley.

1.3.2 Specific objectives

Specifically objectives of the study were to:-

i. Identify land use cover practices and socio-economic activities in Lake Rukwa Valley

ii. Analyse the land-cover changes in Lake Rukwa Valley for the period 1995s to 2020s.

iii. Determine the influence of Land-use and Land –cover changes on the socio-economic activities in Lake Rukwa valley.

1.4 The study hypothesis tested

Ho_1: Increase in human activities has no relationship between the socio-economic impacts in land-use and land-cover changes in Lake Rukwa Valley.

Ho_{II}: Land-use and land-cover changes has no relationship between resource utilization and its socio-economic impacts in Lake Rukwa Valley

1.5 Significance of the study

Since the study contained an updated information on the socio-economic impacts of Land-use and land-cover changes in Lake Rukwa Valley, it will help communities living in Lake Rukwa Valley to understand the current status of land-use and land-cover changes as well as how to adopt measures to solve the problem. Also, the study also will provides information to intellectuals, academicians especially researchers who could use the study findings for further studies or investigation on the socio-economic impacts of land-use and land-cover changes in Lake Rukwa Valley. Moreover, the study helped forest policymakers in Tanzania, to update if not create and reinforce policies that would conserve the resources at Lake Rukwa Valley. It would act as a wake-up call for land, fisheries, and forest policymakers in Tanzania to see the urgent need of creating policies that would safeguard the existence of Lake Rukwa Valley.

1.6 Organization of the Dissertation

This dissertation has been organized into five chapters. Chapter one gives an introduction of the work by providing the background information on land-use, land-cover changes around the world and across the study area as well as introducing the aim of the research in the study area. Chapter two provides a detailed review of various findings related to land-use and land-cover changes and their socio-economic impacts on the Lake Rukwa Valley and other similar areas. Undertaking content analysis of the changes in the existing land use and extent of land cover changes was one of the important agro-ecological ecological knowledge for understanding some of the socio-economic and ecological processes and systems within Lake Rukwa Valley. Chapter three, explains the

methodology used in collecting various information as well as data analysis techniques and tools relevant for addressing the specific objectives of this research study.

The detailed finding and discussion of the research as well as the interpretation of the analysis are provided in chapter four. Chapter five discussed the summary of the results on the land use and land cover changes and their socio-economic impacts on the Lake Rukwa Valley and it provides the conclusions and recommendations to enhance the role of land in the Lake Rukwa Valley and socio-economic growth of the riparian community in Lake Rukwa.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Definition of Terms

Land use; It refers the process of molding the land another use done by human. This includes turning natural ecosystem to economic and cultural activities (e.g. agricultural, residential, industrial, mining and recreation uses) that are practiced at a given places.

Land-cover changes; it's defined as the loss of natural vegetation which leads to land transformation particularly loss of forest to settlement or the loss of agricultural land to industrial area.

Land transformation; involves the modification of natural environment into built area such as settlement, arable land and grazing area. Involves alteration of land forms.

Natural resources; these are resources that are naturally exist without any actions of humankind e.g mineral, forest, land water wildlife etc. This resources may be used for commercial purposes and for economic gain.

Population; refers to the number of people in a single area whether it be a city or town, region, country or the world.

Riparian; the riparian are lands that are found along watercourses and water bodies. The good examples includes lakes, floods plains and stream banks. They are distinctly different from surrounding lands due to its uniqueness in soil and vegetation characterized and strongly influenced by the presence of water.

Socio-economics; the term socio-economic refers to the interaction between the word social and economic of which involves the habit of certain group of people like farmers or pastoralist of fishermen. Socio-economic links agricultural/fishing activities and social issues that influence the economy.

Sustainability; It refer to the long term ability of the resources to meet the basic needs without compromising the ability of future generations. In addition to natural resources we also needs social and economic resources. Sustainability is not just environmentalism, it 'also address social equity and economic development.

Livelihoods; It is defined as a set of activities essential to everyday life that are conducted over one's life span. Such activities could include securing water, food, fodder, medicine, shelter and clothing. It encompasses people's capabilities assets, income and activities required to secure the necessities of life.

Ecosystem services; these are output, conditions or things that nature does directly or indirectly and benefit humans or enhance social welfare. They include various services provided by natural systems such as wild food and clean water regulation, climate regulation, natural medicine, disease regulation, air quality and climate, supporting the pollination of crops and soil formation and providing recreational, cultural and spiritual benefits.

2.2 The concepts of socio-economic impacts of land-use and land-cover changes

The concern of different definitions used in land-use and land-cover and lack of soil nutrient in crop production were among the factors draw attention to different scientists and wining the top decision maker and policy maker in the worlds (Toh *et al.,* 2018) differentiate between land- cover (i.e. whatever can be observed such as grass, building) and land-use (i.e. the actual use of land types such as grassland for livestock grazing, residential area).

However, a brief explanation about these two terms is provided in this section from the Encyclopedia of Earth (Ellis and Pontius, 2007). In general, the term land- use and land -

cover change (LULCC) identifies all kinds of human modification of the Earth's surface. Land cover refers to the physical and biological cover over the surface of land, including water, vegetation, bare soil, and/or artificial structures (Ellis and Pontius, 2007). Land-use has a complicated expression with different views compared with the term land-cover. Definition and description of land-cover, land-use and land- use change vary with the purpose of the application and the context of their use. The land-cover is the biophysical state of the earth's surface and immediate subsurface (Turner, 1995; Yeboah *et* al., 2017) while the land-use denotes the human employment of the land and land-cover type. Land-cover and land-use change mean changes in structure and function (qualitative) and change in the areal extent (quantitative) of a given type of land-use or cover (Set*o et* al., 2004). Furthermore, land-cover changes increase pressure to the limited available resource by altering from one cover type to another, and these modifications increase cost of production on resource utilization as they pose serious threats to the environment (Nichola*s et al*., 2018). The reason why the linkage between land-use and land -cover change is emphasized is that the environmental impacts of land-use change and their contribution to global change are mediated to a considerable extent by land-cover change (Briassoulis, 2007). Thus, their analysis needs the examination of how land-use relates to land-cover change at various levels of spatial and temporal detail. Local-level land-use change may not produce significant local land-cover change (and consequently, no significant environmental impact). However, they may accumulate across space and/or overtime and produce significant land-cover change at higher (e.g. regional, national, or global) levels (Briassoulis, 2007).

2.3 Land-use and land-cover changes in Tanzania

Tanzania is one of the countries experiencing overexploitation of the land resources. Most common is deforestation through extensive cultivation and overgrazing Yanda

(1997). The process has been aggravated by for example land clearing for both small and large scale farming, procurement of building materials, clearing vegetation during tsestefly eradication, and bush fire. As resource declining caused by population increasing, conflict arises between resource users (domestic animals, wildlife, and human) (Rondea, 2018). In Tanzania, land resources account for 30% of forested land, while the remaining 70% mostly miombo woodlands which are village and general lands with very limited protection (Luoga, 2003). Recent use and land-cover change estimates show an overall decline of vegetation cover at the regional and global scales caused by multiple social, cultural, and economic factors (Nzunda, 2011). There is an overall concern on the prevailing land-use practices, such as shifting cultivation and extraction of forest materials as agents of forests losses, but also new, emerging land-uses are threatening vegetation cover (Thomas *et* al., 2014). Understanding of the long-term development and driving forces of forest changes are needed, especially at local levels where many decisions on forest policies and land uses are made (Kashaigili, 2006).

2.4 Research gap

The available data on land use and land cover changes and their socio-economic impact in Lake Rukwa Valley are scant and on the other hand they do not complement each other (Baland, 1996; Young, 2014). The study conducted by (Sanz, 2007; Beumer C and Martens, 2013 and John, 2016) provide a solution based on agroforestry practices and agricultural conservation strategies without a deeper understanding of how land use and land cover changes affects socio-economic livelihoods of the Lake Rukwa Valley. This may have contributed to an underestimation of the potential impacts of land-use and land-cover changes and how this can be used to conserve the land and other resources and ensure its sustainability along the shore of Lake Rukwa Valley. Therefore, by assessing

an in-depth understanding of the land-use and land-cover changes and its socio-economic impacts along Lake Rukwa Valley, this study will contribute to the provision of sufficient information for filling this knowledge gap and thereby contributing to national efforts towards land conservation, reduction of deforestation practices, enhancement of land and forest cover increase and mitigating climate change. These practice are in turn expected to help the poor to accumulate capital and investment in employment and generating income through the use of various improved agricultural practices, land and biodiversity conservation strategies.

2.5 Challenges in land-use and cover changes in Lake Rukwa Valley in the Rukwa Region

Rukwa was designated as a food basket in 1976 among the big six productive regions in Tanzania, the central government built warehouses with the aid of USAID. Despite high agricultural potential, support from central governments through supplying agricultural inputs to subsidize production still the region face food shortage (Ntemi and Jerve, 2009). The presence of the large number of livestock influx and abrupt increase in population (immigration) has led to an increase in depletion of land resources for various uses, land fragmentations caused by settlements, culture, and norms of land tenure system has affected land-use and land-cover changes which in turn significantly affects food production in the basin (Ogechi and Hunja, 2014). The use of land resources for various purposes which includes agriculture, settlement, reforestation, ecotourism, and surface, and groundwater etc., crop production in regard to maximizing the total yield gained per acre in one planting season is the main objective of the region. This is aided with the taboo of using animal husbandry land preparation and weeding (Rawa*t et a*l., 2013). This has enabled the valley to produce food that is used in the region and surplus is sold

for cash (URT, 2014). Although the high cost of agriculture inputs has made farming an economical (Ntemi and Jerve, 2009).

Biodiversity conservation has been affected by different land-use and cover changes, isolated protected areas from their surrounding landscape usually face many challenges which in turn identify management opportunities that maintain ecological functions while minimizing restrictions on human land use (Margare*t et a*l., 2017). As pressure increases in hotspot areas, maintaining ecological function has become an option, including preserving crucial habitats and migration corridors and reducing the dependence of local human populations on protected area resources (Mtui *et al.,* 2017).

Land used for agriculture, forestry, and settlements mostly provide food, fiber and other ecosystem services that satisfy immediate human needs (Ru*th et al*., 2004). The hotspot areas which are mostly protected become the host for the important biodiversity like watershed protection, carbon storage, climate amelioration as well as more difficult to quantify cultural services such as recreation and spiritual fulfillment (Ruth *et* al., 2007).

2.5.1 Deforestation

Globally, among the anthropogenic activities which will result in deforestation have been contributing about 12 to 20% of the carbon emitted in the world (Wang *et al.,* 2020). According to NAFORMA report (2015) indicates that, there is several drivers of deforestation in Tanzania which leads in land-use and land-cover changes adhering in forest loss in every year were 403 870 ha which was caused by agricultural expansion, poverty and population growth.

In the country there about 4 million livestock of different types, a part of having such number the livestock population which contribute about 3.2% in the DGP in the country. The industry also create job opportunity for about 3.6% of the total Tanzanian population, the sector also play a major role in economy depends on livestock products, this includes hide and skin, animal dung, horns, milk etc., also animal are used in farming (oxen).

In Rukwa Region, the major causes of deforestation include poverty, tree felling for fish smoking, road construction, agriculture expansion, rapid population growth, massive wood extraction for charcoal making, livestock rearing, and wildfire and other uses, (Julia, 1985; Geist, 2001; Galinato, and Galinato, 2012). Loss of forest cover has disconnecting high values forest and sensitive area which were used by certain animal species as an ecological habitat (Davenport *et al*., 2007; Minke, 2014). The isolation of certain species at particular forest patch due to human invasion in wildlife corridor for economic activities has affected genetic flow as a result of species extinction like in the Uwanda game reserve and *ashy red Columbus monkey* in Mbizi and Mbuzi forest situated in Ufipa escarpment (Davenport *et al.,* 2007; Minke, 2014). The rate of deforestation has affected rural livelihoods by altering soil and water quality and quantity. The change in forest-cover has impacts in lake Rukwa has soil degradation occurs and deposited on lakes which alters lake depth and yield productions.

2.5.2 Population growth (Immigration)

The increase in population in rural areas caused by immigration accompanied by available resources in Lake Rukwa valley has impacted resource utilization. Most of the population are pushed from their home of origin to these precious resources due to pull and push factors (Estes *et* al., 2012)**.** The increased in pressure on resource utilization due to immigration of human being has affected the wetland, water bodies and protected

areas as a result in resource diminishing at alarming rate and some species extinction especially in the settlement which is close to protected areas (*Estes et al.,* 2012; Tian *et al.*, 2016).

2.5.3 Water-related problems

Lake Rukwa Valley is surrounded by several season and annual rivers. The water from the Ufipa escarpment drains its water from the slope of the mountain to the low land where Lake Rukwa is situated. Despite the availability of water in the four studied villages, there is several water-related problems that differ in magnitude and degree in each ward/village. The problems of water utilization have impacted the economic activities in Lake Rukwa Valley as a result of declining yield production, domestic water supply, and livestock keeping due to its availability and accessibility. For example, during the farming season, the household is forced to tap water runoff during the rainy season and diverted to rice farms to facilitate planting activities (Natash*a et al*., 2018; Musa, 2019). These activities have been used as the substitute of irrigation scheme which is not well developed and mostly are locally made and supported by farmers (Han, 2007).

2.5.4 Human-wildlife conflicts

Conflicts arise when different resource users misconceptions among each other due to overlapping of territorial users rights (Mosepel*e et* al., 2015). In Lake Rukwa Valley, conflict arises among fishermen and conservators in the Uwanda game reserve and Rukwa game reserve which is bordered with Lake Rukwa of which part of the area is immensely in water and is used as a fish breeding site however, fishermen, Farmers, and livestock keeper operates in a restricted area while denied access. Since, the conflicts are always associated with the depletion of natural resources in public open access areas while protected areas are abundant with resources and these are caused by a several

factors includes extending anthropogenic activities into protected areas (Anand and Radhakrishna 2017). According to Zakayo (2014), conflict arises when human and wildlife depends on available limited resources to survive in Lake Rukwa which in turn leads to loss of life and property.

However agricultural expansion and livestock keeping have a negative impact in protected areas as the most affected communities are those residing in close to protected areas (Lon*g et al.,* 2019). Threats posed by overutilization of resources escalating the conflict between fishermen, agro-pastoralist, and conservators which endangers the wildlife and sustainability of fishing activities in Lake Rukwa Valley.

2.5.5 Agricultural activities

In Rukwa region agriculture is practiced in three agro-ecological zones, Lake Tanganyika shores, Ufipa Plateau and Lake Rukwa Valley, the three-zone favours different types of crops (URT, 2020). Agriculture is the main economic activity in Lake Rukwa Valley which are entirely practiced and is rain-fed, although irrigation is applied at small scale farming with the purpose of increasing yields in all crops and doubling agricultural productivity through extending the growing season (Yucer and Ayhan, 2020). Most of the farmers who are smallholders, cultivating food crop and cash crop at the poor arable land (Musa, 2019). The increase in pressure on scarce available productive land and water resource has exerted pressure in exploitation of resources which leads to deterioration of ecosystem (Meng *et al.,* 2018). Figure 1 shows the three agro-ecological zone found in Rukwa region.
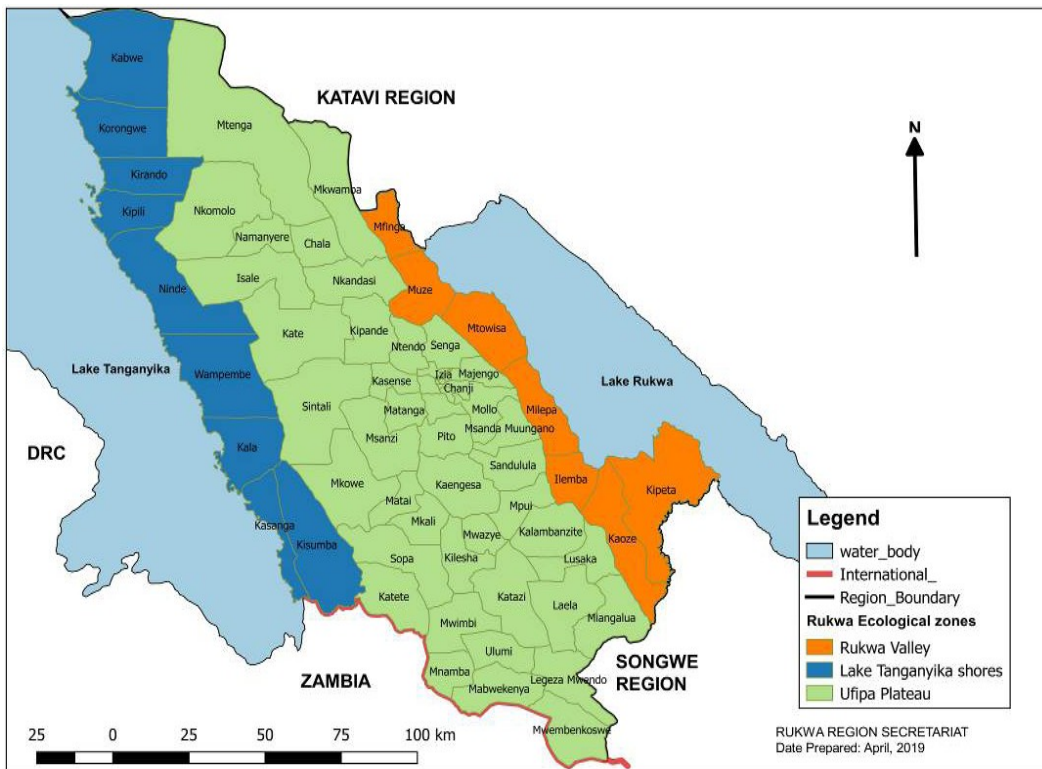
Figure 1: The agro-ecological zone in the Rukwa region

Source: Rukwa Investment Guide (2020)

2.5.6 Land grabbing

The land is a multifunctional resource which is used in different ways as means of production, the most essential is agriculture, and expansion of crop farming and more land for livestock keeping caused by an increase in the market price of land which has made the poor families to be pushed away from productive land to poor and unproductive marginal land which has low soil fertility (Mocanu, Elena, and Mitric, 2018).

Recently land resource in Lake Rukwa Valley has been deprived due to livestock population and rapid human growth, henceforth lack of formalization of land tenure system threatens land utilization at protected areas (Forest reserves and game reserve). Population migration and land abandonment have triggers socioeconomic consequences of resource which are accused of underutilization due to poor conservation and management of protected areas (Bluwstei*n et* al., 2018; Corrales, 2019).

2.6 Theoretical framework on land-use and cover changes

Several theories of land-use changes describe the structure of the change in the use of land from one type to another and to explain why these changes occur, what causes these changes (economic development path) and what are the mechanisms of changes (forest scarcity path) has been developed based on knowledge of the context in Lake Rukwa Valley (Rudel *et al.*, 2005). The theories of land-use changes rely on the more general theoretical framework of discipline studying economics, environmental and spatial changes (or transformation), however this study will use approach that will befit the future use of resource by addressing the key issues that has impacted the resources utilization by improving and maintaining the adaptive capacity to inherent certain socio-ecological systems. Briassoulis, (2007) classified theories of land-use change into three main categories: the urban and regional economic theories, the sociological (and political economy) theories, and the nature-society (or human-nature) theories, which address mainly the human role in causing global environmental change. However the land use change is a result of a complex web of interactions between bio-physical and socioeconomic forces over space and time (Briassoulis, 2007). Rapidly increase in vegetation loss in large areas due to human activities may result in land transformation and loss of natural resource. These transitions may result on regular climate condition (Prasa*d et* al., 2014). Hence, there is a need for a model (land-use change model) which expresses operationally the relationships between the main factors of interest (Turner II *et al.*, 1995).

This study is guided by the theory of the socio-economic impacts as it is assumed to have negative consequences in Land-use and Land-Cover Changes as most of these changes are derived by increasing human activities and not natural processes (Li *et al.,* 2016). Increasing socio-economic activities in the riparian and agro-ecological community

assumed to have negative consequences on land-use, land-cover changes, the physical interaction during resource utilization had impacts on both direction (Mombo, 2018). As suggested by Lambin and Meyfroidt (2010) individual farmers through shifting cultivation and increasing number of livestock per unit areas contribute to increased land-use, land-cover changes which contribute to negative socio-economic impacts in the Lake Rukwa Valley. Farmer's decisions that are made subject to the prevailing farm resource, physical and financial constraints, are often resulting in considerable uncertainty about the changes in the land-use and land-cover. These changes have consequences in the uncertainty with regards to forecasted yields, costs, and prices for the farm resources, yields as well as biodiversity and ecosystem services.

2.7 Conceptual framework

2.7.1 Socio-economic impacts of land-use and land-cover changes

Land-use and land-cover dynamics are widespread, accelerating, and significant processes driven by human actions but also producing changes that impact humans (Toh *et al.,* 2018). These dynamics alter the availability of different biophysical resources including soil, vegetation, water, animal feed, and others. Consequently, land-use and cover changes could lead to a decreased availability of different products and services for humans, livestock, agricultural production, and damage to the environment as well. In Lake Rukwa Valley, the land-use and land-cover changes vary considerably from area to area due to the nature of the agro-ecological zone and human activities (agriculture production, livestock raging, hunting, or fishing).

The traditional management of land-based resources in Lake Rukwa Valley, coupled with a growing interest and reliance on various products and services from the Lake and Valley poses a challenge for managing the forest and lake resources at the same time.

Thus, changes in land-use and land-cover conditions constraints agricultural production, fishing, and livestock raging practices in the region. Inappropriate allocation and utilization, lack of capacity to develop and use poorly accessible water resources, loss of water due to its seasonality, and runoff are some of the problems associated with the water resources in the Valley. Therefore, producing more food under conditions of increasing water scarcity and without creating further environmental degradation is a challenge being faced around the Lake Rukwa Valley.

2.7.1.1 Causes of land-use changes

Land-use/cover changes have long been viewed as continuous and slow but recent studies show that this is not always the case. In the global change newsletter, Lambin and Geist (2001) described land cover change as a disjunct process, with periods of rapid change and often triggered by shock events which if not checked initiates other changes along with the system. Changes in land cover by land use do not necessarily imply a degradation of the land. It might be presumed that any change produced by human use is an improvement until demonstrated otherwise, however, there is a growing concern globally about negative impacts resulting from land-use/cover changes (Meyer, 1995). Though land-use and land-cover changes are usually local and place-specific, their impacts collectively add up to global environmental change, which changes include: desertification, biodiversity loss, global warming, and eutrophication (De Sherbinin, 2002 and Rudel *et al.,* 2005).

The conceptual framework of this study (Figure 2) shows the socio-economic impacts of land-use and land-cover changes in Lake Rukwa Valley. This conceptual framework was developed based on knowledge from various literature such as Lambin and Meyfroidt (2010) and the researcher's firsthand knowledge of the study context. In Lake Rukwa

Valley, land transformation were caused by agricultural expansion, livestock grazing, deforestation and wildfire, however the existing interaction between population and land-use and land-cover changes had impacts on socioeconomic activities (Mombo, 2018). The Construction of the figure is the researcher's idea and it can be observed in figure 2 in box (1.0) that human factors such Shifting cultivation, livestock ranging, deforestation, charcoal, fire, quarrying, fishing and natural factors in box 1.1 such as climate change, wildlife, drought, floods have a direct effect on land-use, land-cover changes which has impacts on ecosystem services, biodiversity loss, loss of soil fertility, water contamination and habitat loss. These changes have direct and indirect negative impacts on the Socio-economic livelihoods such as food insecurity, Land degradation, soil and water contamination. The arrows shows the direction of the effect.

2.7.2 The concept of land-use and land-cover changes

One of the indicators of such change is derived from vegetation status over time. In this study, I focused on the land-use, land-cover changes and assessed the probable socio-economic impacts of these changes on the current status in Lake Rukwa Valley. Understanding both the land-use and land-cover of a track of land provides a comprehensive picture of a particular area. This data is a fundamental component of the planning and decision-making processes for many communities because it helps them to understand better where to plan for different types of growth and where to preserve; it also helps them to understand the connectivity or fragmentation of various features in their community.

Inputs

Process

Outcomes

1.0   Human activities;

Shifting cultivation, livestock ranging, Deforestation, charcoal making, wildfire, quarrying, fishing land tenure system**…....**

3. Socio-economic implication;-

Food insecurity, land degradation, soil and water contamination, poverty**……**

Land- Use and Land- Cover Changes

2. Changes in Land- Cover;-

Reduced ecosystem services, biodiversity loss, loss of soil fertility, water contamination, habitat loss & rainfall reliability**…….**

Contributing to poor management of natural resources and poverty

Decline in land productivity, change of population size and spatial distribution and incidence of migration

1.1 Natural processes;-

Climate change, wildlife extinction, drought, floods**……**

**Figure 2: The conceptual framework model
(Source: Authors idea)**

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the study area

3.1.1 Location

The valley of Lake Rukwa is located in the South-Western part of Tanzania. It is found between the lakes, in the Northwest side of Lake Tanganyika, and on the Southwest side of Lake Nyasa. The Lake Rukwa Valley is located at an elevation ranging from 810 – 2 600 m above sea level (Lake Rukwa Basin, 2016). It's among the three agro-ecological zones found in the Rukwa region with an area of about 650 000 ha. Other ecological zones are the Ufipa plateau and the lake Tanganyika zone (URT, 2014). The water has implication with geomorphology of the landscape, land-use type of the surrounding area, rainfall recharging the areas, slope of the catchment soil and vegetation diversity, all together play a major role in water quality. Anthropogenic activities influencing the water quality as throughout the year the water in Lake Rukwa is alkaline in nature caused by sedimentation of material drained from the slope of the Ufipa escarpment (URT, 2016). The study area support multiple socio-economic activities which includes fishing, farming, casual labour, transportation of goods and services, apart from this activities, also the area has been declared the disease free zone which impacted resource utilization (URT, 2017).

3.2 Vegetation

The vegetation cover found around Lake Rukwa Valley comprises of mainly *Combretum spp,* A*dansonia digitate and, Pterocarpus bussei* which are hardly less frequent in most of the lower slopes. Others species found in the highland grassland are Brachystegia,

Julbernardia, *Bauhinia thoningii, Protea dombeya* while *Acacia Rovumae* occurs occasionally on the lower most slopes Band*a et* al. (2008).

3.3 Topography

Lake Rukwa Valley is found within the Northwest and South East of the Rift Valley system. Its borders Lyambalyamfipa escarpment which extends from the Southwest of the lake with 11 to 40 Kilometer wide. All activities are carried out at lowland zone and the valley is plain with undulating elevation from 800 meters to 2600 meter above sea level where the escarpment is high up at Ufipa Plateau (Charles, 2004; URT, 2012).

3.4 Climate

The valley experiences tropical climate which receives one rainfall in a season typically unimodal which starts from November to April. The mean annual rainfall ranges between 650, mm in low land to 2 500 mm in the highlands. Temperature ranges from 12, ^{0} C in the highlands to 30^0 C in the low lands. Due to slight rainfall variation flooding is common within the valley (URT, 2016).

3.5 Population

According to the National Bureau of Statistics (NBS) the population data projected by the year 2020, the region had a total population of 1 270 049, including 649 861 women and 620 188 men. Based on the 2012 national population census as a benchmark, the Lake Rukwa Valley is estimated to have a population of about 162 557 among 305 846 total Sumbawanga District Council populations compared to 2002s where the valley had 104 073 among 214 979 of the total district populations. Among these, 82% of the population of the Rukwa Region engage in farming activities of various crops including food crops and cash crops. Looking at this data, it shows that, about 53.15% of the

population are residing in the valley which is an increase of about 4.75% (URT, 2013). However 80% of the population lives in the rural areas and only 20% are residing in urban areas (URT, 2016). Changes in land resource utilization attracted a number of people in the study area which raised demand for grazing land, land for settlement and land for agriculture, Figure 3 shows the trend of the population in Lake Rukwa Valley since the 1988s population census.
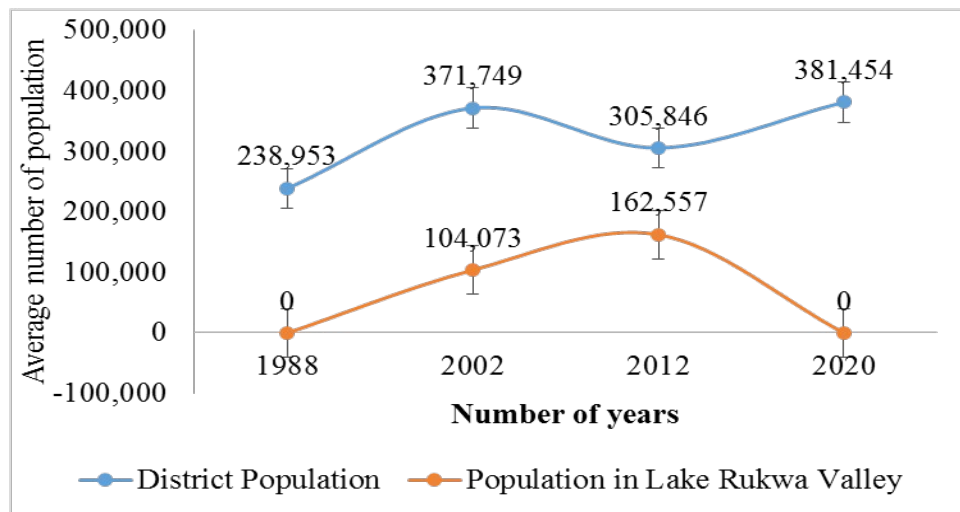
Figure 3: Trend of population growth in Lake Rukwa Valley
Source: URT, (2019)

3.6 Economic Activities

About one-third of the total land areas of the Valley have been and it is continuing to be modified due to high population density and soil degradation occurs as a result of intensification in cultivation and severe grazing (Meyer and Ii, 2014). Despite the existence of the NEP of 1997, and related legislation in Tanzania, land degradation persists. The valley faces many challenges related to land degradation mostly deforestation, inefficient farming practices, livestock overstocking, overfishing, depletion of soil nutrients, land pollution, inappropriate irrigation, and improper utilization of agrochemicals which end up polluting water and threatening aquatic life and biodiversity loss.

However 80% of the livelihoods in Lake Rukwa Valley depends on agricultural (Msigwa, 2018), and the crops grown are simsim (sesame), groundnuts, maize, paddy, rice and cassava, finger millets (URT, 2012). Field experience indicates that the majority of the farmers in the study site use non – mechanized agriculture system. The continuing excessive exploitation of (land, forest, and water) create pressure on this scarce resource. The high exploitation rate is caused by poor access to agricultural inputs which leads to a decrease in crop production (Monela, 1995). The valley has more than 172 701 cattle, 74 463 goats, 15 129 sheep, and 2375 donkeys which contribute only 20% of GDP in the Rukwa region (URT, 2016).

Most of the individual households are involved in off-farm activities to generate income as part of subsidizing agriculture productions apart from fishing, farming, and livestock keeping (Angelo, 2017). During data collection, it was observed that fish vendoring, petty business, brokers, masonry works and carpenters, boats repairing, transporting (marine and roads) and casual labour were the main economic activities undertaken by the communities adjacent to Lake Rukwa.

3.7 Study Design

The cross-section study design was employed in this study which enables to collect data at a particular area at a time. Data collection in this study was carried out in two phases, phase one involved a reconnaissance survey which was conducted to obtain the bigger picture of the study area by pre-testing the questionnaire to check the clarity and meaning of question to be answered by the household head while ensuring they are not consuming time during the study. After the pre-testing of the questionnaire, necessary modification was made to suit locality while phase two includes the field visit with questionnaires to assess the land-use practices and cover changes using a questionnaire.

3.7.1 Sampling procedures

The sampling employed during data collection was applied at a single point at a time involving respondents within the sampled villages. The selected sample for interviews was drawn from village book registry and represent the communities' population at a particular survey area. The four (4) villages were selected out of 24 villages (Muze/Ilanga, Mtowisa/Mtowisa B, Ilemba/Ilemba B, and Milepa/Kisa) which were randomly selected for the study. A total of 126 respondents were interviewed, averaging 30 households were obtained from village book registry. The Sampling frame for the study were drawn from the four selected villages these includes fisherman, farmers, and livestock keepers, influential people, village leaders, governmental officials and entrepreneurs in each sampled village. This study uses precision methods which describes if the study population varies from one village to another, the best methods is to use precision of ± 10% whereby the range of the population varies between 500 and surpass 10 000 (Israel, 2003). Participant observation, focus group discussion and structured questionnaire were also used.

3.7.2 Data collection

The socio-economic data were collected in Lake Rukwa valley. During the survey, the data collected involve economic activities of the communities living around Lake Rukwa Valley and the land-cover changes, the data collected includes satellite imagery downloaded from USGS – GLOVIS (**www.glovis.usgs.gov) for further data analysis and interpretation.**

- **Determine the land cover changes in Lake Rukwa Valley for the period 1995s to 2020s**

The Satellite images for the years 1995s and 2020s with minimal clouds cover was acquired in the study area during the dry season from July to October (Kashaigili, 2006).

i. **Acquisition of selected satellite image**

Proper imagery was acquired while considering clouds cover, the image was taken when the clouds cover is free with an interval of twenty five years from 1995s to 2020s. Table 1 indicates the imagery downloaded from USGS – GLOVIS from September 1995 and October 2020 in the study area. The satellite imagery shows spatial variation and temporal changes of land-use and land-cover in Lake Rukwa Valley.

Table 1:: **Landsat imagery of Lake Rukwa Valley**

Satellite	Sensor	Path/row	Acquisition date	Season	Cloud cover (%)
LandSat 5	TM	170/66	17 September, 1995	Dry	10
LandSat 5	TM	171/66	6 October, 2020	Dry	10

ii. **Preprocessing of Landsat data**

Image pre-processing used in data analysis aimed at correcting distortions of image acquired, degradation and noise obtain during data acquisition (Moik, 1980), and the image obtained will be as similar in character as the original image acquired in the scene. The images layers/bands captured will be imported and layers stacked to the full scene. Both visual and digital image processing methods will be used and subsequent image analysis using SAGA GIS software. The following results were obtained.

a. **Post classification**

Using software of which supervised classification and unsupervised classification was applied and lastly accuracy assessment will be done to compare the imagery acquired are the same as that situated in the ground.

b. Change detection analysis, this methods involved the following formula (Kashaigili and Majaliwa 2010)

$$\% \, Cover \, Change = \frac{Area_{i \, year \, x} - Area_{\, iyearx+1}}{\sum_{i-1}^{n} Area_{i \, year \, x}} \times 100\% \dots\dots\dots\dots\dots\dots (1)$$

$$Annual \, rate \, of \, Change = \frac{Area_{i \, year x} - Area_{\, iyear \, x+1}}{t_{years}} \times 100\% \dots\dots\dots\dots (2)$$

$$\% Annual \, rate \, of \, Change = \frac{Area_{i \, year \, x} - Area_{\, iyear \, x+1}}{Area_{i \, year \, x} \times t_{years}} \times 100\% \dots\dots\dots\dots (3)$$

Where;-

- Area $_{i \, year \, x}$ = area of cover i at the first date,

- Area $_{i \, year \, x+1}$ = area of cover i at the second date,

- $\sum_{n=1}^{\infty} Area_{i \, year \, x}$ is the total cover area at the first and t_{years},

- t $_{years}$ = period in years between the first and second scene acquisition dates.

3.7.3 Reconnaissance survey

A preliminary survey was done to be aware of the study area, this includes gathering general information about the area and the socio-economic activities conducted in the lake Rukwa valley. During the reconnaissance survey, land use practices and socio-economic activities were observed which enables in the selection of villages for data collection.

3.8 Data collection methods

3.8.1 Primary data

The primary data were collected from the four selected villages and included demographic data (family size, marital status, education level, and the family head) and the main economic activities conducted in Lake Rukwa Valley include farming, fishing,

livestock keeping, petty/commercial business, and casual labour. The income and expenditure data were collected with the purpose of determining household income and how they spend their money. Focus group discussions and interviews with key informants were aiding in supplementing the information about the history of their village. The following issues were raised during data collection;-

i. The supply of improved seeds and pesticides which are lately delivered, but if delivered in time some of so called improved seed and pesticides lack the quality hence had impacts on yield production.

ii. Lack of knowledge on land resource utilization based on fertilizer application. Some of the land owner disapprove application of industrial fertilizer has they believe artificial fertilizer destroys the soil of which impacted on yield production.

iii. Farmers, proposed to be linked by financial institutional in order to expand area of production (contract farming),

iv. Lack of market information leads to decrease in production capacity

v. Fisheries propose to be supplied with fishing gears to enable them fishing in high deep water compared to present situation whereby fishing are taking place in the lake shore and capacitated in fish farming/aquaculture.

vi. Lack of land tenure system, land right is one of the factor affecting crop production as land rent/borrowers are not allowed to plan what crop or plant at a particular season, which anticipated to have low yields in case of climate changes.

vii. Land degradation caused by population influx which leads to demand more land for farming, settlement and grazing. Intensively land uses, the more is exposed to degradation has forest is cleared for farming, and livestock keeping and unplanned settlement hence biodiversity loss.

3.8.1.1 Direct observation

Data collected in this scenario includes daily activities practiced in Lake Rukwa Valley, behavior and physical aspects of the socio-economic activities conducted in the villages of study based on resource utilization. The information observed enables the researcher to probe issues which will aid in covering beyond those documented in structured questionnaires, this includes fishing activities, farming practices, and mode of livestock keeping, intermediary small scale/local vending business, causal labour and transportation of goods. The information collected with this methods were done through counting and analyzed with computer software SPSS version 20 when combined with other methods.

3.8.1.2 Household interview

A semi-structured questionnaire was used to interview household heads, the questionnaire used was an open-ended questionnaire (Appendix 1). The questionnaire enables collection of information related to economic activities performed in the study area and the factors that lead to land-use, and land-cover changes. The structured questionnaire with an open-ended question allowed each interviewed individual to comfortably participate fully in the discussion.

3.8.1.3 Focus group discussion

Purposively selection of people with knowledge and experience with land-use changes and variability were involved in the discussion. About 28 people were involved in the discussion in the four selected villages, however 5 to 8 people involved in a discussion in each village while the group discussion was guided with a checklist (Appendix 2) with twelve (12) questions. The discussion involved women and men giving equal proportion in responding to the questions about land-use and land-cover changes in their villages. Application of focus group discussion enabled to achieve in-depth information about

land-use and land-over changes and their impact on socio-economic activities in their villages.

Plate 1: Focus group discussion at Ilemba B village and Ilanga village

3.8.1.4 Key informants interview

The interviews of key informants involved data collection from District Officers, Ward Extension Officer, Ward Executive Officer (WEO), Villages Executive Officer (VEO), and Village Governmental Official, checklist of questions (Appendix 3) used to collect information from the key informants. The Information collected of land utilization and economic activities were linked with the secondary data to observe the relationship between land-cover changes for 1995s to 2020s in Lake Rukwa Valley.

3.8.2 Secondary data

Secondary data were obtained from different sources which include official documents like investment guide reports, investment profile, annual livestock reports, and action plan

from Rukwa Regional Office, Sumbawanga District Council while from the Wards and villages we picked village register book, population (people and livestock) census. Data collected from this source comprise a number of the population residing in the villages, ward. This includes number of farmers, livestock keeper and number of fishermen in the villages.

3.9 Data analysis

3.9.1 Qualitative data analysis

Data analysis were analyzed using content analysis, this method is applied when a verbal discussion is conducted while different respondent involved in interviews. The recorded information was broken down into small meaningfully units to bring the values according to the approaches of respondents (Kajembe, 1994). However, the information collected from focus group discussion was broken down into meaningful information but when the argument by the member reached consensus are the only time note are taken for documentation (Cooksey and Lokuji, 1995).

3.9.2 Quantitative data analysis

3.9.2.1 Analysis of socio-economic data

The quantitative, data collected were organized, summarized, coded, and entered in a computer using Statistical Package for Social Science (SPSS version 20) software and spreadsheet in data analysis aided by MS Excel computer programs. Descriptive statistics were run to obtain frequencies, percentage and then cross-tabulation was performed. Data obtained from different variables enables to compare of different parameters in the four villages. Chi–square test was applied to determine the significance level between data obtained and the trend of land-use pattern and socio-economic activities in Lake Rukwa valley.

3.9.2.2 Analysis of ecological data

Land- use and land-cover changes were analyzed using LandSat T.M satellite imagery by using the computer ArcView program with a combination of QGIS programs. The downloaded satellite images were geo-referenced, classified and interpreted.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

The results presented in this section depicts the picture of the land use types and socio-economic activities conducted in Lake Rukwa Valley but also embarks on the factors which influenced land-use and land-cover changes on socio-economic activities on Lake Rukwa valley.

4.1 The Socio-economic Characteristic of the Respondents

However, among 126 respondent interviewed, indicates that, adults with age between 16 and 59 years contribute much in social and economic participation by (61%), followed by group with less than 16 years with (36%) and the least contributing group is elder with more than 60 years of age (3%). Figure 4 elaborate more
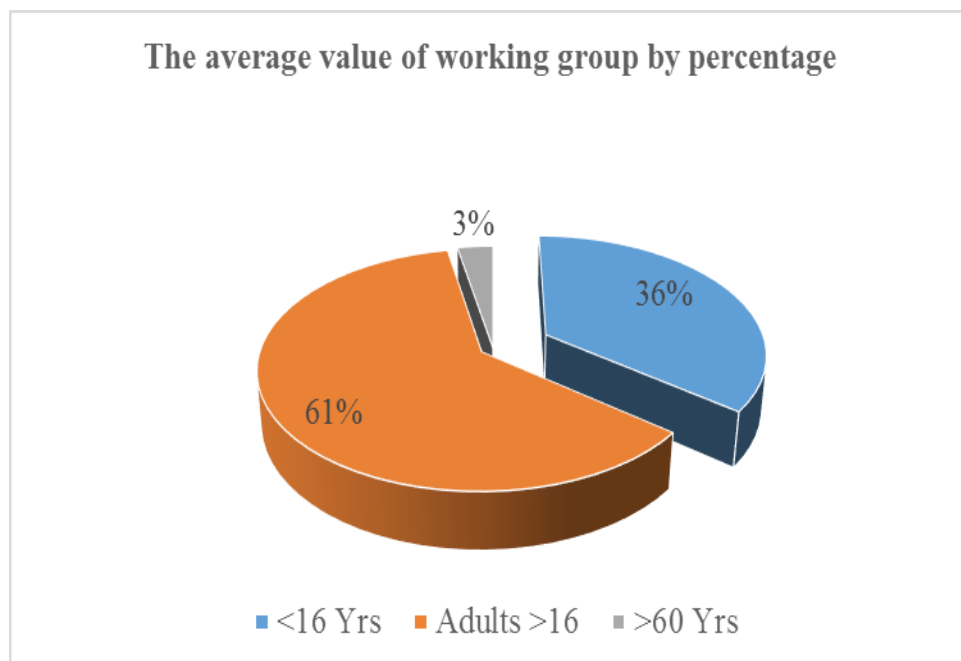
Figure 4: Average value of contribution from working groups in the society

Although disability level was found not much existing within the society where by 98% percent were normal hence involving in their daily social and economic activities, leaving only two percent (2%) of dependent group. Figure 5 shows in details about level of disability in the study area.
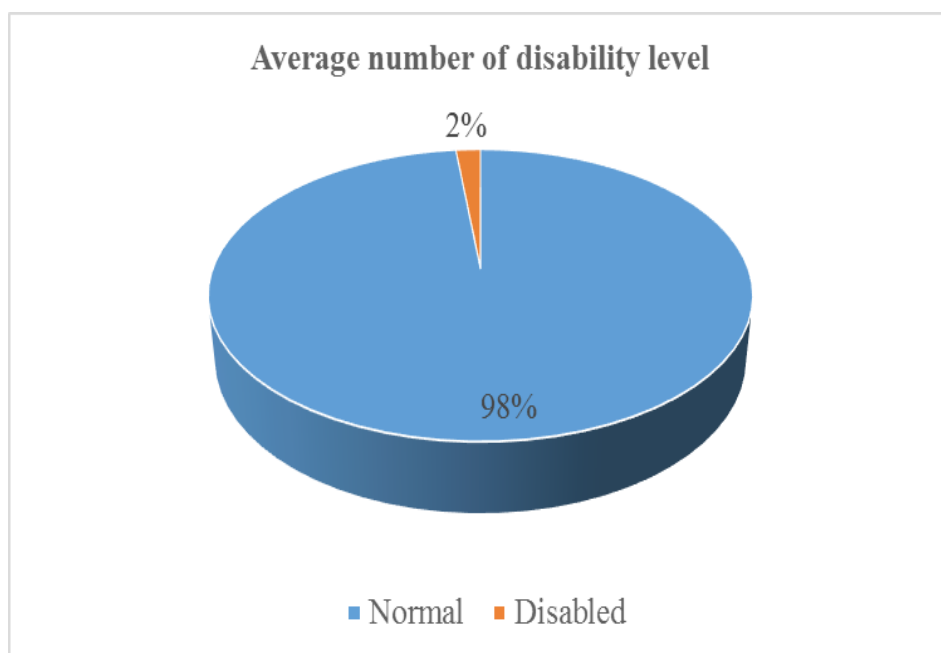
Figure 5: Disability level by Percentage

Most of the families were found to be headed by male (80%) while 20% of the interviewed housed were headed by female. This means most of the families' decision and ownership of family economy depends on male. The figure 6 describes about the head of the family during data collection**.**
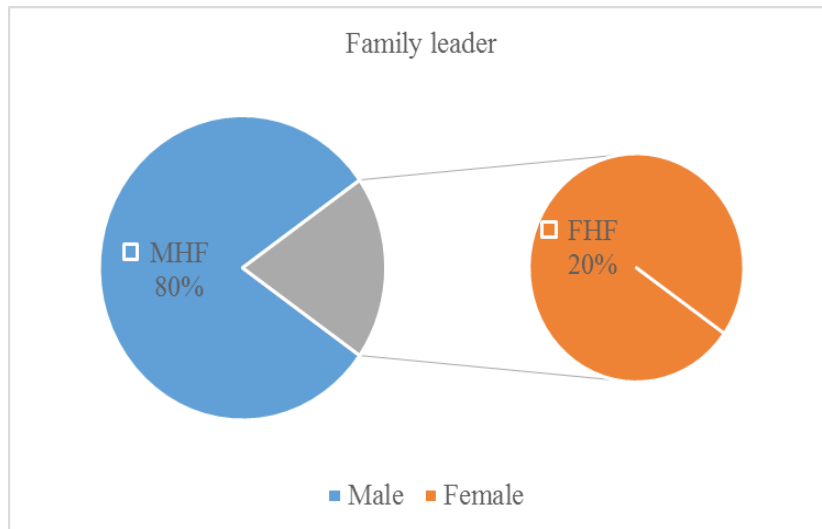
Figure 6: Headed families by genders

Legend: MHF – Male Headed Families; FHF – Female Headed Families

Looking at literacy level, most of the society members attended primary schools education level with an average percentage of 64% while 27% reached secondary education level leaving 9% of the society illiterate and 0% attended vocation training and high education level. This convince that most of the society members have formal education level. Figure 7 shows the level of education in the society.
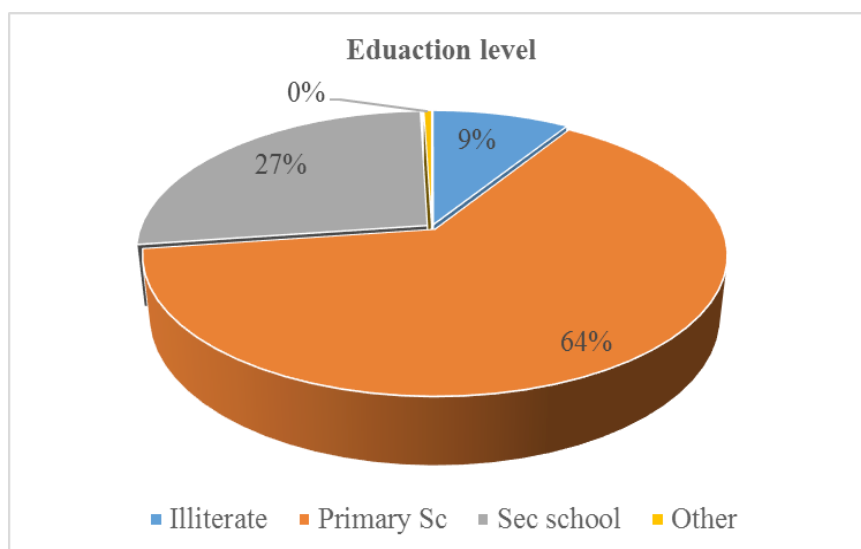
Figure 7: Literacy level among villagers

However, couples who lives with their wife is 78%, while those who are single are 6% followed by polygamy who lives with more than one woman 7% while unmarried 5% and only 1% is showing the widow. Figure 8 elaborate more about marital status.
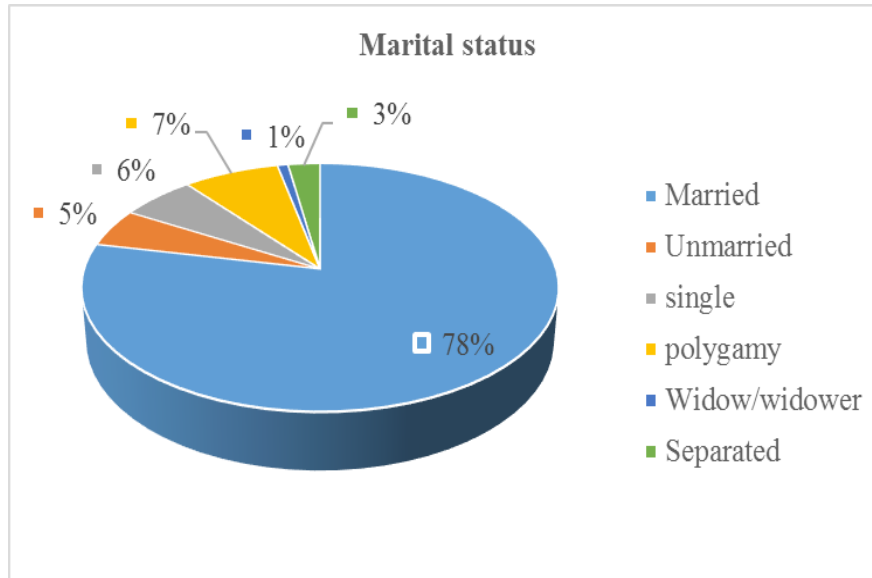
Figure 8: Average percentage number of marital status

4.2 Assessment of land-use cover practices and their socio-economic activities in Lake Rukwa valley

The land-use practices observed in Lake Rukwa Valley includes farming, grazing area, fishing activities, fishing landing site, water bodies, settlement, protected areas (Ilemba forest, Mbizi forest reserve and Uwanda game reserve). Land-use practices mentioned by respondents will enable decision makers to adhere to the stipulated regulation and on different ways of finding the solution on how to reduce the impact on land changes caused by human activities.

4.2.1 Farming activities

Agriculture is one of the major land-use practices by rural households and depends much on rain-fed while irrigation farming is practiced in small quantity. The main food crops and cash crops grown are maize, groundnut sunflower, beans, paddy, simsim (sesame), cassava, finger millet, sweet potato. Others includes vegetables, fruits, sugarcane and cowpea.

However, the survey conducted in Lake Rukwa Valley in 2020 indicates that Ilemba leads in farming activities by 28.1% followed by Milepa with 28.1%, while Mtowisa had 27.2%, and Muze had 16.7%. Looking at this data, Ilemba leads in farming production due to the presence of well-interconnected rough roads with tarmac road and markets (local market and inter-regional market). The center is well established with government institutions and communication, henceforth the economic activities show strong association as t – value = 40.645, p = 0.000. The, average crop production in each hectare of land remains 0.03 to 3.2 tons per hectare for staple food while cash crop ranges from 0.06 to 0.48 tons per hectare (Figure 9). The finding shows the crop production keeping fluctuating year after year. The extent of fluctuation triggered by the market price influences crop production in the coming season (Msigwa, 2018). Figure 9 shows trend of food and cash crop production in Lake Rukwa Valley.
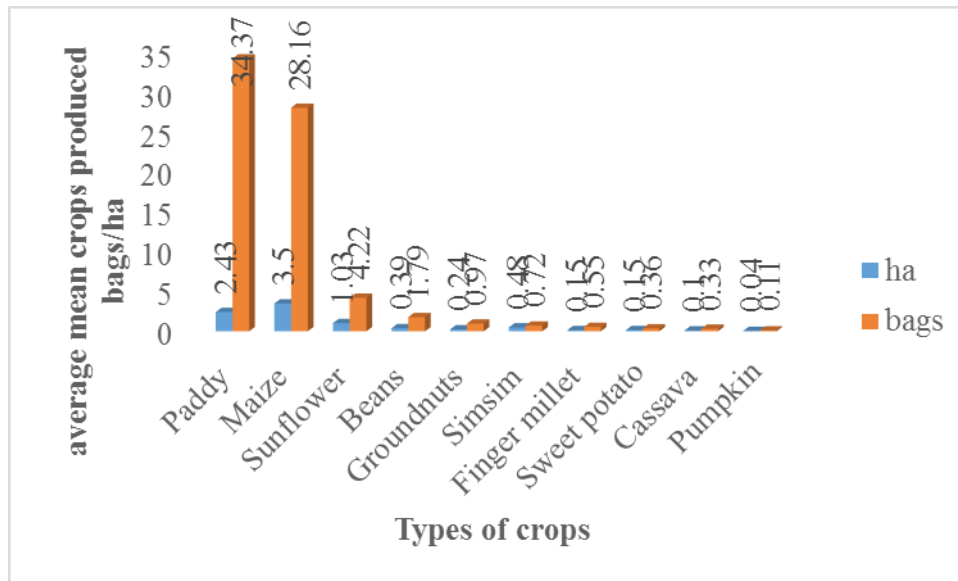
Figure 9: Average food and cash crops production in Lake Rukwa Valley

According to Ministry of Agriculture **in Tanzania, the** Preliminary report of Food Security assessment for 2019/2020 indicates that, Rukwa Region ranked the second region with food production with Surplus 899 731 **tones after Ruvuma Region (URT, 2019). Farming is practiced into the three agricultural zones, Lake Tanganyika shore,** Rukwa Valley and Ufipa Plateau and it's done by **three groups, 75% of the inhabitant is carried out by draught animal power, 22% is done by hand hoe while tractors and heavy machine plays the remaining 3% (Rukwa Region Investment Guide, 2020). In addition, more than 82% of the population of Rukwa Region are farmers using hand hoes and oxen**.

Despite the trend of crop production since 2007/2008 season to 2019/2020, production season in Rukwa Region, the data reveals that, there is fluctuation in crop production versus areas cultivated. Meanwhile, when the area of production increases, also the yield increases, but the average crop production per hectare remain 2.5 ton/ha. Figure 10 shows more results.
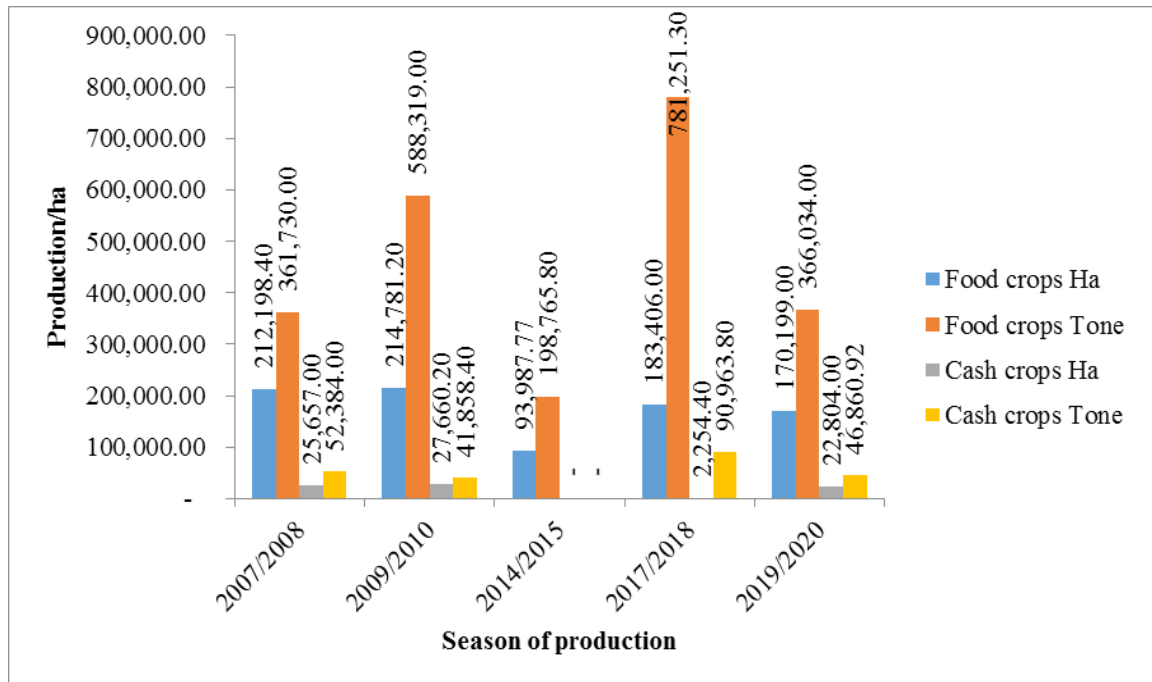
Figure 10: Trend of food and cash crop production

Source: Rukwa Investment guide (2020)

Although the major challenges facing the valley and affecting crop production is to reverse the decline of soil fertility caused by intensive land preparation carried out by hand hoe or plough with a combination of burning crop residual leaving behind the soil exposed to climatic vulnerability such as excess rainfall runoff, prevailing wind and sun. The nutrients depletion leads to soil desiccation which contribute to low yield levels. However, (GEF, 2003 and Rockstr*öm et al*., 2009) declared about 65% of agricultural land in Sub-Saharan Africa (SSA) has been subjected to land degradation which contributes to low yield. Although crops produced under agronomic practices and proper management will save the natural resources from biodiversity loss caused by land degradation and socio economic activities.

4.2.2 Farming and livestock keeping

Muze wards lead with the households practicing farming and livestock keeping at the same time. The survey data shows Muze leads by 56.2% followed by Milepa ward with 28.1% while Mtowisa had 9.4% and Ilemba had 6.2%. However the Village of Muze is well connected by roads to Sumbawanga town and Katavi via Kigoma and Tabora region. The data shows there is a strong association between the two economic activities as t-value = 27.821, p = 0.000. Practicing both farming and livestock keeping ensures the farmers with an alternative source of income during the crop failure season but also with drought animal during farm preparation, and transporting of crops.

4.2.3 Livestock keeping

In Rukwa Region, livestock population are grazed in surveyed communal rangelands (URT, 2020), although the development report of the region, 2019 shows the region has the population of about 691 258 cattle's, 196 800 goats, and 56 291 sheep, donkeys were 11 541, pigs were 40 711 and chicken were 513 467 in total. However the data obtained from District Livestock Officer shows, there is an increase in number of cattle since 2010 in each Ward, while other ruminant their number are decreasing. Looking at the data collected during the survey, Ilemba and Mtowisa ward leads by having 38.8% of total number of respondent interviewed followed by Milepa had 16.4% and Muze has 6.0%. Ilemba leads because is close to Lyambalyamfipa escarpment, Uwanda game reserve and Ilemba forest reserve which enables livestock keeper illegally to moving with their herds and graze in this areas compared to other wards. The activities shows strong association as t- value = 46.595, p = 0.000. Figure 11 representing number of livestock in Sumbawanga District Council and average number of livestock in the study area for the year 2016.
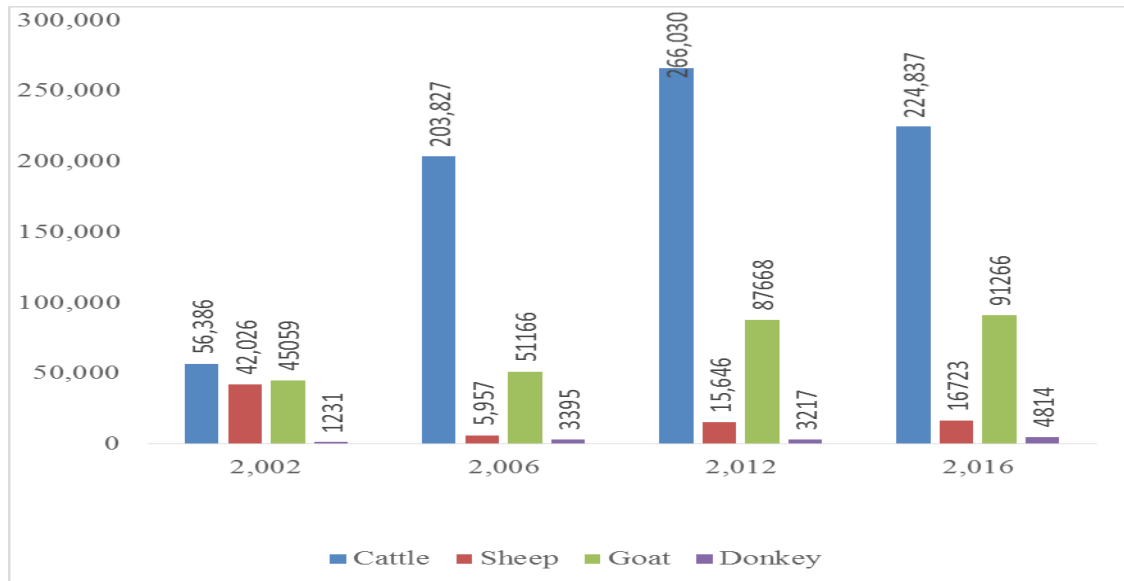
Figure 11: **Trend of livestock population in Sumbawanga District Council**

Source: Sumbawanga Investment Profile, (2016)

4.2.3.1 Grazing land

According to data collected in Lake Rukwa Valley shows Mtowisa had more number of livestock's followed by Muze, Milepa and the Ward with few number of livestock's is Ilemba. The data collected in the four villages of study indicates there are 52 927 cattle's, 27 617 goats, 4172 sheep's and 779 donkeys. Figure 12 indicates number of livestock kept in the study area of which cattle had high number followed by browsers goats, sheep and lastly were donkeys. The donkeys are mostly used in transportation during difficult times especially when it's raining and in areas where there are no roads or during harvesting.
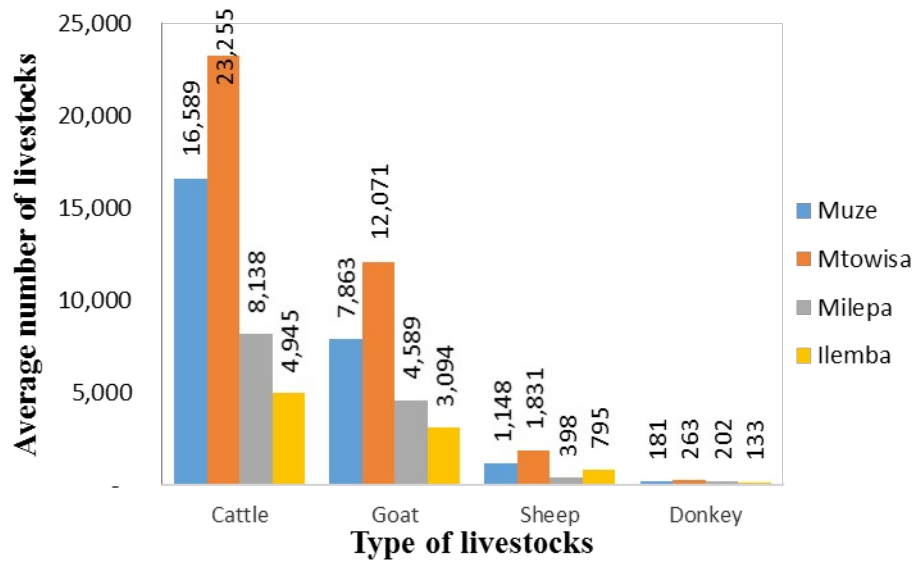
Figure 12: The livestock population data in Lake Rukwa Valley

The villages did not set aside grazing land in the study area except the private and public area which does not accommodate all the animal available in Lake Rukwa valley. However, the average number of livestock kept in the study area for the four villages/wards which vary from one village to another as shown in Figure 13.
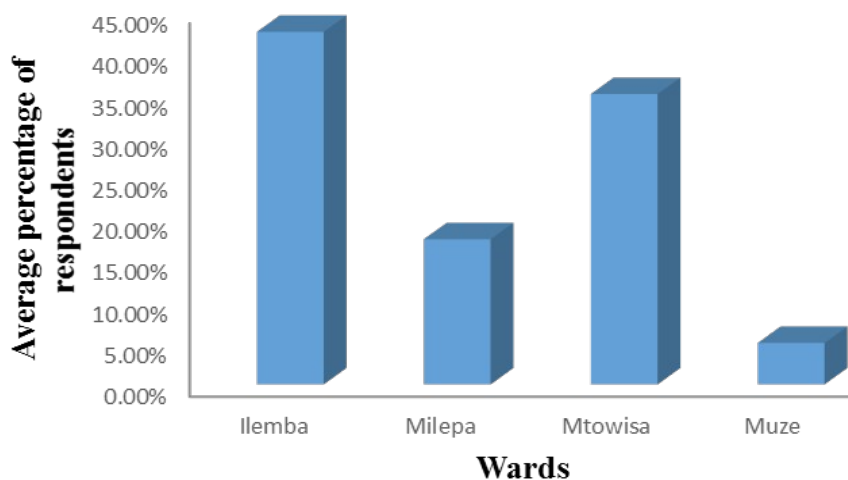
Figure 13: The average livestock keeping as the main economic activities in each Ward

4.2.4 Fishing activities

Lake Rukwa is an inland lake with alkaline turbidity water due to siltation caused by economic activities in high up at steep slope of Ufipa escarpment which impacted the lake. Most of the household engaged in this sector involves in different activities which includes fish processing, fish marketing, boat building and maintenance and selling fish gears (Kyelu, 2016)**.** Milepa ward had 100% of respondents indicating fishing are the main economic activity due to villages being close to the lake but also some families practicing fish farming which sustains livelihoods. Looking at the association of the activities it shows there is a weak association as *t-* value = 12.135, *p* = 0.007. However, according to households interviewed in the study area, there are different types of fish available in Lake Rukwa which includes claries/catfish (*Clarias gariepinus),* Kolokolo (*Synodontis rukwaensis*), Bungunusi (*Oreochromis rukwaensis), Protopterus sp*. The Table 1 indicated the types of fish and its availability in the lake Rukwa valley.

Table 2: Fish varieties with maximum demand throughout the year (n=126)

Fish variety	Frequency	Percentage
Bungunusi (*Oreochromis rukwaensis*	4	3.2
Clarias/catfish *(Clarias gariepinus*)	13	10.3
Kolokolo (*Synodontis rukwaensis*	11	8.8
Protopterus sp	30	23.8
Tilapia sp	17	13.5
None	51	40.5
Total	126	100

However according to respondent interviewed shows that, the favourable fishing season is during the rain season, at this time of the year, food for fish is available compared to summer. Table 3 elaborate more about fishing season.

Table 3: The Most Favourable Fishing Season (n=126)

Fishing season	Frequency	Percentage
Summer	7	5.6
Rainy season	13	10.3
None	106	84.1
Total	126	100

Although there is active days with best fish catch as they receive about 160 kg to 200kg per day, Table 3 indicates the frequency and percentage of fish catch per days.

Table 4: The active fishing days with best catch (n=126)

Active days	Frequency	Percentage
Less than 120 days	2	1.6
120 days – 210 days	10	7.9
210 – 276 days	8	6.3
None	106	84.2
Total	126	100

According to the data collected during the filed survey, among the fishermen interviewed indicated that, there are fishing days without catch and mostly their catch limited to 20-25 kg of fish and this happen mostly inactive days. The result is as shows there are days without catch which represented by 15.9% of the total respondent.

However, among the fishing households interviewed, 2.4% were shows fishing is the main economic activities, furthermore their average income per months ranges from 100 000 TZS to 350 000 TZS per month, (Mpemba, 2016). Some of the households practicing both fishing and farming as the part of their daily activities and this family were about 25.3% of the total number of respondent interviewed, while other households practicing fishing, farming and livestock keeping simultaneous were 3.6% of the total number interviewed. Meanwhile among the household interviewed 3.6% reveals that, they

practicing fishing because of traditional ways of living while 1.2% they practice fishing activities because of poverty, some 7.3% of the fishing households take this opportunity because they think it's a job with low competition of employment.

The families who their daily activities are fishing does not involve their children in this activity, and this household were 96.7% only 3.6% involves their children in fishing activities.

Variation in climatic conditions caused by rainfall invariability had effects in fisheries economic production (Wurtsbaug*h et al.,* 2017).   Long term climatic changes have reduced water balance, in size and volume while affecting breeding ground found in Uwanda and Rukwa game reserves in Rukwa region.

4.2.4.1 Water bodies

The study area has different water sources, this include lake, rivers and underground water and borehole, and however, presence of this different sources has impacts in water availability and utilization. In different villages. Water is used for transportation in Lake Rukwa, crops irrigation, for domestic use, water for wildlife and water for livestock drinking. However some river possess water which can be used for power generation like Nkwiro, Kilambwa, Nzovwe and Luiche river. Based on the results obtained from the study indicates there's problems in availability of water in the study areas despite presence of plenty of water (rivers, ground water and lake Rukwa), hence, there is a need to improve and develop rural water supply schemes to reduce water related problems. Table 5 indicates water associated problems.

Table 5: Water related problems in Lake Rukwa Valley (n=126)

Water related problems	Ilemba (%)	Milepa (%)	Mtowisa (%)	Muze (%)	df	Sign f
Water piped inside	46.7	0.0	35.0	18.3	3	0.000
Water piped outside	13.0	13.0	0.0	73.9	3	0.000
Open well	0.0	85.0	0.0	15.0	3	0.000
Communal water	2.9	32.4	14.7	50.0	3	0.091
Rain water and rivers	24.4	25.4	24.6	24.6	3	0.020

4.2.4.2 Fishing landing site

There are several fishing landing sites around Lake Rukwa Valley which are not well established but the most known are two located in Ilanga and Nankanga C which was the extension of Ilemba village. This landing site is estimated to have more than 1500 population most of them are migrant of which number is fluctuating depends on fish catch season. Apart from employing a number of artisanal fishermen but also boat craftsmen, fish vendor, food sellers and primary fish processors, selling fishing gear and transporters, (Jalloh, 2009)**.**

According to interviewers, the major landing sites in Lake Rukwa Valley is located in Ilanga at Muze ward and Nankanga, the area does not have the proper infrastructure of receiving fish and it is locally operating and most of the fish caught is destined in Sumbawanga and Tunduma, very few are taken to Democratic Republic of Congo and Zambia. Figure 14 indicates the trend of fishing activities for the five year consecutive.
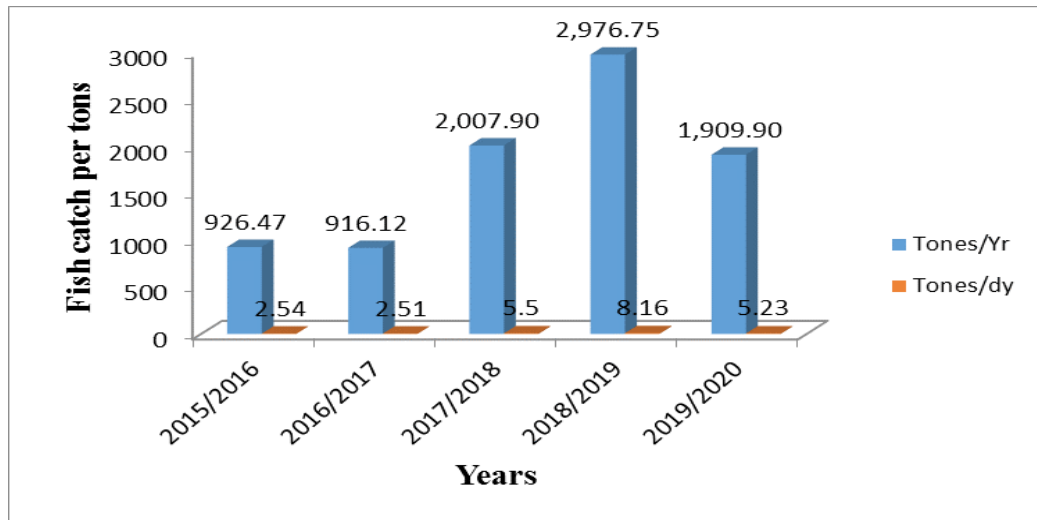
Figure 14: Average trend of fish catch for five years

4.2.5 Farming, fishing and livestock keeping

The households practicing all the three economic activities in Lake Rukwa Valley indicating that, there is weak association between the activities and its impacts on land cover changes as t – value = 9.804 and p = 0.020. Based on the data collected, Kisa village shows both activities are conducted in the village as 100% of the respondent interviewed agreed to practice one or all three activities. Table 6 show the relationship between the activities conducted in Lake Rukwa valley.

Table 6: Relationship between different economic activities across the villages (n=126)

Economic activities	Ilemba B (%)	Kisa (%)	Mtowisa B (%)	Ilanga (%)	df	Sign f
Farming	28.10	28.10	27.20	16.70	3	0.000
Farming and livestock	6.20	28.10	9.40	56.20	3	0.000
Livestock keeping	38.80	16.40	38.80	6.00	3	0.000
Fishing	0.00	100	0.00	0.00	3	0.070
Farming and fishing	9.10	42.40	21.20	27.50	3	0.018
Farming, fishing &livestock	0.00	100	0.00	0.00	3	0.002

4.2.7 Protected area (Uwanda game reserve, Mbizi forest reserve and Ilemba forest reserve)

Lake Rukwa Valley possesses a legally protected area which maintains the ecosystem around the study areas. One is Uwanda game reserve which is found in the south of Lake Rukwa Valley with an average area of about 2100 sq. km. most of it immersed in water (Rukwa Investment Guide, 2020). The importance of the area a part of ameliorating climate condition but also is the fish breeding zone. Presence of Ilemba forest reserve which is a protective forest and possesses a catchment which is used to supply water to nearby villages. Overexploitation of this resource caused by farmers, livestock keeper, illegal logging, charcoal making and firewood collecting for different uses threaten existence forest and leads to biodiversity loss while Mbizi forest which is also protective forest and found in Lyambalyamfipa escarpment which being among biome of ashy red colobus monkey. Economic activities conducted in the mountain slope affect the forest due to farm expansion, wildfire and animal grazing. Despite the restriction imposed in resource utilization (Uwanda Game Reserve, Ilemba Forest Reserve and Lyambalyamfipa escarpment which includes Mbizi Forest Reserve), land degradation still proceeding at an alarming rate which threatened the ecosystem (Musa, 2008).

4.3 The main socio-economic activities in Lake Rukwa valley

4.3.1 Agriculture

According to the data collected in the study area farming activities has been affected by intensive farming which leads to soil erosion and floods, poor roads infrastructure, high price of farm inputs including seeds and pesticides with low quality and lately delivery has also affecting production. The company dealing with seed and pesticides production should make sure their products reach in the site in time and with the same quality by making regular inspection to maintain its quality. Presence of river and river shifting

from its original course has affecting farming activities, lack of proper irrigation schemes. Lack of market information and financial credit to enable them invest in agriculture and increase yield in crop production. Land scarcity and land right were one of the major factor impacting crop production. Some of the farmers believe that, using animal manure for crop production maintain the soil health compared to using artificial/industrial fertilizer, this indicates there's a great chance of improving crop production using available resource as the study area holds a number of livestock's.

4.3.2 Livestock keeping

The valley holds about more than 76% of the total livestock's found in Sumbawanga District Council. According to the households interviewed, presence of a large number of livestock is due to presence of favourable climate which enables livestock growth compared to other areas of the region. However livestock keeper were claiming lacking of grazing land leads them to encroach to the protected areas which ended-up causing commotion by quarreling with conservator. Despite the government setting aside the area for livestock keeper in Ufipa escarpment at Kalambo ranch, but very few livestock keeper responded and the rest still remaining in the study areas.

4.3.3 Fishing

Fishing taking place in Lake Rukwa, although there are few rivers which also supports fishing activities. Presence of fishing activities in Lake Rukwa has attracted a number of people engaging in different activities including, fishing, fishing vending, casual labour, boat making and repairs, transporting and importing of fishing gears. The number keeping fluctuating from season to season depending on fish catch.

4.4 Determine the land-cover changes in Lake Rukwa valley for the period 1995s to 2020s

The Satellite images for the years 1995s and 2020s with minimal clouds cover was acquired in the study area during the dry season from July to October. The following Figure15 presents the results obtained during data collection.
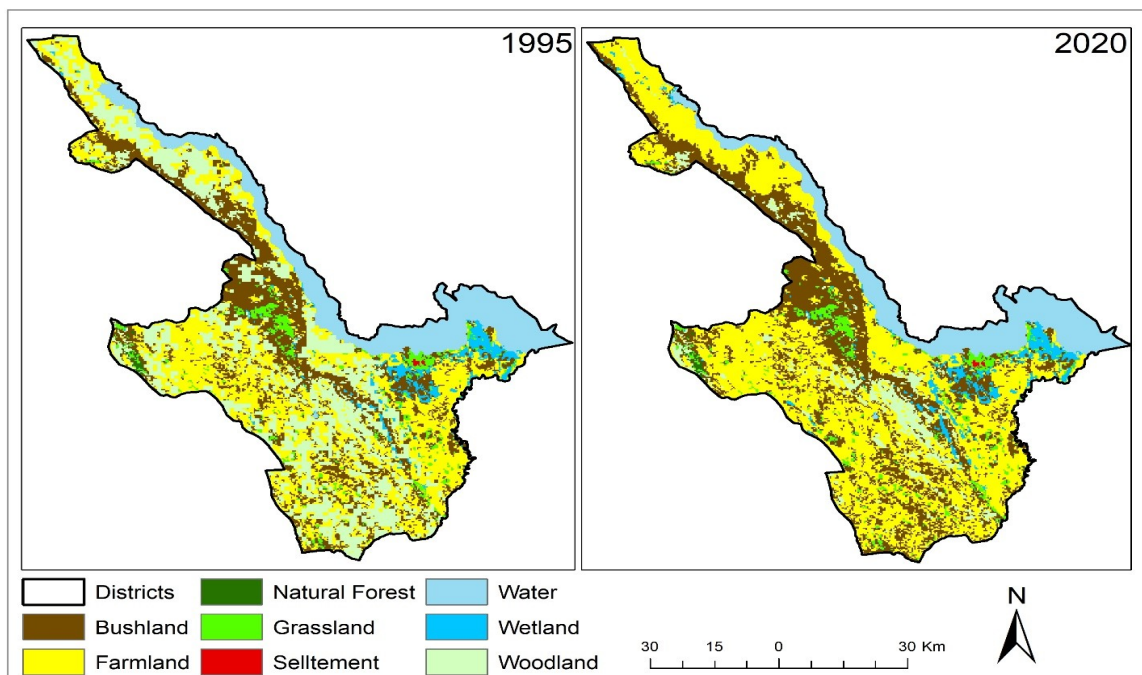
Figure 15: The study area imagery from the year 1995 to 2020

     i.   **Preliminary classification**

The method used in information extraction regarding land use and land cover classification from remote sensing is termed as multi - spectral classification. Different imagery collected from multiple area in a specific study scene shows the physical features of the earth. Preliminary classification of the images will be done in a combination with ground-truthing. Different land-uses were identified and grouped into different classes. The following eight (8) land-cover classes we identified on the study area as shown on Table 7 and 8 (Chilagane 2018**;** Tades*se et al*., 2017)**.**

Table 7: Land-use classes in Lake Rukwa Valley

Land cover classes	Remarks
Bush land	The land possesses wooded shrubs of different tree species, density and varying location. Mostly in abandoned cultivated land
Farm land	An area which is prepared for cultivation, most of this area are found in different elevation and crops grown depend in rainy fed or irrigation
Natural forest	The trees with height more than 5m and predominantly natural covered in built up areas of farm land.
Grassland	The land which is private or communally owned and used for animal grazing, the area possess distantly sparsely tree cover
Settlement	Man-made structures located in one area (centers) usually horizontal found in rural communities
Water	Water bodies of different size located in land with numerous river stream flowing in one direction (lake Rukwa)
Wetland	Land area which is saturated perennial or seasonal river flows
Woodland	The land is densely populated with dominant tree species particularly miombo with limited shade

Table 8: Land-use and land-cover between 1995s and 2020s in Lake Rukwa Valley

	1995		2020		1995-2020	
Land cover classes	Area (Ha)	% cover	Area (Ha)	% cover	Area change (Ha)	% Cover Change
Forest	1 122	0.21	1 188	0.27	-66	0.06
Woodland	133 573	25.49	30 030	5.73	103 543	-19.76
Farmland	164 602	31.41	239 879	45.77	-75 277	14.36
Bush land	113 717	21.70	142 568	27.20	-28 851	5.5
Grassland	16 839	3.21	18 763	3.57	-1 924	0.36
Settlement	358	0.07	405	0.08	-47	0.01
Water bodies	78 520	15.0	73 089	13.94	5 431	1.06
Wetland	15 293	2.92	18 103	3.45	-2 810	0.53
Total area	**524 024**	**100**	**524 025**	**100**		

4.4.1 Factors that leads to land-use and cover changes

Land-use and land-cover changes involves a series of event which accompanied with environmental issue like land expansion for farming, wood extraction for different uses, wildfire, unplanned settlement, population density per unit area, livestock number in unit area, and lack of land tenure in the family, poverty and distance from the market, roads, and town center, (Waisw*a et* al., 2011**;** Kitereja, 2015) all causes enable access to an individual forest and degradation take place instantly. The environmental issue which are imperative and contribute in land transformation with a large proportion of land surface by disturbing the wetland ecosystem and wildlife ecological niches which leads to biodiversity loss, (Lambin, 2003 and Alam, 2020).

However, land-use and cover changes is associating with a combination of factors like high pressure in production, rise in opportunity based in market demand changing of policy governing the countries at a time and other human anthropogenic activities. The underling factors include unplanned development projects, loss of cultivated land, (Lambin, 2003). Looking at the data collected in 2020s during the surveys, it shows forest cover has increased by 0.06% from 1995s to 2020s while woodland has decreased by 19.78%, farmland increases by 14.36%, bushland increases by 5.5%, and grassland increases by 0.36%. The change in land-use and cover changes for more than 25 years has shown in figure 1and shift on available resource as shown in Figure 16.
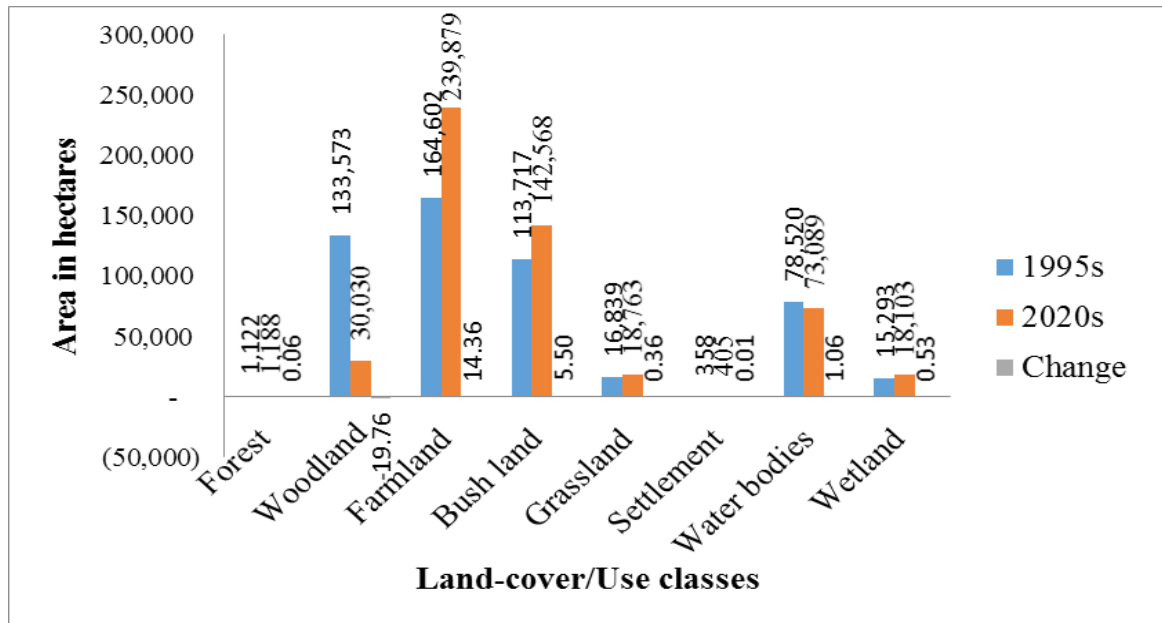
Figure 16: The trend in land-use and cover changes since 1995s and 2020s

i. Forest cover

Forest cover changes caused by several factors which leads to deforestation and degradation although this situation can be reversed by afforestation and reforestation. The rate of deforestation in Tanzania is highly caused by intensive farming, animal grazing, overutilization of natural resources in arable land (Kitereja, 2015). However, according to survey conducted in Lake Rukwa Valley indicates that, the forest cover areas increases by gaining 0.06% of the total forest (Kristensen, 2016).

ii. Woodlands

Woodland is a land with trees covered with thick canopy, always evergreen scattered shrubs and the dominant ground cover is grasses and herbs. Two types of woodland are known which are coniferous and broadleaf which are found in southern highland of the

country (Tanzania), they are classified according to the tree species dominance. Continuing conversion of natural woodland to other forms of land class affects vegetation regeneration although native plant succession is observed from abandoned farm field

(Chinuwo, 2014). Looking at satellite imagery collected and analyzed they shows woodland decreases by -19.76%, this indicates there is transition changes of land-use from one cover to another caused by expansion of agricultural land.

iii.   Water body

Water resource has been a valuable element in human development and wildlife (L*i et* al., 2015). In Lake Rukwa valley, water bodies (Lake Rukwa) covers about 3000 km and is used for fishing and marine transport. The lake Rukwa is an inland lake which is fed by several rivers which drains its water from Ufipa escarpment (Lyambalyamfipa mountain ranges) downstream to the basin where water collected in one points.

However, when water bodies are exposed to land-uses and its ubiquitous exploitation affects its qualities and sustainability. The link between land-uses and water quality is complex and impaired with anthropogenic activities which alter soil physical properties, water quality and quantity. For example alters water runoff volume, temperature variation, leads to increase algae production, affect oxygen concentration and generate pollution **(**Ding *et* al., 2015)**.** According to the data obtained during the survey conducted in Lake Rukwa valley, the satellite imagery indicate there is an increase in water volume by 1.06%.

iv.   Grass land

The grassland in the study area are facing spontaneous farm invasion and livestock keeping which threatening the existence of the grassland ecosystem has most of this area lack legal protections despite of their biodiversity value. (Togorasei, Mashapa and Gandiwa, 2015). The satellite data shows there is an increases in land area by 0.36%

v.   Farm land

Agriculture is the one class in land-use which is the results of forest clearing. The land transition from forest to farm land has been a major threats in land-use and cover changes as land transformation occurs from forest, farmland and finally settlement. Although in time land is being abandoned based in population number and productivity (Togarasei, 2015). The satellite data reveals that, there is an increase of farm land by 14.36% since 1995s,

vi.   Settlement

One of the land-use class detected in the study area is presence of settlements. Looking at the satellite imagery, the land allocated for settlement were 358 ha in 1995s but due to expansion of town center the area increases to 405 ha which is 0.01% of the total area used for town center development. The town center expansion had effects in other land-cover class, (Ziwe*i et* al., 2019). The transition of land use change from forest, agriculture and settlement has impacted resource utilization and resulted in environmental degradation and restructuring of rural areas (Long *et al*., 2019). Center expansion is promoted by demographic and socio-economic factor like close to the roads and proximate land-cover classes (Taylor, Mundia, and Aniya, 2007)**.** Figure 17 shows the preference of energy sources used in a different ward around Lake Rukwa Region.
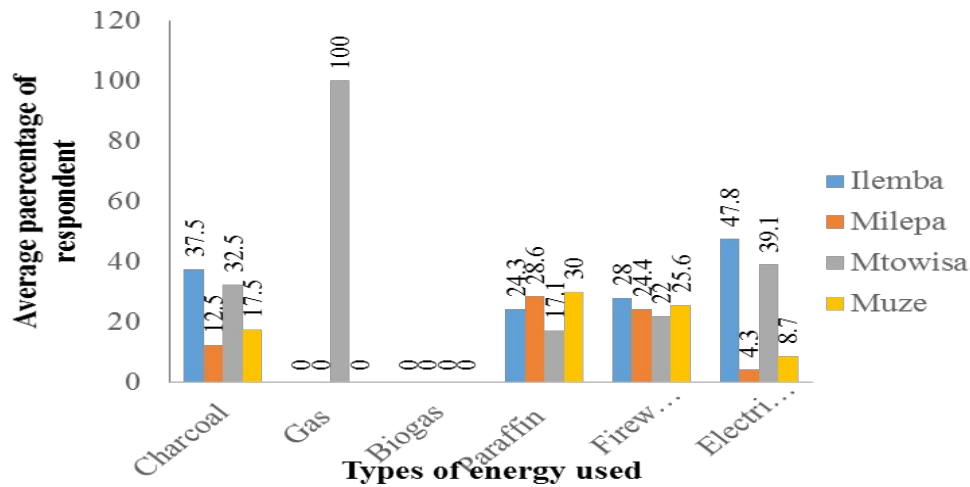
Figure 17: Showing different sources of energy used in Lake Rukwa Valley

vii.   Bush land

The land which is covered by wooded shrubs of different tree species varying in different location and density. Mostly spaced tree in abandoned cultivated land. The collected satellite data shows there is an increase in land area by 5.5% net gain since 1995s.

viii. Wetland

Wetland area possess land-cover with season or perennial river streams flowing around and saturating the area adjacent lake Rukwa. Socio economic activities in the higher land of the mountain slopes (Lyambalyamfipa) alters water flows not only water quantity and volume but also cause water pollution which affect water in lake due to different chemical compound collected and dragged along the way. This result in land degradation which cause soil erosion and deposited in the lake hence reducing the depth of the water through water spill over and altering land-cover. According to Ntongani *et al.* (2014), the benefit and services offered by wetland has attracted human population to establish and carry on farming and grazing livestock activities which bring positive land-cover changes by 0.53%.

Land-use and land-cover changes caused by human activities has some of the area has been increased while other areas has been decreased. This fluctuation of land-use and land-cover changes in the study area since 1995s indicated there is significant changes in land utilization in bush land, farmland and woodland.

4.5 To Assess the influence of LULCC on the socio-economic activities in Lake Rukwa Valley

4.5.1 Productive land resources

Lake Rukwa Valley support multiple socio-economic activities, this includes agriculture, marine transportation, livestock keeping, fishing, mining, wildlife, water for domestic uses, water for irrigation. Among all the activities agriculture is the most economic activities which employs about 80% of the total population residing in the study area (URT, 2016). Rukwa valley cover about 650 000 ha of land, the major economic activities are agriculture, livestock keeping and fishing, based on the household survey data collected from the four villages of Ilanga, Mtowisa B, Kisa and Ilemba B in 2020s, indicates that, more than 82% of the population derives their income from agriculture which play a major role in poverty reduction (Kapitingana, 2014). However growth of agricultural sector depend much on land tenure security in order to improve productivity, while the tenure security helps the farmers in major decision making and type of crop to grow at a particular season and rainfall pattern. According to (Pulmer, 2006) reveals that, the best options in farming system should consider tenure security which influences farming performance with other factors like markets, transport, and subsidized agricultural inputs as local resource users are pushed away from the higher value lands and marginalized due to price caused by land market which forces them to encroach protected reserved land in the nearby (Lorenzo *et al.,* 2009).

Although Midori, and Shinada 2012 reported that, most of the rural women who engage in productive sector than men have been affected by insecurity of land and they lack the cash to enable them to buy subsidized farm input and access market information. Some managed to have land from their spouse, inherited and relative are fully participating in crop production (Kapitingana, 2014).

Looking at the land tenure system in Tanzania which is derived from the Village Land Act No. 5 of 1999 (URT, 1999b) and the Land Act. No.4 of 1999 (URT, 1999a) which explain that "*all the land in the country is public and vested in the President of the United Republic hold the trust on behalf of all the citizens*" although the president delegate power to commissioner of land but the laws are not fully implemented as there part of involvement of communities as their the one who are most affected and left most the tenure resource insecurity (Laiser 2016; Kapitingana, 2014).

For example the data collected in 2020s, most of the households interviewed have indicated that, there is greater association between farming and land utilization as $X^2 > 33.568^a$, $p= 0.000$ as the most activities which attract most of the people in the study area by 88.0% of the respondent, followed by livestock keeping with 48.2% of the respondent while other land practices had no association with the activities in the study area.

4.5.2 Availability of water resources

Water is an important resource for sustainable developments, it is used in domestic purposes, irrigation, navigation, hydropower production etc. (Salehe, 2017) its limited accessibility associated with poor supply of clean and safe water at household level has increased gap between poverty and water borne diseases (Onesmo, 2016) . Water being an catalyst for socio-economic development of the country by reducing poverty and

increase food security, fostering rural economy, growth and protecting the ecosystem by expanding water accessibility and addressing water scarcity availability and competition for water with different water users (Kadigi, 2006)**.**

4.5.3 Presence of protected areas (game reserves)

Protected area around lake Rukwa mostly are the major source of breeding ground for fish, however recently the practice of fishing season closure had impact in trend of biodiversity management and promote sustainability of fishing ground outside the protected areas, (Bucara*m et al*., 2018). In Lake Rukwa Valley there are three game reserves which are bordered by Lake Rukwa. Uwanda game reserve which is located to the south while Rukwa game reserve and Lukwati Piti game reserve are found to west of the lake. Increased pressure from livestock grazing, farming, and fishing had impact on wildlife but also economic activities which undertaken illegally in protected area by anticipating of high yields compared to other areas of land-use in the Lake Rukwa Valley (Kihwel*e et* al., 2021)**.**

4.5.4 Lake Rukwa

Lake Rukwa is an inland lake with alkaline turbidity water which is unclears due siltation, increase of the economic activities in steep slopes has impact on lake Rukwa as soil eroded and depositing sediments into water stream and transported to the destination (lakes) as sediment accumulation increases risk in resource utilization like fishing which support the livelihood of the adjacent families living near lake Rukwa and some fish are transported to other region and outside the countries (Gonzales, 2009). Most of the fish available in lake Rukwa are**,** **“***Poloki*”*,* “*Kachinga*”*,* and “*Ningu*”*,* tilapia *sp*, rukwaensis *sp,* etc (LBR, 2016). Although the economic importance of fish are underestimated when converted into monetary terms. This sector support large number of fishermen with

different workers in related fields, boats repairer and fish gears, fish processing, fish vendors, transport and food vendors. Lately has been a practice of illegal fish catch which disturbing breeding ground by fishing undersized fish due to decrease in fish stock.

Employment of Season closure advocate marine resource management and conservation. In lake Rukwa fishing ground around protected area (Uwanda and Rukwa game reserves has shown a greater ecological which benefits fisheries population than conservation purpose as the areas has been subjected to continuous fish exploitation (Cohen and Foale, 2013). Therefore, periodic closure are expected to build a greater stock in protected areas compared to partially protected areas. Employment of fish rotation model (season of closure and harvesting) in lake Rukwa will enable fish species with fast growing to achieve optimum biomass and recovery after long period of exploitation. Although this system of fishing closed season is a complex process which needs further studies (Balia*n et a*l., 2010;Cohen and Foale, 2013).

4.5.5 Availability of river for irrigation and power generation

Lake Rukwa Valley possess several river which can be used in generating energy, presence of seasonal and permanent river attract investors. There is potential Nzovwe River at Msia with capacity of generating 8MW; Chulu River at Nkwilo with a capacity of generating 1.165 MW, Kilambwa River at Kalumbaleza with a capacity of generating 1 MW while Luiche river at Uzia with a capacity of generating 0.1 MW **(**URT, 2016).

However presence of water for irrigation doesn't suffice the maximum water utilization as only 50% of the total potential land is under irrigation although most of the households depends in traditional irrigation schemes which covers about 78% of total irrigated crops. Looking at the surveyed data collected in the study area, they show there's different water

problems in Lake Rukwa valley. The following data indicates frequency and percentage of water related problems (Table 9).

Table 9: Water-related Problems in Lake Rukwa valley

Characteristic	Frequency	Percentage
Water piped inside the house	43	51.8
Water piped outside the house	11	13.3
Open well	14	16.9
Communal pump	22	26.5

In the study area visited, the household interviewed 47% depends on water available oustside their premise while 21% depends on community pump, those depends in river to obtain water were 13% and 10% depends on open well but 9% of the households have managed to be connected with tap water.

4.5.6 Population growth (people and livestock's)

4.5.6.1 Population increase

According to National Bureau of Statistic (URT, 2019) the population data of the country with a total people of 58 million, and a growth rate of 2.7 while in Rukwa region with a population of 1.27 million and the growth rate of 3.2 percent between 2002 and 2012. This data may provide the insight of the potentiality of the land resources as a results of land use and cover changes in the study area (Msigwa, 2018). Lake Rukwa Valley experiences the strong demographic growth of population between 1995s and 2020s as the ecological zone (Lake Rukwa Valley) host more than 53.15% of the total district population. Presence of off - farm employment opportunities, demand of high quality soil, demand of agricultural product, improvement of infrastructure to enable production, introduction of micro finance service at rural areas and distance to the market altogether

affect migration of population, (Angelsen and Kaimowitz, 2012). According to data collected during the survey conducted in the 2020 year, most of the population residing in Lake Rukwa Valley carrying out different economic activities (farming, livestock keeping, fishing, transportation, and other non-farm activities) has shown to arrive after the 1990s. Figure 18 shows the number of people who migrate in the study area.
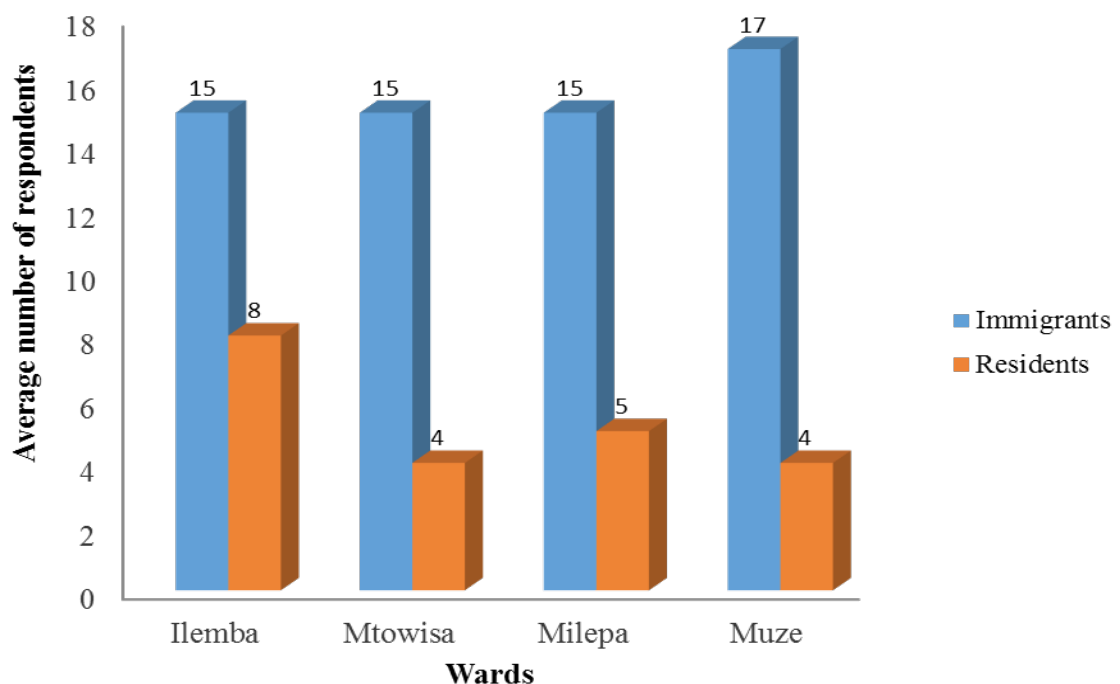
Figure 18: Average number of people migrate in the study area

4.5.6.2 Livestock population increases

In Rukwa region which characterized by agro past   oralist, who traditionally are known as crop/livestock owner who manage to keep indigenous zebu cattle, sheep, goat and other livestock like pigs and chicken (Edwin, 2007). The region possesses a number of domestic animals with a total of 691 258 cattle, 196 800 goats and 56 291 sheep; others were 40 711 pigs, 11 541 donkeys and 513 467 chickens (URT, 2020). This number has increased due to migration of agro pastoralist with their herd grouped between 200 and

300 in number from north west part of Tanzania to south west searching of water and pasture for their livestock after heavy drought in 1990s. Looking at the survey data collected in 2020s, the study area holds more than 7% of the regional total livestock population.

These agro pastoralist practicing farming activities using draft animal power and manure, the animal kept are used to store wealth and income. When the need arise are animal sold to meet family expenses (Samwel, 2017). Presence of large number of livestock are not used to create wealth through sales but stored as capital. Based in their taboo and culture, pastoralist had no tendency of harvesting animal to generate cash and bank but to exacerbate this culture, (Jora*m et al.,* 2017). Based in geographical location, natural barrier of Lake Tanganyika, Lake Rukwa and protected areas (PA), potential indigenous animal with good genetic merit and potential climate for livestock production. However, a wide range distribution of indigenous animals in the region and well adaptation to the environmental lead the Ministry of Livestock and Fisheries Development (MLFD) to establishment of a Foot and Mouth Disease free zone in Tanzania (Ngowi, 2007**;** Jora*m et* al*.,* 2017)**.**

4.5.7 Favourable climate

The Lake Rukwa Valley is situated in lowland area with plain and undulating hills, on western side is found Lyambalyamfipa escarpment with a number of Catchment River while on south part and eastern side lies Uwanda, Rukwa and Lukwati piti game reserves. The lake is fed by several permanent and seasonal rivers which flows downhill to Lake Rukwa. The mean annual rainy full ranging from 650 mm in the lowland and 2500 mm in high up the mountain which promote existence of miombo woodland with closed canopy while continuous utilization of abandoned agriculture land attract browsing

animal and leads conversion of grassland to woodland and vice versa which in turn causes vegetation dynamic (Mtui, 2017). The rainfall is unimodal which start from November to April while June and September there is no rain. The temperature varying depending in altitudes, it ranges from 12^0C in the high up the mountain and in lowland is 30^0C. The valley experience climatic variation which occurs in every 5 to 6 years with high rainfall and a years with low rainfall (URT, 2016).

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

The study findings carried out in Lake Rukwa Valley on socio-economic impact of land use and land cover changes indicates that, there is significant change in land-use and land-cover changes in Lake Rukwa Valley for the period since 1995 to 2020 as $p < 0.05$. Looking at the data collected during field survey indicates that, the number of household families who migrate in the study area and engaging in different socio-economic activities which includes farming, livestock keeping, fishing and other nonfarm activities. However market price has affected crop production, fishing activities and livestock keeping due to late delivery of farms inputs, includes improved seed supply, outbreak of armyworms in every growing season, poor roads (transport) and lack of proper storage and transport facilities.

The assessment on land- use cover practices carried out in Lake Rukwa Valley indicates that, with proper land utilization, well-organized and application of agronomic practices will reduce land deterioration and improve crop production in one hectare. However, utilization of land for crop production may reduce land expansion for agriculture and maintain the biodiversity of Lake Rukwa Valley. Apart from land management, involvement of stakeholder/communities in land use planning will enable them to practice the implementation as their involvement ensure of the ownership. Land use plan will set aside land for different land-user and reduce competition of resources. The intensive utilization of resources through production and limited to market information has limited the households to grow financially and hence poverty reduction due to poor roads.

5.2 Recommendation

The socio economic impact of land-use and land-cover changes in Lake Rukwa Valley have been affected by access to reliable markets, quantity and quality of timely delivery of subsidized farm inputs, poor transportation of produced goods, poor irrigation schemes and land rights. Based on result obtained during this study, I recommend the following should be done at the smallholder's farmers perspectives;-

- Further studies should be carried out on security of land right and contract farming and season fishing closure which assured them with good fish catch, market of produced goods through small and medium enterprises (SMEs) while doubling their efforts in production.
- On land-use cover practices the communities should be capacitated on security of land rights, i.e. land tenure system should be in place to ensure producers with freelance throughout the production season and practice agronomic activities which will ensure them maximum land resource utilization.
 - The determined land cover changes for the period of 1995s and 2020s indicates there is substantial changes in land resources utilization. Therefore famers, livestock keeper and fishermen must be supported and supplied with production inputs in time, quality and quantity to maximize production pathways and limit unsustainably utilization of resources.

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APPENDICES

Appendix 1: Household Questionnaires

Sample Questionnaire for Household Data in Lake Rukwa Valley

This questionnaire is to be filled by the head of the household

Part 1: Demographic Data

1. Date of interview………………………….

2. Start time … end time...............................

3. District …………… Village ……………. Kitongoji …………………..

4.1 Total Average number of family members …….. F………. M……… dependents……

      1.1.1   Average Adults in the family (working groups 16 – 60 years)

           ………………………………….

      1.1.2   Children < 16 years ……………………

      1.1.3   Disables …………………………………

      1.1.4   Elder people with age > 60 years

      1.1.5   Males ………………………………..

      1.1.6   Females………………………………….

      1.1.7   Male headed households ………………..

      1.1.8   Female headed households ……………

1.2   Level of Education

   a.   Illiterates …………………………………

   b.   Attended Primary Schools …………………….

   c.   Attended Secondary Schools …………………..

   d.   Other specify …………………………………..

1.3   Marital status

   a.   Married ………………………………….number of wife(S)………………………

   b.   Unmarried …………………………………………………………………………..

   c.   Widow…………………………………………………………………………………

   d.   Outmigration ………………………………………………………………………..

   e.   Separated …………………………………………………………………………...

   f.   Other specify ………………………………………………………………………….

1.4   Family/Households main economic activities

   a.   Farming …………………………………………………………………...……

b. Farming and livestock keeping …………………………………………….……

c. Livestock keeping ………………………………………………………………….

d. Fishing.………………………………………………………………………….…..

e. Farming and fishing ………………………………………………...……………

f. Farming, livestock keeping and fishing.……………………………………….……

g. Pit sawing ………………………………………………………………………..

h. Beekeeping …………………………………………………………………………..

i. Petty/commercial business …………………………………….………………..

j. Casual employment ………………………………………………….…………..……

k. Other specify …………………………………………………………….......……

Part 2: Socio Economic Data

2 Fisheries questionnaire

2.1 Do you belong to fisheries family i). YES ( ) ii). NO ( )

2.2 Do you have fishing license i) YES ( ) ii) NO ( )

2.3 Why joining fishing give reason a) Traditional ( ) b) Poverty ( )

c) Un employment ( ) and d) Job opportunity with low investment ( )

Do your children wish to join fishing? a). YES ( ) b). NO ( )

If the answer no what is the reason?

i. Irregular income source ( ) ii). Un respectfully Job ( ) iii). Religious factors ( )

iv). Risk factors ( ) v). Any other reason ( )

2.4 Number of household member working with you?

a. Only one ( ) b). Only two ( ) c). Not at all ( )

2.5 Number of fishermen working as group ………………

2.6 Number of boat which you are working with ………….

2.7 Total investment on fishing inputs a) Owned ( ) b). Borrowed ( )

If borrowed specify the name of institution rented you or granted loan ……………

2.8 Which season is favourable for fishing a) Summer ( ) b). Winter ( ) c). Rain season ( )

2.9 How many active fishing days (season) have been observed in a year?

a) Less than 120 days ( ) b). 120 – 210 days c). 210 – 276 days c). Any other specify ( )

2.10 Do you have any active days without catch? a) YES ( ) b) NO ( )

If yes how many days …………………………………………

2.11 Have you receive any Government assistance in fishing activities?

a) YES ( ) b). NO ( )

If yes which type of grant have you received?

a)   Gill nets ( ) b). Tents and boat ( ) c). Gill net and tents ( ) d). Close season relief funds ( )

2.12 Have you received any technical training on fishing a). YES ( ) b). NO ( )

If yes name the agencies which provide training

a.   Cooperative societies ( ) c). Non -Governmental Organization (NGOs) ( )

b.   Fisheries Department ( ) d). Any other specify ( )

2.13 Who is determining the price of fish?

a.   District council ( ) b). Fisheries Department ( ) c). Market ( )

2.14 Which method is used for determining the fish price?

a.   Forces of demand and supply ( ) c) Fisheries agent ( )

b.   On quality basis of fish ( ) d). Any other ( )

2.15 Are you satisfied with price fixation methods followed? a). YES ( ) b). NO ( )

If not, which method of price fixation do you want?..

2.16 Which of the marketing system of fish is commonly adopted?

a) Sale through co-operative ( ) c). Direct to local Market ( )

b) Direct to agents ( ) d). Partly in local market and partly cooperative ( )

e). Any others ( )

2.17 Do you encounter any problem like decay of fish? a). YES ( ) b). NO ( )

If yes: the loss is bear by?

a. Fishery Co-operative Society ( ) c). Fisheries Department ( )

b. Fishermen and Fishery Co-op. Society ( ) d). The District Council ( )

2.18 What is your monthly income earned through fishing?

a) Below Tshs. 100,000 ( )   b). Between Tshs. 100,000 – 350,000 ( )

c). Between Tshs. 350,000 to 500,000 d). Above Tshs. 500,000

b) Above Tshs. 5000 ( )

2.19 Are you satisfied earning through fishing is it sufficient?

a). YES ( ) b). NO ( )

If not, what is the subsidiary source of earning?

a) Agriculture ( ) c). Labour work ( )

b) Dairy farming ( ) d). Any other ( )

2.20 **Which variety of fish is of maximum demand throughout the year? Please specify two**

No	Variety	Remarks
1		
2		

The impact of fisheries on the socio economic development

No	Response	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
1	Help to eliminate poverty					
2	The industry increase individual income					
3	Have improve lifestyle					
4	Improve socio status					

3   Farmers/Pastoralist Questionnaire

3.1   Main crops grown in the villages (estimate the area grown by households)

l.   Maize…………..…………………(ha)

m. Beans ………………………………(ha)

n.   Paddy………….………………..(ha)

o.   Cassava……………..……………(ha)

p.   Simsim………………………………(ha)

q.   Finger millet………………………...(ha)

r.   Groundnuts…………………………(ha)

s.   Pumpkin ……………………………(ha)

t.   Sweet potatoes ……………..……….(ha)

3.2   Land Ownership

i.   Total land Owned ……… (ha)

Type of land	Approximate size of each piece of land				Underlying reason
	Now	10 years ago	20 year ago	30 years ago	
Homestead					
Inherited					
Private grazing					
Communal grazing					
Abandoned					

ii.   How do you evaluate trend of land changes over time

	Now/2018		10 years ago/ 2008		20 years ago/ 1998		30 years ago/ 1988	
	Area	Quality	Area	Quality	Area	Quality	Area	Quality
Crop land rain fed								
Cropland – irrigated								
Grazing land – communal								
Natural vegetation								
Fallow								
Abandoned								

iii.   What are the major factors that affect your decision related to land use or management in order of importance (explain)? And what is the difference in these factors between dry/wet/normal years?…………………………………………………………………………

iv.   Describe land lost on '(ii)'above or additional land gained during the last 30 years and associated factors?

…………………………………………………………………………………………

…………………………………………………………………………………………

Other……...…………………………………………………………………………

…………………………………………………………………………………………

v.   Soil and Water related issues

What are the major problems associated with water resources in your locality?

…………………………………………………………………………………………

…………………………………………………………………………………………

vi. Is land degradation a problem in your locality? Yes No

What type of land (land cover, topography, and soil type) is vulnerable to land

degradation (in order of vulnerability)?

Soil erosion: …………………………………………………………….....................

Gully formation: …………………………………………………………..................

Vegetation decline: …………………………………………………………............

Soil fertility decline: …………………………………………………………..........

Water stress: …………………………………………………………......................

Others, specify: …………………………………………………………..................

vii.   Are there external factors that are out of your control? Describe and explain while differentiating between:

Natural factors:…………………………………………………………………

Demographic factors:……………………………………………………………………………

Institutional factors, laws:…………………………………………………………………

Political factors, policies:………………………………………………………………….

viii.   **What kind of the livestock does the households owns**

Type	Number	Quantity
Cattle		
Goats		
Pigs		
Sheep		
Donkey		
Other		

ix.   What are your strategies during drought seasons or in case production failure?

……………………………………………………………………………………………

x.   Do you receive food aid and how much kilograms, if any?

……………………………………………………………………………………………

3.3 What kind of source of water do households use

No	Types	Remarks
1	Piped inside	
2	Piped outside	
3	Open well	
4	Communal pump	
5	Rain water tank (taping)	
6	River	
7	Other	

3.4 What was the land use type when you settled this place for the first time

No	Type	Remarks
1	Forest	
2	Agriculture	
3	Livestock keeping	
4	Fishing	
5	Other	

3.5 What causes shortage of food?

No	Causes	Remarks
1	Floods	
2	Droughts	
3	Pest	
4	Land shortage	
5	Poor land	
6	Shortage of seeds	
7	Shortage of labour	

3.6 Compare living conditions then and before the presence of this village

No	Item/variable	Better now	About the same	Better before	I don't know
1	Leadership				
2	Availability of land				
3	Distance from water sources				
4	Pasture				
5	Health care				

3.7   Where's is fuel wood obtained

a.   Forest reserves …………………………………..……………………..

b.   Natural forest in the public land …………………………………….….

c.   Natural tree left growing in the farms …………………………………….……

d.   Tree planted in the farms …………………………………………………….

e.   Tree grown in homes…………………………………………………...…….

f.   Villages woodlots …………………………………………………...…….

g.   Other…………………………………………………………………………

Part 3: Income and Expenditure Data Collection

Sources of cash income for the households (Tshs/year, months, season)

Sale of crops………………………………………..

Sale of domestic animals …………………………………

Petty/commercial business ……………………………….

Causal employment …………………………………………

Remittance from relatives……………………………………

Credit ………………………………………………………..

Other……………………………………………………….

Households expenditures (tshs/year, month, season)

Farm inputs……………………………………………….

Food purchase …………………………………………….

Other consumer products ………………………………….

Obligatory levies……………………………………………

Cut to payback subsidized farm inputs and credit …………….

Frequency of crop sales

Daily basis ………………………………………………………

Only when need for cash arises……………………………………

According to purchasing authority schedule…………………………

3.8 Based on availability of customer

3.9 Other specify ……………………………………………………

4   Non - farm income ……………………………………………

 a. Livestock selling…………………………………………………..

 b. Casual labour ……………………………………………………

 c. Borrowing from neighbour ……………………………………

 d. Stockbrokers/traders……………………………………………..

5   What kind of house do the households have (roofs of zinc, walls of cement, bricks, reeds; floors of cement, tiles or earth)?

House	Roof	Walls	Floor
1			
2			
3			

6   What type of lighting and heat source does the household use?

Type	
Charcoal	
Gas	
Biogas	
Paraffin	
Firewood	
Electricity	

7   How did you acquire land you cultivate

Type	Size (ha)	Remarks
Inherited		
Borrowed		
Given by the governments		
Bought		
Other		

Thank you for your valuable time and cooperation

Appendix 2: Checklist for guiding questions for focus group discussion

Dear sir/madam, I'm a master student from SUA dealing with land use and land cover changes and its socio economic impacts in Lake Rukwa valley. Please feel free to give the answer you can based on your knowledge. The information you are providing will be kept confidential according to research regulations of SUA.

1. Is your villages registered, if yes when? And if not why?
2. Do you know your village boundaries?
3. Do you face any problem in resource utilization and how you solve it?
4. What leads to land use changes in lake Rukwa valleys since 1988
5. Where is the most changes can be observed and why?
6. Which group or person responsible for those changes?
7. Do these changes brings conflicts over resources uses (water, land and pastures)
8. How these changes do affects resource uses?
9. What is the role of local Governments and NGOs in retaliating these changes
10. Is there any historical development of these areas
11. Do you experience any environmental changes or problems? (Tree cutting, overfishing, drought water shortage, unsustainable agriculture, over utilization of resources)?
12. What should be done to reverse these problems of land use changes?
13. Do these changes have any effects on land use changes?

Thank you for your valuable time and cooperation

Appendix 3: Checklist for guiding questions for district officers

1. Can you tell me about Lake Rukwa valley?

2. Do the all villages have been mapped?

3. Do they have land use plan, are they executing it?

4. Is there any NGOs or Agency supporting the district on natural resource management?

5. What is the status of land resources utilization in lake Rukwa valley?

6. Do the district councils involve resource allocation and utilization? If not which part of the governments responsible in land resource allocation?

7. What are the biggest challenges people face during resource utilization

8. Does resource utilization affects the communities and district at large

9. Livestock production over the last 30 years by the districts as shown below

   a. Cattle ……………………………………………………………………

   b. Sheep ……………………………………………………………………

   c. Goat……………………………………………………………………..

   d. Donkey ………………………………………………………………….

   e. Camel …………………………………………………………………..

10 Average crop Production levels with fertilizers for the past 30 years

   i. Maize……………………………………………………………..……………

   ii. Beans………………………………………………………………………..

   iii. Sunflower …………………………………………………………………..

   iv. Paddy …………………………………………………………………………

   v. Cassava …………………………………………………………..…………..

   vi. Simsim ……………………………………………………………………..

   vii. Finger millets …………………………………………………………..……….

11. Average crop Production levels without fertilizers for the past 30 years

   a. Maize……………………………………………………………..……………

   b. Beans………………………………………………………………………..

   c. Sunflower …………………………………………………………………..

   d. Paddy …………………………………………………………………………

   e. Cassava …………………………………………………………..…………..

   f. Simsim ……………………………………………………………………..

   g. Finger millets …………………………………………………………..……….

Thank you for your valuable time and cooperation